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ESTIMATED COSTS AND RETURNS FOR COMMERCIAL CAGE PRODUCTION OF SILVER CARP (HYPOPHTHALMICHTHYS MOLITRIX) IN BEHIRA GOVERNORATE, EGYPT.

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ABSTRACT: Field data for commercial silver carp cage culture at El Mahmodia, Idfina, and Fazara in Behira Governorate were used in this study. Costs, returns, and performance indicator of this activity were estimated through budgeting procedure. Budgets were estimated for ten situations. Five stocking rates (4, 6, 8, 10, and $12/m^3$) and two fingerlings sizes (5 and 10g) were considered in the study. Effects of stocking rate and stocking size on the economics of the culture system were explored. Sensitivity analyses with respect to changes in output price and production level were performed. Results indicated the economic viability of the system. Stocking rate and fingerlings size had positive effects on the economic performance of silver carp cage culture. This system is an environmentally friendly way of fish production since no supplementary feeds or fertilizers are used. This production system should not be discouraged unless quantitatively proven that it has negative effects on the environment and these negative effects out weighted the associated benefits.

INTRODUCTION

Fish cage culture dates back many centuries in China (Bao–Tong, 1994), and recently, this practice has expanded throughout the world because of its advantages. Several researchers have pointed out the advantages of cage culture (Beveridge, 1984; 1996; Campbell, 1985; Swann et al., 1994; EL- Sayed, 2006; Phillips and De Silva, 2006). Cages major advantages over other methods of fish culture include: the anticipated high profitability levels, the use of existing water bodies thus reducing the pressure on land; the requirements of relatively low capital outlay; the ease of movement and relocation; the flexibility of management; and it can be used to clean up eutrophicated waters through the culture of planktivorous species.

Silver carp are typical planktivores and low in the food chain, hence, there is no need to provide formulated feed in its culture. Its seeds are available from artificial breeding without reliance on natural sources. In recent decades, silver carp have been widely introduced outside its original habitat as a food source and for algal control (FAO, 2007; Ke et al., 2007). For example, Starling (1993) found that moderate silver carp biomass significantly reduced microzooplankton, phytoplankton biomass and net primary productivity in an eutrophicated reservoir in Brazil. The same researcher reported that apart from increasing nitrogen in the sediement, nutrients and chemical properties of the water were not affected by silver carp presence.

In China, the area of cage culture reached 1,330 ha in 1992 and the average yield was 300 tons/ha, equivalent to 30 Kg/m^2 (Yeping, 1998). Bao–Tong (1994) reported a production level of 65.2 Kg/m^2 for cage culture of silver carp and bighead raised solely on natural food existing in the water of Bailianhe reservoir in China. In Egypt, fish cage operations contribution to aquaculture production ranged from 0.05 % in 1988 to 10.7 % in 2004, while in 2005 its contribution was 3.8%. Its average annual contribution, during this time period, was 11,172.8 tons representing 3.94 % of aquaculture production (GAFRD, 2000 – 2005). In 2005, the major cage culture producing areas in terms of quantity were: Behira (62.3%), Domiat (19.5%), and Kafr EL-Sheikh (15.5%) with tilapia being the main cultured species.

The profitability of cage culture depends, among other things, on cultured species, production level, input costs, and selling prices. Hambry (2002) estimated the rates of return on investment for cage culture of snakehead and sex reversed tilapia at 500% and over 100%, respectively. Snakehead and tilapia seeds were purchased and commercial pellets were used for feeding tilapia, while purchased fresh or semidried fish were used to feed snakehead.

This study described and assessed the economic potential of the actual practices of private sector silver carp cage operations in Behira governorate, Egypt. Costs, returns and performance indicators based on fish stocking density and stocking size were estimated. Also, sensitivity analyses of changes in selling price and production levels were carried out.

