ECONOMIC ANALYSIS OF *Deuterodon iguape* CULTURED IN NILE TILAPIA PONDS*

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ABSTRACT

Polyculture systems can promote greater economic efficiency with decreased use of inputs, making the activity more sustainable. The aim of this study was to evaluate the economic feasibility to grow-out lambari (*Deuterodon iguape*) in cages installed in Nile tilapia (*Oreochromis niloticus*) ponds. We calculated operational costs and determined the Internal Rate of Return (IRR), Net Present Value (NPV) and the Pay Back Period (PBP) to assess the economic viability of the investment. In a ten-year horizon, the largest positive NPV obtained was $ 83,082.55 for the sale price of $ 0.09 unit^{-1} of lambari and $ 2.11 kg^{-1} of Nile tilapia. Under these conditions, the IRR was 61% and PBP was 1.58 years, considered a low risk result due to the speed of the return on invested capital. A simulation of increase the prices of commercial diets shows that the polyculture system can be economic unfeasible if the farmer cannot access the market of live baits for lambari. The polyculture system is economic feasible, even assuming an annual loss of production, considering selling lambari as live baits.

Keywords: live baits; cages; polyculture; economic indicators; Characidae, Cichlidae

ANÁLISE ECONÔMICA DE *Deuterodon iguape* CULTIVADO EM VIVEIROS DE TILÁPIA-DO-NILO

RESUMO

Sistemas de policultivo podem promover maior eficiência econômica com redução do uso de insumos, tornando a atividade mais sustentável. O objetivo deste estudo foi avaliar a viabilidade econômica para criação de lambari (*Deuterodon iguape*) em tanques-rede instalados em viveiros de tilápia-do-nilo (*Oreochromis niloticus*). Foi calculado o custo operacional e determinada a Taxa Interna de Retorno (TIR), o Valor Presente Líquido (VPL) e o Período de Retorno do Capital Investido (PRC) para avaliar a viabilidade econômica do investimento. Em um horizonte de dez anos, o maior VPL positivo obtido foi de US$ 83.082,55 para o preço de venda de US$ 0,09 unidade^{-1} de lambari e US$ 2,11 kg^{-1} de tilápia-do-nilo. Sob essas condições, a TIR foi de 61% e o PRC foi de 1,58 anos, considerado um resultado de baixo risco devido à velocidade do retorno sobre o capital investido. O sistema de policultivo é economicamente viável, mesmo assumindo uma perda anual de produção, considerando a comercialização de lambaris como iscas vivas.

Palavras chave: iscas vivas; tanques-rede; policultivo; indicadores econômicos; Characidae; Cichlidae

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INTRODUCTION

In 2013, the Brazilian aquaculture production had the total production value of $ 1.072 billion ($ 1.00 = R$ 2.85 - Quotation of American Dollars to Brazilian Reais - February 2015), with fish farming representing 66.1% of the total production (IBGE, 2013). The production of exotic species was responsible for a growth of 49.4% of the Brazilian aquaculture production between the period 2003 to 2009 (BRASIL, 2010). Nile tilapia (*Oreochromis niloticus*) is the most representative species in aquaculture production in the State of São Paulo and presents several economic studies (FIRETTI and SALES, 2007; AYROSA *et al.*, 2011; PONTES and FAVARIN, 2013). The lambari, *Deuterodon iguape*, showed the greatest market potential among native species of Atlantic rainforest (LOPES *et al.*, 2013). The most recent data published by the Brazilian government showed that the tilapia production in Brazil was $ 268,860,000.00 and lambari was $ 560,701.75 (IBGE, 2013). Both species have a remarkable importance to brazilian aquaculture. Even with the lower contribution of lambari production, research into native species whose characteristics make them suitable candidates for aquaculture is encouraged (JONES *et al.*, 2007). To intensify fish farming and better utilization of the flooded area, the use of small volume cages installed in ponds for polyculture systems can promote greater economic efficiency with decreased use of inputs, making the activity more sustainable (YI *et al.*, 1996; KARIM *et al.*, 2011).

