CHAPTER - II

REVIEW OF LITERATURE
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Shrimp aquaculture industry is still in its infant stage, when compared to other industries. According to Alagarsamy (1991)\(^1\), the growth of aquaculture industry, though in its infancy is tremendous, which was realised only in the late eighties. He further states that the annual growth rate of aquaculture was 8.75 per cent per annum where as the annual growth rate of the poultry industry is only 2.25 per cent. James Meady, (1989)\(^2\) reveals that in the world's total food production aquatic food production contributed 7 per cent in 1970, 13 per cent in 1980 and it may shoot up to 25 per cent before the year 2010. Alagarsamy (1993)\(^3\) also adds that, though a good number of shrimp species are available for culture, *p.monodon* and *p.indicus* are the most suitable for semi-Intensive and intensive farming and the other shrimp species are suitable only for extensive system of farming.

Purushan(1995)\(^4\) states that India has a conducive environment for developing shrimp aquaculture industry, since the country has 1.4 million hectares of brackish water all along its coast in the form of lagoons, creeks, tidal mud flats, salt pans, estuaries, mangrove swamps etc. Moreover, the natural ingress of tidal waters upto one metre is also another added advantage for aquaculture industry.
According to Dixitulu, (1992)\(^5\) the total estimated brackish water area in India is 1.4 million ha. (1 hectare=2.47 acres) of which about 56000 ha. is under shrimp culture and it is utilised for extensive culture. Soundaraj (1990)\(^6\) says that, the share of Indian shrimp production during 1984 - 89 was 115 per cent with an average increase annually to the turn of 23 per cent as against the global shrimp production through aquaculture which was nearly 200 per cent.

Yogamurthy (1988)\(^7\) cautions that, over exploitation will affect not only India, but also the global seafood industry. It should be seen not only in the economic perspective, but also in the global environmental perspective.

The Indian aquaculture industry is showing an upward growth, therefore, it needs good quality seed (Anonymous, 1992)\(^8\). There is also a need for initiating steps to develop shrimp hatcheries to produce quality seeds. Sakthivel (1994)\(^9\) reveals that the major hurdle in aquaculture industry is lack of viable technology for commercial production. Thus, preserving aquaculture is inter disciplinary requiring engineering inputs along with biological research. Hunner (1994)\(^10\) points out that the prospects of aquaculture varies from country to country due to different variables like markets, physical, environmental, political and socio-economic conditions. Santhanam (1990)\(^11\) substantiate the study of Hunner(1994)\(^12\) by pointing out that the fall in Taiwanese shrimp industry can be attributed to high stocking
density, over use of shrimp pond, unhealthy seed, low quality feed, poor and unhealthy antibiotic and polluted water.

According to Ramesh Babu (1988), successful shrimp yield in aquaculture depends on water quality, quality seed and feed. Purushan (1995) further adds that the production success is related to the management efficiency and the type of farming technique adopted. He also stresses that a successful technique adopted in one area may not yield the same result in another area.

Devasia, (1992) points out that about 71,000 ha of coastal lands in India is brought under shrimp production of which a major part is covered by extensive culture (53,000 ha.) followed by semi-intensive with 14,000 ha. and intensive farming is undertaken only in about 3,500 ha.

ENGINEERING

The four systems of shrimp farming are (i) tidal fed (ii) pump fed (iii) tidal and pump fed (iv) subsoil system of shrimp farming. Pump-fed system and tidal and pump fed system are ideally suitable for Tamil Nadu since Tamil Nadu coast has very low tidal amplitude (Sugumaran, 1993).

Moreover, Pump-fed farming is cheaper, profitable and also its yields are higher when compared to tide fed ponds. This is mainly due to less construction costs (Charles Angle, 1987). For pond construction soil with
high clay content is preferred due to its good water retaining property as well as good compaction characteristics (Chinnasamy, 1995). Location of inlet and outlet in a pond diagonally opposite to each other has been found ideal for a semi-intensive farm for operation, management of water circulation, aeration etc. Further, rectangular or square ponds are appropriate for shrimp culture (Chakrabarhty, 1983). The effective pond designs on the Internal Rate of Return (IRR) are pond shape, pond size, levee width and canal bank slope (Garcia, 1993). Water exchange rate and water depth also play a vital role in the ecological conditions, promoting the growth and survival of the shrimps (Sriram, 1986). If the pond is very deep, the deepest part may be deficient in both light and oxygen. On the other hand, if the pond is too shallow overheating and oxygen depletion may result (Mathu, 1983).