DATA AND METHODS

Budgeting technique can be used to test the profitability of an enterprise. An enterprise budget is a listing of all estimated income and expenses associated with the enterprise to provide estimates of its profitability and performance (Boehlje and Eidman, 1984; Kay and Edwards, 1989; Bernard and Nix, 1994). To facilitate profitability analysis, the budget requires numerical estimates of production, direct costs, and indirect costs. The typical budget format contains three sections: total returns, variable costs, and fixed costs.

A total number of 107 cages, at El Mahmodia, Idfina, and Fazara located at Rosetta Branch of the Nile (Behira Governorate), were surveyed to obtain information regarding a typical silver carp cage operation. The information obtained included data on: cage construction materials, fingerling stocking size and density, production levels, daily and harvest labor, input and output prices, and any other inputs or investments involved in the operation.

RESULTS AND DISCUSION

Survey Results

The cage complex began 20 m from the shore. Three or four parallel rows with a maximum of 20 cages were placed perpendicular to the shore with about 15 m separating each row. The distance between a cage complex and another was about 50 m. Cages were built using wooden frames. The body of the cage was made of 18 mm black plastic mesh. Cage dimensions were 9 x 18 x 4 m depth for a total volume of 648 m^3. The floating devices used were black plastic drums. A number of 60 drums were used for each cage. Each cage was anchored in place using two iron anchors. Cages were covered with 18 mm protective plastic netting. To allow access to all cages, a boat was used for each cage complex. Cages were stocked with either 5 g or 10 g fingerlings (hereafter, production system A or B, respectively). The stocking rates used were 4, 6, 8, 10, and 12/m^3. The fingerlings needed to stock a complex of 20 grow out cages were held in three cages(4 mm) for 45 days then placed in another three cages (8-12 mm) for another 45 days before transferring into the grow out cages. The average rearing period was six months.

Budget Analysis

Enterprise budgets were estimated for silver carp cage production for ten production situations depending on stocking rate and fingerlings size, i.e. five situations for each production system (Appendix, Tables A-1, and A-2). Annual fixed costs include depreciation and the opportunity cost of investment. The straight line method was used for estimating annual depreciation. The useful life was estimated to be three years for nets and wooden frames, two years for ropes and floatation devices, ten years for the boat, and 15 years for metal anchors. A charge for the opportunity cost of investment was estimated based on initial investment. Fixed costs were the same for all production systems. Variable cost components included: fingerlings, labour, maintenance, miscellanies costs, and a charge for the opportunity cost of operating capital. The charge for the opportunity cost of operating capital was estimated based on average variable costs for six months. Differences in operating costs across the production systems were due to fingerling costs which varied according to stocking rate and fingerling weight. In addition, harvest labour costs varied according to production level. Next returns above variable costs and returns to land and management were determined.

Tables A-1 and A-2 indicated that all silver carp cage production systems surveyed were profitable. Production ranged from 1.72 to 12.02 Kg/ m^3, while total returns ranged from 6.02 to 51.10 L.E. / m^3. Production and total returns were positively related to both stocking rate and initial fingerlings weight; however the effect of stocking rate seemed to be more sounded. For example, changing stocking rate from 4 to 6/m^3 resulted in increasing yield by 1.83 and 1.86 Kg/m^3 for production systems A and B, respectively. Meanwhile, switching from production system A to production system B for stocking rates 4 and 6/m^3 increased yield only by 1.07 and 1.11 Kg/ m^3, in order. In general, systems stocked with 10g fingerlings resulted in higher individual fish weight and consequently higher selling price. Selling prices ranged from 3.5 to 4.25 L.E. /Kg according to fish size. Total variable costs (TVC) as percentage of total costs ranged from 41% to 63% for production system (A) and from 48% to 69% for production system (B). TVC percentage increased as stocking rate increased due to the additional cost of fingerlings and harvest labour, while total fixed costs were the same for all production systems. Items with highest proportion of TVC were fingerlings followed by labor and both were positively related to stocking rate. One exception from the above result was for the system stocked with 5g fingerlings at the rate of 4/m^3, where maintenance came in first followed by fingerlings costs. For system (A), fingerlings cost ranged from 32.8% to 34.6% while labor cost ranged from 26.7% to 46.7% of TVC. For system (B), these percentages ranged from 39.9% to 44.2% and from 28.1% to 39.3%, respectively.

