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Economics of Growing Hemp for Cannabidiol (CBD) in NYS: Expected Costs, Revenues and Returns for Three Hemp CBD Production Systems, 2022

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Funding provided by the New York Farm Viability Institute, Syracuse, NY.

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Please consider this work in progress. Comments and, or suggestions are welcome. Please contact the corresponding author, John Hanchar, jjh6@cornell.edu

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Summary

- Estimated variable costs of production per hemp plant equal $9.84, $9.64, and $4.42 for the greenhouse, high tunnel, and outdoor scenarios, respectively, while fixed costs per plant total $33.95, $9.36, and $0.26 for the three scenarios, respectively.
- Initial value of production (revenue) estimates equal $6 per plant, but value of production varies by output price and % point CBD per pound of plant material.
- Estimated returns above variable costs per plant equal negative $3.84, negative $3.64, and $1.78 for the greenhouse, high tunnel and outdoor hemp CBD production systems.

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Introduction

Currently in New York State (NYS), the economic viability of hemp production, processing, marketing and other activities for various end uses are subject to considerable risks and uncertainties – production, marketing, legal, human resources and financial (Pashow and Hanchar). The NYS Office of Cannabis Management (NYSOCM) is working to establish, clarify the legal framework, environment in which hemp industry firms will operate. Other work focuses on addressing other sources of risk and uncertainty.

As risks and uncertainties are addressed, industry firms will evaluate hemp enterprises for viability. What are the conditions for entry or exit? What enterprises, at what sizes make sense? For farm business owners, information needed to best understand the situation, and make decisions include the expected costs of production for various enterprises –fiber, grain, CBD,

multipurpose, and others. Information regarding optimal production systems and practices by end use will also help producers with decision making.

The purpose of this work is to estimate expected costs, revenues and returns for three hemp CBD production systems in NYS: greenhouse; high tunnel; and outdoors, where the outdoor scenario is similar to a horticultural setting for vegetable production. The work adds to previous analysis from NY (Hanchar and others), and to analyses from other states.

Methods

Selected methods, elements of the approach follow. The project team of Hanchar, Shelnutt, Vergara and Pashow

- Identified three hemp CBD production systems for analysis
    - green house
    - high tunnel
    - outdoor, land based, horticultural setting for vegetables, for example, tomatoes
- Established a time period for the analysis, transplant operation (including the cost, expense paid for transplants) through plant material hung to dry
- Collected and summarized resource use information by task, operation, input, including: machinery complement details, machinery performance, and costs; licensing, testing fees and other professional fees; transplant, growing season, harvest and drying operation costs (crop inputs, machinery, labor, fixed inputs)
- Described costs, revenues and returns using cost of production and enterprise budgeting concepts from agricultural economics and farm management (Kay)
- Developed costs estimates with sensitivity analysis using various workbook tools (Hanchar)
- Reported costs, revenues and returns with sensitivity analyses

Data

All project team members provided, gathered information for the above based upon completed and, or ongoing research, during Q&A type discussion sessions. In addition, project team member Vergara gathered information from farm business owners regarding production and harvest practices, costs and outputs.

Please see tables for assumptions, data and other information by production system. The Cornell University Hemp website is a primary source of practices, operations, input and other factors of production <https://hemp.cals.cornell.edu/>

Results

For the greenhouse production system, estimated value of production, variable input cost, total costs, and return above variable costs total $6.00, $9.84, $43.79 and negative $3.84, respectively

(Table 1). Sensitivity analysis suggests that 11 of 35 output price, % point CBD per pound of plant material combinations yield positive returns above total costs per plant (Table 2).

For the high tunnel production system, estimated value of production, total variable input cost, total cost, and return above variable costs total $6.00, $9.42, $18.78 and negative $3.42, respectively (Table 3). Sensitivity analysis suggests that 11 of 35 output price, % point CBD per pound of plant material combinations yield positive returns above total costs per plant (Table 4).

For the outdoor, vegetable type production system, estimated value of production, total variable input cost, total cost, and return above variable costs total $6.00, $4.22, $4.48 and $1.78, respectively (Table 5). Sensitivity analysis suggests that 23 of 35 output price, % point CBD per pound of plant material combinations yield positive returns above total costs per plant (Table 6).

