A Techno-Financial Analysis of Tilapia Production in the Recirculating Aquaculture Systems

BY

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ABSTRACT

The extensive fish farming in Egypt is mainly dependent on drainage water of agriculture, where pollution is most probably occurs. By law the Ministry of Public Affairs does permit raising fish on fresh water. Moreover, extensive fish farming in Egypt means tremendous losses in both land and water. To produce one kg of fish needs around 2 m^2 of land and 5 m^3 of water. The most feasible solution to overcome such problems is to develop a semi-intensive fish farming.

A techno financial analysis of tilapia production was conducted using a recirculating aquaculture system facility, situated at the Banha University, Agriculture College. Tilapia (1.0g), were stocked in the tanks; temperature and water quality parameters were carefully managed until the fish reached the harvestable size (500g) after 180 days. The survival rate and feed conversion ratio (FCR) were 90% and 1.5 respectively.

The results showed that, the operational cost involving the system production was suited and economically viable.

Breakeven price above variable cost, breakeven price above fixed cost and breakeven yield estimated were 7.96 L.E. kg^{-1}, 9.33 L.E. kg^{-1} and 155,495 kg $year^{-1}$ respectively. The sensitivity analysis revealed that, increasing in the fixed cost by +10% decreased the internal return rate (IRR) from 34% to 23%. Also, decreasing the revenue by -10% decreased the internal return rate (IRR) from 34% to 22%. While, change both increasing in the fixed cost by +10% and decreasing the revenue by -10% at the same time decreased the internal return rate (IRR) from 34% to 11%.

Key words: Tilapia, recirculating system, Aquaculture, sensitivity analysis, breakeven yield, breakeven cost, economic analysis.

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1.0 Introduction

Aquaculture is one of the fastest growing sectors of food production in the world. Cultured species such as tilapia, catfish, salmon, trout, oysters and clams are high in demand and the profit level is very high. The boom in this industry can be attributed to the growing demand for a healthy, tasty and affordable food as well as the sharp decline in wild fish populations as a result of overharvest and water pollution (Helfrich & Libey, 1990). The rampant pollution of fresh water resources has also necessitated the need for the culturing of fish in waters free from contamination. Recirculating aquaculture system (RAS) technology has been found to provide away in solving this problem. This is a technology designed for holding and growing a wide variety of aquatic species and defined as production units which recycle water by passing it through filters to remove metabolic and other waste products (Kazmierczak & Caffey, 1995).

In 2008, commercial aquaculture production was about 2.8 million tonnes with a corresponding estimated value of $3.7 billion. The production was forecasted to reach 3.7 million tonnes by the end of 2010 (FAO, 2009; FAO GLOBEFISH, 2011a). By 2015, world production is expected to reach between 4.6 million tonnes and 5 million tonnes (FAO, 2010).

The systems can be designed to cater for different capacities and efficiencies. In comparison to the traditional aquaculture practices, RAS offers more independence from the external environment (i.e. increased levels of control) which provides a basis for improved risk management (Rawlinson, 2002). Majority of the world's tilapia productions are done using the pond systems, however, in the temperate regions, RAS is employed in the production due to the cold climatic conditions. This makes the production cost higher since huge capital is expended on the RAS construction and the running of other production mechanisms such as heating, pumping and filtering of the water (Alceste & Jory, 2002). A lot of countries are now using RAS in fish production; however, production level is very low compared to other forms of fish culture (Martins *et al.,* 2010). The construction and operation of these facilities require high capital injection and this sometimes serves as disincentive to prospective investors (Schneider *et al.,* 2006). To make up for this, high stocking densities are required in the productions to be able to cover the investment costs and generate profit. However, the need for high stocking densities also comes with some welfare challenges (Martins *et al.,* 2005).

Aquaculture production using RAS has been the focus of research and developmental efforts of many groups for decades.

