Commercial Aquaponics Case Study #3: Economic Analysis of the University of the Virgin Islands Commercial Aquaponics System
AEC 2015-18

This case study is the third of a series of three total case studies that analyzes the economics behind three different commercial aquaponics systems. Each case study will be released in this draft form to make the information available. The final report for this project will include the information from these three case studies, an overall analysis, and the summary of a commercial aquaponics industry survey.

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Introduction to the UVI Agricultural Experiment Station & Background Info

The University of the Virgin Islands' Agricultural Experiment Station is located in beautiful St. Croix of the U.S. Virgin Islands. This is where the world renowned commercial-scale aquaponics system developed by the University of the Virgin Islands remains. Years of information and data have been collected while operating this system, which was used as the basis for this updated economic analysis of the original UVI commercial aquaponics system.

UVI Aquaponic System Configuration

The Deep Water Culture system at UVI is one that has evolved from decades of research. What began as a small system with barrels has evolved into a commercial production system that is adaptable and replicable. It consists of four fish rearing tanks, two clarifiers, four net filter tanks, one degassing tank, six hydroponic beds, a sump, and a base addition tank. However, UVI has conducted research that proves swirl separators can replace clarifiers in their system. Therefore, this study will assume that swirl separators will replace clarifiers in the UVI system. The system configuration and tank dimensions are illustrated in Figure 1 and Figure 2 below.

Figure 1: UVI Aquaponic System Configuration

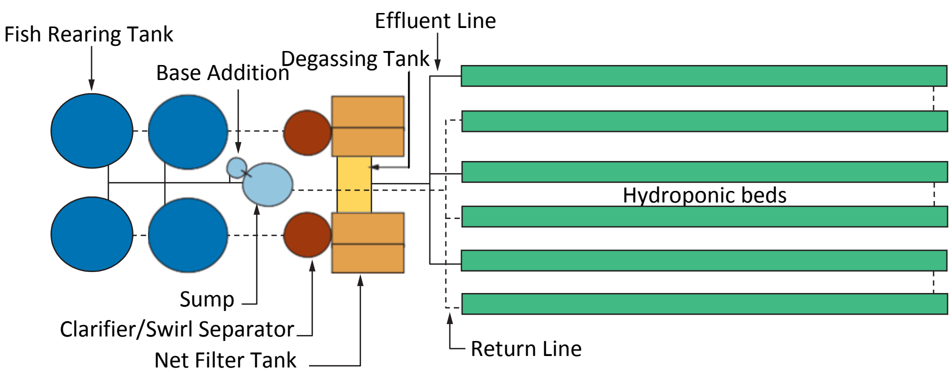

Figure 2: Tank Dimensions & Summary

Tank	Diameter	Height	Water Volume	Cone Depth	Slope
Rearing tanks	10 ft	4 ft	2,060 gal	N/A	N/A
Sump	4 ft	3 ft	160 gal	N/A	N/A
Base addition tank	2 ft	3 ft	50 gal	N/A	N/A
Swirl Separators	4 ft	77 in	493 gal	N/A	N/A

Tank	Length	Width	Depth	Water Volume
Filter tanks	6 ft	2.5 ft	2 ft	185 gal
Degassing tank	6 ft	2.5 ft	2 ft	185 gal
Hydroponic tanks	100 ft	4 ft	16 in	3,000 gal

Total system water volume: 29,000 gallons
Total hydroponic plant growing area: 2,300 ft^2
Flow rate: 100 GPM

Water Pump: ½ hp
Blower: 1½ hp (fish) 2 hp (plants)
Total Land Area: 1/8th Acre

The UVI aquaponic system only requires one eighth of an acre of land and it can contain as much as 29,000 gallons of water. Water first flows from fish rearing tanks to the swirl separators. Water exits the swirl separators, flows through the net filter tanks, and then combines in the degassing tank. From the degassing tank, water flows out to three of the hydroponic beds. Once water flows through these hydroponic beds, it enters the other hydroponic bed it is paired with, and then finally flows by gravity back to the sump. Water from the sump is ultimately pumped by a ½ hp water pump back into the fish rearing tanks, and then the water cycle continues.

Aquaponic System Construction

The aquaculture component of the UVI system requires four fish rearing tanks, two swirl separators, four net tanks, one degassing tank, one sump, and one base addition tank. The dimensions, prices, and other information about these components of the UVI System can be found in Table 1.