The most ideal water level in a pond should be 0.75 to 1 metre throughout the culture period and also it must not exceed 2 metres, so as to enable biological productivity and fish growth. The ideal stocking density of shrimps differs from person to person (Grod Fred, 1991) recommends 30,000 to 45,000 pieces/hectare.

MANAGEMENT

Semi-intensive system is better, since the investment costs are moderate and the rate of return is good. Whereas, in the case of intensive system the investment cost involved is very high and if the expected production yield is not achieved then the entire project may collapse. Further,
there is a relationship between investment and rate of return. On this basis, it is concluded that intensive system is a more income generating technology and on the other hand, it is also proved that semi-intensive farming is economically viable. For proper and efficient pond management the size of a pond may be between one or two hectares or even smaller. Smaller ponds of one hectare and below has management efficiency (Santhanakrishnan, 1992)\textsuperscript{24}. Moreover, aeration and water exchange are the two most common techniques for quality management of marine shrimp farms (Alvandi, 1995)\textsuperscript{25}.

Growth and survival rates were excellent in ponds with normal water exchange (25 per cent daily). It shows a combination of higher stocking density with nil mass mortality (Hoprins, 1993)\textsuperscript{26}. Moreover, maintenance of good water quality is essential not only for survival but also for optimum growth options. (Santhanakumar, 1993)\textsuperscript{27}. P.shrimps can withstand salinity even up to 50 parts per thousand (ppt) (Patrick Sorgeloos 1994)\textsuperscript{28}. Deeper the "grow out" pond, higher the growth rate. (Jose R.Villalan 1993)\textsuperscript{29}.

Organic loading in the pond water will be more, when more quality feed is used. It is estimated that only 17 per cent of the feed supplied are harvested as shrimp meat. The rest is lost in the system in the form of uneaten feed by 15 per cent, excreta by 20 per cent and the energy lost for maintenance is 48 per cent (Wickings, 1985)\textsuperscript{30}. Further the rate of cannibalism decreases, as the feeding frequency increases and vice versa.
Stocking density is the main factor, which affects the growth and survival of shrimps.

**BIOLOGICAL**

To prevent diseases careful pond preparation, water quality and pond bottom management are essential (Boyd, 1989). Moreover, frequent water exchange and adequate food and feeding practices are essential for better growth and survival rate (Cacilia, 1986). Due to growing demand of shrimps vigorous operation without understanding the basic environmental factors is being undertaken, thus resulting in the outbreak of diseases to the shrimps (Rohana, 1994). It may also be added that, the main reason for the collapse of shrimp industry in Taiwan is due to the higher range of 50 - 100 post larvae/m² in the farms. However, the Indian shrimp industry is practising extensive and improved-extensive shrimp culture which are only 4 - 10 pl/m² (Alagarsamy, 1993).

The factors that are responsible for outbreak of diseases in shrimp culture either directly or indirectly include (i) high level of stocking density (ii) over use of antibiotics, (iii) over feeding (iv) low quality of seeds (v) use of polluted water and (vi) over use of ponds without proper reconditioning between the crops (Lin, 1989). It is advised for better survival rate and growth, that the stocking density should be within 6.4 - 7.1 pl/m² (Lazarus, 1988).
Culture shrimps which can tolerate fluctuation in salinity and accept artificial feeds, have high conversion ratio of feed, have high survival and good growth and high market value. To get the desired results, *p.indicus* is ideally suited for culture, during summer, since it can withstand higher salinity than *p.monodon* (Lacanilao, 1989). *p.monodon* also performs better under pond conditions in terms of higher weight gains, better FCR etc. (Massey 1994).