Recirculation aquaculture systems (RAS) are new and a unique way to culture fish. In place of the old conventional methods of growing fish, RAS offers a means to rear fish in indoor tanks where the environment can be controlled. The system filters and cleans the water for recycling back through fish culture tanks (Helfrich & Libey, 1990). In RAS, more than 90% of the water is recirculated through a series of biological and mechanical filtration systems so that only a fraction of the water is consumed (Rawlinson & Foster, 2000). "New" water is added to the tanks only to make up for losses through splash outs; evaporation and for those that is used to flush out waste materials. Fish cultured using this technology must be provided with a congenial environment and conditions suitable for growth and to remain healthy. Clean water, dissolved oxygen, and optimal temperatures are required to ensure better growth. These are achieved by the filtration system, aerators and heaters incorporated in the technology design. The filtration system purifies the water and removes or detoxifies products harmful to the culturing media and species. Organic particles from faeces and uneaten feed are removed by the mechanical particle filters, whereas the poisonous metabolic waste products TAN and NO_2 (total ammonium nitrogen and nitrite) are oxidized to less toxic compounds (NO_3) in nitrification filters. These filters are sometimes referred to as aerobic biofilters or nitrification filters. In the construction of the RAS facility, proper sizing of all system components is very important. When the RAS plant is oversized for its application, the system would function but the cost of running the facility would be high. Under sized RAS, on the other hand, would not be able to maintain proper environment to sustain fish production.

RAS offer various advantages ranging from reduction water consumption (Verdegem et al., 2006 *in* Martins et al., 2010), to the provision of improved opportunities for waste management and nutrient recycling (Piedrahita, 2003 *in* Martins et al., 2010). The systems environment can be controlled to achieve better hygiene and disease management (e.g. Summerfelt et al., 2009 *in* Martins et al., 2010). It offers a near complete environmental control to maximize fish growth year-round, and the flexibility to locate production facilities near large markets(Masser et al., 1999; Schneider et al., 2010) to deliver a fresher, safer product and lower transport cost (Timmons et al., 2001). In terms of product security RAS offers a high degree of product traceability (Smith, 1996; Jahncke & Schwarz, 2000) and biological pollution control (no escapees, Zohar et al., 2005 *in* Martins, et al., 2010).

They may be used as grow-out systems to produce food fish or as hatcheries to produce eggs and fingerling, for stocking and ornamental fish for home aquariums (Helfrich & Libey 1990).

The objectives of this study were estimate the operational cost involved and from this, estimate the breakeven cost, (1) identify and describe the constraints unique to the recirculating aquaculture systems (RAS), (2) to perform financial feasibility of a scale-up production, and (3) to conduct sensitivity analysis to highlight their effect on profitability

2. Analysis Procedures.

2.1. System description:

There is no single recommended design for growing fish in an RAS. In general, a system includes tanks to culture fish, pumps to maintain water flow, and some form of water treatment to maintain water quality. Following are a few considerations on system design and how design can affect profitability. For a more complete explanation of component options and management issues, see Ali, 2006.

The data used for this publication are taken from experiences at El-Nenaiea Fish Farm (Ali, et al., 2006) and Banha University, Faculty of Agriculture, Fish Farm Project.

The system consists of a quarantine tank, two nursery tank, and eight growout tanks. The system represented in this example consists of eleven tanks: one 6.0 cubic meter quarantine tank (Q); two 15.0 cubic meter nursery tanks (N1 and N2), and eight 100.0 cubic meter grow-out tanks. The quarantine and nursery tanks have their own water filtration systems, while each set of four growout tanks shares a water treatment system.

Fish are initially stocked in the Q tank, grown and screened for diseases for 30 days, then harvested, divided into equal numbers, and restocked into the two N tanks. After 30 days of growth, the fish are transferred from one N tank into one of the eight G tanks, where they are grown an additional 120 days until harvest. This 120-day period is divided into four distinct production stages of 30 days each (defined as GS1, GS2, GS3, and GS4 in figure 1). Each of these stages has a different feed rate, oxygen demand, and water flow requirement. (An alternative to this configuration would be to move the fish into a different tank for each of the 30-day periods.) It is important to note that the model reflects four stages of growth in the growout tank phase, so that changing production costs can be accommodated within the spreadsheet. This should not be confused with the need to have a total of eight growout tanks in order to meet required production volumes for cash flow. Additionally, your total number of days to harvest may differ with species, culture temperature, and final average harvest size.