Table 1: UVI Aquaponic System Tanks

Quantity	Size	Item	Purpose	Supplier	Modification	Influent water	Efluent water	Unit Price	Total Price
4	4' high x10' diameter	circular tank	fish production tank	Red Ewald FCT-2350 2350 gal http://www.redewald.com/	4" PVC female adapter coupling as drain in center bottom. Coupling is fiberglassed to outside tank bottom with threaded end flush to inside bottom of tank.	sump	center drain to clarifier - 4" pipe	$ 2,155.00	$ 8,620.00
2	6'5" high x 4' diameter cylindrical swirl separator	swirl separator	swirl separator solids removal	W. Lim Wave-48 Vortex Body and Cover http://wlimproducts.com/vortex-filter.htm		fish tanks (2 tanks supply water to 1 swirl separator)	one pipe connecting to net tank - 4" pipe	$ 1,000.00	$ 2,000.00
4	6' long x 2.5' wide x 2.5' high	rectangular tank	net tank for fine solids removal	Red Ewald FRT-28 280 gallons	install PVC sheet as baffle in center to divide tank into 2 chambers. Cut 6" opening in one end of baffle for water flow between tanks. Each section has 3" drain on bottom for sludge removal.	clarifier	degassing tank - 4" diameter pipe	$ 805.00	$ 3,220.00
1	6' long x 2.5' wide x 2.5' high	rectangular tank	degassing tank	Red Ewald FRT-28 280 gallons	cut 6" holes in bottom and install stand pipe connecting to hydroponic tank.	net tank	hydroponic tanks - 6" pipe	$ 805.00	$ 805.00
1	4' high x 4' diameter	circular tank	sump	Red Ewald FCT-235 235 gal	incoming pipe from hydroponic tank and outgoing pipe to pump/fish production tanks.	hydroponic tank	fish tank - 3" pipe	$ 415.00	$ 415.00
1	1.5' high x 2' diameter	circular tank	base addition	Red Ewald FCT-30	incoming pipe from pump/rearing tank supply line and outgoing pipe to sump	pump sidestream	sump	$ 110.00	$ 110.00
								Total	$ 15,170.00

The hydroponic component of the UVI system requires six hydroponic raceway-style growing beds. Each hydroponic bed is 4 ft wide by 100 ft long. The walls of these raceways are poured concrete walls that are covered by a low density polyethylene (LDPE) liner. Once filled with water, each raceway needs 12 Styrofoam rafts that are 4 ft wide by 8 ft long for growing horticultural products. The dimensions, prices, and other information about these components of the UVI System can be found in the Table 2.

Table 2: Hydroponic Raceway, Liner, and Raft

Quantity	Size	Item	Purpose	Modification	Influent water	Efluent water	Price Each	Total
6	4' wide x 100' long x 16" high	poured concrete 6" wall 5.2 cubic yds. @ $150/yd	hydroponic tank	line with 9' x 106' P2000 LDPE 23 mil. Fit with 6" flange between tanks and to sump.	degassing tank	sump - 6" pipe	$ 1,000.00	$ 6,889.15
1	12' x 750' LDPE liner	Inland Plastics Ltd. Hydroponic tank liner					$ 1,890.00	$ 2,170.08
72	1.5" x 4' x 8' Styrofoam square edge Extruded Polystyrene Insulation	Dow Chemical Co. Hydroponic raft					$ 31.00	$ 2,562.76
		Shipping		$1500 total allocated across above items				
							Total	$11,622.00

The UVI aquaponic system requires two air blowers for aeration and a single water pump for water circulation. The water pump is the only pump required for water circulation throughout the system because the rest of the system utilizes gravity. This water pump simply lifts water from the sump into the fish rearing tanks. The two air blowers circulate oxygen throughout the fish rearing tanks and hydroponic beds separately. The two blowers send air through heat diffusers and then through air hoses, which ultimately deliver oxygen into the system using submerged air stones. One of the air blowers circulates air throughout the fish rearing tanks, while the other blower circulates air throughout the hydroponic beds, providing oxygen for the fish and plants. Air stones are scattered throughout the fish rearing tanks and hydroponic beds in order to maintain proper oxygen levels throughout the entire system. Table 3 displays information about the blowers and the water pump.

