A STUDY ON THE ENVIRONMENTAL IMPACT OF AQUACULTURE INDUSTRIES ALONG THE COAST OF TAMILNADU

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1. INTRODUCTION

The aquaculture scenario in Tamil Nadu during the study period (April 1994 to Feb 1997) has witnessed several significant developments. The period from the end of 1995 is of special importance as the whole industry was caught in the web of endless legal and environmental issues rendering aquaculture very unpopular among the small scale entrepreneurs who initially perceived it as a boon and good alternative for their less yielding agriculture activity. However, this initial enthusiasm is now replaced by a sense of disappointment as both small farmers and large corporate houses which took up aquaculture has ran into heavy losses forcing them to suspend their culture operations either permanently or temporarily.

Tamil Nadu, with a coastline of 1000 kms and distributed in 9 coastal districts was one of the pioneering states in aquaculture and shrimp culture was started since 1989 onwards (Tab. 1 & 2). Tamil Nadu is the only state where nearly 56,000 ha has been identified as suitable for shrimp culture (Tab. 3). Shrimp farms sprang up in almost all the coastal districts. The aquaculture venture of Tamil Nadu is presently at crossroads due to severe setbacks suffered by disease outbreaks, environmental impact and large scale socio-economic problems and increased conflict with other coastal resource users. This final report tries to picturise the aquaculture scenario as it exists today in Tamil Nadu along with an analysis for the prospects for expansion and problems the industry is likely to face as it moves from the present state of infancy to a full pledged industry. An analysis of what should be done to revive the industry and make it environmentally robust and sustainable is also presented.

2. DEVELOPMENT OF SHRIMP FARMING IN INDIA

Co-practising of extensive shrimp farming and rice cultivation is in vogue in some part of our country like Kerala and West Bengal for a long time. This system is in harmony with nature and it met the demands of local community very well. Breeding of commercially important shrimps in laboratory condition was first achieved in Japan during 1957. Similarly, laboratory breeding of

commercially important fishes was demonstrated during 1960 in USA. These two incidents brought to light the feasibility of growing commercially important shrimps and fishes in a confined environment. Following this several attempts were made in US and Japan to culture marine organisms in artificial pond condition.

Successful culture of salmons and milk fish is in vogue in US and other European countries from the early 70s. However, shrimp culture as a profitable venture attracted our attention after several southeast Asian countries like Taiwan, China, Philippines, Thailand and Indonesia successfully demonstrated the economic viability of the venture. Some attempts were made as early as 1920 to culture some commercially important fishes in Tamil Nadu which were however not successful. For the next 50 years no serious attempts seem to have been made for the commercial culture of fishes or shrimps. During early 1970s, the state fisheries department renewed their interest in fish and shrimp culture and a total of 10 demonstration ponds were constructed during this period in all the coastal districts of Tamil Nadu which evoked some interest among the farmers. About 75 fish and shrimp farms varying in size from 0.3 to 10.5 ha were in operation in the coastal districts of Tamil Nadu during this period. Experimental cage culturing of shrimps to know the feasibility of this culture system was carried out initially at Muttukadu lagoon in Kovalam backwaters during early 1970s. Similarly, experimental pen culture of shrimp was carried out in Kovalam and Killai backwaters during 1982 under the auspices of Bay of Bengal Project (BOBP) which demonstrated the feasibility of this type of culture system the coastal waters of Tamil Nadu. Subsequently, the State Fisheries department increased the number of demonstration ponds in all the coastal belts to popularise shrimp culture in Tamil Nadu. However, fish and shrimp culture still remained unknown even among the coastal population. In the private sector an initial attempt was made by Tata Oil Mills Ltd., to start a shrimp farm at the bank of Pulicat lake with a water spread area of 14 ha which was aborted in the middle. Similarly, Spencers Ltd constructed a farm at Pitchavaram mangrove area early 1980s which was also failed to take off due to several reasons.

The enthusiasm shown by the government agencies, farmers and entrepreneurs was not matched by their interest in seed production through hatcheries which is vital for a flourishing culture activity. The slow pace of growth witnessed during early periods of shrimp culture industry is purely attributable to this lack of seed and feed availability. All the early farmers invariably relied on wild collected seeds for their culture operations which in turn led to low survival and production. It

was only in the late 1980s modern hatchery technique was employed in India for commercial breeding after being first developed in Japan, Taiwan, Philippines and Indonesia. In the VIth five year plan, Government of India announced plans to set up 150 ha under brackishwater farming and 50% of the capital cost of setting up of a prawn hatchery. Under this scheme a hatchery at Neelangarai near Madras was established with a production capacity of 16 million PL. Similarly with the subsidy and assistance of MPEDA, a pilot scale shrimp hatchery was started at San Thome near Madras during 1982 which showed encouraging results. Mass larval rearing of M.rosenbergii was achieved in 1975 at the Prawn Breeding Unit at Kakinada now under CIFA. Subsequently, CICFRI, Barrackpore, CIFE, Bombay and fisheries college, Cochin have bred Macrobrachium sp successfully.

Similar to the development of hatcheries, the status of shrimp feed production is totally poor and all the shrimp culture units depend on the imported seeds even now. There was not a single feed mill which produced quality seeds to cater to the needs of semi-intensive and intensive farmers and all the high quality feeds with expected Feed Conversion Ratio (FCR) is being imported. However, at present there are 4 feed mills in Tamil Nadu while one more is expected to commence production shortly. The feed mill of C.P feeds of Thailand, world's premier shrimp feed producers, is expected to commence production shortly which is likely to cut the feed cost by 40%.

The shrimp farming activity in Tamil Nadu gained momentum with the opening of Marine Products Export Development Agency's (MPEDA) regional centre at Pattukottai which was later shifted to Thanjavur. This regional centre is responsible for setting up and operation of first 50 shrimp farms in Tamil Nadu. Initial attempts during early 1980s by some corporate companies like Spensers Ltd., did not yield the expected success due to several reasons like non-availability of seeds and formulated feeds, lack of trained manpower, etc,. However, sustained efforts made by organisations like MPEDA, BFDA and CMFRI to supply seed and technology yielded results and several individuals and corporate companies took up shrimp culture as an industry from late 80s onwards. However, the sustained development and a vigorous dynamism exhibited by the industry lost its momentum because of three major reasons namely, 1. The legal issues, 2. Increased environmental activity and 3. recurrent and widespread disease outbreak in the last 2 years. Of all these things the disease outbreak has almost crippled the whole industry in Tamil Nadu which is yet to revive from its impact.

3. PROBLEMS AND POTENTIALS FOR AQUACULTURE IN TAMIL NADU

Among the maritime states of India, Tamil Nadu has several advantageous factors for aquaculture activities. A coastal stretch of 1000 kms with 52 estuaries, extensive backwater lagoons, luxuriant mangrove swamps and vast low lying brackishwater areas and a vast continental shelf that can be utilised for brackishwater farms presents various agro-climatic and environmental conditions for culturing different kinds of organisms which has not yet been fully recognised. Shrimp culture is actively pursued only in coastal districts such as Nagapatnam, Thanjavur and Puthukotai. Systematic collection of data on the availability of total land mass for inland and coastal shrimp culture is a major handicap in evaluating the true potential for aquaculture in Tamil Nadu. An estimated 56000 ha of land is available in the coastal belt for culture purposes (Ta. 3). However, even a rough perusal of available data clearly shows that the available potential is grossly under utilised. Out of 56,000 ha brackishwater identified as most suitable for coastal aquaculture, only 3017 ha is under use during 1996 which is less than 6% of the total land mass identified for culture. Considering the shallow inshore waters where pen and raft culture can be practised and the area available for freshwater culture in the interior regions, more than a lakh may be utilised for culture purposes. Culturing of other items like sea cucumbers, seaweeds, clams, mussels, lobsters and crabs, which are widely practised in other southeast Asian countries is yet to make a beginning in Tamil Nadu despite a conducive environment. With these vast resources Tamil Nadu has every potential to emerge as a major shrimp producing state in the country.

Salinity and temperature, which are the two major factors for aquaculture activities are most conducive in the coastal belts. With the prevailing monsoonal patterns, harvesting two crops of shrimp will be quite possible. Though the tidal amplitutide in most of the coastal belt is less than 1 metre, pumpfed culture system is quite practiceable. Several mariculture ventures which rely more on the renewable natural resources without harming them has got high potential for development in the regional as well as national context of India.

Among the developing countries per capita intake of meat and fish is lowest in India with 3.3 kg/year whereas in Japan it is 71.2 kg/year which is the highest. Tamil Nadu has a value of 5.91 kg/year which is quite low due to our poor cereal intake.

Though oceans are rich with protein source only 1% of the world's protein requirement is met by sea sources. Since the last one decade world's fishery production by capture has levelled off and increased per unit effort has not increased the production of shrimp and fish, the best alternative to meet the increased demand is farming of suitable species in controlled condition.

While other Southeast Asian countries which are less endowed in terms of landmass, manpower and materials are making rapid strides in the field of aquaculture we are lacking behind. Both the state and central Government is yet to come out with a clearcut policy and long term planning strategy to develop aquaculture in a proper way. China, realising the potential of aquaculture in the overall development of the country, came out with an aquaculture policy with a two pronged thrust on development of new production facilities and increasing the production per unit by adapting modern technology.

There are 442 marine fishing villages along the coast which supports an estimated 4,89,000 fishermen of whom nearly 50% are active fishermen while the rest are occasional in nature. Their production per unit effort is decreasing year after year, fetching them a very low income. Similarly, the rate of unemployment is also estimated to be highest among the agricultural labourers of the coastal villages who often resort to seasonal fishing activity to tide over the period of unemployment. Utilising this vast labour force in aquaculture activity will bring a dual benefit of employment and social upliftment of this poorer section of the society.

when the demand for marine based protein food is on the increase both in the developing and developed countries, the national fishery production has decreased to 2.2 million t during 1995 representing a fall of 3.9% than the previous year. While the possibility to augment production by wild catch is dismal and environmentally counter productive, there has been an increasing demand for fish food in the domestic and international market leading to tremendous pressure being exerted on other non conventional ways like aquaculture to augment production. While the annual demand for fish food in the domestic market is 10 million t, it is met with a supply of only 4.4 million t. This gap between supply and demand for fish in the domestic market is on the increase due to the fast changing dietary habits of people who are now more used to processed and tinned fish.

Likewise, the demand for frozen shrimp and fish is ever increasing in the global market. Simultaneously, the annual export of Indian marine products has also increased from 103552 t during 1989 to 301278 t during 1994 registering an annual growth rate of 58.2% (Fig. 1). Shrimp forms an important item in our marine product export. In the shrimp capture sector India is one of the leading country among the shrimp producing countries since 1973. The value of shrimps exported from India shows a study progress from Rs.165 millions in 1960 to 241.5 million in 1994. The contribution of cultured shrimp to this total marine product export is meagre but increasing steadyly (Fig. 2 a&b). While the demand for the shrimp in the global market is on the increase The shrimp production by capture fishery has levelled off and shows no sign of increasing. Aquaculturing of shrimp seems to be the only alternative to meet this increasing demand in the domestic and foreign market (Fig. 3) Like shrimp, aquaculturing of other important marine organisms like bivalves, seaweeds, crab and lobster fattening, cage culture of sea bass, sea bream, snappers and groupers has high commercial feasibility. Attempts to culture some of these species are in various stages of development. For culturing these marine species the premier research institutions have developed several economically viable small scale technological packages which can be easily adopted by the coastal communities. Some of the proven technologies that are readily available are 1. Pearl culture. 2. Mussel culture, 3. Shrimp culture 4. Shrimp brood stock bank 5. Shrimp backyard hatchery 6. Shrimp seed bank 7. Freshwater prawn backyard hatchery 8. Polyculture of shrimp with other combatable species such as seaweeds, clams, mussels, finfish 9. Cottage shrimp feed industry 10. crab and lobster fattening 11. seaweed culture, 12. raft and line culture of pearl oyster, 13. raft and line culture of mussel. The ICAR research institutions like CMFRI, CIBA and CIFE provide the expertise and MPEDA provides subsidy for setting up such small scale units to individual fishermen and fishermen co-operative societies. These items are in high demand in foreign market and the wild catch which now sustains the export of these items has already crossed the Maximum Sustainable Yield (MSY). Since the growth of shrimp culture industry has slowed down due to environmental, social and legal problems the need for diversification of culture techniques and co-culturing of other marine species like oysters, clams, mussels and sea weeds have arisen. Culturing of these species, besides reducing nutrient load in the effluent, also increase the financial returns. So, for a sustained growth of export and to meet the domestic needs in future and for environmentally sound culture practices, aquaculturing of these organism is the only option available.

Next to shrimp, crab is likely to be the best candidate species for culture purposes in Tamil Nadu due to its highest market potential on par with shrimp. Out of 16 species of commercial importance, 2 species of portunids Scylla serrata and S.tranquebarica have been identified as most suitable for culture. Considering their export and culture potential, attempts were made as early as 1970s. Though the results were encouraging it was not followed up. In the wake of increased shrimp disease incidents, more and more farmers of Tamil Nadu and Andhra Pradesh are turning their attention to crab culture. Recently a farm at Mallipatnam of NQM district (Royal Marines Ltd) is trying to culture crabs and sea cucumbers despite failure in the first attempt. Crab culture is poised for a major development in the years to come in our country.

The feasibility of commercial culture of spiny lobster has been demonstrated recently by Rahman et.al (1994). Like several other marine species lobsters are increasingly in demand in the world market and the wild catch is dwindling year after year. Raising and fattening lobsters in controlled conditions are being attempted in several of our research institutions. Recently there has been considerable success in aquaculturing of clawed lobsters (Homarus americanus).

