Economics of production of channel catfish, *Ictalurus punctatus*, female x blue catfish, *I. furcatus*, male hybrid eggs and fry

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Abstract

Enterprise budgets and sensitivity analyses were used to compare the profitability and risks of the production of channel-blue hybrid catfish eggs to that of channel catfish. Partial budgeting technique was used to determine whether it would be feasible to change from egg to fry production. Average cost of production of hybrid eggs was $49.43/kg ($22.47/pound), compared to $23.34/kg ($10.61/pound) for channel catfish. The net returns to land and management from producing 256 kg (563 pounds) of hybrid eggs were $8,202.20 compared to $7,308.64 for 231 kg (508 pounds) of channel catfish eggs. Sensitivity analyses indicate, that the price and spawning rate, have large effects on hybrid egg profitability. A 30 per cent decrease in price of hybrid eggs reduced net returns of egg production by 74.6 per cent. When spawning rate decreased by 40 per cent, net returns from hybrid egg production were reduced by 82.9 per cent. Risk analyses showed that hybrid egg production had a greater probability of negative returns than the channel catfish egg. Partial budgeting techniques showed a net income of $4,943.95 if a hybrid egg producer changed from producing 64kg of eggs to 774,000 fry.

Keywords: hybrid catfish, eggs, fry, cost, returns

Introduction

Catfish production is a major growth industry within the agricultural sector. Research and development have played a major role in pushing the industry forward. Researchers from Auburn University, Mississippi State University, and other universities in the Southern States of the United States, as well as researchers from the United States Department of Agriculture, Agricultural Research Service (USDA-ARS), have generated research information on new production and marketing practices, that have been used to improve efficiency in the catfish

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industry (Kinnucan 1995). Genetic and breeding improvement, enhancement of the feeding rate, and disease control and prevention were the major research contributions in the past two decades.

The channel (*Ictalurus punctatus* female) x blue catfish (*Ictalurus furcatus* male), CB hybrid, (Masser & Dunham 1998) and other improved released strains have shown promising production characteristics (Guidice 1966; Yant 1975; Smitherman 1983; Dunham & Smitherman 1987). The CB hybrid has superior traits compared to most commonly cultured strains of channel catfish (Dunham 1996). The CB hybrid exhibits faster growth, better feed conversion, tolerance of low oxygen, increased resistance to diseases, tolerance to crowded growth conditions, uniformity in size and shape, higher dress out percentages, and increased harvestability by seining (Masser & Dunham 1998). It has been shown that the CB hybrid grows 60 to 90 per cent faster than both parents (Yant et al. 1975; Jeppsen 1995); is more resistant to bacterial diseases (Ella 1984); and is more tolerant to low levels of dissolved oxygen (Dunham et al. 1982; Jeppsen 1995).

Despite these improved traits, farmers are still slow to adopt the CB hybrid on their farms because reproductive isolating mechanisms between these two species, and the reproductive biology of Ictalurid catfish and egg viability and fry survival, render commercial scale production of CB hybrid eggs difficult. However, recent advancements in the technology for production of CB hybrid eggs may allow commercialization (Kim 1996; Lambert et al. 1999; Masser & Dunham 1998; Dunham et al. 2000). Farmers will only adopt this hybrid if its culture translates into lower per unit cost of production and increased farm profitability and if fry are readily available. Before attempts at diffusion of the hybrid, it is important to determine its effects on costs and net farm income. Here, we examine the short and long run economic feasibility of the CB hybrid egg production and compare the results with that of channel catfish. This exercise is achieved by the use of enterprise budgeting. Risks associated with the production of CB hybrid eggs are also studied. The feasibility of switching from CB hybrid egg to fry was evaluated.

