TECHNOLOGY MANAGEMENT MODELS IN SHRIMP CULTURE
CHAPTER – V
TECHNOLOGY MANAGEMENT MODELS IN SHRIMP CULTURE

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5.0 INTRODUCTION

Moneaert, Barbe, Deschoolmeester and Meyer (1990) opine, "technology determines the competitive position of a company. The direction of technological change is a major force affecting the firm's competitive posture. Various models with a direct or indirect reference to technology have been developed over time. The models generally considered to be helpful tools in the analysis of technology and strategy within the firm are the technological life-cycle and the technological S-curve". They further add, "another reason for this selection is that the above concepts have already been empirically validated".

These two models viz., technological life-cycle (TLC) and technological S-curve are adopted for the purpose of developing technology management practices in shrimp culture so as to make it a sustainable one.

5.1 TECHNOLOGICAL LIFE-CYCLE IN SHRIMP CULTURE

Utterback and Abernathy (1975) introduce technological life-cycle as the one which pictures the absolute frequency of product and process innovations in a productive unit. They say, "the unit of analysis, the productive unit, is a product line and its' associated production process. The model highlights the interaction between product, process and technology during the life-time of a productive unit".

While drawing up the technological life-cycle for shrimp culture, the interaction between the process and technology alone is considered, as the product does not undergo changes or improvement in this type of culture as we are interested in the sustainable development of one product – black tiger prawn.

Considering the total bio-economic matrix of the penaeids, P.monodon, P.indicus and P.semisulcatus emerge as the most suitable species. This was deliberated in detail earlier.
Alagarswami (1991) explains, "P.mondon 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".

Sufficient justification is already given in the earlier chapter for the selection of the product – black tiger prawn – and hence the focus of TLC is only on process and technology.

Abernathy and Utterback identify four stages of development of the process in the technological life-cycle as in figure 15. They say that during the initial 'fluid' stage, trial-and-error method is adopted for the development of the process. This laboratory based method has to reach a stage where the ill effects of the process are understood. This cannot be achieved overnight. Flexibility, entrepreneurship and informal relations between various agencies focusing their attention at the laboratory level will bring in stability of the process at the earliest. The next stage is 'transition' stage where the frequency of process innovation sharply increases. A dominant process design is the generally accepted embodiment of all relevant characteristics. During the 'specific' stage, the process innovation is distinctly predominant and during the mature stage, the innovative ability declines to a very low level.

Due to the nature of shrimp culture industry as such, the technological life-cycle has to be different. The stage of development may not follow a smooth curve but take different slopes as the developments take place in the process technology. As discussed earlier, shrimp culture technology takes many forms, viz., traditional, improved traditional, extensive, modified extensive, semi-intensive, intensive and super-intensive.

Hirasawa (1992) mentions, "when the intensive culture system exceeds a certain stage, it is called as super-intensive culture system. In this culture system, the natural productivity will become unable to be used and instead, inevitably it will have to rely fully on artificial means. Thus this results in
FIGURE 15
TLC FOR SHRIMP CULTURE PROCESS

RATE OF INNOVATION

FLUID

TRANSITION

SPECIFIC

MATURE

STAGES OF DEVELOPMENT
an increase in cost. Furthermore, super-intensive culture system can cause prawn stress”.

Piedrahita Raul and Wang Jaw Kai (----) report, “in high-intensity production in Taiwan, 50 to 100 percent exchange of water per day is not unusual towards the end of the production cycle, while Marine Culture Enterprise, the failed ultra-high-density enclosed shrimp farm in Hawaii, used a water exchange rate of 400 percent per day”.

The super-intensive form is not followed in India. For many decades traditional form of culture is adopted in some parts of the country.

As stated earlier, 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 and are becoming increasingly popular with potentially strong impact on the foreign exchange earnings in particular and on the Indian economy in general”.

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

This substantiates the view point that the culture systems other than traditional one have been tried out only during the past couple of decades.

Study about the experiences of Hindustan Lever Research Centre will give insight into various stages of technological development in shrimp culture, which will be the basis for developing the TLC for shrimp culture.

As stated earlier, Ganguly, while unfolding the experiences of Hindustan Lever Research Centre, mention that sustainable aqua-farming will take nearly 30 years to reach a sustainable level.
This is true, in India commercial shrimp farming attained industrial proposition in the late 1980s. As the returns were attractive, many medium and small farmers and cooperative sectors started extensive, semi-intensive and intensive culture operations.

Srinath Krishna (1996) observes, “the technology adoption in the small scale rural sector is found to be low and beset with several constraints. Only two percent of farmers adopt the technology as soon as they realise its benefits”.

Alagarswami (1991) writes, “while modern technology of brackishwater aquaculture can control some of the culture problems at considerable cost, it can be done only on a selective basis for intensive farming bearing the cost-benefit in mind. Production technology to be applied should be appropriate to each situation and there is need for coexistence at different levels of technologies – extensive, semi-intensive and intensive”.