Table 3: Air Blower and Water Pump

Quantity	Size	Item	Item code	Unit price	Total Cost
1	1.5 HP	Air Blower Sweetwater 1 Phase		$ 739.00	$ 739.00
1	2 HP	Air Blower Sweetwater 3 Phase		$ 797.00	$ 797.00
1	.5 HP	Circulating Pump Grundfos 3 Phase	UMC 80-80 or similar	$1,268.10	$1,268.10
				Total	**$2,804.10**

Many other parts and materials are required for the construction of this system, including many PVC pipes and parts. All of these parts and materials have different uses and purposes. Tables 4 and 5 list all of the other miscellaneous parts that are needed for constructing this aquaponic system, as well as other specific information such as estimated cost, sizes and specifications, uses, and item code numbers. These prices have all been updated, as of 2014, and are estimated as accurately as possible by finding actual price points from manufacturers and distributors that UVI has used.

In total, it is expected that those seeking to replicate this system will need to allocate about $1,300 towards PVC parts alone. The breakdown of these parts and prices can be seen in the table below. These prices can vary depending on factors such as where you purchase materials, the quality of the materials, and the size of the pipes and parts. PVC parts can easily more than double in cost when using 6" as opposed to 4" PVC parts. For example, the above 6" 90º elbow costs $24.81 whereas a 4" 90º elbow only costs $7.80; which is more than 3 times the cost.

However, it is commonly believed that having larger sized pipes prevents maintenance issues such as clogged pipes. There are many tradeoffs and difficult decisions that must be made when building these systems. Although you may save a lot of money buying 3" pipes for the entire system, it may end up being a poor decision in the long run. It is very important to carefully consider all implications in both the long run and the short term when making key decisions such as purchasing materials.

Table 4: PVC Parts with UPC & Estimated Cost

Quantity	Size	Item	Item code	Unit price	Total Cost
2	6"	cap	447060	$ 10.24	$ 20.48
12	6"	pipe flange SCH 80 solid type FIPT	851060 (28165 USPlastic)	$ 21.32	$ 255.84
18	6"	90º elbow	406060	$ 24.81	$ 446.58
2	6"	T	401060	$ 34.19	$ 68.38
3	6"	flexible coupling (fernco)	*1056-66	$ 12.07	$ 36.21
2	4"	cap	447040	$ 4.28	$ 8.56
4	4"	male coupling	436040	$ 3.71	$ 14.84
4	4"	female coupling	435040	$ 3.88	$ 15.52
4	4"	45º elbow coupling	417040	$ 10.16	$ 40.64
16	4"	90º elbow coupling	406040	$ 7.80	$ 124.80
1	3/4" MPT	float valve	*R7003	$ 26.45	$ 26.45
3	3/4"	female adapter	435007	$ 0.25	$ 0.75
1	3/4"	water meter	*FM2	$ 69.93	$ 69.93
1	3" x 2"	reducer bushing	437338	$ 1.87	$ 1.87
4	3"	cap	447030	$ 1.88	$ 7.52
4	3"	coupling	429030	$ 2.17	$ 8.68
1	3"	4 way cross	420030	$ 7.96	$ 7.96
11	3"	90º elbow	406030	$ 4.36	$ 47.96
7	3"	T	401030	$ 5.62	$ 39.34
4	2" x 1"	reducer bushing spig x fipt	438249	$ 1.11	$ 4.44
6	2" x 1"	reducer bushing spig x soc	437249	$ 0.79	$ 4.74

1	2"	cap	447020	$ 0.55	$ 0.55
2	2"	male adapter	436020	$ 0.68	$ 1.36
2	2"	female adapter	435020	$ 0.69	$ 1.38
4	2"	45º elbow	417020	$ 1.41	$ 5.64
21	2"	90º elbow	406020	$ 1.19	$ 24.99
1	2"	T	420020	$ 3.07	$ 3.07
7	2"	T	401020	$ 1.30	$ 9.10
2	1"	male adapter	436010	$ 0.32	$ 0.64
6	1"	female adapter	435010	$ 0.29	$ 1.74
4	1"	poly plug	*114-C	$ 1.85	$ 7.40
4	1"	T poly hose nipple	*107-C	$ 1.77	$ 7.08
4	1"	90º elbow poly hose nipple	*105-C	$ 1.79	$ 7.16
8	1"	male threaded poly hose adapter nipple	*103-C	$ 0.70	$ 5.60
			Total		**$1,327.20**

It is estimated that the other parts and materials required to build the UVI system will cost a total of approximately $7,500. The breakdown of these parts and prices can be viewed in the Table 5. Again, those seeking to replicate this system may experience varying costs for materials. There are many factors that will ultimately determine what price points will be experienced. The cost of these materials can add up quickly so it is important to try to find ways to reduce the cost of accessing these materials.

