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Cost and Returns Budgets for an Intensive Zero Water-Exchange Shrimp Culture Demonstration Project in Nicaragua, 2001

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Cost and Returns Budgets for an Intensive Zero Water-Exchange Shrimp Culture Demonstration Project in Nicaragua, 2001

Facility Description

An intensive zero water-exchange shrimp culture demonstration project was constructed at the Universidad Centro Americana (UCA) in Puerto Morazan, Nicaragua by Aquatic Design Systems. The culture facility consists of four one-half-hectare ponds and two one-hectare settling ponds. Each of the four production ponds is lined with plastic HDP pond liners and aerated. The intensive zero water-exchange system was designed to improve biosecurity and production levels. The four ponds were built during the first half of 2001 and operated for one production cycle from August to December, 2001. The goal was to determine the feasibility of producing shrimp using the zero exchange shrimp culture system where Taura Syndrome Virus (TSV) and White Spot Virus (WSSV) are common.

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The system was built within an existing shrimp culture farm that has been used for traditional semi-intensive farming. Initial investment costs for the facility construction included land preparation, pond construction, building and road construction, effluent/ affluent water system development, electric hookups, HDP pond liners, and other costs associated with actual construction. Other capital costs included lab equipment, harvesting equipment, feeding apparatus, aerators, feed storage, rolling stock, generators, and pumps.

Initial Investment Requirements

Total costs for feeding equipment, permanent equipment, and other costs (including pond construction, plastic liners, electrification, water control structures, roads, drains, etc.) were US\$4,100, US\$65,416, and US\$185,027, respectively. Construction costs totaled US\$254,543 for the entire facility. Total cost per hectare for the prototype facility was US\$127,272 (Table 1).

Converting Semi-Intensive Systems to Zero Water-Exchange

A traditional semi-intensive shrimp farm in Nicaragua, using the latest technology, is capable of yielding on average 1,033,661 pounds of shrimp in a year or 3,133 pounds per hectare per year¹. A total of 2.04 production cycles per year can be achieved while the average area in production is 324 total hectares. In contrast, actual production for the four one-half hectare UCA demonstration farm during the 2001 trial production run was 20,008 pounds of shrimp after one production cycle. Average production per hectare per cycle for the four one-half hectare pond system was 10,004 pounds of shrimp. With two production cycles possible annually, total annual production at this rate will be 40,016 pounds of shrimp (Table 2). This production level is estimated

¹ Lopez, Mayra, Charles Adams, James Cato, and Donald Sweat. 2001. Draft manuscript. Cost and returns budgets for a Semi-intensive shrimp farm in Nicaragua, 1994-2000. Florida Sea Grant. University of Florida. Gainesville.

based on one production cycle, from August to December, 2001, at the demonstration facility, as summarized in Table 2. This was the only production cycle after completion of the demonstration facility. Predicted production levels (pounds/hectare/cycle), survival rate, and average harvest size of shrimp were not achieved. However, it is anticipated they can be achieved as the local operators gain more knowledge about the system and improvements are made based on what was observed during the first production cycle.

Feeding Equipment	Total Cost	
Feed Storage	2,500	
Feeders	1,600	
Sub-Total Feed Equipment	4,100	
Permanent Equipment		
Aeration Equipment	20,969	
Pumps	15,850	
Electrical Generators	25,953	
Scientific Equipment	2,644	
Sub-Total Perm Equipment	65,416	
Other Costs		
Pond Construction		
Earthwork	46,438	
Settling Ponds (1ha)		
Grow-out Ponds (1/2ha)		
Canals/Reservoirs		
Roads/Drains		
HDP pond liners	39,093	
Electrification	32,715	
Wire/Panels		
Water Control Structures	43,677	
Piping/Sluice Gates/Valves		
House/Office	13,921	
Office Equipment	9,183	
Sub-Total Other Costs	185,027	
TOTAL DIRECT COSTS (US Dollars)	254,543	
Cost per hectare (US Dollars)	127,272	

Table 1. Cost to construct the zero water-exchange demonstration project at UCA.

Table 2. Production variables achieved during the initial production cycle at UCA demonstration project.

Production (lbs/ha/cycle)	10,004
Expected Production Level (lbs/2ha/yr)	40,016
Cycles	2
Total Production (lbs/ha/yr) (1 Cycle)	20,008
Total Area (ha)	2
Number of 1/2 ha ponds	4
Average Practical Survival Rate (%)	30
Stocking Density (PL/m2)	115
Average Harvest Size (g)	13.29

Investment costs were determined for various sized zero water-exchange hypothetical systems by varying production levels needed to achieve the same production level per year (1,033,661 pounds) as the traditional system. Production levels (pounds/hectare/cycle) varied from 10,000 to 40,000 pounds/hectare/cycle (Table 3). As a result, the total hectares required changed as well the total investment (Table 3). The capital investment assumptions used were:

- Feed storage cost remains constant at US\$2,500 regardless of the size of the system given the change in production level on a per hectare basis.
- The cost of feeders is estimated at US\$400 per one-half-hectare pond.
- There is a linear relationship between generators and aerators as the number of ponds increase. 40 horsepower of aeration per hectare were used at the demonstration project.
- Current set of pumps on the UCA site can handle up to 6 hectares of production ponds. (Twelve one-half hectare ponds).
- Linearity also exists in costs such as earthwork, HDP liners, electrification, and water control structures.

 Some costs including scientific and office equipment, and office construction do not vary as farm size changes along with the various per hectare yields.

Producti	on Levels	Initial Investment Cost	Total Area	Number of
ising Zero Ex	change System	for Zero Exchange System (USS) in production	1/2- ha
lbs/ha/cycle	lbs/ha/year	to produce 1,033,661 lbs/yr	(ha)	pouds
10,000	20,000	5,602,996	52	103
15,000	30,000	3,744,747	34	69
20,000	40,000	2,815,622	26	52
25,000	50,000	2,258,147	21	41
30,000	60,000	1,886,498	17	34
35,000	70,000	1,621,033	15	30
40,000	80,000	1,421,935	13	26

 Table 3. Initial investment requirements at different production levels for a zero waterexchange system to achieve the same production level as a traditional system.

The predicted production level for the UCA demonstration project was 18,865 pounds/hectare/cycle. Actual production from the project was 10,004 pounds/ hectare/ cycle (Table 2). Project managers maintain that the higher harvest levels can be achieved based on a full year's production and using knowledge gained during the first production cycle.

The traditional semi-intensive farm referenced earlier is to produce 1,033,661 pounds. Assuming 25,000 pounds of shrimp per hectare from two production cycles, a

total of 41 one-half-hectare ponds (21 hectares) and associated holding ponds using the zero water-exchange technology are needed to achieve the same production level (Table 4). Since the total construction cost mentioned above is for the two-hectare demonstration farm and associated holding ponds at UCA, total cost for a 21-ha farm using the zero water-exchange, intensive system has been generated by taking into account all the capital investment assumptions listed previously. Total cost of some specific categories including aeration equipment, electric generators, earthwork, HDP liners, electrification, and water control structures were estimated by multiplying total cost of these categories for the prototype farm by the corresponding multiplier. The multiplier is obtained by dividing the total area in hectares (Table 4) needed to produce 1,033,661 pounds of shrimp by 2 to take into consideration the investment costs on the two-hectare demonstration project. At a production level of 25,000 pounds of shrimp per hectare, the multiplier used to estimate total cost of the categories is 10.34. Since the current set of pumps at UCA can handle a farm of six hectares of production ponds, the cost for pumps for the various sized systems was estimated by dividing the total area (expressed in hectares using the new system to produce the same production level as the traditional system) by 6, and then by multiplying that figure by the price of the current pump at the demonstration project. Total cost of feed storage, scientific and office equipment, and building construction remain constant regardless of the variation in farm size. Finally, the cost for feeders was calculated by multiplying US\$400 by the number of one-half-hectare ponds needed to generate the same annual yield as the traditional system.

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As projected production levels per hectare per cycle increase from 10,000 pounds to 15,000 pounds, 20,000 pounds, and 25,000 pounds, total construction cost decreases from US\$5,602,996 to US\$3,744,747, US\$2,815,622, and US\$2,258,147, respectively (Table 4). Total construction costs at production levels of 10,000, 15,000, and 20,000 pounds are determined by multiplying the specific cost categories by previously defined multipliers of 25.84, 17.23, and, 12.92 respectively. The higher the production levels, the smaller the area needed using the zero water-exchange, intensive system, making total initial investment requirements lower. In contrast, construction costs per hectare decrease as total area in production increases (Table 4). When production level per hectare increases from 25,000 pounds to 30,000 pounds, 35,000 pounds, and 40,000 pounds, total construction cost decreases to US\$1,886,498, US\$1,621,033, and US\$1,421,935, respectively (Table 4). The multipliers to calculate total cost of the categories that vary linearly are 8.61, 7.38, and 6.46 when production level per hectare is 30,000, 35,000, and 40,000 pounds, respectively.

