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ECONOMIC ANALYSIS OF DIFFERENT *TILAPIA* POND CULTURE SYSTEMS

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Abstract

This study investigates the economic potential of five diffrent tilapia pond culture systems . Pond culture systems were based on the use of chemical fertilizer only (CHEM), feed only (Feed) , chemical fertilizer , chicken litter , and feed (TRAD) , chicken litter and feed with mixed sex or monosex stocking CLFEDMS and CLFEDSR , respectively . Data on inputs and outputs of each system were obtained from experiment conducted at the central Laboratory for Aquaculture Research (CLAR) . Data regarding labour requirements and equipments were obtained from the available information from the production ponds at CLAR . Item costs for pond construction were obtained from the General organization for fisheries Resource Development . Budgets were developed for the five systems , utilizing 2.1 ha pond . Net returns , values of production for major inputs , break-even prices and yields , and average rate of returns to capital were estimated for each system.

CLFEDSR ,TRAD , and CLFEDMS systems had the highest yield , net returns , and average rate of return to capital . The same systems had the highest margin betwwen average price and break-even prices to cover total cost which indicated reduced risk to farmers in the event of a decline in market price . The above systems had the highest net returns when production decreased by one or two standard errors . Sensitivity analysis indicated that TRAD and CLFEDSR systems maintained positive net returns if fish yield decreased by two standard errors and prices decreasd by 20% .

INTRODUCTION

Pond fish culture can be practiced at many levels of production intensity based on the quantity and quality of nutrients added to enhance, supplement, or replace natural pond productivity (Bardach *et al.* 1972). Aquaculture ponds also can be stocked with one species (monoculture) or several species (polyculture) of fish . Moreover, since growth may be affected by fish sex, choice of production system may involve monosex culture of the faster growing sex. Economic considerations in selection of an approriate aquaculture production system include their potentiol for economic returns, their economic efficiency, and the farmer's access to operating capital .

There are few reports of economic evaluation of aquacultural production systems in Egypt. Soliman and Gaber (1988) compared production level, production variability, economic efficiency , and technology level for two different fish culture systems . El-Hendy (1990) evaluated technical and economical aspects of tilapia cage culture in Domyatt, Egypt. Reports of evaluation of production level, technology, costs and returns associated with tilapia pond culture practices in Egypt have been lacking .

The objective of the present syudy was to assess the economic potentiol of different pond culture systems for tilapia .

MATERIALS AND METHODS

In order to evaluate economic potential and profitability of an enterprise, estimated expenses and returns associated with the enterprise are considered in the form of a budget (Kay 1981, Boehlje and Eidman 1984 , Hatch and Hanson 1991).

Five tilapia production systems were tested in 0.1-ha earthen ponds at the Central Laboratory For Aquaculture Research (CLAR) at Abbasa, (Green *et al.* 1994). They included: 1) traditional system with mixed sex stocking (TRAD), where urea, superphosphate, chicken litter , and 25 % - protein pelleted feed were used ; 2) chemical fertilization system using monosex (CHEM), where only urea and superphosphate were applied at a nitrogen to phosphorus ratio of 4 : 1 ; 3) feed only using monosex (FEED) , where 25%-protein pelleted feed was used , and 4) Chicken litter followed by feed system with mixed sex or monosex stocking (CLFEDMS and CLFEDSR , respectively), where chicken litter was used for the first 60 days, then, 25%-protein pelleted feed was used. All production systems were stocked with Nile tilapia at 20,000/ha ; average individual weight was 1 to 3 grams per fish. Daily feed allowances were based on 3% of fish biomass. The average rearing period was 145 days. Data on stocking density, fertilization and feeding rates, rearing period, and yield for the above production systems were obtained from the above experiment. Data regarding labour requirements and equipments were obtained from the available information from the production ponds at CLAR. Item costs for pond construction were obtained from the General Organization for Fisheries Resource Development. Enterprise budgets were developed for each production system, utilizing 2.1ha pond stocking rate of 2,000/ha over an aveage rearing period of 145 days (Appendix, Tables A-1, A-2) . No charge for land was included in the cost estimates. Land was assumed to be owned and previously used for aquaculture .