Once system is fully stocked, one of the eight G tanks is harvested for sale every 30 days. The system has a maximum culture density of 83.55 kg m^{-3} of water in each growout tank, and each harvest yields approximately 8355 kg of fish. Depending on design specifications, the maximum culture density may be different. The author of this publication designs systems not to exceed a maximum culture density of approximately 80-85kg $m^{-3}$of water. With 12 harvests annually (one every 30 days once the facility is fully stocked), total production for the facility is approximately 200,000 kg per year.

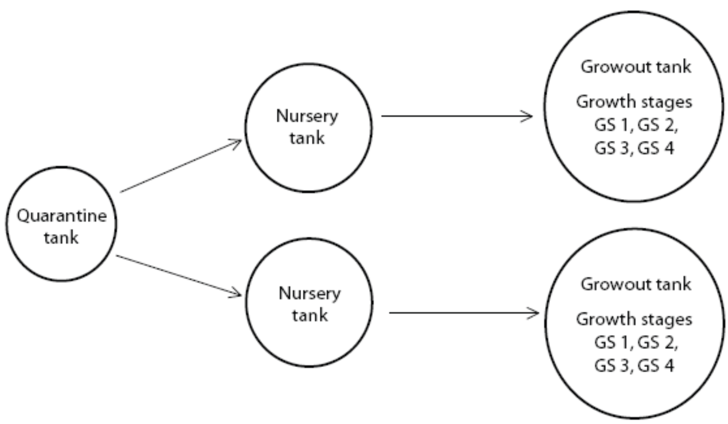

Figure 1. Diagram of fish flow through system.

2.2 Production model for estimations

2.2.1 Biological Model

These tools were used to estimate incomes and production; growth and mortality. The simplest tool to use is the formulas for biomass, B_t, and biomass value, V_t:

$$B_t = N_t \times W_t \tag{1}$$

Where, N_t is the number of fish at time t, and W_t is the weight of the fish at time t. The sales output (value of the fish) from the production is calculated by multiplying price with quantity:

$$V_t = P_w \times B_t \qquad (2)$$

Where V_t is the biomass value and P_w is the price pr. kg of fish. The kg price is assumed to increase as the weight of the fish increases $P_w > 0)$. This formula does not take into consideration the effect of seasonal variations on the price of fish (Bjørndal 1987).

Feed Conversion Ratio (FCR): is considered an important biological production parameter to consider, and could be calculated from the following equation (Einen & Roem, 1997):

$$FCR = \frac{FB}{BM_2 - BM_1 - FT} \qquad (3)$$

Where FCR is kg consumed feed per kg growth, FB consumed feed in kg, BM_2 is biomass at harvest, BM_1 is start biomass, or biomass at stocking, and FT is fish lost to mortality.

2.2.2 Financial Analysis.

2.2.2.1 Net income.

The net income of the production can be estimated using the following formula:

$$Net\ income = Total\ revenue - Total\ production\ cost \qquad (4)$$

Variable costs are those directly related to production; energy, bicarbonate, fingerlings, chemicals, maintenance and labor. According to Hoff, (1998), Variable unit costs, represent the cost involved to produce a kg of the produce and it's given by the formula:

$$Variable\ unit\ (kg) cost = \frac{Total\ Variable\ costs}{Harvested\ Biomass} \qquad (5)$$

2.2.2.2 Payback Period:

Payback period is the one of the oldest and most widely used method used for evaluating a capital investment proposal. As the name implies it refers to the time required to recover the initial investment or the initial cash outlay as it is called in financial terms.

$$Payback\ Period = Year\ before\ recovery - \frac{Unrecovered\ cost\ at\ start\ of\ the\ year}{Cashflow\ during\ the\ year} \qquad (6)$$

2.2.2.3 Internal Return Rate (IRR):

The internal rate of return on an investment is the annualized effective compounded return rate or rate of return that makes the net present value (NPV) as:

$$NPV = \sum_{n=0}^{n} \frac{Cashflow_n}{(1+IRR)^n} \quad (7)$$

where *n* is the project period per year.

