TECHNOLOGY AS CONTINUITY AND CHANGE IN SHRIMP CULTURE
CHAPTER – IV
TECHNOLOGY AS CONTINUITY AND CHANGE IN SHRIMP CULTURE

4.0 Introduction

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4.0 INTRODUCTION

Aqua-products and their usefulness to mankind can be traced back to many millenniums. In fact, right from the beginning of the human race, marine products are identified as a major source of food.

As mentioned in the previous chapter, the avenue available to bridge the demand – supply gap is to grow selected aquatic organisms under controlled conditions. To carryout aquaculture, in this study – the shrimp culture – many technologies are adopted.

4.1 TECHNOLOGY TRAJECTORIES

Nelson and Winter (1982) explain, “the concept of technology trajectory posits an unfolding time-related pattern of technological change”.

The Supreme Court of India Judgement (1996) quoting Alagarswami’s (1995) report details the change in technology with time and is given below:

(a) Traditional: Practised in West Bengal, Kerala, Karnataka and Goa, also adopted in some areas of Orissa. Coastal low-lying areas with tidal effects along estuaries, creeks and canals; impoundments of vast areas ranging from 2-200 ha in size. Characteristics: fully tidally-fed; salinity variations according to monsoon regime; seed resource of mixed species from the adjoining creeks and canals by auto-stocking; dependent on natural food; water intake and draining managed through sluice gates depending on local tidal effect; no feeding, periodic harvesting during full and new moon periods; collection at sluice gates by traps and by bag nets; seasonal fields alternating paddy (monsoon) crop with shrimp/fish crop (inter monsoon); fields called locally as bheries, pokkali fields and khazan lands.

(b) Improved traditional: System as above but with stock control; supplementary stocking with desired species of shrimp seed (P.monodon or P.Indicus); practised in ponds of smaller area 2-5 ha.
(c) Extensive: New pond systems; 1-2 ha ponds; tidally fed; no water exchange, stocking with seed; local feeds such as clams, snails and pond-side prepared feed with fishmeal, soya, oilcake, cereal flour etc.; wet dough ball form; stocking density around 20,000/ha.

(d) Modified Extensive: System as above; pond preparation with tilling, liming and fertilisation; some water exchange with pumpsets; pellet feeds indigenous or imported; stocking density around 50,000/ha.

(e) Semi-intensive: New pond systems; ponds 0.25 to 1.0 ha in size; elevated ground with supply and drainage canals; pond preparation methods carefully followed; regular and periodic water exchange as required; pond aerators (paddle wheel) at 8 per ha; generally imported feed with FCR better than 1:1.5 or high energy indigenous foods; application of drugs and chemicals when need arises; regular monitoring and management; stocking density 15-25/m².

(f) Intensive: Ponds 0.25 – 0.50 ha in size; management practices as above; 4 aerators in each pond; salinity manipulation as possible, Central drainage system to remove accumulated sludge; imported feed; drugs and chemicals used as prophylactic measures; strict control and management; stocking density 20-35/m².

In addition to this, in Japan and Taiwan, one more type of technology is also adopted which is super-intensive. When the intensive culture system exceeds a certain stage, it reaches super-intensive culture stage. Hirasawa (1992) mentions, "a circular tank type pond is already well-known as one of the super-intensive aquaculture pond. This culture requires high turnover of water, sometimes upto 400%. This system in Taiwan might yield an output of 6 tons/ha in one harvest". However, this technology form is not followed in India.

Ganguly (1991) details the aquaculture investigations started at Hindustan Level Research Center in 1973. It took them 10 years to understand how to rear the species, P.monodon in captivity. To transfer the technology from
research into their aquaculture development centre in Tamil Nadu took the best part of the next five years. To transfer technology to grow-out commercial farms in West Bengal took about five years. Ways and means of transferring the know-how to farmers and fisherfolk will take another 10 years, but the main point to remember here is that there are no shortcuts. Therefore, we can conclude from studies and experiments that sustainable aquafarming will take: nearly 30 years to reach a sustainable state.

Sundararaj, Devaraj and Prince Jayaseelan (1992) say, “from time immemorial, traditional methods of brackishwater aquaculture exist in four pockets in India, namely, West Bengal, Kerala, Goa and Karnataka”.