RESULTS AND DISCUSSION

Net Returns and Cost

Net returns to land and management were the greatest for the CLFEDRS, followed in decreasing order by TRAD, CLFEDMS, FEED, and CHEM systems (Table 1) . Net returns to land and management for systems that combined fertilization and feeding, (CLFEDRS, CLFEDMS and TRAD) were, on average, 16.11 times net returns for extensive system (CHEM). Differences in net returns can be explained by production level, price received per unit of production, and total variable costs, since total fixed costs were similar for all production systems .

For the semi-intensive systems, total production ranged from 7,616 kilogram for CLFEDRS to 4,159 kilogram for FEED. For the extensive system (CHEM) , total production was estimalted at 2,973 kilogram. There was a positive relationship between net returns and production level .

Tilapia are marketed by size in Egypt, and market price per kilogram increase with fish size. Tilapia size classes are : 1st (1-5 fish/kg) , 2nd class (6-12 fish/kg) , 3d class (13-25 fish/kg) , and 4 th class (26-40 fish/kg) . Average prices, according to percentage of fish size classes produced, were estimiated (Table 1). There was a positive relationship between intensification of the sytem and average price. A high average price for a production system reflects the fact that , a major part of the production consists of large fish.

Total variable costs (TVC) were higher for the semi intensive systems than for the extensive system. The highest variable cost was for CLFEDMS , and the lowest was for CHEM (Table 1). The high variable costs of CLFED systems primarily were due to the cost of feed. Prior studies have shown that, even though, there is positive relationship between the level of intensification and variable costs ; the average cost may be lower than for extensive operation (Shang 1981, Tucker *et al.* 1979). Average variable cost, in Egyptian pounds (L. E.), per kilogram produced for each system is shown in Table 1. For the semi-intensive systems , they ranged from 2.21 L.E. for TRAD to 3.23 L. E. for CLFEDMS. The average variable cost per kilogram for the more extensive system (CHEM) was estimated at 2.50 L.E. These results indicated that not all intensive systems had lower average variable cost than the extensive system. However, in the case of uniform stocking rate, intesification should positively affect the final size of individual fish , as well as increase fish production. Thus, considering the average price per kilogram, semi-intensive systems had higher average return per kilogram above average variable cost than the sytem (CHEM) (Table 1).

Total variable costs and variable cost components as a percentage of total variable costs for each production system are shown in Appendix, Tables A-1 and A-2. Results of previous research indicated that, feed and fertilizer were the most important cost items for intensive aquaculture (Shang 1981, Hatch *et al.* 1987). For semi-intenive systems, feed costs ranged from 39% of TVC for CLFEDRS to 54% for FEED. Fertilizer costs ranged from 20% of TVC for TRAD to 31% of TVC for CLFEDRS. Together, feed and fertilizer comprised 54% to 75% of TVC of production. The cost of fingerlings and fertilizer represented 56% and 32% of TVC , respectively , for the extensive system (CHEM).

Performance Ratios:

A summary of performance ratios is shown in Table 1. Value of production per man-hour ranged from 104 L. E., for CLFEDRS system to 56 L. E. for FEED and CHEM systems. The highest value of production per L. E. of variable costs was for CLFEDRS followed in decreasing order by TRAD, CLFEDMS, and CHEM system. The value of production per 100 Kilogram of feed ranged from 468 L.E. for CLFEDSR to 245 L. E. for FEED system. Break-even prices and break-even yield to cover total costs also are shown in Table 1. TRAD system had the lowest break-even price to cover total costs followed in increasing order by, CLFEDSR, FEED, CHEM, and CLFEDMS. However, CLFEDRS had the highest margin between break-even price to cover total costs and average price followed in decreasing order by, CLFEDMS, TRA , FEED and CHEM.

To measure the profitability for each sytem, rate of return to capital was calculated. Land valued at 32.640 L. E. for a 2.1 ha pond, other investments were estimated at 34.204 L. E., and return to management was assumed to be zero. The CLFEDSR system had the highest rate of return to capital (29.97%) , followed by TRAD (22.94%), CLFEDMS (22.52%), FEED (6.66%) and CHEM (2.42%).