Another potential area of aquaculture which has not received our attention is seaweeds. There are nearly 800 species of seaweeds in our seas whose culture and collection will be an enormous financial boon. They are a vast source of food, fodder, fertilizer and chemicals and are being used in an array of industrial processes. Although many developing and developed countries have been commercially culturing and exploiting seaweeds, this industry largely remains untapped in our country. Besides being a good candidate for export, co-culturing of sea weeds in the settlement ponds of shrimp culture facilities has been shown to be a reliable method to contain organic effluent load from the culture ponds and provide additional source of income. Several pioneering Southeast Asian countries are successfully adopting this system in their culture facilities to tackle the problem of environmental pollution. It is ironical that we are spending nearly Rs.3 billions on importing seaweed extracts for various industrial purposes. Comparing shrimp culturing, seaweed culturing is relatively easy with a short culture period of 45 days, less farm inputs, and pose very negligible environmental hazard.

Most of our marine products are exported to Japan, USA and West European countries with former two contributing about 47% and 12% of the total value. Of late, several Southeast countries

have emerged as our importers. Our major importers, Japan and USA optimistically will continue to import major marine products like shrimps, bivalves, oysters, crabs and lobsters for decades to come as commercial culturing of these organisms is unviable for them in terms of cost per unit production.

4. STATUS OF AQUACULTURE IN TAMILNADU

India has been in the forefront in marine products export which is mostly from capture fishery. Our marine products export has been growing steadily since last decade (Tab. 4). Penaeid shrimps accounted for 61.3% of the total average shrimp landings, occupying the third place among the national fish landing and ranking second in the world prawn landings during the period from 1981 to 1989 (Tab. 5). India has been one of the world's largest exporter of shrimp for more than a decade. Shrimps contribute substantially to our marine products export which accounts for 3.6-4.3% of the total national export from 1981 to 1995. During 1994-95 and 95-96 the overall production of cultured shrimps reached 82,850 tonnes and 70,573 tonnes. The share of shrimps in the marine products export was 66.3% and 67.74% during 1993 and 1994 (Tab. 6). The shrimp production by capture fishery shows a significant increasing trend in the years from 1984 to 1993 but it is stabilising of late.

As far Tamil Nadu, the penaeid and non-penaeid shrimp production by capture show an increasing trend (Fig. 4). In the item-wise export of marine products from Tamil Nadu, shrimps constitute a major portion during the year 1993-94 besides being an important contributor in the total fishery products export (Fig. 5).

In the culture sector, shrimp culture has been making a steady progress in production and area expansion till the end of 1995 and a decline could be observed in the subsequent years. From an area of hardly 3000 ha during 1986, it has grown to 1.3 lakh ha in 1997 (Tab. 7). Similarly, the shrimp production by culture has grown from a mere 2000 tonnes to 83000 tonnes in this ten years. About 60 companies and more than 2.5 lakh individual farmers are now engaged in shrimp farming in the coastal belt of our country. All the 9 maritime states are engaged in shrimp culture activities of varying intensity and production capacity (Tab. 7). West Bengal has the highest brackishwater area of 34,500 ha under culture which produced 25000 tonnes during 1994. This is followed by Kerala, Andhra Pradesh, Orissa and Tamil Nadu. During the years 1992 to 94 Andhra Pradesh and Tamil Nadu registered fastest growth of shrimp culture activity with record number of farms started. However, the momentum suffered a set back in both states. In Tamil Nadu the area under farming has come down from 3017 ha during 1995 to 1200 ha at the end of 1997 with a concomitant decline in production to a level of 640 tonnes. Recurrent disease outbreak and legal problems are the major reasons for the horizontal and vertical decline in

production.

Large scale outbreak of viral disease and its recurrence, observance of crop holidays in important shrimp culturing states including Tamil Nadu and Andhra Pradesh is attributed to the fall in cultured shrimp production by 20000 tonnes. In Tamil Nadu and Andhra Pradesh alone the production has lowered by 640 and 7000 tonnes during 1997, respectively, due to disease out break and Supreme court's ban. At the national level the production which was expected to reach 90000 tonnes fell to 70000 tonnes during 1997. All maritime states except Orissa suffered because of the disease outbreak. However, the production of cultured shrimp is expected to rise in the coming years.

In the national scenario, a total area of 1.3 million ha of landmass has been identified as suitable for coastal aquaculture of which only a little more than 1.3 lakh ha is under farming giving a measly figure of less than 6% of total landmass. West Bengal, Kerala, Andhra pradesh, Orissa, Tamil Nadu, and Maharashtra are the maritime states in which the potential for aquaculture has been identified as bright.

Coastal aquaculture registered a fastest growth rate in Tamil Nadu from 1989 to 1995 after which a decline in the growth rate could be observed. A total area of 56000 ha has been identified as most suitable for coastal aquaculture practices besides an additional 2 lakh ha brackishwater area suitable for aquaculture in numerous lagoons, mangrove swamps, and backwaters. With the sustained effort of Government agencies like MPEDA and BFDA of state Fisheries Dept and the initiative shown my some corporate business houses nearly 3000 ha have been brought under shrimp culture in coastal region alone within 7 years. However, this area under culture has reduced to 1200 ha at the beginning of 1996 producing only 640 tonnes of shrimps. From a meagre area of 176 ha in 1990 the area under culture has grown to 3000 ha during 1995. The first small quantity of cultured shrimp appeared in Tamil Nadu market towards the end of 1989. From then on production of cultured shrimp rose from 240 tonnes in 1990 to 3000 tonnes during 1994-95. However, during 1995-96 and 96-97 the cultured shrimp production came down to 1092 and 640 tonnes reapectively (Fig. 6). Disease outbreak, widespread socio-economic conflicts, perceived environmental concerns expressed by several groups, regulatory measures announced by Government, legal wrangles and the subsequent ban by the supreme court have all slowed down the growth rate of shrimp culture industry in Tamil Nadu during 1995-96. Of all these problems, large scale mortality of cultured shrimp due to a viral epidemic and

widespread opposition of local people to shrimp culture are the two major causes stifling this industry at its infancy. Sources at regional MPEDA and BFDA reveal that not a single application for registration has been received during the current year (1996-97) for new farms. Field studies have revealed that some few farms have been started and operated during this year in Adhirampatnam and Thondi regions of Nagapatnam and Ramnad districts.

The possibility and potential for aquaculture in Tamil Nadu was realised only after several of our neighbours made rapid stride in this line. The hatchery production of seeds which is imperative to aquaculture of any organism was initiated only in the late 1980s. In the initial period of shrimp culture all the culture facilities relied on wild collected seeds for stocking as the hatcheries were yet to come up. Serious attempts to produce seeds through hatcheries were made only from 1989 onwards. During 1993, a record number of new farms were started and the demand for seed went up to 4000 millions. However, only 20% of the demand was met by hatchery produced seeds and the rest from wild collection. In order to reduce the stress on wild stock, more shrimp hatcheries were started during 1993. As a result, the dependence on the wild seeds was reduced to atleast 30%. The year 1994 witnessed a record number of hatcheries started in private sector which met all the seed requirements. At present there are 50 hatcheries in Tamil Nadu which meet all the seed requirement of the culture industry. Ironically, the 1996-97 witnessed a scenario in which the seed production exceeds the demand as nearly 50% of the farms suspended operation due to disease outbreak.

While there has been considerable improvement in seed production which increased along with culture area expansion, it is not matched in the case of feed production. Right from the beginning, shrimp culture ventures were afflicted by chronic shortage of feed which in several instances led to suspension of operations. The early farmers prepared their own feeds which were often ill balanced and with low FCR. Several locally produced feeds are of low quality with poor Food Conversion Ratio (FCR) and water stability. This forced the farmers to resort to imported seeds at much higher cost which very much increase the total operative cost. It has been estimated that feed alone constitutes 40% of the operative cost in any culture operations. Towards the end of 1995 new feed mills have been started by some multinational companies to produce quality seeds and reduce dependency on imported feeds. Once quality feed production is indigenioused, the feed cost which is now around

Rs.50/kg will come down by 50% which will in turn reduce the total operative cost.

The contribution of Government agencies and NGOs like MPEDA, BFDA and Aquaculture Foundation of India (AFI) in popularising aquaculture and dispelling some misbelief about shrimp farming is commendable. The regional office of MPEDA at Thanjavur and the 5 BFDA offices are striving to develop aquaculture in their respective areas. BFDA has 10 demonstration farms in all the coastal districts to motivate farmers in shrimp culture. The following assistance are being rendered by them to develop aquaculture in Tamil Nadu.

1. Suitable site identification for aquaculture ventures.

2. Preparation of project report and recommendation for bank loan

3. A subsidy of upto 3 lakhs for recurring inputs and land reclamation

4. A subsidy of Rs.1 lakh for small scale hatchery and feedmill

5. Training programs for small scale farmers, fishermen and other backward coastal communities in culture techniques.

Modified extensive and Semi-intensive system with a stocking density of 5 to 15/ha is commonly practised by the majority of the farms of Tamil Nadu. The traditional extensive system of culture (pokkali of Kerala and the bherries of West Bengal) in paddy fields and natural enclosures practised in some maritime states like Kerala and west Bengal is totally absent in Tamil Nadu because of physical and topographical reasons. Almost all the farms are pumpfed due to less tidal amplitutide of Tamil Nadu coast. The farm size generally ranges from one ha upto 60 ha. Only very few corporate business houses own farms with water spread area of more than 25 ha. Small farmers with less than 2 ha generally practice only extensive/modified extensive system of culture with a stocking density of less than 10/sq.m. Big farms with water spread area of more than 10 ha usually go for higher stocking density because of the capital intensive nature of culture. However, some farmers practice extensive culture system in their earthen ponds by low stocking in the range of 2-

5/sq.m if their farm location warrants. The duration of culture is 120-130 days and generally 2 crops are raised in a year. Farmers generally avoid having stock during October to December due to inclement weather. Except sporadic experimental attempts, other types of culture systems like pen culture, rope culture, raft culture and sea ranching are almost negligible and nonexistent in Tamil Nadu. All the coastal districts of Tamil Nadu, except Kanyakumari dt. have shrimp farms of varying concentrations. Majority of shrimp farms are located in the districts of Nagai QM, Thanjavur, Pattukottai and V.O.Chidambaranar (Tab. 8)

Nearly 100 economic aquatic species are the subject of culture in Southeast Asian countries which include 50 species of fin fishes, 13 species of crustaceans, 13 species of mollusc and 5 species of vertebrates and a large number of seaweeds. Almost all of these species can be cultured in Tamil Nadu as the agro-climatic conditions are almost same. Despite this availability of a large number of candidate species for culture and the requisite natural conditions only 2 penaeid species namely Peneaus monodon and P.indicus are being cultured in our brackishwater. Of these 2 species, P.monodon is the most preferred species for culture because of its quick growth and high degree of tolerance to adverse environmental conditions. In Tamil Nadu 90% of the farming area is culturing P.monodon. P.indicus is preferred only next because of its limited growth. Except these two species which are predominantly cultured, aquaculturing of other crustaceans, bivalves, crabs, marine and freshwater fishes and seaweed is almost negligible and non-existent. Very recently some progressive entrepreneurs are attempting culture of the crab Scylla serrata and sea cucumbers in Andhra Pradesh and Tamil Nadu which is however yet to be taken up in a major way. Culturing of aquatic organisms with different utility values like human food (finfish, mollusc, and crustaceans) species with industrial application (seaweeds, pearls, window pane oysters) and species which are used as food organisms for culturing other organisms (phytoplankton, zooplankton, brine shrimp, etc.) have yet to attract our farmer's attention. However, there has been a growing awareness among farmers to diversify culture activity to other threshold species. Brighter prospects exist for increased culture activity of crabs, sea cucumbers, clams, oysters, lobsters, sea weeds and milk fish.

The shrimp culture industry of Tamil Nadu at present is passing through a difficult phase because of problems like 1. the recent apex court's order banning shrimp culture within CRZ, 2. the negative publicity that aquaculture ventures degrade coastal

environment. 3. Conflicts with other coastal resource users like fishermen and 3. increased socio economic tensions and has led to legal battles. Of all these problems, large scale disease outbreak and supreme court ban are factors which totally crippled shrimp culture activity during the last two years. Some salient features of the disease outbreak are described below:

In shrimp culture farms, disease outbreak takes place only when the cultured organisms are stressed beyond its tolerance. Stress results due to environmental factors like super saturation of gases, low dissolved oxygen, heavy organic built-up in the pond, sudden fluctuation of salinity, temperature and pH and other pond parameters. Hence, disease outbreak is attributable solely to 3 factors namely, the deteriorating environmental condition (pond water quality), presence of pathogen and a receptive host (Fig. 7). Enclosed water bodies of shrimp farms with its high organic load is an ideal site for proliferation of different aquatic pathogenic microbes. A qualitative and quantitative difference in terms of bacterial load has been established between effluent and influent water of shrimp farms (Beveridge, 1994). Though drugs are very often used to control these pathogens, efficient water quality management has been found to be the best method to control the disease.

The extensive, modified extensive and semi-intensive system of culture being practised by majority of farmers of Tamil Nadu is generally considered to be safe from the disease point of view because of its low stocking density and reduced organic load in the pond. Nevertheless, majority of shrimp farms in the study area are presently crippled by a viral epidemic of uncertain etiology. Monodon Baculo Virus (MBV) and Infectious Hypodermal and Haematopoietic Necrosis Virus (IHHNV) are the two viral pathogens largely responsible for the present outbreak. Unauthorised import of seeds from Taiwan and Thailand, where these pathogens are widespread, inadequate quarantine measures in our hatcheries and improper water management have been quoted as the reasons for the present epidemic. All the water bodies are reportedly contain viral and bacterial pathogens at a lower concentrations whose population proliferate only when their environment deteriorates by way of organic and nutrient enrichment.