They further add, “extensive and semi-intensive prawn farming came into practice very recently (less than a decade) in Indian aquaculture scenario”.

Paul Raj (1995) mentions, “in India, commercial shrimp farming made a beginning in the early 1980s and attained industrial proposition in the late 1980s”.

Purushan (1995) observes, “emphasis in research is given on the extensive and semi-intensive culture which are within the reach of most farmers”.

4.2 STRATEGIC PROFILE ANALYSIS

Nelson and Winter (1982) while discussing technology trajectory mention, “technology development and application within a particular industry setting may show relatively incremental, continuous progress for long periods”.

Aquaculture Magazine (1997) in the status of World Aquaculture is of the view, “aquaculture will probably expand more rapidly than the current projections because of new players, improved production methods and more efficient exchange of research information. Aquaculture is being recognised and more importantly, understood by the financial community and government agencies. With the needed economic support, aquaculture has substantial
opportunities for improving its production methods and developing expanding markets for a product that is becoming increasingly popular”.

Jory (1997) writes, “there are about 2500 shrimp species worldwide but only a dozen or so are farmed to any extent, and global production of farmed shrimp continues to be dominated by two species. In 1996 the giant tiger shrimp (P.monodon), constituted about 58% of world cultured shrimp production. Giant tigers have comprised more than half of the world production for several years”.

Sudhakara Rao (1997) says, “India with 2 million hectares of brackishwater low lying areas along her coasts offered immense potential for developing prawn farming. This advantage coupled with the technology available in the country and elsewhere in the world attracted the entrepreneurs of every shade and size into this industry and as a result vast areas of the coastal lands have been brought under prawn farming in most of the maritime states”.

Liao Chiu (1992) explains, “often, some people were so impressed by the success of their neighbours that they embarked on an aquaculture enterprise without adequate or basic knowledge on the possible adverse consequences. While this resulted in a rapid increase in production, what was actually occurring was a skipping over a crucial steps in the rational expansion of aquaculture”.

The summary of Aquaculture in Asia of the APO proceedings (1990) details, “different system of prawn farming in India include traditional culture system, tidal and pump fed system, seawater pump fed system, brackish water pump fed system and borewell fed system. These farming practices follow the extensive and semi-intensive types of culture. In some places, the semi-intensive practice is in its transitional stage of intensive farming”.

Purushan (1995) explains, “at present, various shrimp grow out techniques ranging from traditional (stocking density unknown), extensive (low stocking density), modified extensive (moderate stocking density), semi-intensive
(medium stocking density with feeding and water exchange) and intensive (higher density with feeding, aeration and high water exchange) are in practice”.

Sundararaj, Devaraj and Prince Jayaseelan (1992) list the productivity attained by adopting various technologies as follows:

**TABLE 29**

**PRODUCTIVITY Vs TECHNOLOGY MATRIX**

<table>
<thead>
<tr>
<th>Technology Adopted</th>
<th>Productivity (Kg/ha/crop)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional</td>
<td>200 – 500</td>
</tr>
<tr>
<td>Extensive (modified)</td>
<td>500 – 600</td>
</tr>
<tr>
<td>Semi-intensive</td>
<td>1000 – 2000</td>
</tr>
<tr>
<td>Intensive</td>
<td>6000 – 8000</td>
</tr>
</tbody>
</table>

For the selected technology types viz. extensive, semi-intensive and intensive cultures, a position diagram is plotted to show the average values (Figure12).

The phenomenal growth in intensive culture is possible with high element of risk. If any variable becomes uncontrollable or managed wrongly, it not only will result in heavy losses to the firm but also affect the environment adversely. A risk-return trade-off will converge the focus towards semi-intensive form of culturing.

Pillay (1990) estimates, “production of more than 26 million mt (28.7 million tons) can be obtained by the turn of the century if the current percentage rate of increase is maintained and if technical, financial, and policy supports are present”.

Sundararaj, Devaraj and Prince Jayaseelan (1992) say, “brackishwater areas, which include estuaries, mangroves, backwaters, lagoons and saltwater lakes. Such cultivable brackishwater areas account for 1.4 million ha in India of which about 58,000 ha area are used for prawn farming”.