Sensitivity Analysis:

Variation in yield, as indicated by cofficients of variation was less in the extensive system (CHEM) than in the semi-intensive systems (Table 1). Similar results have been reported by other researchers (Tucker *et al.* 1979). Actual received prices were used to estimate total returns. However, these prices were slightly higher than local prices. Therefore, the impact of price reduction, output level reduction, and combinations of the two on net returns were estimated (table 2).

At a 10 or 15% price reduction, all production systems, except CHEM had positive net returns. Decrease in price level by 20% resulted in negative net returns for CHEM and FEED systems. Decrease in production level by one or two standard errors with no reduction in sales price resulted in negative net returns for FEED and CHEM systems. Results of the combined change in price and production level showed that : 1) decrease in production level by one standard error and in price by 10,15 or 20% resulted in negative net returns for FEED and CHEM systems , and 2) decrease in production by two standard errors and in price by 10, 15 or 20% resulted in negative net returns for FEED, CHEM and CLFEDMS systems.

CONCLUSIONS

Table 1. Summary of Performance Ratios for the Five Production Systems in 2.1 ha Ponds For a 145-day Production Period.

Item	Production systems				
	CLFEDSR	TRAD	CLFEDMS	FEED	CHEM
Net returns (LE)	19.104	14.494	14.111	3.710	987
Total poduction (Kg)	7.616	6.757	5.694	4.159	2.973
Average price (LE)	5.41	4.94	6.41	4.61	4.18
Total variable costs	18.100	14.900	18.370	11.461	7.430
AVC/Kg produced	2.38	2.21	3.23	2.76	2.50
Return/Kg above TVC	3.03	2.73	3.18	1.85	1.68
Value of prod. per man-hr	104.05	56.50	94.76	55.90	56.31
Value of production per 100 L.E. of TVC	227.62	224.03	198.71	167.30	167.28
Value of production per 100 Kg of Feed	486.34	368.62	358.25	245.34	na.
Break-even price to cover TC	2.90	2.80	3.93	3.72	3.84
Break-even yield to cover TC (Kg)	3830	3873	3506	3269	2569
Margin between average price and ATC	2.51	2.14	2.48	0.89	0.34
Rate of return to capital	29.97	22.94	22.52	6.66	2.42
C.V %	26.91	20.35	35.18	42.40	18.94

Table 2. Sensitivity of Net Returns to Changes in Production and Prices..

Production System	Change in price	Production Level estimated at		
		Mean	One SE below mean	Two SE below mean
		------------ L. E.----------		
CLFEDSR	0	18.104	13.564	8.020
TRAD	0	14.494	11.120	7.719
CLFEDMS	0	14.111	7.697	1.280
FEEDSR	0	3.710	(356)	(4.421)
CHEM	0	987	(188)	(1.365)
CLFEDSR	-10%	14.983	9.997	5.008
TRAD	-10%	11.154	6.617	5.057
CLFEDMS	-10%	10.463	4.690	(1.085)
FEEDSR	-10%	1.793	(1.867)	(5.525)
CHEM	-10%	(255)	(1.312)	(2.371)
CLFEDSR	-15%	12.923	8.214	3.502
TRAD	-15%	9.485	6.512	3.726
CLFEDMS	-15%	8.639	3.187	(2.268)
FEEDSR	-15%	835	(2.622)	(6.077)
CHEM	-15%	(875)	(1.874)	(2.875)
CLFEDSR	-20%	10.863	6.431	1.996
TRAD	-20%	7.815	5.116	2.395
CLFEDMS	-20%	6.815	1.684	(3.450)
FEEDSR	-20%	(124)	(3.377)	(6.629)
CHEM	-20%	(1496)	2.437)	(3.378)

Table A-1. Estimated Budgets For Tilapia Production Using CLFEDSR, FEED, and CHEM Production Systems.

