

**A SUMMARY REVIEW OF SHRIMP AQUACULTURE
IN THE WESTERN HEMISPHERE AND THE CARIBBEAN**

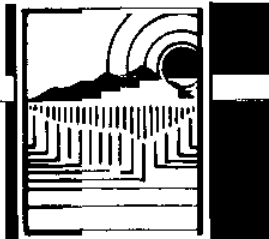
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F.A. Pagán-Font, Ph.D.
Aquaculture Consultant
7820 S.W. 141 St.
Miami, Florida 33158-1513

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Table of Contents

	<u>Page</u>
1. Introduction	1
2. Major Participating Countries	2
2.1. Ecuador	2
2.2. Colombia	3
2.3. Mexico	3
2.4. Honduras	4
2.5. Panama	4
2.6. Peru	5
2.7. U.S.	5
3. Viral Diseases	6
4. Marine Shrimp Aquaculture Production	7
5. Acknowledgments	7
6. Bibliography	7

1. Introduction

Aquaculture originated as a subsistence level farming operation and still continues to be so in some areas. Aquaculture has in most cases developed into small-scale enterprises. Vertically integrated, industrial-level aquafarming is relatively rare, although there are clear trends toward the establishment of such enterprises, particularly in developed countries. There are many intermediate organizational levels to be found. Farm size may vary from less than a hectare to a thousand or more hectares owned and operated by individuals, cooperatives, government corporations or private companies. The enterprise may be solely devoted to the production and sale of seed or baitfish or may provide raw materials for other industries like those that manufacture agar and marine colloids. Most of present-day aquaculture is oriented to the production of human food. The systems of culture adopted may be extensive or semi-intensive to intensive. Extensive cultivation normally involves large areas, low levels of capital investment per unit area, low operating costs, low general management, and low yields per unit area. Intensive systems are characterized by dense stocking, stock selection and manipulation, intensive management and environmental control, partial mechanization of operations, and high production per unit area or volume of water. The level of intensity in operations is governed by technical, economic, and social factors. In the process of development, the level of operations may gradually evolve from an extensive to a semi-intensive level.

The use of aquaculture in the improvement of nutrition and socio-economic conditions of the fish farming communities in the natural and coastal regions cannot be over-emphasized. In fact, rediscovery of aquaculture around the world may provide hope for the rural poor, particularly as an option to the displaced fishermen and fishing communities of the region, for whom the culture of fin fish is the main source of protein.

Shrimp farming usually is considered the commercial production of marine shrimp in impoundments, ponds, raceways, and tanks but freshwater shrimp culture is also practiced. Shrimp culture occurs in the tropics and in countries as far north as China, Taiwan and Japan.

A preliminary appraisal of commercial marine shrimp aquaculture was highlighted in a work by T.V.R. Pillay (1974). He explains the difference between small-scale and large-scale operations. There is considerable overlap between the two main levels of aquaculture development, but one can identify the two main levels of aquaculture by identifying a number of features or characteristics of large-scale industrial operations. Large capital outlay, centralized management and a certain degree of vertical integration are common to all large-scale enterprises. Such large operations may often be in the private sector in many countries. The dominant consideration in large-scale aquaculture would necessarily be the return on investment. Governments may influence this through financial support in the form of loans, grants, interest-free loans or support prices for socio-economic reasons, but still the financial results would determine the feasibility of long-term operations. Small-scale rural aquaculture includes a percentage of high-present-day fish culture, ranging from subsistence-level farming by individual farmers to small production units.

Private investors may commonly have a wider choice of locations, not only within the home country, but by undertaking some or all of the production in different countries where environmental or other conditions are more favorable. Typically, the Caribbean coast has beach and bay habitats with tidal ranges averaging about 0.6 meters.

With 99.8% of production in Latin America, the western hemisphere produced an estimated 20% of the world farm-raised shrimp in 1991 (Weidner 1985). Ecuador, the leading producer with 75% of production, exported \$400 million worth of farm-raised shrimp. Colombia, which quadrupled production in the last two years, moved into second position, and Mexico, with lots of new activity, moved into third position. Honduras occupied second place in 1990, but fell to fourth place this year on slightly improved production. Crustaceans (presumably shrimp) account for over 60% of the total aquaculture production of South America (Saint-Paul 92).

