Prospects for Aquaculture in India
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The aquaculture sector in India has emerged as an important export sector for the country. India benefits from the declining production of the major shrimp producers in the world by increasing its share of the world market. Biotechnology is applied to increase output, as well as to control the environmental pollution caused by the sector. The adverse microeconomic and environmental impact of aquaculture, however, requires authorities to re-examine the aquaculture sector.

Out of the globally farmed shrimp production of 0.9 million tonnes in 1992, 75 per cent is produced in Asia. China is the largest producer (0.2 million tonnes), followed by Thailand and Indonesia (0.15 million tonnes each). India is the fifth largest producer in the world of farmed shrimps, with an annual production of 40,000 tonnes. During the past few years, the Asian production profile has changed. Several of the large producers have experienced declines in production. Excessive use of chemicals and toxic substances adversely affected the coastal environment and thereby the productivity of aquaculture.

In Taiwan, for example, shrimp production declined sharply from about 100,000 tonnes in 1987 to 30,000 tonnes in 1988. In China, shrimp production fell dramatically mainly because of viral, bacterial and protozoan diseases. Other countries such as Vietnam and India are increasing their market share. In a joint venture with the Thai private company CP Foods, Vietnam has developed an infrastructure to cultivate 1000 ha. of shrimps. In 1993, CP Foods exported for US$ 96 million, or about 40 per cent of Vietnam's total shrimp sales.

Potentials for Indian aquaculture
Indian shrimp exports have risen from US$ 566 million in 1992-93, to US$ 671 million in 1993-94, and are targeted at US$ 959 million at the end of the Eighth Five Year Plan in 1996-97. Japan, Western Europe, and the USA account for 62 per cent of the export volume in marine products, and 85 per cent of its value. Although its share in the total exports is decreasing, Japan is still the largest export market in value terms. Europe is the largest market in volume terms.

Although India is among the major producers of shrimps in the world, only 6 per cent of its coastal areas is utilized for aquaculture. This has encouraged the Ministry of Commerce, as the national organization for the regulation and development of the Indian marine industry and for promotion of its export, to focus its attention on shrimp farming to increase the Indian export value. The Ministry set up the Marine Products Export Development Authority (MPEDA) in 1972, which provides financial support by participating in the equity capital of companies engaged in deep sea fishing and aquaculture.

Financial support for aquaculture is also provided by several Indian public sector financial institutions such as the National Bank for Agriculture and Rural Development and the Industrial Development Bank of India. Since 1992, the World Bank has provided assistance for shrimp and fish culture projects in five Indian states.

The Bank's assistance is for the development of about 3,810 ha. of brackish water area, and about 51,000 ha. of reservoirs and lakes in the Indian states Andra Pradesh (South India), Uttar Pradesh (North India), and Bihar, Orissa and West Bengal (East India). 90 Per cent of the estimated costs of about US$ 105 million will be provided through the Bank's softloan affiliate, the International Development Association (IDA).

The private sector has increased the number of joint ventures with foreign companies in recent years, especially with companies from other South East Asian countries (10 out of 23 joint ventures in 1993-94). The foreign collaborators are not only bringing in foreign exchange, but also a range of new technologies. CP Foods, for example, has entered into R&D collaborations with their Indian counterparts for increasing quantity and quality of shrimps.

**Biotechnological applications**
In India, biotechnology is making a significant contribution to the development of aquaculture. Efforts are directed to:

- The improvement of fish feed quality;
- Genetic engineering in order to improve the protein value of fishes;
- The reproduction of recalcitrant species;
- Fish disease diagnoses;
- Hybridoma technology and genetic engineering that could be employed for the production of vaccines. Vaccines are expected to enhance significantly the productivity of aquaculture;
- The treatment of effluents and other pollutants generated by aquaculture.

The Indian Department of Biotechnology (DBT) has funded programmes on the production of monoclonal antibodies for fish diagnosis and disease control, effluent treatment, and development of feed formulation technology for (semi) intensive aquaculture. It also funds research on transgenic fish. Cloning of the gene encoding for the fish gonadotropin releasing hormone (GnRH), and introduction into the major carp induced multiple spawnings and prolonged breeding season.

Generally the major carp takes 8 to 12 months to attain marketable size, while the transgenic line of carp has faster growth rate, which could reduce the production cost considerably. The Central Institute for Fresh Water Agriculture is working on standardization of techniques to introduce foreign genes in fish. Madras University has developed a method for preservation of gametes for up to two years. This development will soon be transferred to industry.

Hindustan Lever is the most prominent private company active in the field of aquaculture development. The company's Aquaculture Development Centre at Muthubadu developed a method of rearing *P. monodon* prawn species in captivity. They achieved an output of approximately 9 tonnes per hectare per year, which is comparable to the productivity of Taiwan in its hey day. Hindustan Lever is also prominent in shrimp feed production.

**Shrimp feed problem**

Problems in acquiring enough feed haunt the shrimp culture industry in India. By the turn of the century demand will be around 100,000 tonnes. Today, only 40,000 tonnes of the total demand of 70,000 tonnes is met by domestic production, while the remainder has to be imported.
The cost of feed is one of the vital factors in the shrimp industry as it constitutes nearly 60 per cent of total production costs. Therefore, efforts are made to enhance the total production of shrimp feed and to reduce its production costs in various research centres such as the Central Institute of Brackishwater Aquaculture and the Central Food Technological Research Institute (CFTRI), Mysore, South India. The latter studies the processing of waste and low cost byproducts as a source of protein in feed formulation. A test in a semi-intensive shrimp culture system at Nellore showed that CFTRI's feed was comparable to imported feed.