Discussion

Total costs ($ per plant) totaled $44, $19, and about $5 for the greenhouse, high tunnel and outdoor settings, respectively. Fixed costs ($ per plant) accounted for 78, 50, and 0 percent of total costs for the greenhouse, high tunnel, and outdoor settings, respectively. Fixed costs for buildings, improvements, and mechanicals for the greenhouse and high tunnel settings accounted for the vast majority of total fixed costs.

Variable costs ($ per plant) represented 23, 50, and about 99 percent of total costs for the greenhouse, high tunnel, and outdoor settings, respectively. For all settings, labor, other crop inputs, and seeds & plants costs were the three largest $ per plant items. Labor costs were the single largest for each scenario, accounting for 46, 46, and 55 percent of total variable input costs ($ per plant) for the greenhouse, high tunnel, and outdoor production settings, respectively. Costs for the other crop inputs item were the second largest item for the greenhouse and high tunnel settings, and third largest for the outdoor setting, accounting for 38, 36, and 9 percent of total variable input costs ($ per plant) for the greenhouse, high tunnel, and outdoor scenarios, respectively. Seeds & plants costs were the third largest item for the greenhouse and high tunnel settings, and second largest for the outdoor setting, accounting for 12, 12, and 29 percent of total variable input costs ($ per plant) for the greenhouse, high tunnel, and outdoor scenarios, respectively. For all production systems, these three greatest variable cost items accounted for at least 93 percent of all total variable input costs ($ per plant).

Given methods and assumptions, estimates suggest that the outdoor setting generates the greatest return. However, a less favorable production risk and uncertainty environment likely is characteristic of the outdoor setting when compared to the indoor setttings. Risk and uncertainty are prominent aspects of growing hemp in New York. Sampling and testing fees – heavy metals, pesticide residues, THC and others – can be substantial over a growing season. Uncertainty regarding how fees will be assessed adds to their importance. Depending upon testing specifics, the outdoor setting in some situations will spread costs over a considerably greater number of plants compared to other settings. Lastly, labor costs are substantial for all settings with estimates equaling $4.49, $4.42, and $2.32 per plant for the greenhouse, high tunnel, and outdoor settings, respectively. Labor costs account for about 50 percent of total variable input costs for

all settings. Availability of labor resources of sufficient quantities and skill levels can be uncertain. Managing human resources risks helps to mitigate risks.

Citations

Cornell University Hemp (website). Ithaca, NY: Cornell University/CALS/School of Integrated Plant Science. Web address <https://hemp.cals.cornell.edu/>

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Kay, R. D. 1981. **FARM MANAGEMENT** PLANNING, CONTROL, AND IMPLEMENTATION. New York, NY: McGraw-Hill, Inc.

Pashow, L. and J. Hanchar. 2022. "NE Hemp Value Chain Participants Identify Priority Sources of Risk, and Discuss Risk Management Strategies." AgFocus. Batavia, NY: Cornell University/CALS & CCE/NWNY Dairy, Livestock and Field Crops Program. March issue, 2022.

Table 1. Estimated value of production (revenue), costs and returns, hemp CBD, greenhouse production system, NYS, 2022

Value of production (revenue), costs and returns for cannabis cbd, greenhouse setting, NYS, 2022.								
							30 ft (w) by 96 ft (l)	
						$ for structure	$ per sq. ft.	$ per plant
Value of Production (Revenue)								
hemp cbd						720	0.25	6.00
	$ per % pt CBD per lb		1	% pt CBD	6			
	lb biomass, plant mat		1					
Costs of Production								
Variable Inputs								
Fertilizer & Lime						14.52	0.01	0.12
Seeds & Plants						144.00	0.05	1.20
Sprays						6.19	0.00	0.05
Other Crop Inputs						448.52	0.16	3.74
Labor						538.64	0.19	4.49
Repairs & Maintenance								
Tractor						0.00	0.00	0.00
Equipment						0.00	0.00	0.00
Fuel & Lube						0.00	0.00	0.00
Interest on Operating Capital						28.80	0.01	0.24
Total Variable Inputs Costs								
						1180.67	0.41	9.84
Fixed Inputs								
Tractor						0.00	0.00	0.00
Equipment						0.00	0.00	0.00
Land charge						14.55	0.01	0.12
Buildings, improvements, and mechanical						4059.41	1.41	33.83
Value of Operator & Family Management								
Other Fixed Inputs						55.56	0.02	0.46
Total Fixed Input Costs								
						4073.95	1.41	33.95
Total Costs								
						5254.62	1.82	43.79
Returns								
	Value of Production (Revenue) less Costs of Variable I					-460.67	-0.16	-3.84
	Value of Production (Revenue) less Costs of Variable a					-4534.62	-1.57	-37.79

…

Selected Notes

1. Underlying the value of production (revenue) variables, price and quantities marketed, is the assumption that product(s) meet all required testing standards, for example, THC
2. All dollar values reflect spring 2022 price levels.
3. The greenhouse structure measures 30 ft (w) by 96 ft (l), its initial capital cost is about $29,000 for the structure, mechanical inputs, etc.

