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# Economic Analysis of Prawn (*Penaeus monodon*) Culture in the Philippines, I: Hatchery Operations

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## Abstract

High prices of prawn (*Penaeus monodon*) fry, profitability of hatchery operations, and a low-cost hatchery design introduced by the Southeast Asian Fisheries Development Center attracted millions of dollars of investments in the mid-1980s. When export prices for prawn fell dramatically in 1989, demand for fry dropped as most prawn growers stopped operations or reduced stocking densities. Natural calamities - typhoons, earthquakes and volcanic eruptions - further depressed conditions in the hatchery sector.

This paper presents an economic analysis of hatchery operations in the Philippines using data gathered through interviews and structured questionnaires in 1992. Economic indicators estimated include: investment requirements, unit cost, benefit over cost ratios, and internal rates of return. Breakeven and sensitivity analyses of operating hatcheries were employed to determine the degree of risk and changes in profitability levels associated with different scales of operation given changes in output price, input price and production level.

Results indicate that net income per productin run was positive for all scales of hatchery operation in spite of the current adverse market conditions. New hatchery investments, however, should be made in medium- and small-scale facilities because these have a better chance to survive worsening market conditions and periodic spawner shortages. Medium-size operations provide the best returns, and large-scale operations showed negative returns. Large-scale hatcheries are operating below capacity due to scarcity of spawners and low market demand.

## Introduction

High prices, profitability of prawn (*Penaeus monodon*) hatchery operations, and the low-cost hatchery designs introduced by the Southeast Asian Development Center (SEAFDEC), attracted a high level of investment in prawn culture in the Philippines in the mid-1980s. Hatcheries proliferated all over the country. As of 1992, there were 461, of which 35% were not operational. When export prices of prawn crashed in 1989, demand for fry dropped as most prawn

growers stopped operations or reduced stocking densities. Most hatchery operators suffered heavy losses resulting in stoppage of operations. Natural calamities, such as typhoons in the Visayas in 1990, an earthquake in Central Luzon and the eruption of Mount Pinatubo, caused massive destruction of hatchery facilities. Hatcheries operating marginally due to low demand and low prices closed permanently. The survivors undertook major repairs, financed either through retained earnings or bank loans.

In 1986 there were only 48 hatcheries existing in Western Visayas (Israel et al. 1986). Because demand was greater than supply, hatchery operators were in a better price-bargaining position than buyers. Prices of fry in 1985 were in the range of P300-400 (US$12-16) per thousand compared to current prices of P100-275 (US$4-11) per thousand.

In addition to low fry prices and higher cost of imported feeds, existing hatcheries are hindered by poor management, and the lack of market information and an efficient distribution system. The closure of about 35% of existing hatcheries is attributable to both internal and external factors. Poor business management caused the failure of many hatcheries in Panay. Some operators invested in the business without knowing its technical and management aspects, relying on technicians to operate their hatcheries. The lack of effective hatchery cooperatives puts operators in an adverse negotiating position, and retards the development of industry-accepted fry quality criteria. Small-scale operators are often at the mercy of traders who have links to the grow-out market. Reduced availability of spawners restricts capacity utilization, especially for large hatcheries; while poor market information results in periods of deficit or excess supply of fry relative to grow-out needs.

This paper attempts to analyze the profitability of operating the different scales of hatcheries in the face of the aforementioned industry problems. The study also evaluates the economic viability of reinvestment or new investments considering the current excess capacity of hatchery facilities in the country.

## Methods

Primary data were gathered in August 1992 through field interviews with 27 hatchery owners and technicians in six regions of the Philippines (Regions 1, 3, 6, 7, 10 and 11) using standard questionnaires. Economic indicators analyzed in the survey were: investment requirements, variable and total unit costs of production, return on working capital, and return on investment. Net present value (NPV), benefit over cost ratio (BCR), and internal rate of return (IRR) were computed to determine risk and profitability levels associated with the various scales of hatchery operations.