Depreciation

Annual fixed costs include concession fee² and depreciation. Using the straightline method, the annual depreciation cost was estimated based on the useful life of the different assets with no salvage value. Aeration equipment was assumed to have a useful life of two years. Feeders, electric generators, and scientific equipment were assumed to

² Concession fee refers to the annual leasing cost of land per hectare paid to the Nicaraguan government. For this analysis, an average of US\$25 per hectare was used.

have a five-year life. A 10-year life was assumed for feed storage, pumps, HDP liners, electrification, and office equipment. Earthwork and water control structures were assumed to have a 15-year life. Finally, the office building on the site was assumed to have a 25-year life. To compute the amount of annual depreciation expense using the straight-line method requires two numbers: the initial cost of the asset and its estimated useful life. The initial cost of the assets (Table 4) predicted and adjusted annual depreciation for the UCA demonstration site, and estimated depreciation costs for the various sized hypothetical systems are also given (Table 5).

TOTAL DIRECT COSTS (US Dollars) Cost per hectare (US Dollars)	O flice Equipment	House/Office	Valves	S luice Gates	Water Control Structures Pining	Pauels	Wire	HDP pond linets	Drains	Roads	Canals/Reservates	Settling Ponds (Iha)	Earthwork -	C. Other Costs Pand Construction		ttear dub weiter	Blockrical (tenerators	Pumps	A eration Equipment	B. Permanent Equipment		Feeders	Feed Storage	A. Feeding Equipment	. ,			Average Harvest Size (a)	Sheking Density (DI /m.2)	Survival Prise (%)	Number of 1/2 to and 1	Total Production (18s/ha/yr) Total Area (1-2)	Cycles	Total Average Production of Traditional System (165/324ha/vr)	Expected Production Level (lhs/2ha/vr)	Production (The/ho/ocolo)	
ars)	Sub-Tatal Othan Cast.			-											Sub-Total Perm Equipment	-					Sub-Total Feed Equipment						Muhipliat				-	•		ual System (15s/324ha/vr)			
435,027 304,543 152,272	9,183	13,921			58,677		32,715	54,093				00,430	4 L L 2 2		65,416	2,644	25,953	15,850	20.969		4,100	1,600	2.500	Total Cost	Exchange System	Investment Cost far Zero	13.30	115	5.5	4	2	37,370	2	/4,740	18,685	Predicted	UCA Prototype Farm
185,027 254,543 127.271	9,183	13,921			43,677		32,715	39,093				40,438			65,416	2,644	25,953	15,850	20.969		4,100	1.600	2 500	Total Cost	e System	lost far Zera	13.29	115	30	4	2	20,008	2	40,016	10,004	Actual	type Farm
4,207,440 5,602,996	9,183	13,921			1,128,683		845,402	1,010,231				2,200,019			1,351,710	2,644	670,665	136.529	541 871		43.846	41.346	1 500	Total Cost		1,04	13.50	19	5 5	103	52	20,000	1,023,001	1 013 221	10,000		
2,812,661 3,744,747 108 684	9,183	13,921			752,455		563,602	673,488				800,013			902,021	2,644	447,110	91.020	7.1.7.		30.064	27 564	3 600	Total Cost		itment Cost	13.50	26	55	69	34	30,000	1,033,001		15,000	a	
2,115,272	681'6	13.921			564;341		422,701	505,116				600,009			677,177	2,644	335,333	68 365		1 1/02	23.173	20 673	2 2 2 2	Total Cost	as Tradition	to Achieve P	13.50	122	55	52	·	40.000	1,033,661		20,000	Different Proc	
1,696,838 2,258,147 100 711	9,183	13.921			451,473		338,161	404.093	· · · ·			480,008			542,270	2,644	268.266	216,748		<u> </u>	10 010	16 530		Total Cost	al Semi-Inte	roduction I.	13.50	i 53	55	41	21	<u>30.000</u>	1,033,661		25,000	t Production Scenarios	
1,417,883	9,183	11 071	,		376,228		281,801	336.744				400,006			452,333	2.644	223.555	180,624		10,404		2,500		Total Cost	as Traditional Semi-Intensive Systems	Lavestment Cost to Achieve Production Level of 1 013 441		183	55	34	17	2 09	1,033,661		30,000	arios - Hypo	
1,21	9,183	1 1 1 1			322,481		<u></u> † • • †	812 886				342,863			3	+	Ť	154,820	1	1 14,313	1	╈		Total Cost	la Atanı (na, İta îtanı			214	55	30	15	1	1,033,661		35,000	- Hypothetical Farms	
1,069,188	681'6 176'61				282.171		211,351	855 C5C				300,005			339,911	2.644	34,132	135,468		12,837	10,337	2,500		Total Cost	т усыг	6,46	13.50	244	35	26	13	2 000	1,033,661		40,000	11 8	

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•			TOTAL DEBUG OTTOTAL COSta		Office Equinment		Shine Gates	Pining -					Canals/Reservoire	Grow-out Ponds (1/2ha)	Settling Ponds (1ha)	Earthwork	V. Vier Costa (US Dellarg) Pond Construction		Sub-Total Perm Equipment	o creating Realing and	Electrical Uenerators		A station Equipment	B. Permanent Equipment (US Dollars)		Sub-Total Feed Equipment	Feeders	Feed Storage	A. Feeding Equipment (US Dollars)			Jaardina ee		Average Harvest Size (g)	Stocking Density (PL/m2)	Survival Rate (%)	Number of 1/2 ha pouds	Total Area (ha)	Total Production (Ibs/ha/yr)	Cycles	Total Average Production of Traditional Contact (11. 1994).		Production (Ika/Ika/
	18,428	36,856	18,497	816	557			3,912		3,271	5,409				4,429				17,789	529	5,191	1,585	10,484			570	320	1 4 2 4	10131 - 080	Territor and an array of the second s	Depreciation Cost for Zero	<u> </u>	0	11 40	118		2	01015	2 20	د ا	74,740	18,685	Predicted
5	16,511	33,022	14,664	918	557			2,912		3,271	606'E				3,096			1.1.1	17.789	529	5,191	1,585	10,484			570	120		A otal Cost	oystent	ost for Zero		13.29	11.00	30	, , , , ,	2	800,07	2 2		40,016	10,004	Actual
	14,899	770,050	342,285	916	557			75,246		84,540	101,023				80,001				710 272	529	134.133	13.653	270,931		/ w m h o	9 4 10 70 7 10	0.52		Total Cost		Depre	26	13.50	19	55	501	52	20,000	2	1,033,661		10,000	
	14,921	514,118	228,682	918	557			50,164		56.360	67.349				53,334			01010	330 573	0.05	89.422	9.102	180.621		0,100	515,5	250		Total Cost	35	Depreciation Cost to	17	13.50	92	55	69	34	30,000	2	1,033,661		15,000	Different)
	14,943	386,152	171,880	918	557			37,623	 ~ 1 2 6	42 270	50 51 2				40,001			409,001	3 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	1005	67 0.67	6 8 2 6	135.465		4,200	4,135	250		Total Cost	s Traditiona	to Achieve P	<u> </u>	13.50	122	55	52	26	40,000	2	1,033,661		20.000	Different Production Scenarios - Hypothetical Farms
	14,955	309,373	137.799	B36	557			860.05	010,00	13 81 4					32,001			108,010	67C	20,00	104,0	5 4 61	108 373		3,338	3,308	250		Total Cost	Traditional Semi-Intensive Systems	roduction L	10	13.50	153	55	41	21	50,000	2	1,033,661		25.000	Scenarios -
	14,987	258,186	115.070	918	\$57			25.082	20,100	10,00	12 671				26,667			140,101	67.5	44,113	1004	1 5 6 1	011 00		3,006	2,756	250		Fotal Cost	isive System	evel of 1,03	6	13.50	183	55	34	17	60,000	2	1,033,661	000.05	UUU UL	H ypothetic
	15,009	221.624	010 40	816	557			91 400	4 C L + 2 Z	40,004	20 4 2 4				22,858			120,162	529	38,524	106'5	1 001	14 100		2,613	2,363	250		Total Cost		Achieve Production Level of 1,033,661 ibs. per year		13.50	2:4	55	30	15	70,000	2	1,033,661	000,00	25 000	cal Farms
	15,030	194.203		012	447		110,01	19 011	21,135	20,200					20,000			105,208	529	33,533	3,433	01,133			2,317	2,067	250		Total Cost Total Cost Total Cost Total Cost Total Cost Total Cost		r year	6	\$3.50	244	55	26	C I	000,08	2	1,033,661	40,000	1000	

Table 5. Annual depreciation costs for zero water-exchange demonstration project and different farm scenarios.

UCA Prototype Farm Predicted Actual 18,685 10,004 74,740 40,015

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Production Economics of the Zero Water-Exchange Shrimp Farming Demonstration Project

For the zero water-exchange UCA demonstration project in Puerto Morazan, Nicaragua, the costs and returns budget represents (1) <u>predicted</u> values for one cycle and for an annual operation before first harvest, (2) <u>actual</u> values for the first production cycle, and (3) <u>projected</u> values for annual operation costs and revenues based on the actual data obtained from one real production cycle³. The analysis focuses initially on both per cycle and annual operating expenses for the prototype farm. These estimates are then utilized to construct an annual operating budget to generate 1,033,661 pounds of harvested shrimp from different hypothetical farms by varying production levels on a per hectare basis. Finally, a sensitivity analysis is included to determine how financial performance measures change as key management parameters including farm production levels and shrimp price are varied. The sensitivity analysis provides the potential investor with some insight into the production and financial risks associated with the zero waterexchange system.