The magazine Fisheries World (1994) in its cover story warns, “scientific farm management practices should be strictly adhered to, even at an additional cost failing which the aquaculture industry might be facing a premature death”.

Purushan (1995) tells, “at present, various shrimp grow out techniques ranging from traditional, extensive, scientific extensive, semi-intensive and intensive are in practice simultaneously”.

Santhana Krishnan (1995) is of the view, “at present several entrepreneurs are urging to gain higher yield, to the tune of 5 MT / ha crop and above. While this effort deserves appreciation, one should not be greedy like the man in Golden Goose story. Farmers should therefore consider several factors and decide system of culture as listed below:

1. Farms located in the seafront where quantity and quality of water is not a constraint, could plan for modified extensive / semi-intensive with a production of not less than 4-5 MT/ha/crop.
2. Farms located in the creek area may be classified into the following three categories:

i) Farms having more than 2 mts tidal amplitude at farm site – semi-intensive culture is recommended.

ii) Farms having 1-2 mt tidal amplitude practice, only modified extensive system with a production of 2 to 3 MT/ha/crop.

iii) Farms having less than 1 mt tidal amplitude at site may aim at a production of 1 to 1.5 MT/ha/crop.

However, many technological forms are adopted by entrepreneurs simultaneously along the coast of the country. This results in a heterogeneous group formation.

Liao (1992) while tracing the history of aquaculture in Taiwan, divides it into four stages, viz., the embryonic stage, boom stage, leaping or growth stage and maturity stage. The stages are presented in Figure 16.

Embryonic stage has been in existence for many decades and technology form adopted is mostly traditional. Polyculture is practised widely. As mentioned in previous paragraphs, shrimp is cultivated alongwith paddy and other species. There is no scientific management process adopted at this stage. The natural seedlings are used for culture. No standardised practice is followed for culture. The number of players are also restricted as the technological venture is not so attractive to entrepreneurs.

"Blocking strategy" is adopted during the embryonic stage of the shrimp culture TLC in order to make entry by competitors unattractive. Here the technology used is defensive and industry as a whole adopts this.

Boom stage is one in which the intensity of technology marginally increases resulting in the improvements in the traditional form. This calls for focus on improved practices of culture. This stage attracts more entrepreneurs comparatively, as the productivity and profitability increase. Many agencies - Government, NGOs – carry out many researches and breakthroughs are made.
FIGURE 16
TLC OF SHRIMP CULTURE

YEAR

PRODUCTION (000 TONS)

EMBRYONIC

LEAPING/GROWTH

MATURE
so as to help maintain the boom. Supreme Court of India’s judgement (1996) observes, “one of the future management strategies is the development of standards for effluent discharge as applicable to local conditions”. Even in the absence of coordination between the players, the boom will still sustain itself and move into the next stage.

"Locking-in strategy" is used during the boom stage of the TLC, which is aimed at offering cost effective, quality product in sufficient quantity. Here again, as in the earlier stage of TLC, technology is used as a defensive tool but this time at the individual company level and not at the industry level. Competition sets in, leading to a race between the players to achieve maximum output, slowly adopting various means to succeed.

Leap or growth stage of TLC will benefit the industry at large. This is possible through the frequency of process innovations that take place. The technology forms are also multiplied and entrepreneurs have the option to choose either extensive or modified extensive or semi-intensive or intensive methods. All these methods will be simultaneously adopted at various parts of the country leading to higher production in a disorganised manner. This stage has to be focused by the controlling agencies; if not, it may lead to several complications, due to the heterogeneous nature of the technology adopted, resulting in catastrophic effects once the up trend is halted.

"Value-added strategy" is adopted during this growth stage to achieve competitive advantage. This is made possible through the use of technology, which is used as an offensive tool. Purushan (1995) says, "the marginal success achieved by adopting sophisticated technologies is generally associated with problems of disease, water quality and environment". Here, customers distinguish themselves with the use of different technological forms - some would like to more aggressive and they adopt intensive culture thereby exposing themselves to more risk whereas some others will adopt modified extensive method to reduce their risk with a reduction in return as a trade-off.
This heterogeneity in industry will result in more porous boundaries among the players, which will make them to be more receptive to external inputs by way of technical assistance programmes, focus group and other inter-organizational efforts.

Maturity stage of TLC is the next stage after the industry leaped forward. According to Liao, during this stage, the process innovation activity declines to a low level. The degree of familiarity with technological form is high and the technology internalization is through inter-company cooperation. The sustainability is maintained by properly utilising the appropriate technology.

"Preemptive strategy" is used during the maturity stage of TLC. This strategy uses the technology offensively to transform and raise the industry's technical standard. They typically establish or change the technological standards of the industry. Thus, the technology is mastered by all leading to conversion of the existing technology into a base technology. The degree of knowledge diffusion should be high leading to higher level of standardisation and codification of the technological management practices.