Materials and Methods

Relevant information from previously developed budgets (Hebicha 1984; Crews et al. 1992; Tieman 1995), together with new research information from the Goldkist Catfish Genetics Research Farm, and from the Auburn University Catfish Genetics Research Unit, are used to develop and update budgets for the production of eggs for both channel and hybrid catfish. Capital budgeting techniques are used to evaluate the long-term profitability of CB hybrid eggs and fry. A software program, *@Risk*, is used to evaluate the risk income trade-off associated with producing CB hybrid eggs. Partial budgeting technique is used to determine whether a change from the production of 64 kg of CB hybrid eggs to the production of 774,000 fry is profitable (64 kg of CB hybrid eggs will produce approximately 774,000 fry). Comparative analyses are conducted between CB hybrid egg and that of the channel catfish.

Baseline assumptions and procedures

Facility description

An open hatchery with a 135 m^2 (1500 ft^2) cement floor was used for producing, and hatching hybrid eggs. The hatchery contained six 0.56 m^3 (20 ft^3) fiber glass hatching troughs, four 0.56 m^3 fiber glass rearing troughs, and ten 1.08 m^3 (37.8 ft^3) fiber glass holding tanks. The cost components of constructing the hatchery building are described in Hebicha (1984). These costs have been adjusted for production and price changes due to inflation. Cost of maintenance and

repair of equipment used were charged about ten per cent of the original fixed costs for production of hybrid and channel brood stock.

Land and water use

It was assumed that land was owned by the farmers, but that the ponds had to be built. The ponds that were used in these budgets were excavated ponds used to keep the brood fish. The hatchery, which was used for the production of hybrid eggs, received well-water. Water was used for the holding tanks. Two 1.08 m^3 holding tanks were used to hold and acclimate the brood fish until they were ready for their first hormone injection. The flow rate for the water to the holding tanks was 1.14 m^3/hour. The brood fish were held six hours in the holding tanks. After the female brood fish received their first injection, they were placed in another holding tank that was divided into three compartments with three female brood fish placed in each. Four of these holding tanks were needed for 30 fish. The female brood fish were held for 36 hours in tanks. The size and water flow in these tanks were the same as earlier described.

Production

The spawning season was of eight weeks duration. Spawning began in the first week of May when the water temperature was around 24°C (75.2°F) and continued until the first week of July when the water temperature was around 30°C (85.4°F).

Brood stock needed for producing hybrid catfish eggs were purchased on December 1st, and were fed one per cent of their total body weight three times a week, with a 38 per cent protein diet. In April when water temperature reached 18°C (70°F), these brood stock were fed five times a week (Tucker & Robinson 1991).

Twenty per cent of the channel catfish female brood stock used for making hybrid eggs were not gravid, and were not used to produce eggs (Kim 1996; Lambert et al. 1999). Eight per cent of the blue male catfish did not have useable testes. The average weight of the channel catfish female brood fish was 2.5 kg (5.45 pounds) while that of the male was 3.5 kg (7.75 pounds).

Additionally, four-year old channel catfish females weighing 2.5 kg released, on average, 261 ml of dehydrated eggs. One ml of the dehydrated eggs weighed 0.99 gram, while there were 50 eggs in one ml of dehydrated eggs. One ml of hydrated eggs (after being in contact with water) contained 46 eggs. The fecundity of the stripped channel catfish female was 4,900 eggs/kg body weight.

Ninety per cent of the five-year-old blue catfish males, averaging 3.0 kg, developed good testes that could be used for the hybridization of the channel catfish. The average weight of the testes of the blue catfish male was 6 g. One gram of testes was macerated in 5 ml Hank's solution, and 2.5 ml of the sperm solution was used to artificially fertilize 100 ml of eggs. Artificial fertilization rate of channel catfish eggs with blue catfish sperm was 80 per cent. This rate was used in developing the budgets for producing hybrid eggs.

The selected channel catfish brood females were injected with 10 mg carp pituitary per kg female body weight for the production of hybrid catfish eggs. This hormone injection was administered in two doses, the first was two mg carp pituitary per kg female body weight, while the second was eight mg carp pituitary per kg female body weight.

