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A SUSTAINABLE SHRIMP MARICULTURE INDUSTRY FOR ECUADOR

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International Coastal Resources Management Project

The University of Rhode Island

Role of Hatcheries in the Shrimp Pond Culture Industry

El Papel de los Laboratorios en la Industria del Cultivo del Camarón en Piscinas

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Resumen

Desde 1982 el precio promedio del camarón para exportación ha sido de un US$3,60/lb, produciendo un ingreso anual estimado en unos 200 millones de dólares. Desde 1980, el 75% de estas exportaciones provienen de las piscinas y el 25% de la pesca camaronera de la flota de arrastre.

Para 1986-1987, del 60 al 70% del suministro de larvas proviene del ambiente natural, obtenidas por los "larveros".

La industria del camarón, con una inversión inicial de 2 x 109 dólares, no puede continuar dependiendo sólo del suministro de larvas obtenidas en el medio natural, donde están disponibles sólo estacionalmente. El desarrollo de los laboratorios es requerido para mantener los niveles actuales de exportación.

Los 68 laboratorios autorizados hasta la fecha, podrían producir 6,7 x 109 postlarvas por año.

Para producir pls los laboratorios ecuatorianos usan dos sistemas: (a) desove expontáneo de hembras grávidas capturadas por pescadores; y, (b) suministro de huevos de hembras grávidas mantenidas en condiciones de maduración en el laboratorio (ablación).

Los autores concluyen en que la producción de camarones puede aumentar inmediatamente mejorando el manejo de las piscinas existentes, incluyendo la solución de problemas en el transporte y aclimatación de las pls capturadas del ambiente natural o de laboratorio, así como en la alimentación, captura y mercadeo. Recomiendan que se estimulen las investigaciones aplicadas para estabilización de la producción y de los procesos de maduración.

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Introduction

The Ecuadorian shrimp industry has experienced a substantial increase in activity since the 1970s. Exports totalled 2,700 metric tons (m.t.) in 1970, 10,200 m.t. in 1980, 23,400 m.t. in 1984 and approximately 30,000 m.t. in 1986.

Since 1982 the average price for exported shrimp has been U.S. $3.60 per pound, producing an estimated annual income of more than $200 million. Since 1980, 75 percent of these exports came from ponds and 25 percent from the shrimp trawler fleet.

By 1986-1987, 60 to 70 percent of the larval supply came from the natural environment, caught by artisanal fishermen called "larveros." Estimates vary, but apparently more than 90,000 people are involved in this fishery. When fishing is good, a larvero may earn as much as 2,500 sucres or approximately U.S. $17 per day.

The shrimp industry, with an initial investment of approximately $2 billion, cannot continue to depend solely on a natural supply of larvae, which are only seasonally available. If the industry is to stabilize, the development of hatcheries is required to maintain current levels of exportation. Conventional conservation methods for shrimp resources, which can help maintain the levels of the resource as well as improving its management, are still in the planning stages, and will require many years of research.

The still unexplained annual fluctuations in larvae distribution on the coast, both seasonal and spatial, make it impossible to adequately predict Ecuador's annual wild stock shrimp production. For this reason, the shrimp industry has started to plan and develop shrimp hatcheries to guarantee a steady supply of postlarvae as the natural populations become less available. The table below summarizes the status of shrimp hatcheries in Ecuador in August 1986:

Shrimp Hatcheries in Ecuador: August 1986

Status	Location				
	Esmeraldas	Manabi	Guayas	El Oro	Total
Hatcheries					
in operation	3	7	16	3	29
in construction	6	6	6	2	20
authorized	–	4	12	3	19
land allocated	–	–	26	–	–
Sub Stations*	10	–	–	–	10
Ecuadorian Hatchery					
Technicians	5	13	44	1	63
Expatriate Technicians	9	15	42	3	69
Investment**	46	623	2374	207	3250
Operational Costs**	6	104	378	74	562

* Sub stations used to spawn mature female shrimp to obtain nauplii.
** Costs given in millions of sucres, 150 sucres to U.S. $1.

Hatcheries

Technical and economic information from the 68 laboratories cited in Table 1 indicate that they would be able to produce 6.7 billion postlarvae per year. It should be noted that hatcheries do not function on a continuous basis, and including "down-times" this estimate of productive capability could be approximately half. The average size of hatcheries under construction today has decreased, apparently because managers want to supply 100 percent of the larvae for ponds controlled by the enterprise and many have realized that large hatcheries by themselves are not cost effective. By February 1987 there were 105 hatcheries in various stages of planning or construction, 51 of which have received approval to begin operation (see Table 1).

Farms larger than 800 hectares of cultivatable area generally plan for a minimum of two harvests per year with an average stocking density of 50,000 postlarvae per hectare and an average harvest of 2,500 pounds/harvest/year at sizes from U21/25 to U36/40. Hatcheries associated with farms of this size can produce at least 10 million postlarvae per month. There is also a high percentage of shrimp farms in the 80 to 400-hectare size range. In these cases the hatchery is designed to produce up to 5 million postlarvae per month and a correspondingly smaller harvest.

From an economic point of view, higher levels of production would seem to lower the relative production cost. In small hatcheries, production costs depend on the initial investment, the growing system applied and the number of personnel involved. Present experience indicates that smaller hatcheries tend to be more economical and operate at better profit margins.

Currently, it appears that integrated companies will function better for the short term since the personnel have more job stability than those in non-integrated companies; but in the long term the small and medium-sized hatcheries will be better able to survive economical, technical or administrative crises because their complexity and expenses are less.