Table 5: Other Parts & Materials with UPC & Estimated Cost

Quantity	Size	Item	Item code	Unit price	Unit price	Total Cost
4	3"	ball valves	F01300S	to regulate flow to rearing tanks	$ 45.87	$ 183.48
1	2"	ball valve		supply water to base addition tank	$ 12.04	$ 12.04
1	2"	4 way cross	420020	fish air distribution system	$ 6.02	$ 6.02
4	2"	ball valve		fish air distribution system	$ 12.04	$ 48.16
725	ft. 1"	poly tube		fish air distribution system	$ 0.24	$ 175.76
2	3"	toilet flange		sludge collecting and net tank drain	$ 5.00	$ 10.00
2	6"	cap	448060	sludge collecting and net tank drain	$ 10.24	$ 20.48
2	5 gallon	bucket		sludge collection from clarifiers	$ 5.00	$ 10.00
2	2"	ball valve		sludge collection from clarifiers	$ 12.04	$ 24.08
4	14' x 100'	orchard netting		solids trap	$ 62.10	$ 248.40
8	1" x 2" x 7'	ceder wood slats		fry screen	$ 5.00	$ 40.00
16	4" x 4"	flat angle braces		fry screen	$ 1.00	$ 16.00
8	yards 1000 micron	nylon net material		fry screen	$ 18.47	$ 147.76
10	ft. 3/4"	plastic mesh screen (vexar)		screening pipes	$ 4.75	$ 47.50
3	sheets 3/8" x 4' x 8'	PVC sheet		cut from PVC sheet - to connect hydroponic pipe to liner	$ 40.00	$ 120.00
50	2" x #8	stainless steel screws		to attach donut to pipe flange	$ 0.50	$ 25.00
176	6" x 1.5"	airstones	AS15L	aquaculture airstones	$ 6.20	$1,091.20
88	1/4" x 3/8"	nipples	62008		$ 0.30	$ 26.40
4	3/8" i.d.	vinyl hose	TV60		$ 18.45	$ 73.80
150	3" x 1"	airstones	AS5L	hydroponic airstones	$ 2.97	$ 445.50
150	1/4" NPT x 1/4" barb	nipples	62006		$ 0.30	$ 45.00
6	1/4" i.d.	vinyl hose	TV40		$ 25.27	$ 151.62
6	tube	silicone			$ 5.00	$ 30.00
8	gallon	fiberglass resin and hardner			$ 20.00	$ 160.00
10		fiberglass mat			$ 10.00	$ 100.00
10		paper buckets -disposable			$ 1.00	$ 10.00
10		paint brushes - disposable			$ 1.00	$ 10.00
50		latex gloves - disposable			$ 0.50	$ 25.00
10		dust mask - disposable			$ 2.00	$ 20.00
1	organic vapor	vapor mask			$ 25.00	$ 25.00
3	1"	ball valve (slip x slip)		hydroponic air distribution	$ 3.20	$ 9.60
1	48'x30'	Quonsset greenhouse			$2,000.00	$2,000.00
1	48'x47'	100% shade cloth			$ 500.00	$ 500.00
120	6"	PVC pipe			$ 4.00	$ 480.00

80	4"	PVC pipe			$ 4.00	$ 320.00
100	3"	PVC pipe			$ 4.00	$ 400.00
120	2"	PVC pipe			$ 4.00	$ 480.00
10	1"	PVC pipe			$ 4.00	$ 40.00
					Total	**$7,577.80**

Table 6 explains the purpose of all the aforementioned parts and materials. As you can see, each item has a very specific purpose for the UVI system.

Table 6: Purpose of Parts & Materials Needed for Assembly of UVI Aquaponic System