A rate of return for which this function is zero is an internal rate of return.

2.2.2.4 Income/Outcome ratio:

$$\text{Income/Outcome ratio} = \frac{\sum_{n=0}^{n} \text{Income Cashflow}}{\sum_{n=0}^{n} \text{outcome Cashflow}} \quad (8)$$

2.2.2.5 Breakeven analysis

Breakeven analysis informs producers about the price they need to receive for their product in order to cover all costs of production. It also indicate to the producer, the kilogram of fish, and price for the fish needed to cover the variable, fixed, and total costs of production.

The breakeven cost/price is the price at which the product must be sold in order for profit to be zero. It is also the sales level at which the accruing revenue is exactly equal to the cost of making the output.

$$Breakeven\ point = \frac{Total\ cost\ of\ production}{Produced\ quantity\ (kg)} \quad (9)$$

The *breakeven per unit yield* represents the number of units, or kilograms needed to be sold in order to break even.

$$Breakeven\ point/unit\ (kg) = \frac{Total\ cost\ of\ production}{Unit\ price\ per\ kg} \quad (10)$$

2.2.2.6 Sensitivity Analysis.

Sensitivity analysis was conducted to test the effect of some variables on the profitability of the production and to know the areas where an improvement in performance may have a positive impact on the economic performance of the RAS (Losordo & Westerman, 1994). The simplest form of sensitivity analysis (one-way sensitivity analysis) was employed. This was done by varying one variable by a (+/-) percentage and the impact on the financial performance of the production were examined. The analysis was then repeated for the other variables identified in the operational costs.

The identified cost variables were varied by +/- 10% since such variations usually occur in commercial productions (De Ionnoet al., 2006).

2.3. Financial Evaluation.

An Excel program was developed and used to estimate initial investment, operating costs, and annual returns for the system under study. Production costs and sale price are based on the experiences over the past 14 years at El-Nenaeia fish farm.

2.3.1. Initial Investment.

The initial investment (Table 1) includes the total value of a land and effluent pond, building, equipment, construction labor, annual depreciation on building and equipment and interest rate on operating capital.

Table (1): Initial Investment

Initial investment			
	Land		L.E. 120,000.00
	Effluent pond		L.E. 60,000.00
	Equipment		L.E.1,300,000.00
	Building		L.E. 550,000.00
	Construction labor and overhead		L.E. 100,000.00
Total initial investment			**L.E.2,130,000.00**
Annual depreciation on building			L.E. 171,500.00
Interest rate on operating capital			**9%**
Interest rate on building and equipment			**10%**

2.3.2. Operating costs and returns.

Table (2), includes the variable costs, fixed costs, sale price, system parameters, water volume (m^3), size harvested, survival rate, survival rate and feed cost per kg. It is to be mentioned that, these parameters (tables 1 and 2) are calculated in tables (5 and 6) as set in the program.

Table (2): Operating costs system parameters.

Item		Unit or Description	Value
Variable Costs:			
	Liquid oxygen	L.E. per cubic meter	**-**
	Energy	L.E. per kW h	**0.20**
	Bicarbonate	L.E. per kg	**3.00**
	Fingerlings	L.E. per fingerling	**0.12**
	Chemicals	L.E. per cycle	**720.00**
	Maintenance	L.E. per month	**3,800.00**
	Labor: management	L.E. per month	**6,000.00**
	Labor: transfer & harvest	L.E. per hour	**50.00**
Fixed Costs:			
	Liquid oxygen tank rental	L.E. per month	**-**
	Electrical demand charge	L.E. per month	**-**
	Building overhead	L.E. per month	**900.00**
Average overall sale price		L.E. per kg	**12.00**
System Parameters			
	Annual production	kg	**200,000**
	Average size at harvest	kg	**0.5**
	Number of production units	number	**11**
	Days per production unit	days	**30.5**
	kW h per kg of production	kWh kg^{-1}	**3.00**
	System volts	volts	**230**
	Transfer/harvest labor	hours per cycle	**64**

3. Economical Results.

Data in tables 1, 2 and 3 are used to calculate the information were presented in tables 4, 5 and 6. Data in tables 4, 5 and 6 show the operational parameters of the system.