The channel catfish brood females used to produce hybrid catfish were anaesthetized prior to stripping their eggs. Twenty grams of Meta-amino benzoic acid-ethylester (MS-222)® were used to anesthetize 30 channel catfish females.

Labor and management

The farmer supplied all routine management and labor, while additional labor was hired for monitoring dissolved oxygen, for producing hybrid catfish eggs, for checking spawning cans and for other activities. In these budgets, it was assumed that labor was paid $6.56/hour.

The brood stock needed for the production of the hybrid eggs were seined and selected based on their secondary sexual characteristics. Only channel catfish females with outstanding secondary sexual characteristics (swollen and soft belly, an open and reddish vent) were selected. Approximately 90 per cent of the channel catfish females that were initially stocked were selected for their improved secondary characteristics over the eight weeks spawning period. On average 1.5 hours were needed to seine and select 30 females with the best secondary characteristics. Two tractors were used to pull the seine. To inject 30 channel catfish females, 1.5 hours were needed per injection round. There were two injection rounds, each administered 12 hours apart. Stripping of 30 channel catfish females of their eggs took about 4.5 hours. Killing of four blue male catfish and processing of testes took 1.06 hours, and the fertilization of 30 egg masses took 1.5 hours. These tasks were conducted by three experienced workers. Labor was needed for the treatment of the eggs three times a day for a five-day period.

Financial and economic

Enterprise budgets were developed using data from the Gold Kist hatchery and experiments conducted at Auburn University Research Station. Other data on channel egg production were taken from research papers published at Auburn University and other research centers in the SouthEastern States (Table 1).

Table 1 Parameters for the production of hybrid and channel catfish eggs and fry

Source	Production of Specie	Total Number of Female Catfish	Total Weight of Female Catfish (kg)	Spawning Rate %	Fecundity (eggs/kg)	Fertilization Rate %	Hatching Rate %	Fry (fry/kg)
Kim[1]	Hybrid[4]	147	507	89 ± 12	5,516 ± 1,622	58 ± 13	37 ± 23	2,276 ±1,505
Lambert[1]	Hybrid[4]	139	377	72 ± 23	5,276 ± 981	52 ± 21	15 ± 7	789 ± 391
Argue[1]	Hybrid[4]	19	47	84	5,676 ± 3,552	64 ± 29	22.8	1294
Tiemen[1]	Hybrid[4]	30	37	90 ± 0.31	7,667 ± 2,829	91 ± 8	46	1,796 ± 700
Gold Kist[2]	Hybrid[4]	464	1,475	n.a.	3,604 ± 1,480	n.a	12 ± 9	443 ± 390
Bice[1]	Channel	96	240	41 ± 12	7,075 ± 1,250	n.a.	65 ± 4	4,375 ± 1,315
Tiemen[1]	Channel	30	43	47 ± 0.51	11,254 ± 1.191	96 ± 3	57	4,712 ± 700
Hebicha[3]	Channel	100	214	50	8000	90	60	4800
Current Study[3]	Hybrid[4]			80	4900	80	30	1472

[1] Research done at Auburn University (see References), [2]Research done at Gold Kist, Inverness, Mississippi
[3] Production parameters used in this study
[4] Artificial production of hybrid catfish, catfish female are injected with hormones, eggs are manually stripped out of the catfish female, eggs are artificially fertilized with blue catfish sperm.

In the absence of a structured and recognized market for the CB hybrid eggs, the price of these eggs was set at $79.78 per kg ($36.26/pound). This was an altered cost plus pricing method, where a profit margin of 36 per cent based on the same percentage margin for channel catfish eggs, was used. This method of pricing is commonly used when a new product is being introduced on the market. When introducing a new product on the market it is necessary to conduct a price search where prices are varied to determine the competitiveness of the new product. Sensitivity analyses will, however, generate information on the pricing competitiveness of the CB hybrid eggs and that of the channel catfish. Channel catfish eggs were priced at $55.00 per kg or $25.00 per pound.