Cost and Returns Budgets for Zero Water-Exchange UCA Demonstration Project

Single Cycle and Annual Estimates

The demonstration farm consisted of four one-half-hectare production ponds. Predicted practical survival rates varied from 40 to 60 percent and predicted harvest size ranged from 13 to 15 grams (heads-on). For this analysis, the average predicted survival rate and harvest size of shrimp were calculated at 55 percent and 13.50 grams (heads-on), respectively. After the completion of the August-December 2001 production cycle, actual average survival rate was 29.69 percent while actual weighted average size was 13.29 grams (heads-on). The weighted average size was determined based on the production yields as reported in the liquidation report by the processing plant (Table 6). Survival rate was calculated by using the following formula:

Computed = <u>Total Pounds Harvested</u> Survival Rate (Stocking Density*Total Seeded Area (m²)*Harvest Weight*Cycles)/453.59237

Table 6. Actual production yields from zero water-exchange demonstration project.

	Stocking Density PL/m ²		Total Number	
		Received at Plant	of Shrimp	(g) (heads-on)
Pond 1	· 100	3,275	129,953	11.44
Pond 2	120	5,750°	200,308	13.03
Pond 3	120	5,713	175,763	14.76
Pond 4	120	5,270	177,041	13.51
TOTAL		20,008	683,065	

Source: Camarones de Nicaragua. S.A.

³ The word "predicted" is used to indicate what was originally thought would happen. The word "actual" refers to the actual harvest data including selling price, harvest size, etc. Finally, the word "projected" indicates what can happen by using specific assumptions, better knowledge, at various prices, etc.

Total production was 20,008 pounds from the August-December 2001 demonstration project. Using the same production variables (Table 7) for two cycles per year, projected annual production would be 40,016 pounds.

Production Variables	Pred	licted	Actual	Projected
	1 Cycle	2 Cycles	1 Cycle	2 Cycles
Total Seeded PL/ pond	2,300,000	4,600,000	2,300,000	4,600,000
Stocking Density (PL/m2)	115	115	115	115
Survival Rate (%)	55.00	55.00	29.69	29.69
Days Shrimp in Pond/cycles				
Weeks Shrimp in Pond/Cycles				
Harvest Size (g) Fixed	13.50	13.50	13.29	13.29
Number of cycles per year	. 1	2	1	2
Feed Conversion Ratio	1.73	1.73	2.44	2.44
Total Seeded Ha	2	4	, 2	4
Total Seeded Ha in m2	20,000	40,000	20,000	40,000
Total Pounds Harvested (2ha farm)	37,370	74,740	20,008	40,016
Lbs Harvested/ha (head-on)	18,685	18,685	10,004	10,004

Table 7. Production assumptions based on first cycle of demonstration farm.

Unit costs and prices used to determine annual operating expenses for the UCA Zero Water-Exchange system are shown in Table 8.

 Table 8. Unit costs based on first cycle of demonstration farm.

	Pred	icted	Actual	Projected
Unit Cost	1 Cycle	2 Cycles	1 Cycle	2 Cycles
Average Shrimp Price (US\$/lb)	3.00	3.00	2.05	2.05
Postlarvae (US\$/1000)	5.22	5.22	5.22	5.22
Feed (US\$/lb) (excluding shipping cost)	0.21	0.21	.0.21	0.21
Shipping Cost (US\$/lb)	0.11	0.08	0.14	0.10
Fertilizer/Chemical (US\$/ha)	625.74	625.74	625.74	625.74
Fuei (US\$/ha)	2,933.16	2,933.16	3,433.16	3,433.16
Direct Labor (US\$/lb harvested)	0.15	0.15	0.28	0.28
Indirect Cost (US\$/ha)	21,547.49	11,054.02	18,900.35	9,552.72

Production costs include both direct and indirect costs. Direct costs include variable costs for post-larvae, feed, chemicals and fertilizers, fuel, and labor. Indirect costs include equipment and facility maintenance costs, depreciation, concession fees, and taxes. In order to determine the annual operating expenses for both the UCA demonstration project and the hypothetical farms, the formulas below were used.

Post-Larvae Cost. The average stocking density for the UCA system was 115 PL/m² and the cost per thousand PL was US\$5.22. Annual PL cost was calculated by using the following formula:

[(Total seeded area(m²)* # of cycles)*(Stocking Density (PL/m²))]*PL Cost per thousand 1,000 PL

Feed Cost. Based on actual project results, the food conversion ratio (FCR) was estimated at 2.44. During the first production cycle, 48,840 pounds of feed were consumed and only 20,008 pounds of shrimp were harvested.

Feed price per pound was determined at US\$0.21 by (1) excluding a shipping cost of US\$3,400 for every 44,000 pounds of feed and (2) by dividing the total reported feed cost after excluding the shipping cost, by the total pounds of feed. Shipping cost on per pound basis decreases as the number of pounds of feed approaches the 44,000 pounds (capacity of a load).

The formula used to calculate annual feed cost is as follows:

2.17

= (FCR * Expected Annual Production (lbs. of shrimp) * Feed Price/lb. excluding shipping costs) + (US\$3,400 for every 44,000 pounds of feed)

Chemicals, Fertilizers, and Fuel Cost. Actual cost for chemicals and fertilizers on a per hectare basis was US\$626 while actual per-hectare cost for fuel was US\$3,433.16. The annual cost is computed by simply multiplying the corresponding cost per hectare by the total area in hectares using the new system, and then by two, which is the number of cycles per year.

Direct Labor Cost. Direct labor is estimated at US\$1,400 per month for a two-hectare farm. This cost includes food, transportation, and security. The duration of every production cycle is approximately four months. Annual labor cost for a two-hectare farm is then calculated by multiplying US\$1,400 by eight, which is the number of months to complete two production cycles and by the total area in hectares employing the zero water-exchange system. The total cost is then obtained by multiplying the number by the total number of four half-hectare ponds used in the system.

Indirect Costs. Annual indirect costs per hectare, based on the results obtained were estimated at US\$9,553. All the variables included in this cost category have been determined utilizing the following assumptions:

- Equipment and facility maintenance costs equal 1.5 percent of the total initial investment cost.
- Depreciation costs are estimated by considering zero salvage value and by using a straight-line method. Given the economic life of the corresponding asset, depreciation reported is annual.

- Annual land concession fees are estimated on average as US\$25 per hectare.⁴
- Taxes are determined as US\$500 plus one percent of total revenues.⁵

Cost and Returns Budget

Detailed budgets including revenue, operating costs, and gross profit in total U.S. dollars, per seeded hectare and per harvested pound (heads-on) basis are presented below (Table 9). Predicted annual expenses and revenues for the prototype UCA farm were based on two production cycles per year and an annual predicted production of 74,740 pounds of shrimp (heads-on) per four half-hectare pond system. At a selling price per pound of US\$3.00(heads-on), total revenue would have equaled US\$224,220. Total annual operating expenses would have been US\$131,280, generating an annual gross profit of US\$92,940.

Total harvest for the two-hectare demonstration farm was 20,008 pounds for the one cycle. Average selling price was US\$2.05 (heads-on)⁶, given the average size of shrimp harvested from the four ponds (Table 10). Based on the production yields from the first cycle, annual production is assumed to be 40,016 pounds of shrimp. Table 9 also presents the adjusted production costs and revenues after completing the first production cycle.

	Prec	licted	Ann	ual	Actual	Projected	Ann	val
	Total	Total	Per harvested	Per Seeded	Total	Total	Per barvested	Per Seeded
	1 Cycle	2 Cycles	Pound	На	1 Cycle	2 Cycles	Pound	Ha
Pounds Harvested	37,370	74,740			20,008	40,016		
Price (US\$/lb)	3.00	3.00			2.05	2.05		
Total Revenue USS	112,110	224,220	3.00	56,055	41,016	82,033	2.05	20,508
Operating Expenses								
Postlarvae US\$	11,995	23,991	0.32	5,998	11,995	23,991	0.60	5,998
Feed US\$ (include shipping cost)	20,518	37,636	0.50	9,409	17,176	30,952	0.77	7,738
Chemicals/Fertilizer US\$	1,251	2,503	0.03	626	1,251	2,503	0.06	626
Fuel US\$	5,866	11,733	0.16	2,933	6,866	13,733	0.34	3,433
Direct Labor US\$	5,600	11,700	0.15	2,800	5,600	11,200	0.28	2,800
Indirect Costs US\$	43,095	44,216	0.59	11,054	37,801	38,211	0.95	9,553
Total Operating Expenses US\$	88,326	131,279	1.76	32,820	80,690	120,590	3.01	30,147
Gross Profit US\$	23,784	92,941	1.24	23,235	(39,674)	(38,557)	(0.96)	(9,639)

Table 9. Cost and returns budget for zero water-exchange UCA demonstration project.

⁴ Rivera, César. 2000. Guía Informativa. Nicaragua y el Sector Pesquero. Administración Nacional de La Pesca. Centro de Investigaciones Pesqueras y Acuícolas (CIPA). p. 21

⁵ Rivera, César. 2000. Guía Informativa. Nicaragua y el Sector Pesquero. Administración Nacional de La Pesca. Centro de Investigaciones Pesqueras y Acuícolas (CIPA). p. 21

⁶ The average heads-on price for 70/80 count per kilogram shrimp is currently lower than it has been for several years. The price for 70/80 count per kilogram heads-on shrimp during the same time in 2001 was in excess of US\$3.00

Size	Heads-on Prices
Ct/Kg	US\$ per lb
50/60	2.41
60/70	2.16
70/80	2.05
80/100	1.95

Table 10. Prices for shrimp sold from demonstration project.

