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An Assessment of Economic Considerations for Industrial Hemp Production

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An assessment of economic considerations for industrial hemp production

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Abstract

United States farm policy and programs are governed by the Farm Bill. The 2014 Farm Bill allows for the legal production and research of industrial hemp as long as it meets the standards outlined in the Farm Bill. Although it has a wide range of uses (upwards of 25,000 products use hemp), there is a lack of recent information regarding the economic feasibility of hemp production for the private agricultural sector. Through an extensive search of existing literature, information was gathered to construct an enterprise budget for industrial hemp. Data from the enterprise budget were used in a constrained linear programming model to compare how introducing industrial hemp production could change crop allocations in all 75 counties of Arkansas When industrial hemp was introduced, the total number of acres farmed increased by 2.8% to 4.4%, the statewide profit increased by 0.3% to 18.2%, and rice was the only crop that increased in acreage by 5%. While these results suggest that industrial hemp may be an economically promising crop, there are still hurdles to overcome. The lack of clearance (permitting) by the Drug Enforcement Agency and the absence of hemp processing facilities in the United States are clear roadblocks to hemp production. Once permitting hurdles are overcome, additional research will be needed to identify optimal locations for processing facilities and target markets for hemp goods.

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Meet the Student-Author

Luke Lane

I am from a very small town in southern Arkansas where baseball is king and hunting is the only other activity. I graduated as the valedictorian from Taylor High School in Taylor, Arkansas in 2013. I graduated Summa Cum Laude in May 2017 from the Dale Bumpers College of Agricultural, Food and Life Sciences with a degree in Agribusiness and a minor in Political Science with a concentration in pre-law. Throughout my undergraduate career I was active in Bumpers College activities and student organizations. I served for three years as an officer on the Agricultural Business Club executive team. I was the public relations officer for one year and the treasurer for two years. I served on the honors student board for three years. I was a member of the Southern Agricultural Economics Association and American Agricultural Economics Association quiz bowl teams. I have traveled from California to south Texas to Boston competing in agricultural quiz bowl and presenting research posters while representing the University of Arkansas.

During the summer of my junior year, I was awarded the Spitze Public Policy Legislative Internship Award allowing me to intern with Representative Rick Crawford in his Washington D.C. office. I married the love of my life in May 2017 shortly after graduating.

I would like to thank Jennie Popp for being the chairperson of my honors committee. She consistently went above and beyond the call of duty keeping me on track and making sure I was achieving my highest potential. Throughout the course of my undergraduate career, she became less of professor and more of a trusted mentor and friend.

Introduction

The omnibus agriculture Farm Bill, passed in 2014, allows producers in America to grow industrial hemp for research purposes; whereas, only universities could grow industrial hemp prior to its passage. The bill passed by the House of Representatives amends "the Controlled Substances Act to exclude industrial hemp from the definition of marijuana, and for other purposes" (House of Representatives, Bill 1778). 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).

The most recent legislation, Arkansas H.B. 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 and development of an Arkansas-specific seed, a licensing process, renewable energy production, and research of the potential of Arkansas-grown hemp in the world market.

Currently there is limited information, particularly in Arkansas, regarding the economic feasibility of producing and marketing industrial hemp as a commodity. 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.

Materials and Methods

This research was conducted in two parts. Using information from Roulac (1977) and Russell et al. (2015), first a spreadsheet-based industrial hemp production budget relevant to producers in Arkansas (thus using English units) was created. Best management practices were taken from Kaiser et al. (2015); Barta et al. (2013); Cochran et al. (2000); and Bocsa and Karus (1998). Default values for ownership charges of equipment were obtained from the Mississippi State Budget Generator (Laughlin and Spurlock, 2014) and input prices for fuel and fertilizer were taken from University of Arkansas System Division of Agriculture's Cooperative Extension Service enterprise budgets (Flanders et al., 2015). All dollar values were converted to 2016 real prices. The finished budget includes a breakdown of expected yields for fiber and seeds, expected variable and fixed costs, breakeven prices, and expected revenue as partially shown in Table 1.