4. Plant density for the structure is 120 plants.
5. Fertilizer and lime requirements, production practices, input levels and other production factors per: Cornell University researchers, specialists <https://hemp.cals.cornell.edu/>; and information provided by cooperating growers.
6. Seeds and plants values reflect the following: price paid per seedling is $1.20; plant population for the structure is 120 plants.
7. Sprays expenses reflect use of a bio fungicide for an average year.
8. Testing requirements for hemp material, plant bed prep materials and supplies -- for example, grow bags -- account for the vast majority of the other crop input expense value.
9. Major sources of labor costs per structure are: pruning activities (12 person hours per growing season); harvest and post harvest tasks, excluding hanging of plants (8 hours per growing season); miscellaneous daily growing season tasks (5 person hours per growing season). Cost of labor is $17.50 per hour including wages, employer paid taxes, and others.
10. The annual charge for buildings, improvements and mechanicals includes depreciation, interest, repairs & maintenance, and insurance costs based upon the initial capital cost from note 3.

Table 2. Return above costs ($ per plant), hemp CBD, by output price by % point CBD per pound of plant material, greenhouse scenario, NYS, 2022

Return above variable costs ($ per plant) by ouput price by % point CBD per lb of plant m							
			% pt CBD per lb plant material				
	-3.84	2	4	6	8	10	
	0.5	-8.84	-7.84	-6.84	-5.84	-4.84	
$ per %	0.75	-8.34	-6.84	-5.34	-3.84	-2.34	
point CBD	1	-7.84	-5.84	-3.84	-1.84	0.16	
per lb of	1.25	-7.34	-4.84	-2.34	0.16	2.66	
biomass	1.5	-6.84	-3.84	-0.84	2.16	5.16	
	1.75	-6.34	-2.84	0.66	4.16	7.66	
	2	-5.84	-1.84	2.16	6.16	10.16	
Return above total costs ($ per plant) by ouput price by % point CBD per lb of plant mate							
			% pt CBD per lb plant material				
	-37.79	2	4	6	8	10	
$ per %	0.50	-42.79	-41.79	-40.79	-39.79	-38.79	
point CBD	0.75	-42.29	-40.79	-39.29	-37.79	-36.29	
per lb of	1	-41.79	-39.79	-37.79	-35.79	-33.79	
biomass	1.25	-41.29	-38.79	-36.29	-33.79	-31.29	
	1.5	-40.79	-37.79	-34.79	-31.79	-28.79	
	1.75	-40.29	-36.79	-33.29	-29.79	-26.29	
	2	-39.79	-35.79	-31.79	-27.79	-23.79	

… end greenhouse scenario

Table 3. Estimated value of production (revenue), costs and returns, hemp CBD, high tunnel production system, NYS, spring 2022

Value of Production (Revenue), Costs and Returns for Cannabis CBD, High Tunnel Production System, NYS, 2022								
							$	
						for structure	per sq. ft. undercover	per plant
Value of Production (Revenue)								
Hemp CBD						720	0.23	6
$/% point/lb		1	lbs of biomass/plant		1			
			% point cbd/lb		6			
Costs of Production								
Variable Inputs								
Fertilizer & Lime						14.52	0.00	0.12
Seeds & Plants						144.00	0.05	1.20
Sprays						6.19	0.00	0.05
Other crop inputs						416.36	0.13	3.47
Labor						529.96	0.17	4.42
Repairs & Maintenance								
Tractor						1.89	0.00	0.02
Equipment						4.03	0.00	0.03
Fuel & Lube						11.61	0.00	0.10
Interest on Operating Capital						28.21	0.01	0.24
Total Variable Inputs Costs								
						1156.77	0.37	9.64
Fixed Inputs								
Tractor						4.74	0.00	0.04
Equipment						4.03	0.00	0.03
Land charge						14.55	0.00	0.12
Buildings & improvements						1016.33	0.32	8.47
Value of Operator & Family Management						0.00	0.00	0.00
Other fixed inputs, costs						83.33	0.03	0.69
Total Fixed Input Costs								
						1122.98	0.35	9.36
Total Costs								
						2279.75	0.72	19.00
Returns								
	Value of Production minus Costs of Variable Inputs					-436.77	-0.14	-3.64
	Value of Production minus Costs of Variable & Fixed I					-1559.75	-0.49	-13.00