2 C 7

Source: Camarones de Nicaragua, S.A.

Based on predicted values before first harvest, indirect costs constituted the largest operating expense. Indirect costs accounted for 33.68 percent of the estimated production costs from two production cycles. Depreciation accounted for 28.07 percent of indirect costs. Feed was the largest direct expenditure at 28.67 percent of the annual estimated operating expense. Post-larvae cost was 18.27 percent of total annual costs. Fuel and direct labor accounted for 8.94 and 8,53 percent of total expenses. Chemicals and fertilizers accounted for 1.91 percent of total production costs (Table 11).

Based on the actual demonstration project results, total actual operating expense was US\$80,690. The actual percentage contribution of every operating expense to total operating expenses increased over what was predicted, except feed and indirect costs. Feed cost decreased because only 48,840 pounds out of the 64,570 pounds (purchased) of feed were consumed. Although feed consumption decreased by 24.36 percent from the quantity originally predicted, total feed cost decreased by only 16 percent due to the fixed shipping cost associated for every 44,000 pounds of feed. The percentage contribution from total indirect costs decreased as total investment cost of the UCA facility decreased, thus lowering depreciation and facility and equipment maintenance costs. Taxes decreased due to (1) a lower average price per pound of shrimp and (2) the lower actual production achieved, thus generating lower revenues.

	Pred	licted	Actual	Projected		
	1 Cycle	2 Cycles	1Cycle	2 Cycles		
Operating Expenses	Percent	Percentage (%)		Percentage (%)		ntage (%)
Postlarvae	13.58	18.27	14.87	19 .89		
Feed (include shipping cost)	23.23	28.67	21.29	25.67		
Chemicals/Fertilizer	1.42	1.91	1.55	2.08		
Fuel	6.64	8.94	8.51	11.39		
Direct Labor	6.34	8.53	6.94	9.29		
Indirect Costs	48.79	33.68	46.85	31.69		
Total Operating Expenses	100.00	100.00	100.00	100.00		

Table 11. Percentage contribution to	total operating expenses for zero water-exchange
demonstration project.	

Annual Cost and Returns Budgets for Different Sized Farms

Annual expenses include both cash expenses and non-cash expenses such as depreciation. The operating budget assumes that production levels, survival rate, average harvest size, number of operating cycles, and unit prices remain constant for each cycle and across the different sized farms. For instance, the selling price per pound of 13.50 grams heads-on shrimp (the average harvest size) is US\$3.00. Since target annual production yield is at least 1,033,661 pounds of shrimp (head-on), total revenue across the different sized systems is constant at US\$3,100,983. Some costs including postlarvae, feed, and taxes remain constant (since production is constant) across the different sized farms. Total annual cost for chemicals and fertilizers, fuel, and concession fees vary accordingly with increases or decreases in total area expressed in hectares using the zero water-exchange system. Equipment and facility maintenance cost is set at 1.5 percent of the corresponding total investment cost given the production level per hectare. Depreciation also varies accordingly with the economic life of assets and ultimately with total investment cost associated with the size of the farm. Total operating expenses decrease as production level per hectare increases and as the total production area expressed in hectares decreases. The lower operational costs result in higher gross profit.

Sensitivity Analysis

Tables 12a - 15b show the variation in costs, net returns, and break-even prices as production levels (pounds/hectare/cycle) and average shrimp price per pound (heads-on) vary. Production levels range from 15,000 to 40,000 pounds per hectare per cycle while four different shrimp prices per pound were considered: US\$2.50, US\$3.00, US\$3.50, and US\$4.00. For all the price levels and for every hypothetical farm, annual gross profits, expressed in (1) total US dollars, (2) per pound harvested, and (3) per hectare seeded, are positive. As annual yields increase per hectare and less area using the zero water-exchange technology is needed to produce 1,033,661 pounds of shrimp annually, the hypothetical farms become more efficient. Influenced by economies of size, certain total costs including chemicals/fertilizers, fuel, direct labor, and indirect costs decrease.

Table 12a. Cost and returns budgets for the UCA zero water-exchange system and hypothetical farms at US\$2.50 per pound.

4	30	115	13.29	
4	55	115	13.50	

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Pounds Harvested	Price (US\$/lb)	Total Revenue USS

Operating Expenses

operating rapenses	Postlarvae US\$	Feed US\$	Chemicals/Fertilizer US\$	el USS	Direct Labor US\$	Indirect Costs US\$	Equipment & Facility Maintenance US\$	Depreciation US\$	Concession Fees US\$ Taxes US\$	Total Operating Expenses USS	
	Postlar	Feed U	Chemi	Fuel US\$	Direct	Indirec	-	_		Total (

Gross Profit USS

•	•										
type Farm	Actual	10,004	40,016	2	20,008	2	4	30	115	13.29	
UCA Prototype Farm	Predicted	18,685	74,740	2	37,370	2	4	55	115	13.50	

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al Farms	0 40.000	1,033,661	5	80,000				1 244		
Hypothetic	35,000	1,033,661	5	70,000	15	30	55	214	13.50	
Different Production Scenarios - Projected Hypothetical Farms	30,000	1,033,661	2	60,000	17	34	55	183	. 13.50	
n Scenarios	25,000	1,033,661	2	50,000	21	41	55	153	13.50	
nt Productio	20,000	1,033,661	2	40,000	26	52	55	122	13.50	
Differe	15,000	1,033,661	2	30,000	34	69	55	92	13.50	

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$T_{\alpha+\alpha}$		2 Cycles	1.033.661	10060-06-	2.50		2.584.153	and had
Thatal			1.033.661		2.50		2.584.153	
Tafal	1 Culor	4 Lyuca	1,033,661		2.50		2,584,153	
Total	2 Curlas		1,033,661		2.50		2,584,153	
Total	2 Cveles		1,033,661		- 0C-7		CI1490;7	
Projected	2 Cveles		40,016		00.7		040'00T	
Actual	1 Cycle	1000.00	20,008	0.9 0	00.4	20.000	070,050	
cted	2 Cycles	012 12	/4, /40	7 5 0	0.07	106 060	100'001	
Predicted	1 Cycle	1040 50	n/ci/c	2.50	0.0.7	201 50	034600	

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1,496,588	1,562,699	1,650,848	1,774,255	1,959,366	2,267,885	120,770	80,780	130,905	88,139
26,342	26,342	26,342	26,342	26,342	26,342	1,500	1,000	2,369	1,434
323	369	431	517	6 <u>6</u>	861	S .	00	00	
154,203	470,122	001 007	2126222				V2	42	4
104 000	201 604	748 196	300 373	386.152	514.118	33,022	33,022	36,856	36,856
21329	24.316	28,297	33,872	42,234	56,171	3,818	3,818	4,568	4,508
242,197	272,651	313,256	370,103	455,374	597,492	38,391	168,75	45,842	44,508
144,713	165,386	192,950	231,540	C75'687	າມຮຸເອເ	11,200	nnn'r	11,200	000 01
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675 456	675.456	675,456	675,456	675,456	675,456	30,952	17,176	37,636	810,02
329,335	329,335	329,335	329,335	329,335	CCC,67C	166,62	C64,11	1///	

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933,305 1,021,453 1,087,565

	17 15 13 30,000 35,000 40,000	1,033,661 1,0		[]] []		2.50 2.50 2.50		0.32 0.32 0.32	0.65		0.19 0.16 0.14		1.51	0.90 0.99 1.05				75,000 87,500 100,000		9,558 11,151 12,744	22,871	626				27,087 34,587 42,086	
<u>Scenarios - Projected Hypothetical Farms</u>	21 25,000 30	1,033,661 1,033,661	Annua]	Per Harvested Pound	036		-			1 10		0.36 (1.72	0.78		Anua!	Fer Seeded Ha	62,500 75,			16,336 19,			2,0UU 5, 8 051 0		19,588 27,	
o Different Production Scenarios	26 20,000	1,033,661			2.50			0.32	0.65	0.17	0.28	0.44	1.90	0.60				50,000		6,372	13,069	626	3,433	8,811	37,911	12,089	
Differen	34 15,000	1,033,661			2.50			0,32	C0.0	0.23	0.37	0.58	2.19	0.31				37,500		4,779	9,802	626	5,435	8.671	32,910	4,590	
ype Farm Projected	2 10,004	40,016		d Pound	2.50		And the second se	0.60	0.06	0.34	0.28	0.96	3.02	(0.52)		, M.		25,010	- 000 P	866.0	/,/38	020	- 00% C	9,598	30,192	(5,182)	
UCA Prototype Farm Predicted Projected	18,685	74,740	Anna	Fer Harvested Pound	2.50			0.32	0.03	0.16	0.15	0.59	1.75	0.75		ADRUAL Der Sandad Wa		46,713	 000 	846°C	207	070	2.800	10,961	32,726	13,986	
Total Area (ha)	Production (18s/ha/cycle) Production (18s/ha/cycle) Rynaedad Ammod Broduction (1	LAPECTED AUTIUM FIODUCTION LEVEL	OPERATING COST AND RETURN BUDGET	Pounds Harvested	Price (US\$/1b) Total Revenue US\$		O perating Expenses Postlarvae RSS	Feed US\$	Chemicals/Fertilizer US\$	Fuel US\$	Direct Labor US\$ Indirect Costs 118 t	Total Onerating Expanses 1120		Gross Profit USS	OPERATING COST AND DUTIEN MEETING	LEGAR NAURAL MALAN	Pounds Harvested Price (US\$/1b)	Total Revenue USS	Operating Expenses Postlarvae USS	Feed US\$	Chemicals/Fertilizer USS	Fuel US\$	Direct Labor US\$	Indirect Costs US\$	Total Operating Expenses US\$	G ross Profit USS	

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Table 13a. Cost and returns budgets for the UCA zero water-exchange system and hypothetical farms at US\$3.00 per pound.