Performance Indicators

Table (1) shows some performance indicators which were extracted from the budgets of silver carp cage production. However, one should notice that in cage culture of silver carp as compared to static pond fish culture, there are no costs or investments for: feed, fertilization, land, pond construction or pond maintenance, and water pumps. The data in Table (1) revealed that variations in yield, as indicated by the coefficients of variation (CV), were generally less for production system B than for production system A. Lowest and highest stocking rates in both production systems had lower variations as compared with other stocking rates. Net returns ranged from 1.12 to 38.05 L.E. /m^3 for system A and from 11.9 to 51.1 L.E. /m^3 for system B (Table 1). Net returns were positively related to both stocking rate and stocking size. As observed for total returns, the effect of stocking rate seemed to be more pronounced than the effect of stocking size on net returns. Average total cost (ATC) and average variable cost (AVC) per kilogram of fish produced from the different production systems are shown in Table 1. ATC and AVC were both negatively related to stocking rates since production increased with increasing stocking rate. ATC ranged from 0.73 to 2.85 L.E. and from 0.78 to 1.98 L.E. for production systems A and B, respectively. At low stocking rates (4 and 6/m^3), system B had lower ATC than system A by about 30.5% and 12.2 %, respectively. For higher stocking rates (8, 10, and 12/m^3), system B had slightly higher ATC by about 1.8%, 8.9%, and 6.8 %, respectively. AVC range was from 0.46 to 1.61 L.E. for system A, and from 0.54 to 0.95 L.E. for system B. At stockingrate 4/m^3, production system B had lower AVC than System A by about 41 %, and for higher stocking rates system A had slightly lower AVC. Break even quantity (BEQ) are the output quantity required to cover total production costs so that there will be no profit or losses. BEQ increased with increasing stocking rates because of the additional costs of fingerlings and labour. Only one exception for the above result was observed in production system A when stocking rate changed from 4 to 6/m^3. In this case, BEQ was decreased by 0.01% and this was due to changing selling price from 3.5 to 4.0 L.E. /Kg. (Table 1). Production safety margin (PSM) is the percentage by which production can be decreased before the business begins to run at a loss. The estimated coefficients of PSM were positively related to stocking rates. PSM coefficients varied from 18.6% to 82.9 % for production system A and from 53.3% to 81.6 % for production system B (Table 1). Average rate of returns on investments and operating capital (ARR) for the specified stocking rates for both production systems were estimated and presented in Table 1. ARR values were positively related to stocking rate and stocking size. ARR values varied from 21.7 % to 333.9 % for production system A, and from 75.6 % to 325.9 % for production system B

Table 1. Performance Indicators for Different Stocking Rates and Sizes of Silver Carp Cage Production.

	Coefficient of Variability in Production (%)	Net Returns (L.E.)	ATC/ Kg (L.E.)	AVC/ Kg (L.E.)	Break -Even Production. (Kg.)	Safety Margin in Production. (%)	Average Rate of Return. (%)	Selling Price (L.E./Kg)
Production System A: stocking rates of 5 g fingerlings								
4 / M^3	6.20	724.9	2.85	1.16	907.86	18.6	21.7	3.50
6 / M^3	27.22	5608.6	1.56	0.74	898.85	60.9	99.87	4.00
8 / M^3	27.44	11548.3	1.10	0.59	953.25	74.0	183.75	4.25
10 / M^3	16.03	15831.8	0.89	0.52	1128.55	77.8	233.6	4.00
12 / M^3	6.25	24656.5	0.73	0.46	1196.48	82.9	333.9	4.25
Production System B: stocking rates of 10 g fingerlings								
4 / M^3	13.41	4111.6	1.98	0.95	846.56	53.3	75.57	4.25
6 / M^3	15.47	8685.34	1.37	0.75	978.39	67.6	138.3	4.25
8 / M^3	17.79	13109.5	1.12	0.67	1108.4	73.7	190.06	4.25
10 / M^3	14.42	17918.5	0.97	0.62	1241.89	77.2	239.40	4.25
12 / M^3	5.18	27039.7	0.78	0.54	1429.72	81.7	325.90	4.25