Table (3): Operating Parameters per Production Unit

Item	Quarantine Stage	Nursery Tank 1	Nursery Tank 2	Growout Tank 1	Growout Tank 2	Growout Tank 3	Growout Tank 4	Growout Tank 5	Growout Tank 6	Growout Tank 7	Growout Tank 8	Average
Water volume, m3	6	15	15	100	100	100	100	100	100	100	100	
Size stocked	1	15	15	60	60	135	135	250	250	385	385	
Size harvested	15	60	60	135	135	250	250	385	385	500	500	
Survival rate	0.95	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.90
Feed cost, per kg	5.50	4.50	4.50	3.80	3.80	3.80	3.80	3.80	3.80	3.80	3.80	
Feed conversion	1.00	1.10	1.10	1.30	1.30	1.60	1.60	1.60	1.60	1.60	1.60	1.50

Table (4): Inputs per production unit.

Input Use	Quarantine Tank	Nursery Tank 1	Nursery Tank 2	Growout Tank 1	Growout Tank 2	Growout Tank 3	Growout Tank 4	Growout Tank 5	Growout Tank 6	Growout Tank 7	Growout Tank 8	Total per harvested cohort	Annual Total
Beginning number of fish	36,997	17,574	17,574	17,397	17,397	17,223	17,223	17,050	17,050	16,879	16,879	36,997	442,752
Ending number of fish	35,147	17,397	17,397	17,223	17,223	17,050	17,050	16,879	16,879	16,710	16,710	35,147	420,612
Beginning biomass, kg	37	264	264	1,044	1,044	2,325	2,325	4,263	4,263	6,498	6,498	37	443
Ending biomass, kg	527	1,044	1,044	2,325	2,325	4,263	4,263	6,498	6,498	8,355	8,355	16,710	199,972
Maximum standing biomass, kg m^{-3}	87.87	69.59	69.59	23.25	23.25	42.63	42.63	64.98	64.98	83.55	83.55	---	---
Feed used, kg	490	858	858	1,666	1,666	3,100	3,100	3,577	3,577	2,971	2,971	24,834	297,190
kW h used	1,471	2,341	2,341	3,844	3,844	5,812	5,812	6,708	6,708	5,570	5,570	50,019	598,588
Oxygen used, m^3	182	319	319	618	618	1,150	1,150	1,328	1,328	1,102	1,102	2,055	24,597
Bicarbonate used, kg	19	33	33	65	65	121	121	140	140	116	116	969	11,590

Table (5): Costs per production unit (L.E.).

Input Use	Quarantine Tank	Nursery Tank 1	Nursery Tank 2	Growout Tank 1	Growout Tank 2	Growout Tank 3	Growout Tank 4	Growout Tank 5	Growout Tank 6	Growout Tank 7	Growout Tank 8	Total per harvested cohort	Annual Total
Fingerlings	4,440											4,440	53,130
Feed	2,696	3,862	3,862	6,330	6,330	11,779	11,779	13,594	13,594	11,288	11,288	96,403	1,153,674
Energy	294	468	468	769	769	1,162	1,162	1,342	1,342	1,114	1,114	10,004	119,718
Oxygen	0	0	0	0	0	0	0	0	0	0	0	0	0
Bicarbonate	57	100	100	195	195	363	363	419	419	348	348	2,906	34,771
Total of above costs for this production unit	7,487	4,431	4,431	7,293	7,293	13,304	13,304	15,354	15,354	12,750	12,750	113,752	1,361,293
Cumulative cost for cycle	7,487	8,174	8,174	15,467	15,467	15,467	15,467	15,467	15,467	15,467	15,467	147,575	1,766,067

