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Conflicts of Water and Soil Resources over Aquaculture Production in Coastal Tamil Nadu and Pondicherry

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Final Report
of
World Bank aided EMCaB Research Project

Conflicts of Water and Soil resources over Aquaculture Production in Coastal Tamilnadu and Pondicherry

Submitted to

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CONTENTS

Project Background

The marine products exports from India depend heavily on the availability of shrimp as this single item commands very high unit value combined with heavy world demand. In India we are facing a near stagnation or decline in the marine fisheries production; especially with respect to shrimp. The limited nature of the resources is being realized of late and the accusing finger is pointing to the indiscriminate exploitation, with considerable investment, beyond sustainable limits. The efforts are now on for production through aquaculture. The initial success beyond expectations has attracted huge investment in this sector and the tempo is on. The potential of aquaculture to meet the challenges of food security and to generate employment and foreign exchange has led to the rapid expansion of this sector, which has grown at an average annual rate of almost 10 percent since 1984, compared with 3 percent for livestock meat and 1.6 percent for capture fisheries production. The inexorable expansion of marine shrimp farming generated by market demand, short term gain and government support because of export earnings has brought with it super – intensive systems, nomadic farmers, environmental and sociological disputes, water quality and disease problems resulting in crashes in the production of shrimps. All of these appear to be threatening the long-term sustainability of what has undoubtedly become the world's fastest growing aquaculture industry. India has some differences when compared to other S.E. Asian Countries such as: abundant land and labour, supply varying climatic zones, weak infrastructure and paucity of power supply. It is because of these that the farming techniques adopted in India will be different from those used in other countries.

A major portion of the conflicts arising from this expansion of shrimp farming is the result of environmental and social degradation that is not included in the costs of shrimp production, where the industry assumes no responsibility for damages to other groups arising from its activities, economists call them "externalities". For example, abandoned ponds are usually virtually unusable for other purposes for indefinite periods without costly rehabilitation, which is seldom

undertaken. Mangrove destruction, flooding of crops, salinization or pollution of land and water associated with the expansion of shrimp farming altogether form degrading factors that affect the surrounding population are dependent on these resources. These are the conflicts of important concern since the emergence of the aquaculture industry in Tamil Nadu.

The type of land used for shrimp farming has an effect on the success of the shrimp farming it self, and other environmental impacts with the adjoining areas and the coastal communities inhabiting the coastal belt. However, aquaculture practices are market-driven and profit-motivated, and result in situations of auto-pollution causing more damage to culture production than to the general environment, confuses the perception of environmental damage. Over-concentration and intensification can certainly result in degradation of water quality. Abstraction of the freshwater from underground aquifers and release of saline water due to semi intensive shrimp farming are some of the major issues against shrimp culture that seems hardly justified in either social or economic term.

The impetus given to shrimp aquaculture is mainly due to its lucrative foreign exchange earning capacity. In India this realization materialized only in last decade, which coincided with unprecedented pressure on natural resources such as water and land as they form the important pre-requisite for aquaculture development. The type of land used for shrimp farming has an effect on the success of the shrimp farming itself environmental impacts and conflicts with other people inhabiting or using coastal areas.

Though the development of Aquaculture industry along the Coastal regions of Tamil Nadu and Pondicherry appears a big boom owing to a tremendous increase in the revenue of India, environmental degradation due to pollutants from the aquaculture industry has been recognized to be controversial by the environmentalists. If not properly planned, the spread of brackish water shrimp culture into other user area will lead to adverse effect on natural habitat and social customs. Therefore, it is essential to give due consideration to assess and evaluate the environmental impacts of shrimp culture resulting in conflicts since it

causes unprecedented pressure on natural resources such as water and soil so that a sustainable aquaculture industry with increased production can be met for the future generations. The major goal of society should be to stimulate production and consumption that do not diminish the capacity of life-support systems to recover after disturbance and that remains within the carrying capacity of the supporting eco-systems.

Shrimp Aquaculture in the International Arena

Today there are 106 countries engaged in shrimp farming and 16 countries alone account for 85 to 90 percent of shrimp supply in the world. Shrimp account for 20 percent of world seafood production and 30 percent of total world trade in seafood. The cultured world shrimp production has increased from 84,000 tons in 1982 to 8,91,000 tons in 1994. The percentage share of cultured has increased from 4.8 in 1982 to 25 in 1989 and this started declining from the year 1990 due to viral attack in the shrimp farms in the South East Asian countries. Again the percentage share has increased to 29.7 in 1994. Thailand, Indonesia, Taiwan, Philippines, Ecuador and Vietnam are among the top world shrimp producing countries.

Thailand has been the leading world producer of farmed shrimp from 1993 onwards. About 80.0 % of the shrimp farms are owned by small-scale farmers, operating 1-2 ponds each ranging in size from 0.16 –1.6 ha. Indonesia is the second largest shrimp producing country after Thailand. Indonesia still has large undeveloped land in the outer islands, particularly in Sumatra and therefore has the potential to become the World's largest farmed shrimp producer, if the farming practices are done in a sustainable and responsible manner. China initially started with fresh water culture but in 1993, China found that overstocking and lack of provision for treating wastewater discharge resulted in decline in production. Unlike other South–East Asian countries, Phillippines lacks the abundance of resources suitable for shrimp culture. At its peak in 1993, Philippines produced 95 816 mt of tiger shrimp. The total production in 1997 fell

largely due to shrimp disease. Vietnam has steadily increased to a ten-fold growth over 12 years and Bangladesh is increasing its production year by year with extensive, semi-intensive and intensive culture systems. In the Middle East, Saudi Arabia is undertaking culture trials but resulted in slow growth. Over 12 000 ha of new farms are being designed and built with an average harvest of 1.8 metric tonnes per hectare and almost the entire crop is exported to Europe. Equador stands fourth in position as early in 1984 the production was more than the Asian countries. The production touched a peak of about 130 000 metric tonnes in 1997 with extensive and semi intensive methods of culture. In 1997, the Latin American countries Mexico, Honduras and Columbia produced 16,000, 12 000 and 10 000 MT respectively.

Table 1. International Shrimp Production

Country	Production (tons)	Grow out area (ha)	Average production (Kg/ha.)	Estimated no. of farms
EAST- Thailand	1,50,000	70,000	2134	25,000
China	80,000	160 000	500	8000
Indonesia	80000	350 000	229	60 000
India	40 000	100 000	400	100 000
Bangladesh	34 000	140 000	243	32 000
Vietnam	30 000	200 000	150	8000
Taiwan	14000	4500	3111	2500
Philippines	10 000	20,000	500	2000
Malaysia	6000	2500	2400	800
Australia	1600	480	3333	35
Srilanka	1200	1000	1200	800
Japan	1200	300	4000	135
Other Countries	14000	20 000	700	2000
TOTAL	**462 000**	**1 068 780**	**1455**	**241 270**
Average global %	70%	82 %		99%
WEST - Ecuador	130 000	180 000	722	1800
Mexico	16,000	20,000	722	1800
Honduras	12 000	14 000	857	220
Columbia	10 000	2800	3571	20
Panama	7500	5500	1364	40
Peru	6000	3200	5	45
Brazil	4 000	4000	1000	100
Nicaragua	4000	5000	800	25
Venezuela	3000	1000	3000	8
Belize	2500	700	3571	7

United States	1200	400	3000	20
Other Countries	2000	2000	1000	15
TOTAL	**198 200**	**238 600**	**1797**	**2390**
Average Global	30 %	18 %		1 %

Source : Jory .d.(1998). World Shrimp Farming in 1997. Aquaculture Magazine Buyer's Guide, 27: 32-41

The world shrimp farming production has increased rapidly for more than a decade but the rate of increase has remained fairly constant. However, in India it has recorded a dramatic increase emerging as the third largest producer of aquaculture shrimp in the world. In 1991, shrimp production accounted for approximately 12 to 14% of the total yield from the fisheries of the world, and is the only worldwide growth sector within fisheries (Aqua International, 1995).