Economic studies can guide fish farmers to make decisions. Their knowledge can also be an important tool to adjust production technology compared to the market price of the product. Thus, the present study aimed to assess the economic viability of grow-out lambari (*Deuterodon iguape*) in cages, installed in Nile tilapia (*Oreochromis niloticus*) ponds.

MATERIAL AND METHODS

The study was conducted in rural municipality of Itanhaém/SP (24°07'S; 46°50'W), in ponds of 2,500 m². We considered the rental and use 1 ha of water surface available in a farm and installation of 120 cages of 1 m³ of cages.

Zootechnical aspects

The factors of production (Table 1) were based on the observations in farms and preliminary studies and we assumed the stocking density of 700 lambaris m^{-3} with initial average total length (Lt) of 3 cm and 2 tilapias m^{-2} with initial average weight (Wt) of 34 g. We considered the survival rate and grow-out time for tilapia based on YI *et al.* (1996), KUBITZA and KUBITZA (2000), GRAEFF and AMARAL-JUNIOR (2005), PONTES and FAVARIN (2013), and for lambari based on SILVA *et al.*, (2011a).

Table 1. Factors of production estimated for grow-out lambari (*Deuterodon iguape*) and Nile tilapia (*Oreochromis niloticus*), February 2015.

Indicators	LAMBARI	TILAPIA
Number of cycles per year	3	1,5
Grow-out time (months)	4	8
Feed conversion	1.38	1.3
Average final weight (g)	9	500
Volume / production area	120 m³	10,000 m²
Stocking density of fingerlings	700 m^{-3}	2 m^{-2}
Survival rate (%)	88	92
Units produced per cycle	84,000	20,000
Units produced per year	252,000	30,000
Biomass produced per cycle (kg)	756	10,000
Biomass produced per year (kg)	2,268	15,000

Economical aspects

We considered a time horizon of ten years operation to evaluate the prospect of economic viability of this polyculture system. We adopted the methodology used by the Institute of Agricultural Economics of the State of São Paulo (MATSUNAGA *et al*., 1976), to estimate the production cost, which includes: a) Effective Operating Cost (EOC), b) Total Operating Cost (TOC), c) Total Production Cost (TPC).

a) Effective Operating Cost (EOC), in which costs are included with: lease of the production area, permanent labor and temporary acquisition of young forms of lambaris and Nile tilapia, diets, materials for liming and fertilization of ponds and other infrastructure and maintenance costs;

b) Total Operating Cost (TOC) includes the sum of EOC plus social charges in the case of labor (the INSS - National Institute of Social Security, rental and other expenses). For this calculation, we considered 40% of the cost spent with labor (SANCHES *et al*., 2006); financial burden, estimated as an annual interest rate charged on half the EOC in the production cycle; and depreciation of equipment;

c) Total production cost (TPC) which is the sum of TOC added to the cost of the annual depreciation of facilities and annual interest of capital for investment.

The investment feasibility was evaluated using indicators such as the Internal Rate of Return (IRR), Net Present Value (NPV) and the Period of Recovery Capital (PRC). We used the method of the IRR, which takes into account the variation of capital over time. This indicator can be considered as the interest rate received for an investment over a given period within regular intervals where payments are made to cover all the costs of creating and proceeds from the sale of the product. According to ALLEN *et al*. (1984), it is important to attempt to assess and evaluate the rate of attraction for the project to be selected. When evaluating a project by IRR, it appears that it is economically viable only when the rate exceeds a specified hurdle rate. The minimum annual hurdle rate considered in this study was 11.10%, equivalent to the interest received on cash investments, which is based on the SELIC (Special System of Settlement and Custody), which is released by the Brazilian Monetary Policy Committee (COPOM). Demarcated by SELIC is that are set interest rates charged by financial market.