Moreover, seeds from the wild perform better when compared to those from the laboratory. (Daniel J. Miller, 1994). Smaller shrimps can withstand low DO (dissolved oxygen) better than large shrimps, because of their gill area to body volume ratio (Claude Alzieu-1990). Shrimps are stressed when DO falls below 2.0 mg/litre (Wickings-1985). Moreover, the DO content should not go below 3.5 mg/ltr in shrimp farms (Suseelan, 1978). Fresh water is more favourable for shrimps during their earlier stages while the brackish and saline water is conducive for its growth during the later stage (Gopalakrishnan, 1991). *p.monodon* can tolerate very low salinity up to 0 - 5 ppt. However, their growth is at the optimum, when the salinity is beyond 4 ppt. (Nivas, 1989). Shrimp growth is directly proportional to feeding frequency (Sweeney, 1989). Soyabean meal is poorly utilised by shrimps (Dean M. Akima, 1989). However, pellet feed is suitable for all culture species (Daniel J. Miller, 1994). Application of pelletised feed increases survival percentage with very quick growth rate (Apurba...
Ghosh, 1987)\(^{49}\), (Johnwood, 1990)\(^{50}\) and also pelletised feed enables better survival rate when compared with duff ball feeding (Ali, 1990)\(^{61}\).

**ENERGY**

Fish needs less energy than terrestrial birds and mammals because they are cold blooded. Hence, it expands less energy to maintain the body temperature in different environmental conditions (Gowey, 1980)\(^{53}\). In aquatic animals, feed conversion ratio (FCR) is the maximum, when compared to the land based warm-blooded animals (Durairaj, 1992)\(^{64}\). A successful shrimp feed should contain protein content of 45.10 per cent to 46.90 per cent and the energy level should be at least 350 kcal/100 grams. The diet containing 40 per cent of starch has recorded the highest growth (Ansuman, 1987)\(^{55}\).

According to one estimate, supplementary feed for shrimp would raise to about 33,000 tons in 1995 to 82,500 tons in the year 2000 A.D. (Johnwood, 1988)\(^{56}\). Tapioca functions as a good binder due to its qualities like good water stability, high calorific value and cheap cost when compared to other chemical binders (Syed Ahmed Ali, 1988)\(^{57}\). More than 50 per cent of the production cost for fishing shrimps in the high seas is spent on fuel whereas, the fuel cost in aquaculture is very low (Gordon, 1992)\(^{58}\).

**ENVIRONMENT**

Various problems encountered from the ecological perspective in aquaculture are due to unplanned and uncontrolled development, propelled by
greed and unlimited profit motives of a section of the aquaculture community who follow "Rape and Run" aquaculture (Gomes, 1992). The destruction of mangroves for aquaculture purposes, globally, is very less compared to that of some other purposes (Pillay, 1992). According to the Coastal Ocean Monitoring and Prediction Programmes (COMP) studies, aquaculture is not the only culprit for the coastal pollution. They identified forty hot spots along the Indian coasts all within five kilo metres during 1991-95 such pockets are situated mainly near industries and urban discharge areas. About thirteen billion liters per day of sewage and half a billion cubic metres of industrial water are discharged into the Indian sea. (Anonymous, 1995).

Mangrove areas contain potential acid sulfate soil, which will affect the aquaculture industry in a big way. Investing lots of fund and energy, which is not economically viable, can solve this problem. Hence aquaculture industry alone may not be the only culprit for the depletion of mangrove forest area. In reality, coastal aquaculture itself is the biggest looser (Cassavas, 1982).

Shrimps are usually abundant in areas where there is turbulence due to wind action. Hence, feed less in areas where there is less turbulence. Importing and introducing exotic species may bring genetic pollution and introduction of diseases. In the long run, inter-breeding may result in genetic diversity hence it should be avoided (Vergheese, 1995). Straw cleans the wastewater of aqua farms. (Anonymous, 1993). There are three methods
for treating the accumulated effluents in ponds which are physical, chemical and biological methods and among these biological methods of treatment is the best (Sunderrajan, 1993)\textsuperscript{65}.

Large-scale construction of shrimp farms in fresh water zones will affect the soil and the fresh water aquifers (Truong Trongnghia, 1994)\textsuperscript{66}. An alternate seed supply mechanism is urgently needed, since seeds collected from the wild are bound to deplete due to irrational collection practise (Lisac Durande, 1992)\textsuperscript{67}.

**ECONOMY**

Aquaculture is capital intensive and it generates less employment when compared to agriculture. Shrimp aquaculture provides less employment to labour than paddy cultivation, rendering more labour unemployed, due to conversion of agricultural lands into aqua farms thus creating social tensions (Ajan Datta, 1995)\textsuperscript{68}. India has abundant skilled work force, and such excessive skilled work force for shrimp production is probably not available any where in the world (James, 1993)\textsuperscript{69}.