Sensitivity Analysis:

Sensitivity analysis was undertaken to demonstrate the effect of changes in selling price, production level or both on net returns, ATC, AVC, BEQ, and ARR. Selling price was reduced by 10% and 20 %, while production level was decreased by the value or twice the value of the standard error of the mean (S.E.). Results of the indicated changes on the selected performance indicator are shown in Table 2. The absolute reductions in net returns as selling prices decreased were positively related to stocking rates and stocking sizes. However, the reductions in net returns as percentage were negatively related to stocking size. Decreasing selling prices by 10% led to reductions in net returns by 12% to 53.5% for system A, and by 12.2% to 18.6% for system B. Decreasing selling prices by 20% doubled the above reductions in net returns in absolute or percentage terms. Decreasing production by the value of the S.E. resulted in decreasing net returns by 7.5% to 33.1% for system A, and by 6.3% to 25% for system B. The absolute reduction in net returns increased with increasing stocking rate up to $8/m^3$, then started to decrease with increasing stocking rates in both systems. Decreasing production by the value of the S.E. had grater effect on net returns than decreasing selling prices by 10% except for cages with stocking rates of 4 and $12/m^3$ in production system A and cages with stocking rate of $12/m^3$ in production system B. This may be explained by the fact that production figures associated with these stocking rates had lower CV (6.2%, 6.25%, and 5.18 %, respectively). Decreasing production by twice the value of S.E. resulted in doubling the above effects on net returns, and the same patterns of relationships with stocking rates were observed.

Results of the combined decrease in selling prices by 10% or 20 % and in production level by the value or twice the value of the S.E. were shown in Table 2. The resulted percentage decreases in net returns were negatively related to stocking rates in both production systems. The absolute decreases in net returns were positively related to stocking rates up to $8/m^3$ for production system A, and up to $10/m^3$ for production system B. The percentage decreases in net returns when selling prices were reduced by 10% and production by the value of S.E. varied from 18.8% to 83.6 % for system A, and from 17.9% to 41.2 % for system B. Decreasing selling prices by 10 % and production by twice the value of S.E. resulted in decreasing net returns by a range of 25.6% to 113.6% in production system A, and by a range of 23.6% to 63.8 % in production system B. In addition, decreasing selling prices by 20 % and production by the value or twice the value of S.E. resulted in negative net returns for stocking rates of 4 and $6/m^3$, in production system A.

Decreasing selling prices resulted in increasing BEQ. The resulted increases in BEQ were positively related to stocking rates in both production systems. The increases in BEQ when selling prices were reduced by 10 % ranged from 94.5 to 156.4 Kg and from 92 to 155.6 Kg, for production systems A and B, respectively. Reducing selling prices by 20 % resulted in increasing BEQ by 218.6 to 295.1 Kg for production system A, and by 209.4 to 353.8 Kg for production system B.

Decreasing production by the value or twice the value of S.E. increased ATC and AVC. The effects of production changes were greater on ATC than on AVC. Generally, the effects of production changes on both average costs were negatively related to stocking rates.

Reducing selling prices or production or both resulted in decreasing ARR. The decreases in ARR resulted from decreasing prices were positively related to stocking rates. While the decreases in ARR resulted from decreasing production levels were positively related to stocking rates up to 8/m^3 and negatively related to higher stocking rates in both production systems.