	Predi
Production (lbs/ha/cycle)	1
Expected Production Level (Ibs/2ha/yr)	7
Total Ave. Production_Traditional System (lbs/324ha/yr)	
Cycles	
Total Production (lbs/ha/yr)	ι Έ
Total Area (ha)	
Number of 1/2 ha ponds	
Survival Rate (%)	
Stocking Density (PL/m2)	
Average Harvest Size (g)	

	Ē										
type Farm	Actual	10,004	40,016	2	20,008	2	4	30	115	13.29	
UCA Prototype Farm	Predicted	18,685	74,740	2	37,370	2	4	55	115	13.50	

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Differer	nt Productio	Different Production Scenarios - Projected Hypothetical Farms	- Projected	Hypothetica	Farms
15,000	20,000	25,000	30,000	35,000	40,000
			-		
1,033,661	1,033,661	1,033,661	1,033,661	1,033,661	1,033,661
2	2	2	2	2	2
30,000	40,000	50,000	60,000	70,000	80,000
34	26	21	17	15	13
69	52	41	34	30	26
55	55	55	55	55	55
92	122	153	183	214	244
13,50	13.50	13.50	13.50	13.50	13.50

Farm	
Prototype	
ncal	
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OPERATING COST AND RETURN BUDGET

Predicted	cted	Actual	Projected	Total	Total	Total	Totol	Tratal	177 T
vele	2 Oveles	1 Ocle	Orles	J Cala				TUIN	10131
	ľ				4 Lycites	4 Cycles	2 Cycles	2 Cycles	2 Cycles
7,370	74,740	20,008	40,016	1,033,661	1,033,661	1,033,661	1.033.661	1.033.661	1 033 661
3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	302	1005001
11 110	OCC YCL				Construction of the local division of the			00.0	7.00
2,110	774,220	60,024	120,048	3,100,983	3,100,983	3,100,983	3,100,983	3.100.983	3,100,003

710 001	911 125 1	1.444.967	1.321.560	1,136,449	827.930	(922)	(20,856)	92,941	23,784
1,501,756	1,567,868	1,656,016	1,779,423	1,964,535	2,273,055	0/6/071	1000/100	6/7/101	070'00
31,510	31,510	31,510	31,510	31,510	31,510	1,700	1,100	24/77	170,1
323	369	431	517	646	198	00			n 1 1 1
124,203	470,122	100					202	2	5
194 201	221.624	258,186	309,373	386,152	514,118	33,022	33,022	36,856	36,856
21,329	24,316	28,297	33,872	42,234	56,171	3,818	3,818	4,568	4,568
247,365	277,819	318,424	375,271	460,542	602,661	38,591	166,12	44,216	43,095
144,713	165,386	192,950	231,540	289,425	385,900	11,200	5,600	11,200	- 000°C
88,718	101,392	118,291	141,949	177,436	236,582	13,733	6,866	11,733	008,0
16,170	18,480	21,560	25,872	32,340	43,120	2,503	1,251	f0c'7	107,1
675,456	675,456	675,456	675,456	675,456	675,456	30,952	17,176	37,636	810,02
329,335	329,335	329,335	329,335	329,335	329,335	23,991	11,995	23,991	11,995

Equipment & Facility Maintenance US\$

Indirect Costs US\$

Direct Labor US\$

Fuel US\$

Depreciation US\$

Chemicals/Fertilizer USS

Operating Expenses

Postlarvae US\$

Feed US\$

Total Revenue US\$

Pounds Harvested

Price (US\$/lb)

Gross Profit US\$

Total Operating Expenses USS Concession Fees US\$ Taxes US\$

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827,930 1,136,449 1,321,560 1,444,967 1,533,116 1,599,227

			•	19					
51,912	41,937	31,963	21,989	12,015	(230)	23,235	Gross Profit US\$		
53,088	48,063	1/50,54	1 170'00	0.110					
9,407	9,242	9,076	11.0	32.085	30,242	32,820	Total Operating Expenses US\$		
5,600	5,600	5,600	5,600	000,0 8 746	4,0VU 9.648	11.054	Indirect Costs US\$		
3,433	3,433	3,433	3,433	3,433	3,433	2,933	Direct Labor US\$		
626	626	626	626	626	620	070	Fuel USS		
22,871	19,604	16,336	13,069	9,802	1,138	202	Chemicals/Fertilizer US\$		
11,151	9,558	7,965	6,372	4,779	5,998	5,998	Postarvae US\$ Feed US\$		
							Operating Expenses Postlarvae 13.5.		
105,000	90,000	75,000	60,000	45,000	30,012	56,055	Total Revenue USS		
							Price (US\$/Ib)		
	ded Ha	Per See			led Ha	Fer See	Pounds Harvested		
	ual	αuγ			ua}	Ann.	OPERATING COST AND RETURY BUDGET		
1.48	1.40	1.28	1.10	0.80	(0.02)	1.24			
1.52	1.00	1.1 k							
17.0		66 F	1.90	2.20	3.02	1.76	Total Operating Expenses USS		
0.16	0.19	950	0.45	0.58	0.96	0.59	Indirect Costs US\$		
0.10	11.0		80.0	0 37	0.28	0.15	Direct Labor US\$		
0.02	0.02	E0.0	0.13	0.23	0.34	0.16	Fuel US\$		
0.65	0.65	0.65	0.65	C0.0	0.06	200	Chemicals/Fertilizer US\$		
0.32	0.32	0.32	0.32	0.32	0.60	0.32	Posuarvae US\$ Feed US\$		
							O perating Expenses		
3.00	3.00	3.00	3.00	3.00	3.00	3.00	Total Revenue US\$		
							Price (US\$/1b)		
	ssted Pound	Per Harve			ted Pound	Per Harves			
	nual	A.n.			ual	Ann	OPERATING COST AND RETURN BUDGET		
100,000,1	100,000,0	1005000							
-	1.033.661	1,033,661	1,033,661	1,033,661	40,016	74,740	Expected Annual Production Level		
	30.000	25.000	20,000	15,000	10,004	18,685	Production (lbs/ha/cycle)		
	17	21	26	34	2	2	l utal Area (na)		
Hvnothetic	- Projected	on Scenarios	nt Productio	Differe	Projected	Predicted			
		÷			type Farm	UCA Proto			
		₽° •							
stical farms	na nypothe	A system a		ממסת דוההומו ה		- - -	4		
4 loo 1	nd homothe	A svetem a	for the UC	eded hectare	and per se	harvested pound	Table 13b. Costs and net returns per har		
	tical farms Hypothetica 35,000 15 35,000 1,033,661 1,033,661 1,033,661 1,033,661 1,033,661 1,033,661 1,033,661 1,133,610 1,065 0,000 0,027 1,131 1,52 3,407 53,000 53,000 53,000 1,151 1,151 2,2,871 2,2,871 2,2,871 2,2,871 2,2,871 2,2,871 2,2,871 2,2,871 2,2,871 2,2,871 2,2,871 2,2,871 2,2,2,871 2,2,2,871 2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,	nd hypothetical farms (US\$3 - Projected Hypothetical Farms (US\$3 - Projected Hypothetical Farms (US\$3 17 15 30,000 35,000 40 1,033,661 1,033,661 1,033 3.00 0,02 0,05 0.02 0,05 0.11 0,10 0,10 0.10 0,10 0,10 0.11 0,10 0,10 0.12 0,000 1,55 1,40 1,151 1,26 1,40 1,151 1,26 1,50 5,600 5,600 5,9 4,1937 51,912 61	A system and hypothetical farms a System and hypothetical farms a Scenarios - Projected Hypothetica 1,033,661 1,033,661 1,033,661 1,033,661 1,033,661 1,033,661 1,033,661 1,033,661 1,033,661 1,033,661 1,033,661 1,033,661 3.00 3.00 3.00 3.00 3.00 3.00 3.00 3.00 3.00 3.00 1.52 0.11 0.16 0.14 0.11 0.16 0.14 0.11 0.16 0.14 0.11 0.16 0.122 0.19 0.14 0.11 0.148 1.28 1.40 1.48 1.28 1.40 1.48 1.28 1.40 1.48 1.35 0.00 7.965 9,558 1.1,1,151 1.52 1.60 10.558 1.1,1,151 1.53 3,433 3.433 3.433 3.433 3,433 3.433 3.433 3,433 3.433 3.433 3,433 3.433 3.433 5.600 9,0463 5.600 3.0600 9,076 9,242 9,407 43.037 48,063 5.003 5.000 9,076 9,242 9,407 43.037 48,063 5.003 5.000	for the UCA system and hypothetical farms if Production Scenarios - Projected Hypothetical 26 21 1,033,661 1,033,661 1,033,661 1,033,601 1,033,661 1,033,661 1,033,661 1,033,601 3,000 1,033,661 1,033,661 1,033,661 1,033,601 3,000 1,033,661 1,033,661 1,033,601 1,033,601 1,032 20,000 3,00 3,00 3,00 3,00 0,02 0,17 0,14 0,11 0,010 0,00 0,17 0,14 0,11 0,010 0,00 0,17 0,14 0,11 0,010 0,00 0,17 0,13 0,01 0,01 0,010 0,016 0,02 0,03 0,03 0,03 0,02 0,000 0,000 1,10 1,28 1,40 1,1,151 13,069 16,336 19,604 22,871 626 626 626 626 626 626 626 626 626 626	eded hectare for the UCA system and hypothetical farms Different Production Scenarios - Projected Hypothetica Different Production Scenarios - Projected Hypothetica 3 00 3 00 1,033,661 1,033,661 1,033,661 1,033,661 1,033,661 1,033,661 1,033,661 1,033,661 1,033,661 1,033,661 1,033,661 1,033,661 1,033,661 0.10 3.00 0.32 0.32 0.32 0.32 0.32 0.32 0.32 0.32 0.32 0.32 0.32 0.32 0.32 0.32 0.32 0.32 0.32 0.32 0.32 0.32 0.32 0.32 0.32 0.32 0.32 0.32 0.32 0.32 0.32 0.32 0.32 0.32 <th <="" colspan="2" td=""><td>1 and per secded hectare for the UCA system and hypothetical farms type Farm Different Froduction Scenarios - Frojected Hypothetic 10.012 $1.033,661$ $1.033,$</td><td>vested pound and per seeded hectare for the UCA system a UCA Prototype Farm Different Production Scenarios Predicted Projected Table Different Production Scenarios $\frac{2}{74,740}$ $\frac{3}{40,016}$ $\frac{2}{1,033,661}$ $\frac{2}{1,033,661}$ Annuel An Predicted Projected $\frac{3}{400}$ $\frac{3}{3.00}$ $\frac{2}{3.00}$ $\frac{2}{3,000}$ $\frac{3}{2.000}$ $\frac{1}{2.000}$ $\frac{1}{2.000}$ $\frac{1}{2.000}$</td></th>	<td>1 and per secded hectare for the UCA system and hypothetical farms type Farm Different Froduction Scenarios - Frojected Hypothetic 10.012 $1.033,661$ $1.033,$</td> <td>vested pound and per seeded hectare for the UCA system a UCA Prototype Farm Different Production Scenarios Predicted Projected Table Different Production Scenarios $\frac{2}{74,740}$ $\frac{3}{40,016}$ $\frac{2}{1,033,661}$ $\frac{2}{1,033,661}$ Annuel An Predicted Projected $\frac{3}{400}$ $\frac{3}{3.00}$ $\frac{2}{3.00}$ $\frac{2}{3,000}$ $\frac{3}{2.000}$ $\frac{1}{2.000}$ $\frac{1}{2.000}$ $\frac{1}{2.000}$</td>		1 and per secded hectare for the UCA system and hypothetical farms type Farm Different Froduction Scenarios - Frojected Hypothetic 10.012 $1.033,661$ $1.033,$	vested pound and per seeded hectare for the UCA system a UCA Prototype Farm Different Production Scenarios Predicted Projected Table Different Production Scenarios $\frac{2}{74,740}$ $\frac{3}{40,016}$ $\frac{2}{1,033,661}$ $\frac{2}{1,033,661}$ Annuel An Predicted Projected $\frac{3}{400}$ $\frac{3}{3.00}$ $\frac{2}{3.00}$ $\frac{2}{3,000}$ $\frac{3}{2.000}$ $\frac{1}{2.000}$ $\frac{1}{2.000}$ $\frac{1}{2.000}$