Besides IRR, other indicators of economic viability as the Period of Recovery Capital (PRC), defined as the number of years required for the company to recover the initial capital invested in the project, and the Net Present Value (NPV) is the present value of series of future revenues for a period, discounted using the interest rate, subtracted from net investment. We also considered an indicator of cost in terms of units produced, called Leveling Point (LP), which determines what minimum production of Nile tilapia and lambaris needed to cover the total operating cost considering a determined sale price per kilogram of fish, referring to Nile tilapia (LPt) and for the lambari (LPl), as follows: LP = TOC/(LPl +LPt).

Other indicators of profitability assessment used in this study as described in MARTIN *et al.* (1998).

a) Gross Revenue (GR) is the production kg of both cultured fish species and production per unit for lambari multiplied by the sales price of the market;

b) Operating Profit (OP): difference between GR and TOC. This indicator measures the profitability in the short term, showing the financial and operating conditions of the activity. Thus we have: OP = GR - TOC;

c) Gross Margin (GM): margin relative to TOC, the result obtained after the producer bear the operational cost, considering a certain selling price of kg of fish produced from both species and price of unit for lambari and productivity of production system. Formalizing, we have: GM = (GR - TOC/TOC x 100;

d) Profitability Index (PI): relationship between OP and GR in percentage. Important indicator that shows the available revenue rate of activity after paying all operating costs. So: PI = (OP/GR) x 100;

e) Cash Flow (CF): is the algebraic sum of inputs (gross revenue) and expenses incurred during the course of the activity. It is a tool that helps identify a net cash flow each year, which will be used to calculate the IRR. According to MARTIN *et al*. (1994), allows showing the status of the activity box and the result is too much to cover fixed costs, risks, returning on capital and entrepreneurship.

To calculate the cash flow the expenses were related to the initial investment in the first year (year zero) and the actual operating costs plus financial, social costs of labor and annual interest of capital for investment.

To assess the impact on rates of IRR and NPV obtained by sales prices, we assumed the possibility of a total annual loss of production, which could occasionally occur due to any unforeseen occurrence of such diseases, floods, etc.

Costs composition

We provided for the composition of the costs of hiring labor for the installation of the anchoring structures of the cages, preparing the pond as well as two fixed employees to work in feeding, maintenance, fishing periods and delivery production for consumers. We predicted proportional compensation in accordance with the minimum wage in Brazil, $ 237.90. We monthly lease the area at $ 210.53 per count with infrastructure ready for use, avoiding investments with excavation of ponds and construction of house and shed. This value is based on existent condition in the local, being already included taxes on rural property. The area will serve as housing for the entrepreneur and employees, eliminating the need for security guards for the venture. No compensation was provided to the entrepreneur.

We predicted the installation of anti-bird nets to minimize losses to predation, paddle aerators for possible critical periods in the dissolved oxygen concentration in the water and a small boat to assist in feeding. A utility vehicle can help with other services unrelated to the polyculture system, so we assumed 50% of the value. Costs of bookkeeping and accounting to control payroll of hired labor and cash flows have been included.

In economic evaluation costs, we considered income and profit for the production of Nile tilapia and lambaris in the polyculture system, using partial budget analysis to compare costs and fluctuations of revenue in each proposed situation (SHANG, 1990).

We obtained 300 thousands of lambari fingerlings from the municipal hatchery of native fish, administered by the city of Mongaguá, and 32.6 thousands of Nile tilapia juvenile, GIFT strain, sexually reversed, from proximity of producers, at the cost of $ 14.04 and $ 112.28 for the respective species. These amounts of fingerlings are according to the survival rates (Table 1), which are enough to achieve the stocking density scheduled to the end of the production cycle. The fish were fed twice a day, totaling between 1 and 3% of live weight with commercial ration with differentiation in the concentration of crude protein, 32% for lambari and 28% for Nile tilapia at the cost of $ 0.61 kg^{-1} and $ 0.46 kg^{-1}, respectively.