Entrepreneurs lack knowledge and information about the economic values of other culturing species like mud crab, sea cucumber, sea weeds, edible oysters etc. owing to which they concentrate on shrimp culture (Ayyakkannu, 1993)\textsuperscript{70}. P.monodon constitutes 75 per cent of the total world
production of culture shrimps followed by p.chinesis and p.vannmai (Lumar). Shrimp aquaculture is more profitable than that of other industries.

Moreover in shrimp culture alone, investment could be recovered from the profits earned in a single year (Cassavas,1994)^71. Production cost for "captured shrimps" ranges from Rs.67/- to Rs.166/- per kilogram depending on the power of the "vessel", whereas for "cultured shrimps" it costs Rs.30 to Rs.120/- per kilogram according to the technique adopted (Vergheese,1995)^72.

India requires 800 hatcheries and fifty feed mills for its shrimp industry. The shrimp production in the country is considered cheaper, when compared to other countries. For example the production costs for one kilogram shrimp comes to one to two U.S dollars in India, while in Taiwan it costs four to five U.S dollars and seventeen to twenty U.S dollars in Japan respectively. The live weight production per kilogram of pigs, which is the cheapest among the land-based sources of animal protein comes to Re.1. On the contrary, the live weight production per kilogram of cultured shrimps comes to 53 paise for brackish water, 43 paise for fresh water and only 24 paise for marine aquaculture (Arignon,1982)^73.

Shrimp culture is capital intensive rather than labour intensive; which creates shrimp culture refugees. It is possible to raise 30,000 mt of fin-fish with an investment required to produce only 200 mt of shrimps. (Pillay,1992)^74. Integrated salt-shrimp farming is profitable which is
successfully proved in vinh-chan district of Vietnam. This can be implemented in the salt production areas of Thanjavur district such as Adiramappattinam and Vedaranyam. Rice-shrimp system provides higher net returns than rice monoculture. (Nguyen Quang Tuyen, 1994)\(^7\).

Shrimp industry can survive only by reducing the production costs per kilogram. (Hirsasawa, 1990)\(^7\). Aquaculture research should not only be production oriented but also be resource oriented and it should take into account the market, socio-economic feasibility and viability as well as adequacy of the target groups towards the future products (Hans Ackefors, 1979)\(^7\). The aquaculture growth rate in the country is 8.7 per cent per annum, when compared to poultry farms (2.5 per cent per annum) in spite of the fact that the shrimp industry lacks good quality seeds and feed. (Kothandaraman, 1994)\(^7\). The total cost of production per crop per hectare on an average is inversely related to the size of the farm (Usha Rani, 1993)\(^7\). Shrimp producing giants like Taiwan, Philippines, Thailand have come back to semi-intensive shrimp culture after their bitter experience with super-intensive, intensive shrimp culture, thus, producing 2.5 tons/ha/annum (Alagarsamy, 1993)\(^8\). Investment Rate of Return (IRR) is higher in semi-intensive than other culture systems (Wade L. Griffin, 1993)\(^8\). Intensive farming on a per kilogram basis is characterized by low fixed costs because of its high productivity per unit area, and at the same time, operational cost is very high. Further, it is profitable only if the market prices are favourable. On the other hand, intensive farming enjoys both relatively higher productivity (2 to
3 tons/ha) as well as scale down production costs (Lisa Durante, 1992). Intensive shrimp production technique is expensive both in terms of private and social costs. (Chong, 1992). Maximum economic returns were recorded in pools stocked at 15 to 45 pc/m² (Macintosh, 1992). The market for "ready to cook" shrimp products in recent years is increasing sharply (Hunter, 1992).

In the year of 1993 - 94 about 12,000 tons of shrimps (both cultured and captured) were exported from Tamil Nadu valued Rs.388 crores. More than 75 per cent of the export of marine products from Tamil Nadu value wise is contributed by a single item, namely, shrimps. The contribution of Tamil Nadu to the total export of marine products from India during 1994 - 95 is Rs.673 crores, (18.94 per cent) out of the total revenue of Rs.3,553 crores. (Shajizacharia, 1995). The Bio-economic aquaculture models mostly are based on maximising the private profits, and in future, it should also include the social planning (Padilla, 1994).