Selected Notes

1. Underlying the value of production (revenue) variables, price and quantities marketed, is the assumption that product(s) meet all required testing standards, for example, THC.
2. All dollar values reflect spring 2022 price levels.
3. The high tunnel structure measures 33 ft (w) by 96 ft (l), its initial capital cost is about $13,000 for structure, mechanical inputs, etc.
4. Plant density for the structure is 120 plants.
5. Fertilizer and lime requirements, production practices, input levels and other production factors per: Cornell University researchers, specialists <https://hemp.cals.cornell.edu/>; and information provided by cooperating growers.
6. Seeds and plants values reflect the following: price paid per seedling is $1.20; plant population for the structure is 120 plants.

7. Sprays expenses reflect use of a bio fungicide for an average year.
8. Testing requirements for hemp material, plant bed prep materials and supplies account for the vast majority of the other crop input expense value.
9. Major sources of labor costs are: transplanting activities (15 person hours for structure); growing season plant maintenance (5 person hours for structure); hand harvest, transport to storage, and plant hanging tasks (7 person hours for structure). Labor cost is $17.50 per hour including wages, employer paid taxes, and others.
10. Selected machinery and other mechanicals include: a walk behind roto tiller; 22 hp tractor with mowing deck for between row weed management; walk behind fertilizer spreader.
11. The annual charge for buildings and improvements includes depreciation, interest, repairs & maintenance, and insurance costs based upon the initial capital cost in note 3.

Table 4. Return above costs ($ per plant) by output price by % point CBD per pound of plant material, cannabis CBD, high tunnel, NYS, 2022

Return above variable costs ($/plant) by output price by % point CBD per lb of plant material, cannabis CBD, high tunnel, NYS, 2022						
			% point CBD per lb of plant material			
	-3.42	2	4	6	8	10
	0.5	-8.42	-7.42	-6.42	-5.42	-4.42
$ per %	0.75	-7.92	-6.42	-4.92	-3.42	-1.92
point CBD	1	-7.42	-5.42	-3.42	-1.42	0.58
per lb of	1.25	-6.92	-4.42	-1.92	0.58	3.08
biomass	1.5	-6.42	-3.42	-0.42	2.58	5.58
	1.75	-5.92	-2.42	1.08	4.58	8.08
	2	-5.42	-1.42	2.58	6.58	10.58
key assumption: biomass meets all required testing standards, e.g., THC						

Return above total costs ($ per plant) by output price by % point CBD per lb of plant material, cannabis CBD, high tunnel, NYS, 2022						
			% point CBD per lb of plant material			
	-12.78	2	4	6	8	10
	0.5	-17.78	-16.78	-15.78	-14.78	-13.78
$ per %	0.75	-17.28	-15.78	-14.28	-12.78	-11.28
point CBD	1	-16.78	-14.78	-12.78	-10.78	-8.78
per lb of	1.25	-16.28	-13.78	-11.28	-8.78	-6.28
biomass	1.5	-15.78	-12.78	-9.78	-6.78	-3.78
	1.75	-15.28	-11.78	-8.28	-4.78	-1.28
	2	-14.78	-10.78	-6.78	-2.78	1.22
key assumption: biomass meets all required testing standards, e.g., THC						

… end high tunnel scenario

Table 5. Estimated value of production (revenue), costs, and returns, hemp CBD, outdoor production setting, NYS, Spring 2022