## Results

### *Capital Investment*

The average investment for different scales of hatcheries based on the 27 field observations is shown in Table 1. Capital investments include purchase of land; construction of tanks, buildings and other infrastructure; purchase of equipment and machinery; and installation of aeration, water and power systems. Most small hatcheries are on leased land. Operators pay the landowners 2-4% of income after deducting operating costs. Most small hatcheries use canvas larval and rearing tanks, while medium and large hatcheries use concrete. Average capital investments are P0.126 million, P1.7 million and P6.4 million for small, medium and large hatcheries, respectively.

Working capital per year is estimated to be 1.5 times the operating cost for one cycle. Working capital covers the cost of inputs such as spawners, feeds and fertilizers, chemicals, labor, power, gasoline and oil, and other miscellaneous expenses. Working capital of hatcheries averages P36,000 (small), P85,000 (medium) and P469,000 (large) per production run. Total investments are approximately P0.182 million (small), P1.8 million (medium), and P7.142 million (large).

Small hatcheries are "open" without roofing. Larger hatcheries have culture tanks built inside roofed structures which protect against temperature changes and severe weather that can damage the hatchery facilities as well as fry stock. Unlike small hatcheries, medium and large hatcheries need broodstock tanks for nauplii production to optimize the use of their rearing tanks. Larger hatcheries can convert their broodstock tanks into rearing tanks, when needed, to optimize fry production. With proper planning and management, large hatcheries can also use rearing tanks as broodstock tanks in order to reduce investment in tank facilities. Small hatcheries do not need broodstock tanks because they depend on wild spawners for nauplii production. Table 2 shows the breakdown and total estimated capital investment for new hatchery facilities: P0.231 million (small scale), P2.154 million (medium size) and P6.137 million (large scale).

### *Costs and Returns*

Figures for comparative production, and costs and returns by scale of hatchery operations are reported in Table 1. Ex-hatchery prices differ both by scale of operation and by region. The prevailing supply and demand for fry in the different regions primarily determine prices of fry. Average prices in Regions 7, 10 and 11 are higher than in other regions of the country. The participation of intermediary brokers and traders reduces the ex-hatchery prices of fry, especially those produced by small-scale hatcheries. Survey results also revealed that prices of fry from small-scale hatcheries are lower than from medium- and large-scale hatcheries. This is because almost all small-scale hatcheries depend on traders to market their fry. The low volume of production makes it difficult

Table 1. Investment requirements, production, costs and returns of various scales of hatchery operations in the Philippines, 1992.[1]