Table 2. Total shrimp export from 1979 - 1988

Year	Total shrimp export (MT)
1979	51,162
1980	52,068
1981	51,358
1982	52,180
1983	55,002
1984	54,444
1985	55,398
1986	50,349
1987	49,203
1988	55,736

Source: Department of fisheries, Govt. of India

Table 3. Contribution of cultured shrimp to total export of shrimp from India by volume

Year	Total Shrimp Export (MT)	Culture Production (MT)	Product Weight (MT)	% Contribution
1988 – 89	56,835	28,000	18,300	33
1989 – 90	57,819	30,000	19,500	34
1990 – 91	62,395	35,500	23,075	37
1991 – 92	76,107	40,000	26,000	34
1992 – 93	74,393	47,000	30,550	41

1993 – 94	86,541	62,000	40,300	47
1994 – 95	1,01,751	82,850	53,853	53
1995 – 96	95,724	70,573	47,922	51
1996 – 97	1,05,426	70,686	45,945	44
1997 – 98	1,01,318	66,868	43,454	43
1998 – 99	1,02,484	82,634	53,712	52
1999 – 00	1,10,275	86,000	54,000	49
2000 – 01	1,11,874	1,13,700	65,894	59
2001 – 02	1,27,656	1,27,170	74,826	59

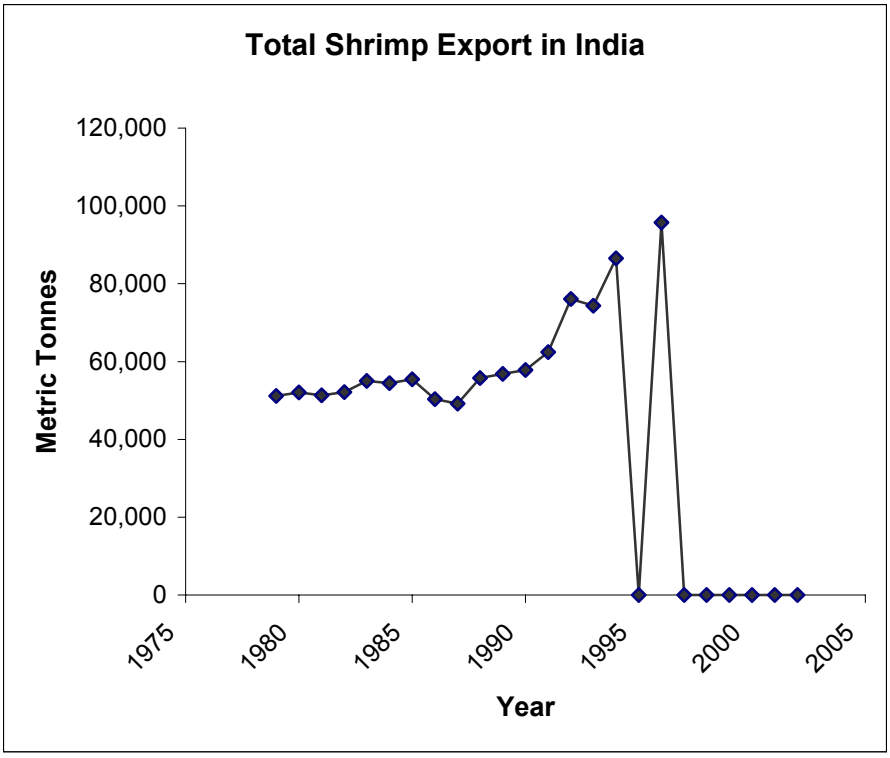


Table 4. Contribution of cultured shrimp to total export of shrimp from India by volume

Year	Value of shrimp exports (Rs. Crores)	Value of shrimp aquaculture exports (Rs. Crores)	% of aquaculture shrimp
1988 – 89	470	229	49
1989 – 90	463	261	60
1990 – 91	663	376	57
1991 – 92	976	545	56
1992 – 93	1180	766	65
1993 – 94	1771	1289	74
1994 – 95	2510	1866	74
1995 – 96	2356	1532	64
1996 – 97	2702	1643	61
1997 – 98	3141	2086	66
1998 – 99	3345	2511	75
1999 – 00	3645	2780	76
2000 – 01	4481	3870	86
2001 – 02	4132	3545	86

Source: Department of fisheries, Govt. of India

Shrimp Farming in India

The commercial scale shrimp farming using semi-intensive method started only in late 1980s and early 1990s with the setting up several large ventures in the coastal regions of Andhra Pradesh and Tamil Nadu. India, a minor player in the total seafood trade, enjoys a fairly prominent position in the world production of shrimps and commands an 8 % share in the world trade of shrimp exports.

India is endowed with rich natural resources in the form of brackish water and estuaries for taking up shrimp culture in the coastal zone of the country. The estimated potential brackish water area available in India is about 1.2 million i.e., 12 lakh hectares, of which only an area of around 82,540 hectares is utilized for shrimp farming, mostly adopting traditional practices in spite of “extreme focus” status given in our national plans in the late 80s and 90s to increase exportable production. The inadequacy of the catch in natural waters and high price in the international market impelled many countries to achieve higher levels of production through aquaculture using modern techniques.

The estimated area of shrimp farming is 1.2 million ha. (ie). 12 lakh hectares. The area under culture in India is 1,48,533 ha. in 1999(Table 2). The exact area of aqua farming varies year to year since in some areas of aqua farming conversion of aqua lands to agriculture takes place to maintain rotation of crops.

Table 5 : State-wise Details of Shrimp Culture (to be inserted)

Status of Shrimp Culture

- ✓ Shrimp culture in India is synonymous with coastal aquaculture
- ✓ It stands for export-oriented aquaculture
- ✓ As on today 1,94,000 ha are under shrimp culture producing about 1,27,170 MT of shrimps (31.03.2002)
- ✓ Aquaculture shrimp production today contributes substantially to shrimp exports – 74,826 MT by weight and Rs. 3, 545 cr. By value.

Objectives

1. To evaluate the environmental impacts of aquaculture farms in Tamil Nadu and Pondicherry at Bay of Bengal region.
2. To find out the impact on groundwater and surface water and measure the environmental cost of water salination.
3. To calculate the economic benefits of aquaculture in Tamil Nadu and Pondicherry.
4. To analyse the degradation/encroachment of agricultural lands & mangroves.
5. To value soil degradation of coastal land nearer aquaculture farms.
6. To suggest policy measures for sustainable aquaculture in India.

Methodology

Survey method	-	Socio-economic implication
Hedonic pricing method	-	Land evaluation, cost of decay
Contingent valuation	-	Pollution abatement and willingness to pay for pollution abatement
Opportunity cost	-	Between alternative uses of land

Sampling Design: Schedules

1. Prawn cultivators and owners
2. Farm agriculturists and landowners nearer to aquafarm.
3. Workers in Aquaculture

Socio Economic Benefits – Effects on living standard-consumption pattern – Employment- Standard of living conditions. Loss in agricultural production has to be assessed by input-output-net return assessment-farmlands before and after aquaculture - and strategies to be suggested for pollution abatement. Pollution Abatement cost added with fixed cost in order to prevent pollution. Farm owner's

willingness to be studied by ***contingent valuation method***, how much they spent on pollution abatement rather than stop production. Willingness to pay to be assessed from producers of shrimps. The hedonic price version will be used to predict the changes in the prices of extent measurement by the increases in values and depletion will be measured by increase in values.

Shrimp farms in Tamil Nadu

With an area of 130 058 Sq. km, Tamil Nadu is situated on the southeastern side of the Indian Peninsula. The state is bounded in the east by the Bay of Bengal, in the south by Indian Ocean, in the west by the states of Kerala and Karnataka and the north by Karnataka and Andhra Pradesh. Tamil Nadu is one of the nine maritime states of India endowed with the second longest coastline of 1076 km. The continental shelf of Tamil Nadu (up to 100 fathom/200 mts. depth) is narrow in most places varying from 4.0 to 6.0 Km in width from the coast and covers an area of 41 412 km.

Tamil Nadu with a total of 56,000 ha of potential shrimp farming area ranks sixth among the maritime states of the country. Although a total of 4455 ha has been developed (Government of Tamil Nadu, March 2001) in the state of shrimp farming, yet only a maximum of 2879 ha has been reported in use for farming (MPEDA, 2000). The average production rate reported during 1994-95 was about 1500 kg/ha, which declined to 400 kg/ha during 1995-96 due to the outbreak of viral diseases. By 1998-99, the production levels again recovered to 1674 kg/ha. In Tamil Nadu total area of an estimated brackish water resource is of 0.08 million hectare and about 27,000 ha are available for immediate utilization in the state. Of the total area developed in Tamil Nadu, farms covering 3178 ha area creek based and the remaining 1277 ha are sea based. About 3268 ha of the developed area is within the CRZ while 1187 ha in outside CRZ (Government of Tamil Nadu, March 2001).

Shrimp farms have been constructed on a variety of coastal lands including saltpans; areas previously used for agriculture crops, such as rice, sugar and

coconut, abandoned and marginal land, and wet land, including ecologically important mangroves and marshes.

The district wise break –up details brackish water potential is given in the table1. The total area under shrimp farming is 4455 ha, out of which 3178 ha are creek based and 1277 ha are sea based. The composition based on the area holdings revealed that 16 percent of farmers having less than 2 ha culture area; 32percent are having 2 to 5 ha and 35 per cent are having above 5 ha of culture area. The corporate sector is having only 17 percent of total culture area. The present culture is $ 455 ha which is only 30 percent of the estimated potential area of 14 880 ha rapidly available for shrimp farm development. Hence there is a wide scope for land based coastal aquaculture development in Tamil Nadu.

Table 6.

S No.	Districts	Brackish Water Area	Potential area readily available in ha
1	Chennai	240	---
2	Thiruvallur	14 660	2 662
3	Kancheepuram	---	---
4	Villupuram	8 100	2 703
5	Cuddalore	---	---
6	Nagapattinam		6300
7	Thiruvarur	31 400	
8	Thanjavur	---	---
9	Pudukottai	---	247
10	Ramanathapuram	900	1 385
11	Tuticorin	400	1 565
12	Thirunelveli	---	---
13	Kanniyakumari	300	18
	Total	**56 000**	**14 880**

Source: Department of Fisheries, Tamilnadu.