In order to boost the blue revolution, apart from providing financial assistance to the farmers, they should also be provided with modern technological inputs and technical assistance thus, ensuring the farmers greater share in the output. Further, the sources of an aquaculture industry depends on site selection, pond preparation, stocking, water management and finally timely harvest (Gordon Bilney, 1995). So far aquaculture development has been a technology lead and this has a very poor grounding.
in economic knowledge because this is relatively younger than the other industries (Neiland, 1994). The major hurdle in the production of quality shrimp feed in the country is the high import duty on the raw materials for the feed (Shaktivel, 1991). The Indian aquaculture can rise to the level of the Chinese aquaculture, provided the shrimp culture is undertaken through scientific aquaculture which includes seed production programmes, supply of better feed, along with the expansion of area of shrimp culture (Ratta, 1992).

In 1993-94, out of the total area of 82,500 ha of shrimp culture, the traditional system was practised in 53,360 ha (64.68 per cent) and extensive/semi-intensive was practised in the balance 29,140 ha (35.32 per cent), amounting to average all India production of 776 kg/ha. In Tamil Nadu, a good number of farms that is, 70 per cent are doing improved-extensive and semi-intensive. Further, Durairaj has given some points to sustain shrimp farming in harmony with environment. Sustainable culture practises should be adopted so as to have a ceiling on production, say, 3 - 4 tons/ha/crop in semi-intensive in the case of seawater based farms and not exceeding 2 tons/ha/crop in the case of creek based farms. (Durairaj, 1996).

**RISK MANAGEMENT IN AQUACULTURE**

Risk management is defined as "the identification, measurement and economic control of risks that threaten the assets and income of venture." Husbandry of the stock must remain the focal point of interest throughout.
However, any comprehensive study must examine management of the risks during harvesting, processing, packaging, shipping and marketing of stock. Knowledge of the comparative level of risk inherent in the business is also useful. On a scale of one to hundred, it might be said that we know 75 per cent of the biology of human beings, and perhaps we know 50 to 60 per cent of the biology of chickens, cows, pigs and other farm animals. But our knowledge of the aquatic creatures the farm ranges from a minimum of 20 per cent down to 5 per cent. We thus have a good indication of one of the industry prime risks - the biological one. Any attempt at uniform identification of risks across the industry encounters the problem of its enormous diversity, e.g; the hazards to trout in Denmark are substantially different from those in Italy. To further complicate the problem, there are differences in risk within the cycle of each species. But there are also similarities, with a surprising number of aspects of each type of rearing system common from one system to another. Moving water in a controlled way is very common in many systems; so, too are heating, filtering and sterilizing it. Although aquatic plants and creatures have widely different biological demands, they can still share common needs such as treatment of parasites, treatment with antibiotics, and common water temporizers.

Equally common to all aquacultural operations, regardless of species and their requirements, or even the systems involved, are the perils of the elements - of wind, wave, flood, drought, freezing, and so on. It is clear that, despite the diversity of the industry, techniques developed for the
management of any risk, while they may be related to a particular species or system may be directly transferable to another species or system. But the risks need to be identified. For convenience, the various types of risk can be grouped within two main categories - business risk and pure risk.

**Business Risks**

There is variation in consumers’ tastes and social resistance. It is probable that seafood can gain substantial ground in world food markets through aquaculture. It is equally probable that it can hold that ground. To do so, however, there will have to be considerable expansion of production and an increase in the area of the world’s marine and freshwater resources that are taken over for aquaculture. Such an expansion in production could possibly engender social resistance to the take-over by the industry.

**Economic risks**: Inflation, changes in the level of economic activity, the actions of competitors are considered economic risks.

**Marketing risks**: Errors in forecasting demand, and loss of markets to competitors are considered marketing risks.

The problem of forecasting demand is a subject for separate discussion, as is the loss of markets, which may arise for a substantial number of reasons. However, the high biological risk factor in aquaculture is very relevant to this heading. It is well recognized that, to compete in the market, the fish farm product must be able to harvest at the last moment, when a purchaser has been found. It is one of the advantages that aquaculture enjoys over traditional fish hunting. The potential for disease to
impede growth or to cause unbalanced growth, is quite substantial. Several sectors of aquaculture have already had to grapple with the problems of unsightly lesions, misshapen product, "muddy" taste, and poor shell-to-meat ratios.