Electricity was used for the hatching trough. Each kilowatt-hour (KWH) of electricity was charged $0.09 in the different budgets. The total time requirement is based on a rate of one kilowatt per horsepower per hour (Crews et al. 1992).

Two forms of carp pituitary hormones are available on the market: a-ready-to-use form at a

cost of $132.00 per gram, and a more granular form that requires pulverization in a mortar. This form was less expensive, one gram is sold for $87.50. The granular form is used in developing the budgets for egg production. The price for the anaesthesia (MS-222) was $0.45 per gram. The price for the formaline used to treat the eggs was $6.00 per liter.

The straight-line depreciation method was used. Salvage value was assumed to be 10 per cent of the original cost of the equipment and hatchery. Depreciation of brood stock was calculated as the annual replacement of brood stock due to a 15 per cent mortality (Hebicha 1984). The interest on the hatchery, equipment, machinery and ponds was charged over the whole year. The interest rate used for the ownership costs was 10 per cent.

Market availability

As was previously stated, there is a limited market for hybrid eggs, but as the technology develops and proves to be profitable, it is anticipated that production and marketing will become more specialized, and influence the nature of transactions and marketing. The point of sale of eggs was at the farm and hatchery levels. All costs during these transactions were charged to the farmer who sold these products.

Capital budgeting

Capital budgeting techniques were used to evaluate the long-term feasibility of producing CB hybrid channel catfish eggs. Conventional capital budgeting criteria for evaluating capital investments are Net Present Value (NPV), Internal Rates of Return (IRR), and Profitability Index (PI). Since the size of the CB hybrid egg operation might vary from that of the channel catfish, heavy dependence will be placed on the use of PI when comparisons are made. The discount rate was assumed to be 10 per cent and the planning horizon was 10 years.

Risk analysis

Risk analysis was conducted by altering parameters to which the production of CB hybrid eggs were thought to be sensitive. The soundness of the CB hybrid egg enterprises was evaluated by varying critical variables such as prices, costs, yield, and spawning rate. A Monte Carlo simulation model with 1000 iteration was developed to determine the risk-income trade-off for producing and marketing eggs.

Partial Budgeting

The farmer has the option of purchasing eggs for the production of fry for sale. Though this activity is seldom practiced by catfish producers, if it proves profitable, farmers may decide to examine this production stage more closely. The production of CB hybrid requires technical skill; and therefore, CB hybrid producers may become more specialized with time. For speculative purposes we examine the possibility of a farmer changing from an enterprise which produces 64 kg (141 pounds) of CB hybrid eggs to the production of 774,00 CB hybrid fry from 141 pounds of eggs.

Once the eggs were stripped and fertilized, they were placed in the hatching troughs. Ten egg masses went into one 0.54 m^3 hatching trough which had a flow rate of 1.14 m^3/hour. Three hatching troughs and one rearing trough were needed for these egg masses and fry. The hatching troughs had a gear motor that was used to turn their paddles. The eggs in the hatching trough were treated three times daily. The egg masses started hatching after seven days, the water was agitated and was kept flowing constantly during these seven days in the hatching troughs. The hatching rate of hybrid eggs was 30 per cent. After four days the fry began swimming to the surface in search of food. The fry were held for another six days in the rearing trough, and during this period the water was aerated and exchanged constantly.

The swim-up fry were fed a powdered 45 to 50 per cent protein catfish starter diet, three times a day for a six-day period, before moving them to the nursery ponds. Feed conversion

during this period was assumed to be one, and weight increased by 150 per cent. The initial weight of 1,000 swim-up fry was estimated to be 29.4 grams or 1.05 ounces (Murai 1979).

Labor was needed to feed the fry three times a day for a period of six days. The price for the CB hybrid fry was set at $15.00 per thousand fry, which was based on a profit margin of 25 per cent. Operating capital used in the different budgets for producing and growing hybrid fry was charged 9 per cent over the production period. We used partial budgeting techniques to evaluate whether a producer of eggs would attempt to change from egg to fry production and marketing.