Peru, Panama, Brazil and Guatemala have small shrimp farming industries, and scattered farms exist in Venezuela, Nicaragua, El Salvador, Belize, Costa Rica and the Caribbean (Cook 1978). Most new farms adopt scientific, semi-intensive strategies. Shrimp farms in Latin America market most of their shrimp in the United States, while developing receptive markets in Western Europe, particularly France and Spain which purchase raw, frozen, whole animals (Emberson 1984). In the United States, a five-pound box of raw, frozen, shell-on tails is the most popular product.

The United States supplies equipment, feeds and services to shrimp farmers worldwide. Its shrimp farming industry is small by world standards.

This discussion is in two parts (Gallagher 1992). In the first, we present a brief description of the current status of shrimp aquaculture in the principal participating countries of the Western Hemisphere. In the second, we discuss viral and, possibly, some other diseases, which are a general problem in all shrimp aquaculture (Lightner et al. 1989).

2. Major Participating Countries

The major Latin American countries involved in shrimp aquaculture today are Ecuador, Colombia, Mexico, Honduras, Panama, and Peru. In all countries and the United States, aquaculture operations have common problems of acquiring seed stock, maintaining water quality, controlling disease, and maintaining an adequate ratio of profit to capital investment (New and Rabanal 1974). To do this, they require know how and expertise as well as land, equipment, and labor. The shrimp aquaculture industry has expanded in Latin America and is still growing as can be seen from the aquaculture production figures in section 4.

2.1 Ecuador

Ecuador, with one of the most organized and efficient shrimp farming industries in the world, has been the consistent production leader in the Western Hemisphere for 15 years (Rosenberry 1990,91,92). Ecuador exports 70% of its production to the United States (frozen tails) and 30% to Europe (frozen whole).

From March through May, 1991, Ecuadorean coastal waters produced abundant supplies of wild seedstock, and prices for hatchery produced seedstock dropped to a two-year low. Some hatcheries had to dump their surplus production of seed stock. During the Ecuadorean winter (June-September), when wild seedstock is not available, hatcheries come to the rescue (Sandifer et al. 1992). While large-scale hatcheries handle the industry's needs (Shang 1986).

Despite its leadership in the industry, Ecuador has temporarily experienced a decline in recent production, according to U.S. corporations operating in Ecuador. El Niño; declining shrimp prices, disease, pollution, and slower growth have been blamed for what might be only a temporary decline.

United States corporations operating in Ecuador reported mixed results in 1991, with improving numbers toward the end of the year. In 1991, a year of declining shrimp prices, Ecuador increased production by 35%. In some years, farmers produced larger crops of smaller shrimp to make up for slower growth, possibly caused by disease.

2.2. Colombia

In the last few years Colombia's shrimp farming industry, based primarily on *Penaeus vannamei* (85% of production), has grown by leaps and bounds, but it's still a distant second to Ecuador in the production of farm-raised shrimp in the Western Hemisphere. The Colombian industry is dominated by a small number of companies that operate most of the farms. Some of the companies are incorporated; most of the rest are limited partnerships. As of 1990, Colombia had 12 hatcheries and 40 farms. Two thousand hectares of ponds produced 3,500 MT annually (Rosenberry 1989, 1990).

Farmers argue that the Caribbean coast has tidal ranges that are better for shrimp farming than those along the Pacific coast of Ecuador. Sea surface temperatures for both the Caribbean and Pacific coasts are stable at 27 to 29°C, and the moderate rainy season (May to November) rarely exceeds 15 cm per month, so there are few sharp swings in salinity. In addition, the relatively modest tidal amplitude simplifies daily operations (pumping, water exchange, harvesting, transportation). Pond construction is easy because there are fewer mangroves.

2.3. Mexico

Private-sector shrimp farming is a priority of Mexico's president, Carlos Salinas de Gortari. On April 22, 1992, the Mexican congress approved new laws and regulation on shrimp farming to its fishery law, allowing--for the first time--private sector shrimp farming and foreign investment (Rosenberry 1992). Formerly, shrimp farming was reserved for fishing cooperatives and ejidos (agrarian reform communes). The regulations implementing the amendments were published in the Mexican government's Diario Oficial on February 7, 1991. They clearly permit private as well as social [cooperative and ejido (agrarian reform communes)] groups to use their own land to farm shrimp. Fishery cooperatives and ejidos retain the exclusive right to collect postlarvae and mature females.