Technology deployment during various stages of TLC is shown in Figure 17. The applications and uses of technology give rise to TLC strategy matrix which will have four strategies as part of it. They are: blocking strategy, locking-in strategy, value-added strategy and preemptive strategy. They are identified as offensive vs defensive depending on the use of technology and individual vs industry depending on the application of the identified technology and its form.

5.2 TECHNOLOGICAL S-CURVE MODEL

The second model which has the direct reference to technology and its management, as stated by Moenaert, Barbe, Deschoolmeester and Meyer is 'technological S-curve model'.

Development of this model and its applicability to shrimp culture is deliberated in this chapter.
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<td>LOCK - IN (BOOM)</td>
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<td>AQUACULTURE INDUSTRY</td>
<td>BLOCK (EMBRYONIC)</td>
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5.2.1 SELECTION OF TECHNOLOGICAL FORM

Though there are about six technological forms taken up in India simultaneously, few of them are dropped from the list of feasible culture practices for the following reasons:

- Intensive form is left out as it calls for heavy initial investment and high risk-return trade-off. Liao (1992) highlights, "aquaculture in the traditional sense need not be capital intensive, but certain amount of capital is nonetheless necessary". Sundararaj, Devaraj and Prince Jayaseelan (1992) mention, "since shrimp farming is not as simple as crab culture and is capital intensive". Higher production and productivity is possible through this type of culture but the threat to environment is quite high. Since proper scientific technology management practices are not developed, adoption of this form can be discouraged.

- Super-intensive form is attractive from the returns view point, whereas the effect on environment may become unmanageable. Use of this form in Taiwan resulted in failure and in India, practice of this form has not taken roots, and considering the risks involved, it can be straightaway discouraged.

- As discussed earlier, the traditional, improved traditional, extensive forms are not focused, as they do not follow the scientific grow-out practices. All are tidal fed with no water exchange; no control over the seedlings; no specified feed management practices; and the stocking density is very low not worth the study and focussing on a nationwide scale.

- Modified extensive though adopts scientific management practices, still is not complete. Hirasawa (1992) mentions, “because the technical level of culture is low in extensive or semi-intensive culture farms, the mortality of prawn is generally higher than in the case of intensive culture”. Some water exchange is carried out with pumpsets for a stocking density of around 50,000/ha. Other important requirements like proper pond engineering, use of aerators, good FCR (Food Conversion Ratio), regular monitoring of the whole culture system
is not available/practiced and hence this form of culture is also kept out of focus.

All these factors – both scientific management and economic – converge towards the selection of semi-intensive form of culture as the one ideal for Indian conditions.

5.2.2 TAIWAN'S SHRIMP CULTURE EXPERIENCE

In the magazine, Fisheries World (1994), a cover story on 'Aquaculture and Environment' analysed the Taiwan and China's experience in culturing shrimp, which is presented in the next few pages.

Though Taiwan has had a long history of aquaculture, its shrimp culture history is relatively shorter. Till early sixties shrimp culture was never considered a profitable venture in the country. The epoch – making year of 1968 during which the large scale hatchery rearing technology for shrimp was established unequivocally and the development of shrimp feed industry during the seventies, changed the scenario.

From a meager 69 tonnes in 1969 the production rose to 270 tonnes in 1976; in 1977 the output was 100 tonnes and in 1985 10,000 tonnes. The production peaked at 80,000 tonnes in 1987.

Intensive farming practice was the main feature of the Taiwanese shrimp culture industry. In 1987, the average production rate per hectare was 10 tonnes. In other words the 80,000 tonnes of shrimp produced during the year came from just 8,000 hectares. The industry as a whole was a network of highly specialised business areas. There were importers, suppliers of spawners, hatchery operators producing naupalii and PLs, grow out farmers specialising in production of different sizes of shrimp, specialists in harvesting, pond cleaners, feed manufacturers, algae growers, suppliers of aquaculture equipments and other inputs and shrimp exporters.

Though Dr. Liao I Chiu, the man known as the "Father of tiger shrimp industry" had been warning about the dangers of diseases, there was no
indication of the debacle till the year 1987. But the year 1988 saw the shrimp production drop suddenly to 43,700 tonnes. (Figure 18)

Wide-spread outbreak of diseases was the factor for mortalities and low production. Viral, bacterial, protozoan infections were identified as the pathogenic factors. But the task force employed to study the causes of mortalities, significantly, identified some widespread 'malpractices' in the industry which were considered as the real culprits for the downfall. Atleast eight such non-pathogenic causes were identified which are listed below:

- Use of excessively high temperatures in hatcheries to accelerate production cycles, lowering the disease resistance of the larvae.
- Deterioration of the pond condition and reduction of their carrying capacity.
- Extremely high stocking densities.
- Poor quality of feeds, over 13 per cent of the feeds tested showed sub-standard quality.
- Indiscriminate use of antibiotics.
- Polluted water.
- Incompetent aquaculture operators.
- Lack of suitable hygienic practices.