Status of shrimp farming

Brackishwater Fish Farmers Development Agency

Considering the potential available for coastal aquaculture development the Government of India during the seventh five-year plan period introduced establishment of Brackishwater Fish Farmers Development Agencies (BFDAs) for providing a package of technical, financial and extension support to the

shrimp aquaculturists; strengthening the technical wing in the state Fisheries Directorate; establishing demonstration-cum-training center and establishment of brackishwater shrimp farms and hatcheries in the Government sector under the centrally sponsored scheme.

The Government of Tamil Nadu established five BFDAs (Cuddalore, Pattukottai, Thoothukudi, Vanianchavadi and Ramanathapuram Districts) between 1991 and 1993 to look after the shrimp culture development of the 12 coastal districts. Apart from that one shrimp hatchery was established at Neelankarai. For the purpose of demonstration-cum-training, the Government of Tamil Nadu established model prawn farms in ten locations. (Pulicat, Vanianchavadi, Parangipettai, Thondiakkadu, Eripurakkarai, Kattumavadi, Keezhavaipar, Kannamunai and Punnakayal). Between the year 1991 to 1996 about 1 100 ha were brought under prawn farming benefiting 542 persons.

Semi intensive / Intensive culture

The untiring efforts of the Government have made the shrimp farming from the stage of century old subsidence oriented activity to that of an industry. The high profitability of shrimp faming coupled with liberalized policy of the Government, lured many entrepreneurs to import technology of semi-intensive and intensive farming systems in Tamil Nadu. It is reported that adopting of intensive farming technique reached the peak production of 16-17 tonnes /ha/annum in a private firm near Thoothukudi. Tamilnadu ranked first in the per ha yield of shrimp production which is 1787 Kg/ha. The rapid development in shrimp farming made the entrepreneurs to bring imported technology for hatchery production of shrimp seeds and feed mill units.

Infrastructure

Shrimp hatchery – in Tamilnadu there are 73 shrimp hatcheries with a production capacity of 3000 million –post larvae. These hatcheries cater need of shrimp farms of other states like Andhrapradesh, West Bengal, Goa,

Maharashtra, Gujarat etc., Because of the high quality of *naupli* derived from the wild brooders collected at Pazhayar, the hatcheries in the other parts of the country are also airlifting the required naupli from Tamil Nadu.

Shrimp feed – there are two feed mill units with a production capacity of 700 mts have been established with the foreign tie-up in Tamil Nadu.

Ice plants and processing plants – to support both the local and export market, there are 29 ice plants 43 processing plants, 89 cold storages have been established both the Government and private sector. The details are given below.

Table 7

S No.	Particulars	Nos	Capacity Day (in tonnes)
1	Freezing plants (Processing plants) i. Government ii. Private	 2 41	 48 500 586.250
2	Ice plants i. Government ii. Private	 -- 29	 -- 48 600
3	Cold storage, Walk in cooler i. Government ii. Private	 2 87	 1 70 000 8 875.00
4	Sea Food Manufacturing Exporter	75	--
5	Sea Food Merchant Exporters	268	--

Source : Department of fisheries, Tamilnadu, Chennai.

Port facilities – The ports at Chennai and Thoothukudi play a major role in marine product export. During the year 2001 – 2002 a recorded quality of 41 517 tonnes valued 1570.13 crores and 16 966 tonnes value 446.27 crores in export through Chennai and Thoothukudi port respectively. Among the marine products shrimps contributed the maximum of 74 percent.

Fish health management – Due to the efforts of MPEDA, in Tamil Nadu there are 8 PCR laboratories have been established in the private sector. The central

Institutions also have the PCR facility, which support by the farmers for disease investigation.

Leasing of Lands for Brackishwater Activities

Regarding the allegation that agricultural lands are being converted for shrimp aquaculture there is not much substance in the allegation as is evident from the findings of the study team of members of Parliament that visited eight coastal states during June-July 1997. The Ministry of Agriculture as early as in December 1987 issued guidelines to all the coastal states for classification, use and lease of brackish water lands for shrimp/fish culture, According to these guidelines 50% of the brackishwater ands requiring low investments may be reserved for individuals, group of fishermen or economically weaker sections or fishermen cooperative societies. The remaining 50% area requiring relatively high investment may be allotted to the public sector and private entrepreneurs. The potential areas for shrimp farming among the salt affected areas have been identified by the States after taking into account the nature of terrain, present land use and other biological interrelationships. Thus the vast resources of saline affected fallow lands can be put into productive use without compromising on the quality of the environment. The Supreme Court's directives that the agricultural lands, mangroves etc. shall not be used or converted for construction of shrimp culture ponds have been duly taken care of by the Aquaculture Authority already constituted under the provisions of the Environment Protection Act, 1986 as per the directives of the Supreme Court.

Land leasing policy – During the year 1992, the Government of Tamil Nadu introduced leasing government lands in brackishwater areas for prawn farming to private entrepreneurs. The leasing of Government land to private parties has evoked very hostile reaction among the local people. As per the Government policy 60 percent of the Government land is to be reserved for small-scale sector aquaculture industry including priority category. There lies a paradoxical situation i.e., those entitled for leasing of land will not be able to raise bank loan to carry

out capital works even for scientific extensive culture system. For these complex socio economic reasons the leasing of Government lands has been dispensed.

Encroachment of Government poromboke land – Most of the shrimp farms in the coastal districts have been established on private land or on encroached Government lands or on a combination of two. Out of the total area developed under shrimp farming about 465 farms covering an area of 677.52 ha have been established either under government poromboke lands or the lands being utilized for common purposes by the local community. This unregulated shrimp farm development provoked conflict among the resource users.

Aquaculture act – Government of Tamil Nadu

The Government of Tamil Nadu enacted an Act called Tamil Nadu Aquaculture (Regulation) Act, 1995 to regulate the unregulated development of coastal aquaculture, which has caused several social, and environmental conflicts. Subsequent to the direction of Apex court in a case related to shrimp farming development in the coastal areas, the Tamil Nadu aquaculture (Regulation) Act, 1995 become null and void, as the national level authority has been constituted to regulate the shrimp aqua farms of the country.

Financial Support – to make aquaculture more productive farmers need adequate timely financial support along with crop insurance and other supporting services. In Tamil Nadu NABARD was instrumental in financing the brackishwater fisheries activities prior to 1995. The social/disease problems faced by shrimp farming and the Supreme Court judgement to ban aquaculture in the CRZ and slow pace of regulatory measure made the financial institution to reduce their scale of operation in recent years. It is reported no refinance was disbursed to banks in Tamil Nadu by NABARD under the sub sector brackishwater fisheries during the last five years. Lack of awareness among banks about regulations with regard to brackishwater activities. Permitted activities, licensing system and over dues made reluctance by banks in financing this sector.

Supreme Court Judgement – December 1996

The unregulated growth of this sector with mushrooming of shrimp farms in coastal areas resulted in the filing of a Writ petition in the Supreme Court in 1994. The Supreme Court held that aquaculture is an industry and hence covered by the prohibition imposed in the CRZ notification mentioned above. The salient features of the Supreme Court judgement are:

- ☞ No shrimp culture pond can be constructed within CRZ except traditional and improved traditional type ponds.
- ☞ Shrimp culture ponds other than traditional and improved traditional set up within CRZ shall be demolished.
- ☞ An authority to be constituted under Environment (Protection) Act, 1986 to deal with the situation.
- ☞ Shrimp ponds outside CRZ to be set up with prior approval of the authority.

The authority so constituted by the Central Government shall implement the "Precautionary principle" and "Polluter pays principle".

Regulation of shrimp farming – In response to a public interest petition from Tamil Nadu the Hon'ble Supreme Court of India in 1996 directed to close down all the shrimp farms in the CRZ and to constitute an authority to regulate aquaculture based on "Precautionary Principle" and "Polluter Pays Principle" and approvals from Aquaculture Authority was made mandatory for establishing aquaculture farms. In Tamil Nadu there are 1 703 shrimp aqua farms established across the 12 maritime districts. The applications received from the shrimp farmers are scrutinized by the District Level Committees (DLCs) / State Level Committee (SLC) and Aquaculture Authority issues approvals based on the recommendation of the SLC. In Tamil Nadu the SLC scrutinized 383 applications as on date and recommended 253 cases for the issuance of approvals. The Aquaculture Authority issued 161 approvals so far the district-wise status of processing of application is given in the table 8.

Table 8

S no.	Districts	Total no of shrimp farms	No. of applications received for approval	Total no of inspected farms scrutinized by SLC so far	Nos. recommended and forwarded to AAI	Nos. approval by AAI
1	Thiruvallore	56	52	34	19	8
2	Kancheepuram	56	53	18	3	3
3	Villupuram	28	19	18	8	8
4	Cuddalore	156	123	112	85	60
5	Nagapattinam	996	454	56	42	30
6	Thiruvarur	32	30	21	---	---
7	Thanjavur	119	106	---	---	---
8	Pudukkottai	50	45	22	20	13
9	Ramnad	165	102	78	60	25
10	Thoothukudi	35	26	23	15	14
11	Tirunelveli	6	2	1	1	---
12	Kanyakumari	4	1	---	---	---
Total		1 703	1 013	383	253	161

Source : Department of fisheries, Tamilnadu, Chennai.