Second, a constrained linear programming model of Arkansas row crops was modified to include industrial hemp to compare its profitability to competing crops produced in a county. Given historical crop acreage and irrigation constraints, the model solves for profit-maximizing land use choices. This means the model considers what grows well in the county and the expected yield of the crop in the county. The model calculates producer returns above total specified expenses (NR) to 15 crop, hay, and pasture land use choices for each of 75 counties in Arkansas as follows:

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

Subject to

$$x_{min_{ij}} \leq x_{ij} \leq x_{max_{ij}}$$
$$iacres_{min_i} \leq \Sigma\Sigma x_{ij} \leq iacres_{max_i} \ \forall \ irrigated \ x_j$$
$$acres_{min_i} \leq \Sigma\Sigma x_{ij} \leq acres_{max_i}$$

Table 1. Total specified expenses for industrial hemp fiber and seed production, 2016 dollars.

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	ton/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 ft	acre		2	9.15	18.30
Grain Drill	30 ft	acre		1	11.05	11.05
Seed		lbs		70	1.00	70.00
					Subtotal	184.31
Harvest			Oct			
Combine	25 ft	acre		1	23.65	23.65
Grain Cart	1000 bu	acre		1	1.77	1.77
Disc Mower	10 ft	acre		1	9.06	9.06
Hay Rake	8.5 ft	acre		2	5.78	11.56
Large Hay Square Baler	4 ft x 8 ft	acre		1	41.25	41.25
Sisal Twine		$/bale		3.08	1.00	3.08
Large Square Bale Stacker	16 bales	acre		1	4.98	4.98
					Subtotal	95.35
Operating Interest				1	4.75%	5.72
Total Specified Expenses						307.98

where p_j – 5-year averge Arkansas prices for different commodities except hemp [(National Agricultural Statistics Service (NASS)]; y_{ij} – 5-year average county crop yields (2011-2015); c_{ij} –UAEX county and crop-specific 2016 total specified costs; x_{ij} –choice variable describing what crop j to plant in which county i; $x_{\text{min/max}_{ij}}$–NASS reported min and max county acres by crop since 2000; $\text{iacres}_{\text{min/max}_i}$ – 1987-2012 census based county irrigation acreage restrictions; and $\text{acres}_{\text{min/max}_i}$ – 1987-2012 census based county total harvested acreage restrictions (USDA- NASS, 2016).

Note that hemp acreage was restricted to 25% of harvestable acreage to account for likely crop rotation restrictions. 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 as a function of yield-driven equipment speed (speed declines with higher yields and thereby raises labor, fuel and equipment charges per acre). With hemp yield indexed to non-irrigated corn, these changes in cost per acre as well as hemp fiber price drive model outcomes.

In the model, hemp price is modified by selecting from $25 to $75 per ton of fiber; whereas seed price was held constant at $0.33/lb. The average industrial hemp price per pound of processed fiber was $0.82 CDN (Canadian dollars) in 2014 for the Alberta Canada providence (Alberta Agriculture and Forestry, 2015). Industrial hemp seed 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.

Hemp seed and fiber (and all other crops in the model) are assumed to be sold free on board (F.O.B.) farm site in the model. As such, the prices modeled for fiber and hemp were lower than in the above-mentioned studies. Further, 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 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 (2000) 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 when contemplating a dual harvest system.

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 and thereby hemp fiber yields in the model.

Results and Discussion

As indicated above, the model was solved for acreage allocation to list crops using hemp fiber prices of $25/ton to $75/ton in $10 increments to determine changes in hemp acreage holding all else constant. At $45/ton for fiber, most row crops demonstrated better returns than non-irrigated industrial hemp (Table 2). Note, however, that the average profit per acre shown is not the same in each county as yields vary among counties. Hence as the price of hemp rises, lowest yielding and thereby least-profitable acreage of competing crops are diverted to 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 3.

Note that the price of hemp seed was held constant as it proved less volatile historically than hemp fiber prices. These model runs provide a spatial assessment of supply response to hemp fiber prices using the modeling assumptions presented above (Fig. 1).

