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# A Preliminary Assessment of the Costs and Earnings of Commercial, Small-Scale, Outdoor Pond Culture of Tilapia in Florida[1]

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## Abstract

This analysis examines the cost and earnings of a hypothetical pond culture facility for tilapia in Florida. Given the assumptions concerning yield, harvest size, market prices, and per-unit input costs, the hypothetical six-acre tilapia culture facility will require an initial investment of $65,850, generate $40,259 in annual operating costs, and yield $29,221 in net returns during an average year within the planning horizon. Net returns are especially sensitive to changes in market price, feed costs, and survival rates.

## Introduction

The culture of tilapia (*Oreochromis spp*.) in Florida has typically been characterized by high density, indoor, recirculating production systems. This relatively high cost production method has achieved limited success in Florida although several commercial operations currently exist. The culture of tilapia in outdoor pond systems provides a potentially viable alternative production method. The economic benefits of outdoor pond systems may be relatively low initial investment requirements and lower operational costs, which would allow production at a more competitive per-unit cost. Disadvantages would include less control over water quality conditions, predation, larger land area requirements, and possible restriction of culture sites to the southern regions of the state. Potential investors need to the be aware of the economic tradeoffs among alternative tilapia production methods. Unfortunately, no studies exist that describe the economic characteristics of low cost, low tech, outdoor tilapia culture systems in Florida, nor do studies exist that compare and contrast indoor systems with outdoor systems.

The following discussion provides a brief overview of projected costs and earnings associated with a small-scale, outdoor pond culture system in Florida. Since a typical operation does not exist, the costs and earnings presented represent projected, or *pro forma*, values for initial investment, annual operation costs, and revenues. The estimates are presented for a hypothetical six-acre facility

1. This is document FE 210, a publication of the Department of Food and Resource Economics, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. Published October 2000. This document was originally prepared for presentation at the Tilapia Workshop, November 14, 1998, at the University of Florida Tropical Aquaculture Laboratory, Ruskin, FL. Please visit the EDIS website at: http://edis.ifas.ufl.edu.
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consisting of three two-acre ponds which have been added to an existing farming or aquaculture facility. The projected values are based upon discussions with commercial tilapia producers in Florida and University of Florida research/extension faculty familiar with outdoor production systems similar to those proposed in this analysis. The discussion will initially focus on initial investment requirements and annual operational expenses. These estimates will then be utilized to construct an annual enterprise budget and an annual cash flow over a five-year planning horizon. Finally, a sensitivity analysis will be presented that examines how financial performance measures change as key management parameters are altered. The sensitivity analysis should provide the potential investor with some insight into the production and financial risk associated with the proposed outdoor production system.

## Initial Investment Requirements

Initial investment for the hypothetical culture facility consists of pond construction, well and pump placement, and the purchase of the necessary equipment (Table 1). The facility consists of three two-acre ponds. The ponds have a common levee design and are rectangular in shape. The dimensions of each pond are 205 feet by 425 feet. The ponds each have a six-foot levee providing a water depth of five feet with one foot of freeboard. The levees are designed with a 3:1 slope and a 16-foot top width. They are constructed via cut and fill. The levees are also stabilized with grass seed and gravel on the top surface to provide all weather access for feeding and harvesting, as well as to minimize erosion (Zimet and Lazur, 1994). The costs associated with pond construction include excavation ($1 per cubic foot), drainage pipes, water supply lines, levee stabilization costs, and electrical hookups. The latter is necessary to power the aerators and automated feeders for each pond. The total cost for each pond is $8,000 for excavation and $3,667 for "outfitting" the ponds. Total cost for pond construction is $35,000. A six-inch well and a 250-gpm submersible pump ($10,000) will be required for filling and periodic augmenting of the water in the ponds due to evaporation and seepage. An additional 400-gpm pump ($1,200) is needed for water movement between ponds during harvest. A 3-hp electrical aerator ($2,100 each) will be placed in each pond. In addition, two electrical feeders ($400 each) will be placed on each pond to deliver feeds on a consistent basis, while reducing the labor cost. Two hapas-style nursery pens ($200 each) will be placed in each pond during the nursery phase to allow the juvenile fish to grow from one-inch fry to 100-gram fingerlings for grow-out.