| | Small scale | | Medium scale | | Large scale | |
|---|---|---|---|---|---|---|
| A. Investment requirements | | | | | | |
| Capital outlay | 126,278 | | 1,718,878 | | 6,437,500 | |
| Working capital | 55,310 | | 127,155 | | 704,999 | |
| Total | 181,588 | | 1,846,033 | | 7,142,499 | |
| B. Production parameters | | | | | | |
| Tank capacity (tons) | 79 | | 204 | | 606 | |
| C. Costs and returns | Per run | Per year | Per run | Per year | Per run | Per year |
| Average price (P•fry$^{-1}$) | 0.15 | | 0.16 | | 0.20 | |
| Sales | 76,669 | 383,344 | 287,191 | 1,483,819 | 1,107,755 | 4,154,083 |
| Less: Variable costs | | | | | | |
| Spawners, broodstock and nauplii | 11,397 | 58,628 | 22,492 | 115,708 | 106,731 | 467,831 |
| Starters and fertilizers | 338 | 1,888 | 950 | 4,800 | 3,413 | 13,238 |
| Supplemental feeds | 3,599 | 19,735 | 11,223 | 46,480 | 52,188 | 200,313 |
| Artemia | 6,470 | 34,230 | 21,457 | 93,242 | 130,425 | 465,900 |
| Chemicals and medicines | 2,063 | 10,813 | 3,018 | 14,585 | 9,563 | 34,313 |
| Power | 1,348 | 7,414 | 7,082 | 32,220 | 44,500 | 195,625 |
| Gasoline, oil and lubricants | 974 | 6,575 | 498 | 2,915 | 23,995 | 98,225 |
| Salaries and allowances | 4,894 | 31,625 | 7,663 | 47,320 | 38,450 | 151,650 |
| Sales commissions | 2,248 | 13,579 | 7,354 | 32,285 | 32,230 | 134,744 |
| Repairs and maintenance | 1,632 | 11,345 | 658 | 3,508 | 5,369 | 25,093 |
| Miscellaneous expenses | 1,913 | 12,675 | 2,375 | 12,267 | 21,702 | 106,259 |
| Subtotal | 36,876 | 208,507 | 84,770 | 405,330 | 468,566 | 1,893,191 |
| Net operating income | 39,793 | 174,837 | 202,421 | 1,078,489 | 639,189 | 2,260,892 |
| Less: Incentives (technicians) | 8,561 | 52,102 | 29,066 | 127,841 | 112,072 | 382,332 |
| Fixed cost: | | | | | | |
| Interest charges | 1,969 | 9,398 | 1,280 | 6,762 | 34,167 | 152,500 |
| Depreciation | 2,713 | 12,772 | 14,076 | 58,345 | 115,030 | 431,548 |
| Rental | 705 | 3,672 | 1,288 | 7,525 | 0 | 0 |
| Subtotal | 5,387 | 25,842 | 16,644 | 72,632 | 149,197 | 584,048 |
| Total cost | 50,824 | 286,630 | 130,480 | 605,139 | 729,835 | 2,859,571 |
| Annual net income (good runs) | 25,845 | 96,893 | 156,711 | 878,016 | 377,920 | 1,294,512 |
| Loss from bad runs | 4,533 | 22,608 | 8,933 | 41,335 | 75,590 | 226,769 |
| Annual net income (loss) | 21,312 | 74,285 | 147,778 | 836,681 | 302,330 | 1,067,743 |
| D. Economic indicators | | | | | | |
| Variable unit cost | | 0.07 | | 0.05 | | 0.08 |

[1]All monetary values are expressed in Philippine pesos P25=US$1.

for them to sell directly to prawn growers, especially big growers. Traders have the advantage over small-scale hatchery operators in price bargaining. Most large-scale hatcheries have their own sales force who contact growers directly. Some large hatcheries are part of integrated companies with their own prawn ponds. Large operators also use traders to sell their excess production of fry. Hatcheries which produce consistently good quality fry and have established goodwill in the market command higher prices for their fry.

On the cost side, medium-scale hatcheries registered the lowest variable cost (P0.05·fry$^{-1}$) and total cost (P0.08·fry$^{-1}$). Large hatcheries, on the other hand, registered the highest variable cost (P0.09·fry$^{-1}$) and total cost (P0.13·fry$^{-1}$). Because of low utilization rates of rearing tanks for big hatcheries, volume of production is low, and therefore depreciation cost is high relative to total cost.

Table 2. Investment requirements for new prawn hatcheries in the Philippines, 1992.[1]

| Items | Small scale | Medium scale | Large scale |
|---|---|---|---|
| Land development | P 30,000 | P 300,000 | P 600,000 |
| Rearing (tons) | | | |
| Rearing | 30,000 | ? | 900,000 |
| Broodstock | n/a | ? | 150,000 |
| Algal | 6,000 | ? | 90,000 |
| Reservoir | 20,000 | ? | 200,000 |
| Buildings | | | |
| Technicians' quarters | 50,000 | 150,000 | 300,000 |
| Laboratory | | 100,000 | 300,000 |
| Hatchery building | | 200,000 | 1,000,000 |
| Equipment | | | |
| Seawater pump | 13,000 | 50,000 | 150,000 |
| Submersible pump | 7,000 | 24,000 | 72,000 |
| Blower | 18,000 | 60,000 | 120,000 |
| Generating set | 15,000 | 50,000 | 50,000 |
| Laboratory equipment | | | |
| Microscope | 25,000 | 15,000 | 45,000 |
| Refractometer | 20,000 | 20,000 | 60,000 |
| Seawater lines | 15,000 | 50,000 | 500,000 |
| Aeration lines | 7,000 | 30,000 | 300,000 |
| Electrical lines | 10,000 | 30,000 | 300,000 |
| Transport equipment | | 400,000 | 600,000 |
| Other equipment | | 20,000 | 200,000 |
| Materials | 10,000 | 30,000 | 200,000 |
| Total | P 231,000 | P2,154,000??? | P6,137,000??? |

[1]Values are expressed in Philippine pesos P25=US$1.

