by Itamar de Paiva Rocha

Current status and trends in Brazilian shrimp farming

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The Brazilian shrimp farming sector has been working exclusively with Pacific white shrimp *Litopenaeus vannamei* since the late 1990s. Although in 2010 it used only 1.85% (18 500 ha) of its potencial production area of 1 000 000 ha, shrimp farming is already a firmly established activity in Brazilian aquaculture, having demonstrated its technical, economic, social and environmental viability while actively contributing to the alleviation of rural poverty through the generation of business opportunities, income, foreign exchange and creation of permanent jobs.

Starting at an experimental level in the 1970s, the activity took more than 20 years to finally take off with the introduction of the *L vannamei* species and some technological breakthroughs in the 1990s. During the beginning of this century, the sector was finally enjoying the dividends of decades of hard work and the development of proper management techniques suitable to local conditions. Until 2003-04, shrimp farming was the rising star of Brazilian aquaculture, with ever-increasing production and productivity figures year after year, at one point even being the world leader in productivity. At that time, the sector was very much export-oriented having reached the position of number one supplier to the French market and number two supplier to the Spanish market (2003-04) while making strong inroads into the US market.

Beginning in 2005-06, however, the sector (which was also included in the anti-dumping

Brazilian shrimp farming has made a remarkable recovery from the ravages and trials of disease, natural disasters, the US anti-dumping action, strengthening of the Brazilian currency, and lack of official support to become, once again, a force to be reckoned with.

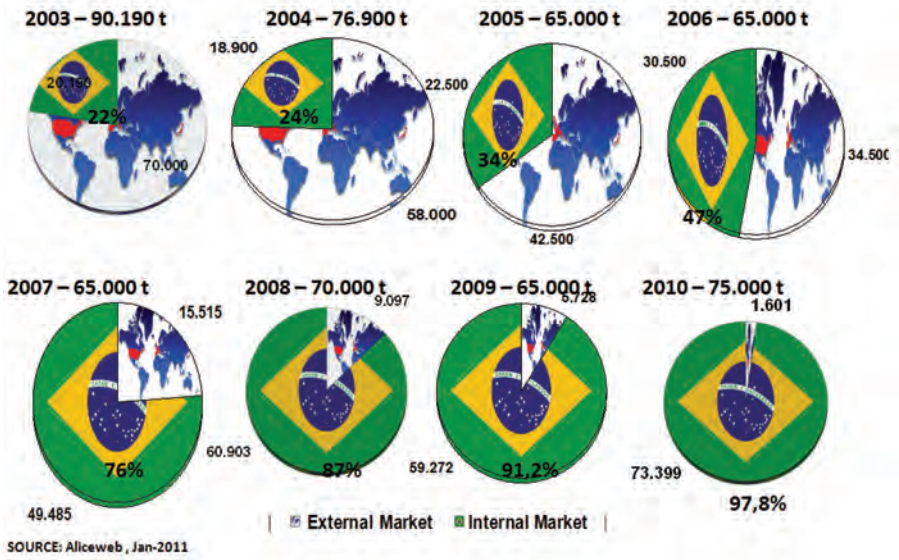
Aerial view of a commercial shrimp farm in Brazil.

action imposed by USA on six countries) began to encounter difficulties, in part due to the restrictions from the USA market and in part due to factors out off its control. The strengthening of the Brazilian currency, which directly affected the competitiveness of Brazilian farmed shrimp exports, as well as the US anti-dumping process, plus the new disease IMNV and a series of natural disasters in shrimp farming areas, together with a lack of any kind of official support, resulted in drastic changes. Production fell from 90 190 mt in 2003 to 65 000 mt in 2005 and remained at this level for the next four years while exports fell from 58 455 mt in 2003 to just 1 601 mt in 2010.