Besides, there was over-exploitation of groundwater causing major crises like the land subsidences, salination of aquifers etc. Abuse of the environment was so excessive that the debacle was inevitable.

5.2.3 CHINESE SHRIMP CULTURE EXPERIENCE

History of China's shrimp culture can be traced back to centuries. But the industry blossomed as a commercial venture only in the 1980s, thanks to the development of hatchery and pond management technology coupled with the active governmental support. From about 9,000 tonnes in 1983 the farmed shrimp production shot up to 1,99,400 tonnes in just five years' time.
FIGURE 18
CULTURED SHRIMP PRODUCTION IN TAIWAN (1983-93)
A species highly suited for culture, agri-minded family run business culture, abundant supply of frys at US$1.0/1000 and admirable government support were considered to be the secret behind the success of China.

Shrimp were being farmed along the whole length of the Chinese coast. But the bulk of the production used to come from large semi-intensive farms concentrated around the Gulf of Bhai. Compositional structure of the farming enterprise in the country in 1992 was semi-intensive farms: 95%, extensive farms 4% and intensive farms: 1%.

Chinese farmers used low-value feeds such as trash fish, shellfish such as thick-shelled, small bivalves, clams, etc. The fresh feeds are usually fed directly or after mincing. In some farms pelletised feeds, often prepared by the farmers themselves at their own farms, supplemented the natural feeds. In other words, from the farm management point of view, the Chinese farms were using feeds of undesirable quality. Feed conversion ratios were over 3.4:1.

Poorly designed farms in the low-lying areas, use of ponds over long durations, virtually without any cleaning or renovation, unhygienic pond conditions and pollution from domestic, agricultural and industrial sources were playing havoc with the environment. The production started declining after reaching a peak of 1,99,400 tonnes in 1988.

CR "Corny" Mock, a US aquaculture expert, who visited China in 1988 and 89 declared, "shrimp farming still increase in China, technology will improve." But his prediction was proved wrong.

Since 1989 the production has been on the decline. It hovered around 1,50,000 tonnes during the three years after 1990 and then plummeted in 1993 to less than 50,000 tonnes. Some estimated that the actual production during the year was less than 35,000 tonnes. (Figure 19).

5.2.4 MYOPIC TECHNOLOGY STRATEGIES

The players in the aquaculture industry do not have completely free choice about choosing the type of technology to be adopted in their firm.
FIGURE 19
CULTURED SHRIMP PRODUCTION IN CHINA (1983 - 93)
Jory Darryl (1995) explains, “shrimp farming is a monoculture ecosystem. As such it is fragile, unstable and easily disturbed and thrown out of equilibrium”.

Jory Darryl (1996) after examining the shrimp farming industry worldwide concludes, “it is surprising that an industry that has reached such commercial relevance still depends on nature to such an extent for its’ existence”.

Jory Darryl (1997) says, “shrimp farming must strive to become a self-regulating industry. The catastracal collapses experienced in recent years by the shrimp farming industries in the Philippines, China, Taiwan, Thailand and recent problems in other major shrimp producing countries undoubtedly prove that shrimp farming procedures cannot be sustained indefinitely. These collapses clearly show the need to reassess and re-evaluate the wisdom of achieving short term economic profit at the expense of major environmental damage, versus the option of pursuing rational and sustainable shrimp farming practices”.

This is due to the earlier established fact that the firms in this industry are not stand alone system but heavily depend on the environment. Whatever may be the size of the firm – whether a corporate one or a partnership based one running few farms – it really does not have a free hand to be a leader or follower.

Alagarswami (1991) points out, “in the brackishwater sector, the small scale entrepreneurs have adopted simple technologies of pond construction, water supply, low stocking with wild seed and feeding with locally available semi-processed or unprocessed materials. Very little management practice goes into the system”.

Gopal Rao (1995) observes, “several assumptions have been made among farmers and local technicians regarding the disease, which led to distress harvesting causing heavy economic loss”.
Paul Raj (1995) mentions, "a bio-pond for treating the waste water is a necessity for small, large and corporate farms. Only few corporate farms are creating this facility”.

This is because, not all the players will follow the scientific management practices, but the few who do not follow things systematically will decide the sustainability of the industry as a whole. Form of technology adopted is heterogeneous and all the players run the race to attain higher productivity and not vying for an optimum one. Even the corporate players leading the rest to set industry standards may be brought down by the environment and end up as failures, because players are equipped with different technologies. They are running the race without knowing the start or finish lines, sometimes without knowing the purpose of running the race.

Liao (1992) highlights, "most of the farmers’ culture practices did not conform to the usual normal procedures, which resulted in the crisis". The firms develop their own method of cultivation like pond preparation, fertilization, seed procurement, stocking, feed management practices, sampling, harvesting, transportation to state a few”.

Sudhakara Rao (1997) mentions, “the development of shrimp culture has been haphazard, unscientific and without any respect for the ecosystem. As a result of the unscientific expansion of shrimp farming there was a crisis in 1994 caused by disease and it still haunts the shrimp farming industry. It is high time to develop standards for the industry”.