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FIGURE 12
SHRIMP CULTURE TECHNOLOGY COMPARISON

Average Product-Stocking Activity (Kg/Density ha/crop) (Lakhs)

<table>
<thead>
<tr>
<th></th>
<th>Extensive</th>
<th>Intensive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modified</td>
<td>50000</td>
<td>200000</td>
</tr>
<tr>
<td>Semi</td>
<td>550</td>
<td>1500</td>
</tr>
<tr>
<td>Intensive</td>
<td>7000</td>
<td>275000</td>
</tr>
</tbody>
</table>
Jory (1996) says, “there are between 2000-4000 species of microorganisms in shrimp ponds at any time, and they perform important biodegradation roles. Their successful management will depend on various factors, mainly defining the ecological processes that are to be changed, what species are naturally dominant and under what pond conditions, and what are the desirable alternate species to promote”.

These things make clear that the aquaculture industry is facing high strategic uncertainty, which has to be tackled by a multi-faceted approach.

Abernathy (1978) while discussing technological change and continuity mentions, “there may be a myriad of technological possibilities and productive units in the early stages of industry development”.

Ken Clarke and Howard Thomas (1990) observe, “with the emergence of a dominant design, process innovation becomes more significant and is directed towards specialized and capital intensive systems”.

Shrimp culture started picking up only from the late 80's. A mixed portfolio of modified extension and semi-intensive types of farming were being followed at different parts of India during the early part of this decade. Success was forthcoming and new technology – an intensive culture – was being adopted. This was not backed by scientific research or studies owing to which it had started showing negative results as the farmers were unable to understand the pond dynamics. Simultaneously, all the above mentioned forms of technology were adopted, resulting in the following up of different culture practices. The players were heterogeneous in size of farm holding, leading to a mix of scientific and unscientific practices on the culture management front.

These factors led to the "boom-and-burst" scenario and the latter part happened during mid 90's. The government and the agencies related to aquaculture and environment protection tried to put pressure on the entrepreneurs to strictly follow scientific procedures. This led to less intensification of technology, entrepreneurs started adopting modified extensive
and semi-intensive forms of culture during the second half of the 90's. This is continuing now, and when the country enters the new millennium these culture practices will come to stay.

Many new players will step in. The composition of entrepreneurs at the end was homogenous containing only the successful ones who followed the scientific technology management practices. Others who were playing earlier would have shifted their attention towards other industries. This structure will come under threat, due to the new entrants. Hence, the overall management skills are to be developed along with technical skills to avoid the recurrence of the burst scenario.

In the industry under focus — shrimp culture — the technological diversity is more, which is clear from the fact that many technological forms are practised simultaneously.

Purushan (1995) is of the view, "even though a lot of shrimp farming technologies both foreign and indigenous and readily available, a uniform type and commonly practiced one which can be applied in the varied geographical and environmental situations on a 'turnkey basis' has not yet been evolved. Further, irrespective of whether they are of indigenous origin or imported, the technologies available are exclusively location and unit specific".

Yamamoto (1992) while classifying aquaculture mentions, "coastal culture is practiced in brackishwater or marine water. The water area under coastal culture is either public marine/brackishwater or private pond".

APO symposium on aquaculture (1990) calls for "promotion of aquaculture products using the mass media, creation of stabilization funds and setting up of an aquatic product inspection system".

Gopal Rao (1995) is of the view, "the disease has caused panic among the farmers because of rapid spreading of the disease, mass mortality of the prawns and lack of scientific information regarding disease and control measures. Several assumptions have been made among farmers and local
technicians regarding the disease. This has led to the distress harvesting of the growing crop causing heavy economic loss both to big as well as small farmers. Further the farmers are in a dilemma whether to continue the shrimp farming as they have faced the continuous problems".

Ronald Calori (1990) brings out the strategic profiles of organisations which are given below:

TABLE 30

<table>
<thead>
<tr>
<th>STRATEGIC PROFILES OF ORGANIZATIONS</th>
</tr>
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<tbody>
<tr>
<td>Strategy – 1</td>
</tr>
<tr>
<td>Strategy - 2</td>
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<tr>
<td>Strategy – 3</td>
</tr>
<tr>
<td>Strategy – 4</td>
</tr>
</tbody>
</table>

In aquaculture industry, during the initial years, the scope of the industry is limited to few technologies and applications from traditional to intensive. The application is on the improvement of the process of development of shrimp culture for which it brings value.