Cooperatives produce shrimp in extensive, low-lying ponds. They control the best shrimp farming sites, some of them along estuaries with the mid-range salinities that favor shrimp farming. But the cooperatives cannot use their land as collateral; they cannot borrow money to develop the sites.

2.4. Honduras

The Honduras federation of agricultural and agro-industrial producers and exporters (FPX) has published a 46-page booklet (Spanish) on the production of farm-raised shrimp in Honduras. It covers the basic principles of shrimp farming, site selection, the collection and management of postlarvae, growout and capital and operating expenses. FPX is also a good source of information on investing in Honduran shrimp farming.

In Honduras, farmers raise *Penaeus vannamei* and *P. stylirostris*. Yields from *P. stylirostris* ponds are low, averaging 425 kg of tails per hectare. It is necessary to import better feeds to meet the higher protein requirements of *P. stylirostris*. Farms that use import quality feed yield 860 kg of tails per hectare per year. The main product is shell-on, frozen tails exported to the United States.

In the past, hatchery seedstock shortages have disrupted the industry. Supplies of wild seedstock, which fluctuate seasonally between *P. vannamei* and *P. stylirostris*, have limited hatchery development. There is a potential solution by opening new seedstock hatcheries, but few sites along the Honduran coast offer the high water quality necessary for a seedstock hatchery.

2.5. Panama

Panama has been raising shrimp since the mid-1970's. Agromarina de Panama, owned by a United States company, is the largest farm in Panama and operates a hatchery, which supplies seedstock world wide. This farm/hatchery is reported to be very successful and is currently engaged in a big expansion. Panama has several other world-class hatcheries that supply seedstock to farms in North, Central and South America.

Overall, shrimp farming has progressed rather slowly in Panama. Many farms lose money; others are only marginally profitable. Some farms started with no plan, no practical experience, and no general understanding of the complexities of shrimp farming. Other farms paid little attention to site selection and farm design. Small farms are unable to take advantage of the economies of scale compared with large farms. Other problems that hindered the industry included poor commercial feeds, a long dry season, and high energy costs. These problems were compounded in the early 1980's by the regional debt crisis, and in the late 1980's by the economic and political instability as a result of the Noriega government and United States-imposed sanctions. Few investors were willing to commit funds in the chaotic Panamanian economy.

Since the fall of Noriega, several small farms have gone out of business. New farms are better designed, larger, and more likely to succeed. Consequently, the outlook for Panamanian shrimp farming is improving, and should produce over 4,500 MTs in 1994. Eventually the hatcheries may eclipse the farms in economic importance.

2.6. Peru

Although shrimp farming sites are limited in Peru, there is plenty of room for increased production from existing farms. Most shrimp are harvested at 12 to 14 grams (31/35 or 36/40 tail-on count), although this depends very much on market conditions. Some of the major producers use aeration and high-quality feeds, hoping to produce yields of 875 kg per hectare per year (Rosenberry 1990).

The demand for seedstock creates high prices for postlarvae, which are consistently \$1 to \$2 more per thousand than in neighboring Ecuador. Total hatchery production in Peru averages 20 to 30 million postlarvae per month, compared to demand, which averages 40 to 50 million per month. Despite seasonal red tides and a difficult economic climate, the Peruvian hatchery industry is in a growth phase. Intensification and further development of shrimp farming will lead to even greater demand for postlarvae.

Farmers get their seedstock from hatcheries, from sporadic catches of wild postlarvae, and from contraband shipments (wild or hatchery) from Ecuador. The construction and development of well managed hatcheries and the application of effective maturation technology should lead to self sufficiency in seedstock production.

Four Peruvian feed manufacturers supply the industry. As with most materials in the country, feeds are expensive (\$700 to \$760 a ton), approximately twice the cost of Ecuadorean feeds (Rosenberry November 1991). Six plants process shrimp in Peru.