In Tamil Nadu, disease outbreak was first reported towards the end of 1994. What appeared to be a minor incident turned out to be a disaster within few months, afflicting majority of the farms. The first symptom the infected cultured organisms exhibit is reduced feed intake followed by surfacing and swimming along the bunt edges. Zoothamnium sp and other ectoparasite protozoans

are abundant on the ventral abdominal segments and appendages. Administration of OTC and other antibiotics at the rate of 2-3 gms/Kg of feed do not generally yield any results. Mortality starts after five to seven days with 10 to 15 animals in each pond. within five days majority of the cultured animal in the pond die. Animals with an advanced stage of disease exhibited white spots and badges throughout the body which was diagnosed as Microsporidium sp - a protozoan. The hepatopancreas of diseased animals assumes a distinct colour presenting crystal like structures under microscope. Symptoms like cut antenna, maimed appendages, corroded uropod and empty guts are observed in all the diseased animals. In the initial days of outbreak, when the usual antibiotic treatment did not yield results, farmers frantically sought help from agencies like CMFRI, MPEDA, CIBA and fisheries colleges of Tuticorin and Mangalore. When it was learnt that nothing could be done to stop the onslaught, the whole infected stock was let loose into the water source though quarantine measures require it to be buried deep in a pit to contain further spread. As a result, the whole water body get contaminated, carrying the pathogens to other farms which are still healthy. Many farmers in their frenzy to save the crop resorted to overdosing the crop with antibodies and using several plant products like turmeric, garlic and neem leaves, etc. When all attempts failed, the pond was simply emptied by opening the sluice gates.

Today the disease outbreak is the singlemost factor next to legal ban curtailing further development of shrimp farming in Tamil Nadu. Nearly 90% of the farms, irrespective of their size and method of culture are hit and suspended culture operation after successive crop failure. The concept of disease management is yet to be fully learnt by our farmers as the viral epidemic still have a tight grip on the shrimp farms, forcing majority of the farms to suspend culture operations either permanently or temporarily. Several industrial houses which resorted to shrimp farming in a big way have incurred lose and are unable to decide the future of the industry.

Even in this chaotic scenario, stocks in some farms are still healthy. In the shrimp farms of Mallipatnam region of Ramnad district, stock are comparatively healthy without any disease symptoms. In some farms the initial symptoms and mortality ceased after 4 to 7 days after which the stock was healthy without any symptoms. Questioning of the farmers and a general study of the farm environment revealed the following factors might be the reasons for the healthy stock of this region:

1. Shrimp farmers of this area stopped water exchange more than 10 days when the epidemic was at its peak. This was done with the belief that the influent water was the pathogen carrier.

2. Most of the farms are located at considerable distances in between. Hence farm effluent get diluted very much.

3. The source water body experiences good tidal amplitude and the effluent water is flushed adequately.

4. The stocking density in most of the farms are moderate and never exceeds 10/sq.m.

5. Regular advice is being sought from experienced technical personnel regarding water quality management, feeding schedule and other farm related procedures.

The above said factors sums up the key to success to shrimp culture industry as a whole. Most of the farmers in the affected area resorted to heavy stocking density after the initial success in order to make quick profit. This very often leads to conditions conducive to disease outbreak. Farmers greediness to make quick money seems to be largely responsible for the present problem.

5. AQUACULTURE AND ENVIRONMENT

The future prospects of aquaculture in any country lies in striking a balance between exploitation and conservation of natural resources. Any food producing technology must have the wellbeing of the resource base as its priority which alone will make it sustainable. Like any other human ventures, food production, including agriculture has its environmental effects like occupation and fragmentation of natural habitats, threat to biodiversity and changes in soil, water and landscape which is very often irreversible beyond a limit. Though all these qualities can be attributable to agriculture which is being practised for thousands of year by mankind, there are some basic difference between the two which make agriculture more sustainable and less harmful to environment. Agriculture is waste consuming whereas aquaculture is waste producing. The aquatic medium is in direct contact with its biotic components whose metabolic processes and the quality and composition of water are controlling each other. The resource inputs and turnover is several fold greater in aquaculture. Unless practised carefully, aquaculture will jeopardise the very resource base on which it depends. In view of its recent origin, aquaculture has a far weaker technological base than agriculture. In view of all these factors, aquaculture is perceived to have some impact on the biotic, abiotic and social components of its surroundings.

All these factors point to the need to practice aquaculture cautiously. The need to develop aquaculture in a sustainable way and striking a balance between resource exploitation and Maximum Sustainable yield (MSY) is strongly felt presently if aquaculture is to be turned into an everlasting food producing system. This goal can be achieved only if the right type of system and technology to suit the local condition is adopted.

The extensive, modified extensive and semi-intensive system of culture, in view of its less hazards to the environment, was thought to be fit and safe right from the beginning for our environment. The expert committee constituted by the Tamil Nadu Government to suggest regulations to aquaculture industry during 1994 recommended only semi-intensive system of culture with the output of 3 to 4 t/ha as this system and stocking density is thought to be environmentally benign for our coastal conditions. However, the semi-intensive system as it is being practised to day has raised several questions on its environmental soundness because of some inherent drawback in practising the system.

These drawbacks are attributable to improper site selection, inappropriate stocking density not in tune with the carrying capacity of the water source, locating the farm too closely in few ideal sites, inadequate water management, erratic feeding regime and drug overdosing etc.

Commercial shrimp feeds of high nutritional value are used almost invariably by all shrimp farmers in Tamil Nadu. There is a tendency even among extensive shrimp farmers to go for imported high energy feeds to get a better FCR which increase the operational cost so much. It has been estimated that 15% of the total feed input is leeched unconsumed to the sediment; 20.3% is egested as faeces; 48% covers the metabolic expenditure and only 16.7% is converted into harvestable body tissue (Primavera, 1993; Tab. 9). Given the kind of feed management being practised in the farms of Tamil Nadu, the percentage of feed being wasted to the water source appears to be higher. Several small farmers chart out their own feeding regime which very often leads to overfeeding. Analysis of samples collected from the outlet points of the shrimp farms in 5 stations revealed that the level of different parameters were found to be fairly higher (Tab.10 a&b). However, interpreting the impact of these effluents will not give clear picture in the absence of other relevant information about the receiving waterbody

An estimated 5000 mt of shrimps out of nearly 2000 ha of brackish water area was produced during 1993-94 in Tamil Nadu (Sakthivel, 1994). Assuming an FCR of 1.6 to 2, a total of 8000 to 10000 mt of formulated feed was consumed in a single year alone. Assuming that 15% of it was wasted as unconsumed feed and another 20.3% is egested as faecal matter, thousands of tonnes of organic waste should have reached the coastal waters in the last six years alone which witnessed an intense shrimp farming in Tamil Nadu. Since shrimp farms are generally located in close proximity in areas perceived to be ideal, organic loading in such selected area might be more than the assimilative ability of that particular water body. Similarly, organic loading in the pond itself is reported be very higher, polluting the culture ponds as well (NEERI, 1993). Organic matter level in the intensive Peneaus monodon ponds was reported to be more than 30% (Pascual & Corre, 1991). This estimation may be applicable as well to all semi-intensive ponds of the study area due to erratic feeding. Beveridge et.al (1994) estimates that 300 to 1000 Kg of solid waste are produced for every tonne of cultured organism much of which are organic in nature. According to Central pollution Control Board, the effluent generation from aquafarms from east coast alone is 2.37 Million Cubic Meters (MCM) per day. Out of these Andhra pradesh has a lions share of

2.12 MCM.

The Alagarswami report on the basis of which the supreme order banning shrimp culture within CRZ was given identifies salination of land and drinking water wells, obstruction of natural drainage of flood water and access to the sea by fishermen, pollution of source water, destruction of mangroves and land subsidence, pressure on wild seed resources and consequences thereof as environmental issues involved in coastal shrimp farming.

In several farms of Tamil Nadu, the feeding schedule being followed grossly overfeed the stock much of which ultimately reaches the source water body. The availability of natural nutrients and planktonic food resources for cultured shrimp are usually not being taken into account in semi-intensive systems by our farmers which further adds up to the organic load of the effluent water. Removing this shortcoming in feed management alone will drastically reduce the variable (operational) cost of each culture, besides greatly reducing the organic load in the effluent water.

The impact of organic matter effluent from the shrimp farms on the coastal waters is widely discussed (Pascual and Core, 1991). Impact of organic matter on the ecosystem of the receiving water body is controlled by several factors like prevailing water velocity, depth and its rate of exchange with the open sea etc,. Similarly, the type of organism being cultured, stocking density, culture system management, feed type, health of stock and rate of water exchange are also equally important in determining the impact of effluent on the receiving water body. The ecosystem of any receiving water body is stressed once its assimilative ability is exceeded which is defined as the capacity for oxygenic degradation of organic matter at the bottom of the system (Omori et.al. 1994). The first and foremost effect of this overloading of organic matter is the depletion of dissolved O^2 due to the decomposition of organic matter by aerobic bacteria. Further addition of organic matter leads to an anaerobic condition in a radius of up to 100 metres from the discharge points. This azoic area is characterised by lack of diversity of macrobenthos but high number of opportunistic, pollutant tolerant polychaetes like Capitella sp. predominate. The end result is simplification of aquatic food webs and a reduction in the efficiency of nutrient and energy cycling (Beveridge et.al. 1994). Though no conclusive studies showing the prevalence of azoic condition in the aquacultural belt of Tamil Nadu has been conducted, the possibility of its occurrence exists if shrimp farm developments are not streamlined

immediately.

By far, site selection and location of an aquafarm mostly decides its environmental soundness. In Tamil Nadu, until recently site selection for aquafarm location is done in an arbitrary way giving little consideration for technical and environmental details. Typically, small and medium farmers acquire land and establish their culture area independently without giving due thought to the units operating nearby their site. This very often leads to overcrowding and stressing the whole water source paving way to environmental degradation. Establishment of shrimp farms, until recently, has not been overseen by any environmental assessment and developmental plan on the part of Govt agencies. The apex court's ruling all the shrimp farms should be located only beyond 500 mts is yet to be seriously followed by majority of farms as final judgement is awaited for the demolition of farms within the stipulated 500 mts marks. Though Tamil Nadu state Government regulation stipulates a maximum distance of 200 mts between adjacent farms how this can be uniformly adopted to all the farms without considering other environmental factors is not known. Without exception the critical point of carrying or assimilative ability of the water source is overlooked which results in the collapse of the all the farms in that area in the event of a disease outbreak.

All the aquaculture ventures as it is practised today requires inputs of nutrients and feeds and high rate of water exchange averaging about 10 to 40% of the pond volume depending upon the period and system of culture. The dissolved nutrients, organic solids and chemicals in the effluent water may lead to large scale deterioration of water quality if the dilution is inadequate. Similarly, large scale discharges of waste following harvest and pond preparation for the next culture also yields enormous amount of organic matter which is released into the water supply systems shared by many adjacent farms. This situation assumes a serious proportion when the water source is an estuary or backwater or brackish water whose rate of water exchange with the sea is limited. As more and more farmers crowd the nearshore area the farmers upstream get only relatively less purer water. Because of the indiscriminate release by each farmer in the nearshore water, and development of farms in upper reaches where tidal flushout is not adequate to effectively dilute effluent, farms very often pump in water with a heavy load of organic matter. This impure water very much lower the pond productivity and paves way to disease outbreak. Once the disease outbreaks, it can spread to the adjacent ponds and other farms of that area very quickly. This scenario is a common sight

in several areas of Tamil nadu coastal belt.

Currently, no shrimp farm in Tamil Nadu has water treatment systems and the effluent water is drained directly into the back water or into the sea. This very often leads to pumping in of polluted water by the adjacent farms. Even in farms located in open coast like Poompuhar and Tranquebar, the inlet and outlet points of adjacent farms do not exceed 200 meters. There is every possibility that the outlet waters of a farm reaches another farm before being diluted adequately.

Next to organic matter, the farm effluent are characterised by metabolic wastes and nutrients like ammonia, nitrite, nitrate phosphate and its oxidative products. Nitrate and nitrite are toxic to a wide range of aquatic organisms like fishes, crustaceans and mollusc. Ammonia, in an unionised condition is highly toxic to aquatic organisms (Colt and Armstrong, 1981). Cultured shrimps excrete metabolic nitrogen only in the form of ammonia. Urea, uric acid and other minor products are also excreted in varying amounts (Claybrook, 1983). The rate of ammonia excretion has been observed to decrease with increasing body weight in P.monodon and P.semisulcatus (Mohanty et.al.1989; Wajsbrot et.al 1989). A P.monodon with a size range of 62 to 72 gms was observed to release 21.975 +/- 3.045 mg/day of total ammonia. So, a one ha pond with a semi-intensive stocking density of 7/sq.m will release total ammonia to the tune of 13.251 to 17.514 kg/day. Calculating it to the total area of 3000 ha in Tamilnadu coast will give a figure of 26.502 to 35.028 tonnes of total ammonia per day at the final days of culture. Nutrients like nitrite, nitrate and phosphate are also added whose impact will largely depend on the assimilative ability of the receiving water body.

A study conducted by NEERI (1992) shows that biotic characteristics of bottom waters like suspended solids, BOD, ammonia and sulphide are more in extensive ponds followed by modified extensive and semi-intensive ponds. Conversely, in the bottom sediments, concentration of organic carbon, sulphate, total phosphate and total nitrogen were more in semi-intensive ponds followed by modified extensive and extensive type of ponds (NEERI/MPEDA 1992). while semi-intensive ponds will continue to release low dosage of pollutants on the a daily basis, harvesting will release a sudden load of pollutants in both the systems in the receiving water body.

In marine environment, where the volume of water is great, there is little evidence that this addition of nutrients leads to hypernutrification. However,it is opined that intensive

aquaculture operations can make significant contribution to the coastal nutrient levels (Folke et.al 1993). Similarly, there are increasing amount of evidences which circumstantially link aquaculture effluent and redtide (Smayda, 1989; Corrales and Gomaz, 1990; Maclean, 1993; Hallegraeff, 1992, 1993). This continued addition of nutrients will bring about changes in the nutrient cycling and concomitant impact on the macro and micro benthos in the area of deposition if the assimilative ability of the receiving water body is exceeded. In the coastal waters of Tamil Nadu, no study conclusively establish the occurrence of eutrophication due to aquaculture borne nutrients.