Diversification of shrimp farming – Aquaculture in India has remained synonymous to shrimp culture in brackishwater. Due to the outbreak of shrimp disease, the farmers were at crossroads without having any alternative technology for other marine finfish species. The Government of Tamil Nadu during 1998 – 99 initiated a pilot cum demonstration project on grouper culture at Punnakayal. The wild seeds collected from the Gulf of Manner Region are stocked in the pond. A production of 1 020 Kg/ha ten months was achieved with an average weight of 600 gms. Lack of perfected technology for breeding and rearing of groupers and the lack of bulk. Quantum for expert is the two major constraints in the development of marine finfish farming. Trails are on progress to perfect the farming technology of groupers, sea bas and milkfish.

Fisheries Development Mission – In Tamil Nadu the vast potential available in marine and inland fisheries including aquaculture is yet to be optionally exploited

for augmenting fish production. The Hon'ble Chief Minister's 15-point programme was announced this year, which *inter alia* includes the objectives of improving fish production and biodiversity in the inland and marine waters and there by improving the social and economic status of the poor fishermen and fish farmers. Working towards this goal, the Government has launched a Fisheries Development Mission with the aim of giving fillip to the production of inland and marine fisheries, to increase domestic consumption and export in an environmentally sustainable manner. Under the mission programme, it is proposed to develop about 1000 ha of coastal saline land every year for aquaculture purposes for the next five years of mission period utilizing low intensive traditional and improved traditional shrimp farming practices.

Pondicherry

The union territory of Pondicherry covers an area of 492 sq. km is unique in geography and consists of four isolated pockets far away from one another – Pondicherry, Karaikal, Mahe and Yanam. While Pondicherry, Karaikal and Yanam are situated on the Coramandel Coast, Mahe is situated on the Malabar Coast. Pondicherry has a coastline of 45 km, which is rich in marine fisheries resources. The total fish production of Pondicherry for 1998-99 was 42700 tonnes. Of this, 38600 (84.31%) tonnes was from marine sector alone. The Union Territory has only 45 kms of total coastal length in a discontinuous distribution, with limited brackishwater resources. Due to spatial constraints fishermen have adopted a short–term strategies to meet the basic family needs.

About 155 ha of shrimp farms have been developed from the available potential area of 800 ha. Of this area, 92.0% are creek-based farms. Further 15.0% farms are small with less than 2.0 ha farm holding; 41% within 2.0 – 5.0 ha holding; and 44% having holdings larger than 5 ha. All the farms have been developed outside the CRZ (Government of Pondicherry, January 2001). It is further reported that presently about 15 – 20% of the total farm area is only under operation (MPEDA, 2000).

Macro level survey was conducted to identify the potential brackishwater resources in the Union Territory of Pondicherry by the officials of Tamil Nadu Fisheries and Marine Products Export Development Authority of India (MPEDA), Tanjore. The surveys revealed that about 125 ha in Pondicherry, 745 ha in Karaikkal and 339 ha in Yanam regions were suitable for aquaculture.

A total of 98.06/6.80 ha (Private/Government) brackishwater land has been developed in this Union Territory for shrimp farming in the recent past. The Government of Pondicherry under the Centrally Sponsored Scheme (CSS) has developed 4 ha brackishwater farm at Karukalacherry, Karaikkal and licensed to Rajiv Gandhi Centre for Aquaculture, Mayiladuthurai, for sea bas culture technology and demonstration to the farmers/entrepreneurs. Another 40 ha developed under the CSS in Iskithippa Island, Yanam has been licensed to the three Fishermen co-operative Societies of Yanam region for shrimp farming. Brackishwater land measuring about 12-13 ha at Vanjour, Karaikkal, has been licensed for the purpose of shrimp culture and aquaculture demonstration-cum-training programme for promoting the economical status of women and to extend training to the women fisher folks of the nearby village. Further about 2 ha of brackishwater land at Akkaravattam is proposed for shrimp hatchery management by the M S Swaminathn Research Foundation, Chennai.

Generally, improved traditional type of culture is practiced by the private entrepreneurs using shrimp species such as *Penaeus monodon* and *Penaeus indicus*. No ground water is drawn for this purpose. The farm size ranges from 0.5 ha to about 13 ha respectively. There is only one private shrimp hatchery, M/s. Silva Aqua farm functioning at Nallavadu fishing village, at Pondicherry.

Harvest of the shrimp ranges from 100 kg to 134 kg per ha year as traditional and improved traditional methods are adopted. The harvest is being disposed off by the private entrepreneurs in the shrimp farm itself. The labour employed for the farm activities ranges from 5-5 employees in each farm. The socio-economic conditions of the near by inhabitant are enhanced by providing water facilities,

inter-connecting road facilities, employment opportunities etc., No adverse impact has been reported by the aquaculturists. Environment impact assessment study has been conducted by the Central Marine Fisheries Research Institute (CMFRI), Kochi, in Karaikal region and has reported no adverse impacts.

On the directions of Government of India, Government of Pondicherry has also constituted one District Level Committee / State Level Committee under the chairmanship of the collector and Secretary (Fisheries) respectively to regulate the aquaculture projects / shrimp culture in the Union Territory of Pondicherry. The Director of Fisheries is the member Secretary to the District Level Committee and State Level Committee and the Department of Fisheries and Fishermen welfare in the Nodal department.

Nearly 53 aquaculturists have applies for the approval of the Aquaculture Authority for undertaking shrimp farming. Approval of the Aquaculture Authority is obtained for 15 aquaculture projects (4 Government and 11 private). The remaining projects are under scrutiny by the District level Committee. Since both the District Level Committee and State Level Committees in Karaikal, and Yanam, and Pondicherry region headed by the respective Regional Executive Officers and Additional District Magistrate, and one State Level Committee headed by the Secretary (Fishery) has been constituted.

The policy undertaken for developing brackishwater aquaculture is by way of extending Government subsidy facilities to the aqua farmers. The farms, which have obtained the approval of the Aquaculture Authority, are being inspected periodically by the officials of the Fisheries Department of Pondicherry, as and when diseases are reported in the course of shrimp farming, the experts are invited from institutions such as CMFRI and MPEDA and their assistance is sought for treatment. In recent years, shrimp farming practices are gaining momentum among the aquaculturists because of its high commercial value and increased demand in the global market.

Role of MPEDA in Aquaculture

- Export potential of shrimp aquaculture identified as early as in 1979.
- Field offices were established for promoting shrimp aquaculture in all maritime states during early 1980s.
- Bottlenecks identified and steps taken to remove them.
- First two commercial shrimp hatcheries were established in 1989 with overseas collaboration
- Played a key role in promoting shrimp aquaculture more vigourously after introduction of market economy
- Production increased from 28,000 tonnes in 1988-89 to 82,000 in 1994-95 and 1,27,000 tonnes in 2001-02.

Table 9. Shrimp production and exports from India

(Quantity In Tonnes)

Year	Quantity (In Tonnes)	Percentage Growth Rate	Value (Rs. in Lakhs)	Percentage Growth Rate
1985 – 86	50349	--	32981	--
1986 – 87	49203	-2.28	37793	14.59
1987 – 88	55736	13.28	42578	12.66
1988 – 89	56835	1.97	47033	10.46
1989 – 90	57819	-1.79	46331	-1.49
1990 – 91	62395	7.91	66333	43.17
1991 – 92	76151	22.05	97912	47.61
1992 – 93	74394	-2.31	118026	20.54
1993 – 94	86541	16.33	177073	50.03
1994 – 95	102335	18.25	251809	42.21
1995 – 96	95947	-6.24	235901	-6.32
1996 – 97	105482	9.94	270361	14.61
1997 – 98	101318	-3.95	314056	16.16
1998 – 99	102484	1.15	334491	6.51
1999 – 2000	110275	6.25	395678	12.56
2000 - 2001	111874	5.26	412567	8.69
2001 - 2002	127656	9.45	456897	11.56

Source: MPEDA & Production of Export Quantity and Value.

Table 10. Comparative Statements of Production and Export

(Quantity in tonnes)

Year	Production	Percentage Growth Rate in Production	Export	Percentage (Growth Rate in Export)
1990 – 91	35,500	--	62395	--
1991 – 92	40,000	12.67	76151	22.05
1992 – 93	61,100	52.75	74394	-2.31
1993 – 94	62,000	1.47	86541	16.33
1994 – 95	82,850	33.63	102335	18.25
1995 – 96	70,573	-14.82	95947	-6.24
1996 – 97	70,687	0.16	104582	9.94
1997 – 98	66,868	-5.40	101318	-3.95
1998 - 99*	83,819.39	25.35	102484	1.15
1999 – 2000*	87569.32	12.56	112459	6.57
2000 – 2001*	75896.24	13.54	110596	2.36

* - Projection Figure.

The export of Shrimp has been increasing rapidly from 62395 tonnes in 1990-91 to 105482 tonnes in 1996-97. The production of shrimp shows marginal increase from 1990-91 to 2000-2001.