The composition of the revenues of the project was calculated considering the selling price of $ 2.11 kg^{-1} of Nile tilapia with 500 g final weight for fish and pay establishments in Santos region. SILVA *et al*. (2011b) pointed that the selling prices of lambari were $ 3.51 kg^{-1} for human consumption and $ 0.06 $unit^{-1}$ for live bait marketing in the year 2011 in the State of São Paulo. For this study, we assumed the current selling price of $ 0.09 $unit^{-1}$ for live bait market and $ 4.39 kg^{-1} for human consumption. The items considered essential to be acquired through investment to begin deployment of the polyculture system of lambari (*D. iguape*) and Nile tilapia had the values obtained through survey data and quotations in specialty stores.

RESULTS

The total amount of investment required for the implementation of the polyculture system was $ 30,257.79 (Table 2). The equipment used exclusively for grow-out lambari represented 50.6% of the total value, while the necessary equipment for investments with Nile tilapia had a contribution of 49.4% of total investment, and the equipment for delivery (vehicle and fish transport boxes) represent 50.1% of the total value scaled.

Items that had greater relevance in the composition of the Total Production Cost (TPC) were juveniles with 27.95%, representing 10.20% for lambari and 17.74% for Nile tilapia (Table 3). The values of diets represented 26.63% of the composition of the TPC, representing 21.88% and 4.75% for Nile tilapia and lambari, respectively.

Table 2. Projected Investment required for implantation of polyculture of lambari (*Deuterodon iguape*) and Nile tilapia (*Oreochromis niloticus*), February 2015[1].

Items	Quantity	Total Price	Lifecycle[2]	Depreciation	Interest rates[3]	Total
1 - Installation (days)	10	198.25	.	.	11.89	11.89
2 - Equipment						
Lambari						
2.1. Cages	120	5,684.21	5	1,136.84	341.05	1,477.89
2.2. Fixation of cages (m)	200	207.02	5	41.40	12.42	53.82
2.3. Boat (for feeding)	1	701.75	10	70.18	42.11	112.28
Nile tilapia						
2.4. Fishing net	1	175.44	5	35.09	10.53	45.61
2.5. Anti-bird screen	4	2,129.12	10	212.91	127.75	340.66
2.6. Aerator	4	3,929.82	10	392.98	235.79	628.77
Polyculture						
2.7. Water analysis kit	1	175.44	5	35.09	10.53	45.61
2.8. Oximeter	1	596.49	10	59.65	35.79	95.44
2.9. Transport box (2.400L)	2	6,385.96	5	1,277.19	383.16	1,660.35
2.10. Oxygen cylinder	1	421.05	10	42.11	25.26	67.37
3 - Vessel (50%)	1	8,771.93	10	877.19	526.32	1,403.51
4 – Project	3%	881.29	.	.	52.88	52.88
Total Nile tilapia	.	14,949.59	.	1,786.60	896.98	2,683.57
Total Lambari	.	15,308.19	.	2,394.04	918.49	3,312.53
Total	.	30,257.79	.	4,180.63	1,815.47	5,996.10

[1] *Values in American Dollars;* [2] *Expressed in years;* [3] *Rate of 12% per year on initial capital.*

Table 3. Projected operating cost per year of polyculture of lambari (*Deuterodon iguape*) and Nile tilapia (*Oreochromis niloticus*), February 2015[1].