As far Tamil Nadu, it is the intensity of culture that lies at the root cause of all maladies. Farmers in Tamil Nadu until the large scale outbreak of disease were producing 5 to 6 tonnes per ha while the recommended yield was 1.5 to 2 tonnes per ha. This greed to produce more implies more seed, feed and naturally more pollution,

Drugs and Chemicals

Application of drugs and chemicals are inevitable in any aquacultural operation. These are used both as a therapeutic and prophylactic measure. During the initial days of disease outbreak, a large quantities of drugs and chemicals have been used in the farms though the causative microbe for the disease was largely unknown (Tab. 11). Oxytetracycline (OTC) of veterinary grade is the antibiotic very widely used by the shrimp farmers of Tamil Nadu to treat a wide range of microbial diseases. This drug is used both as therapeutant and prophylactic. All the farmers and farm managers interviewed for this study stated that a constant level of 2 to 3 gms/kg of feed is administered whenever the need arises. When disease outbreak and mass mortality of stock was first reported towards the end of 1994, all the farmers, even when their stock do not show any sign of disease, blindly resorted to large scale antibiotic treatment without any expert advice. Farmers whose stock was still healthy overdosed their stock with OTC even after the disease was suspected to be viral against which OTC is ineffective. Following the disease outbreak during late 1994 and its regular recurrence since then addition of drugs along with the feed has become a regular feature in several farms.

Beside Oxytetracycline, other chemicals like chloramphenicol, Malachite green, copper sulphate, formalin, Benzalgonium chloride, Iodine and Potassium permanganate are also used against a wide range of fungal, protozoan and bacterial infections. The common piscicide very frequently used is tea

seed cake which contain saponin. Besides this, a wide range of products like immune boosters, growth stimulants, appetizers and probiotics have appeared in the market whose efficacy and safety is doubtful. Small farmers fell easy pray to the tall claims made by such manufacturers whose fallacy is realised only after considerable damage has been done to the stock and environment.

The Government agencies are yet come up with clear guidelines for the application of different chemicals and drugs which are being used in shrimp farms without any experimental test under local conditions. In the absence of such regulatory mechanisms, shrimp farmers are left to follow any procedure developed for culture conditions in foreign waters which may not be appropriate for our environment. This very often leads to unethical and indiscriminate usage of drugs with counter productive results. All the southeast Asian countries which actively pursue aquaculture impose several regulations for aquacultural applications of drugs whereas Indian farmers use any drug available in the market. Registration oriented research on drugs and other chemical compounds is urgently needed (Meyer, 1989). Similarly, an inventory of drugs and chemicals being used in our aquacultural facilities has to be prepared as a first step to regulate their usage.

A major portion of drugs and chemicals used in shrimp farms ultimately reach the water source (Beveridge, 1994). These drugs may reach the environment directly by leeching from the unconsumed feed or pass through the body unabsorbed and excreted in the faeces. In the case of OTC, a drug predominantly used by the farmers of Tamil Nadu, only 20 to 30% is effectively taken by the cultured organisms and the remaining 70 to 80% reaches to the environment and persist in the sediment for a longer time (Jacobson and Berglind, 1988; Samuelson, 1989). High levels of drugs such as oxolinic acid have been detected in wild fish, crabs and mussels up to several hundred meters distance from a salmon farm several months after its usage (IOE, 1992). Many antibiotics and drugs are known to be highly toxic to several organisms even after much degradation. Heavy use of antibiotics can cause qualitative and quantitative changes in sediment flora, fauna and microbes and the process responsible for waste metabolism is very much inhibited. Many of the products newly introduced to the Indian shrimp culture are reportedly highly lethal to several non-target organisms. The philippine hatcheries and grow-out ponds using the same products have experienced mortalities and morphological deformities in their stock (Primavera, 1994). Similarly, heavy use of tea seed cake as a pisicide have resulted in mass mortalities of wild fish in natural water when the pond water is drained immediately after

its application.

Development of resistance seems to be the most critical problems associated with the investigated effects of antibacterial agents in fish farm sediments (Aoki et.al., 1981; 1987; Hansen et.al. 1992). The main reason attributed to the total collapse of shrimp culture industry in Taiwan during 1988 was the indiscriminate use of antibiotics which led to development of resistance among the microbial pathogens. The rampant use of antibiotics in hatcheries has led to high prevalence of infectious diseases in our hatcheries. This explains the widely held belief among our shrimp farmers that wild caught seeds are more healthier and sturdier than the hatchery reared one. The possibility of all major aquatic pathogens becoming resistant to oxytetracycline, an antibiotic which is widely used in the farms of Tamil Nadu and Andhra Pradesh can not be ruled out completely. Several workers have suggested banning of chloramphenicol and oxytetracycline because of possible plasmid mediated transfer of resistance to human pathogens (Baticades and Paclibore, 1992). The US FDA enforces total ban on Chloramphenicol and restricts experimental drugs which pose danger to human safety (Battitch, 1990). In Philippines registration of aquaculture drugs needs technical review of scientific literature to demonstrate its safety, efficacy, potency and therapeutic value (Baticolas and Paclibare, 1992). Formulation of such regulations even while the industry is at its infancy in our country will definitely go a long way from an environmental point of view.

Judged from the shrimp farmers behaviour, it is almost impossible to avoid drugs both prophylactically and therapeutically in our country. But farmers can be made aware of the dangers in using drugs indiscriminately. In most of the instances, use of antibiotics is surplus as imported feeds, which are generally preferred and used, are adulterated with antibiotics adding up to the drug load ultimately reaching the water column. To regulate the usage, accurate diagnosis of the disease and usage of right type of drugs for a minimum period of time is essential. The farmers should be made aware that the residues of drugs and chemicals will backfire and cripple the whole industry if misused. All the Asian countries practising aquaculture have experienced negative outcome of mismanaging the drugs.

The foregone discussion points out some of the serious lapses in our aquacultural practises which may have some impact on the environment. The whole concept of aquaculture, as it is practised today in our country needs to be re-examined and

streamlined to make it environmentally sustainable. Resource utilisation and environmental concerns arising out of aquaculture should be a central theme in all the decision making process of aquaculture. If aquaculture in our country is to survive it will have to make adequate room for environmental sustainability and other users of resources. In all the past ventures profit has been the motivating factor with little thought given to the long term benefits of natural resources. With few exceptions, most of the investors in shrimp culture do not intend to stay in the profession for a long period and they quit the trade as soon as their goal of profit is achieved or the production declines. In this context, the environmental disaster faced by countries like Taiwan, China and Thailand is a worthy lessen to learn. The wrong priority on economic benefit of shrimp culture at the cost of environmental destruction and social equity has had a disastrous consequence in this countries. Continued development of intensive shrimp farms in Thailand in mangroves, wetland and in the coastal regions of commercially important breeding grounds has led to the total destruction of the coastal environment besides rendering the culture facilities useless. This can best be avoided in our country by incorporating the environmental damage and loss in the cost benefit analysis of aquaculture.

A recent study conducted by NEERI clearly states that the aquaculture ventures as practised today in our country is environmentally highly incompatible and the cost of ecological and social damage far exceeds the benefits that come from coastal aquaculture activity. In Tamil Nadu, the damage has been quantified as 480 crores against an annual income of 280 crores. Very often the environmental and social cost of the aquaculture venture is not an integral part giving a false picture of benefit.

It is also to be noted that the impact of aquaculture borne effluent on the coastal environment has not been quantified in real terms even in countries where aquaculture is being practised for decades. It is often difficult to determine the impact of aquaculture in isolation as the observed consequences are in many cases the cumulative effect of several factors that disturb its natural state (Pillay, 1992). Available data seem to indicate that the pollutive effects of aquaculture are comparatively small and highly localised. Hakanson et.al.(1988) have compared the Nitrogen and Phosphorus loads from different sources including aquaculture in Denmark. Of the total quantity of 150,000 tonnes of Nitrogen, sea farms contributed only 0.2% (Fig. 8). This is in a country where intensive aquaculture is being practised for decades. Similarly, Leffertstra (1988)

pointed out that fish farming industry in the north sea does not contribute significantly to its nutrient loading despite some localised effect. Pillay (1992) opines that the environmental impact of aquacultural ventures could be determined only if the background concentrations of nutrients in the receiving water, as well as the emission of nutrients from the farm per unit time and the retention time of water in a given area. Only a holistic look integrating all these factors will decide whether aquaculture ventures in a given area is polluting that ecosystem or not.

Eco-friendly Aquaculture

There has been an increasing tendency among the policy makers and some environmentalists to dismiss aquaculture as totally destructive to the coastal environment. The development of an aquatic resource based industry which in terms of volume, resource base and employment potentials can be compared with any land based industry needs to be scrutinised with all care to find out the maladies afflicting it. The allegations levelled by environmentalists on shrimp farming of Tamil Nadu and for India do not made the industry deserve an outright condemnation.

Aquaculture like agriculture is a food production system with a natural resource base though it is quiet recent in origin in our country. This relatively nascent nature makes it practitioners to commit mistakes which can be corrected through discussions and proper planning. As the industry develops, proper technologies that is eco friendly and suit the local conditions will be developed and deployed with the help of authorities. Any industry in its nascent stage is likely to undergo recessions and drawbacks which should not dissuade one from abandoning the whole venture.

The problems like disease outbreak, legal wrangles and increased environmental problems can be best sorted out by developing new technologies and need based research which will definitely relieve the industry from its present predicament.

The negative impacts of uncontrolled shrimp culture on the environment was realised only after several Southeast Asian countries experienced severe environmental degradation due to wrong priorities and high targets. Despite this severe environmental impacts these southeast Asian countries like China, Taiwan, and Thailand did not stop shrimp farming but made adequate amendments in their priorities to make this booming industry an environmentally sustainable one. In Thailand, collapse and abandonment took place mainly because of greed and

lack of knowledge. However, the trend was reversed with proper guidance and governmental effort resulting in the highlest production rate of 2,50,000 tonnes during 95-96.

Comparing the culture system and methodologies being adopted in our country one should concede that our production targets are far lower than several southeast Asian countries causing probably less environmental impact though all can not be termed well with our culture system and methodologies. All the more, it points out that the development of an ecofriendly, healthy and environmentally sustainable culture system is possible and much necessary. A prospective industry with plenty of scope and potential for export and alleviating the protein needs of the country should not perish due to our lack of foresight and understanding.

Problems like salt intrusion and salivation of groundwater seem to have been raised without any scientific basis and study. Any coastal environment is bound to be subjected to salt water intrusion whose intensity is governed by several geological factors. The salt intrusion caused by shrimp culture may not be higher than those caused by industries like salt panning as well as in areas where the salinity levels are generally higher. Shrimp culture is as much a natural industry as salt. However, the methodologies and culture practices like intensity of culture and stocking density is selected so as to cause least impact on the environment. This approach is totally lacking in with our farmers. Consideration of such viable culture techniques is quite worthy to pay attention when a huge investment, employment potential and foreign exchange earnings are at stake.

The aquaculture activity in our country in view of its nascence does not permit us to much experience to develop a totally eco friendly shrimp culture. Despite this shortcoming it could be achieved with the available vast technical and scientific manpower. The vast experience gained by several southeast Asian countries are worthy to emulate and adopt with modification to our local context. For attaining the goal of ecofriendly aquaculture what is needed is understanding and will of our people to make the aquaculture sustainable venture.

6.AQUACULTURE AND COMMUNITY: SOCIO-ECONOMIC IMPLICATIONS

Within a span of 8 years, coastal shrimp farming elicited large scale and widespread public opposition from the coastal belts of Tamil Nadu where it is being pursued actively. Development of shrimp culture activities in the coastal belts was welcomed initially by local populations because it was thought to increase the job opportunities and income. However, within a short span of time the local mass turned hostile to all shrimp farming activity largely because of negative propaganda by some over enthusiastic environmental organisations. What was initially sporadic clashes turned into a mass movement with two organisations like Land for Tillers Freedom (LAFTI) and Campaign Against Shrimp Industry (CASI) taking up and spearheading campaigns against shrimp farms. Though several of the land based industries are equally damaging, coastal aquaculture impact on the environment is strongly perceived by the coastal community due to the increased environmental awareness in recent years and its immediate exposure to the local population. In Tamil Nadu shrimp culture is very active in the districts such as Nagapatnam, Thanjavur and Tuticorin with more than 50% of the farms located in the Nagapatnam District (Tab. 8). So the opposition for shrimp culture industry was strong in these districts.

Numerous instances of clashes between shrimp farmers and local population have been witnessed in the last 3 years. During 1994 the Perunthottam and Pudukuppam villagers of Sirkali Taluk of the same district threatened to capture all the shrimp farms within 3 weeks if they do not stop their culture operation. Village committee in 24 panchayats in the coastal region had been formed to ensure that no shrimp farm come up in their coastal belt. Myladuthurai, the Aquaculture headquarters of Tamil Nadu became a hot spot with many anti-shrimp culture agitations and rallys. The participants in the demonstration and rally organised by the movement LAFTI on May, 1 1995 in Myladuthurai where arrested which underlined the gravity of opposition.

The shrimp culture lobby also tried to show their opposition by way of posters and demonstrations. All major and shrimp farming unit arranged for the private security of their farm. Frequent clashes between these two groups developed into a law and order issue for the district authorities.

As per the contention of anti-aquaculture group, the negative socio- economic impact of shrimp farming is mainly due to the following factors:

1. Shrimp culture does not mean to feed the local protein starved mass. Instead, it is meant for export and to feed westerners at the cost of local populations

2. It destroys the fishing grounds of inshore water by releasing effluent and by collection of wild seeds. This has a negative impact on fishermen who solely rely on sea for their livelihood. It also impedes the free movement of fishing vessels by partially denying access to the coast.

3. The agricultural lands and domestic wells are salinised and coastal aquaculture produces an acute shortage of drinking water in coastal villages.