Present status of shrimp culture

The rapid development of shrimp culture has been accompanied by many controversies resulting in a closer look at the environmental and socio-economic impacts of shrimp aquaculture. Its unregulated growth especially in the east coast passing Andhra Pradesh and Tamil Nadu has been a matter of serious concern and has been resulted in a serious matter of consideration by the supreme court of India as a public interest litigation in 1994 against the writ petition field by Shri. Jagannathan, Chairman, Tamil Nadu Gram Swaraj Movement. The Hon'ble court by its order of December 12, 1994,(order enclosed as annexure) directed all the respondent states not to permit the setting up of any

industry or the construction of any type on the area atleast upto 500 metres from the seawater at the maximum high tide. Apart from this, a special team from NEERI, Nagpur was appointed to investigate the impacts on the environment due to aquaculture. Following reports submitted by the NEERI experts, the Hon'ble court issued interim orders banning conversion of agricultural lands and self farms into commercial aquaculture, withdrawal of ground water for aquaculture purposes and setting up of shrimp farms or any aquaculture farms in the area of dispute in the future.

Study Areas

The following zones were selected for survey by the project to study the conflicts and environmental impacts of aquaculture in Tamilnadu and Pondicherry

Zone 1	-	Chennai , Ponneri, Minjur, Kancheepuram
Zone 2	-	Pondicherry, Cuddalore, Parangipettai, Chidambaram
Zone 3	-	Nagapattinam, Sirkazhi, Vedaranyam, Thanjavur
Zone 4	-	Pattukottai , Thondi, Mimisal, Ramnad

Informations were collected from the agriculturists and aqua culturists by land survey and through questionnaires distributed to them by the project researchers. Soil and water samples were collected from problematic zones at the respective areas and analysed for their impacts.

Results / Data analysis

The results of the project are summarized below based on the objectives.

1. Environmental impact of shrimp farm effluents

The pollution caused by the water discharged from the shrimp farms is a big matter of concern responsible for the conflicts between aquaculturists and other protesting groups in Tamilnadu and Pondicherry. The fact understood is that the effect of pollution from shrimp farm effluent is considerably less than that of domestic or industrial wastewater. However, the effluent discharged during pond

cleaning has a much greater pollution potential. The release of effluent is rich in organic matter and results in siltation, changes in productivity and community structure of benthic organisms. The creeks and canals receiving the discharge also get silted up as a result of organic matter discharged from shrimp farms, which leads to the depletion of dissolved oxygen levels in the receiving waters. Further, the discharge of nutrients carries the risk of eutrophication and sudden outburst of algal bloom in coastal waters affecting the environmental conditions and ecology of the area. Again the environmental deterioration will work against the sustainability and play a major role in the development of disease problems with serious production losses. It is to be pointed out here that even though the disease outbreaks are directly linked to the environmental factors no conclusive study is available to understand the pathways of disease causing pathogens and the interaction involved.

A greater understanding of the relationship between shrimp stress, disease and pond production would certainly help to provide the basis for improved management of ponds. Managing the environment in a way, which ensures it, is suitable for the shrimp and not for the pathogen, is now recognized to be an important procedure put forward in disease control. This approach also put self-reliance and sustainability for development of farm level solutions. It is learnt that due to the lack of awareness or neglect most of the shrimp farm projects are established without any environmental impact assessment that provides means of examining sustainability during the planning of aquaculture projects. Therefore it is essential to give due consideration at the planning stage for the potential risks inherent in the site i.e., soil and water quality and the potential impacts on the external environment such as effects of effluent discharge.

1.1. Agriculture V/s Aquaculture Issues

The environmental problems associated with modern shrimp aquaculture are not related to ownership, culture practices or scale of operation. All types and sizes of farms have created environmental problems. However, the nature of the problem and impact are somewhat different. Another prevailing environmental

issue is that the fertilizers and bio-pesticides applied in aqua farms are other components degrading the soil quality is the comments by the opposition groups. However, it was found that the main chemicals used in aquaculture are lime and chlorine. There is so far no scientific evidence to show that these two chemicals will lead to irreversible soil degradation. It is therefore wrong to say that shrimp culture is a short-lived industry. The aqua farmers in India largely practice extensive farming and there is therefore no need to apply a large quantity of lime and chlorine as is the case in Thailand and Taiwan. Further, lime and chlorine are used for hygienic maintenance of surroundings and chlorine even in drinking water. Unlike toxic pesticides used in agriculture, aquaculture does not involve usage of such concentrated chemicals except use of medicines / antibiotics and probiotics to ensure the steady growth of the shrimps and to prevent diseases and mortality in intensive culture systems. In preliminary stages of aquafarming chemical components such as lime and zeolite are used as disinfectants and to maintain the alkalinity and fertility of the soil and water. Certain compounds like iodine if used at very high concentrations is reported to cause havoc to the productivity of the water systems

2. Impact of aquaculture on water quality

Water with required quality and quantity is required for different stages of shrimp farming. In the shrimp hatchery unpolluted seawater is required for brood stock maintenance, spawning, larval rearing and culture of food organism. Potable water is required in sufficient quantities for drinking and cooking food for the workers. The grow out farm ponds need sea/brackish water, free from agriculture, domestic and industrial pollution and also within the required salinities, pH and temperature ranges. The quality of water and even the impacts from external environmental changes pose threat to the sustainability of shrimp culture. The higher water demand of more intensive culture is such that demand can easily outstrip supply in areas with poor tidal flushing. Therefore, people are of the opinion that the deterioration of drinking water quality is due to aquaculture. However, this fact that drinking water quality is affected by shrimp

culture in coastal habitats is not true since seawater intrusion is also found to attribute salinization in coastal areas of Nagai and Ramnad districts.

2.1 Impact on surface water and ground water

The salinisation of surface water is another water quality impact from shrimp farms to the receiving waters. It is reported that shrimp farm construction can potentially alter surface water flow patterns and water quality. Water flows were found to be affected by the temporary blockage of permanent division of canals and discharge of untreated pond effluents into the natural system was known to hinder the water quality. Further, seepage of saline water from the ponds into the ambient areas also leads to the salination of the ground water. There are cases of stratification occurring in the surface of fresh water zone with the mixing of deeper saline water that will affect the agriculture land when the farmers unknowingly pump the salinised water into farmland, which damages the land quality. Effective pumping of saline water in case of bore water dependent farms and fresh water in case of coastal farms are reported to have resulted in fall of ground water table. The salinated ground water also affects the drinking water sources of the coastal villages. Shrimp farming causes dispersion of salt into land around the shrimp farms there by increasing the salinity intrusion affecting the paddy fields and other plantations. The soil salinisation further resulted in devaluation of marginal agricultural land. Abstraction of fresh water from underground aquifers for intensive shrimp farming has also resulted in saltwater intrusion and salinisation of fresh water aquifers. While fresh water aquaculture poses little negative impact on ground water and aquifers, brackish water aquaculture is detrimental to subterranean water resources. It is suggested that a system of geo-grid fabrics can be utilized in order to prevent salinisation of ground water (Isaac, 1995). This issue concerns the proper site selection and engineering rather than negative aspect of aquaculture.

2.2. Aquaculture Vs Water quality

Parthasarathy (1995) pointed out that many drinking water sources in villages adjacent to shrimp farms have turned saline due to the indiscriminate pumping of ground water by shrimp farms. The intrusion of seawater coupled with the seepage of effluents has caused health hazards like Cholera, Malaria, Jaundice and Eye ailments. The Bhagavathi Environment Development Institute, Dindigul claims that an analysis of water samples from half a dozen villages in Sirkazhi Taluk has shown a disturbing degradation in the quality of ground water. Hardness and alkalinity levels of water collected at 17 points in seven villages were alarmingly in excess of the prescribed tolerance limit of drinking water. These are attributed to shrimp farms setup along the coast in the past two years. But CMFRI (1995) reported that the quality of groundwater in the entire coastal area (Nagapattinam Quaid-e-Milleth district) is saline. As such implicating the very recently started shrimp farming for such development is not at all justified and that too in the absence of any data before shrimp farming came into operation for comparison.

An investigation on water quality has been carried out in 14 villages in coastal area (Sirkazhi Taluk) of Nagapattinam district. Out of 14 villages 8 are found near to shrimp culture ponds, viz. Thirumullaivasal, Thazhanthondi, Radhanallur, Vazhuthalakudi, Thirunagari, Thirukovalur, Annappanpettai and konaiampattinam. Another 5 villages are found in agricultural area, viz. Amaipallam, Vadakal, Thirukarukavur, Keeranallur and Semmangudi. One more village/colony (Ambedkar nagar) is away from both shrimp culture and agricultural area. Water samples were collected on monthly intervals and analyzed for physico-chemical parameters to find out the quality and suitability for drinking purposes. Physico-chemical values are given in Table 3 and compared with drinking water standards given by WHO.

Drinking water samples from Thazhanthondi, Vazhuthalakudi, Varusapathu and Thirukarukavur are safe for human consumption. There is no substantial amount of data regarding water quality in particular area for yester years to compare the

quality. These findings clearly indicate that shrimp farms have not salinated their neighbourhood as charge sheeted by the anti-aquaculturists.