Item	Unit	Price or Cost/ unit (L.E)	CLFEDSR			FEED			CHEM		
			Quantity	Value or Cost (L.E)	%	Quantity	Value or Cost (L.E)	%	Quantity	Value or Cost (L.E)	%
1- Gross Retuns											
Tilapia 1st class	Kg	7.85	1843	14.467.55	35.11	307	2.409.95	12.57	7	54.95	0.44
Tilapia 2nd class	Kg	6.00	3413	20.478.00	49.70	1832	10.992.00	57.33	1099	6.594.00	53.10
Tilapia 3rd class	Kg	3.40	1290	4.386.00	10.65	1355	4.607.00	24.03	1516	5.154.40	41.51
Tilapia 4th class	Kg	1.75	1070	1.872.50	4.54	665	1.163.75	6.07	351	614.25	4.95
Total Returns				41.204.05	100.00		19.172.70	100.00		12.417.60	100.00
2- Variable Costs											
Fingerlings	Thou.	100	42	4.200.00	23.20	42	4.200.00	36.64	42	4.200.00	56.53
Feed	Ton	800	8.797	7.037.60	38.88	7.814	6.251.20	54.54			
Superphosphate	50kg	18							73.75	1.327.50	17.87
Urea	50kg	25							43.34	1.083.50	14.58
Chicken litter	Cu.m.	55.5	101.38	5626.59	31.09			2.27			
Labour	Hrs.		396	297.57	1.64	343	260.51	0.65	220.50	183.09	2.46
Equip. repair				74.90	0.41		74.90	3.05		74.90	1.00
Pond maint				350.00	1.93		350.00	2.83		350.00	4.71
Interest on op. cap				512.94	2.83		324.82	100.00		210.55	2.83
Total variable costs				18.099.60	100.00		11.461.42			7.429.54	100.00
3- Income above vaiable costs				23.104.44			7.711.27			4.988.05	
4- Fixed Costs											
Dep. pond equip.				1.948.58	48.70		1.948.58	48.70		1.948.58	48.70
Interest on invest.				2.052.24	51.30		2.052.24	51.30		2.052.24	51.30
Total fixed costs				4.000.82	100.00		4.000.82	100.00		4.000.82	100.00
5- Net returns to land and Management				19.103.62			3.710.45			987.24	

Table A-2. Estimated Budgets For Tilapia Production Using TRAD and CLFEDMS Production Systems.

Item	Unit	Price or Cost/ unit (L.E)	TRAD			CLFEDMS		
			Quantity	Value or Cost (L.E)	%	Quantity	Value or Cost (L.E)	%
1- Gross Retuns								
Tilapia 1st class	Kg	7.85	467	3.665.95	10.98	2212	17.364.20	47.60
Tilapia 2nd class	Kg	6.00	3477	20.862.00	62.47	2914	17.484.00	47.92
Tilapia 3rd class	Kg	3.40	2390	8.126.00	24.33	388	1.319.20	3.62
Tilapia 4th class	Kg	1.75	423	740.25	2.22	180	315.00	0.86
Total Returns				33.394.20	100.00		36.482.40	100.00
2- Variable Costs								
Fingerlings	Thou.	100	42	3.360.00	22.55	42	3.360.00	18.29
Feed	Ton	800	9.055	7.244.00	48.62	10.187	8.149.60	44.36
Superphosphate	50kg	18	89.04	1.602.72	10.76			
Urea	50kg	25	10	250.00	1.68			
Chicken litter	Cu.m.	55.5	21.23	1.178.26	7.91		5.626.59	30.63
Labour	Hrs.		591	417.42	2.80	101.38	288.44	1.57
Equip. repair				74.90	0.50	385.00	74.90	0.41
Pond maint				350.00	2.35		350.00	1.90
Interest on op. cap				422.25	2.83		520.61	100.00
Total variable costs				14.899.55	100.00		18.370.14	
3- Income above vaiable costs				18.494.64	1.948.60		18.112.25	
4- Fixed Costs								
Dep. pond equip.				1.948.58	48.70		1.948.58	48.70
Interest on invest.				2.052.24	51.30		2.052.24	51.30
Total fixed costs				4.000.82	100.00		4.000.82	100.00
5- Net returns to land and Management				14.493.82			14.111.43	