4. It generates more unemployment by rendering the agricultural labourers jobless. Several families are forced to migrate to cities in search of livelihood.

5. The present practice of shrimp culture is capital intensive and the income generated is cornered by outsiders. While the local resources are utilized by outsiders much to the detriment of local community, it gets only a negligible share of income generated.

6. The socio-cultural aspect of the local community is disturbed by the outsiders frequent visit.

On the basis of the aforesaid factors, the anti aquaculture lobbyists preferred a PIL (Public Interest Litigation) in the supreme court which in turn asked the National Environmental Engineering Research Institute (NEERI) on March 27, 1995 to assess the socio-economic impact of shrimp farming in the maritime states of India. On the basis of several technical reports from NEERI and Dr.Alagarswami, supreme court after several stay finally imposed a ban on the establishment of any coastal shrimp culture venture in coastal regulation zone (CRZ). This, coupled with the widespread occurrence of disease and opposition from several environmentalists groups have to the present lean period in shrimp culture activity in Tamil Nadu. Though some allegations of this anti-aquaculture lobbyists are true, several of them appear to be baseless and exaggerated. Only a careful analysis of pros and cons will give an unbiased picture.

When shrimp farming was taken up in late 80s, there was much demand for land in the coastal belt and land price shot up several folds. One acre of land which cost less than ten thousand in 1990 shot up to 1 lakh in 1993. Over and above the barren and fallow lands, small farmers came forward to sell their cultivable lands when they felt the price was very attractive. This initial euphoria was replaced by frustrations and disgust when these land values increased enormously and fetched money in lakhs as a shrimp farm in an outsiders hand. Several small scale farmers demanded their land back which led to violence and unrest.

A common phenomenon observed in the shrimp culture activity of Tamil Nadu is the social and financial background of people who start shrimp farming. In majority of the cases it is the urban elites, industrial tycoons with vast and different business interest and considerable political clout who own farms which are more than 10 ha in all the coastal belts. When the high returns of shrimp culture was realised by these business groups during 1989 they went on a land buying spree and monopolised all the available lands suitable for shrimp culture. Since their motive was to gain maximum profit within a short time span, factors like environmental sustainability and acceptance of local mass as their partners in their activity was thrown to winds. When it was realised that shrimp culture has a shorter durability than was originally believed due to their unhealthy practices, they were all the more haste in reaping the benefits in shortest possible time. This again led to the vicious circle of deteriorated environment and reduced productivity. The partnership of local mass and social wellbeing has little place in their scheme of things. This shortsightedness and greediness of some individuals and companies promoted by them is a major factor which contributed to all social upheavals in the coastal community.

The foremost impact of these lands when converted into shrimp farms was the salivation of adjacent paddy fields and reduction of its fertility. When the farmers of these lands raised their opposition, the shrimp farmers bought these lands as well to convert it into shrimp farms and to silence the opposition. Those who do not want to sell their land became more vehement to oppose shrimp culture activity. This very often leads to social tension and enmity between shrimp culturists and local people who are mostly peasants.

In the Nagapatnam district instances of some corporate companies monopolising the whole paddy fields of the village is common. Since most of these lands belong to them for generations, they

feel frustrated and rise in revolt against shrimp farmers when the same land fetches enormous profit in an outsiders hands. Since most of the shrimp culturists are urban elites who are not the permanent residents of the village the dislike become more strong. Most of the socio- economic problems due to shrimp farming arise only because of resource monopoly by some private parties. Conversion of coastal lands like mangroves, wetland and agricultural lands by these private parties turns multiple use, multiple user resources to a single purpose resource (Bailey, 1988; Pollnac, 1992). Forest and coastal wetland conversion leads to marginalisation of coastal communities because stable and varied mangrove based resources of income are replaced by seasonal less dependable employment in aquaculture farms (Primavera, 1993).

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Similarly, in aquafarms employment of local people is often limited to low paying jobs whereas technical and managerial positions are reserved for outsiders because shrimp farming is capital intensive rather than labour intensive (Askornkae et.al 1986; Velasco, 1991a). Similarly, funds invested in shrimp culture are generated from outside the community so profits also leave the community and local people receive very few benefits (Velasco, 1979a; Smith and Peterson, 1982). A study conducted by Amante et al. (1989) shows that the economic benefits of shrimp farming did not trickle down to the residents of coastal villages but remained with the farmers, entrepreneurs and traders. Instead of improving living standards and village welfare, shrimp farming brought about social displacement and marginalization of fishermen (primavera, 1993). The capital intensive nature of shrimp farming favours the entry of corporate investors and local elites who can provide the needed capital and absorb financial risks (Primavera, 1992). This large scale investors, because of their easy access to permits, credits and subsidies easily outcompete the traditional users of coastal areas like fishermen and small farmers (Csaras, 1990).

Complaints about salivation of drinking water wells and shortage of potable water is very often raised in all the coastal villages where aquaculture is pursued intensely. The seawater drawn in by the aquafarms can contaminate aquifers, especially the depleted ones and cause salivation of ground water and drinking water shortage (Chen, 1990). Large scale usage of water in aquafarms to the tune of 10,000 to 40,000 m3 per tonne of shrimps require drawing of ground water which can otherwise be used for potable and agricultural purposes. In the village of Katoor, near sirkali, salivation of drinking water well and subsequent protest by the local people forced the shrimp farming concern to provide drinking water to the affected village.

Salivation of domestic wells is the single most factor cited by several villagers who oppose shrimp farming.

Shrimp farms are ideally located in backwaters and lagoons which hinder the free movement of country crafts in this water bodies. Several back waters and lagoons are rich fishery grounds where the traditional fishermen of the area cast their net. The kollidam estuary of Sirkali Taluk, The Pulicat backwaters near Madras, The Pitchavaram mangrove backwaters are some of the cases in point where conflicts between traditional fishermen and shrimp culturists are simmering and marked by occasional outburst of clashes. Since cultured shrimps compete with wild caught one in the export market, the demand for wild caught is either stable or low leading to a hostile attitude towards shrimp culture among fishermen.

The simultaneous advent of disease outbreak and social tension has led to the present lean period in shrimp culture activity in the coastal belt of Tamil Nadu. The late entrants to the field are sitting with their fingers crossed due to the uncertain future of the industry as it is bessetted with problems like local opposition, disease problems, increased govt regulations and capital investment. Though seemingly unrelated, social tension and disease outbreak are the outcome of unplanned and irregular development. What is needed is a holistic approach of all the factors before embarking on shrimp culture venture.

All the above said problems can be effectively addressed by involving local mass in the shrimp culture activity. Fishermen's societies can be encouraged to take up aquaculture in their respective areas and formation of shrimp farming fishermen's co-operative societies, establishing shrimp farming estates with local participation and giving some special subsidies to them will bring about a change in this scenario. If Government's effort is directed to see that atleast part of the shrimp income reaches the local mass, much of the social problems can be addressed effectively. Above all, imparting awareness that multiple use of coastal resources will be more beneficial will increase the social acceptance of shrimp farming and other coastal aquaculture ventures.

Aquaculture related social tensions could be avoided with a clear understanding of factors like social structure, land ownership, demographic pattern, current economic activities, cultural patterns and lifestyle of the local mass and other coastal management tools before siting an aquaculture venture (Sullivan,1991). In addition to these factors a clear picture

about the physical, chemical and biological characteristics of the area and sensitivity of its environment will make the venture an environmentally and socially acceptable one.

7. AQUACULTURE AND THE PREVAILING LAWS

The foremost cause of the environmental issue of shrimp farming is the unorganised way in which the industry has been developing since its inception. Shrimp farming mushroomed in an unscientific, uncontrolled and unplanned manner during the initial period of late 80s in the absence of any regulations, rules and guidelines. The entrepreneurs who ventured into this new field made use of these lack of regulations and guidelines and started shrimp farming in any coastal belt which they felt convenient. These farms where started with scanty scientific advise and pre project survey without taking into consideration the social, scientific, demographic and legal implications of shrimp farming. Once this unscientific and unregulated growth pattern was established, people who entered into this venture subsequently found it easy to tread the same line. Lack of guidelines and the uncontrolled development resulted in the large scale outburst of social, environmental and legal problems. However, the first intervention of Supreme court of India dated 9th May 1995 banning conversion of cultivable lands into shrimp farms and further orders banning setting up of shrimp farms in the CRZ has slowed this process of indiscriminate development. This was followed by several rulings and review petitions (see box). In its final judgement dated 19 August '97 supreme court banned all coastal aquaculture activity except traditional ones in the coastal regulation zone.

Even before this developments, Tamil Nadu Government has enacted a law called Tamil Nadu Aquaculture (Regulation) Act, 1995 (Vide Tamil Nadu Government Gazette Extraordinary dt. March 15th 1995) with the sole objective of regulating the coastal aquaculture. It is to be noted that the Tamil Nadu Govt has taken the lead to enact a legislation while other maritime states are contemplating it. The salient features of this Act is as follows:

1. No aquaculture units shall be established without a licence granted by Director of Fisheries and with the consent of Tamil Nadu Pollution Control Board (TNPCB).

2. A sum of Rs.5000 per Ha has to be deposited by the shrimp farmer for an Eco-Restoration Fund.

3. The effluent and its treatment plants should be in conformity to the standard provided by TNPCB.

4. The culture practices should be in harmony with nature.

5. The chemicals and drugs used in the culture practices should be at an undetectable level in the effluent.

6. Aquaculture practices shall not be near the prohibited areas like mangroves and swamps, migratory bird routes, breeding grounds, sanctuaries, national parks, place of heritage and worship, conserved and protected forests, grey and dark areas in the map of PWD.

7. Ground water shall not be drawn for aquaculture purposes.

8. A buffer zone of adequate width as prescribed shall be maintained between the farm and nearby habitation.

9. Adequate gap as prescribed should be given between farms to have access to the common water body.

10. Contravention of these rules shall entail a fine of upto Rs.20000 for the first time and Rs.1000 for each day of continued contravention.

However, the act is galore with several loopholes which could render the whole act meaningless (Kishore Vanguri, 1995). The following are some of the serious drawbacks of this act:

1. Though the act stipulates that shrimp culture effluent should be in conformity with the standards set by the TNPCB, no such standard for shrimp farming effluent has been set by the TNPCB.

2. The "Polluter Pay Principle of the Act which stipulates to collect Rs.5000 per ha for Eco Restoration Fund is too meagre and insufficient to take corrective steps to restore the environment to its previous state

3. The clause relating to conversion of cultivable land is vague and leaves much room for a different interpretation enabling the farmer to convert the cultivable land with ease.

4. Though the law stipulates that the aquaculture practices should be sustainable and in harmony with nature, the term "sustainable" has not been defined. Practising sustainable aquaculture can differ from place to place in relation to the environmental conditions of a given area.

5. Similarly, the law is totally silent on intensity of culture. If the stocking density is kept below 10/sq.m by stipulating appropriate laws, several of the present environmental problems can be alleviated besides paving way for sustainability.

6. Likewise, the legislation needs to be more specific regarding the disposal of waste water and usage and application of different drugs and chemicals.

7. Several technical details like usage of seawater and mode of pumping and outleting has also been neglected.

8. The present legislation leaves much room for violation as the ensuing penalty is negligible.

9. The act does not permit any court to take cognizance of any offence punishable under this act leaving no scope for any individual of general public to sue the erring units.

SOME LEGAL LANDMARKS IN THE AQUACULTURE SCENARIO	
10 July 1995	Aquaculture Regulation Act passed by Tamil Nadu Government.
7 March 1996	Aquaculture Authority constituted under the chairmanship of Justice G.Ramanujam.
12 Dec. 1996	Apex court orders demolition and closure by March 31 1997 all aquafarms which violate CRZ notification.
20 March 1997	Aquaculture Authority bill was introduced in Rajya sabha. The upper house passed the bill. Kept in abeyance by the Lok Sabha in view of supreme court hearing on review petitions.
21 March 1997	Apex court stayed till April 30 '97 the demolition of aquafarms.
15 April 1997	Supreme court orders closure of all aquafarms and hatcheries. The state Governments to demolish the existing farms before 15 April 97.
25 April 1997	Apex court extended deadline for demolition of aquafarms till July 30 '97. The stay granted earlier was again extended.
19 August 1997	Apex court extends deadline indefinitely till further date of hearing of review petitions by MPEDA and other environmental groups.

Though this act provided some guidelines to be followed, the overall growth of aquafarms was characterised by lack of integrated and cohesive policy at national level. To overcome this the central Government introduced an Aquaculture Authority Bill during 20 March 1997. The bill states that the intension of the Government is not to treat coastal aquaculture as a prohibited activity within the meaning of Coastal Regulation Zone notification. On the apex court's judgement it further states that the effect of this judgement is to close all the aquaculture farms except the traditional ones in the coastal

area. The aquafarms mainly utilises saline areas in the coastline which are not suitable for other activity and provides employment to 3 lakh workers. It further argues that large investment of public and private funds have been made in the activity. Hence, it is considered necessary to bring this bill to save the employment of workers and investment already made in this economic activity. It is also considered necessary to provide for future aquafarming in a manner consistent with the requirement of safeguarding of environment. The bill further states that aquaculture is not intended to be a prohibited activity within the meaning of CRZ notification. Since it is necessary to validate the aquafarms setup hitherto retrospectively introduction of this bill has become necessary.

The Government is also considering amendment of Environment Protectection Act 1986 in order to facilitate aquaculture development in the country. In the meanwhile, various environmental groups in the country are lobbying with parliamentarians to prevent the passage of the bill in Lok Sabha. Similarly, Government organisations like MPEDA and NGOs such as Aquaculture Foundation of India are making efforts to convince supreme court that eco-friendly aquaculture is quite possible and a blanket ban is quite illogical as it will stifle a million dollar industry besides rendering 3 lakh people jobless.