Quantity	Size	Item	Item code	Purpose
4	4"	male coupling	436040	adapt for screen sock in rearing tank bottom
4	4"	female coupling	435040	fiberglass to bottom of each rearing tank
12	4"	90º elbow coupling	406040	connect rearing tanks to swirl filter
4	4"	45º elbow coupling	417040	inside clarifier, drains to net tank
4	4"	90º elbow coupling	406040	regulate water level in swirl filter/direct water down in net tank
2	4" x 6"	pipe		connect swirl filter to first net tank
6	6" x 18"	pipe		connect 2 net tanks
2	4" x 6"	pipe		connect net tank to degassing tank
3	6"	flexable coupling (fernco)	*1056-66	regulate water level in degassing tank
3	6"	pipe flange	851060	to connect degassing discharge pipe and support
9	6"	90º elbow	406060	connect degassing tank to hydroponic tank
9	6"	pipe flange	851060	to connect hydroponic pipe to liner
6	6"	90º elbow	406060	connect hydroponic tanks together
3	6"	90º elbow	406060	connect hydroponic tank to sump
2	6"	T	401060	connect hydroponic tank to sump
1	3"	T	401030	to connect pump to rearing tanks
10	3"	90º elbow	406030	to connect pump to rearing tanks
1	3"	4 way cross	420030	to connect pump to rearing tanks
4	3"	ball valves		to regulate flow to rearing tanks
1	3"	T	401030	supply water to base addition tank
1	3" x 2"	reducer bushing	437338	supply water to base addition tank
3	2"	90º elbow	406020	supply water to base addition tank
2	2"	male adapter	436020	supply water to base addition tank
2	2"	female adapter	435030	supply water to base addition tank
1	2"	ball valve		supply water to base addition tank
4	2" x 1"	slip x FNPT	438249	fish air distribution system
4	2"	T	401020	fish air distribution system
8	2"	90º elbow	406020	fish air distribution system
1	2"	4 way cross		fish air distribution system
1	2"	cap	447020	fish air distribution system
4	2"	ball valve		fish air distribution system
125 feet	1"	poly tube		fish air distribution system
4	1"	male threaded poly hose adapter nipple	*103-C	fish air distribution system
4	1"	90º elbow poly hose nipple	*105-C	fish air distribution system
4	1"	T poly hose nipple	*107-C	fish air distribution system
2	3"	toilet flange		sludge collecting and net tank drain
5	3"	T	401030	
1	3"	90º elbow	406030	sludge collecting and net tank drain
4	3"	coupling	429030	sludge collecting and net tank drain
4	3"	cap	447030	sludge collecting and net tank drain
2	6"	cap		sludge collecting and net tank drain
2	4"	cap	447040	sludge collecting and net tank drain
2	5 gallon	bucket		sludge collection from swirl filters
4	2"	90º elbow	406020	sludge collection from swirl filters
4	2"	45º elbow	417020	sludge collection from swirl filters
2	2"	ball valve		sludge collection from swirl filters
2	2" x 1"	reducer bushing	437249	sludge collection from swirl filters

2	1"	male adapter	436010	sludge collection from swirl filters
2	1"	female adapter	435010	sludge collection from swirl filters
6	2"	90º elbow	406020	hydroponic air distribution
3	2"	T	401020	hydroponic air distribution
4	2" x 1"	reducer bushing	437249	hydroponic air distribution
4	1"	female adapter	435010	hydroponic air distribution
4	1"	ball valve (slip x slip)		hydroponic air distribution
4	1"	male poly adapter	*103C	hydroponic air distribution
4	1"	poly plug	*114C	hydroponic air distribution
3	3/4"	female adapter	435007	fresh water supply to system
1	3/4" MPT	float valve	*R7003	fresh water supply to system
1	3/4"	water meter	*FM2	measure water additions to system
4 rolls	14' x 100'	orchard netting		solids trap
4	1" x 2" x 7'	ceder wood slats		fry screen
8	4" x 4"	flat angle braces		fry screen
8 yards	1000 micron	nylon net material		fry screen
10 ft	3/4"	plastic mesh screen (vexar)		screening pipes
6	12" o.d. x 6" i.d.	PVC donuts		cut from PVC sheet - to connect hydroponic pipe to liner
88	1/4 NPT x 1/4 barb	male tubing adapter	62006	nipple adapter for vinyl hose
50	2" x #8	stainless steel screws		to attach donut to pipe flange
88	6" x 1.5"	airstones		aquaculture airstones
500 feet	1"	poly hose		hydroponic tank air supply
112	1/4 NPT x 1/4 barb	male tubing adapter	62006	hydroponic nipples
112	3" x 1"	airstones		hydroponic airstones
6	tube	silicone		
8	gallon	fiberglass resin and hardner		
		fiberglass mat		
		paper buckets -disposable		
		paint brushes - disposable		
		latex gloves - disposable		
		dust mask - disposable		
1	organic vapor	vapor mask		

Aquaponic System Construction Materials Costs

Assuming the proprietor would perform all system construction activities, it should cost about $40,500 to purchase the materials to build a replica of the UVI aquaponics system (Table 7). Construction costs can add up quickly when building these systems, especially when it is required to hire contractors or outside labor. The proprietor would need to have experience with digging, plumbing, electrical wiring, general construction, and much more to be able to do this on their own. Many individuals would need to hire contractors, electricians, surveyors, or other professional services to complete construction. This would certainly impact the cost of constructing the UVI system. However, producers building this system within the Continental United States would also experience lower costs for equipment, materials, and supplies. This is because shipping is a significant cost for everything from tanks to feed when you operate in the Virgin Islands. Even water and electricity are much more expensive in St. Croix than would be encountered stateside.