Table (6): Annual costs and returns to system in full production

Items		Unit	cost/unit	quantity/ harvest cycle	L.E. /harvest	L.E. /year	L.E per kg of fish	% of total
Variable Cost								
	fingerlings	each	0.12	36,997.07	4,439.65	53,130.23	0.27	2.85%
	feed	kg	3.88	24,833.69	96,402.92	1,153,674.24	5.77	61.83%
	energy	kWh	0.20	50,019.01	10,003.80	119,717.63	0.60	6.42%
	oxygen	Cubic meter	0.00	92.17	0.00	0.00	0.00	0.00%
	bicarbonate	kg	3.00	968.51	2,905.54	34,771.24	0.17	1.86%
	chemicals	L.E. /harvest cycle	721.97	1.00	721.97	8,640.00	0.04	0.46%
	maintenance	L.E. /harvest cycle	3,810.41	1.00	3,810.41	45,600.00	0.23	2.44%
	labor: management	L.E. /harvest cycle	6,016.44	1.00	6,016.44	72,000.00	0.36	3.86%
	labor: transfer & harvest	L.E. /harvest cycle	50.00	64.00	3,200.00	38,295.08	0.19	2.05%
	interest on variable costs	L.E.	0.09	65,970.19	5,457.45	65,310.49	0.33	3.50%
Subtotal, Variable Cost					132,958.18	1,591,138.90	7.96	85.27%
Fixed Cost								
	oxygen tank rental	L.E.			0.00	0.00	0.00	0.00%
	electrical demand charge	L.E.			0.00	0.00	0.00	0.00%
	building overhead	L.E.			902.47	10,800.00	0.05	0.58%
	interest on bldg. & equip.	L.E.			7,729.45	92,500.00	0.46	4.96%
	depreciation on bldg. & equip.	L.E.			14,330.82	171,500.00	0.86	9.19%
Subtotal, Fixed Cost					22,962.74	274,800.00	1.37	14.73%
Total Costs					155,920.92	1,865,938.90	9.33	100%
Returns above Variable Costs					67,561.82	808,526.67	4.04	
Returns above Total Costs					44,599.08	533,726.67	2.67	
Breakeven point price L.E./kg (above Variable Costs)							7.96	
Breakeven point price L.E./kg (above Total Costs)							9.33	
Breakeven point unit kg /year							155494.91	

3.1 Total costs, returns and breakeven point.

From table (6) the total cost per kg produced, per cycle and per year were 9.33, 155,921 and 1,865,939 L.E., respectively. Returns above variable costs were 4.04, 67,562 and 808,527 L.E. and above total costs were 2.67, 44,599 and 533,727 L.E. for the same previous order, respectively. Breakeven point price over variable and fixed cost and breakeven point unit were 7.96 L.E kg^{-1}, 9.33 L.E. kg^{-1} and 155,495 kg $year^{-1}$, respectively. These results show the economic feasibility of the system.

3.2 Outcomes/Incomes.

Table (7) shows the percentage of outcome to income, which was 1.24.

Table (7) Percentage of outcomes to incomes.

Year	Outcome Cash Flow	Income Cash Flow	Net Present Value (NPV) at 10%	
			Income	Outcome
1	2,453,183.00	200,000.00	2,230,166.36	181,818.18
2	1,591,138.90	2,399,665.57	1,314,990.83	1,983,194.69
3	1,591,138.90	2,399,665.57	1,195,446.21	1,802,904.26
4	1,591,138.90	2,399,665.57	1,086,769.28	1,639,003.88
5	1,591,138.90	2,399,665.57	987,972.07	1,490,003.52
6	1,591,138.90	2,399,665.57	898,156.43	1,354,548.66
7	1,591,138.90	2,399,665.57	816,505.84	1,231,407.87
8	1,591,138.90	2,399,665.57	742,278.04	1,119,461.70
9	1,591,138.90	2,399,665.57	674,798.22	1,017,692.45
10	1,591,138.90	3,229,665.57	613,452.93	1,245,175.89
			10,560,536.20	13,065,211.10
Outcome/Income			1.24	

3.3 Internal Return Rate (IRR).

Table (8) shows the internal return rate (IRR), which was 34%.