Though the Government legislates enactment with the intension of streamlining the industry, effective enforcement of the regulations will continue to be a problem. For example, though the Aquaculture Regulation Act was passed by Tamil Nadu Government during 1995 large scale violation of this act has been reported. Out of 910 units functioning in the state, 744 units reportedly have no licence and 702 units have not applied for Consent Order Certificate as required under Tamil nadu Pollution Control Act 1974. Most of the pollution control officials feel that their work is very much hampered by inadequate manpower. As a result, most of these regulations are not implemented and shrimp farmers are least inclined to observe pollution control norms. Lack of technical personnel and funds for the enforcing agencies is the hurdle in implementing the law. Hence, removal of the shortcomings in the present legislation and proper enforcement of regulations will go a long way in making this industry robust and eco-friendly. The viability of aquaculture in general and shrimp culture in particular as an industry depends on how we plan and regulate its growth in the future.

As aquaculture is poised for further development and diversification in Tamil Nadu, increasing conflicts between different users of resources can be expected which will lead to further legal battles. Though the competitors for coastal space in our country is less compared with other countries, in future, it will be acute and strongly felt. Hence, formulation of an integrated and comprehensive policy taking a balanced view of environment and coastal development alone will solve many of the legal problems besetting aquaculture.

8. AQUACULTURE : FUTURE PROSPECTS IN TAMIL NADU

The prospects for coastal aquaculture in Tamil Nadu appears brighter comparing other maritime states of India despite several soio-economic,legal and environmental issues. Shrimp culture made its appearance in Tamil Nadu only during the later part of 1980 and within a period of 7 to 8 years more than 3000 ha have been brought under culture. Areawise, there is still enormous scope for expansion despite hurdles like disease outbreak and increased regulations as only less than 6% of the total 56000 ha has been utilised so far. At present culture is active only in 3 coastal districts i.e.Thanjavur, Nagapatnam and Tuticorin where nearly 90% of the farms are located in view of the suitability of their coast for on shore pumpfed shrimp culture system. The potentiality of other coast for other kinds of culture systems is largely unexplored. Other types of culture systems like cage culture, pen culture, sea ranching, raft culture, etc., are likely to be taken up in this coastal belts. The pulicat lake near Madras, the pitchavarm and Muthupet mangroves and rocky coast of Kanyakumari have been identified as suitable for culture systems like ranching, pen culture, and bottom culture. Some of these culture systems which have already been carried out at demonstration level is being done sporadically and are likely to gain popularity among the coastal farming community. The interest evinced by some private sector business houses and entrepreneurs in this direction is a good sign.

A major advantage of the Tamil Nadu coastline is its relatively unpolluted and undeveloped nature contrary to the situation found in several Southeast Asian countries where coastal aquaculture venture are already reeling under serious urban, industrial, agricultural and self pollution. The high cost of coastal real estate, production and labour are all becoming major hurdles for the continued development of aquaculture in these countries. Environmental incompatibility of their venture is another insurmountable problem which very much threaten the industry. The 1989 debacle of Taiwan is the case in point. The environmental sustainability assumes increasing significance in the light of several ban on import of cultured shrimp imposed by US and several European countries where environmental wellbeing is neglected in shrimp culture practices. In this context, the

scope for coastal and shrimp culture development is enormous in India.

The scope for developing aquaculture in consonance with environment is fully possible as the industry is still in its nascent stage. The recurrent outbreak of disease all increased legal regulations, can be expected to streamline and develop the industry in a planned manner instead of stifling it. Once the Aquaculture Authority bill is ratified it will be a boost to all coastal aquaculture ventures. There is no dearth for both skilled and unskilled manpower availability. The Government agencies and research institutions are all bent to provide a conducive climate for aquaculture ventures with their various schemes. In the home front, the marine and inland fish landing of India was 4.3 million tonnes while the demand was 10 million tonnes during 1993. Since the production by capture is unlikely to increase further, the culture products have a good market in the domestic front also providing impetus to culture activity. Therefore, shrimp farmers have a bright scope to enter and compete in certain domestic and international markets. However, all the future culture activities will be motivated by economic and financial considerations in view of the high cost for marine food in the global and domestic market.

The escalating fuel cost worldwide will also likely to increase the cost per unit catch from the wild which will make capture fishery more and more unviable. Shrimp trawling has the highest energy consumption of any fishery. US shrimp trawlers consume 1.1 litre of diesel per kg of shrimp captured while Thai trawlers consume 1.9 litres per kg of diesel (Boonchumong & Lawapong 1988). In our country an energy balance analysis of fisheries reveal that in 1981 for every KCal of energy spent in fishery 3.2 KCal was received which decreased to one-third KCal during 1988 (Kurien, 1995). As a consequence, captured shrimp production is likely to become more costlier and mechanised capture vessels are likely to be affected. However, traditional method of fishing with country vessels which do not rely on fossil fuels will still be profitable. This energy intensive nature of shrimp capture itself is likely to boost further culture efforts. So the dependence on culture will be more to meet the increasing demand. Already, cultured shrimp production is increasing rapidly in Asian countries which pay great attention to this emerging food producing technology (Fast and Lester, 1992; Fig. 9). During 1980 cultured shrimp contributed only 2% of the world production and the remaining 98% came from the world oceans. During 1989, 26% of the world production was from the pond culture (Rosenberry, 1990). Nearly 45% will be from the world oceans during 2000. It is projected that

production by capture will stabilise around 60 million tonnes and while production by culture will register a several fold increase. However, the year 1997 witnessed a decline in production nationally and globally mainly due to environmental issues and disease outbreak. Since extensive and semi-intensive culture systems have higher profit margin per unit production and environmentally more compatible, all future culture activity will follow these two systems only. The production cost per unit will decrease and production per unit land will increase as farm inputs like seed and feed will be available at lesser cost as their production is indigenised. The pond dynamics and the requirements of cultured organisms will be better understood to improve the overall culture efficiency. Semi-intensive culture would benefit more from advances in farm management, biological characterisations of cultured organisms, seed production and genetics (Fast & Lester 1992). Above all, better disease management and solutions to the disease problems will likely to boost the production.

The two penaeid shrimp which are the sole species cultured now will be replaced by other organisms like crabs, bivalves, seaweeds, crustaceans and other commercially important fishes which offer equally good financial returns. However, P.monodon and P.indicus will continue to be the major organisms cultured for another 10 to 15 years in view of the strong infrastructure, technical expertise, suitability for culture and familiarity with the farmers. Among other penaeid shrimps P.semisulcatus (flower shrimp) and crabs like S. serrata and P. pelagicus have a good potential to emerge as a culturable species since its hatchery techniques are being perfected. The continued popularity of peneaid shrimps among farmers will be largely decided by domestic and international market and its cost per unit production.

In all the future culture activity, concern for environment and social acceptance of aquaculture will be a prime factor. Addressing the social and environmental problems will be the major task in any new venture. Siting criterion including the environmental, social and demographic pattern will be paid greater attention by the government and farmers alike so as to preclude all possible impacts. In the face of increased regulations and their strict implementation, some order in siting the farms can be expected which will pave way for the orderly growth of the industry.

In Tamil Nadu disease outbreak is the nightmare of all shrimp farmer. The recent disease outbreak has been an ordeal for all the shrimp farmers and educated them some valuable lessons. The

falsehood of the notion that the oceans are bottomless pits where all our pollutants can be dumped endlessly has been fully realised and the need for an eco-friendly culture practice is felt. In the aftermath of the disease, a perceptible change in deciding the stocking density, feeding schedule and water changing can seen. Several farmers are toying with the idea of ETPs, sedimentation tanks and recirculation system to make their operation more eco-friendly. The farm design, effluent drainage system and farm management practices like feeding, water change and chemicals and drugs usage is also undergoing a re-evaluation as they are the cause for concern. It can be hoped that atleast a part of the present lacuna on the lack of data on the environmental impact of shrimp farming can be addressed enabling the authorities to take appropriate measures in this direction. In short the survival and development of aquaculture in Tamil Nadu depends on how the following three conditions are fully met:

1. Environmental sustainability

2. Social acceptability

3. Low production cost]

9. CONCLUSION

Aquaculture industry in Tamil Nadu, which is largely shrimp culture, has had a turbulent period in the last 3 years due to environmental, social and legal issues. The growth of the industry is at crossroads whose further development as a major food producing sector will be determined by how the present problems besetting the industry is addressed to make it environmentally and socially acceptable. In the last 7 years coastal aquaculture in Tamil Nadu has witnessed a multifold growth because of its commercial viability and high demand for the produce in the global market. However, these initial years of shrimp culture is marked by an unrestrained and haphazard growth which largely paved way to all the problems besetting the industry. However, aquaculture as a whole is likely to make rapid strides if all the environmental, social and legal problems are adequately addressed.

The urgent need of the industry is breaking the monotony of culturing only shrimps and diversification in culture system and species. This is likely to address several of the problems besetting the industry. Though numerous candidate species for different kinds of culture systems like raft culture, cage culture, pen culture and ranching are available, commercial venture in this aspect is yet to begin. The determining factors for the successful commercial farming of these threshold species is largely technological. Though we have a strong research backup available in different premier research institutions of the country which have perfected several of these techniques, diversification in culture species and system is slow to take off. However, considering the enormous technical expertise and skilled manpower available in the country, the successful commercial cultivation of large number of threshold species should be possible within a short span of time.

Though the growth of the industry is hampered recently due to environmental, social and legal problems other factors like economic and legislative climate, research support from central and state Government agencies and initiative and enthusiasm of farmers and entrepreneurs in this aspect is quite encouraging. Though the state and central Governments were previously accused of being apathetic towards this new field, this attitude has been reversed of late once the potential of this emerging industry is realised and the determination of the Government to promote coastal aquaculture is seen by the introduction of the Aquaculture Authority Bill passed by Rajya Sabha. Once made into

a bill, it will provide all the impetus necessary to develop this industry.

Besides being economically and commercially beneficial, an ecofriendly and socially acceptable aquaculture provides opportunity for improved utilization of our natural water resources and will reduce fishing pressure on natural stock. The last point assumes significance in view of our exhausting fishery resources. In the socio-economic front the industry is likely to play a constructive role if the present trend of monopoly by a few urban elites is curtailed. In this vain, proper Government planning should see that the benefits of coastal aquaculture reach the coastal communities like fisher men and unemployed agricultural labours. Social acceptance and economic upliftment will entail through such measures. Making this industry a socially acceptable one will be the prime task of Government agencies and pro-aquaculturists.

Though the state Government has come out with some guidelines and an Aquaculture Regulation Act, 1995, more active participation of Government agencies will eliminate several alleged negative impacts of this industry. Countrywide and statewide macro and micro level identification of potential sites and earmarking them for different culture systems, fixing production limits for the farms in tune with the carrying capacity of the respective water source, identification of ecologically and socially sensitive areas in order to ban farms in that area, motivating fishermen and farmers through fish and shrimp farming co-operative societies, improving the infrastructural facilities like roads, communication and electricity in potential coastal belts are some areas the Government can make lot of contributions.

In short the future expansion and viability of aquaculture industry in our country depends on responsible waste disposal management, which in turn implies several factors like proper site selection, adaption of suitable culture system and proper water management and socially acceptable planning of the industry. Besides economic profitability, the future development must be sensitive to our society's needs. Several of the environmental, socio-economic and technical problems afflicting our shrimp culture industry can be traced to factors like siting the farm in an appropriate location, adopting a suitable culture system, and proper water management. The present predicament of disease outbreak, socio-economic issues and environmental concerns could have been averted if a cautious and environmentally sensitive approach in the light of the experiences gained by other southeast Asian countries had been

adapted. It is high time aquafarmers were more sensitive to the causes of environment and sustainable growth. Only than aquaculture as a whole will bring the expected economic prosperity for our country. Under such changed perspective the question of total banning of shrimp farming never arises.

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Table 1. Some General Information on Seas of Tamil Nadu.

S. NO	COASTAL INFORMATION	TAMIL NADU			INDIA
		E.Coast	W.Coast	Total	
1	Coastal length (in Kms)	940	60	1000	8,085
2	Continental Shelf (in sq.kms) upto 50 m depth 51m to 200 m depth	22,411 11,205	844 6,952	41,412 23,255 18,157	4.5 lakhs
3	Exclusive Economic Zone(EEZ) 200 nautical miles from shore(in million sq.km)			0.19	2.02
4	Territorial waters (in sq.km)			19,000	

Table 2. District-wise Coastal Length of Tamil Nadu

S. NO	DISTRICT	COROMANDAL COAST	PALK BAY	GULF OF MANNAR	WEST COAST	TOTAL
1	Madras	22				22
2	Chengai-MGR	137				137
3	S.A.V & V.R.P	89				89
4	Nagai Q.M.	102	63			165
5	Thanjavur		35			35
6	Pattukottai		42			42
7	Ramnad		130	141		271
8	V.O.C.			121		121
9	Thirunelveli Kattabomman			50		50
10	Kanyakumari			8	60	68
	Total	350	270	320	60	1,000

Table 3. Districtwise Details about Brackishwater area Suitable for Shrimp Culture

Table 3. Districtwise details about Brackishwater area Suitable for Shrimp Culture

S.NO	DISTRICT	BRACKISHWATER AREA (HA)	IDEAL SHRIMP FARMING AREA (HA)
1	Chengai	14,841.00	2,662.90
2	South Arcot	8,072.00	2,703.93
3	Thanjavur & Nagapatnam	31,425.65	7,297.47
4	Pudukkottai	NA	247.00
5	Ramanathapuram	874.22	1,385.27
6	Nellai-& Tuticorin	401.25	565.62
7	Kanyakumari	205.25	18.25
8	**TOTAL**	55,879.37	14,889.4

Table 4. Growth of Marine Product Exports

S. NO	COUNTRY		1990	1991	1992	1993	1994
	Japan	Q	40598	40109	38277	43563	54063
		V	44231	61066	70267	10240	165758
2	USA	Q	14832	20937	18690	25127	33004
		V	9216	15114	16594	26930	48836
3	West Europe	Q	40955	51937	61874	74822	74966
		V	20353	34640	47237	62098	75499
4	Middle East	Q	3166	6560	7472	7530	7974
		V	815	2458	4268	3076	4662
5	SE Asia	Q	28358	37875	55783	77085	124126
		V	5634	10832	16041	24133	565690
6	Others	Q	5744	5512	9218	11791	7145
		V	1592	3314	3737	6603	5237
	TOTAL	**Q**	**133653**	**162930**	**191314**	**239918**	301278
		V	**81841**	**127424**	**158144**	**225280**	356552

Q: Quantity in tonnes; V: Value in lakhs
Source: Fisheries Statistics Year Book ,1994.