2.7. United States

The United States supplies equipment, feeds, and services to shrimp farmers worldwide. Its own shrimp farming industry is small by world standards. The United States is a major player in world shrimp farming, not because of its production, which is insignificant, but because of its role as a supplier of capital, feeds, equipment, research, education information, research and technology to shrimp farmers in fifty countries (McVey 1993). The United States Department of Commerce supports shrimp farming research at Texas A&M University and elsewhere. Researchers study shrimp diseases at the University of Arizona and several other Sea Grant institutions. The United States Department of Agriculture supports the industry through its cooperative states research service, which funds a program at Mississippi's Gulf Coast Research Laboratory. This research institution heads a consortium of U.S. research facilities that are attempting to determine the feasibility of shrimp farming in the United States.

In the United States, shrimp farms are located in Hawaii, South Carolina, Texas, and, to a lesser extent, Puerto Rico. In Hawaii, with its high land and labor costs, the Oceanic Institute backs an intensive round pond production system and conduct research on maturation, nutrition, equipment, economics and diseases. In South Carolina, the Waddell Mariculture Center, with about half its budget devoted to shrimp farming, encourages semi-intensive and intensive shrimp farming in earthen ponds. Texas, the leading producer in the United States, supports semi-intensive and intensive shrimp farming. Good support from the state and an influx of Taiwanese capital and farms have revived the Texas shrimp farming industry.

Shrimp farming in the United States is undergoing a reorganization. The new initiatives are mainly in research and prototype studies by universities and federal and state agencies. Texas appears to be the most active area in shrimp farming research and expects to produce the majority of the over 3,000 MTs to be produced in the U.S. in 1994.

Two basic references on the larval development of *Penaeus* spp. are Fastetal (1992) and McVey (1993). These books describe the topic larval stages of *Penaeus* spp. Other contributors to the knowledge of *Penaeus* spp. are given by Fujinaga (1934), Hanson and Goodwin (1977), Cook (1978), Mock (1992), Fastetal (1992) and McVey (1993).

3. Viral Diseases

At least six virus diseases are presently known in cultured penaeid shrimp. Each of these six penaeid virus diseases (bp = baculovirus penaeid; mbv = *P. monodon* - type baculovirus (including pbv of Australian penaeids; bmn = baculoviral midgut gland necrosis; hpv = hepatopancreatic parvo-like virus; ihhnv = infectious hypodermal and hepatopoeitic necrosis virus; reo = reo-like virus of the hepatopancreas) may be comprised by a multitude of individual strains, some of which are highly pathogenic to some penaeids, while being of little importance to others (Sinderman 1989, Lightner 1989). Bp is widespread in its distribution in cultured and wild penaeids in the Americas, and except for Hawaii, it has not been observed elsewhere. Mbv-type baculoviruses have a diverse host range and wide distribution on the Indopacific coasts of Asia, Australia, Africa and in Southern Europe. Reports of bmn have been confined to *p. Japonicus* cultured in Southern Japan. Hpv has a geographic range similar to that of mbv in Asia and Australia. Ihhnv has a world-wide distribution in cultured penaeid shrimp; but its distribution in wild penaeids remains virtually unknown. The only occurrences of ihhnv (or a similar agent) in shrimp culture facilities using only wild broodstock have been in Southern Asia. Little is known about reo-like virus; the only reports of viruses of this type come from cultured penaeids in France, Malaysia, and Hawaii. Three basic diagnostic procedures are used in screening penaeid shrimp stocks for virus infections:

- 1) direct samples for microscopic (wet-mount) examination or histopathology for sign of virus infections (e.g. Polyhedral occlusion bodies);
- 2) enhancement of infection by severe crowding "stress" followed by microscopic examination or histopathology;
- 3) bioassay of a suspect shrimp population with a sensitive indicator species followed by sampling and histopathology; more rapid and sensitive advanced diagnostic procedures based on serological gene probe technologies are being developed, but are not yet available to the industry (Sinderman 1989).

4. Marine Shrimp Aquaculture Production

Marine shrimp production 1992-1993
1,000 Metric tons (mt)

Year	World	Western Hem.	Central America
1992	721,000	129,500	13,400(est)
1993	609,000	132,000	15,730

Major shrimp aquaculture producers:

	Colombia	Ecuador	Honduras	Panama	Mexico	Peru	U.S.
1992	8,000	95,000	8,000	4,000	8,238	3,000	2,000
1993	9,000	90,000	9,000	4,560	9,000	3,000(est)	3,000

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