Department of Agricultural and Resource Economics

2020 INDUSTRIAL HEMP EXTRACT BIOMASS (CBD) PRODUCTION BUDGET (1 Acre)

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This spreadsheet contains the 2020 University of Tennessee Industrial Hemp Extract Biomass (CBD) Production budget. Production systems vary tremendously in industrial hemp production, so producers are encouraged to modify practices, inputs and expenses to reflect their business. There are no protected cells in the spreadsheet, so the user should make sure that any changes made do not affect formulas. Any changes made on the "Industrial Hemp Extract Budget" will be reflected in the "Profit Matrix," where the total cost is utilized to determine the potential profit for several yield and price scenarios. This spreadsheet should not be considered representative of all circumstances and is provided as a template or guide that can be used to estimate production costs for planning purposes. Inputs, production practices and prices for inputs vary tremendously from county to county and farm to farm; as such, producers are encouraged to use their own inputs, input prices and cost structures for planning purposes.

Disclaimer: This budget does NOT imply any production recommendations. Significant variability in plant spacing, fertilization rate, irrigation, labor hours, drying and storage methods, and other input costs exist in the production of industrial hemp for extract. The information contained in this spreadsheet relies on assumptions and observations in Tennessee. The market and price of industrial hemp for extract is not well established, so extreme caution is recommended when evaluating price potential. The profit matrix estimates the profitability of industrial hemp extract production based on different yield and price projections. This budget should not be construed as a reflection of all circumstances across the state, as significant variability will occur. To improve accuracy, users are encouraged to use inputs, prices and processes that are utilized on their specific farms. Note that there is a large amount of uncertainty and unknown factors associated with hemp extract production, costs and markets; therefore, growers should do their own research and understand and manage their risk.

2020 Industrial Hemp Extract Production Budget (1 Acre)

REVENUE [1]	Description	Quantity	Unit	Total ($/acre)
	Projected Cannabidiol (CBD) % of Dry Matter	10%	% of dry matter	
	Price Per % CBD Oil (***Enter Your Price; Prices Vary***)	$0.75	$ per %	
	Total Plant Population (# of Transplants Per Acre)	1,500	transplants/acre	
	Percent of Transplants Marketed	81%	%	
	Average Dried Floral Material Per Plant (lbs)	1.20	lbs/plant	
	Total Harvested Dried Floral Material	1,458	lbs/acre	
	Other Revenue (government payments, by-products, etc.)	$0.00	$/acre	
Estimated Gross Revenue				**$10,935.00**