Results

Budget analyses

When 64 kg (141 pounds) of CB hybrid eggs were produced, the total cost per kg of egg was $58.62 ($26.65/pound) with the variable cost accounting for 61 per cent of total cost. The net returns to land and management was $1,357.30 (Table 2). Depreciation of fixed assets contributed 29.2 per cent.

Table 2 Hybrid egg budget for producing 64 kg (141 pounds) of eggs from 682 kg (1,500 pounds) of broodfish during an eight week spawning period.

Items	unit	price/unit ($)	quantity	value/costs ($)
Gross receipts				
Catfish eggs	kg	79.78	64.00	5,105.81
Variable costs				
Feed for broodstock	kg	0.22	818.18	180.00
Hormone	gram	87.50	6.80	590.63
Labor	hours	6.56	139.00	913.49
Supplies	$			50.00
Anesthesia	gram	0.45	160.00	72.00
Maintenance & repair	$			439.68
Ground water	m^3	0.006	342.00	2.05
Interest on oper. cap (9 . for 8 weeks)	$	0.09		31.12
Total variable costs	$			2,278.97
Income above variable costs	$			2,826.83
Fixed costs				
Depreciation (equipment & hatchery & brood)	$			1,095.53
Int. on building and equipment	$	0.10		379.17
Total fixed costs	$			1,474.71
Total Cost				4,301.54
				3,753.68
Net returns to land & management	$			1,352.13
Break even costs				
Total cost /kg eggs	$			58.62
Total variable cost/kg eggs	$			35.61
Total fixed cost /kg eggs	$			23.04
NPV	$			1,158.57
IRR	%			11.21%
PI				1.09

The largest size operation examined, utilized 2,727 kg (6,000 pounds) of females and 909 kg (2,000 pounds) of males, and produced a total of 256 kg (563 pounds) of eggs. This size of enterprise generated net returns to land and management of $8202.20, but the cost per kg of eggs only reduced slightly to $47.78 ($21.72/pound). The ratio of variable to fixed costs, was almost the same as that of the previous size operation. Variable costs made up 64 per cent of total costs. The net returns to a dollar of fixed capital invested was 1.85 and to total capital was 0.67 (Table 3). The results indicated that, though the larger size operation produced larger total revenue, and revenue above costs, it generated relatively less net returns to land and management per dollar invested.

Table 3 Budgets for producing 128 kg (281 lbs), 192 kg (422 lbs), and 256 kg (563 lbs) of hybrid eggs and 231 kg (508 lbs) and 462 kg (1016 lbs) of channel catfish eggs during an eight week spawning period.

	Hybrid Catfish Eggs			Channel Catfish Eggs[1]	
	128 kg	**192 kg**	**256 kg**	**231 kg**	**462 kg**
Items	value/costs ($)	value/costs ($)	value/costs ($)	value/costs ($)	value/costs ($)
Gross receipts for catfish eggs	10,211.61	15,317.42	20,423.23	12,700.00	25,403.50
Total variable costs	4,068.14	5,869.93	7,791.31	2,748.33	5,191.83
Income above variable costs	6,143.47	9,447.49	12,631.92	9,951.67	20,211.67
Total fixed costs	2,254.14	3,192.92	4,429.71	2,643.03	3,737.54
Net returns to land & management	3,889.33	6,254.57	8,202.20	7,308.64	16,474.13
Break even costs					
Total cost /kg eggs	49.43	47.26	47.78	23.34	19.34
Total variable cost/kg eggs	31.81	30.60	30.47	11.90	8.10
Total fixed cost /kg eggs	17.62	16.65	17.31	11.44	11.24
NPV	10,684.71	18,293.27	23,283.55	4,650.42	31,377.28
IRR	21.96 %	24.58 %	23.18 %	13.12 %	23.48 %
PI	1.57	1.70	1.63	1.15	1.76