Items	EOC	Social charges[2]	Financial charges	TOC	Other fixed costs	TPC
1 - Lease Land	2,526.32	.	151.58	2,677.89	.	2,677.89
2 – Permanent labor	2,854.74	1,141.89	171.28	4,167.92	.	4,167.92
3 – Fingerlings						
3.1. Lambari	4,210.53	.	252.63	4,463.16	.	4,463.16
3.2. Tilapia (juvenile)	7,322.65	.	439.36	7,762.01	.	7,762.01
4 – Feed intake						
4.1. Lambari diet (32%)	1,960.83	.	117.65	2,078.47	.	2,078.47
4.2. Tilapia diet (28%)	9,031.58	.	541.89	9,573.47	.	9,573.47
5 – Liming, fertilization	70.18	.	4.21	74.39	.	74.39
6 – Cleaning Materials	63.16	.	3.79	66.95	.	66.95
7 – Maintenance vehicle						
7.1. Fuel, oil, filter, tires	3,124.12	.	187.45	3,311.57	.	3,311.57
7.2. Property taxes, licenses and insurance	1,200.88	.	72.05	1,272.93	.	1,272.93
8 – Electricity, phone	1,334.21	.	80.05	1,414.26	.	1,414.26
9 – Accounting	486.84	.	29.21	516.05	.	516.05
10. Oxygen refill	350.88	.	21.05	371.93	.	371.93
11 – Depreciation equip						
11.1. Lambari		.	.	2,394.04	.	2,394.04
11.2. Nile tilapia		.	.	1,786.60	.	1,786.60
12 – Investment						
12.1. Lambari		.	.		918.49	918.49
12.2. Nile tilapia		.	.		896.98	896.98
Total cycle^{-1}	14,224.20	.	.	16,251.76	.	17,261.71
Total year^{-1}	34,536.90	.	.	41,931.64	.	43,747.11
Total cycle^{-1} lambari	3,044.25	.	.	3,668.90	.	3,783.71
Total year^{-1} lambari	12,177.01	.	.	14,675.59	.	15,134.84
Total cycle^{-1} Nile tilapia	11,179.95	.	.	12,582.87	.	13,478.00
Total year^{-1} Nile tilapia	22,359.89	.	.	25,165.73	.	26,956.00

[1] *Values in American Dollars;* [2] *40% interest disbursement;* [3] *Rate of 12% per year about half of the EOC added to social charges.*

We observed the production cost above the selling price of lambari practiced by weight for the human consumption market, which makes their production through this system uneconomical. However, considering the live bait market for selling price per unit, the polyculture system becomes very attractive (Table 4).

When selling lambari per unit, the polyculture system has IRR of 61%, (Table 5), which is very attractive and much higher than the SELIC rate (11.10%). It confirms the feasibility of activity, considered low risk due to the short period of capital recovery (PRC) of 1.58 years. The best NPV rate of 10% was $ 83,082.55 with selling price of $ 0.09 unit^{-1} for lambari and $ 2.11 kg^{-1} of Nile tilapia. Whereas the selling price of lambari is $ 4.39 kg^{-1} and Nile tilapia $ 2.11 kg^{-1}, the NPV was $ 4,848.11 for the rate of 10%. These values, with the IRR of 14% and PRC of 4.33 years, may indicate economic viability for the polyculture system in the two selling conditions of lambari, but pointing out that the production cost per kg of lambari (Table 4) is higher than the selling price (Table 5). However, it is possible to promote economic viability in all related indexes when the year production be higher than the Leveling Point.

Table 4. Production cost of polyculture of lambari (*Deuterodon iguape*) and Nile tilapia (*Oreochromis niloticus*), February 2015.

Indicators	Nile tilapia	Lambari
Cycles year^{-1} (years 1-10)	1.5	3
Annual production (kg year^{-1})	15,000	2,268
Units produced (units year^{-1})	30,000	252,000
Effective operational cost ($ kg^{-1})	1.49	5.37
Total operating cost ($ kg^{-1})	1.68	6.47
Total production costs ($ kg^{-1})	1.80	6.67
Effective operational cost ($ unit^{-1})	0.75	0.05
Total operating cost ($ unit^{-1})	0.84	0.06
Total production costs ($ unit^{-1})	0.90	0.06

Table 5. Cost analysis and return on investment of polyculture of lambari (*Deuterodon iguape*) and Nile tilapia (*Oreochromis niloticus*), February 2015.