EXPENSES		Unit	Quantity (#/acre)	Price ($/unit)	Total ($/acre)
Variable Expenses					
Transplants [2]	Purchased	Transplants	1,500	$3.00	$4,500.00
Soil Test [3]	Soil Fertility Test	plot	1	$15.00	$15.00
	Heavy Metal	plot	1	$40.00	$40.00
	Pesticide Residue	plot	1	$190.00	$190.00
Fertilization [4]	Dolomite Lime - Spread	ton	1	$25.00	$25.00
	Nitrogen - N	lb	150	$0.42	$63.00
	Phosphorus - P	lb	60	$0.33	$19.80
	Potassium - K	lb	60	$0.32	$19.20
	Other	lb	0	$0.00	$0.00
Fertigation	Nitrogen - N	lb	0	$0.48	$0.00
	Other	lb	0	$0.00	$0.00
Weed/Disease/Insect Control	Chemical	acre	0	$0.00	$0.00
	Biological	acre	0	$0.00	$0.00
	Other	acre	0	$0.00	$0.00
Plastic Mulch [5]	Plastic Mulch	acre	0	$285.00	$0.00
Irrigation [6]	Drip Tape	acre	0	$156.00	$0.00
	Pumping Cost	hr	0	$2.14	$0.00
	Water Cost	1,000 gal	0	$3.00	$0.00
Machinery Costs [7]	Fuel, Operator Labor, Repair and Maintenance	ac	1	$253.30	$253.30
Other Processing Costs	Drying/Grinding/On-Farm Processing	ac	1	$0.00	$0.00
Storage [8]	Opportunity Cost of Storage	ac	1	$333.52	$333.52
Other Expenses [9]		acre	1	$0.00	$0.00
Nonoperator Labor Expense [10]					
	Preplant and Planting Labor	hrs	50	$12.40	$620.00
	In-season Labor	hrs	50	$12.40	$620.00
	Harvest Labor	hrs	100	$12.40	$1,240.00
	Postharvest Labor	hrs	175	$12.40	$2,170.00
	Management Labor	hrs	25	$15.00	$375.00
	Other Labor	hrs	0	$12.40	$0.00
Total Labor Expense		hrs	400		**$5,025.00**
Marketing and TDA Charges					
Pallet Boxes	Boxes and Plastic Cover	box	10	$22.50	$225.00
Transportation to Processor [11]	50 miles One-Way to Market	ac	1	$54.62	$54.62
License Fee [12]	Up to 5 acres	plot	1	$250.00	$250.00
Sampling Fee [13]	1 Variety	variety	1	$150.00	$150.00
Inspection Fee [14]		hr	2	$35.00	$70.00
Cannabinoid Test [15]		variety	1	$40.00	$40.00
Total Marketing and TDA Charges					**$789.62**
Interest [16]	Half of Specified Variable Expenses	$	$11,273.43	6.10%	$343.84
Total Variable Expenses					**$11,617.27**
Fixed Expenses					
Machinery [17]	Depreciation, Interest, Taxes, Insurance and Housing	ac	1	$49.32	$49.32
Irrigation System [18]	Capital Recovery	ac	0	$424.46	$0.00
Drying Barn [19]	Annual Lease	ac	1	$555.00	$555.00
Drying Materials [20]	Depreciation	ac	1	$50.00	$50.00
Land Rent [21]		ac	1	$95.00	$95.00
Total Fixed Expenses					**$749.32**
Total Expenses					**$12,366.59**
RETURNS OVER SPECIFIED EXPENSES					**-$1,431.59**

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FOOTNOTES

1) Prices and yields are estimates. Markets and prices have not been well established, so variability in price is likely. Prices may change dramatically between planting and harvest. The most common pricing methods are: 1) price is based on the percent of CBD oil, which is variety and environment dependent; 2) payment is based on sharing agreement between the grower and the processor; 3) payments are not made until processors sell the extracted oil. Discussions regarding processor requirements (minimum CBD percentage, production methods, and delivery and payment terms) are strongly advised prior to planting the crop. A floral dry matter yield of 1.2 lb per plant is assumed, based on an informal survey of hemp growers in April 2020; however, plant weights can vary. To modify revenue: number of transplants per acre, plant survival rate, pounds of floral material per plant, percentage of CBD oil in dry matter, and price can be modified to more accurately reflect individual circumstances. Payment timing, storage and delivery should be discussed with the processor to ensure sufficient cash reserves or operating credit is available.
2) Spacing: There are no recommendations on plant populations for industrial hemp. *The informal survey of hemp growers conducted by UT Extension indicated* planting rates ranged from a low of less than 600 plants/acre to a high of greater than 2,500 plants/acre, with the three most common planting rates for transplants being: 600-1,199 plants/ac; 1,200-1,799 plants/ac; and 1,800-2,399 plants/ac. Row spacing and number of plants per acre will be different based on production method and may affect disease, weed and insect infestation and per-acre expenses.
3) Soil testing is highly recommended for production of hemp for CBD extracts. A heavy metal test (arsenic, cadmium, lead, methyl mercury) should be performed on all production sites. Pesticide residue tests should be performed on the fields that may have contamination issues. Costs are surveyed from two labs that are commonly used by Tennessee hemp producers. Note that producers should consult with the buyer or processor on which lab to use and what tests need to be conducted. Additional fertilizers may be needed based on soil tests (substantial site variation exists).

4) Fields should be tested for fertility prior to planting. Currently, the University of Tennessee does not have fertility recommendations for hemp. Estimates are based on industry/expert opinions; however, substantial variation in fertilizer application rates and application methods exists. This budget assumes a preplant broadcast application and incorporation of N-P-K. Producers with the appropriate equipment may band the fertilizer or use fertigation (with application rates adjusted) as an alternative to broadcasting. Application of nitrogen should be distributed over multiple applications during the growing season. It is strongly recommended to consult a qualified agronomist to determine application timing and quantity of nitrogen applied per application during the growing season.