Table 7: Construction Materials Costs

Item	Quantity	New cost each	New cost total	Years of Life	Annual Depreciation
Rearing tanks	4	$ 2,155.00	$ 8,620.00	20	$ 431.00
Swirl Separators	2	$ 1,000.00	$ 2,000.00	20	$ 100.00
Net tanks	4	$ 805.00	$ 3,220.00	20	$ 161.00
Degassing tanks	1	$ 805.00	$ 805.00	20	$ 40.25
Base addition tank	1	$ 110.00	$ 110.00	20	$ 5.50
Sump	1	$ 415.00	$ 415.00	20	$ 20.75
Circulating Pump	1	$ 1,268.10	$ 1,268.10	5	$ 253.62

Air Blower (1.5 HP)	1	$ 739.00	$ 739.00	10	$ 73.90
Hydroponic Tank Wall	6	$ 1,148.19	$ 6,889.15	10	$ 688.92
Liner		$ 1,890.00	$ 2,170.08	10	$ 217.01
Rafts	72	$ 35.59	$ 2,562.76	10	$ 256.28
Air Blower (2 HP)	1	$ 797.00	$ 797.00	10	$ 79.70
Equipment		$ 2,019.00	$ 2,019.00	10	$ 201.90
PVC Parts		$ 1,327.20	$ 1,327.20	10	$ 132.72
Other Parts		$ 7,577.80	$ 7,577.80	10	$ 757.78
			$ 40,520.10		

Aquaponic System Variable Costs

Table 8 explains the variable costs associated with running the UVI system after the first year. As you can see below, variable costs typically amount to about $67,000 on an annual basis for the UVI system. Variable costs are $4,146 lower in the first year since there is no production happening during the construction and system acclimation processes. During these phases, and for some time after, fish feed and plant production costs are low. The variable costs associated with growing lettuce from seed in the system are relatively low compared to the variable costs associated with raising fish to market size. In fact, the variable costs associated with growing lettuce are only about 10% of the variable costs associated with raising fish. Labor is also clearly a very significant contributor to total variable cost; labor accounts for over 69% of total variable cost in year one, and 65% in subsequent years. Labor figures are based on employees working 30 hours per week 52 weeks out of the year. It is recommended by Donald Bailey, and others who have worked with the system at UVI, to run the UVI aquaponic system with just 2 employees working 30 hours per week. This labor is reflected under *other variable costs* in Table 8 below.

Table 8: Variable costs for the operation of the UVI Aquaponic System

Fish Variable Cost	Unit	Cost/Unit	Quantity	Total Cost
Fingerlings	ea	$ 0.30	5,220	$ 1,566.00
Feed	kg	$ 0.96	8,503	$ 8,175.00
Shipping	bag	$ 9.61	375	$ 3,603.75
Chemicals				
KOH	kg	$ 1.30	182	$ 236.60
Ca(OH)2	kg	$ 0.12	182	$ 21.84
Electrical	kwh	$ 0.54	14,235	$ 7,686.90
				$ 21,290.09

Lettuce Variable Cost	Unit	Cost/Unit	Quantity	Total Cost
Seedlings	ea	$ 0.01	44,928	$ 584.38
Chemicals				
Fe	kg	$ 29.00	17	$ 493.00
Insecticide	bags	$ 16.00	2	$ 32.00
Electrical	kwh	$ 0.10	9,125	$ 912.50
Equipment (Knives)	system	$ 10.00	5	$ 50.00
				$ 2,071.88

Other Variable Cost	Unit	Cost/Unit	Quantity	Total Cost
Manager / Operator	Hourly	$ 20.00	1,560	$ 31,200.00
Hired Labor	Hourly	$ 8.00	1,560	$ 12,480.00
				$ 43,680.00
			Total Variable Cost	**$ 67,041.97**

Aquaponic System Revenue

Things like construction and system acclimation, which is essentially the process of the system building up nutrients, take time in the first year of operating the UVI system. This is why production levels will be lower in the first year. Certain things such as lettuce can only be produced in cooler weather months in this tropical climate, which means production is seasonally limited for certain items.