**Production risks**: (changes in cost, problems in supply of raw materials and services, interruptions in production). Probably the major topics deserving discussion under this heading are, firstly, the supply of juveniles in a rapidly expanding industry, and secondly, the generally scarce resources of biological knowledge which are needed to ensure the success of each venture in the industry. Any business, which is founded in circumstances in which the supply of juveniles is very limited, must in effect bear the burden of the risks to the hatchery that supplies it. If the hatchery goes down and there is no other source of juveniles, then production facilities could lie idle for a long time. Production risks are also greatly increased in a situation where a high level of biological skill is needed but is not available. More often than not success can be traced to the quality of government back-up or to the availability of a skilled technical back-up provided by universities and other centers of excellence. Much waste in an industry can be eliminated if an active, knowledgeable source of risk management is available to it. Insurance is one of the most effective tools for handling risk. However, such are the production risks of aquaculture that the insurance industry is handling them with great difficulty. Some major production risks are virtually unanswerable. It is still a possibility that the insurance industry may in future withdraw from covering, or decline to cover a number of other risks of production.
**Political risks**: Nationalization, political unrest, and war, trade restriction etc are considered political risks.

**Financial risks**: changes in the availability or cost of credit, bad debts, etc. are considered financial risks. The availability of credit could become a problem for the industry. The early successes of the industry have engendered a formidable desire on the part of some banks to lend money on new aquacultural ventures. In many instances, these investments have been based on unsound business plans, formulated on unsound basic assumptions. Around the world, a number of projects have failed and lending institutions have lost substantial amount of money and more may well follow.

Risk management has a great deal to offer banks and other investors. But unless they embrace the concept of risk management and apply it to their investment considerations, they will go on investing in projects which stand no chance of success.

"**Business technical risks**": snags in new processes, lack of knowledge are considered technical risks. If we know twice as much of the biology of chickens, as we know of the biology of trout, it could be said the risks of growing trout are fundamentally twice as great as those of growing chickens. In fact, because of the "water" element in the trout business, the risks of growing them are even greater; supplying air to chickens is a lot easier than supplying water to trout. Since new processes and technologies are available for aquaculture; it is impossible to overemphasize the risks
associated with them. When combined with a general lack of biological knowledge, they can be debilitating to the aquacultural business venture.

**Pure Risks**

*Physical effects of nature*: windstorm, earthquake, drought, flood, etc. It is an old, thoroughly proven adage in the aquacultural insurance market that "if you want to find out the extremes of nature in a particular place, then put a fish farm there". At every stage of the production cycle, aquaculture has to manage the risks associated with water, and with all the physical effects of nature.

*Deviations from expected standards of social conduct*: Theft, fraud, riot, sabotage, malicious damage, etc.

Liability (hostile legal action from clients, employees, the public). It only needs one careless producer to sell one infected fish for the image of the industry in a whole country, or even wider afield, to be blackened. The liability exposure is small thing but consequent effect on markets could be devastating. It has happened in the canning industry and it could happen in aquaculture. Some area of liability to be watched is the liability of the vendor of fish which will transfer of diseases to the purchaser, to his site, and his other stock. (There is no such thing as "Disease Free" in aquaculture). There are other liabilities likes the liability for environmental damage by fish farms and the liability of system designers (and builders!) whose system does not come up to standards of performance promised.

"A certain proportion of risk to the aquaculture venture is site-related and therefore a prerequisite to measuring the risks in individual operations is a
large amount of information on each particular venture and on the site(s) it operates." That is a statement related to measuring risk at a very basic and isolated level. The risk exposures to individual sites can be intelligently estimated if an appropriate amount of information is available. There is a need to coordinate all kinds of risk-related information of which the following are general examples: The average and the extreme effects of various catastrophic and sub-catastrophic diseases. The average and extremes of various environmental factors such as droughts, hot cycles, cold cycles, floods, etc. The basic parameters for monitoring cages and crafts in the marine environment. The indication of plankton blooms, there make-up, the circumstances in which they occur, the extent of the area they cover, and the way in which they can be handled.

The list will prove to be a long one. But the compiling of risk management priorities in aquaculture urgently needs to be undertaken. Such a priority task deserves the immediate attention of the leading authorities in the industry.