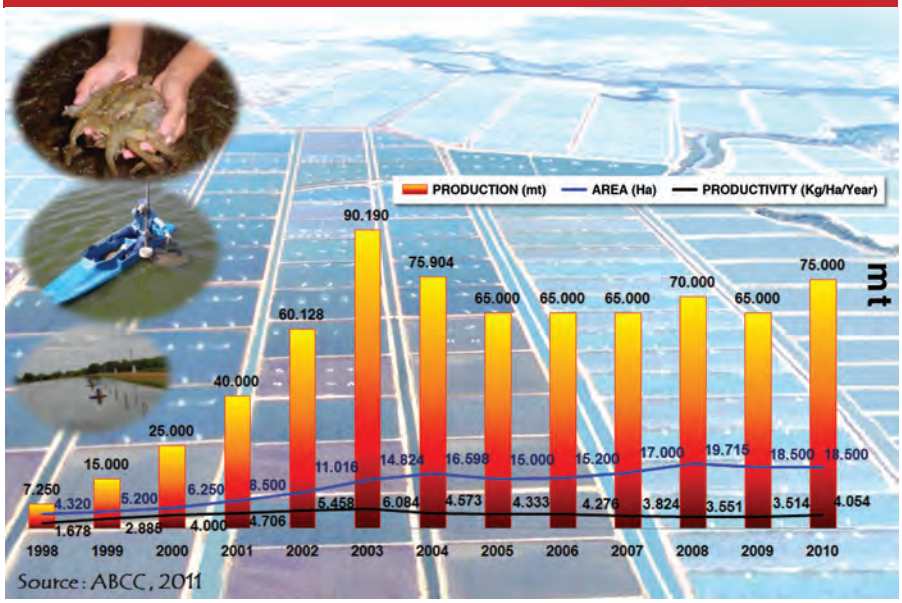
The sector survived the difficult years between 2005 and 2009 and learned from the experience. Management practices were improved: lower densities became the norm as one of the ways to successfully deal with IMNV, thus reducing production and financial risks; probiotics started to make a difference; but the most important component for the survival of the sector was the market shift that took place during this period. Shrimp farmers finally started to work the country's domestic market, where there existed and still exists, to a degree, a large untapped potential. The standards of quality that served the sector so well during the export phase were now directed towards the domestic market, where consumption of fresh, frozen and value added shrimp has increased dramatically. According to the Ministry of Fisheries and Aquaculture, average yearly per capita shrimp consumption in the country increased from 270 g in 2005 to 500 g in 2009, an 85% increase in a four-year period.

After some positive signs of recovery in 2008-09, the sector finally started to grow again in 2010 with a total production of 75 000 mt and a production area of approximately 19 000 ha. In 2010, 98% of production was consumed by the domestic market compared with 22% in 2003. This growth trend is expected to continue in the coming years, although in smaller increments than in the past, with practically 100% of production directed to the domestic market.

Destination of Brazilian farmed shrimp production, 2003-10



Brazilian farmed shrimp production, area and productivity (1998-2010)



Technological processes adopted

The major differential that arises between farmed shrimp and captured shrimp is directly related to the high degree of predictability of production of farmed shrimp and the possibility to identify and correct problems or faults that may occur during the production cycle, which basically involves the following steps:

Maturation and Hatcheries

In Brazil, all the nauplii come from maturation units where broodstock are kept under special conditions such as photoperiod control. Density is 80-100 shrimp per tank, maintaining a ratio of 1:1 (male:female) in round tanks (20 000 l), with constant water exchange and aeration. Feeding takes place six times a day.

As a result of the natural mating process, about 10-12% of stocked females are ready

to spawn on a daily basis and are, therefore, transferred to a special tank where spawning takes place within a 5-6 hour period. The eggs are immediately washed and treated against bacteria and fungi and stocked in carboy tanks where they are kept under heavy aeration until they hatch into nauplii. These nauplii are then concentrated, washed, counted and transferred to hatchery tanks.

During the hatchery stage, larvae receive special care in terms of feeding, temperature control, oxygen, ammonia, nitrite, pH, *etc* so that they can overcome the many challenges that arise from the various metamorphoses that take place during this stage. Feeding starts at the zoea-I (Z_1) stage and is based on microalgae complemented with *Artemia salina* nauplii and microencapsulated feed. After 18-20 days in the hatchery, postlarvae at the PL_{10} stage with a survival rate of 70-80% are concentrated, counted and placed into plastic bags or special tanks that contain water, oxygen and artemia nauplii, in order to be shipped by land or air to the shrimp farms.