SUMMARY and CONCLUSIONS

This study developed enterprise budgets utilizing field data for different production systems of commercial silver carp cage operations in Behira Governorate, Egypt. Production systems were based on fingerlings stocking density and size. Costs, returns, and performance indicators were estimated and analyzed. Sensitivity analysis to evaluate how returns and performance indicators change in response to changes in selling prices and production levels were performed. In addition, the relationships between returns and performance indicators on one hand and stocking size and density on the other were explored. The total production costs per kilogram of silver carp produced varied from 0.73 to 2.85 L.E. depending on the production system. ATC and AVC were negatively related to stocking rate. Production, total returns, net returns, and ARR were positively affected by stocking rate and size, however stocking rate seemed to have greater effect than stocking size. Production (Kg/m^3) ranged from 1.72 to 12.02. Estimated net returns varied from 1.12 to 51.1 L.E. /m^3 according to production system employed. Production safety margin estimates were positively related to stocking rate and varied from 18.6% to 82.9%. Results of the sensitivity analyses revealed that operations with low stocking rates and stocking size were more sensitive to reductions in selling prices or production level.

The results indicated sufficient incentives for the expansion of silver carp cage culture system. The economics of such system are attractive, it uses the existing water bodies, it requires low capital investment. no land surface area, no supplementary feeds or fertilizers are required, and it has high production levels. However. two main points should be considered regarding silver carp cage culture. First. silver carp cage culture is positively related to water primary productivity therefore, cage production may be decreased and its economic viability be impaired if large number of cages are placed in one area. Hence, there is a need to estimate the carrying capacity of the selected site for cage culture. The second point is related to cage culture impact on the environment. Beveridge (1996) reported that uneaten feed and feces from cage culture are the main sources of the negative effects on the environment. Even though no supplementary feeds are used in silver carp cage culture, its environmental impact should be quantified in water quality terms before banning or discouraging this activity.

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APPENDIX

Table (A-1). Estimated Budgets for Silver Carp Cage Production Under Different Stocking Rates of 5 g Fingerlings.

Item	Unit	4/m³			6/m³			8/m³			10/m³			12/m³		
		Q	Value or Cost	% of TC	Q	Value or Cost	% of TC	Q	Value or Cost	% of TC	Q	Value or Cost	% of TC	Q	Value or Cost	% of TC
1. Total Returns																
Silver Sales	Kg.	1115 (69.1)	3902.5		2301 (626.3)	9204		3670.5 (1007.3)	15599.62		5086.5 (815.3)	20346		6998 (437.2)	29741.5	
2. Variable Costs																
Fingerlings	Thou	2.6	425	13.4	3.9	587.5	16.3	5.2	750	18.5	6.48	910	20.2	7.8	1075	21.1
Labor	L.E.		345.87	10.9		577.61	10.1		845.21	20.9		1121.9	24.9		1495.4	29.4
Maintenance & Miscellaneous.	L.E		450	14.2		450	12.5		450	11.1		450	10.0		450	8.6
Interest on Op. Capital	L.E.	610.4	73.25	2.3	807.56	96.91	2.7	1022.61	122.71	3.0	1240.95	148.91	3.3	1510.2	181.22	3.7
Total Variable Costs			1294.12	40.7		1712.02	47.6		2167.93	53.5		2630.82	58.3		3201.6	69.0
3. Income above V.C.			2608.38			7491.98			13431.70			17715.18			26539.87	
4. Fixed Costs																
Depreciation			1428	44.9		1428	39.7		1428	35.3		1428	31.6		1428	28.1
Interest on Invest.		4554	455.4	14.3	4554	455.4	12.7		455.4	11.2		455.4	10.1		455.4	8.9
Total Fixed Costs			1883.4	59.3		1883.4	52.4		1883.4	46.5		1883.4	41.7		18834.	37.0
5.Net Returns to land & mgt.			724.98			5608.57			11548.30			15831.78			24656.47	

Note: numbers between brackets are the standard errors of the production means.

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Table (A-2). Estimated Budgets for Silver Carp Cage Production Under Different Stocking Rates of 10 g Fingerlings.