[1] *Source*: Hebicha, H. 1984

Production techniques of channel catfish and CB hybrid eggs are not the same, however, we assume that a comparison of approximate quantities of CB hybrid and channel catfish eggs may provide some information on relative profitability. If we compare the production of 231 kg (508 pounds) of channel catfish eggs to that of 256 kg (563 pounds) of hybrid eggs, it can be deduced that the cost of production per kg is much higher for the CB hybrid than the channel catfish eggs (Table 3). However, the net returns to land and management per kg of eggs for the channel catfish is 31.66 ($14.39/pound), compared to $32.04 ($14.57/pound) for the CB hybrid. Net returns to land and management for the production of 231 kg (508 pounds) and 462 kg (1016 pounds) of channel catfish eggs were $7,308.64 and $16,474.13, respectively (Table 3). Assuming the higher price for the hybrid eggs, the net returns to fixed investment and to total cost are 2.7, and 1.33, respectively for the channel catfish eggs compared to 1.85 and 0.67 for the CB hybrid. These ratios demonstrate that the production of eggs using the CB hybrids is not cost effective in the short run.

Capital budgeting

Investment in 64 kg (141 pounds) of hybrid eggs was profitable both in the short and long runs. If the farmer invests $12,962.30 in the production of hybrid eggs, assuming a discount rate of 10 per cent, he will recoup his investment in less than three years, and the net present value (NPV) would be $1,158.57 over a 10 year planning horizon (NPV is the present value discounted at the firm's required rate of return on the stream of net cash flows from the project minus the net investment). Borrowed capital in the investment of 64 kg (141 pounds) of hybrid eggs will generate an internal rate of return of 11.21 per cent after ten years (Table 2). The IRR is the interest rate that equates the present value of the expected future cash flow to initial investment. The farmer will be able to pay the cost of borrowed capital which approximates 10 per cent for agricultural loans.

With an investment of $16,662.30 in the production of 128 kg (281 pounds) of hybrid eggs, the NPV was $10,684.71 and the investment generated an IRR of 21.96 per cent (Table 3). The profitability index was 1.57 (PI, the ratio of the net present value of future net cash flows over the life of the project to the net investment).

Investing $26,086.00 in the production of 191 kg (422 pounds) of hybrid eggs, generated a NPV of $18,293.27, and an IRR of 24.58 per cent. The profitability index was 1.70 (Table 3). Long-term investment of $28,951.99, producing 256 kg (563 pounds) of hybrid eggs was profitable. The IRR was 23.18 per cent while the NPV was $23,283.55, and the profitability index was 1.63 (Table 3). The NPV's for the production of 231 kg (508 pound) and 462 kg (1,016 pound) of channel catfish eggs were $4,650.42 and $31,377.28. The IRR's were 13.12 per cent and 23.48 per cent respectively, while the profit indices were 1.15 and 1.76 for the production of 231 kg and 462 kg (508 and 1016 pounds) of channel catfish eggs (Table 3).

Fry Production

If the farmer decides to produce 774,000 CB hybrid fry, it will result in additional income of $6,498.25, but at additional costs of $1,493.03. The net change will be a positive $4943.95 (Table 4). This means that producers of eggs may be willing to engage in an enterprise of CB hybrid egg production if there is an available market for this output. Net change = $6,498.25-$1,554.03 = $4,943.95.

Table 4 Partial budget for changing from producing 64 kgs (141 lbs) of eggs for sale of 774,000 fry

Additional Cost			**Additional Income**		
			Sale of Fry	thousand	6,498.25
Feed for Fry	0.5	12.51			
Chemicals	$/L	216.00			
Labor	hr	432.96			
Electricity	kwh	120.48			
Maintenance and repair	$	82.03			
Groundwater		36.62			
Interest on Capital	%	83.34			
Depreciation					
Equipment		309.87			
Ownership		199.22			
Sub-Total		**1,493.03**	**Sub-Total**		**6498.25**
Reduced Income			**Reduced Cost**		
Interest Income		61.27			0.0
Total		**1,554.03**			**6,498.25**

Sensitivity and risk analysis

The profitability of production of CB hybrid eggs is superior to that of the channel catfish only if a high market price can be obtained for the hybrid eggs. However, before encouraging farmers to engage in CB hybrid production, information on sensitivity of net returns to changes in critical parameters should be provided. It is important to determine whether the enterprise is still profitable if costs change due to changes in the price of eggs.