The maps show the amount of industrial hemp grown in each county at different hemp fiber price levels. At $25/ton, it is first farmed in the Arkansas River Valley, central, timberlands, and the delta regions of Arkansas. As the price increases, there is more change in the Arkansas Delta region than anywhere else. Only the easternmost counties in the Ozark region produce industrial hemp. No industrial hemp is produced in the Ouachitas 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). All changes in crop acreage due to 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 crops not affected. The largest percentage decreases (<25%) in crop acreage occurred in non-irrigated cotton, non-irrigated soybeans, irrigated soybeans, and low-input hay acreage. The highest percentage change in crop acreage allocation at $25/ton of hemp fiber was a 12.9% drop in double-cropped soybeans. The total amount of acres harvested increased with the introduction of non-irrigated hemp, while the total amount of irrigated acres decreased.

The above analysis shows non-irrigated industrial hemp to compete well with other crops in Arkansas. Least profitable irrigated acreage was diverted to rice production when hemp was introduced and more of available crop land was used to grow industrial hemp given its favorable relative profitability when compared to the other crops using five-year average yields and prices. This is encouraging information that leads to a positive outlook for industrial hemp as a competitive cash crop in the state of Arkansas.

That said, industrial hemp sold at the farm gate is not yet processed. Hence, the next step is to research the market for a processing facility and everything that should be considered after the farm gate. This would include factors such as storage and transportation costs, and the possibility of trading industrial hemp futures and options.

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Table 2. Average (Avg.) cost of production and 2011-2015 National Agricultural Statistics Service average prices in 2016 dollars.

Crop	Price	Unit	Avg. Yield	TSE	Avg. Profit
Rice	11.8	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	-30.9
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	125.6	5.94
Pasture Cash Rent	18.5	acre	1.17	77.45	18.5
Low-input Hay	50.74	ton	1.61	76.56	5.26
Dry Industrial Hemp	45	ton	3.08	307.98	61.63

Note: cwt = hundred weight; bu = bushel. Average cost of production or total specified expenses (TSE) and estimated profitability per acre by crop for the model solution using $45/ton for hemp fiber. All dollar values are in constant 2016 Dollars. Cost of production pertains to 2016 whereas crop commodity prices and yields reflect 2011-2015 averages. Yields, TSE and profitability vary by county.

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Table 3. Crop production change in Arkansas after introduction of industrial hemp

	Baseline	% Change		
Hemp Fiber Price	**$0**	**$25**	**$45**	**$65**
State Profit (000’s $/yr)	1,002,522	0.30%	7.90%	18.20%
Acres (000s)				
Rice	1560	0.00%	5.00%	5.00%
Cotton				
Irrigated	313	0.00%	0.00%	0.00%
Non-irrigated	29	-7.20%	-53.80%	-53.80%
Corn	870	-0.40%	-1.30%	-1.30%
Soybean				
Irrigated	1422	-0.10%	-26.30%	-30.60%
Non-irrigated	336	0.00%	-38.20%	-38.20%
Double cropped	175	-12.90%	-12.90%	-12.90%
Sorghum				
Irrigated	81	0.00%	-13.10%	-13.10%
Non-irrigated	42	0.00%	-7.00%	-7.00%
Wheat	943	-1.10%	-15.00%	-31.20%
Hay	1252	-2.20%	-5.90%	-5.90%
Pasture	3914	0.00%	0.00%	0.00%
Low-input Hay	640	-3.70%	-64.50%	-64.50%
Dry Industrial Hemp (000s of acres)	-	326	1585	1800
Total Harvested	7821	2.80%	4.40%	4.40%
Total Irrigated	4391	-0.60%	-7.70%	-9.10%

Note: 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.