A number of established animal feed manufacturing companies have entered into the production of shrimp feed. Some of them entered into foreign collaborations in order to get access to improved technology. Lately, private companies have invested in research on alternative ingredients for shrimp feed. Avanti Industry, a South Indian company, for example, plans to use the amino acid fluid from a cystine containing plant as a substitute. The research for this company is conducted by its joint venture partner CP Foods, which extracts amino acids from chicken feathers. CP Foods is the world's largest shrimp feed manufacturer, with an annual production of 250,000 tonnes. Additionally, local Indian companies are developing feed ingredient, such as vitamins for improving the quality of shrimp production.

**Waste treatment**

Biotechnological research on environmental pollution resulting from brackishwater aquaculture is quite recent. Ammonia, nitrates, hydrogen sulphide, acidity and depletion of dissolved oxygen are among the major causes of disease and mortality in aquaculture. Beside the chemical treatment of the effluents, mixtures of cultured bacteria with enzymes and buffers are adopted to speed up the decomposition of organic wastes. Methane-producing bacteria are studied for their possibility to combine decomposition of organic wastes with energy production. In 1993, DBT launched a four year, US$ 3.1 million project on environmental monitoring of semi-intensive aquaculture farms in seven different parts of India. Under the project, various research schemes would be initiated for studying the possible biotechnological methods to deal with the adverse environmental implications of aquaculture.

**Impact on the rural economy**

Development of aquaculture has its attendant cost. NGOs in particular have indicated that aquaculture could severely affect agricultural communities and fishermen earning their livelihood in areas where this sector is growing. Paddy fields are being converted into hatcheries resulting not only in decreasing production of food grains, but also in a
growing number of displaced farm workers. Several case studies, mostly from the Southern states Tamil Nadu and Andhra Pradesh which have seen a mushrooming aquaculture industry, have listed the adverse impacts. Sirkuli taluk, in Nagapattinam Quaid-e-Milleh district in Tamil Nadu, for example, has seen extensive conversion of 2000 ha. of prime agricultural land into 150 shrimp farms. In the district, 40 per cent of its work force consists of landless labour, one of the highest levels in India.

The companies that invest in aquaculture argue that the converted lands were low-yielding, but agricultural labourers reject this argument and, more importantly, point to the loss of employment opportunities. The new aquaculture farms predominantly require highly skilled workers, which the companies usually bring along with them. In Andra Pradesh, the districts Krishna and Godavari have seen a 15 per cent conversion of paddy fields. This is significant in view of the fact that these two districts contribute about 78 per cent of the total paddy production of Andra Pradesh. In another region of the same state, 614 ha. of paddy land has been converted to aquaculture ponds resulting in an additional 340 ha. of paddy land that has become unproductive due to increased salinity. According to Prepare, a South India based NGO, paddy production has decreased by 10 million kg., or the basic food for 10,000 families.

Extending aquaculture by using saline water has farreaching implications. The converted land cannot easily be reused for agriculture should the need arise. According to one estimate, it would take at least 7 years to rid the rice fields of salt. Apart from the decreasing productivity of agricultural land, aquaculture has a long term implication for the rural economy arising out of its adverse effects on the environment due to largescale use of chemicals, discharge of toxic effluents and deterioration of the quality of ground water. Kurrupattapupalam, for example, a small village of 500 families in Andhra Pradesh, has no drinking water and will have to move elsewhere.

All the wells and other fresh water sources in the village have turned saline in the past two years, due to shrimp farm affluent seeping into the ground. Local fishermen fear that the shrimp farms which release the effluents into the creeks, may damage fishing in the estuaries which provide a major source of subsistence during the monsoon when the sea is rough. Also complaints by fishermen have been reported about festering sores when they come in contact with the effluents when they retrieve their nets.

**Environmental impact**
The National Remote Sensing Agency has found that thousands of hectares of mangroves in Andhra Pradesh have been lost. Because the existing hatcheries cannot cope with the high demand for shrimp seeds, villagers are employed to hunt for wild seeds in the mangroves areas, thereby destroying many pockets of mangroves. A large concentration of aquaculture also has negative aspects for the aquaculture farms themselves.

Recently, outbreaks of viral and bacterial diseases in certain areas of Andhra Pradesh have caused serious concern within the sector. Due to unplanned concentration of shrimp farms, farms use the same water courses to fill their ponds and drain their effluents, thus increasing the spread of contagious diseases.

**Governments responses to protests**

Rural communities, particularly in the two states of Andhra Pradesh and Tamil Nadu, have organized largescale protests against the growth of aquaculture. These communities have been supported by human rights organizations. As a result of these actions, some of the planned expansion has been frozen.

In recent months, the movements in Tamil Nadu and Andhra Pradesh have drawn the attention of both the federal and state governments. The legislative assembly of Andra Pradesh has passed a resolution to control the growth of aquaculture, but a legal instrument has still to be framed.

The Tamil Nadu government has appointed a 14 member expert committee to recommend guidelines to regulate aquaculture industry. A second expert committee was set up to suggest norms for discharge of effluents, and formulate measures to prevent salinization of ground water and agricultural land. The Indian government has commissioned a study by the National Engineering Research Institute to set guidelines for mitigating pollution due to agriculture.

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**Sources**