Table 11: Levels of physico-chemical parameters in Drinking water samples from coastal villages (Sirkazhi taluk) (July – Nov 2001)

No.	Parameters	July	August	October	November
1	PH	7.09-7.33	7.24-8.43	6.8-8.8	5.3-6.76
2	Conductivity	493-2910	222-5220	---	431-5840
3	TDS	246-1450	111-2610	---	215-2920
4	Carbonate	0-108	18-108	12-90	12-96
5	Bicarbonate	12.2-171	6.1-299	18.3-372	12.2-220
6	Chloride	97.5-833	79.8-1383	26.6-3562	17.7-1560
7	Sulphate	3.5-378	12.7-420	15.4-304	6.5-98.2
8	Calcium	12-66	20-76	36-132	24-92
9	Magnesium	14.4-79	4.8-86	2.4-175	4.8-763
10	Sodium	---	---	35-810	38-680
11	Potassium	---	---	11-230	9-180
12	Nitrate	---	0.14-2.3	0.05-1.96	0.01-3.76
13	Silicate	---	12.5-233	37.7-38.4	0.55-37.7
14	Phosphate	---	10.6-150	9.25-290	0.1-14.6
15	Fluoride	---	---	0.1-0.24	0.62-0.74

All values are in mg/l: Conductivity - μ mhos.

2. 3. Impacts on soil and water – Environmental analysis

It was reported that shrimp culture activities lead to the salinization and contamination of the adjacent agricultural fields and the surface / ground water of the nearby locality in some areas of the Nagai district. However, there were no such complaints in other zones surveyed. However, it was intended to investigate the impact on soil and water in most areas of the study irrespective of the complaints by the public. Soil samples were collected from the near by agricultural / non-agricultural areas close at the aqua farms at varying distances (1Km, 3 Km, 5 Km) and water samples from wells respectively. Water samples could not be collected in some areas of the survey due to water scarcity in the domestic sources and the long distances to retrieve it. The samples collected were analyzed for their environmental impacts in the Soil Research Institute, Kancheepuram and their quality was determined. The analytical data obtained from different locations of the project study is presented in tables 6 and 7.

Analysis – Based on the analytical data it could be inferred that among the 42 soil samples collected in the 4 zones, certain areas (10 samples) in Nagai district and Ramnad district (2 samples)) were found to be slightly influenced by the shrimp farms with increased pH (8.4 – 9.9) tending to alkaline soil and increased EC values (4.7 –30.0) which depicts the increase in the salinity of the soil. However, no other changes or impacts were noted in the soil quality. Most of the sample soils were under paddy cultivation. Impacts on the water quality also show slight changes in the pH (8.3) in Kurichi area of Nagai district (1 sample) and slightly increased EC values in Minjur (Kancheepuram district) (3.0) (1 sample) and Nagai district (3.0 – 7.6) (12 samples). Other chemical components are found to be within the permissible limits. Based on this environmental analysis, it could be confirmed that shrimp culture activities may result in slight disturbances in areas at the vicinity of the shrimp farms (1–3 Kms) whereas areas away from the farms (5 Km) are least affected.

It is also found that may aqua farms in Nagai and Ramnad districts are situated in the coastal areas close to the sea or backwater areas. Even at areas where there are no shrimp farms, the lands and ground water are saline because of the nearness of sea and regular tidal flushing, seepage, humid climate, and meager and narrow fresh water tables in the coastal belt. The normal soil texture appears to be sandy loamy soil with saline patches on the surface layers, which attributes to the coastal salinity from seawater intrusion. Therefore, it is not correct to say that shrimp culture is the only causative factor for soil salinization or water contamination in these areas.

The only problem identified by our survey is that the shrimp farmers directly discard wastewater without treatment into the public canal or coastal area or river and inshore areas that results in conflicts. It is therefore important to mention that if the effluents from aqua farms are treated before reaching the environment particularly when the organic load is high at time of harvest and such effluents are passed through primary sedimentation and secondary biological oxidation treatment before discharging into the water bodies there may be an amicable solution for the development of the industry.

3. Economic benefits of Aquaculture in Tamilnadu and Pondicherry

It is an industry of the rich, is the common belief among the public. This is not true. About 99.9 percent of the shrimp farmers belong to the small-scale sector while there is a small proportion of middle level entrepreneurs. About a dozen companies, which had setup large farms, could not do well. Most of them have ended their operations. However, the contribution of the corporate to developing the basic infrastructure for shrimp farming along with support services such as hatchery seed and feed supply in the beginning as well as the development of roads, communications and electric supply in the rural areas cannot be denied. The Socio-economic survey conducted in the Coastal Tamilnadu indicates that the standards of the people living around the ponds are better than the agriculturists. The reason behind this was noted due to the vast employment opportunities generated by the aqua farms of Tamilnadu. The average income of a skilled labour ranges between Rs. 4000 – 5000 / month.

Infra structure facilities are the most basic need of the people, which is the responsibility of the Government. However, this has been lacking in many places of Tamilnadu has been found to possess increased basic infra structure facilities like basic transport facilities and communication. Apart from this, shrimp farm areas in Tamilnadu were found to possess more other infrastructural facilities like educational institutions, banking and non-banking services and a number of voluntary organizations. (Table 12)

Table 12. Infrastructure Facilities

Institutions	Tamil Nadu (%)
Education facilities	94
Banking and non –Banking	76
Communication	82
Voluntary Organizations	54
Transport facilities	100

Employment is the basic requirement of the people for the better standard of living. According to the study, the overall observation and response of the

interviewed people it is inferred that prawn culture gave more employment in Tamilnadu. (Table. 13) Refer annexure.

Table 13. Dynamism of Employment in the area

Status of Employment	Tamil Nadu (%)
Change in Employment	30
Family Employment	18
Women Employment	18
Village Employment	14

Table 14. Infra structural changes in Tamil Nadu

Infrastructure	Tamil Nadu (%)
New Roads	46
Construction of new houses	48
Improvement in Transport facilities	4
Change in communication	32
Offices	66
Quarters	2
Market facilities	22

Infra structural changes were found to be significant in the area of shrimp culture of Tamilnadu (Table. 14). According to the response of the interviewed people, it was known that changes in infrastructure facilities like new roads, construction of new houses, transport facilities, communication facilities, Office, Quarters and market facilities are undertaken. It is also understood that the efforts are taken by the shrimp farmers in these villages for these developments.

4. Degradation of Mangroves for aquaculture

Mangroves are endangered by hostile habitats and human abuse in the past. This has resulted in the fast destruction and degradation of the mangroves that

have already caused coastal erosion and decline in fishery potential in Tamil Nadu. It is difficult to assess the impact of shrimp aquaculture on mangroves in terms of quantity and quality although it is indicated that the overall loss of mangroves due to shrimp farm development is less than 3% of the total loss. The loss of mangroves on account of shrimp culture is diminishing because of regulations imposed by the Government.

The two important mangrove ecosystem of Tamil Nadu are:

Pichavaram Mangroves in Chidambaram.

Muthupet mangroves in Vedaranyam.

The coastal belt of Vedaranyam in Tamil Nadu has been reported to have lost nearly 40% of its mangrove area utilized for various purposes, which has led to the reduction of 18% of fishery resources with 13-year period from 1976-1989. Mangroves have been exploited by various farms of pressures viz. the agriculture, industries, fuel wood extraction and diversion of water for irrigation and aquaculture (prawn culture) which was carried out at the expense of mangroves in the early 1990's.

Though degradation of mangroves for aquaculture activities have taken place significantly in other states of India like Andhra Pradesh, the mangroves of Tamil Nadu that exists in Pichavaram and Muthupet are well conserved without any interference of the aquaculture activities. The only problem encountered in these mangroves regions is cattle grazing, indiscriminate fuel woodcutting in Pichavaram and Muthupet. Other factors involving constructions of urban development and industrialization also account for the degradation of mangroves. The survey hitherto undertaken in these areas has emerald no aquaculture activity being carried out in the vicinity of mangroves of Tamil Nadu. It is understood that after the verdict of the Supreme Court on 11 December 1996 to the Aquaculture Authority of India, proper measures are enforced to curb any such activities to preserve the posture beauty of these natural resources, which act as the major nursery grounds for the prawns.

The degradation has occurred mostly in sparse mangrove forests due to expansion of saltpan and human activities. The mangrove forest at Point Calimere is also found to be degraded in density. However, dense mangrove forests have increased from 706 ha to 958 ha. In total, nearly 87 ha of total mangrove forest have been degraded. As Muthupet area is dry for most of the year, human activity like cutting the wood for fuel, grazing by cattle, etc., have caused the degradation of mangroves. Agriculture areas, habitation with vegetation and saltpan areas have increased at the expense of mangrove vegetation and mudflat areas (Ramachandran , et al., 2000).

The Pichavaram mangrove forest area was declared as a Reserve Forest in 1897. The total area of the wetland including the forest area, water spread area, barren mud flat, etc., is about 1 100 ha. Subsistence fishing is the main activity within the mangroves. Agriculture is the main land use in the area around the mangrove wetland and in recent years a large number of small-scale shrimp farms are being constructed very close to the mangroves (MSSRF, 1995).
The studies carried out in Pichavaram area of Tamil Nadu by M S Swami Nathan Research Foundation, Chennai showed that the degradation of mangroves is largely due to biophysical factors such as changes in topography and tidal water flow pattern (MSSRF, 1996). Further, remote sensing studies conducted by the Institute of Ocean Management, Anna University in Pichavaram, have shown that the mangrove forests have increased from 461.98 ha in 1987 to 475.99 ha in 1998; while the degraded mangroves have reduced from 152.93 ha to 120.25 ha. During the same period, area under aquaculture increased from 6.99 ha to 331.27 ha. it is also reported that 6.0 ha of mangrove area has been converted into shrimp farms and fallow lands have reduced from 1 045 ha to 425.88 ha (Jayanthi and Ramachandran , 2000)

Brackish water aquaculture in the mangrove rich areas of the coastal zones has been practiced traditionally. These sites were considered suitable for farming due to the tidal flow, fresh water influx and availability of seed resources. The last two decades have seen a great expansion of this activity, with commercial shrimp

culture as the most dominant component planned conversion of mangrove forest areas to aquaculture focus is the outcome of these efforts.