On the other hand, with more small hatcheries, more technical personnel are needed which temporarily created a shortage of these people in Ecuador, as well as all over the world. In Ecuador, the solution to this problem has been to use technicians who move from one hatchery to another. In this way, the transfer of "know-how" is being facilitated, assuming the technicians have sufficient experience.

The question is how many hatcheries and of what size does Ecuador require to guarantee a steady level of production? This is a very difficult question to answer exactly because only now is the country prepared technically to support a "boom" of hatcheries. However, if this necessary development is not undertaken now, the increases in costs, the rise in the dollar and the difficulties with importing of equipment will make future costs and investments much greater and possibly prohibitory. The shrimp mariculture industry is affected by a number of factors: supply of postlarvae, demand, price and levels of production. The table below gives a summary of these factors:

Summary of How Larvae Control the Shrimp Mariculture Industry

Wild caught	Affected by climatological factors
Postlarvae Supply	Hatchery produced (affected by technical ability and cost effective measures). Pollution effects
Demand	Growth in cultivable area (ha of ponds) Number of harvests per year (2-4) Stocking density (pls/ha) (30,000-60,000-120,000; Extensive--Semi-intensive--Intensive system)
Price	Availability of wild caught seed stock Area caught (beach vs. estero) Distance transported Percent *Penaeus vannamei*

Production	Acclimation ability and transportation lbs/ha/year vs. dollars/ha/year Optimization of profits in ponds and hatcheries
Market	Price fluctuations of shrimp. Quality of the product. World production.

Although many commercial hatcheries claim to have the best technology, complicated technologies will not necessarily benefit the hatchery industry in the long term. Instead, relatively simple production methods that will not cause major stress or problems in the system are needed.

Shortages of Broodstock and Nauplii

Hatcheries raise larvae from eggs through a metamorphic stage to postlarvae. Shrimp hatcheries obtain fertile eggs in two ways. The first is to gather the spontaneous spawn of gravid females caught by shrimp fishermen (sourcing). To produce 2 billion postlarvae, Ecuador's hatcheries will require 4 billion nauplii or approximately 14 million nauplii each night. Gravid female shrimp are available all year from coastal waters in Esmeraldas. Empacadora Nacional operates the largest sourcing fleet in Ecuador, and they, among others, produce 2-5 million nauplii each night. Gravid females are also captured off San Pablo from October through March, where 4-20 million nauplii are collected each night. These data suggest that the wild stock gravid population(s) can almost supply the projected demand from October through March, but the supply of nauplii from Esmeraldas cannot supply the hatcheries with nauplii for the rest of the year.

The second source of eggs is from gravid female shrimp maintained in maturation facilities within the hatchery. This method employs the ablation of one eyestalk to accelerate the development of the ovaries (maturation) and, where natural mating has not occurred, the attachment of sperm to the female shrimp prior to spawning. Maturation production varies depending on techniques used, the experience of the manager and availability of brood stock. Year-round production ranges from 20,000 to 150,000 nauplii per tank per night, which suggests a need for some 250 tanks. All hatcheries presently under construction incorporate maturation systems and as many as 400 tanks may be available when these facilities begin operating. The production of nauplii will then depend upon how rapidly commercial maturation techniques can be mastered and the availability of brood stock. Currently, almost 50 percent of nauplii used in hatcheries came from maturation facilities.

The zones and times of spawning of *P. vannamei* are not exactly known, although some areas where this species is common are known, and large quantities of brood stock *P. vannamei* are captured between December and March when ocean temperatures are higher. If a hatchery does not have an operational maturation system, it is difficult to produce postlarvae throughout the year. Because there are large quantities of nauplii at certain times of the year, there is a tendency to use more cost effective, high density larval culture techniques, but disease problems have on occasion become critical, leading to short-term decreases in productive capacity.

The short supply of high quality broodstock for use in maturation systems could be solved by maintenance of special tanks of ponds at the hatchery or pond site, or by selective fishing (sourcing) by the offshore fleet. To date attempts to use pond-raised broodstock has been unsuccessful in Ecuador. Special consideration needs to be placed on pond environment and nutritional quality of diets for these animals.

Conclusions and Recommendations

Shrimp production could be increased immediately by making optimal use of facilities already installed. Improving management of existing ponds includes addressing problems of transportation and acclimation of wild-caught and hatchery-produced postlarvae, appropriate feeding, harvesting and adequate marketing.

The future of shrimp hatcheries and the industry is dependent upon a stable quality and supply of a large quantity of larvae. Producing 1 billion PL 5/6 postlarvae of low quality each year is not as profitable as producing 500 million PL 15s. The hatcheries must consistently produce larvae of superior nutrition and

larger size, even at lower production levels, since these larvae have higher market acceptability and stable price.

Wildstock postlarvae may always exist as strong competition for hatchery-produced seed, but if the use of hatchery products in ponds becomes standard, the hatcheries may be a long-term solution for a stable mariculture industry in Ecuador.

Applied research with direct, rapid impact on the stabilization of production, should be stimulated, and research on diseases should be initiated in government and private laboratories. The study of broodstock maturation processes is urgently needed so that an adequate supply of eggs and nauplii can be obtained on a continuing basis. Once these maturation processes are adequately understood, a nauplius distribution center should be installed to facilitate the operation of small and medium-sized hatcheries.

Long-term, applied research with direct and rapid impact on production should be strongly stimulated. The Ecuadorian government should encourage ESPOL, by means of its Shrimp Larval Culture Project, to serve the needs of the entire shrimp industry. One way to assure this is through grants. Another might be to permit ESPOL to operate ponds, as other government agencies do, to export the product, and to use the funds to support hatchery training operations.