3.4 Payback Period.

Table (9) shows that the payback period is 3.79 years.

3.5 Sensitivity Analysis

A variation of +/-10% was used to analyze the capital variables and revenues, respectively. Table (10) shows the effect of increasing in the outcome cash flow by +10% on internal return rate (IRR), which was 23%.Table (11) shows the effect of decreasing income cash flow by -10% on internal return rate (IRR), which was 22%.

Table (12) shows the effect of increasing outcome cash flow and decreasing income cash flow about ±10%, which was 11%.

Table (8) Internal Return Rate (IRR).

Year	Outcome Cash Flow	Income Cash Flow	Net Cash Flow
1	2,453,183.00	200,000.00	-2,253,183.00
2	1,591,138.90	2,399,665.57	808,526.67
3	1,591,138.90	2,399,665.57	808,526.67
4	1,591,138.90	2,399,665.57	808,526.67
5	1,591,138.90	2,399,665.57	808,526.67
6	1,591,138.90	2,399,665.57	808,526.67
7	1,591,138.90	2,399,665.57	808,526.67
8	1,591,138.90	2,399,665.57	808,526.67
9	1,591,138.90	2,399,665.57	808,526.67
10	1,591,138.90	3,229,665.57	1,638,526.67
IRR		0.34	

Table (9) Payback Period.

Year	Yearly Revenue	Accumulation Revenue
1	-2,253,183	(2،253،183)
2	808,527	(1،444،656)
3	808,527	(،636،130)
4	808,527	،172،397
5	808,527	،980،924
6	808,527	1،789،450
7	808,527	2،597،977
8	808,527	3،406،504
9	808,527	4،215،030
10	1,638,527	5،853،557

Table (10): Effect of increasing in the outcome cash flow by +10% on internal return rate (IRR).

Year	Outcome Cash Flow+10%	Income Cash Flow	Net Cash Flow
1	2,698,501.30	200,000.00	-2,498,501.30
2	1,750,252.79	2,399,665.57	649,412.78
3	1,750,252.79	2,399,665.57	649,412.78
4	1,750,252.79	2,399,665.57	649,412.78
5	1,750,252.79	2,399,665.57	649,412.78
6	1,750,252.79	2,399,665.57	649,412.78
7	1,750,252.79	2,399,665.57	649,412.78
8	1,750,252.79	2,399,665.57	649,412.78
9	1,750,252.79	2,399,665.57	649,412.78
10	1,750,252.79	3,229,665.57	1,479,412.78
IRR		0.23	

Table (11): Effect of decreasing income cash flow by -10% on internal return rate (IRR).

Year	Outcome Cash	Income Cash Flow-10%	Net Cash
1	2,453,183.00	180,000.00	-2,273,183.00
2	1,591,138.90	2,159,699.02	568,560.12
3	1,591,138.90	2,159,699.02	568,560.12
4	1,591,138.90	2,159,699.02	568,560.12
5	1,591,138.90	2,159,699.02	568,560.12
6	1,591,138.90	2,159,699.02	568,560.12
7	1,591,138.90	2,159,699.02	568,560.12
8	1,591,138.90	2,159,699.02	568,560.12
9	1,591,138.90	2,159,699.02	568,560.12
10	1,591,138.90	2,906,699.02	1,315,560.12
IRR		0.22	

Table (12): Effect of increasing outcome cash flow and decreasing income cash flow about ±10% on internal return rate (IRR).