Supreme Court of India judgement (1996) suggests, “one of the future management strategies is the development of standards for effluent discharge as applicable to local conditions”. Without a standard for the industry it is difficult to measure the correctness of the practices followed.

These problems and deficiencies will result in the formulation and adoption of myopic technology strategies. These, in the short run, may bring in more profit but the sustainability of the industry comes under question, as these
strategies neglect the benefits from the knowledge accumulated over a period of time. This accumulation combined with the adoption of knowledge from outside will bring in foresightedness into the industry.

5.2.5 TECHNOLOGICAL S-CURVE FOR SHRIMP CULTURE INDUSTRY

Twiss (1979) observes, “the technological S-Curve pictures performance capability of a technology with respect to the invested R&D resources”. As mentioned earlier, many technological forms of shrimp culture are practiced simultaneously in an unorganised fashion, it is difficult to segregate the performance indicator data technology-wise.

Yamamoto (1992) observes, “very little is known on the types of aquaculture that has been developed in every Asian country. Such a situation poses an obstacle for any comparative study of aquaculture in Asia”. He further adds, “statistical details are broadly classified into freshwater culture and coastal culture and not on other headings”.

According to the regional survey report on aquaculture in Asia (1992) “aquaculture statistics need to be improved for appropriate productivity and cost studies”.

Jory Darryl (1997) observes, “collecting reliable production data for aquaculture and fisheries in general is difficult, and farmed shrimp statistics are not the exception; there are several reasons for this. Many private companies are often reluctant to provide data, particularly for high-value species like shrimp that are normally exported to high-demand markets. Considerable amounts can be exported illegally, or are under-reported or not reported at all to reduce local assessments and surcharges. In addition, concerned government agencies in many countries do not keep aquaculture data current – available data are typically 2-3 years old and may have a tendency to exaggerate production or even present contradictory statistics. Unreliable data also result because in many areas a substantial amount of production, particularly from artisans, subsistence – type aquaculture activities stays in local or regional markets, or is processed
into a value-added product that does not indicate the origin of the raw material and this is unreported in national statistics”.

Balan, Sukumaran and Suresh (1996) write, “the average total returns obtained from semi-intensive shrimp farming in Tuticorin was around 12 lakh rupees /ha/crop”.

Hirasawa (1992) reports, “gross earnings per hectare increased as the intensity went up and expenditure per hectare outgrew gross earnings per hectare. With the assumption that the gross earnings of extensive culture system is 1, semi-intensive culture system represents 3.1 and intensive culture system, 9.8. In regard to expenditures, on the other hand, assuming that extensive culture type is 1, semi-intensive culture type and intensive culture type, respectively, account for 3.2 and 14.9.

This shows that semi-intensive and intensive culture types become higher in terms of cost per kilogram than extensive culture type. But from the overall profit view, the culture systems with higher intensities are preferred”.

Also, if successfully cultured, the profit from the venture is very high and this is another reason for the entrepreneurs not letting out the type of technology adopted, stocking density etc. Giving adequate attention to these details and to the reality of the industry, the technological S-curve is developed for the shrimp culture industry as a whole.

Sahal (1981) and Foster (1986) explain, “the S-curve for shrimp culture will have the following stages as depicted in Figure 20. These are identified based on the cumulative effort put in by the industry and other related agencies alongwith the performance indicator:

- Emergence
- Growth stage and
- Maturity stage.
FIGURE 20
TECHNOLOGICAL S-CURVE FOR SHRIMP CULTURE

PRODUCTION ('000 TONS)

LIMIT OF PERFORMANCE DUE TO NATURAL CONSTRAINTS MATURITY STAGE

LIMIT DUE TO INDUCED CONSTRAINTS

PRINCIPLES

PSEUDO-MATURITY STAGE

R & R MODE BEA MCZ

TDG

1973 1983 84 85 86 87 88 89 90 91 92 93 94 95

EMERGENCE STAGE DORMANT STAGE GROWTH STAGE
5.2.5.1 EMERGENCE STAGE

Sahal, Foster and Twiss advocate that the initial efforts bring about a merely marginal performance improvement.

In shrimp culture, in Indian context this has taken a longer time. The culture commenced in a traditional way many decades back, whereas scientific experiments have started only during the 70's. Hence, this emergence stage is further sub-divided into:
- experimental stage and
- dormant stage

A) EXPERIMENTAL STAGE

In some parts of our country, fish culture is taken up alongwith the paddy culture due to the conducive climate created by geographical considerations. Lessons are learnt about culture practices – of course not at a single species level because the culture adopted here is polyculture.

Srinath Krishna (1996) observes, “in spite of the modern advances the main cause of concern has been the implementation of faulty practices leading to material and environmental resource degradation. Overuse of practices in the intensive systems and low level of adoption and trial and error approach in the extensive systems are the major problems which are to be solved”.