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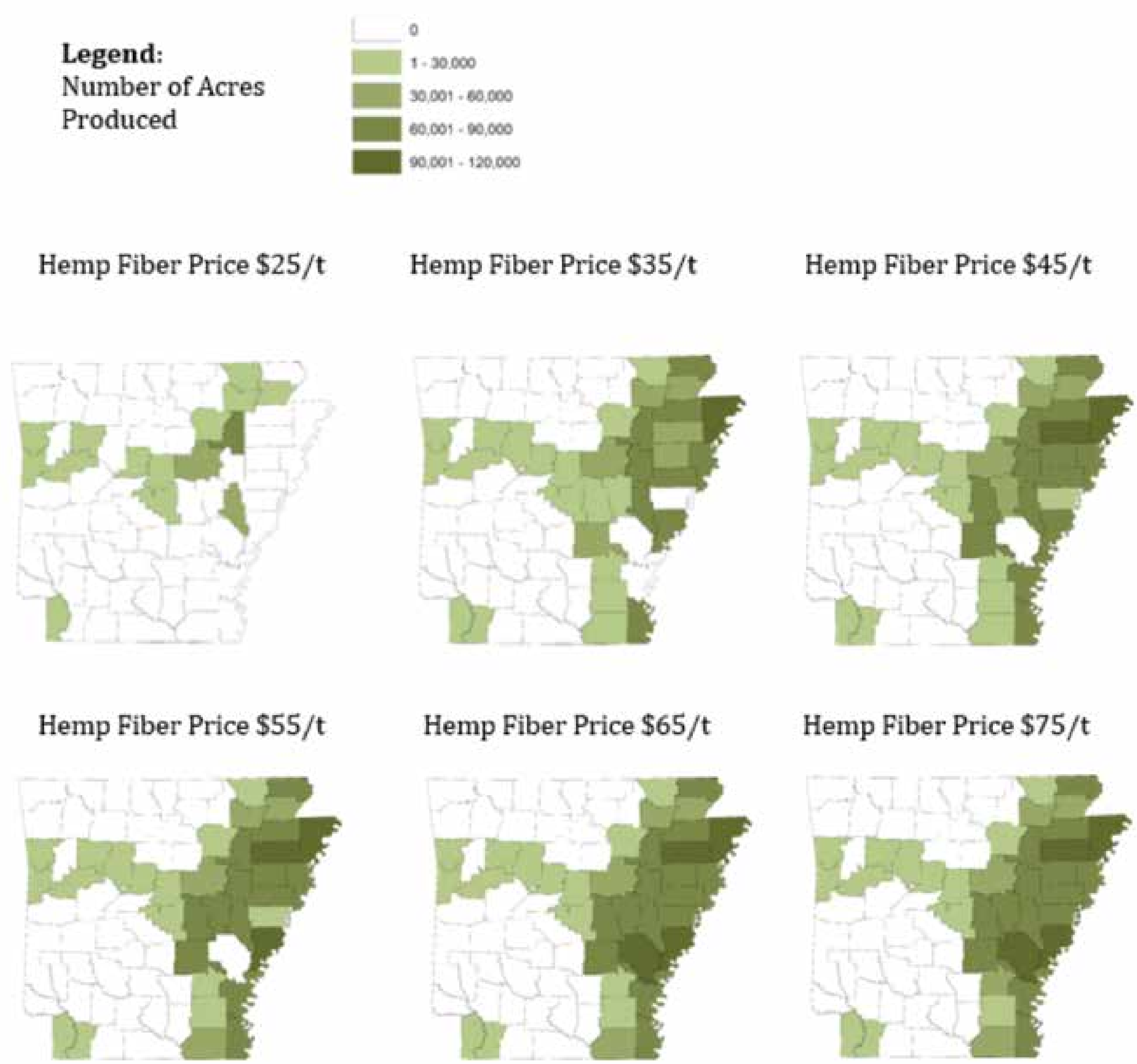

Fig. 1. Hemp production by county at various fiber prices.
Note: Hemp acreage by county at hemp fiber prices ranging from \$25 to \$75/ton and hemp seed price of \$0.33/lb. Seed yield is 700 lbs/acre. Fiber yield averages to 3.08 ton/acre once indexed to non-irrigated corn yield when the price of hemp fiber was set at \$45/ton.

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