Shrimp harvest in progress (top) and a sample of harvested shrimp (right).

Nursery Tank Growout

The use of nursery tanks serves to improve the acclimation process of the postlarvae allowing them to further develop and become stronger in order to meet the challenges of the pond growout stage. During this acclimation period (10-15 days), the postlarvae, which are stocked at a density of 20-30 PL_{10}/l, are kept under constant aeration with feeding taking place at two hourly intervals. Proper management techniques together with the use of appropriate feeds result in an average survival rate of around 90%. Besides this system, some farms also use the fenced-in system (10% of the area) located in the pond itself where postlarvae from hatcheries or nursery tanks are kept for 10-15 days and then released into the pond.

Growout Ponds

Prior to stocking, growout ponds undergo a disinfection process in order to eliminate opportunistic pathogens and predators. They also undergo some specific preparations so as to eliminate metabolites, reduce organic matter, increase pH and promote the development of bacterial communities. After these steps, the ponds are filled with previously filtered water and stocked with 20-70 PL/m². The growout period can vary from 70-150 days which is when the shrimp reach commercial size (7-25 gm). During this period, shrimp are fed 2-4 times daily using pelleted feed distributed by kayaks in "fixed trays". The leftover feed is routinely checked and removed thus avoiding its degradation which can be a cause of stress and have an overall adverse impact on the growout environment. Moreover, control of physico—chemical and biological parameters allows for the adoption of corrective measures so as to ensure an ecologically balanced environment. In addition, the use of probiotics as a biosecurity tool as well as a prophylactic and nutritional control is becoming part of the management routine of hatcheries, nursery tanks and growout ponds.

Likewise, the undertaking of weekly biometrics and presumptive analysis generates information that allows for the adoption of corrective or preventive measures during the growout process as well as information on the performance of the shrimp which, once they reach commercial sizes, are assessed for the predominant consistency of the shell and incidence of defects. Depending on these analyses, the harvesting process may begin, preferably at night due to the movement of the shrimp and the milder temperatures, reducing stress and improving the final quality of the shrimp.

Harvesting is done with bag nets (manual) or by machines (mechanical) placed behind the flood gates. The harvested shrimp are placed in plastic containers and immersed in a solution of water, ice and sodium

Farmed shrimp being processed.

metabisulphite. After this treatment, they are placed in boxes with ice and transported by insulated trucks to the processing plant or packed in insulated boxes containing ice to be sold fresh to the local markets.

Processing

Once the shrimp arrive at the processing plant, samples are taken and subjected to sensorial and quality analysis in order to ensure that they comply with and fall within the standards set forth by the Health Authority. They are immediately stored in holding chambers (-5ºC) to preserve their characteristics and natural freshness. Once they are released for processing, they go through an ice separator containing hyperchlorinated ice water (temperature below 5ºC and residual chlorine above 10 ppm) where they are mechanically sorted and transported via a nylon conveyor belt to the washing and inspection platform where foreign materials and damaged shrimp or shrimp unsuitable for consumption are removed.

After this process, they are transferred via a nylon conveyor belt to a mechanical grader with six chutes, each one corresponding to a size classification as established by national and international standards. They are then weighed, packed in small boxes and placed in freezing tunnels. The frozen blocks are removed from the freezing shelves and packed in master boxes that are stored in cold chambers according to type, classification, product lot and date of manufacture. Afterwards, depending on commercial demand, they are removed from the storage chambers and shipped by land or sea to consuming centres in Brazil and abroad.

Socioeconomic and environmental impacts

The farmed shrimp agribusiness has taken on an increasing social importance in Brazil, especially in the northeast of the country which accounts for 95% of national production. This region has 1 200 shrimp farmers with an area of 19 715 hectares of ponds, creating 50 000 jobs, with a production of 75 000 mt of shrimp and US$ 350 million in revenue in 2010.