An air conditioned feed storage shed ($800) is required for storing bagged feed. Two block-construction purging/holding tanks ($2,250 each) are required. These tanks will be fully plumbed and fitted with aeration systems and designed to hold fish at a density of two pounds per cubic foot. Fish will be harvested in 5,000-pound batches and retained in the tanks for off-flavor purging and holding for shipment. Other equipment costs include a 1,000-gallon live haul box for transfer of harvested fish to the holding tanks, seine nets, a water quality kit, oxygen meter, and other miscellaneous items. The total initial investment amounts to $65,850. The analysis assumes the necessary trucks, tractors, and trailers have already been purchased for use on an existing farm/culture operation. The initial investment cost associated with these items has not been included. For the same reasons, the cost of the necessary land has not be included.

The depreciation associated with capital purchases is computed on a straight-line basis across the full length of serviceable life, with no remaining salvage value. Total annual depreciation amounts to $7,030. Most large items are assigned a 10-year life, while some less expensive equipment is assigned a five-year life. Thus, reinvestment in capital equipment will begin during the sixth year of the planning horizon.

## Annual Operating Expenses

Annual operating expenses consist of variable and fixed costs. Variable costs are those expenses that vary directly with level of production, which in this case is pounds of tilapia stocked and harvested. Fixed costs represent those expenses that are insensitive to annual production decisions. Both sets of costs are important components of the total annual

cost of operating a hypothetical tilapia culture system.

### Variable Costs

Major variable costs include fry, feed, harvest labor, and interest associated with an operating capital loan (Table 2). The largest cost is for feed. Tilapia fry will be held in the nursery pens from initial stocking size to 100 grams. During the period, they will be fed a feed designed for juvenile fish. Tilapia are stocked as one-inch fry at 10,000 per acre. The assumed price at the volume required for the proposed facility is $0.08 each. A higher price may be warranted at lower volumes. Total cost of fry for initial stocking is estimated to be $4,800. Two types of feed are utilized. One is for feeding to fry in the nursery pens, while the other is for grow-out. The juvenile feed is purchased in bag form at $0.20 per pound. A food conversion ration (fcr) of 1.2 (i.e., 1.2 pounds of feed for each pound of harvested fish) is utilized for the juvenile feed. The grow-out feed is purchased in bag form at $0.15 per pound. An fcr of 1.75 is used for the grow-out feed. In addition, a 10,000 per-acre stocking density and a 72 percent survival rate is utilized for back calculating total feed consumed by the total harvested weight. This is done for both the nursery and grow-out stages. Total feed costs is estimated to be $13,961 per year, given assumptions regarding the initial stocking densities, survival rates, and nursery/grow-out harvest sizes (i.e., 100 gm and 1.25 lbs, respectively). Electrical utility costs were estimated for the initial filling of the ponds; aeration during the production period; and the lights, A/C, etc. utilized during the course of a year. These costs were estimated given a $0.07 kwh cost. Total electrical utility costs are estimated to be $2,600 per year. Other costs include prorated fuel/oil/lubricants ($300) needed for a previously purchased truck and tractor. Repair and maintenance costs for all equipment is estimated to be $1,000 per year. Initial chemical treatment of the ponds prior to filling (i.e. liming) is included for a cost of $600. Labor required during harvest period is estimated to be approximately $3,000. This labor includes that needed for actual harvest of each pond, transportation of fish to the holding system, and assisting in loading fish into the buyer's live-haul truck prior to shipment. Owner labor, including that provided by family members, is not included. Potential investors need to carefully estimate their total labor charge, including owner and family labor, to fully account for the cost of labor. Other variable costs include periodic marketing activities ($300 per year for phone and advertising) and the interest associated with an operating capital loan ($2,390). All variable costs were assume to be financed by an annual operating capital loan, which is accounted for by charging one percent per month of the total variable costs for a period of nine months. Total annual variable cost is estimated to be $28,951.

### Fixed Costs

Fixed costs are those which do not vary with the level of production. These costs include long-term loan interest, overhead such as insurance and bookkeeping, annual permits and licenses, and depreciation (Table 2). The total amount of the initial investment is financed by a 10-year loan at an annual rate of eight percent. The average annual interest charge during the loan period is $3,228. Insurance and bookkeeping costs are included at $1,000 per year. Several permits are required, but only the Florida Department of Agricultural and Consumer Services (FDACS) aquaculture certificate ($50) is incurred on an annual basis. The annual depreciation cost of the equipment initially purchased is $7,030. Total annual fixed cost is estimated to be $11,308.