Item	Unit	$4/m^3$			$6/m^3$			$8/m^3$			$10/m^3$			$12/m^3$		
		Q	Value or Cost	% of TC	Q	Value or Cost	% of TC	Q	Value or Cost	% of TC	Q	Value or Cost	% of TC	Q	Value or Cost	% of TC
1. Total Returns																
Silver Sales	Kg.	1814 (243.2)	7709.5		3022 (467.4)	12843.5		4193 (746.2)	17820.25		5458 (786.9)	23196.5		7792 (403.6)	33116	
2. Variable Costs																
Fingerlings	Thou.	2.6	685	19.0	3.9	977.5	23.5		1270	27.0		1558	29.5		1855	31.0
Labor	L.E.		482.45	13.4		718.50	17.3		947.31	20.1		1194.49	22.6		1650.56	27.2
Maintenance & Miscellaneous.	L.E		450	12.5		450	10.8		450	9.6		450	8.5		450	7.4
Interest on Op. Capital	L.E.	808.73	97.05	2.7	1073	128.76	3.1	1333.7	160.04	3.4	1601.3	192.15	3.6		237.33	3.9
Total Variable Costs			1714.5	47.7		2274.76	54.7		2827.35	60.0		3394.64	64.3		4192.89	69.0
3. Income above V.C.			5995			10568.74			14992.9			19801.86			28923.11	
4. Fixed Costs																
Depreciation			1428	39.7		1428	34.3		1428	30.3		1428	27.1		1428	23.5
Interest on Invest.			455.4	12.7		455.4	11.0		455.4	9.7		455.4	8.6		455.4	7.5
Total Fixed Costs			1883.4	52.4		1883.4	54.3		1883.4	40.0		1883.4	35.7		1883.4	31.0
5.Net Returns to land & mgt.			4111.60			8685.34			13109.5			17918.46			27039.71	

Note: numbers between brackets are the standard errors of the production means.

تقدير التكاليف و العائد للإنتاج التجاري لأسماك المبروك الفضي بالأقفاص بمحافظة البحيرة – مصر

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الملخص العربي

تم في هذه الدراسة استخدام بيانات ميدانية خاصة بالاستزراع التجارى لأسماك المبروك الفضى فى الأقفاص بمناطق المحمودية وإدفينا وفزاره بمحافظة البحيرة وذلك لتقييم هذا النشاط إقتصادياً .تم تقدير التكاليف والعائد ومؤشرات الأداء لهذا النشاط باستخدام أسلوب الميزانية . تم تقدير الميزانية لعشرة حالات ، حيث تم الأخذ فى الاعتبار خمسة معدلات للتخزين (٤ ، ٦ ، ٨ ، ١٠ ، ١٢ إصبعية للمتر المكعب) وكذلك وزنين مختلفين للإصبعيات (٥ ، ١٠جم) . تم دراسة تأثير الكثافة التخزينية والوزن الابتدائى للإصبعيات على إقتصاديات هذا النظام من الاستزراع . كما تم إجراء تحاليل الحساسية الخاصة بتأثير التغيرات فى الأسعار ومستويات الانتاج على الأداء الإقتصادى لهذا النشاط . أكدت نتائج الدراسة الجدوى الاقتصادية لهذا النظام الانتاجى . كما أكدت النتائج أن الكثافة التخزينية والوزن الابتدائى للإصبعيات لهما أثر ايجابى على إقتصاديات استزراع المبروك الفضى فى الأقفاص . وتجدر الاشارة أن هذا الأسلوب الانتاجى لأسماك المبروك الفضى هو أسلوب صديق للبيئة حيث لا يتم استخدام الأسمدة أو أى تغذية إضافية لاعتماده على الغذاء الطبيعى بالمياه (الفيتوبلاكتون) مما يساعد على الحد من تلوث البيئة . وعلى ذلك يجب تشجيع هذا النظام الانتاجى إلا إذا ثبت أن له تأثيرات سالبة على البيئة وأن قيمة هذه التأثيرات أكبر من قيمة المنافع المرتبطة به .