During year 1, it should take about 3 months from breaking ground until the first harvest of produce is possible. It is possible to harvest about 37 cases of lettuce per week for 16 weeks out of the year in St. Croix; other weeks are typically too warm for lettuce harvests. This is because the water temperature becomes too high during this time of year, which can last for up to 36 weeks out of the year. During this time, basil production typically replaces lettuce production. It is possible to produce a total of 3,000 kilograms of basil per year, based on past production figures experienced at UVI. Finally, tilapia can be harvested only about 4 or 5 times the first year, and UVI has experienced an average of about 497 kilograms of tilapia per harvest. This amounts to a total annual production of over 2,100 kilograms of tilapia during the first year (Table 9).

Table 9: Year 1 Revenue

Product	Unit	Price/Unit	Quantity	Total Cost
Lettuce	case	$ 20.00	592	$ 11,840.00
Basil	kg	$ 26.46	3,000	$ 79,380.00
Tilapia	kg	$ 5.51	2,162	$ 11,917.75
				$103,137.75

Future harvest amounts of tilapia are essentially doubled moving into the future. During the first year of production, tilapia can likely only be harvested about 4 to 5 times (Table 10). The UVI system has historically experienced an average of 8.7 tilapia harvests per year. Based on this figure, it is estimated that this system can produce an average of 4,324 kilograms of tilapia per year. However, this figure is based on stocking 600 fish per tank. Increasing tilapia stocking density could increase revenue, but the increase in feed and other expenses must be taken into account when making a stocking density decision. Lettuce can only be produced during the cooler months so revenue will likely remain the same. Basil comes in many different varieties, and many varieties can grow year round on St. Croix, which means basil revenue will likely have little variation from year to year.

Table 10: Subsequent Revenue

Product	Unit	Price/Unit	Quantity	Total Cost
Lettuce	case	$ 20.00	592	$ 11,840.00
Basil	kg	$ 26.46	3,000	$ 79,380.00
Tilapia	kg	$ 5.51	4,324	$ 23,835.50
				$115,055.50

All of these revenue figures are highly dependent upon price. Where the UVI station is located, in St. Croix, many things can command higher prices. Food can especially command higher prices here compared to many other places. Much of the food eaten on the island is imported, which makes it more expensive. Furthermore, there is limited agricultural production on the island. Therefore, locally grown food can command a fairly significant price premium. This is especially true when selling to upscale restaurants and hotels that are fairly abundant on the Island near tourist destinations. The prices used in this analysis are based on price points experienced by UVI when selling their products on the island.

Aquaponic Pro Forma Income Statements

The pro forma income statements in Table 11 represent what producers will likely experience in the first 5 years of running the UVI aquaponic system. As you can see, it is possible for producers to experience a slight loss in the first year of production. However, it must be kept in mind that these estimates include wages for a manager and one additional employee. After the first year of production, it is likely that producers could experience a net income of over $47,700 annually.