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Production (Ibs/ha/cycle)	Total Area (ha)
Expected Production Level (Ibs/2ha/yr)	Number of 1/2 ha ponds
Total Ave. Production _Traditional System (Ibs/324ha/yr)	Survival Rate (%)
Cycles	Stocking Density (PL/m2)
Totat Production (Ibs/ha/wr)	Average Harvest Size (g)

pe Farm Actual	10,004	40,016	2	20,008	6	4	30	115	13.29	
UCA Prototype Farm Predicted Actual	18,685	74,740	2	37,370	2	4	55	115	13.50	

41- 41 -Different Production Scenarios - Projected Herr

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Differen	Different Production Scenarios - Projected Hypothetical Farms	n Scenarios	- Projected)	Hypothetica	i Farms
15,000	20,000	25,000	30,000	35,000	40,000
1,033,661	1,033,661	1,033,661	1,033,661	1,033,661	1,033,661
2	2	2	2	2	2
30,000	40,000	50,000	60,000	70,000	80,000
34	26	21	17	15	13
69	52	41	34	30	26
55	55	55	55	55	55
92	122	153	183	214	244
13.50	13.50	13.50	13.50	13.50	13.50

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OPERATING COST AND RETURN BUDGET

yclust 1.0134 1.0131 1.0131 1.0131 Total yclust 1 Cycle 2 Cycles	Phoningrad	~	Antinol	Designated	To to 1		E	I	ļ	
I Cycle 2 Cycles	ş		Umnu	TIUGUIGU	TOUND	LOTAL	lotal	Total	Total	Trifa
20,008 40,016 1,033,661 1,033,661 1,033,661 1,033,661 1,033,661 1,033,661 1,033,661 1,033,661 1,033,661 1,033,661 1,033,661 1,033,661 1,033,661 1,033,661 3,50	Ч	Cycles	1 Cycle	2 Cycles	2 Cycles	2 Cycles	2 Oveles	2 Cveles	2 Orles	2 Contac
3.50 3.50 <th< td=""><td>Ĺ</td><td>74,740</td><td>20,008</td><td>40,016</td><td>1,033,661</td><td>1,033,661</td><td>1.033.661</td><td>1.033.661</td><td>1 033 661</td><td>- ugues 1 033 661</td></th<>	Ĺ	74,740	20,008	40,016	1,033,661	1,033,661	1.033.661	1.033.661	1 033 661	- ugues 1 033 661
70,028 140,056 3.617,814 3.617,814 3.617,814 3.617,814 3.617,814 3.617,814		3.50	3.50	3.50	3.50	3.50	3.50	3.50	US E	1 40
	Ä	61,590	70,028	140,056	3.617.814	3.617.814	3.617.814	117 814	1 617 914	110 417 C

110.000	1 977 AMO C	1.956.630	1,833,222	1.648.111	1339.592	18,886	(10,952)	129,938	42,282
1,506,925	1,573,036	1,661,184	1,784,592	1,969,703	2,278,222	121,170	80,980	700'101	CICÍOO
36,678	36,678	36,678	36,678	36,678	36,678	1,901	1,200	3,116	1,808
323	369	431	517	646	861	20	00	00	2 2
194,203	221,624	981,862	5/5,205	701'000	014,110	420400	440600	000fm	103
620,12	010427	1/160-				000 00	LUV 62	36 956	14.956
21 220	24 316	28.297	33.872	42,234	56,171	3,818	3,818	4,568	4,568
252,533	282,987	323,592	380,440	465,711	607,829	38,791	38,091	44,590	43,282
144,713	165,386	192,950	231,540	289,425	385,900	11,200	5,600	11,200	2,600
88,718	101,392	118,291	141,949	177,436	236,582	13,733	6,866	11,733	3,866
16,170	18,480	21,560	25,872	32,340	43,120	2,503	1,251	2,503	1,2,1
675,456	675,456	675,456	675,456	675,456	675,456	30,952	17,176	37,636	810,02
329,335	329,335	329,335	329,335	329,335	329,335	23,991	11,995	23,991	11,995

Equipment & Facility Maintenance USS

Indirect Costs US\$

Direct Labor US\$

Fuel US\$

Depreciation US\$

Chemicals/Fertilizer US\$

Operating Expenses

Postlarvae US\$

Feed US\$

Total Revenue USS

Pounds Harvested

Price (USS/lb)

Gross Profit US\$

Total Operating Expenses USS Concession Fees US\$ Taxes US\$

20

18,886 [1,339,592 1,648,111 1,833,222 1,956,630 2,044,778 2,110,889

nd and per seeded hectare for the UCA system and hypothetical farms (US\$3.50).	
14b. Costs and net returns per harvested pound a	
Table 14b.	