This is in spite of a relatively high survival rate (19%). The low utilization rates of big hatcheries are caused by lack of spawners and low market demand.

Large hatcheries also registered the most number of bad runs in a year. Bad runs are caused by disease infestation of fry stocks either early or late in the rearing period. The study showed that when fry stock is discarded during the early larval stage, expenses have already been incurred for the following: spawners, fertilizers, supplemental feeds (partial cost), chemicals, medicines, power, and food allowances of hatchery workers. These amount to approximately 25% of average operating cost per complete run. If the stock is discarded at the end of the culture period, expenses incurred are equivalent to the normal operating cost per run. Thus, the loss during a bad run is assumed to be about 50% of the average operating budget for one run. Some stocks are also discarded due to lack of buyers when stock are harvestable. If the fry stock overstays in the hatchery without assurance of being sold, the hatchery incurs more losses.

The distribution of fixed and variable costs are similar in all scales of hatchery operation (Table 1). Fixed cost (depreciation, interest expense and rental) is 11-12% of total cost, direct operating cost is 72%, and the remaining 16% is the incentive pay or profit share of hatchery technicians.

The cost of spawners, *Artemia* and supplemental feeds comprise 36% of total cost. The price of spawners is P800-1,200 each depending upon the distance of the source to the hatchery site. In Region 6, the average price of a spawner is P1,100-1,200 due to competition among hatcheries. In Regions 7 and

10, the price is lower by 20-30%. When spawners are abundant, many hatcheries stock at about the same time, often resulting in an oversupply of fry and low prices. The cost of imported *Artemia* and other supplemental feeds which are subject to import tariffs, represent 13-16% of total cost. Reduced import tariffs could significantly lower cost of production, enabling hatcheries to survive even during seasons of low prices.

Typically, hatchery operators provide workers with food allowance and profit sharing (20-30% of operating income), but no fixed salaries. However, some medium and big hatcheries pay fixed salaries, plus food allowance and profit-sharing. This arrangement has generally worked well for hatchery owners and technicians because it serves as an incentive to increase production of good quality fry. The annual profit share of a hatchery worker is about P13,000 (small hatcheries) to P21,000 (medium and large hatcheries). Interviews with experienced hatchery technicians in Iloilo revealed that the profit share can go as high as P20,000 per worker for one good run. The practice of profit-sharing without fixed salaries may, however, subject hatchery workers to increased risk, if the hatchery experiences continuous bad runs. This leads to the question of opportunity cost of labor, since the time spent by a hatchery worker should at least be equal to minimum wage. There is no strict employer-employee relationship between owners and workers. The technicians are more like industrial partners with technology as their contribution to the partnership. It seems that such an arrangement has worked out well as evidenced by its continuous practice. Both parties share profit and risk. The owner risks his investment and the worker risks his time.

Another considerable cost are commissions paid to brokers. The standard rate is P10 per thousand fry sold. This represents 4-7% of the hatchery's total cost. In spite of these commissions, hatchery operators complain of unfair trade practices of some brokers. For example, when fry stock reach PL 10-14, samples are sent to laboratories for diagnosis based on criteria set by growers and hatchery operators. If the fry samples pass the test, the grades are recorded on a score card which the hatchery operator gives to the broker as a support document of the quality of the fry. Small-scale hatchery operators in Aklan and Iloilo complain that some brokers change the name of the hatchery on the score card, recopy the score card, and use it to sell another hatchery's stock where the price is lower. When there is an excess supply of fry in the market, the victimized hatchery operator ends up selling at a low price; otherwise, the stock will not be sold if it stays in the hatchery tanks past PL 20.