Indicators	A	B
Gross Revenue ($)	41,526.32	53,684.21
Operating profit ($)	-405.33	11,752.57
Gross margin (%)	-0.97	28.03
Profitability index (IL) (%)	-0.98	21.89
Period of Recovery Capital (PRC) (years)	4.33	1.58
Internal Rate of Return (IRR) (%)	14	61
Net Present Value (NPV) 10% ($)	4,848.11	83,082.55
Net Present Value (NPV) 15% ($)	-1,457.91	62,385.81
Net Present Value (NPV) 20% ($)	-6,029.80	47,226.19
Leveling point (LP) (kg)	2,952.93	1,816.01

A - Sales per kg of Nile tilapia ($ 2.11 kg^{-1}) and lambari ($ 4.39 kg^{-1}); B - Sales per kg of Nile tilapia ($ 2.11 kg^{-1}) and per unit of lambari ($ 0.09 unit^{-1}).

Considering that the tilapia diet represents 22.88% of the production costs, Figure 1 shows the simulation of the impacts in Internal Rate of Return (IRR) due the variation of the price of tilapia diet. The analyzed interval was from $ 0.39 kg^{-1} to $ 0.91 kg^{-1}. If the price of tilapia diet raise from $ 0.46 to $ 0.53, the polyculture system becomes economic unfeasible for selling lambari per kg. However, for selling lambari per unit, the IRR is higher than hurdle rate even if the price of diet raise from $ 0.46 to $ 0.91.

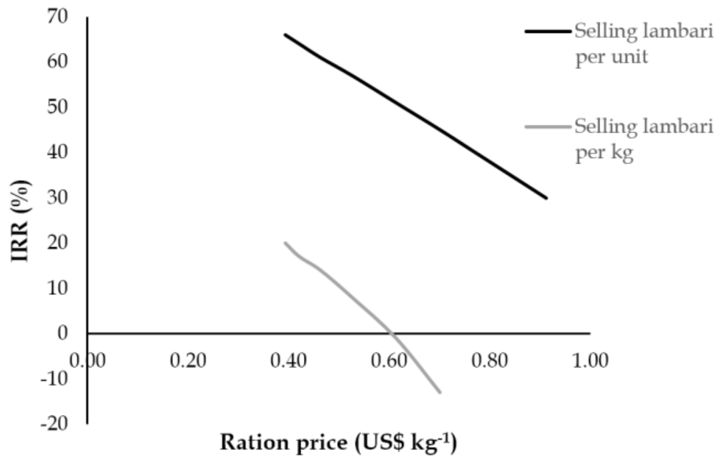

Figure 1. Sensibility analysis of two marketing conditions to grow-out lambari (*Deuterodon iguape*) in cages in Nile tilapia (*Oreochromis niloticus*) ponds considering variations of the Nile tilapia ration price and its impacts in the Internal Rate of Return.

The possibility of a total annual loss due to any factor that provides interruption in production still keep economic viability for selling lambari per unit with IRR of 26% and above the hurdle rate based on the SELIC rate 11.10% (Table 6).

Table 6. Costs and return on investment of polyculture of lambari (*Deuterodon iguape*) and Nile tilapia (*Oreochromis niloticus*), with the possibility of a total annual loss of cash flow, February 2015.

Indicators	A	B
Internal Rate of Return (IRR) (%)	-3	26
Net Present Value (NPV) 10% ($)	-25,941.72	38,715.44
Net Present Value (NPV) 15% ($)	-30,031.72	21,792.83
Net Present Value (NPV) 20% ($)	-32,583.16	9,945.49

A - Sales per kg of Nile tilapia ($ 2.11 kg^{-1}) and lambari ($ 4.39 kg^{-1});
B - Sales per kg of Nile tilapia ($ 2.11 kg^{-1}) and per unit of lambari ($ 0.09 unit^{-1}).