Table 5 Top Ten Shrimp producing countries of the World (1984-1993)

	COUNTRIES	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
1	CHINA	249.5	367.0	426.6	457.5	583.6	502.1	532.2	534.2	544.9	488.8
2	THAILAND	136.2	126.3	139.5	149.8	164.5	203.1	224.4	289.9	302.1	338.8
3	INDONESIA	132.9	144.1	157.3	186.9	229.9	239.6	249.9	286.4	321.5	333.4
4	INDIA	203.2	232.5	215.3	197.2	216.4	226.1	246.0	300.5	280.1	279.7
5	USA	145.0	152.7	183.3	165.0	150.8	161.6	159.0	146.9	154.5	134.9
6	PHILIPPINES	52.2	62.4	72.1	68.0	79.1	82.7	87.0	84.9	118.8	130.1
7	ECQUATOR	39.9	36.2	52.8	78.7	60.8	78.7	84.7	110.9	113.1	100.6
8	MEXICO	76.1	74.6	73.2	83.96	73.2	63.2	62.3	70.6	66.2	79.8
9	GREENLAND	41.5	52.4	64.1	64.4	60.0	65.1	73.2	73.1	81.9	77.2
10	MALAYSIA	70.1	69.0	72.9	72.9	72.9	72.9	72.9	71.3	73.5	74.4
	Total World Landing	1916.7	2133.6	2232.9	2364.0	2515.4	2525.5	2601.4	2808.3	2912.5	2892.9

Source: FAO Year book of Fishery Statistics (In thousand tons)

Table 6. Share of Shrimp in Marine Products Export & 1994

S.NO	COUNTRY		1993	1994
1	Canada	Q V	8182 1620454	27010 7082587
2	USA	Q V		234613 69534089
3	China	Q V	40800 10086180	437400 133780747
4	HONG Kong	Q V		35160 9903024
5	Japan	Q V	1117296 415111094	1992758 830627683
6	France	Q V	6048 2220170	
7	Italy	Q V		18500 3646864
8	United Kingdom	Q V		39640 12633331
TOTAL		Q V		2785081 106720832

Q; Quantity (in Kg); V: Value (in Rupees)
(Source: Fisheries Statistics Year Book, 1994).

Table 7. Statewise Details about Area available, Area under Culture and Estimated production

S. NO	STATE/UNION TERRITORIES	ESTIMATED BRACKISH WATER AREA (HA)	AREA UNDER CULTURE (HA)	PRODUCTION (T)
1	West Bengal	4,05,000	42,605	19,949
2	Orissa	31,600	11,000	6,805
3	Andhra Pradesh	1,50,000	60,249	30,557
4	Podicherry	840	--	3,000
5	Tamil Nadu	56,000	640	1,129
6	Kerala	65,000	14,658	8,225
7	Karnataka	8,000	3,500	2,300
8	Goa	18,500	1,000	850
9	Maharashtra	80,000	2,400	523
10	Gujarat	3,76,000	500	700
	TOTAL	11,90,940	1,36,467	70,686

Table 8 Present Status of Shrimp Farming in 3 important Coastal Districts of Tamil Nadu

S.NO	DISTRICT & TALUK DETAILS		SMALL SCALE FARMERS			MEDIUM SCALE FARMERS			LARGE SCALE FARMERS			TOTAL		
	Name of the District	Name of the Taluk	No. of farms	Total land area (Ha)	water spread area (Ha)	No.of farms	Total land area (Ha)	water spread area (Ha)	No of farms	Total land area (Ha)	water spread area (Ha)	Total no of farms	Total land area (Ha)	Total water spread area (Ha)
1	Nagai-Quaid-E-Milleth	Sirkali	93	387.37	193.00	23	492.12	173.5	6	850.00	100	122	1729.4	466.5
		Tranquebar	16	69.89	26.60	14	348.37	41.00	2	167.00	-	32	585.2	67.6
		Nagapatnam	114	412.47	256.01	1	10.36	6.00	--	--	--	115	422.83	262.01
		Vedaranyam	204	364.43	260.18	2	20.00	16.00	--	--	--	206	384.43	276.18
		Thiruthurai-poondi	11	21.65	12.40	2	86.87	22.00	--	--	--	13	108.52	34.4
	Total		438	1255.81	748.19	42	987.72	258.5	8	1017.0	100	488	2230.3	1106.6
2	Thanjavur	Pattukottai	23	92.99	34.94	7	103.83	62.68	--	--	--	30	196.82	97.62
		Peravurani	21	84.35	40.26	7	72.19	53.32	--	--	--	28	156.54	93.58
	Total		44	177.24	85.20	14	176.02	115.10				58	353.36	191.30
3	Pudukkottai	Avudaiyarkoil	29	108.29	66.78	5	76.16	57.39	--	--	--	34	184.45	124.17
4	Total		511	1541.44	890.17	61	1209.90	431.89	8	1017.00	100	580	2768.1	1922.3

Source: BFDA, Pattukkottai

Table 9 . Fate of Formulated Feeds in Intensive P.monodon Ponds

S.NO	FATE OF THE FEED	% OF TOTAL
1	unconsumed	15.0
2	consumed or ingested/ egested as faeces digested	20.3
3	Assimilated and harvested biomass	16.7
4	Molted exuviae Energy and maintenance Metabolites,etc.,	48.0
	Total	100.0

Reference: Primavera,1993.

Table 10 a

CONCENTRATIONS OF PARAMETERS IN THE AQUAFARM OUTLET WATERS OF THE STUDY AREA IN 5 SITES.

S.NO	PARAMETER	COLLECTION SITES					ANALYTICAL METHOD
		1	2	3	4	5	
1	COD mg/l	248	372	124	248	1116	open Reflex method
2	DO mg/l	5.9	6.2	7.0	7.2	6.3	Winkler's method
3	SULPHIDE mg/l	3.2	3.6	3.1	2.7	2.8	Iodometric method
4	pH	7.7	8.1	7.8	8.3	8.2	pH meter
5	SALINITY ppm	33.4	34.2	34.1	33.9	34.2	Argentrimetric
6	TEMP ^{0}C	31.2	30.6	30.0	29.0	29.0	Thermometer
7	ALALINITY mg/l	306.1	301.2	290.2	261.3	321.3	Titrimetric
8	CHLORIDES mg/l	1275.6	1276	1296	1236	994	Argentrimetric
9	SUSPENDED SOLIDS	290	340	458	375	346	
10	AMMONIA mg/l	310	298	279	260	170	Spectrometric
11	PHOSPHATES mg/l	0.3	0.2	0.4	0.3	0.5	Murphy and Riley

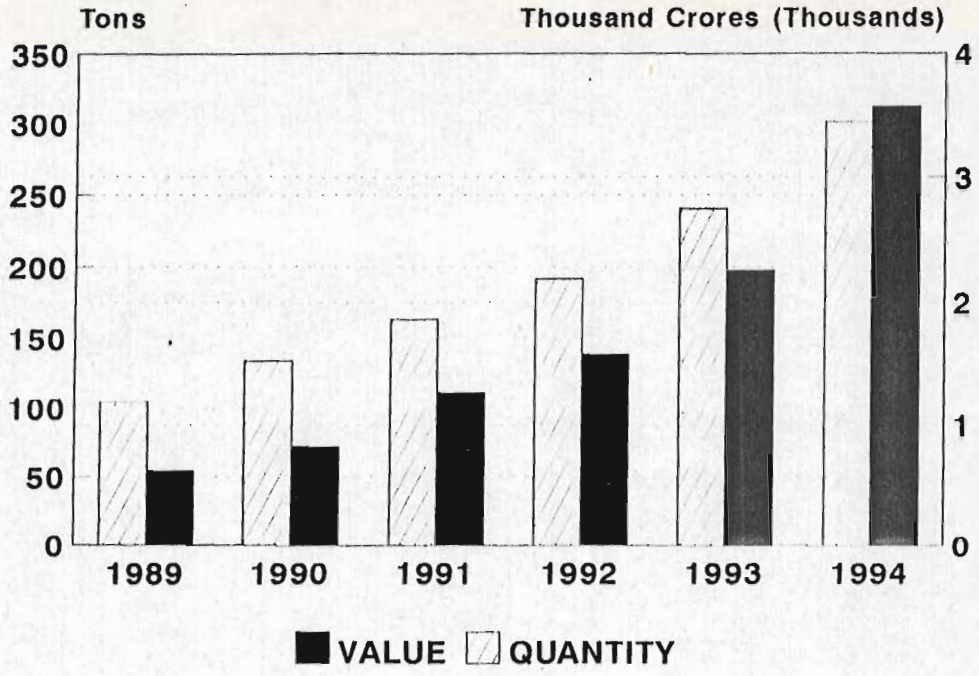
Collection sites: 1. Tranquebar a: 2.Tranqubar b: 3.Pitachavaram

TABLE 10.b MEAN VALUES OF WATER QUALITY PARAMETERS OF EFFLUENT SAMPLES.

Parameters	Tondi	Adhiram patnam	Kattuma vadi	Vedara nyam	Velan ganni	Nagapa tinam	Tranq uebar	poom buhar	Kollid am	Pitcha varam	Pondiche rry
Temp °C	29.6	30.1	29.9	304	29.8	30.1	29.8	28.7	28.8	30.2	28.1
pH	7.4	7.9	7.8	7.5	7.8	7.2	7.3	7.2	7.9	8.1	8.2
DO_2 g/l	7.1	6.9	6.8	5.9	5.9	6.4	6.3	6.1	5.2	5.6	5.9
COD mg/l	487	498	445	678	349	276	465	368	181	255	359
BOD mg/l	46	65	39	87	45	71	56	64	79	62	68
T.Solid mg/l	19,765	21,342	17,435	15,328	15,567	14,675	17,897	19,612	14,674	18,780	15,875
Sus.Solids mg/l	345	235	425	390	341	298	423	328	356	378	435
Tot.Alkal. mg/l	128	178	114	134	176	156	190	197	187	187	246

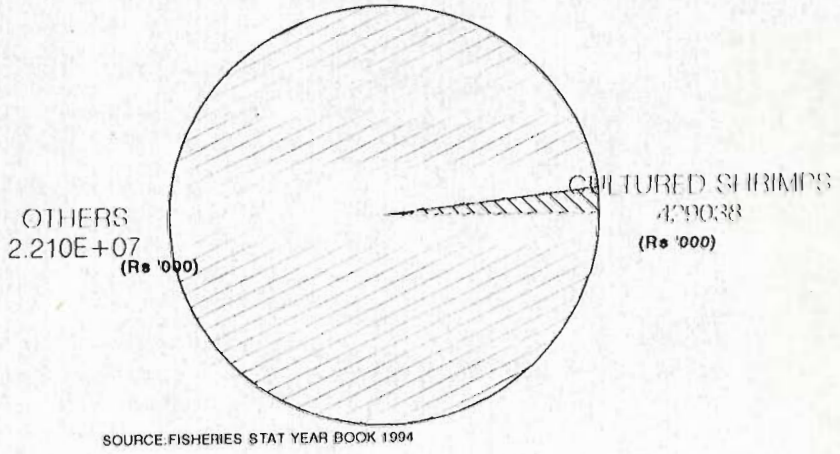
Table 11 Chemicals and Drugs Used in Grow-Out Ponds and Hatcheries of Tamil Nadu

S.NO	CHEMICALS/ DRUGS	USAGE	REMARKS
1	chloramphenical	Antibacterial	Commonly used in hatcheries;added to feeds by some farmers
2	Erythromycin	Antibacterial	Used as a hatchery bath
3	Formalin	Fungicide,Parasiticide	For necrotic shell and gill diseases;also for spawner disinfection
4	Malachite green	Parasiticide;Antifungal	Shell and gill diseases; disinfection of eggs;used as bath or added to the pond system
5	^Oxolinic acid	Anti-bacterial	added to feeds
6	Oxytetracycline	Anti-bacterial	Added to feed or to the pond directly
7	Rifampicin	Anti-bacterial	Used in hatcheries
8	Sulpha drugs	Anti-bacterial	Added to feeds
9	Trifluralin	Anti-fungal	Agricultural herbicide;used in hatcheries
10	Calcium sulfide;Calcium hypochlorite or Commercial bleach	Disinfectant	Widely used in hatcheries
11	EDTA	Chelates heavy metals	
12	Iodophore compounds	Disinfectant	Used for shell related diseases
13	Alkyl benzyl dimethyl ammonium chloride	Anti-bacterial;anti-fungal	Used for soil and water treatment
14	Benzalkonium chloride	Anti-bacterial	Also used to induce moulting
15	Lime(Hydrated limeCaoH2;Agricultural limeCaCo3;Burnt lime CaO	Increases pH;pond disinfectant	Used to correct pH;induce moulting;act as a soil conditioner
16	Pottasium permangnate	Oxidizer and detoxifier	Used in pond systems
17	Zeolite	Absorbs toxic gases	For water quality maintenance
18	Ammonium sulphate	Piscicide	Used in combination with burnt lime
19	Chelated copper compounds;copper sulfate	Algicide;Anti-bacterial	Also used to induce moulting
20	Tea seed cake	Piscicide	Used to kill predatory and competitive fishes;also used to induce moulting