Aquaculture embraces strategy - 2, in which the critical mass for success is obtained by focussing on few technologies and applications to serve the international market. Here, every firm is a focused one, because failure in one firm may result in environmental degradation which may lead to technological deadlock.

Exporting a high share of production is one of the important features of organisations adopting strategy - 2. In the case of shrimp culture, almost all the farm cultured shrimps are exported, as export fetches good
revenue in foreign exchange. Moreover, the profits accruing through exports are tax-exempted. According to MPEDA (1991), India depends heavily on one product (shrimp) and one market (Japan). Satya Sundaram (1997) mentions that the frozen shrimp constitutes 70.7% of total export of marine products during 1993-94 which is depicted in Figure 13.

The export trend of Indian marine products by value is given in Figure 14. Frozen shrimp constitutes a lion's share of the export which is maintained between 73 and 82% during the period 1986-91. However, this has come down to 70.7% during 1993-94. This is due to many factors and the major ones are: i) many nations, of late, started realising the potential of aquaculture and entering into the competition; ii) the dilution of one product one country philosophy leading to one product (shrimp) to many countries; iii) due to competition, the price realisation was also low; and iv) when the intensity of technology increases, possibility of threat of virus; and natural constraints on productivity.

Eighth five year plan proposals of MPEDA (1991) details, “World seafood trade is expanding very fast due to increase in per capita consumption of seafood in many industrialised nations. The gap between supply and demand is widening and it is projected by FAO to the tune of 20 million tonnes by the turn of the century”.

Regarding the buyers and markets, Liao (1992) is of the view, “the cultural prawn production in Asia is expected to double to over 1 million tons by the end of the country. The traditional market may not be able to absorb all these, thus, there is a need to look for alternative markets. Overproduction can be both beneficial and detrimental, that is, it can be beneficial to consumers but detrimental to aqua-farmers”.

Another reason Yamamoto (1992) identifies is, “the producer’s price of black tiger prawn converted into US$ followed a downward trend. Such a
FIGURE 13
EXPORT OF MARINE PRODUCTS (1993-94)
(% IN TERMS OF VALUE)

FROZEN SHRIMP (70.7)
FROZEN SQUID (7.7)
FROZEN CULTURED FISH (5.5)
FRESH/FROZEN FISH (11.8)
OTHERS (4.3)
FIGURE 14
INDIAN MARINE PRODUCTS EXPORT TREND

YEAR | VALUE (CRORES) ₹
--- | ---
1986-87 | 377.9
1987-88 | 425.8
1988-89 | 531.2
1989-90 | 597.85
1990-91 | 893.37

- FROZEN SHRIMP
- TOTAL
downward trend in the producer's price may be due to a downward trend in the purchase price of a prawn.

APO symposium (1990) concludes, “as Japan's home consumption becomes increasingly important, future demand for prawn will depend on this variable. It was argued that there is a possibility that consumption will not grow despite a price decline suggesting that it has come close to the saturation level”.

High initial cost coupled with the steep cost reduction is the feature of the shrimp culture. Hirasawa (1992) clarifies, “prawn culture production will continue to increase in the future, leading to further decline of the international price of prawn. If the international price becomes lower than the MSRC (Maximum Sustainable Reproduction Cost), then prawn culture businesses with higher costs should not survive. The only way for prawn culture farmers to survive is obviously to reduce cost per kilogram”.

Jory (1997) feels, “reducing the cost of feeds is critical to sustain the industry and improve its competitiveness relative to other protein sources. Work also continues on the development of lower – cost, environment – friendly feeds”.

Hirasawa (1992) further adds, “cost reduction will be effected if the culture system is progressively elevated from extensive to semi-intensive and further to intensive culture. However, making culture intensive as emphasized does not mean the conventional type of making culture intensive such as simply increasing the number of input seedlings and volume of feeds. It is a new type of making culture intensive that pays the greatest attention to the improvement of pond construction and the ultimate utilization of natural productivity”.