Year	Outcome Cash Flow+10%	Income Cash Flow-10%	Net Cash Flow
1	2,698,501.30	180,000.00	-2,518,501.30
2	1,750,252.79	2,159,699.02	409,446.23
3	1,750,252.79	2,159,699.02	409,446.23
4	1,750,252.79	2,159,699.02	409,446.23
5	1,750,252.79	2,159,699.02	409,446.23
6	1,750,252.79	2,159,699.02	409,446.23
7	1,750,252.79	2,159,699.02	409,446.23
8	1,750,252.79	2,159,699.02	409,446.23
9	1,750,252.79	2,159,699.02	409,446.23
10	1,750,252.79	2,906,699.02	1,156,446.23
IRR		0.11	

Conclusion

According to the obtained results, it could be concluded that to produce one kg of fish, it would cost 9.33 LE, while will profit 2.67 LE which represents 28.6%. The results should that, above variable and total costs were 4.04 LE and 2.67 LE, respectively. Incomes/outcomes was 1.24, IRR recorded 0.34. The payback period was 3.79 years. The results showed that, the operational cost involving the system production was suited and economically viable.

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تحليل فني ومالي لإنتاج أسماك البلطى في نظم إعادة تدوير المياه

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تحتل مصر المرتبة الثانية بعد الصين فى إنتاج أسماك البلطى في العالم، إلا أن معظم هذا الإنتاج يتم إنتاجه باستخدام مياه الصرف الصحى أو الزراعي تبعاً لقرار وزارة الري رقم (١٢٤) لسنة ١٩٨٣، مما يسبب أضراراً بالغة على صحة الإنسان. ويعتبر إنتاج الأسماك في نظم إعادة تدوير المياه أحد الحلول للتغلب على تلك المشكله، حيث أن تلك النظم لاتحتاج إلى كميات كبيرة من المياه (١.٠-١٠.٠% من حجم المياه يومياً) بالإضافة إلى توفير المساحات الكبيرة من الأراضى، حيث أن تلك النظم تعتمد على التكثيف (معظمة إنتاجية الوحدة).

لذا كان من الضرورى دراسة تلك النظم فنياً ومالياً للوقوف على مدى إمكانية تطبيقها إقتصادياً في مصر، وبالتالى كان الهدف من هذا البحث هو عمل تحليل فني ومالي لإنتاج أسماك البلطى في نظم إعادة تدوير المياه في الزراعة المائية. بناءً على تلك الدراسة وخبرة الباحث لمدة ١٤ سنة في هذا المجال، تم إنشاء مزرعة سمكية تعمل بهذا النظام لإنتاج ٢٠٠ طن من الأسماك سنوياً بكلية الزراعة بمشتهر- جامعة بنها، حيث إعتمد المصمم (الباحث) على الإنتاج المحلي كلما توفر ذلك لتقليل التكاليف الإستثمارية.

بلغت التكلفة الاستثمارية لمزرعة انتاج البلطى ٢٠٠ طن سنويا ٢,١٣٠,٠٠٠ جنيه، وكانت التكلفة المتغيرة ١,٥٩١,١٣٩ جنيه سنويا وقد كانت الارباح السنوية ونسبة المنافع للتكاليف ١.٢٤ ومعدل العائد الداخلى ٠.٣٤ وفترة استرداد رأس المال ٣.٧٩ سنة.

وقد أجرى إختبار الحساسية وأسفرت عن النتائج التالية:

- زيادة التكاليف الثابتة (التدفقات الخارجة) بنسبة ١٠% أسفرت عن إنخفاض معدل العائد الداخلي من ٣٤% إلى ٢٣%.
- إنخفاض سعر البيع (التدفقات الداخلة) بنسبة ١٠% أسفرت عن إنخفاض معدل العائد الداخلي من ٣٤% إلى ٢٢%.
- زيادة التكاليف الثابتة (التدفقات الخارجة) وإنخفاض سعر البيع (التدفقات الداخلة)معاًبنسبة ١٠% أسفرت عن إنخفاض معدل العائد الداخلي من ٣٤% إلى ١١%.

ومن هنا تأتى اهمية الدراسة فى القاء الضوء على مدى جدوى الاستثمار فى هذه المشاريع.

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