## Annual Cash Flow

An annual cash flow was compiled over a five-year planning horizon (Table 3). The cash flow includes only cash expenses, excluding non-cash costs such as depreciation. The cash flow assumes that production levels, input use, unit prices, and production costs remain constant over the entire planning horizon. For example, the market price per 1.25 pound tilapia harvested at the end of the production period is $1.30/lb live weight. The analysis assumes all harvested fish attain this weight. The absence of any size distribution and the market price are assumed to remain constant. Total revenue each year is estimated to be $70,200 (i.e., 10,000 initial stocking density per acre X 72% survival X 1.25 lb X $1.30/lb X 6 acres). Total variable production costs, excluding operating capital loan

interest, is estimated to be $26,561 per year. Operating capital loan interest is estimated to be $2,390 per year. Overhead costs total $1,650 the first year, and include insurance, bookkeeping, and the necessary permits and licenses. Note that the FDACS aquaculture certificate ($50) is required every year, while the water use permit ($500) and the Florida Department of Environmental Protection (FDEP) general aquaculture permit ($100) are required every five years. Thus, the overhead costs decreases to only $1,050 for the second through fifth years. Interest and principal payments for the loan required for pond construction and initial equipment purchases varies for each year, but the total payment is constant at $9,814 per year. The total cash outflow is estimate to be $39,814 in years two through five, and the annual cash position (annual revenue minus cost) is $30,386 in years two through five. The ending cash balance is positive and increasing for each year. Note also that the Annual Cash Position reflects cash returns to owner labor, management, and taxes. As with many of the costs estimated in this analysis, these costs will vary considerably across individual investors and geographic site. As a result, owner labor costs and taxes have not been included in the analysis. The Ending Cash Balance should be adjusted to reflect the actual labor and management payment expectations, and tax costs (including local property and federal income/self employment taxes, if required). However, in lieu of accounting for these other costs, the annual cash flow is positive for each year in the planning horizon and suggests a three-year payback period for the initial investment. Including annual payments to owner labor/management skills and taxes may generate a negative cash flow initially, which would prolong the payback period. Also, reinvestment in some capital equipment begins in year six, with major reinvestment occurring in year 11. The cash flow characteristics beyond the five-year planning horizon have not been described.

## Average Annual Enterprise Budget

An annual enterprise budget provides an assessment of the average costs and earnings associated with a specific production activity, or enterprise, for a typical year in the planning horizon of the business. Enterprise budgets are useful tools for comparing the profitability of ongoing individual production activities, or generating estimates of expected profits of potential alternative production activities. In this case, the revenue and costs are averaged over the five-year planning horizon (Table 4). Annual revenue and most cost categories are the same as seen in Table 2, with the exception of interest on the initial investment loan, permits/licenses, and depreciation. The loan interest has simply been averaged over the five payments found in the cash flow. The permits and licenses are averaged over the five-year period, with the water use permit and the FDEP permit included. The depreciation includes the total annual value found in Table 1 plus some additional depreciation for the previously purchased truck and tractor (included at 20 percent of the total annual depreciation for a $15,000 truck and tractor with a 10-year useful life for each). Total annual costs are estimated to be $40,979.

Net returns are assumed to be defined as returns to owner labor, management, taxes, and reinvestment. The owner operator labor/management payment and family income have not be deducted from the net returns. In addition, taxes have not been estimated. Finally, the cost of withdrawing net income for future investment in replacement equipment has not been estimated, although the depreciation charge can be viewed as an approximation of this reinvestment cost. Thus, with annual revenue estimated to be $70,200, average annual net returns are expected to be $29,221.

The values found in an enterprise budget are useful for estimating other measures of financial performance. For example, the ratio of total cost to total pounds harvested for market provides the cost per pound of producing tilapia in the pond system. In this case, the cost per pound is $0.76. However, recall that this value does not include the total labor charge, taxes, and withdrawals for reinvestment. An additional measure of performance is the break-even survival rate. This is the rate of survival that is needed to just cover the total cost of production. This value is defined as the ratio of total cost and market price, then divided by the number of tilapia initially stocked. In this case, the break-even survival rate is 53 percent, well below the survival rate expected.

However, if total survival falls below 53 percent, the hypothetical tilapia culture system in this example will not be profitable.