DISCUSSION

Most species show an inverse relationship between stocking density and growth rate, but the most appropriate stocking density varies with the species and not always the optimal biological density is necessarily the best economically (SOUZA-FILHO and CERQUEIRA, 2003). HAYASHI and VILELA (2001) studied different stocking densities of juvenile lambari *Astyanax bimaculatus* in cages. They concluded that lower stocking density resulted in larger individuals, but recommended the use of 124 fish m^{-3} due productivity to be higher.

This study considered to buy a vehicle, and its cost has significant portion of the investments costs. However, when assuming the delivery of production to consumers, it increases the market competitiveness and strengthen trade relations, promoting sustainability in economic activity by offering this service. SILVA *et al*. (2011a) found that there are producers who travel great distances to deliver live baits to consumers, so there are loyalty and building relationships of trust.

The price of commercial diets and juveniles can cause a hard impact in economic viability of the activity (SANCHES *et al*., 2014). A simulation of increase the prices of commercial diets shows that the polyculture system can be economic unfeasible at $ 0.53 kg^{-1} if the farmer cannot access the market of live baits for lambari. It is noteworthy that there was an increase in the value of commercial diets of 32% crude protein in the Santos region of \$ 0.39 kg^{-1} in year 2012 for \$ 0.61 kg^{-1} in 2013. FIRETTI and SALES (2007) showed that the kg price of commercial diets in the state of São Paulo in 1996 was \$ 0.27 rising to \$ 0.31 in 2006. The year 1999 appears as a milestone in historical series, and in 2007, the price of the diets was even louder, with the price of \$ 0.44 kg^{-1}. This factor has also contributed to the increase in market values of Nile tilapia juveniles. However, this polyculture system has Total Production Costs 1.45 times higher than the total amount of investment.

The costs of Nile tilapia production are below the selling price of \$ 2.11 kg^{-1}. PONTES and FAVARIN (2013) studied the production of Nile tilapia in excavated ponds in the city of Presidente Prudente, São Paulo State, considering selling price \$ 1.82 kg^{-1}. They points effective operational cost of \$ 1.30 kg^{-1}, addition of TPC and TOC at \$ 1.31 kg^{-1} and \$ 1.34 kg^{-1}, respectively. The values presented by the authors are close to those obtained in the present study. In 1996, the selling price of Nile tilapia and the average effective operational cost was \$ 1.84 kg^{-1} and \$ 1.02 kg^{-1}, respectively. In 2006, these values were \$ 0.95 kg^{-1} paid to the farmer with effective average operating cost of \$ 0.61 kg^{-1}. The average gross margin suffered a decrease from \$ 0.77 in 1996 to \$ 0.31 in 2006 (FIRETTI and SALES, 2007). These differences in production costs are variables that depends on local specificities and particular realities, which strengthens the importance of periodic reviews to identify critical points and adjust details to minimize costs and optimize results.

The lambari production cost for human consumption is above the selling price, but the polyculture system becomes feasible due to the profit on the production of Nile tilapia, reaching IRR of 14% and PRC of 4.33 years. These conditions are attractive, but the market must absorb the production by weight in a way that overcomes the current pricing limitation. The polyculture system positively yielded operating profit, gross margin and profitability index, even with the total production cost of lambaris higher than the selling price by weight. In this case, the tilapia profits supports the polyculture system. However, when considering the sale of lambari per unit, the values achieved gross revenues were higher than the TPC.