The price difference between the ex-hatchery price and the landed price in the ponds is P0.07-0.09·fry$^{-1}$. Packing and transport costs by plane approximate P0.03·fry$^{-1}$. This leaves the broker with a margin of about P0.04-06·fry$^{-1}$, exclusive of other operating expenses. During consultations, hatchery operators have stressed the need for a strong cooperative to protect members from unfair trade practices. The presence of brokers in the channels of fry distribution is justified by their important marketing function, which most operators cannot perform effectively. The brokers' wide geographic coverage of the fry market gives hatchery operators the advantage of expanding their market. Moreover, brokers sometimes provide financial assistance to small hatchery operators, as

well as valuable market information on prawn growers' fry requirements. Hatchery operators will have to strengthen their cooperatives in order for them to effectively perform marketing functions such as following up on growers' requirements, providing technical assistance and credit, and maintaining good business relationships with growers.

On the income side, survey results show that the average operating income per run (net of variable costs) for all scales of hatchery operations is positive, ranging from P39,000 (for small hatcheries) to P202,000-639,000 (for bigger hatcheries). Except for Regions 1 and 10, all other regions registered positive income. Net income per run (net of total cost) is also positive for all scales of operation. This is indicative of good management for those hatcheries which are still operational despite harsh market conditions.

Consistently, returns on working capital and on original investment are positive. Returns on working capital are 71.95% (small scale), 159.19% (medium scale) and 90.46% (large scale). Similarly, returns on investment are 40.81% (small scale), 45.34 (medium scale) and 14.85% (large scale). Between the two economic indicators, the return on working capital is more important to the hatchery investor and workers because actual profits are realized after every good run. The low rate of return on investment is due to the huge capital investment for infrastructure and equipment at the start of operation. Except for a few respondents, most of the hatcheries surveyed started operations in the mid-1980s when prices were high. It is highly probable that the original capital investments were recovered during the earlier years of operation when prices were still high.

### *Breakeven and Sensitivity Analysis*

Breakeven and sensitivity analyses are applied to both existing and new investments in hatchery facilities. Breakeven points in terms of prices, volume and survival rate are evaluated for the different scales of operations (Table 3). For small hatcheries, breakeven points are P0.10·fry$^{-1}$, 323,037 pieces of fry, and 7.16% survival, respectively. For medium hatcheries, breakeven points are P0.05·fry$^{-1}$, 561,067 pieces of fry, and 5.95% survival, respectively. Large hatcheries have the highest breakeven points at P0.09·fry$^{-1}$, 3,081,357 fry pieces, and 8.81% survival, respectively.

Risk analysis using sensitivity analysis shows changes in profitability levels when changes occur in output price, input prices or production level (Table 4). A decrease in production may be due to low stocking density caused by lack of

Table 3. Breakeven analysis for existing hatcheries in the Philippines, 1992.

| Indicators | Small scale | Medium scale | Large scale |
|---|---|---|---|
| Breakeven price (P)[1] | 0.10 | 0.05 | 0.09 |
| Breakeven quantity per run | 323,037 | 561,067 | 3,081,357 |
| Breakeven survival rate (%) | 7.16 | 5.95 | 8.81 |

[1]Values are expressed in Philippine pesos P25=US$1.

spawners, or low survival rate because of technical factors such as diseases. A 20% decrease in fry prices decreases profitabaility by 20%, 10% and 11% in small-, medium- and large-scale hatcheries, respectively. If input prices increase by 20%, profitability levels decrease correspondingly by 15%, 75% and 8%. When production falls by 30%, the small-scale hatchery becomes unprofitable with negative NPV, BCR and IRR of less than one. Large hatcheries, however, can still stay profitable with positive NPV, BCR of greater than one, and IRR higher than the assumed 10% discount rate. If a combination of these hypothesized changes occur, existing small and large hatcheries are expected to suffer losses and only medium-scale hatcheries are likely to survive.

For new hatcheries, the results of the sensitivity analysis indicate that small hatcheries can survive worsening market conditions and productivity, assuming the same magnitude of changes in production parameters. Medium-scale hatcheries can remain profitable even if fry prices decrease by 20% or input prices increase by 20%. Financial losses, however, will be experienced when the production level falls by 30%. With the exception of large-scale hatcheries, the breakeven prices, volume and survival rate for new investments do not differ much from the breakeven conditions obtained for existing hatcheries. The breakeven quantity per run increases with the scale of operation. The breakeven survival rate is lowest for medium-scale hatcheries (5.95%), and highest for large-scale hatcheries (10.58%). The survival rate for small hatcheries is 7.16%.