Purushan (1995) says, “the marginal success achieved by adopting sophisticated technologies is generally associated with problems of disease, water quality and environment”.

Liao (1992) cautions, “although there exist several pathogenic explanations to the infestations, some culture techniques are found to actually
facilitate the spread of disease. Certain warnings must be considered with the onset of more intensive aquaculture such as the impact of aquaculture on the environment and possible subsequent impact on the industry. Land depression and disease are manifestations of this impact”.

Gopal Rao (1995) suggests, “in order to achieve full control, an integrated approach to management to be adopted”.

MPEDA’s Eighth five year plan proposals say, “India depends heavily on one product (shrimp) and one market (Japan). Therefore there is a need for diversification in products and market. India’s predominant position in shrimp market is being eroded due to sudden spurt in farmed shrimp production in China, Thailand, Indonesia, Vietnam, etc.”.

Hirasawa (1992) details, “intensive culture ponds are generally well maintained, with the producer’s high level of culture technology and this will help in proper pond management. In extensive culture, the pond is left unmaintained, not allowing the natural productivity to be used. Furthermore, super-intensive culture system can cause prawn stress”.

Alagarswami (1991) explains, “P.monodon has the advantages of outstanding growth rate, omnivorous feeding habit with a relatively low dietary protein requirement, euryhaline nature and high tolerance to handling stress”.

Discussing shrimp culture Sundararaj (1992) observes, “about 55 species of prawn occur in India. Considering the total bio-economic matrix of the penaeids, P.monodon, P.indicus and P.semisulcatus emerge as the most suitable species”.

Satya Sundaram (1997) reports, “during 1994-95, marine exports from India was placed at a peak of Rs.3576 crores”.

The Supreme Court (1996) in its’ deliberations considered three reports viz. (a) Alagarswami report (1995), (b) NEERI report (1995) and (c) Suresh Committee report (----). The Alagarswami report highlights various environmental and social problems created by coastal aquaculture. NEERI
conducted its studies in two phases and it provides details regarding the impact of aquaculture farming on ecologically fragile coastal areas of India. Suresh Committee – an expert committee consisting of members like fisheries administrator, ichthyologist, an I.A.S. Officer, a University Professor and a Medical Surgeon and headed by a retired high court judge – studied the impact of shrimp farms along the coast of Tamil Nadu and Pondicherry. The gist of these committee’s findings are:

- It is a common practice to convert agricultural land, and land under salt production, into coastal aquaculture units infringing on the fundamental rights to life and livelihood.
- Brackish aquaculture units have been installed in deltaic regions which is ecologically an unsound practice.
- The loss of mangrove eco-systems which provide protection against cyclones and natural hazards.
- Traditional fishermen have lost their grounds for fish catch.
- Saline water intake and effluent discharge points from aquaculture farms are located in close vicinity, resulting in contamination of feed water.
- Blockage of free access for the fishermen to sea shore.
- Accumulation of pollutants in the creek due to wastewater discharge from farms.
- Commercial infrastructure farm owners have not contributed to any social infrastructure facilities for the villages.
- Employment avenues of the contiguous population have been considerably reduced due to the commercial aquaculture farming.
- Encroaching upon government lands.
- Seepage of pond effluent to the surrounding fields.
- Soil quality of the adjoining aquaculture fields gets affected by the seepage from culture ponds leading to desertification of cultivable lands.
• Practice of installing coastal aquaculture farms within 500 mt. HTL violates the fundamental rights and livelihood of people in some states.
• Groundwater also gets contaminated due to seepage.
• There is a perceptible increase in the diseases of skin and eye, and water borne disease in the contiguous population.
• Wild seed collection from creek and sea must be prohibited, otherwise it will have detrimental effect on the ecology of the sea, creek and estuarine water bodies.
• Waste water/sediment treatment facilities do not exist at many aqua-farms.
• Improper farm design.
• Barbed wire fencing along the periphery of the farm has resulted in restriction to free access for the farmers, fishermen and cattle to the creek.
• No regulation or control over the farming technology type adopted in any region of the country.
• Many government departments (Central and State) issue separate notifications which are not in line with the common norms. For example, the State Government of Tamil Nadu has enacted a bill to provide for the regulation of coastal aquaculture on April 10, 1995. This bill is not in consonance with the Central Government's Ministry of Environment and Forest's (MEF) notification dated Feb. 19, 1991, as it allows the construction of aquaculture units within 500 mts of HTL (High Tide Level) of the sea.
• Artificial creeks are being constructed to allow high tides of creek/estuarine water into large reservoir, and this results in flooding of low-lying areas.
• System of maintenance of quality of feed is not practised in farms.
• Assorted stocking of healthy and unhealthy seed together in a farm.
• A strict vigilance by the Fisheries Department and Pollution Control Boards are required to keep a check on pollution abatement measures.
• Comprehensive and scientific environmental impact assessment (EIA) study has to be carried out by the entrepreneur and the environment management plan (EMP) approved by various Central and State bodies.