Changes of 10, 20, and 30 per cent in variable costs and price of eggs did affect the relative profitability of CB hybrid egg production. Such changes as seen in Table 5, had little effect on the IRRs. Sensitivity analyses show that a reduction of egg price by only 30 per cent will result in returns to a dollar invested in CB hybrid egg production of $0.88. When the price of CB hybrid eggs declines by 30 per cent, the IRR for CB hybrid drops to 6.30 per cent.

Risk analysis using the *@Risk* program was used to examine the production feasibility of CB hybrid and channel catfish eggs. Triangle and truncated normal distribution were used for some variables in the budgets while each budget was simulated 1,000 times to get a probability density function for the net returns and NPV for the egg.

The NPV for the production of the hybrid egg had a 25 per cent probability of being negative, compared to only 5 per cent probability for channel catfish egg production. CB hybrid egg production showed a wide range (0 to 200 per cent) risk dominance compared to the channel catfish (Figure 1).

Table 5 Sensitivity analysis for the production of 256 kg (563 lbs) of hybrid egg by changing variable cost, egg price, spawning rate, eggs produced by catfish female, and the effects on net returns, variable cost, tc, IRR, PI.

Hybrid Catfish Eggs					
Variable cost ($)	**Net returns ($)**	**Variable cost**	**Total Cost (tc) ($)**	**IRR**	**PI**
7,791.31	8,202.20		47.78	23.2 %	1.60
8,570.44	7,423.07		50.84	16 8 %	1.40
9,349.58	6,643.94		53.88	15.5 %	1.40
10,128.71	5,864.81		56.94	14.1 %	1.40
egg price ($)	**net returns ($)**	**variable cost**	**tc ($)**	**IRR**	**PI**
36.30	8,202.20	7,791.31	47.78	23.2 %	1.60
32.67	6,159.88	7,791.31	47.78	14.6 %	1.30
29.04	4,117.56	7,791.31	47.78	10.7 %	1.09
25.41	2,075.23	7,791.31	47.78	6.3 %	0.88
spawn rate	**net returns ($)**	**variable cost**	**tc ($)**	**IRR**	**PI**
0.90	8,202.20	7,791.31	47.78	23.2 %	1.63
0.80	5,932.95	7,791.31	53.77	14.2 %	1.27
0.70	3,663.71	7,791.31	61.45	9.8 %	1.04
0.60	1,394.46	7,791.31	71.68	4.7 %	0.80
ml eggs per	**net returns ($)**	**variable cost**	**tc ($)**	**IRR**	**PI**
261.00	8,202.20	7,791.31	47.78	23.2 %	1.63
235.00	6,159.88	7,791.31	53.11	14.6 %	1.30
209.00	4,117.56	7,791.31	59.73	10.7 %	1.09
183.00	2,075.23	7,791.31	68.27	6.3 %	0.88