					2 ²			
•	UCA Prototype Farm Predicted Projected	ype Farm <u>Projected</u>	Differer	it Productio	n Scenarios	- Projected I). Different Production Scenarios - Projected Hypothetical Farms	Ĥarms
Total Area (ha)	2	2	34	26	21	17	15	13
Production (lbs/ha/cycle)	18,685	10,004	15,000	20,000	25,000	30,000	35,000	40,000
TAPPECTED ANNULL FOULCHON LEVEL	74,740	40,016	1,033,661	1,033,661	1,033,661	1,033,661	1,033,661	1,033,661
OPERATING COST AND BETHEN RIDGET	Annal	 					A CONTRACTOR OF	
					Annual	uaf		
Pounds Harvested	rer Harveste	Harvested Pound			Per Harve	Per Harvested Pound		
Price (US\$/Ib)								
Total Revenue USS	3.50	3.50	3.50	3.50	3.50	3.50	1 4.0	3 60
								00.0
U peratug Expenses Postlarvae LISS								
	70.0	0.00	25.0	0.32	0.32	0.32	0.32	0.32
Chemicals/Pertilizer 1184	0.00	0.77	0.65	0.65	0.65	0.65	0.65	0.65
	21.0	0.0	0.04	0.03	0.03	0.02	0.02	0.02
Direct Labor USS	<u>910</u>	0.34	0.23	0.17	0.14	0.11	0.10	60'0
fundiment Proto IIO 0		07'0	/ 5*0	0.28	0.22	0.19	0.16	0.14
	0,60	0.97	0.59	0.45	0.37	0.31	0.27	0.24
I ULAI OPERALING EXPENSES USS	1.76	3.03	2.20	1.9.1	1.73	1.61	1.52	1.46
Gross Profit USS	1.74	0.47	1.30	1.59	1.77	1.89	1.98	2.04
						-		
OPERATING COST AND RETURN BUDGET	Annual	al			Annual	ual		المراجع br>المراجع المراجع
	Per Seed	Seeded Ha			Per Seeded Ha	ded Ha		; ****
Founds Harvested Price (IIS\$/Ib)								
Total Revenue (SS	66 200	7 6 0 1 1						
	occ'en	+10,66	100,20	74,000	87,500	105,000	122,500	140,000
Operating Expenses								,
Postlarvae US\$	5,998	5,998	4,779	6,372	7,965	9,558	11,151	12,744
	9,409	7,738	9,802	13,069	16,336	19,604	22,871	26,138
Chemicals/Fertilizer US\$	626	626	626	626	626	626	626	626
	2,933	3,433	3,433	3,433	3,433	3,433	3,433	3,433
LUICOCI LEDOF USA Ta Airest Costs 1100	2,800	2,800	5,600	5,600	5,600	5,600	5,600	5,600
	11.14/	9,698	8,821	9,011	9,201	9,392	9,582	9,772
l otal Uperating Expenses US\$	32,913	30,292	33,060	38,111	43,162	48,213	53,263	58,314
Gross Profit IISS	191 22							
	34,464	4,722	19,440	31,889	44,338	56,787	69,237	81,686

Table 15a. Cost and returns budgets for the UCA zero water-exchange system and hypothetical farms at US\$4.00 per pound.

UCA Prototype Farm

Total Ave. Production _Traditional System (lbs/324ha/yr) Expected Production Level (ths/2ha/yr) Total Production (lbs/ha/yr) Stocking Density (PL/m2) Production (lbs/ha/cycle) Average Harvest Size (g) Number of 1/2 ha ponds Survival Rate (%) Total Area (ha) Cycles

115 10,004 40,016 20,008 30 13.29 খ Predicted Actual 18,685 115 13.50 74,740 55 37,370 \sim 2 4

Different Production Scenarios - Projected Hypothetical Farms

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Statement of the second se					
13.50	13.50	13.50	13.50	13.50	13.50
244	214	183	153	122	92
55	55	55	55	55	55
26	30	34	41	52	69
13	15	17	21	26	34
80,000	70,000	60,000	50,000	40,000	30,000
2	2	2	2	2	C1
1,033,661	1,033,661	1,033,661	1,033,661	1,033,661	1,033,661
40,000	35,000	30,000	25,000	20,000	15,000

BUDGET	
(ETURN)	
T AND F	
VG COS	
OPERATING COST AND RETURN BUDGET	
	i

	I Cycle	2 Cycles	1 Cycle	2 Cycles	
Pounds Harvested	37,370	74,740	20,008	40,016	1
Price (US\$Vb)	4.00	4.00	4.00	4.00	1
Total Revenue USS	149,480	298,960	80,032	160,064	1

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Operating Expenses Postlarvae US\$ Feed US\$ Chernicals/Fertilizer US\$ Fuet US\$ Direct Labor US\$
Equipment & Facility Maintenance USS Depreciation US\$ Concession Fees US\$

Taxes US\$	tal Operating Expenses USS
	Total

Gross Profit US\$

UCA Prototype Farm

T_{OFG}	2 Cvcles	1,033,661	4.00	4,134,644
Total	2 Cycles	1,033,661	4.00	4,134,644
Total	2 Cycles	1,033,661	4.00	4,134,644
Total	2 Cycles	1,033,661	4.00	4,134,644
Total	2 Cycles	1,033,661	4,00	4,134,644
Total	2 Cycles	1,033,661	4.00	4,134,644
Projected	2 Cycles	40,016	4.00	160,064
Actual	1 Cycle	20,008	4.00	80,032
cted	2 Cycles	74,740	4.00	298,960
Predicted	1 Cycle	37,370	4.00	149,480

1,512,093	1,578,204	1,666,352	1,789,760	1,974,871	2,283,390	121,370	81,080	132,026	88,700
41,846	41,846	41,846	41,846	41,846	41,846	2,101	1,300	3,490	1,995
323	369	431	517	646	198	50	8	ନ	8
194,203	221,624	258,186	309,373	386,152	514,118	33,022	33,022	36,856	36,836
21,329	24,316	28,297	33,872	42,234	56,171	3,818	3,818	4,568	4,568
257,702	288,155	328,761	385,608	470,879	612,997	38,991	38,191	44,963	43,469
144,713	165,386	192,950	231,540	289,425	385,900	11,200	5,600	11,200	5,600
88,718	101,392	118,291	141,949	177,436	236,582	13,733	6,866	11,733	5,866
16,170	18,480	21,560	25,872	32,340	43,120	2,503	1,251	2,503	1,251
675,456	675,456	675,456	675,456	675,456	675,456	30,952	17,176	37,636	20,518
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1,851,254 2,159,773 2,344,884 2,468,292 2,556,440 2,622,551

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Total Area (ha)	Production (ibs/ha/cycle)	Expected Annual Production Level
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OPERATING COST AND RETURN BUDGET

Total Revenue USS Pounds Harvested Price (US\$/Ib)

Chemicals/Fertilizer US\$ Fuel US\$ **Operating Expenses** Direct Labor US\$ Postlarvae US\$ Feed US\$

Gross Profit US\$

Total Operating Expenses USS

Indirect Costs US\$

OPERATING COST AND RETURN BUDGET

Total Revenue US\$ **Pounds Harvested** Price (US\$/Ib)

Operating Expenses Postlarvae US\$ Feed US\$

Direct Labor US\$ Indirect Costs US\$ Total Operating Expenses US\$ Chemicals/Fertilizer US\$ Fuel US\$

Gross Profit USS

41,733

			-
type Farm Projected	5	10,004	40,016
UCA Prototype Farm Predicted Projected	2	18,685	74,740

Different Production Scenarios - Projected Hypothetical Farms

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13	40,000	1,033,661
15	35,000	1,033,661
17	30,000	1,033,661
21	25,000	1,033,661
26	20,000	1,033,661
34	15,000	1,033,661
~	4	16

Annal	Per Harvested Pound		4.00 4.00	
			4.00	
			4.00	
ual	ted Pound		4.00	
Annual	Per Harvested Pound		4.00	

							į
0.60	0.77	0.06	0.34	0.28	0.97	3.03	
0.32	0.50	0.03	0.16	0.15	0.60	1.77	

2.23	

0.97

2.54

2.47

2.39

2.27

2.09

1.79

0.02

0.32 0.65

4.00

4.00

0.25 1.46

0.14

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0,65 0.02

0.02

0.11

0.14

0.22 0.37 1.73

0.28

0.37

0.59 2.21

0.461.91

0.32

0.32 0.65

0.32 0.65 0.03

0.32 0.65 0.03 0.17

0.32 0.65 0,04 0.23

1.8 J	ded Ha	
anna	Per Seeded Ha	

n.a			40,016	
Anaua	Per Seeded Ha		74,740	

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5,998	7,738	626	3,433	2,800	9,748	30,343
5,998	9,409	626	2,933	2,800	11,241	33,007

			160,000
			140,000
Ausual	Per Seeded Ha		120,000
	Per See		100,000
			80,000
n south a finite and a supervised and the supervised of the			60,000

86.562	71,637	56,713	41,789	26,865
53,438	48,363	43,287]	38,2111	33,135
9,757	9,542	9,326	9,111	0,020
000.5	0001	2000		2000
2 200	5 600	5.600	5.600	5,600
3.433	3,433	3,433	3,433	3,433
626	626	626	626	626
22,871	19,604	16,336	13,069	9,802
11,151	9,558	7,965	6,372	4,179
	22,871 22,871 3,433 5,600 53,438 53,438 86,562	19,604 22,871 626 626 626 626 3,433 3,433 5,600 5,600 9,542 9,757 48,363 53,438 71,637 86,562	19,604 626 3,433 5,600 9,542 48,363 71,637	16,336 19,604 626 626 3,433 3,433 5,600 5,600 9,326 9,542 43,287 48,363 56,713 71,637

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101,486

86,562

71,637

Comparing Zero Water-Exchange and Semi-intensive Systems

This section contains information on the projected investment cost of a hypothetical 26-hectare farm with a projected production level of 20,000 pounds/hectare/cycle⁷ employing a zero water-exchange technology. Total production cost and revenues as well as annual operating costs per harvested pound and per seeded hectare for both the hypothetical zero water-exchange farm and a typical semi-intensive farm are also presented.

Even though each shrimp producer has a unique set of resources and thus experiences investment requirements and operating costs unique to a specific situation, the information provided in this document may be used as a guide for evaluating individual investments, operating costs and production practices.

Table 16. Investment requirements for a zero water-exchange system to produce annually1,033,661 pounds of shrimp (heads-on) at a production level of 20,000pounds/hectare/cycle on a 26-hectare farm.