These analysis indicated sufficient incentive for the expansion of intensified pond culture of tilapia. The analysis indicated that, CLFEDRS, TRAD, and CLFEDMS, in decreasing order, were more economically viable than FEED and CHEM systems . The highest total production, net returns, and average rate of return on capital were for CLFEDSR, TRAD, and CLFEDMS, in decreasing order. The same culture systems had the highest values of production per man-hour, kilogram of feed, or per L. E. of variable costs. Also, they had the highest margin betwwen average price and break-even prices to cover either total variable costs or total costs. CLFEDSR, TRAD and CLFEDMS systems can tolerate up to 46,43 and 39% reduction in average prices, respectively, before net returns becom negative. This indicated reduced risk to farmers in the event of unexpected fall in market price. Morever, the above systems had the highest net returns when production levels were estimated at one or two standard errors below the mean . In the extreme case of the combined effects of production failure, estimated at two standard errors below the mean, and the fall in market price by 20%, the TRAD and CLFEDSR systems maintained positive net returns to land and mangement. Finally, the CLFEDSR, TRAD, and CLFEDMS production systems had great potential for increasing fish yield as compared with production figures for monoculture or polyculture systems for private and governmental fish farms by Shelton (1989) .

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التحليل الإقتصادى لنظم مختلفه لإستزراع البلطى بالأحواض

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تبحث هذه الدراسه الإمكانيه الإقتصاديه لخمس نظم مختلفه لإستزراع أحواض البلطى وهى:

١– إستخدام الأسمده الكيماويه فقط.
٢– إستخدام الغذاء المصنع فقط.
٣– إستخدام الأسمده الكيماويه وزرق الدواجن والغذاء المصنع.
٤– إستخدام زرق الدواجن والغذاء المصنع مع البلطى وحيد الجنس.
٥– إستخدام زرق الدواجن والغذاء المصنع مع البلطى مختلط الجنس.

تم الحصول على البيانات الخاصه بمدخلات ومخرجات كل نظام من هذه النظم من بيانات تجربه تم إجراؤها بالمعمل المركزى لبحوث الثروه السمكيه بالعباسة – شرقيه. وتم استكمال هذه البيانات ببيانات أخرى تتعلق بالعماله ومعدات الصيد وذلك عن طريق المعلومات المتوفره من أحواض الإنتاج التجارى بالمعمل وكذلك ببيانات خاصه بتكاليف الإنشاء تم الحصول عليها من الهيئه العامه لتنمية الثروه السمكيه.

تم تقدير الميزانيه لكل نظام على أساس أن مساحة الحوض ١ر٢ هكتار. وبتقدير صافى العائد وقيمة الناتج لعناصر الإنتاج الأساسيه والحد الأدنى للأسعار والإنتاج لتغطية التكاليف ومعدل العائد على رأس المال لكل نظام من نظم الإستزراع نتج الآتى :–

١– نظم الإستزراع ٤ ، ٣ ، ٥ حققت أعلى إنتاج وأعلى صافى عائد وأعلى معدل عائد على رأس المال (مرتبه ترتيباً تنازلياً).

٢– نفس نظم الإستزراع سابقة الذكر حققت أعلى فرق بين متوسط سعر البيع والحد الأدنى للسعر اللازم لتغطية التكاليف الكليه للإنتاج بالنسبه للوحده المنتجه مما يؤدى إلى تقليل المخاطره للمزارع فى حالة إنخفاض سعر البيع.

٣– نفس هذه النظم حققت أعلى صافى عائد عند تخفيض متوسط الإنتاج لكل نظام بقيمة الخطأ المعيارى أو بضعف قيمته وبتحليل الحساسيه وجد أن نظامى الإستزراع رقمى ٣ ، ٤ حققا صافى عائد موجب عند تخفيض متوسط الإنتاج لكل منهما بمقدار ضعف الخطأ المعيارى مع تخفيض الأسعار بمقدار ٢٠٪.