Table 11: Pro Forma Income Statements

	Item	Year 1 Total Value	Year 2 Total Value	Year 3 Total Value	Year 4 Total Value	Year 5 Total Value
Income						
	Lettuce	$ 11,840.00	$ 11,840.00	$ 11,840.00	$ 11,840.00	$ 11,840.00
	Basil	$ 79,380.00	$ 79,380.00	$ 79,380.00	$ 79,380.00	$ 79,380.00
	Tilapia	$ 11,917.75	$ 23,835.50	$ 23,835.50	$ 23,835.50	$ 23,835.50
	Total Income	**$103,137.75**	**$115,055.50**	**$115,055.50**	**$115,055.50**	**$115,055.50**
Fixed Cost						
	Land / Rent	$ 300.00	$ 300.00	$ 300.00	$ 300.00	$ 300.00
	System Construction	$ 40,520.10	$ -	$ -	$ -	$ -
	Total Fixed Cost	**$ 40,820.10**	**$ 300.00**	**$ 300.00**	**$ 300.00**	**$ 300.00**
Variable Cost						
Fish Variable Cost						
	Fingerlings	$ 1,566.00	$ 1,566.00	$ 1,566.00	$ 1,566.00	$ 1,566.00
	Feed	$ 3,533.37	$ 8,175.00	$ 8,175.00	$ 8,175.00	$ 8,175.00
	Shipping	$ 3,603.75	$ 3,603.75	$ 3,603.75	$ 3,603.75	$ 3,603.75
	Chemicals					
	KOH	$ 236.60	$ 236.60	$ 236.60	$ 236.60	$ 236.60
	Ca(OH)2	$ 21.84	$ 21.84	$ 21.84	$ 21.84	$ 21.84
	Electrical	$ 7,686.90	$ 7,686.90	$ 7,686.90	$ 7,686.90	$ 7,686.90
	Equipment	$ 496.00	$ -	$ -	$ -	$ -
		$ 17,144.46	$ 21,290.09	$ 21,290.09	$ 21,290.09	$ 21,290.09
Lettuce Variable Cost						
	Seedlings	$ 584.38	$ 584.38	$ 584.38	$ 584.38	$ 584.38
	Chemicals					
	Fe	$ 493.00	$ 493.00	$ 493.00	$ 493.00	$ 493.00
	Insecticide	$ 32.00	$ 32.00	$ 32.00	$ 32.00	$ 32.00
	Electrical	$ 912.50	$ 912.50	$ 912.50	$ 912.50	$ 912.50
	Equipment (Knives)	$ 50.00	$ 50.00	$ 50.00	$ 50.00	$ 50.00
		$ 2,071.88	$ 2,071.88	$ 2,071.88	$ 2,071.88	$ 2,071.88
Other Variable Cost						
	Manager / Operator	$ 31,200.00	$ 31,200.00	$ 31,200.00	$ 31,200.00	$ 31,200.00
	Hired Labor	$ 12,480.00	$ 12,480.00	$ 12,480.00	$ 12,480.00	$ 12,480.00
		$ 43,680.00	$ 43,680.00	$ 43,680.00	$ 43,680.00	$ 43,680.00
	Total Variable Cost	**$ 62,896.35**	**$ 67,041.97**	**$ 67,041.97**	**$ 67,041.97**	**$ 67,041.97**
Net Income		**$ (578.70)**	**$ 47,713.53**	**$ 47,713.53**	**$ 47,713.53**	**$ 47,713.53**

The above information was used to calculate the Net Present Value (NPV) and Internal Rate of Return (IRR) for this operation. NPV is the sum of the present values of cash flows experienced in a project over a period of time. IRR is the rate of return that makes the NPV of cash flows equal to zero. A conservative approach was taken towards estimating NPV and IRR for this operation. Typically, NPV is estimated over the lifetime of a project and includes figures for asset depreciation. However, NPV was estimated for just 5 years worth of time and it was assumed assets would have no value at the end of the project.

Therefore, the true NPV and IRR of this project would be higher because the aquaponics system is likely to still be operational for much longer than 5 years. The NPV of this operation has been estimated to equal $87,797. This assumes a tax rate of 30% on net income and an interest rate of 8%. The IRR for this operation was then estimated to be 71.2%. Again, these values are likely to be higher when the entire lifetime of the investment is taken into account.

Considerations

There are clearly some assumptions that have to be made in this analysis. In order to be as accurate as possible, actual price points, production values, and costs experienced by UVI have been used. All figures have been updated and estimated as accurately as possible. If you were to replicate this system in a milder climate within the Continental United States, then you would likely experience lower costs for materials, supplies, labor, shipping, and utilities. Furthermore, the production values could be higher for things like lettuce in milder climates. However, start-up costs may be higher in parts of the United States where there is a need for infrastructure such as a greenhouse with climate control.

It would be wise for producers interested in commercial aquaponics to begin with operating a small scale system for some time before investing in building a commercial system. Individuals interested in commercial aquaponics should attend an educational workshop at the very least. Aquaponic producers need to perform all the due diligence possible before breaking ground or seeking funds. There have already been numerous high publicity failures of extravagant aquaponics systems around the world. Some of the failures in aquaponics can be blamed on cash flow issues, which means it is important to perform a cash flow analysis before beginning operations. In order to succeed in aquaponics, it is vital to seek training, use researched and proven system models, conduct research, and have some type of emergency or contingency fund in place in the event that something goes wrong. Aquaponics, like other methods of farming, is subject to the forces of nature and operator error so it is important to be prepared for the worst.

Conclusion

These figures are meant to be used as a guide for potential commercial aquaponic producers, in order to help those interested in replicating the UVI system. All figures used in this research were estimated as accurately as possible, but that doesn’t mean these figures are what producers will experience when replicating the system in different locations, climates, or economies. Aquaponic systems typically involve facing a difficult learning curve. These systems also involve a significant financial investment. This means that individuals should consider entering commercial aquaponics carefully, as they should with any other business or enterprise.