The other encroachments for shrimp farms are taking place in mangroves. In Thailand, Taiwan, Philippines, etc. the expansion of shrimp culture has led to destruction of mangroves. The loss of mangrove area can lead to ecological, economic and social impacts. Biologically, mangroves are important breeding ground or nursery area for many commercially important finfish, crustacean and mollusks. It has been reported from Thailand and Bangladesh that the expansion of shrimp farming into mangrove areas has lead to reduction in fish catches and declining socio-economic conditions for traditional coastal fishermen. In India we are receiving reports that the coastal population is deprived of the firewood collection facility and fodder to their cattle, due to the conversion of mangroves into farms.

The mangrove also contributes to the sustainability of other human activities through coastal water quality regulation and shoreline protection. It is alleged that the carry over effect of the destruction of mangroves for short-term benefits will lead to greater economic effects in the long run. When we think of sustainable shrimp aquaculture it is necessary to keep the mangroves free from encroachments. It is also recognized that shrimp farms on mangrove land often support profitable shrimp culture for only short period. In other words, mangroves are not normally the places for sustainable shrimp farming. The acid sulphate soils common in mangroves also can affect the sustainability very badly.

Sustainability in Shrimp Culture

For better sustainability Government needs to recognize aquaculture as a distinct agriculture sector that requires a complex regulatory framework. Aquaculturists must understand the fundamentals of management, economics, marketing and environmentally friendly concepts and not just advanced techniques alone. The effect of neglecting sustainability in aquaculture development has been well illustrated by the dramatic collapse of the shrimp culture industry in Asia during

later part of the last century. The scarcity of aquaculture regulations and management measures resulted in the aquaculturists to expand the culture areas enormously to make unreasonable increases

Modern scientific shrimp farming is not carried out in mangrove areas owing to the following disadvantages:

1. Mangrove lands are mostly potential acid sulphate soils characterized by acidic nature which is not suitable for shrimp culture
2. Clearing of the mangrove forest is cost- prohibitive
3. High organic content of the mangrove forest soil is unusable for dyke construction, and the cost of construction escalates many fold if the soil is brought from outside.
4. Reclamation of acid sulphate soil and pre-conditioning of the pond bottom requires heavy application of lime and several months are required for the purpose

The positive effects of retaining mangroves to the sustainability of shrimp farms also have to be considered. The coastal ponds if constructed behind the mangrove buffer zones, get the protection from several physical hazards and also may favourably influence water quality in the farming areas. Mangroves have potential to remove excess nutrients, reduce suspended solids, remove heavy metals and absorb toxic hydrocarbons. Considering all these aspects a mangrove coastal buffer zone is essential to sustainable shrimp culture. To enable the development of sustainable shrimp farming it is necessary to prepare an area wise master plan demarcating the area considered suitable, the areas that have to be retrained untampered with existing type of utilization and a buffer zone between shrimp farms and agricultural land and/or mangroves.

Impacts of aquaculture in Taiwan, Philippines – A Comparison

There has been considerable expansion of aquaculture in the mangrove areas of some countries like Taiwan, Philippines and Indonesia. In Philippines, out of the total area of 500,000 ha, 322,154 ha, of mangrove area has been converted for utilization, of which 206,525 ha was under aquaculture. Taiwan had an area of 11,000 ha out of which 8000 ha under aquaculture. Production rates in shrimp culture have gone up to 20 tonnes per ha as in Taiwan and also in isolated cases in the Philippines, which practice intensive shrimp farming techniques ; this against an average of 500 kg per ha in the traditional exclusive culture practiced in the mangrove regions.

Taiwan, with only 8000 hectare land under culture, has the highest production rates for shrimp industry over two decades has climaxed to a production of 89,622 tonnes in 1987, however there was a sharp decrease to 43,887 tonnes in 1988. The drop was almost entirely due to a sharp drop in the volume of shrimp production from 78,848 tonnes in 1987 to 30,603 tonnes in 1988. The crisis was caused by utter disregard for environmental health, which led to serious diseases of epizootic proportions identifying the causes for the collapse it was found that viral, bacterial and protozoon diseases were rampant. The first such national complete collapse in shrimp culture was that of Taiwan followed by partial collapses in of shrimp production in China, Indonesia and Thailand (FAO/NACA, 2000).

Since the Taiwan experience of 1987, there has been an increasing realization towards sustainable development of aquaculture. Aquaculture sowing and diversification of species to make use of natural location advantages and environmental compatibility are being stressed. Though many senses were considered as “waste land” most parts of the world and were either ignored or alased, until the 1960’s, the ecological and economic values of mangroves began to be well documented. The roles of mangrove forests in coastal protection (e.g., against storms and erosion), the perpetuation of coastal water quality and the maintenance and production of coastal fishery resources are worth mentioning.

They also help the socio-economic development of the coastal communities by traditional sources of medicines, firewood, and timber.

5. Degradation / encroachment of lands

Shrimp culture in Tamilnadu was actually introduced with full support from the Government as viable alternative for paddy cultivation and also for utilizing the barren and uncultivable, alkaline lands profitably. This culture has helped the area directly and indirectly with more business and economic activities in the region. The unexpected protests due to various reasons gave a dead blow to the growth as well as to the future of the Industry. But, in spite of the country's apex court's rulings, the Industry is still surviving and considerably contributing to the state’s economy.

Land being a prime component of aquaculture is found in the following proportions in Sirkali Taluk, a prime location of flourishing aquaculture in Tamilnadu. Sirkali taluk is comprised of 583.73 Sq. km i.e. 58373 ha of land. The net sown agricultural area in the taluk accounts for about 57 percent of the total geographical area. Agriculture has been the major occupation of the people in this area. About 1102 ha (less than 2 percent) of land remains as forestland which is far below the national average of 23 percent. The area occupied by shrimp /prawn farms in the taluks of Sirkali, Tharangampadi and Nagapattinam is about 2000 ha, which is less than 2 percent of the total geographical area. These farms have actually paved the way for the utilization of the barren, uncultivable lands. This area is situated at the tail end of the River Cauvery irrigation system and the prospects of cropping have been dim and disappointing due to inadequate and untimely water supply. Hence, the farmers were frantically looking for an alternative use of their lands or for disposing them off for good prices. The per capita available arable land in Sirkali taluk is 0.163 ha as compared to the national availability of arable land, 0.219 ha. As the size of the arable land is decreasing with the increasing population, it would be difficult to produce the staple food grains like rice and other cereals. But some of the agricultural farm owners have taken up prawn farming for making quick and huge

profits. Some others have sold their lands to private and Corporate bodies, interested in setting up aqua farms for earning huge profits in a short time.

Shrimp farming in Nagai district commenced in a small - scale in 1991 and became intensive from 1993. Due to shrimp farming, the value of land has increased manifold. Before the commencement of shrimp farming, the land value was only about Rs.18,000 to Rs.20,000 per ha., but has increased to about Rs.1.5 lakhs to Rs.1.8 lakhs per ha., i.e. 10 times when shrimp farming gained popularity. The ownership pattern of land has also radically changed. About 20 percent of the coastal lands holdings were sold to big aqua farms as the size of the lands were small (less than one ha), (40 percent due to high price, 30 percent due to inadequately profitable crop production and 10 percent because of non-availability of labour). Some entrepreneurs have not set up their farms after spending huge sums for buying the lands due to the protests against the prawn farms. The price value of land has come down now because of the prevailing situation in this area.

The traditional agriculturists in the coastal areas have profitably utilized the money realized from the sale of their lands to purchase interior fertile farmlands. Those who have purchased lands for shrimp farming are mostly from other regions and now they are in a fix and some of them have given their lands to the local farmers on lease for setting up shrimp farms. Most of the aqua farmers in Sirkali Taluk have taken up shrimp culture mainly for export purposes, as aquaculture is financially a lucrative venture from individual entrepreneur point of view. Profits have ranged from 20 to 50 percent per annum, which cannot be thought of in any other activity. This increased profits and better wages are also responsible for the overall improved economic activities and better standard of living of the people in the region. In the case of shrimp farming, drinking water is polluted and the society is forced to spend money for getting drinking water. This has been a major issue in the recent past due to rising oppositions against shrimp culture industry, which has rendered a helping hand to many poor farmers and agriculturists. Therefore, it was sought to identify the positive and negative impacts of aquaculture and formulate measures to curtail the persisting conflicts to form a conducive industry favourable for mankind.