5) Based on UT Extension's informal survey of hemp growers, it was determined that only 22 percent of respondents used plastic mulch in 2019. Plastic mulch can help control weeds and maintain soil moisture. Additional chemical, manual and mechanical weed control may be required in non-mulch systems.

6) UT Extension's informal survey of hemp growers determined that less than half of respondents used irrigation in 2019. Irrigation can assist in controlling the growing environment and securing yield. Irrigation costs will vary based on water source, irrigation system, energy source, irrigation quantities and irrigation frequency. Irrigation costs are calculated based on irrigating one inch of water per week for eight weeks. A total of 96 hours will be needed to cover an acre. Cost of fuel per hour is surveyed from one Tennessee hemp grower. Water cost is not included; however, if county or municipal water is used for irrigation, prevailing water rates from the utility company should be included. The cost of establishing a water source (pond or well) is not included. Users should include these costs if it applies to them.
7) Variable machinery costs include estimates for fuel, operator labor, and repair and maintenance from Mississippi State University's budget generator. Machinery costs will vary based on existing farm resources and the equipment used. It is important to note that some labor requirements may be offset by mechanization. Additional machinery may be required based on site-specific characteristics. For example, depending on the condition of the planting site, plowing of the soil may be necessary. Disking alone to prepare the planting area, even with a tiller, may not be sufficient if no chemical weed control is available. Using irrigation or plastic mulch will increase machinery expenses.

8) Due to price uncertainty and lack of market access, producers should be prepared and budget for storing the crop for extended periods of time after harvest and drying. No UT recommendations are currently available for how to store hemp. Cost considerations for equipment and facilities plus carrying charges should be accounted for in individual budgets. The 2020 budget assumes storage costs equal to gross revenue multiplied by an annual interest rate of 6.1 percent for six months.
9) Other expenses may include security cost, insurance cost, etc. Growers should consider all the costs and risks involved with industrial hemp production. Producers should be aware of the huge amount of risks involved, from sourcing seed, production, to marketing. Federal crop insurance is available for hemp production. Additionally, several private insurance companies are offering programs for protecting growers from liability or natural disaster; however, the cost can be substantial. Consult with professionals before choosing any policy.

10) Labor: Production of industrial hemp extract can be very labor intensive. As such, securing sufficient labor for your operation's production methods and size is strongly advised. Preplant and planting labor will be contingent on plant populations, level of mechanization and the production/irrigation system utilized. In-season labor to control weeds and operate/maintain irrigation systems will depend on weed infestation and if irrigation is used. Harvest labor includes harvesting, transporting and hanging the crop. Postharvest labor includes on-farm processing (removal from the drying barn, removing leaves and floral material, bagging and preparation for transportation to the processor). Processing costs are not considered in the budget; however, vertically integrated operations should account for all costs. Management labor should be included. Labor is assumed to be the 2020 H2A rate in Tennessee: $12.40/hr.

11) Transportation costs will vary based on distance, gas mileage, cost of fuel and cost of labor. Transportation cost of $54.62 is calculated: (50 mile distance one way, 13 miles per gallon, $1.25/gallon fuel, 3 hours of labor, $15.00/hour).

12) License fee: See 2020 Tennessee Department of Agriculture Industrial Hemp Application guidelines. Fee for a grower license is based on planted acreage for production: $250 for less than 5 acres, $300 for 5 to 20 acres, and $350 for more than 20 acres. One-acre production is assumed in this budget. Growers should modify the license fee per acre if more than 1 acre is planted.

13) Sampling fee: TDA charges $150 per variety for the THC test preharvest, and the harvest material should contain no higher than 0.3 percent THC on a dry mass basis; if tested "hot" (over 0.3 percent), plants from the area sampled will be grounds for stop movement and destruction orders. If more than one variety is planted, growers should adjust the cost per acre.

14) Inspection fee: There are several inspectors working in different areas that are in charge of the compliant sampling process. They charge $35 per hour for the time spent traveling to the farm and collecting samples.