The production chain of lambaris targets the market of live bait (PORTO-FORESTI *et al.*, 2005; SILVA *et al.*, 2011a; SABBAG *et al.*, 2011), which presents itself as a link between the aquaculture production chain with the tourism market (SILVA *et al.*, 2011a). The high value of live baits turns this market niche economically viable. Coastal regions have possibilities for human consumption and other markets such as fish shops, bars, restaurants and beach kiosks. It has also demand for use as forage fish in public aquariums. The demand exists and it is more than 400 kg per week in the sampled places (SILVA *et al.*, 2011b). The selling price of \$ 0.09 lambaris $unit^{-1}$ is equivalent to \$ 9.75 kg^{-1}, so it is economic feasible for the selling price kg^{-1}. Lambari derived from aquaculture has competitive advantages compared with anchovy (*Anchoviella lepidentostole*) from extractive fishing. Besides the flavor preference (SILVA *et al.*, 2011b), there are a social and cultural importance, considering that people used to eat fried lambari fished in rivers. Nowadays, the natural stocks are decreasing due overfishing or pollution. Thus, this environmental importance may add value and strengthens the appreciation of lambari derived from aquaculture production. The farmer must adjust the costs of production and the presentation of the final product to the specific requirements of each market segment. So that it enables a differentiated product be available to access the consuming market more efficiently.

In commercial production of yellow tail lambari, *Astyanax altiparanae*, SABBAG *et al.* (2011) were able to recover the capital from the third year, with an IRR of 25.68% and 89.0% return of the producer in 5 years. The authors achieved operating income of \$ 1,099.46 $cycle^{-1}$, with a profit of 18.65% for 4 months of production, at the cost of \$ 4.63 kg^{-1}. Converting to annual values, it corresponds to an operating income of \$ 3,298.37. In our study, we obtained better results for the same live bait market reaching operation income and profitability index of \$ 12,636.44 and 23.83%, respectively.

In Brazil, bi-cultivation in ponds of pacu (*Piaractus mesopotamicus*) and piauçu (*Leporinus* *macrocephalus*) has economic viability in 1 ha, where the values of IRR were 15.20% and PRC of 6.4 years (FURLANETO *et al*., 2009), lower than those obtained in the present study. KARIM *et al.* (2011) points out that in Bangladesh, including tilapia polyculture systems are alternatives that can increase productivity for small farmers in rural and peri-urban area bringing socio-economic benefits for communities in need. This trend also occurs in other places in the world like in Mexico, with tilapia and Australian Redclaw crayfish (*Cherax quadricarinatus*) polyculture in masonry tanks (PONCE-MARBÁN *et al*., 2006). Their results, even in a different production scale, showed a remarkable improvement in profitability by adopting the strategy of polyculture. It indicates reduced time to recovery the investment and mitigate the risk of changes in selling price and production cost of tilapia.

FURLANETO *et al*. (2009) indicated that the bi-cultivation fish in ponds in the Middle Paranapanema in São Paulo State is an alternative for farmers with 0.5 ha of ponds. The average productive area of the region studied is 0.6 ha and the State of São Paulo is 1.0 ha (SÃO PAULO, 2008). Lambari is a small fish that has potential to reactivate small ponds on farms in São Paulo State, specially where environmental laws limits the production of exotic species (LOPES *et al*., 2013). As a native small fish, lambari can be used as bio-indicator of pollution in biomonitoring studies (SCHULZ and MARTINS-JUNIOR, 2001). These features increase the relevance and importance of lambari production within the environmental context, as is necessary for good water quality conditions. This polyculture system exclude agonistic encounters, reducing competition between species, favoring productivity and the use of cages facilitates the handling for the farmer. Thus, the fact that the production cycle of lambari is shorter than the tilapia promotes anticipation of revenue for the producer, directly affecting the economic viability of the enterprise.

CONCLUSIONS

The production of lambari, *D. iguape,* in cages of tilapia ponds is economic feasible especially when considering the sale of lambari per unit and Nile tilapia by weight, even assuming a loss of annual production.

Production costs, return on investment and profitability indicators can be even more attractive for marketing lambari with the adoption of higher sales prices, as is usual in the live bait market.

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