ENVIRONMENTAL FRIENDLY AQUACULTURE:

Aquaculture practitioners and the general public (through advocacy) can take action for environment-friendly aquaculture. They should go for sustainable, low-input, high yield culture system and selective native species that feed low on the food chain. They also Plankton, Grass or detritus-feeders grow fast and breed naturally. They are also disease resistant. This eliminates the need for feeds and chemicals, such as fertilizers,
pesticides, antibiotics, and hormones. Exotic species, which may carry disease and pests or displace local populations, must not be formed unless they have gone through a strict quarantine. Proper seeds must be selected for aquaculture facilities to minimize the environmental impact. Thorough, honest socio-economic and ecological impact assessment should also be conducted before proceeding with the implementation. Facts like who benefits or profits and who loses interim jobs and income; how much land, energy, water, labour, and other resources are diverted from other uses; how the wastes will affect the surrounding community should be assessed. Proper pond/cage/tank preparation and management should be practiced and promoted.

Keep buffer strips of mangroves or other trees around the ponds to minimize erosion. Pond tillage that exposes acid soils if feeds must be used the appropriate kind and amount should be minimized, the clearing of mangrove forests, wetland, and other virgin areas for new ponds must be opposed. Mangroves or other trees along the dikes of pond should be replanted. Stream modification and massive ground water extraction for aquaculture must be opposed. They can cause soil salinisation, land subsidence and flooding. Keep fresh water fishponds weed-free and well stocked to control mosquitoes. Awareness of the water-borne diseases present in the locality and assess whether the establishment and operation of ponds significantly add to the risks of contraction of farming works, fish handles and consumers have become essential. Professional advice from public health workers is very essential. Ban on the production,
sale and use of antibiotics, hormones and pesticides in food production should be supported. Waste effluents from aquaculture facilities to prevent adverse effects on other water uses should be cleaned. Shrimp farms; set aside some filter pond to stocked with filter feeding mussels and nutrient-consuming seaweed must be cultured. Pond effluent should be let (with the excess feeds and other wastes) through the filter pond before disposal in to coastal waters. Since, antibiotics, pesticides and hormones can not be removed from effluents, do not use these chemicals.

SUSTAINABLE AQUACULTURAL DEVELOPMENT FOR INDIA

Sustainable Aquaculture Development (SAD) would be possible, provided the planning process is scientifically carried out, with due respects and regards to the ecological and social needs. It is understood that for SAD there is no short-term strategy. The planning has to be done on long term policies and appropriate targets, coastal aquaculture development in some regions of India possibly the main reasons for the negative impacts relate to improper site selection and poor designs. Pillay felt that atleast some of the fears are based on assumptions. Further he added, that in Thailand introducing "Contract Farming" has mitigated many of the situations which caused social unrest. He opined that such programmes might give positive results in India also. Pillay reiterated that the objective of aquaculture development should be to cater to both domestic markets and exports. It is to be stressed that profitable aquaculture is not confined to shrimp farming alone. There are several systems, which could be developed in our country
on industrial scale, using fin-fish, seaweed etc. both for exports and domestic markets. For example, Integrated Fish Farming Systems in fresh and brackish waters can be established on a high-profit basis, using environment-friendly technology. Having accepted the fact that land is generally a valuable and sometimes scarce resource, the multi-purpose use of the same for crop, animal and fish production will have to be achieved with proper planning and management. Land evaluation leads to possible farm systems criteria for production of crops, vegetables, livestock, poultry and fish. The feasibility of combinations of farming and animal husbandry practices involving fish and animal production; crops and fish; and crops, fish and animal production in order to achieve maximum sustainable benefits leads to successful integrated fish farming. Under conditions, available natural resources should be efficiently utilized and recycled in order to increase and maintain the overall production rate. In determining management principles of integrated fish farming systems, the technical efficiency of different farming combination and economic benefits need to be properly understood.

**Negative Impacts**

A casual review of media reports, seminar presentations, R&D findings and personal communications will reveal that adverse or negative impacts of shrimp farming, especially in West Bengal, Orissa, Andhra Pradesh and Tamil Nadu have reached a dangerously critical situation. In essence, the threats posed are under the following categories:
Villages have become floods prone due to establishment of aquaculture facilities in the coastal region. While this may be true of certain locations, the adverse impact cannot be generalised.

Land subsidence has occurred due to drawal of underground water for dilution in coastal shrimp ponds. This condition is possible in some areas, but again it cannot be considered as a general issue.