15) Cannabinoid Test: A cannabinoid test is needed when selling/delivering the dry floral material to the buyer, often a processor. Most growers get paid per CBD percentage per pound. Costs are surveyed from one lab that is commonly used by Tennessee hemp producers. Note that processors often require a minimum level of CBD content in the delivered product. If the tested result is lower than the minimum requirement, processors will not accept the product. Growers also reported that some processors require a yeast, mold and terpenes test, which will add $50 to the cost.

16) Operating interest is assumed to be charged on half of specified variable expenses at an interest rate of 6.1 percent.

17) Fixed machinery cost estimates include depreciation, interest, taxes, insurance and housing for specified pieces of equipment. Each operation will have different machinery lines available; as such, capital costs will vary tremendously. For producers entering hemp production with limited or no current machinery, alternatives such as leasing, custom hiring and barter should be fully explored to limit up-front capital requirements. Adding plastic mulch or irrigation will increase fixed machinery expenses.

18) Fixed irrigation expenses include depreciation and interest for the irrigation system (only applicable if irrigation is used).

19) Industrial hemp production requires access to drying facilities. Costs for lease expense or capital recovery for ownership should be considered. This budget assumes industrial hemp requires three to four times the space needed to dry 1 acre of tobacco (this will vary tremendously based on number of hemp plants per acre). Drying structures other than tobacco barns can be considered.

20) Drying material expenses include the capital recovery cost of tobacco sticks for hanging the harvested materials.

21) 2019 Tennessee State Average Cropland Cash Rents, as reported by USDA NASS, are used. However, rental rates are subject to local market conditions.

Hemp Extract Net Return Table ($/acre)

Price ($/lb) is determined by CBD percentage and price per percentage in dried floral material (leaves and flower). The mid-point price and yield will update with changes on the budget tab.

		Yield (lb/acre)										
		208	458	708	958	1,208	1,458	1,708	1,958	2,208	2,458	2,708
Price ($/lb)	-0.50	(12,471)	(12,596)	(12,721)	(12,846)	(12,971)	(13,096)	(13,221)	(13,346)	(13,471)	(13,596)	(13,721)
	0.50	(12,263)	(12,138)	(12,013)	(11,888)	(11,763)	(11,638)	(11,513)	(11,388)	(11,263)	(11,138)	(11,013)
	1.50	(12,055)	(11,680)	(11,305)	(10,930)	(10,555)	(10,180)	(9,805)	(9,430)	(9,055)	(8,680)	(8,305)
	2.50	(11,847)	(11,222)	(10,597)	(9,972)	(9,347)	(8,722)	(8,097)	(7,472)	(6,847)	(6,222)	(5,597)
	3.50	(11,639)	(10,764)	(9,889)	(9,014)	(8,139)	(7,264)	(6,389)	(5,514)	(4,639)	(3,764)	(2,889)
	4.50	(11,431)	(10,306)	(9,181)	(8,056)	(6,931)	(5,806)	(4,681)	(3,556)	(2,431)	(1,306)	(181)
	5.50	(11,223)	(9,848)	(8,473)	(7,098)	(5,723)	(4,348)	(2,973)	(1,598)	(223)	1,152	2,527
	6.50	(11,015)	(9,390)	(7,765)	(6,140)	(4,515)	(2,890)	(1,265)	360	1,985	3,610	5,235
	7.50	(10,807)	(8,932)	(7,057)	(5,182)	(3,307)	(1,432)	443	2,318	4,193	6,068	7,943
	8.50	(10,599)	(8,474)	(6,349)	(4,224)	(2,099)	26	2,151	4,276	6,401	8,526	10,651
	9.50	(10,391)	(8,016)	(5,641)	(3,266)	(891)	1,484	3,859	6,234	8,609	10,984	13,359
	10.50	(10,183)	(7,558)	(4,933)	(2,308)	317	2,942	5,567	8,192	10,817	13,442	16,067
	11.50	(9,975)	(7,100)	(4,225)	(1,350)	1,525	4,400	7,275	10,150	13,025	15,900	18,775
	12.50	(9,767)	(6,642)	(3,517)	(392)	2,733	5,858	8,983	12,108	15,233	18,358	21,483
	13.50	(9,559)	(6,184)	(2,809)	566	3,941	7,316	10,691	14,066	17,441	20,816	24,191
	14.50	(9,351)	(5,726)	(2,101)	1,524	5,149	8,774	12,399	16,024	19,649	23,274	26,899

***Disclaimer**: The total cost is utilized to determine the potential profit for several yield and price scenarios. The price of industrial hemp for extract is not well established, so extreme caution is recommended when evaluating price potential. This budget should not be construed as a reflection of all circumstances across the state, as significant variability will occur.