	Total Cost
Feeding Equipment	
Feed Storage	2,500
Feeders	20,673
Sub-Total Feed Equipment	23,173
Permanent Equipment	
Aeration Equipment	270,935
Pumps	68,265
Electrical Generators	335,333
Scientific Equipment	2,644
Sub-Total Perm Equipment	677,177
Other Costs	-
Pond Construction	
Earthwork	600,009
Settling Ponds (1ha)	
Grow-out Ponds (1/2ha)	
Canals/Reservoirs	
Roads	
Drains	
HDP pond liners	505,116
Electrification	422,701
Wire	
Panels	
Water Control Structures	564,341
Piping	
Sluice Gates	
Valves	
House/Office	13,921
Office Equipment	9,183
Sub-Total Other Costs	2,115,272
TOTAL DIRECT COSTS (US Dollars)	2,815,622
Cost per hectare (US Dollars)	108,957
Annual Depreciation	386,152
Depreciation per ha	14,943

⁷ Actual production achieved at the UCA demonstration project was 10,004 pounds/hectare/cycle.

One of the objectives of this analysis was to compare traditional and zero waterexchange systems. Thus, a zero water-exchange system using actual production rates from the demonstration project was designed to achieve a production level of 1,033,661 pounds. A 26-hectare-zero water-exchange system would be required⁸. Total investment requirements for feeding equipment, permanent equipment, and other costs associated with the construction of a 26-hectare zero water-exchange farm (52 one-half-hectare ponds) amounts to US\$2,815,622 or US\$108,957 on a per hectare basis. Total annual depreciation for this system is US\$386,152 and per hectare depreciation cost equals US\$14,943. As indicated above, total initial investment requirements may vary from producer to producer. For instance, earthwork cost could increase or decrease depending on the existing land characteristics. Utilizing the levees of an existing farm system would decrease the cost of pond construction. In contrast, the per hectare cost of building a pond system utilizing the semi-intensive technology has been estimated to be between US\$4,000 and US\$10,000.

The assumptions used for estimating production costs and revenues for the hypothetical zero water-exchange farms and the typical semi-intensive farm are shown in Table 17. It was estimated that the 20,000-pounds/hectare/cycle-production level might be achieved if optimum production management practices of the zero water-exchange intensive technology are employed. The total area utilized by each of the two systems was determined dependent on the production objective (1,033,661 pounds annually) and the production variables after implementing the corresponding production strategies. With the zero water-exchange technology, a 26-hectare farm with 52 one-half-hectare ponds is needed to produce the desired annual production with a survival rate of 55 percent and average harvest size of 13.50 grams (heads-on). In contrast, a 324-hectare farm using the semi-intensive technology will be required to produce the 1,033,661 pounds annually. For the semi-intensive farm, survival rate is 31.68 percent and average harvest size is approximately 13 grams (heads-on). Stocking density varies as well between the two systems: 122 PL/m² for the zero exchange system and 18 PL/m² for the semi-intensive system. The selling price used in this comparison is US\$3.00 per pound of shrimp.

 Table 17. Production assumptions for the 26-hectare zero water-exchange farm and the 324-hectare semi-intensive farm.

	Zero Exchange System	Semi-Intensive System
Production (lbs/ha/cycle)	20,000	1,536
Cycles	2.00	2.04
Total Production (lbs/ha/yr)	40,000	3,133
Total Area (ha)	26	324
Number of 1/2 ha ponds	52	-
Survival Rate (%)	55.00	31.68
Stocking Density (PL/m2)	122	18
Average Harvest Size (g)	13.50	12.98
Shrimp Price US\$/lb (heads-on)	3.00	3.00

⁸ This is actual pond production area and des not include the land needed for settling ponds. Costs for settling ponds are included in estimates.

Comparing the Cost and Earnings of the Zero Water-Exchange System and the Semi-intensive System

The costs vary between the two systems mainly due to the total area needed to produce the desired production. The costs for each system are compared on a total, per harvested pound of shrimp, and per seeded hectare basis (Tables18-21). The cost of postlarvae per pound harvested for the zero water-exchange system is lower than for the semi-intensive technology. However, PL cost per hectare is greater for the zero waterexchange system since stocking density (PL/m²) is much higher. Feed cost, on the other hand, is greater in both per pound harvested and per seeded hectare for the zero waterexchange system. The estimated value was calculated using the feed conversion ratio of 2.44; however, this ratio should decrease significantly if more efficient production strategies, such as a better assessment of the actual survival rate, are used. The cost of chemicals and fertilizers per pound harvested is lower, while on a per seeded hectare basis this cost is much greater for the zero water-exchange system. When considering this cost in total U.S. dollars, the zero water-exchange system costs less money to operate than the semi-intensive system. Direct labor for the hypothetical farm using the zero water-exchange technology is always greater (on per seeded hectare, per harvested pound, and in total U.S. dollars) than for the semi-intensive system. With respect to indirect costs, it was not accurate to make a comparison between the two systems since the variables included in this cost category vary for each system. (i.e. the semi-intensive system indirect cost data available for this analysis do not allow a comparison with the UCA demonstration project indirect costs). Nevertheless, total operating costs clearly indicate that the zero water-exchange system can be more cost efficient than the semiintensive system.

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Table 18. Annual financial comparison for the 26-hectare zero water-exchange farm	and
the 324-hectare semi-intensive farm.	

Financial Item	Zero Exchange System	Semi-Intensive System
	Total	Total
Annual Production per ha.	40,000	3,133
Total Area (ha)	26	324
Founds Harvested	1,033,661	1,033,661
Shell-On Price (US\$/lb)	3.00	3.00
Total Revenue US\$	3,100,983	3,100,983
Total Operating Expenses US\$	1,964,535	2,069,834
Gross Profit US\$	1,136,449	1,031,150

Table 19. Detailed annual operating expenses for the zero water-exchange and semiintensive systems (on a per harvested pound basis).

Operating Expenses	Per harv	ested Lb.
	Zero Exchange System	Semi-Intensive System
Postlarvae US\$	0.32	0.47
Feed US\$	0.65	0.46
Chemicals/Fertilizer US\$	0.03	0.06
Direct Labor US\$	0.28	0.06
Indirect Costs US\$ including Fuel	0.62	0.95
Total	1.90	2.00

 Table 20. Detailed annual operating expenses for the zero water-exchange and semiintensive systems (on a per seeded hectare basis).

Operating Expenses	Per See	eded Ha.
	Zero Exchange System	Semi-Intensive System
Postlarvae US\$	6,372	720
Feed US\$	13,069	713
Chemicals/Fertilizer US\$	626	91
Direct Labor US\$	5,600	96
Indirect Costs US\$ including Fuel	12,344	1,456
Total	38,011	3,076

Total revenue, total operating costs and gross profit summarized on per harvested pound and per seeded hectare for the two systems are also shown (Table 21). Even though the zero water-exchange system provides a small profit (10 cents) difference on per harvested pound when compared to the semi-intensive system, gross profit generated by the zero water-exchange technology on per hectare basis is significantly higher. Annual profit per seeded hectare for the zero water-exchange system was US\$21,989, whereas the same value for the traditional system was US\$1,552.

Table 21. Annual financial comparison for the 26-hectare zero water-exchange farm and the 324-hectare semi-intensive farm (per harvested pound and per seeded hectare).

Cost and Revenues	Zero Exchan	Zero Exchange System		Semi-Intensive System		
	Per Harvested Lb.	Per Seeded Ha.	Per Harvested Lb.	Per Seeded Ha.		
Annual Production per ha.	40,000		3,133			
Total Area (ha)	26		324			
Pounds Harvested	1,033,661		1,033,661			
Shell-On Price (US\$/lb)	3.00		3.00			
Total Revenue US\$	3.00	60,000	3.00	4,608		
Total Operating Expenses US\$	1.90	38,011	2.00	3,076		
Gross Profit US\$	1.10	21,989	1.00	1,532		

Advantages and Disadvantages of the Zero Water-Exchange System

Disadvantages

The zero water-exchange system requires a very large initial investment, which may discourage many potential investors from considering the system as a profitable alternative to traditional semi-intensive shrimp farming. This may be particularly true for those semi-intensive farmers who might wish to retrofit a portion of their existing farms.

Given the relatively large initial investment, the financial risk associated with a crop failure is much higher with the zero water-exchange system.

Advantages

The zero water-exchange technology can result in sustained higher yields. The yields are higher due to (1) the high survival rates because of the biosecurity practices implemented and (2) the high stocking density.

The zero water-exchange system also reduces the amount of nutrients released into the environment since no water is exchanged.

The above technical advantages can lead to lower operating costs in total U.S. dollars and per pound harvested. The feed conversion ratio should be better for the zero water-exchange system due to high levels of aeration, which creates a current that suspends solids for shrimp grazing. Thus, feed costs should be reduced.

Another advantage of the new system is the use of less land to produce the same desired production objective. This should result in lower annual concession fees.

Due to lower operating costs, the zero water-exchange system generates slightly higher profits per pound harvested, but much higher profits on per hectare basis when compared to the semi-intensive technology.

Finally, the zero water-exchange system reduces the amount of time required to prepare pond water for stocking. By using both the recycled water and the ponds lined with plastic, restocking can take place as soon as five days after a pond is harvested. A more efficient use of the available growing season is allowed.

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