Supreme Court of India in its judgement (1996) mentions, “since long the fishermen in India have been following the traditional rice/shrimp rotating aquaculture system. During the last decade, the traditional system which, apart from producing rice, produced 140 Kgs of shrimp per hectare of land began to give way to more intensive methods of shrimp culture”.

No scientific management practices are followed and hence returns are also sub-optimal. Entrepreneurs, through these culture practices, learned lessons about modern culture which was used to develop their own technology. Few others, living in other parts of the country, who do not have this opportunity,
started learning culture practices from governmental agencies or through aquamarine specialists or through literature from abroad and started developing their own technological methods of carrying out culture.

Sudhakara Rao (1997) feels, "the major problem of the industry was created by the so called consultants who infiltrated from freshwater fish culture, agriculture and veterinary fields into prawn culture. These people having very little knowledge about the basic principles of life of shrimps and brackishwater aquaculture prescribed unscientific procedures to the farmers". The practice here is basically "trial-and-error" method.

Shrimp culture in India on modern experimental lines was started during 1973 by Hindustan Lever Research Foundation. Such kind of experimental researches are only a few and the majority follow polyculture as stated earlier. The emergence of experimental phase goaded the entrepreneurs to take up shrimp farming on modern lines seriously.

B) DORMANT STAGE

This stage commenced during 1983 and continued till 1988. The research groups that were carrying out the experiments at the "lab" level were engaged in taking the laboratory experience to the model farms during the earlier stage viz., the emergence or experimental stage. They are yet to prove themselves and hence were not willing to let out their results as the probability of success was not known to them. Whenever they are published, there is a definite time period between information dissemination and assimilation. This time span is based on many factors and few major ones are:

- seed availability is through marine landings only as the hatchery technology was at the emergence state;
- artificial feed production technology development was rather slow resulting in the dependence of imported feed which is prepared for the technical environment prevailing at this place;
- initial investment on land procurement, pond engineering was very high;
• local population especially the fisherfolk could not afford such huge investment;
• assured current income from activities like fishing, agriculture, salt production with lesser risk discouraged entrepreneurs from entering high risk business;
• reduction in the employment potential also went against the setting up of such ventures;
• government encouragement was not forthcoming in the form of subsidies, policy announcements which if announced at proper time could have provided a clear direction to the industry;
• experimental cultivations in laboratory are carried out under specific environmental conditions which were not disseminated fully to the entrepreneurs; and
• the problem of tactful handling of the situation of carrying the lab experience to farms on a larger scale.

B.1) TECHNOLOGY ASSIMILATION DURING DORMANT STAGE

The importance, necessity and willingness to accept a new technology is the key to the technology assimilation process. Also sources of technology and the technological intensiveness available to the entrepreneurs are equally critical for assimilation of technology at a given pace.

Sources of technology may be internal or external. Here, internal means those technologies developed by an organisation and external means those developed by other agencies within the country and outside, and properly and fully disseminated. The intensiveness of technology identified can be gauged by verifying whether the technology brings in incremental and radical changes and benefits to the organisation. Figure 21 shows the "technology assimilation grid", which depicts the entrepreneur's readiness to accept a technology.

Whenever the technological intensiveness is incremental and source is internal, the assimilation process is slow because entrepreneurs are not sure of the benefits that will accrue and if the existing technology is giving the
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<th>TECHNOLOGY ASSIMILATION GRID</th>
<th>TECHNOLOGICAL INTENSIVENESS</th>
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<td>INTERNAL</td>
<td>EXTERNAL</td>
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<td>FAST</td>
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<td>FAST</td>
<td>VERY FAST</td>
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<td>INCREMENTAL</td>
<td>SLOW</td>
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required profit they may not be willing to experiment with the new one and expose themselves to unknown risk. However, if it is radical, a few will take a bet on the new one and – if it succeeds, will give them a windfall of profit.

Though the intensiveness is incremental and if it comes from external sources the willingness level is quite high and the technological assimilation level is fast. This will further get enhanced, if the technological intensiveness is radical and the source is external, especially if it is from other countries. This will make or mar the existing situation depending upon the level of understanding of the prevailing environmental, culture conditions in those countries from where it is brought in.

5.2.5.2 GROWTH STAGE

As stated in the TLC discussion earlier, the boom stage is technology driven. Research and development activities can and do happen outside the organisation and even outside the country. The assimilation grid shows the eagerness or willingness of the entrepreneurs to accept the changes quickly or slowly. Primary focus areas (PFA) are to be identified on which a high level of attention to be put.

In shrimp culture, out of the many variables identified under Chapter 3, few are very critical and they are: pond engineering, preparation of grow-out ponds, seedling, stocking density, feed and its management and water quality management.