A study by Sampaio & Costa (2003) showed that shrimp farming generated more direct and indirect jobs per hectare compared other sectors such as grape, mango, sugar cane and coconut. In this context, it must also be pointed out that another study by Sampaio *et al* (2005) analysed the socioeconomic impact of shrimp farming in the ten most important shrimp farming municipalities in the northeast. It identified significant benefits derived from the activity, of which the following stand out: (1) the number of legally registered jobs in the shrimp farming sector in the Jandaíra (BA) and Cajueiro da Praia (PI) municipalities, corresponded respectively to 63% and 91% of all formal jobs in these municipalities; (2) the participation of the economically active population of Porto do Mangue (RN) and Pendências (RN) municipalities in shrimp farming was 34.5% and 30.9% respectively and, (3) the sector's share of tax revenue contribution in Porto do Mangue (RN), Cajueiro da Praia (PI) and Jandaíra (BA) municipalities was 58.2%, 30.0% and 25.6%, respectively.

Throughout the years, Brazilian shrimp farming has developed and used sound management practices based on technical, social and environmental criteria that ensure a harmonious coexistence with a balanced environment. In this context, a number of research studies that analysed and identified

Job generation by some primary sectors in Brazil (Sampaio & Costa, 2003)

Product	Direct Jobs generated per ha	Indirect Jobs generated per ha	Total
Grape	1.44	0.70	2.14
Mango	0.42	0.70	1.12
Sugar Cane	0.35	0.70	1.05
Coconut	0.16	0.70	0.86
Farmed Shrimp	1.89	1.86	3.75

the main vectors and human actions that stress, pollute and impact rivers and estuaries in Brazil, demystified and proved wrong the tenets and false dogmas of the more radical environmentalists who, mistakenly or on purpose, attribute to shrimp farming negative effects on water quality and the integrity of the biodiversity of environments adjacent to shrimp farms.

Moreover, one of the conclusions of the post-doctoral thesis of Dr Raul M M Madrid, environmental analyst of IBAMA/CE, states that "… statistically speaking, pond water in microbiological terms is cleaner than the water supply of the farms, which leads one to deduce that shrimp ponds act as stabilisation and purification pools for effluents". The research showed that the level of total and faecal coliforms in pond waters was reduced by 30 and 35% respectively, compared to supply waters, thus showing the beneficial effects that shrimp farming can have on the environment.

In addition, an important study on mangrove areas undertaken in the main shrimp producing states in the northeast region, which analysed a 26-year period (1978-2004), showed that there was an increase in mangrove areas of 36.56%, which goes against the claims that shrimp farming destroys mangroves.

Opportunities, obstacles and prospects

Brazilian shrimp farming is back on the growth path. Some new factors such as increasing production from inland farming areas that use fresh or low salinity waters, polyculture with tilapia and a rapidly increasing internationally certified organic shrimp production are all contributing towards this recovery while also presenting new production and product options.

The infrastructure that existed prior to the difficult years is still in place. Brazil has at present 18 hatcheries that were responsible for a production of over 15 billion PLs in 2010, 11 different feed manufacturers and 32 processing plants which, in most cases, are not operating under full capacity and are able to provide support for further growth and expansion.

The main problem the sector faces today concerning future expansion is an internal one that has nothing to do with diseases, exchange rates, international or internal prices and the like. After decades of activity, clear rules are still not in place regarding environmental permits which, in turn, affects access to credit. The lack of clear rules and existing difficulties in most states to not just obtain but, often, also renew environmental permits is the main roadblock to continued success for the sector. The Ministry of Fisheries and Aquaculture, which was only created two years ago, has stated that finding a solution to this is one of its priorities but the sector is still waiting for concrete results.

If explored in an efficient manner, based on average national productivity, Brazil can reach a prominent position of leadership in shrimp farming in terms of global production as it has 1 000 000 ha of suitable areas, with exceptional natural conditions, infrastructure, and location as far as the main consuming centres are concerned while also having the appropriate technology in place and a large and promising internal market to lead this growth.

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