• Design and construction of the drainage canal/bund must be undertaken scientifically, based on the topographical features of the area. This will avoid the flooding of the area with saline water and will help in restoration of hygienic and sanitary conditions in the nearby residential areas.

• The number of crops raised per year also affects the environment and pond productivity.

• Lime is regularly used but continued use of lime impoverishes the soil. It also hardens the soil.

• Use of drugs indiscriminately, will damage the environment.

These findings highlight the problems faced by aquaculture industry. Few of the above mentioned problems are solvable by strictly enforcing rules and regulations; few others are solvable by proper selection of technological form that is suitable for that particular region. These arguments also reinforce a point that aquaculture is not a stand alone system but depends heavily on environment, for its very existence.

4.3 INDUSTRY PROFILE

Porter (1980) mentions, “emerging industries are characterized by technological newness and uncertainty. They may be in the introduction or growth stage, and have several high differentiation opportunities based on their research and development. At such times they are in a "fluid phase" not having come out with any dominant product or process design. When some dominant product or process design becomes evident, this technological maturity turns the competitive system into a mature one. In this sense, this concept is different from the well known product life-cycle theory which is based on the market growth rate".
Aqua-products and their usefulness to mankind can be traced back to many millennia. In fact, right from the beginning of the human race, marine products are identified as a major source of food. With this background, a question arises as to whether aquaculture, especially the species under focus - shrimp culture - can be treated as an emerging industry or otherwise.

To answer this question, let us proceed further into the emerging industries paradigm to find out its applicability to shrimp culture.

Ronald Calori (1990) avers, "technological uncertainty, which is one of the main characteristics, has some other major structural consequences which are also identified as other characteristics of emerging industries:

- high strategic uncertainty
- high rate of new entrants and exists
- many embryonic companies and spin-offs
- first-time innovative buyers
- high initial costs but steep cost reduction".

He further adds entry barriers common to emerging industries as:

- the maximum critical mass of research and development is high,
- the R&D/Sales revenue ratio is high,
- the technological uncertainty of products and processes is high and
- the technological know-how is hard to find.

The information obtained from various secondary sources and presented in this chapter has direct relevance to the argument - whether shrimp culture is an emerging industry or not?

1. There is mention about the entrepreneurs' entry into the industry; but no specific data are available on the number of entrants. Similarly, there is no information regarding the exit.
2. Shrimp culture is a monoculture eco-system and hence there is no spin-offs.
3. India depends heavily on Japan as a major market for its' export of shrimps. It is mentioned that the market has come close to the saturation level.
4. It is highlighted that many firms follow unscientific management practices for culture. Also, simultaneous adoption of various technological forms are found. These spell out the fact, that not much money is spent on the R&D.

5. Difficulties in obtaining accurate and relevant data is highlighted. Nowhere is the expense on R&D mentioned.

6. There is no technological uncertainty of products found, as the species identified – black tiger prawn does not undergo change.

7. Due to trial-and-error method of culture practice, there is no uniformity in the technological know-how.
   
   As detailed earlier, commercial shrimp farming in India made a beginning in the early 1980s and attained industrial proposition in the late 80’s.

   Though shrimp culture attained the industrial proposition only during a decade back, the above mentioned details underline the point that shrimp culture is not an emerging industry.