Machinery Operations and Irrigation Cost Estimates for Hemp Extract Production ($/Acre)

Machinery	Size	Purchase Price	Fixed	Repair & Maintenance	Fuel	Labor	Number of Passes	Variable	Fixed	Total
Disk/Tractor	5'/75 hp	$ 2,070/49,300	$ 3.06	$ 0.65	$ 2.86	$ 5.57	1	$ 9.08	$ 3.06	$ 12.14
Bed Shaper/Tractor	8'/75 hp	$ 4,280/49,300	$ 12.39	$ 3.42	$ 5.62	$ 19.32	1	$ 28.36	$ 12.39	$ 40.75
Planter - Transplanter/Tractor	1-R/75 hp	$ 2,820/49,300	$ 21.00	$ 1.79	$ 11.02	$ 70.83	1	$ 83.64	$ 21.00	$ 104.64
Utility Trailer/Tractor	10 ft/75 hp	$ 2,820/49,300	$ 2.69	$ 0.48	$ 2.77	$ 8.10	1	$ 11.35	$ 2.69	$ 14.04
BS Lay Tape/Tractor	8' center/75 hp	$ 4,590/49,300	$ 12.92	$ 3.61	$ 5.62	$ 10.92	1	$ 20.15	$ 12.92	$ 33.07
Plastic Layer/Tractor	8'/75 hp	$ 2,580/49,300	$ 9.46	$ 2.39	$ 5.62	$ 10.92	1	$ 18.93	$ 9.46	$ 28.39
Fertilizer Spreader/Tractor	6'/75 hp	$ 1,280/49,300	$ 0.81	$ 0.16	$ 0.58	$ 1.13	1	$ 1.87	$ 0.81	$ 2.68
Rotary Tiller/Tractor	5'/75 hp	$ 2,130/49,300	$ 9.37	$ 3.95	$ 6.74	$ 13.11	5	$ 119.00	$ 9.37	$ 128.37
Mulch Lifter/Tractor	1-R/75 hp	$ 2,230/49,300	$ 6.33	$ 0.75	$ 4.09	$ 7.96	1	$ 12.80	$ 6.33	$ 19.13
Total			$ 78.03	$ 6.34	$ 44.92	$ 147.86	-	$ 305.18	$ 78.03	$ 383.21

*Tractor and implement size will be dependent on the existing resources of the farm. Farms will have different machinery compliments and cost structures. The table above is an estimation based on the assumptions provided.

Irrigation System	Unit	Price	Quantity	$/acre
Fertigation System	each	$ 47.37	1	$ 47.37
Barb Lock Sleeve	1/4"	$ 0.54	30	$ 16.20
Transfer Barb	1/4"	$ 0.23	30	$ 6.90
Feeder Tube	ft	$ 0.11	50	$ 5.50
Header Line 1 1/2"	ft	$ 0.39	300	$ 117.00
Adapter (Reg to Head)	1 1/2"	$ 5.64	1	$ 5.64
End Plug for Header	1 1/2"	$ 3.77	1	$ 3.77
Hose Clamp	1 1/2"	$ 1.05	2	$ 2.10
Pressure Regulator	12 PSI	$ 41.60	1	$ 41.60
PVC Female Adaptor	1 1/2"	$ 5.64	1	$ 5.64
Y Filter	1"	$ 23.16	1	$ 23.16
PVC Fitting (bush)	1 1/2"	$ 3.37	1	$ 3.37
PVC Fitting (adpt)	1 1/2"	$ 2.08	1	$ 2.08
Hole Punch	1/4"	$ 4.68	1	$ 4.68
Coupler	5/8"	$ 0.58	4	$ 2.32
Pump (annual fixed)		$ 115.00	1	$ 115.00
Interest	5.50%	-	-	$ 22.13
Total		-	-	$ 424.46

Drip-tape irrigation system, 8-ft row spacing.

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