The primary focus area identification should help in identifying the relevant technology with high potential. Depending on the stage in TLC, this varies. During the growth stage in S-curve, semi-intensive and intensive forms of technology are adopted which results in higher production. In Indian shrimp culture scenario, the growth stage starts from 1988 and continues till 1993 and peaks in 1994-95. Fisheries World (1996) cover story details, “during the year 1994-95, the total foreign exchange realisation through marine exports touched
Rs. 3553.08 crores and the contribution of shrimp (both capture and culture) came to Rs. 2551.60 crores”.

Fisheries World (1994) depicts the cultured shrimp production in India during 1983-93 which is presented in Figure 22. Part of this is the growth stage identified under the technological S-Curve. Managing this stage is very important and highly critical as this will decide the things to come in the future.

A) PSEUDO - MATURITY STAGE

While the industry is in the growth stage, after few years, before the actual maturity stage begins, there will appear a maturity stage like situation. In the shrimp culture it happened during 87-89 period, just after a few years of the beginning of the growth stage. This is owing to the following reasons:
- rush of entrepreneurs had stabilised during this period;
- the players who would like to take moderate risk are still waiting in the wings;
- productivity constraints started showing its effect on the culture; and
- government was trying to exercise control over the industry.

B) PRECAUTIONARY AND POLLUTER PAY PRINCIPLES

Supreme Court of India in Dec. 1996 judgement on shrimp culture defines, details and adopts the two principles viz., precautionary principle and polluter pays principles. These two principles are highly relevant during the growth stage of the technological S-curve as the government control over the industry goes up during and just after the pseudo - maturity stage. (Appendix 1)

C) MANAGEMENT COMFORT ZONE (MCZ)

Just after the pseudo-maturity stage where the precautionary principles are developed and introduced, the industry managers will find a zone which is comfortable to them. This is so due to the fact that the policies are developed and scientific practices are introduced to the industry. During this, symptoms will be towards higher growth. Various forms of technologies are adopted. Since this zone, from the management angle brings in comfort, break-
FIGURE 22
CULTURED SHRIMP PRODUCTION IN INDIA (1983 - 93)
even chart is developed for extensive, semi-intensive and intensive types of shrimp culture.

D) BREAKEVEN ANALYSIS BY INTENSITY

The breakeven chart exhibits the relative cumulative position of various costs and revenue. In the case of shrimp culture, breakeven analysis is carried out on the basis of the technological intensity. There are six technological options available for entrepreneurs to carry out the shrimp culture. Out of these, as justified earlier, three technological forms are focused for calculating the breakeven point.

Hirasawa (1992) explains, “since, data on shrimp culture is not available technology-wise, the breakeven chart is drawn on per hectare basis. This also serves the purpose of identifying the productivity, as on the horizontal axis, production volume or value is taken in. On vertical axis, expenditure value is taken up. Cost details are identified along the vertical axis”. (Figure 23)

He adds, “fixed cost and variable cost go up depending upon the level of intensity of technology. Higher is the total cost if the technological form adopted is intensive. The total revenue flow is also high as the production level becomes higher if we move from extensive to intensive. The breakeven point ‘B’ identified on all the three charts should not be read as such. If done, may mislead”.

It is further clarified that along with the level of technological intensiveness, the breakeven point will also move towards right. It is true, in the case of intensive culture, BEP is at a higher level compared to other two forms, as it occurs at a higher level of production. This does not mean that extensive form is efficient. Many more hidden things are there in intensive culture like the volume of production, which is very high when compared to extensive form. Though the B.E.P. occurs at a higher volume of production, the profit zone is much higher than the rest. This is represented by the double arrow which indicates the hidden potential. The single arrow in the case of semi-intensive
PRODUCTION
LOW « IN VOLUME (OR) VALUE » HIGH
(b) SEMI-INTENSIVE (c) INTENSIVE
A
COST
FIGURE 23
BREAKEVEN BY INTENSITY
form of operation indicates that it falls between the other two cases under reference.

E) RAPE AND RUN MODE OF PRODUCTION

When the industry is going through the management comfort zone, adequate precautionary steps should be taken up against the use of technological forms. Higher the technological intensiveness, lower will be the utility of that particular region for shrimp culture. During the deliberations in the Supreme Court of India (1996) on the petition against the existence of shrimp farms, certain UN reports were analysed and the relevant portion is presented to highlight a new mode of production viz., 'Rape and Run' (R&R mode), which is very short term oriented with environmental aspects not acceptable. (Appendix-2)

5.2.5.3 MATURITY STAGE

Husain and Sushil (1997) mention, "every technology has an upper limit of performance imposed by nature". Allocation of resources to further enhance the capability of the existing technology will prove to be counter – productive due to this reason.

Maturity can happen at two levels, viz. industry maturity and technology maturity. Industry maturity can happen when all the players put together concentrate on all the customer groups and every player is operating in their own niche market without disturbing others. Varieties are also not forthcoming and the requirements of customers are met through present form itself.