## Sensitivity Analysis

A major source of risk in an aquaculture operation includes unanticipated changes in market conditions, input prices, and yield. An understanding of how sensitive profit is to such change can allow the manager to focus attention on those controlling factors, or management parameters, that have the greatest influence on the financial performance of the culture operation. A sensitivity analysis was conducted on market price, fry price, feed prices, survival rate, and stocking density (Table 5). Each of these factors was changed, while holding all other underlying assumptions constant. In a real world setting, several of these factors may be changing simultaneously, which would likely compound their individual effect. However, for simplicity, only one factor is altered at a time in the following analysis. The measures of financial performance examined include net returns, total costs per pound, and break-even survival rate. These values were computed from the average annual enterprise budget, while allowing a change in the respective management parameter.

### Market Price

Market price for a 1.25 lb tilapia was allowed to change from the baseline value of $1.30 per pound to $1.00 and $1.60 (e.g., approximately a 23 percent change). Note that as market price changes, net returns change by over 50 percent in the same direction. In addition, break-even survival rate changes, but in the opposite direction. This is due to the fact that costs remain constant, while market price changes. A lower market price requires a higher survival rate to cover costs. The opposite is true for a price increase. Cost per-pound harvested remains unchanged.

### Fry Price

The per-each fry price (for one-inch fish) was allowed to increase to $0.10 (e.g., a 25 percent increase). This input price increase decreases net returns by four percent, while total cost per pound and break-even survival rate increases by three percent and two percent, respectively. Total cost of fry represents a relatively small percentage of total cost.

### Feed Prices

The prices for juvenile and grow-out feed was allowed to increase to $0.25 and $0.18, respectively. These changes represent increases of 25 percent and 20 percent. Net returns decrease by about 11 percent, while the total cost per pound increases by eight percent. Break-even survival rate increases by four percentage points (eight percent) as additional production is required to cover the cost increase.

### Survival Rate

Total survival rate was allowed to change to 58 percent and 86 percent (a 20 percent change in either direction). Net returns changed in the same direction by approximately 40 percent. Total cost per pound increased with a decline in survival rate as total costs are spread over a lower total yield. The opposite is true for an increase in survival. Similarly, the break-even survival rate decreases with a decrease in survival as the total feed cost is reduced, while most other costs remain constant.

### Stocking Density

The initial per-acre stocking density was allowed to change from the baseline assumption of 10,000 to 8,000 and 12,000 (a 20 percent change). As expected, net returns changed in the same direction. A 20 percent change in stocking density changes net returns by 34 percent. A decrease in initial stocking density of 20 percent increases the total cost per-pound harvested by 12 percent (yield decreases faster than costs decrease), while break-even survival increases by 11An increase in stocking density generates opposite changes in total cost per pound and break-even survival rates.

### Sensitivity Analysis Summary

The factors that have the greatest impact on the financial performance of the hypothetical culture system include market price, feed costs, and survival rates. The owner/operator may have more or less control over each of these factors, but should strive to

exert as much control over this complement of factors as possible to reduce the chance of unanticipated reduction in profits.

## Conclusion

This analysis suggests that a small-scale, outdoor pond tilapia culture facility may be profitable. Positive average annual net returns and a cash flow that is positive throughout a five-year planning horizon support this conclusion. However, major costs that have not been included in the analysis include family labor, returns to owner management skills, and taxes. In addition, some essential capital equipment and land have been assumed to have been previously purchased and available with excess capacity to be utilized for tilapia culture. Given the assumptions concerning yield, harvest size, market prices, and per-unit input costs, the hypothetical six-acre tilapia culture facility will require an initial investment of $65,850, generate $40,259 in annual operating costs, and yield $29,221 in net returns during an average year within the planning horizon. Net returns are especially sensitive to changes in market price, feed costs, and survival rates, although additional factors including prices for other input units and stocking densities can influence profits.

Potential investors in small-scale, outdoor pond culture of tilapia should note that these findings pertain only to the hypothetical system described in this analysis. **The findings should serve as a guide only.** Actual costs and returns will vary with operator skill and technical ability, geographic location of the facility, prevailing market conditions, and other factors. Potential investors should carefully consider all costs and "crunch their own numbers" to better ensure against an unwise investment.

## Acknowledgments

The authors would like to thank Mike Picchietti (Aquasafra, Inc.) for providing assistance in designing the hypothetical system utilized in the analysis. The study would not have been possible without his technical assistance and advice.