Fisheries Statistics,1994

FIG.2.CULTURED SHRIMP EXPORT 1993



SOURCE:FISHERIES STAT YEAR BOOK 1994

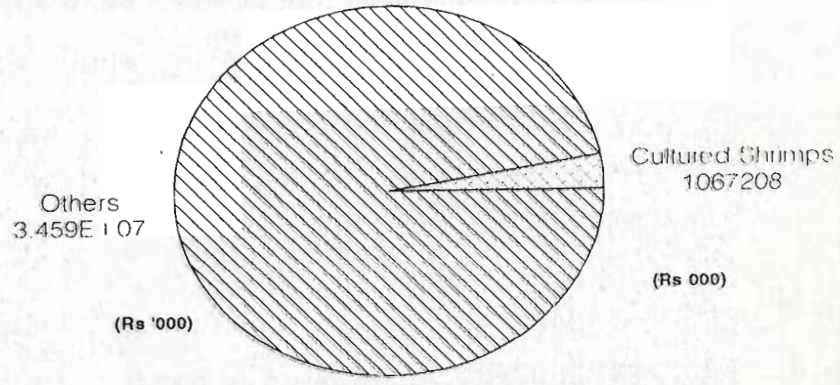
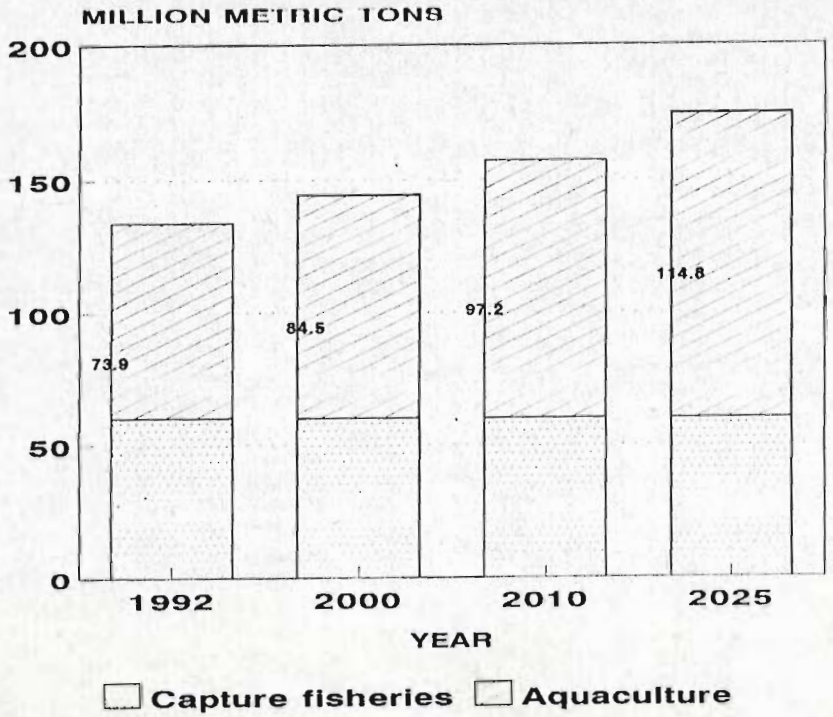
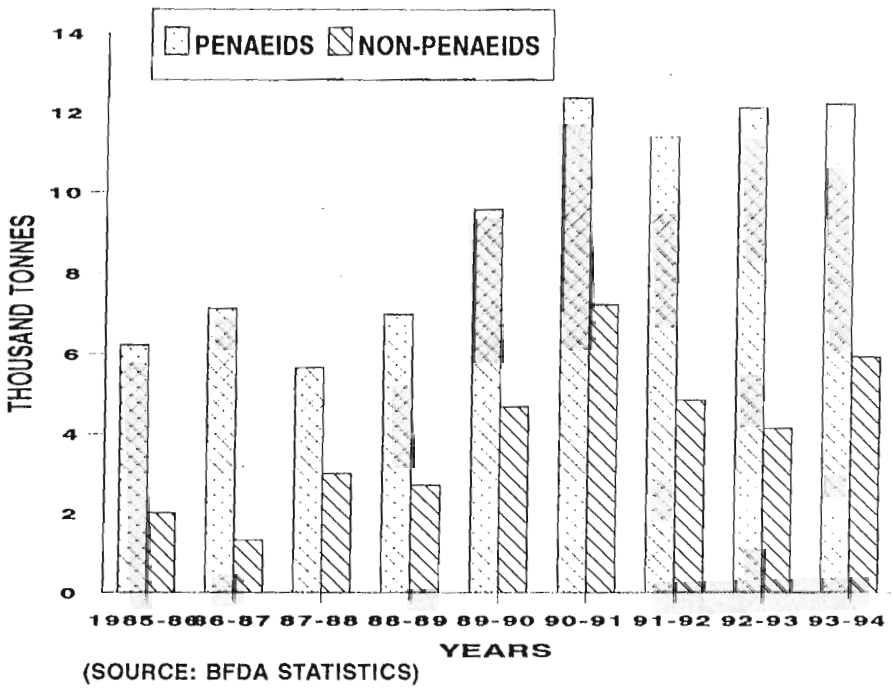


FIG. 3, PROJECTED SEA FOOD DEMAND



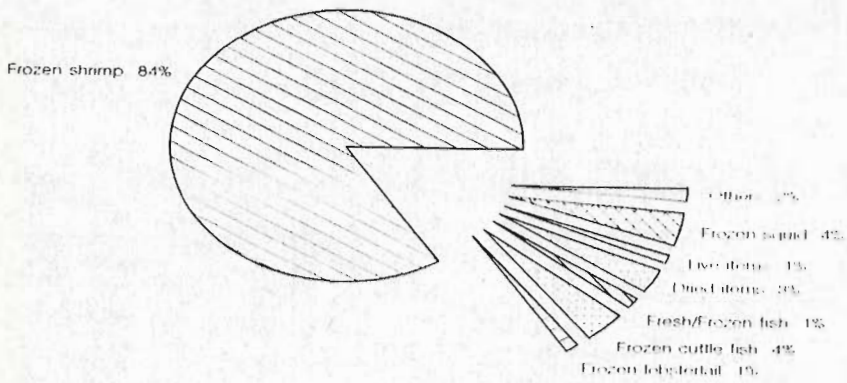
Csavas, 1994

FIG 4 SHRIMP PRODUCTION IN TAMIL NADU



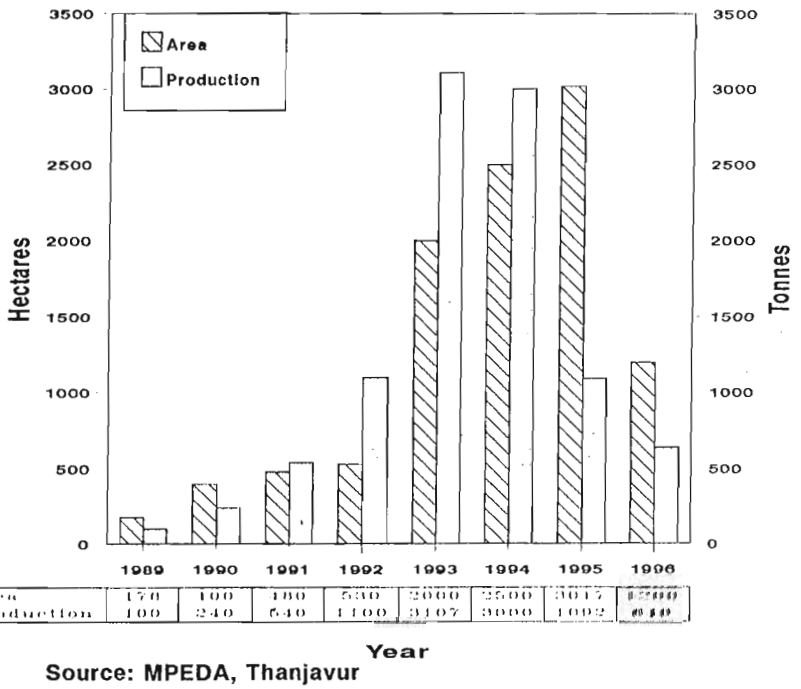
(SOURCE: BFDA STATISTICS)

FIG.5 MRINE PRODUCTS EXPORTS FROM TAMIL NADU 1993-94



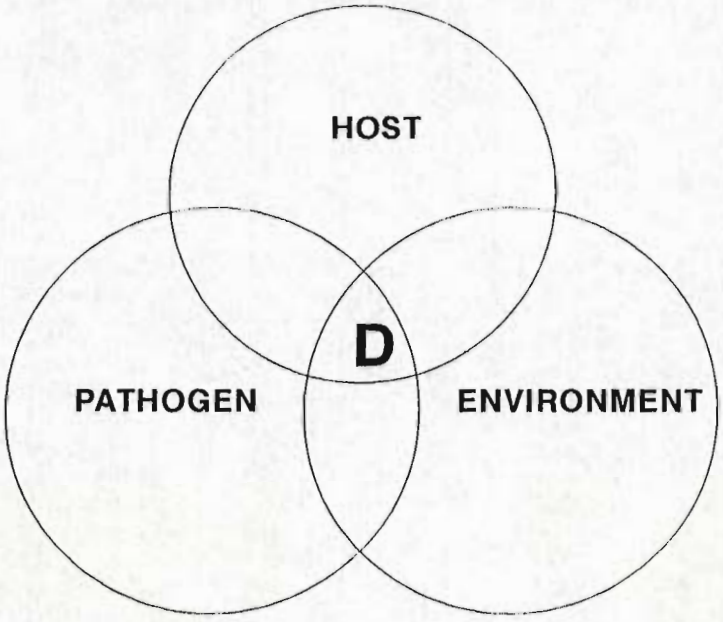
Source : BFDA Tamil Nadu

FIG.6 GROWTH OF SHRIMP CULTURE IN TAMIL NADU



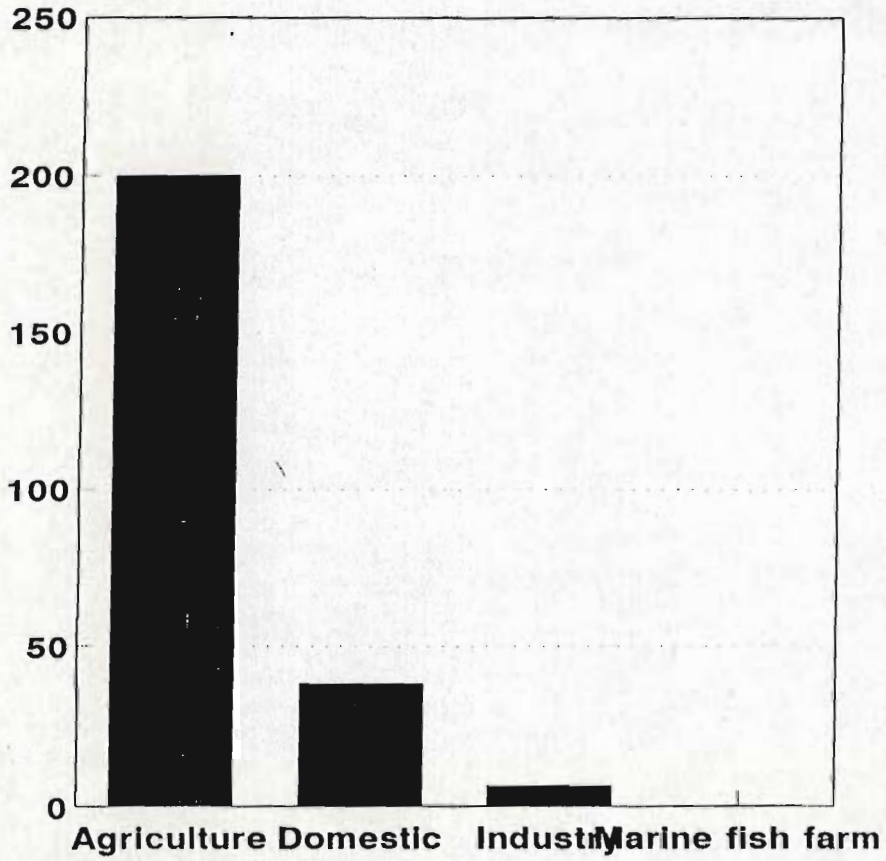
Source: MPEDA, Thanjavur

FIG 7 DISEASE OCCURRENCE IN CULTURE SYSTEM



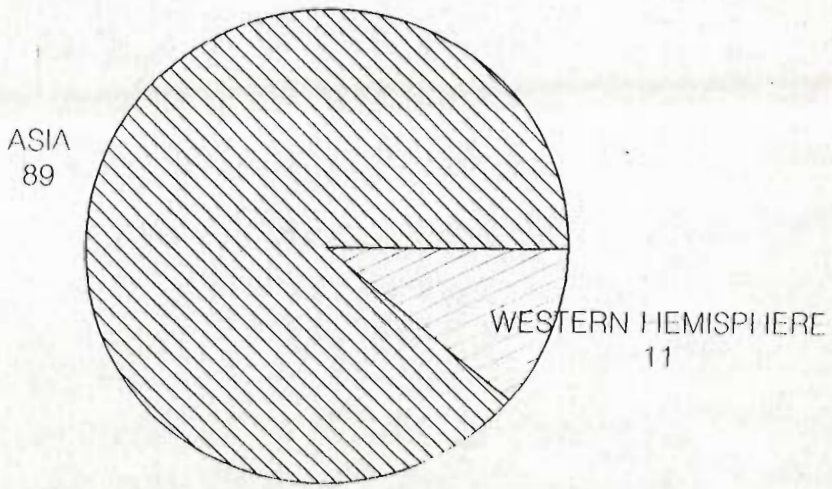
SNIESZKO'S SPHERES SHOWING THE RELATIONSHIP BETWEEN ,
PATHOGENS, HOST AND ENVIRONMENT AND DISEASE OUTBREAK

FIG.8 NITROGEN LOAD DERIVED FROM DIFFERENT SOURCES IN DANISH SEAS- 1994



Moller, 1987

FIG. 9 WORLD SHRIMP FARM PRODUCTION 1990



Vondruska, 1987