Cultivable lands are being converted to salt water shrimp farms, mainly as a result of the high prices and incentives offered to the landowners. The main reason in such conflicts is non-involvement of the community at the planning phase itself. In this connection it would be of interest to observe that surveys made in some of the coastal regions have indicated the saline nature of the soils now being claimed as cultivable areas.

Underground water in many villages become saline and/or get polluted by shrimp farm effluents. Such instances are factual, but need not be a general phenomenon.

Shrimp pond effluents discharged into surrounding water systems are reported to cause multifarious problems like salinity disturbances, destruction of spawning and nursery areas, physico-chemical contamination, biological degradation, increase in Biological Oxygen Demand (BOD) causing oxygen depletion in receiving waters, eutrophication, benthic overloading,
hypernutritification, etc. Some villagers in Tamil Nadu are reported to have complained bitterly about the occurrence of skin diseases among people living near shrimp farm discharge zones.

Conversion of land to shrimp farms is believed to be irreversible and also may lead to intrusion of salt water into drinking water sources.

Unregulated collection of wild shrimp seed from natural waters is reported to have reduced abundance of species in shrimp fisheries, habitat destruction for spawning and nursing grounds and wasteful destruction of other species of shrimps, other invertebrates and fin-fish.

Use of antibiotics in the shrimp ponds could lead to antibiotic resistant bacterial strains.

Although mangroves are protected areas under the Wildlife Act, several instances of aquaculture facilities established in such wet lands have been reported in recent years. The Pulicat Lake (in Tamil Nadu and Andhra Pradesh) appears to be a typical example of such negative impact on environment. Destruction of sanctuaries and fishing grounds has been reported in different states. Cultured shrimps are known to be targets for diseases. Imported shrimp seed and feed could have been responsible for the deadly shrimp diseases reported in Nellore Dist. (Andhra Pradesh).
The negative social impacts reported include loss of paddy fields and other cultivable areas, vocational problems caused by depletion of natural fishery resources, difficulties encountered in fishing operations due to aquaculture structures erected in coastal waters, community displacement caused by drinking water depletion, harmful effects suspected to be caused by shrimp farm effluents, lack / loss of employment opportunities etc.

How true these reported negative impacts are can be easily probed. As could be expected, most of the aquaculturists strongly oppose the reported seriousness of the negative impacts, while environmentalists and sections of communities are equally vehement in their protest against aquaculture development.

A balanced review of the situation will reveal that it is high time for the aquaculturists as well as the concerned authorities to realise that while the potential for aquaculture development in the coastal zone is indeed high, what is needed is a co-ordinated approach to ensure that only sustainable aquaculture projects should be allowed and developed in future. One of the major reasons for social opposition appears to be the lack of community interaction while planning major aquaculture projects. The general belief appears to be that the intensive fish farming potential has been overplayed to a dangerously critical stage. The above negative impacts of shrimp farming development had surfaced in many countries during the later half of nineteen eighties. The concern expressed on this by different affected countries led to a
meeting of the Food and Agriculture Organization of the United Nations in 1991, which discussed the situation in extend and arrived at a set of guidelines towards development of strategies, related mainly to:

Balanced plans for coastal aquaculture development and management establishment of Environmental Impact Assessment (EIA) programmes. Regulating and monitoring of aquaculture management methods. Treatment of aquaculture effluents and appreciation of the importance of assessing the carrying capacity of the surrounding ecosystem.

Establishment of appropriate regulations and enforcement for pond construction and management, mangrove protection and use of wet lands.

It is well known that intensification in land based systems has resulted in numerous socioeconomic conflicts in strategic situations. There is no second opinion to the fact that for aquaculture to be established as a sustainable industry in the country, public involvement is a must. To quote from an authority on this subject: "Aquaculture must be good for the investor as well as the community at large. Communities which accept aquaculture will allow it to succeed". It is believed that there is a good future for sustainable shrimp farming in the country, provided due consideration is given, without further delay, to proper planning with due concern for the environment as well as the community, enforcement of appropriate guidelines for pond management and allowing equitable use of coastal zones to the
benefit of all concerned. It is therefore suggested that urgent action may be taken towards enactment and implementation of rules and regulations for further growth and standardisation of the shrimp farming industry, taking into consideration the technical requirements, social harmony and ecology protection, for production of food and earning foreign exchange.
FOOTNOTES