## References

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**Table 1.** Initial investment for a 6-acre outdoor pond tilapia culture facility.

| Item | Number | Unit Price | Initial Investment | Years of Life | Annual Depreciation |
|---|---|---|---|---|---|
| Ponds — 2 acres (205' x 425') | | | | | |
| Excavation costs | 3 | $8,000 | $24,000 | 10 | $2,400 |
| Drain pipes, electrical hookup, water supply line, gravel, levee stabilization, etc. | 3 | $3,667 | $11,000 | 10 | $1,100 |
| Submersible pump and well (6-8" well with 250-gpm pump) | 1 | $10,000 | $10,000 | 10 | $1,000 |
| Pump (remove "trash" for water movement) | 1 | $1,200 | $1,200 | 10 | $120 |
| Aerators (3-hp electric) | 3 | $2,100 | $6,300 | 10 | $630 |
| Electrical feeders | 6 | $400 | $2,400 | 10 | $240 |
| Purging/Holding tank (10'x40' block, with water supply, aeration system) | 2 | $2,250 | $4,500 | 10 | $120 |
| Live haul box (1,000 gallon plastic tank with fittings) | 1 | $1,200 | $1,200 | 10 | $120 |
| Nursery cages (hapas-style net pen) | 6 | $200 | $1,200 | 5 | $240 |
| Feed storage shed (with A/C) | 1 | $800 | $800 | 10 | $80 |
| Water quality kit | 1 | $200 | $200 | 5 | $40 |
| Seine nets (275 feet) | 1 | $1,400 | $1,400 | 5 | $280 |
| Oxygen meter | 1 | $650 | $650 | 5 | $130 |
| Miscellaneous equipment (loading nets, scales, waders, etc.) | — | — | $1,000 | 5 | $200 |
| TOTAL INITIAL INVESTMENT | — | — | **$65,850** | — | — |
| TOTAL ANNUAL DEPRECIATION | — | — | — | — | **$7,030** |

**Table 2.** Total annual operating expenses (cash and non-cash) for a 6-acre outdoor pond tilapia culture facility.

| Item | Number | Unit Price | Total Expense |
|---|---|---|---|
| Fry (stocked at 10,000 per acre) | 60,000 | $0.08 each | $4,800 |
| Feed | | | |
| Juvenile (to 100 gm @ 1.2 fcr) | 11,405 lbs | $0.20/lb | $2,281 |
| Grow-out (to 1.25 lbs. @ 1.75 fcr) | 77,868 lbs | $0.15/lb | $11,680 |
| Utility costs (@ $0.07/kwh) | | | |
| Fill ponds/purge fish | — | — | $1,400 |
| Aeration | — | — | $600 |
| Facility lights, A/C, etc. | — | — | $600 |
| Fuel/oil/lubricants | — | — | $300 |
| Repairs and maintenance | — | — | $1,000 |
| Annual pond treatment (liming, etc.) | — | $100/acre | $600 |
| Harvest labor (50 hrs/pond + handling) | — | $10/hr | $3,000 |
| Marketing | — | — | $300 |
| Operating capital loan interest | — | — | $2,390 |
| *Fixed Costs* | | | |
| Construction/equipment loan interest (average) | — | — | $3,228 |
| Insurance and bookkeeping | — | — | $1,000 |
| Permits and licenses (DACS) | — | — | $50 |
| Depreciation | — | — | $7,030 |
| TOTAL ANNUAL COSTS | | | **$40,259** |

**Table 3.** Annual cash flow for a 6-acre outdoor pond tilapia culture facility.

| | Year | | | | |
|---|---|---|---|---|---|
| **Cash Item** | **1** | **2** | **3** | **4** | **5** |
| *Beginning Cash Balance* | $0 | $29,785 | $60,171 | $90,557 | $120,943 |
| *Cash Receipts* | $70,200 | $70,200 | $70,200 | $70,200 | $70,200 |
| *Cash Outflow* | | | | | |
| Production costs | $26,561 | $26,561 | $26,561 | $26,561 | $26,561 |
| Overhead (licenses, permits, insurance, bookkeeping, etc.) | $1,650 | $1,050 | $1,050 | $1,050 | $1,050 |
| Construction/Equipment loan | | | | | |
| Principal | $4,546 | $4,909 | $5,302 | $5,726 | $6,184 |
| Interest | $5,268 | $4,904 | $4,512 | $4,087 | $3,629 |
| Operating capital loan | | | | | |
| Principal | $26,561 | $26,561 | $26,561 | $26,561 | $26,561 |
| Interest | $2,390 | $2,390 | $2,390 | $2,390 | $2,390 |
| Total cash outflow | $40,415 | $39,814 | $39,814 | $39,814 | $39,814 |
| *Annual Cash Position* | $29,785 | $30,386 | $30,386 | $30,386 | $30,386 |
| *Ending Cash Balance* | $29,785 | $60,171 | $90,557 | $120,943 | $151,329 |