## Discussion

The overall results of the economic analysis suggest that potential investors in prawn hatcheries are better off investing in small- or medium-scale hatcheries. The five-year cash flow projections based on current prices show that the small hatchery is the most economically viable scale of operation with a BCR of 1.38 and an IRR of 48.73%. Medium-scale hatcheries are also profitable with a BCR of 1.87 and an IRR of 656.29%. Setting up a large-scale hatchery, however, is a losing proposition based on the assumptions of the study as indicated by the negative economic indicators (BCR $< 1$, IRR $= -3.23\%$).

Demand for fry is a derived demand from prawn. Hatchery operators will greatly benefit if they produce good quality fry to help prawn growers produce good quality exportable prawn. It is imperative that hatchery operators continuously update their technology, follow proper sanitary operations, and adopt good entrepreneurial management. Prawn growers, on the other hand, could help operators set fair prices by paying promptly to ensure the viability of hatchery operations. The setting of fry quality criteria should be a joint undertaking of both hatchery operators and prawn growers; the criteria should be updated continuously with the help of researchers. The establishment of provincial/regional hatchery cooperatives supported by government will provide much needed laboratory equipment and training of technicians on fry analysis.

Considering the state-of-the-art technology currently in use by the industry, high investment, large-scale hatcheries will probably lose money. Large hatcher-

Table 4. Sensitivity analysis of various scales of prawn hatcheries in the Philippines, 1992.[1]

| | Small scale | | | Medium scale | | | Large scale | | |
|---|---|---|---|---|---|---|---|---|---|
| | NPV (P) | BCR | IRR | NPV (P) | BCR | IRR | NPV (P) | BCR | IRR |
| Existing hatchery | 459,711 | 1.38 | 48.73% | 3,002,358 | 1.87 | 656.29% | 4,836,501 | 1.36 | 542.15% |
| Changes | | | | | | | | | |
| 20% decrease in output price of fry | 125,938 | 1.10 | 5.75% | 2,097,728 | 1.68 | 463.72% | 2,520,989 | 1.21 | 290.66% |
| 20% increase in input costs | 247,821 | 1.17 | 22.76% | 2,722,532 | 1.73 | 596.73% | 3,576,504 | 1.25 | 405.36% |
| 30% decrease in production | -41,098 | 0.97 | -25.24% | 1,645,413 | 1.57 | 367.40% | 1,363,233 | 1.12 | 164.24% |
| New hatchery | 368,000 | 1.29 | 23.68% | 3,002,358 | 1.87 | 656.29% | (563,881) | 0.97 | -3.23% |
| Changes | | | | | | | | | |
| 20% decrease in output price of fry | 459,711 | 1.38 | 48.73% | 46,728 | 1.01 | 0.74% | | | |
| 20% increase in input costs | 167,021 | 1.11 | 4.43% | 671,532 | 1.12 | 10.14% | | | |
| 30% decrease in production | 459,711 | 1.38 | 48.73% | (405,587) | 0.92 | -6.77% | | | |
| 20% decrease in production | | | | | | | 7,903,710 | 1.57 | 875.03% |

[1]Values are expressed in Philippine pesos P25=US$1; NPV = net present value, BCR = benefit over cost ratio, IRR = internal rate of return.

ies can profit only through optimum utilization of tank facilities. However, one constraint to this is the scarcity of wild spawners and broodstock. Locating the hatchery in areas where wild spawners abound could be a short-term solution. Traditional sources of spawners, however, have been depleted through overexploitation. It is imperative, therefore, that research and technology transfer on broodstock development be undertaken.

Returns to the hatchery sector may also be improved by lowering cost of production by reducing tariffs imposed on imported feeds (e.g., *Artemia*), reinforcing profit sharing between hatchery owners and workers, and expanding the market for fry by lifting the current ban on fry export.

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