Value of Production (Revenue), Costs and Returns, cannabis CBD, outdoor vegetable type productio								
						$ per acre	$ per sq.	$ per plant
Value of Production, Revenue								
cannabis CBD_price times quantity						9000	0.20661	6
output price ($ per % point CBD per lb material)					1			
% point CBD per lb material			6	lb mtrl/pl	1			
Costs of Production								
Variable Inputs								
Fertilizer & Lime						193.40	0.00	0.13
Seeds & Plants						1848.98	0.04	1.23
Sprays							0.00	0.00
Other Crop Inputs						538.09	0.01	0.36
Labor						3482.90	0.08	2.32
Repairs & Maintenance								
Tractor						10.92	0.00	0.01
Equipment						11.72	0.00	0.01
Fuel & Lube						84.56	0.00	0.06
Interest on Operating Capital						154.26	0.00	0.10
Total Variable Inputs Costs								
						6324.84	0.15	4.22
Fixed Inputs								
Tractor						77.97	0.00	0.05
Equipment						102.08	0.00	0.07
Land, buildings and improvements charge						200.00	0.00	0.13
Other fixed input chargs						16.67	0.00	0.01
Value of Operator & Family Management							0.00	0.00
Total Fixed Input Costs								
						396.71	0.01	0.26
Total Costs								
						6721.55	0.15	4.48
Returns								
	Value of Production less Costs of Variable Inputs					2675.16	0.06	1.78
	Value of Production less Costs of Variable and Fi					2278.45	0.05	1.52

Selected Notes

1. Underlying the value of production (revenue) variables, price and quantities marketed, is the assumption that product(s) meet all required testing standards, for example, THC.
2. All dollar values reflect spring 2022 price levels.
3. Plant density for the 1 acre unit is about 1,550 plants while plants harvested is about 1,500.
4. Fertilizer and lime requirements, production practices, input levels and other production factors per: Cornell University researchers, specialists <https://hemp.cals.cornell.edu/>; and information provided by cooperating growers.
5. Seeds and plants values reflect the following: price paid per seedling is $1.20; plant population is about 1550 plants; cost of seed for a cover crop is about $30 per acre.
6. Testing requirements for hemp material, plant bed prep materials and supplies account for the vast majority of the other crop input expense value.
7. Major sources of labor costs are: in season hand pruning activities (80 person hours for the 1 acre unit); hand harvest, transporting and post harvest activities excluding hanging of plants (38 person hours for the 1 acre unit); plant hanging tasks (60 person hours for the 1 acre unit). Labor cost is $17.50 per hour including wages, employer paid taxes, and others.
8. Selected machinery and other mechanicals include: 15 foot chisel plow with harrow; 10 foot prairie grass drill; boom sprayer; 12 foot offset disk; small tractor drawn dry manure spreader; water wheel planter; 5 foot rotary tiller; and tractor units of appropriate sizes for the machinery complement.
9. Fixed costs for tractors and equipment include depreciation, interest as an opportunity cost, taxes, and insurance.
10. An annual cash rent expense for irrigated crop land is used to estimate an annual charge for land.

Table 6. Returns above costs ($ per plant) by output price by % point CBD per pound of plant material, hemp CBD, outdoor production scenario, NYS, Spring 2022

Return above variable costs ($ per plant) by output price by % point CBD per lb of plant m							
			% point CBD per lb of plant material				
	1.78	2	4	6	8	10	
	0.5	-3.22	-2.22	-1.22	-0.22	0.78	
$ per %	0.75	-2.72	-1.22	0.28	1.78	3.28	
point CBD	1	-2.22	-0.22	1.78	3.78	5.78	
per lb of	1.25	-1.72	0.78	3.28	5.78	8.28	
biomass	1.5	-1.22	1.78	4.78	7.78	10.78	
	1.75	-0.72	2.78	6.28	9.78	13.28	
	2	-0.22	3.78	7.78	11.78	15.78	
Return above total costs ($ per plant) by output price by % point CBD per lb							
of plant material, outdoor scenario, NYS, 2022							
			% point CBD per lb of plant material				
	1.52	2	4	6	8	10	
	0.5	-3.48	-2.48	-1.48	-0.48	0.52	
$ per %	0.75	-2.98	-1.48	0.02	1.52	3.02	
point CBD	1	-2.48	-0.48	1.52	3.52	5.52	
per lb of	1.25	-1.98	0.52	3.02	5.52	8.02	
biomass	1.5	-1.48	1.52	4.52	7.52	10.52	
	1.75	-0.98	2.52	6.02	9.52	13.02	
	2	-0.48	3.52	7.52	11.52	15.52	
key assumption: biomass meets all required testing standards, e.g., THC							

… end outdoor production scenario