Note: Cash flow assumes production costs remain constant over the 5-year planning horizon. The Annual Cash Position reflects cash returns to owner labor, management, and taxes. As with many of the costs estimated in this analysis, these costs will vary considerably by individual and site location. As a result, owner labor costs and taxes **have not been included**. Thus, the Ending Cash Balance should be adjusted for individual labor and management payment expectations, and tax costs (including local property and federal income and self-employment taxes, if applicable).

**Table 4.** Average annual enterprise budget for a 6-acre outdoor pond tilapia culture facility.

| Revenue/Expense Category | Number | Unit Price | Total Value |
|---|---|---|---|
| Yield is 9,000 lbs/acre, shipped live | 54,000 lbs | $1.30/lb | $70,200 |
| *Variable Costs* | | | |
| Fry (stocked at 10,000 per acre) | 60,000 | $0.08 each | $4,800 |
| Feed | | | |
| Juvenile (to 100 gms @ 1.2 fcr) | 11,405 lbs | $0.20/lb | $2,281 |
| Grow-out (to 1.25 lbs @ 1.75 fcr) | 77,868 lbs | $0.15/lb | $11,680 |
| Utility costs (@ $0.07/kwh) | | | |
| Fill ponds/purge fish | — | — | $1,400 |
| Aeration | — | — | $600 |
| Facility lights, A/C, etc. | — | — | $600 |
| Fuel/oil/lubricants | — | — | $300 |
| Repairs and maintenance | — | — | $1,000 |
| Annual pond treatment (liming, etc.) | — | $100/acre | $600 |
| Harvest labor (50 hrs/pond + hauling) | — | $10/hr | $3,000 |
| Marketing | — | — | $300 |
| Operating capital loan interest | — | — | $2,390 |
| *Fixed Costs* | | | |
| Construction/Equipment loan interest | — | — | $3,228 |
| Overhead | | | |
| Permits and licenses | — | — | $170 |
| Insurance, bookkeeping, etc. | — | — | $1,000 |
| Depreciation (including pre-owned tractor and truck) | — | — | $7,630 |
| *Total Costs* | — | — | $40,979 |
| *Net Returns to Owner Labor, Management, Taxes, and Reinvestment* | — | — | $29,221 |
| Cost per pound of Tilapia harvested (total cost/pounds harvested) | — | — | $0.76 |
| Break-even survival rate (total cost/market price/number stocked | — | — | 53% |

**Table 5.** Sensitivity analysis by key management parameters for a 6-acre outdoor pond tilapia culture facility.

| Management Parameter | Net Returns | Total Cost per Pound | Break-Even Survival Rate |
|---|---|---|---|
| *Market Price* | | | |
| $1.00 | $13,021 | $0.76 | 68% |
| **$1.30** | **$29,221** | **$0.76** | **53%** |
| $1.60 | $45,421 | $0.76 | 43% |
| *Fry Price* (per each) | | | |
| **$0.08** | **$29,221** | **$0.76** | **53%** |
| $0.10 | $27,913 | $0.78 | 54% |
| *Fry Price* (per pound for Junvenile/Grow-out) | | | |
| **$0.20/$0.15** | **$29,221** | **$0.76** | **53%** |
| $0.25/$0.18 | $26,053 | $0.82 | 57% |
| *Survival Rate* (%) | | | |
| 58% | $18,469 | $0.88 | 49% |
| **72%** | **$29,221** | **$0.76** | **53%** |
| 86% | $39,911 | $0.68 | 56% |
| *Stocking Density* (per acre) | | | |
| 8,000 | $19,270 | $0.85 | 59% |
| **10,000** | **$29,221** | **$0.76** | **53%** |
| 12,000 | $39,171 | $0.70 | 48% |

Note: Bold values are baseline assumptions.