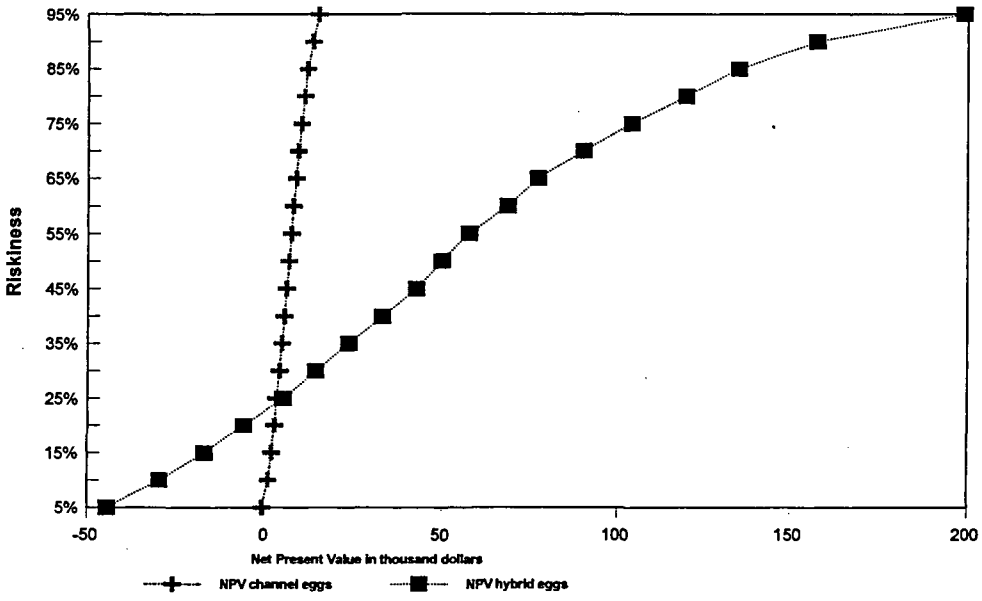

Figure 1 Riskiness and net present value for 256 kg (563 lbs) of hybrid and 231 kg (508 lbs) of channel catfish eggs production

Summary

The cost of production of hybrid egg masses was $47.78 per kg ($19.22/pound) when 256 kg of eggs are produced and $23.34 per kg ($10.61/pound) for channel catfish. The average market price per kg was $72.60. These values are considerably different from those obtained by Tieman (1995) $13.46 per kg ($6.12/pound) for hybrid eggs and $8.23 per kg ($3.74/pound) for channel catfish eggs. However, the magnitude of the differences was similar, hybrid eggs produced by strip spawning were about twice as expensive to produce than channel catfish eggs produced by open pond spawning. The primary difference is that Tieman (1995) overestimated egg production (Table 1). Hebicha (1984) estimated channel catfish egg production costs at $22.86 per kg ($10.39/pound) and $20.68 per kg ($9.40/pound) for surveyed and recommended practices in Alabama, and these are similar to the figures obtained in the current study. Hebicha (1984) concluded that egg production was least profitable of all catfish enterprises. Hybrid catfish egg production will not be a profitable enterprise unless the eggs can be marketed at a premium price. This can only be attained if buyers of the CB hybrid recognize superior attributes of the fish, are willing to pay for those attributes, and the benefits derived from food fish sales are transmitted to egg producers.

CB hybrid egg production is more costly than channel catfish egg production for approximate quantities. However, if part of the price received for an improved fish is transmitted to the egg producers and the price of eggs is 30 per cent more than that of channel catfish, CB hybrid egg production can be competitive in the short and long runs. It is doubtful that a premium market price would be obtained for hybrid eggs since catfish egg production is generally one of the least profitable stages of catfish production and marketing and catfish egg sales are still limited. However, the sensitivity analyses conducted showed CB hybrid producers

would have to receive a premium even with a reduction in price of eggs from $36.30 to $25.41 a kg, the egg enterprise was still profitable.

CB hybrid egg production shows risk dominance at net returns above $5,000.00. When hybrid and channel eggs were sold at the same price, channel catfish egg production was risky. The analyses showed that changes from CB hybrid egg production to specialize in fry production resulted in reduced net income. This can be explained by the variable hatchability of catfish eggs and the assumed high price of eggs. The feasibility of the CB hybrid catfish egg production depends on the market price received for the product at a given point in time. A caveat should be placed on the results stated since we are not sure whether buyers will evaluate the channel catfish eggs as different products from the CB hybrid eggs.

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