According to Moenaert, Barbe, Deschoolmeester and Meyer (1990), "in the case of technological maturity, output of research and development activities are becoming inelastic leading to only marginal increase in the product or process innovations. Technology maturity does not imply that innovation has come to an end at the organisation level. Some of the players may throw a surprise by introducing an innovation. Technology maturity is a process by which the drive toward standardisation inoculates the unit against competitively
significant innovation. Intermediate plateaus could create the illusion that the ultimate plateau has been reached”.

In shrimp culture, this phenomenon of intermediate plateau was observed just after the management started concentrating on the focus areas and introducing the precautionary and polluters pay principles. These induced constraints bring in a plateau which is not a maturity stage whereas it is identified as “pseudo-maturity stage”.

But after the higher growth rate and the rape-and-run mode of production is established indicate that maturity stage has commenced. Adequate control over the industry as well over the organisations on the technology adoption practices have to be exercised. This is due to the fact that industry maturity and technology maturity are two different concepts and do not necessarily coincide in time.

5.3 TECHNOLOGICAL DE-GROWTH

Moenaert, Barbe, Deschoolmeester and Meyer (1990) observe, “a technologically mature industry is one in which uncertainty about process design has been reduced to such an extent that the details can be codified”.

In the strategic profile analysis carried out in Chapter 4, it was highlighted that the shrimp culture industry is facing high strategic uncertainty. Due to this fact, the process design adopted at present, can not be taken up as a standard one. Things also get complicated due to the simultaneous adoption of several technological forms in the industry – the point which is already deliberated.

From this, we can conclude that the shrimp culture industry is still in growth stage and has not attained maturity.

Clark (1983) identifies, “the supply-side changes in technology as the major possible cause of reversal in the trend to maturity”.

As deliberated earlier, the sources of technology are very many – in house development, association from other agencies within the country and also
from abroad. It was mentioned earlier that each company is a focused one and the technology practiced should suit the company. This is not strictly adhered to, as the entrepreneurs adopt the latest culture practices without validating it.

This supply-side change in technology, as said earlier, causes the reversal in the trend. Since it is already proved that the industry has not entered the maturity stage and still is in growth stage, there occurs 'Technological De-Growth (TDG)'.

5.3.1 TDG IN SHRIMP CULTURE: COUNTRYWISE COMPARISON

Technological de-growth study in shrimp culture is carried out focusing on the major shrimp producing countries viz., Taiwan and China. Parallels are drawn between these countries and India so as to study whether TDG happened in India or not. The time span selected for this purpose is between 1983 and 1993, as during this period all the three countries have completed a cycle. Figure 24 depicts the production pattern during this period based on actual data.

5.3.1.1 BOOM-AND-BURST

During 1983, at the beginning of the study, all the three nations' output of shrimp was around 10,000 tonnes, with China at the end. Within an year, China overtook the rest and peaked during 1988 with a production level of 199,400 tonnes – a figure unimaginable to reach within such a short period. The average rate of growth was around 40%. There are two major reasons for this development. One is the technological intensity. The country moved towards semi-intensive culture without proper planning of support services. The other reason is the vast coastal line available in China for culture.

The "burst" scenario followed the "boom". When multiple technologies were adopted to raise the production to historical levels at a very high average rate, it resulted in the reversal. The result was a drastic decline in production and by the end of 1993, i.e., after another five years it was below
FIGURE 24
TDG IN SHRIMP CULTURE - COUNTRYWISE COMPARISON
50,000 tonnes – a negative average rate of around 30% and is continuing without a hold.

Taiwan's scenario is equally good and bad with regard to 'boom-and-burst'. During 1983, it was ahead of others and within a four year time frame, it peaked to 80,000 tonnes which came from just 8000 hectares. It means that the average rate of growth was around 20% whereas the productivity was very high at 10 tonnes per hectare. Taiwan with limited coastal line at its disposal adopted super-intensive form of culture also during this period resulting in early reversal of trend.

In fact, Taiwan took only four years from its peak to go below India's production and it happened during 1991. The worst was continuing and at the end of 1993, it had almost come back to the production level of 1983 to around 20,000 tonnes.

5.3.2 INDIAN EXPERIENCE

The country is able to increase its production at an average rate of 6% over the ten year period starting from 1983. In fact it took more than six years for the production to get doubled and the leap stage started only during the 90's. At the end of the period, ironically, India topped the list production-wise. This is due to the fact that majority of the entrepreneurs adopted either improved extension or semi-intensive forms of culture. Comparatively, the growth in India is identified as moderately regulated. Even this is not adequate which became clear after the 1994 debacle, which took its toll of many shrimp farms.

Excessive precautionary principles were adopted by several governmental agencies due to pressure from various quarters viz., agriculturists, fisherfolk, environmentalists. Even today, shrimp culture industry is limping without knowing the direction towards which it can move.

With an extensive coastal line spread over eight thousand and odd kilometres, still lot of hidden potential is there for carrying out shrimp culture
under regulated environment, as only 8-9% of the coastal line has been utilised so far for this purpose.

Shrimp culture is a gold mine. If properly managed, it may become the country's top foreign exchange earner, of course with due consideration to the environment.