Use of Chemicals/antibiotics

The food and Agriculture Organisation of the United Nations through a press release dated 24 January, 2002f has suggested that countries should take steps to stop the sue of Chloramphonicol, a broad spectrum anti-biotic used in human and pet animal medicine. It is stated that the studies have shown that this compound is genotoxic which means it could cause genetic damages and possibly lead to cancer. It is understood that the European Union has imposed a complete ban on import of all aquaculture marine products from a few countries on acunt of detection of chloramphonicol in their products. Some of these antibiotics are used in some of the culture system mainly for shrimp culture. Steps are to be taken to discourage the use of these anti-biotics in the culture system. The Ministry of Agriculture (Department of Animal Husbandry and Dairying) vide a notification dated 7 July,2001 has made I tmandatory that import of all livestock products shall be allowed only against a sanitary import permit to be issued by this Department. Through another notification issued on 16 October, 2001 all aquatic animals including fish, crustaceans and moll uses have also been covered under he purview of the earlier notification relating to sanitary import permits. Accordingly all import of fish and fishery products now require a sanitary import of fish and fishery products now require a sanitary import permit from the Department of A.H. & Dairying and Committee set up in this Department on Risk Analysis on sanitary imports constituted under the chairmanship of Animal Husbandry Commissioner scrutinize the import applications and imposes the condition that feed for aquaculture should be free from any chemical residues including anti-biotics. The chemical contents are to be indicated in the product in order to determine its admissibility. The Ministry of Agriculture has already written to all the State Governments to issue suitable orders to impose effective ban on the use of notified drugs, chemicals etc., in aquaculture and educated the shrimp farmers on the implications. The matter has also been taken up with the drug controller through the Ministry of Health for issuing suitable directives to the veterinary grade drugs with “Not for use in shrimp culture”.

Conflicts - The opposition to shrimp aquaculture stemmed from both environmental and socio-economic problems. The socio-economic problems arise from issues like land alienation; displacement of coastal communities from open access public lands used by them for fish drying, net drying, grazing, subsidence cultivation, etc., Additionally, the conversion of paddy lands, resulting in loss of employment and local level food security and problems of access to the sea for fishermen were also encountered in many areas.

The corporate investors generally chose the beach lands due to the availability of large tracts at low prices although they were aware of the inherent disadvantages for the farming operations. The investments made to compensate for the inherent disadvantages of beach sand, such as sea and ground water pumping apparatus, were the root cause of the negative environmental impacts encountered in these areas particularly by communities living close to these units. Individual farmers made large-scale use of upstream lands, especially paddy fields. The vast majority of them were struggling with low returns from paddy farming and lack of adequate canal water for a second crop. Sensing the opportunity for making quick returns, they shifted en masse to shrimp aquaculture.

The culture practices of both the corporate units and small farmers were dictated by considerations of short-run profits. These were often risky for the investors themselves and for the environment as well. Some large corporate farms on beach sites adopted culture practices, which required costly high-energy inputs that were propagated as being the most scientific by the foreign controlled feed manufacturing companies. This approach put both the pond ecosystem and the external terrestrial and aquaculture environment under stress. It raised the risk of disease in the ponds and pollution of groundwater outside. Some of the corporate units, which depended on creek-based water sources, went for the second crop when salinity was low. This exposed the crop to virus attacks. As far as the small farms in the upstream lands were concerned, their technology and practices were completely unscientific. Without the use of adequate water exchange mechanisms they used the high-energy imported feeds (swayed by the

hard sell of feed suppliers), leading to quick loss of water quality and increase of stress to the shrimp. Thus, almost all categories of farms took far too many liberties with nature's assimilative capacity and embarked on unwarranted financial risks, due to both greed and ignorance.

Problems Encountered in Shrimp Farming

In the wake of its growth the aquaculture shrimp farming also posed a number of social and ecological and economical issues mainly on account of improper planning and unregulated and uncontrolled growth of the enterprise. The experience gained in the Asian countries including India has clearly shown that if this activity is not scientifically managed and judiciously monitored they will not be sustainable and may cause a number of environmental and social problems as well as increased incidence of disease outbreaks. It is, therefore, necessary that the various issues encountered during the past need careful consideration while developing strategies for sustainable development of this sector. The general complaints voiced against this activity include conversion of agricultural land for shrimp aquaculture, salinity ingression affecting drinking water supplies, destruction of mangroves, displacement of labour, outbreak of disease and social conflicts between different user groups etc. Intensive aquaculture practices – a recent transition from the traditional improved traditional and extensive system is characterized by the use of high levels of inputs i.e., feeds and fertilizers leading to increases in organic loading which causes stress in the eco system leading to outbreak of diseases and pollution of adjacent water areas due to improper waste water discharge system. Use of chemicals antibiotics and chemical fertilizers in some of the areas has resulted in long-term adverse conditions. The cumulative effects of all these problems resulted in legal conflicts to Government's direct intervention.

Specific Conflicts in Tamilnadu

Common Property Resources and Rights

Creeks and Coast lines have been used to set up shrimp farms along the East coast in Tamilnadu from Chennai to Ramnad as they are Common Property Resources. The same as well as the sea have been used by the local fishermen community for their living from time immemorial due to open access but now in some place of Nagai district they are denied access to the sea. These interests have come to conflicts and clashes resulting in protests and threats to destroy the shrimp farms in this area

Types of Conflicts

A number of shrimp farms have been set up violating many rules and there were no proper systems for supervising and monitoring these farms. This has resulted in conflicts in the use of common property resources. The shrimp farms fenced their area without giving any notice and did not allow the public, especially the fisherman community who were using the beaches for years together because of lack of proper rights to use Common Property Resource. The shrimp farms have been set up without considering the hardships of the local fishermen community because of the open access to the seashore. Open access system has given rights to the fishermen for using the seafront for their livelihood.

Likewise the owners of the shrimp farms just purchased the cultivable lands from the agriculturists and converted into aqua ponds. This is also resulting in conflicts with the users of land for agricultural activities. Some of the farms have not shown any concern when the ground water sources turned into brackish. Only a very few farms have made arrangements for the supply of potable water to the local people. Such conflicts have made the local people to voice and protest severely against the shrimp farms.

Conflicts between Fishermen and Aqua farm

A major issue noticed by this study was the conflict between the shrimp farmers and the fishermen regarding accessibility to fishing areas in Nagai district. The

shrimp farms do not provide access to the beach for traditional fishermen who have to reach the sea from their villages. As aqua farms are located on the sea front and entry is restricted, the fisherman have to take a longer route of 4-5 Kms to sea for their operations. The traditional, local fishermen, doing fishing for years are subjected to such hardships because of the newly emerging aqua farms. The accessibility to fishing areas / beaches through larger aqua farms is major concern creating the conflicts between aqua farmers and local people. It can be resolved through mutual negotiations among themselves by providing suitable approach roads. While such large farms do help in providing advanced aquaculture know-how, supply of aquafeed, hatchery produced seed etc. to small farmers, but coastal communities in general seldom become direct beneficiaries of such aqua cultural development in a big way.

Conflicts in the land use pattern

Indiscriminate conversion of fertile agricultural lands into aqua farms in the initial stages of aquaculture development was found to have led to many conflicts prevailing still today. This has happened in the Sirkazhi taluk of Nagai district. This practice aggravated landlessness among the farmers. Absentee land lords sold away their lands to aqua enterprises, getting high price. Those who were doing jobs or cultivation under tenancy farming lose their livelihood occupations and agricultural production of crops was also affected. The utilization of mangrove area for shrimp farming was minimum and that too only for traditional aquaculture practice by only those who cannot take up cost-intensive systems of shrimp farming.

Conflicts between aquaculture and agriculture

In the early nineties, when aquaculture begun the entrepreneurs acquired lands from agriculturists in the Cauvery delta of Thanjavur and Nagai districts who were facing a tragic scenario due to loss in agriculture. But as this continued, conflicts arose with the support of NGO's against aquaculture. Realizing this conflict, the commercial farms that developed subsequently were constructed on fallow wastelands, which are not suitable for any productive agricultural activities.

These lands are registered in the revenue records under the agricultural category. There by, it is always blamed that the aqua farms are constructed on agriculture lands. Depending on the quality of soil texture, the soil salinization may take place in the neighbouring agricultural land where coastal aqua farms are constructed. This phenomenon is a well-established fact that the aqua farms having higher percentage of sand particles are causing salinization of agricultural lands, the major conflict that led the coastal aquaculture to legal disputes. Similarly where coastal aqua farms exist on clayey soils the soil salinity could not exceed the permissible limits in the adjacent agriculture farms.

The salinization of ground water and agricultural lands purely depends on the soil texture and fabrication. Even where there are no shrimp farms also, the lands and ground water are saline because of the nearness of sea and regular tidal flushing, seepage, humid climate, and meager and narrow fresh water tables in the coastal belt. That is why not only around shrimp farms but most areas of coastal plains in Tamil Nadu remain devoid of any agricultural activities worth the name.

Use of ground water for aquaculture activities is a disputed issue in Nagai district. The use of ground fresh water for inland aquaculture can lead to reduce ground water table which may further act as a limiting factor for future aquaculture. Similarly in the coastal areas the use of ground freshwater (abundant in sandy soils) can reduce the water table and simultaneously may have the chances of salinization due to intrusion of saline water.

However, it was also inferred from various experts concerned that salinization of land and drinking (borewell water) may be also attributed to various other factors like nearness of the area to the sea, frequency of the tides, nature of soil, climatic conditions, ground water table, geomorphological characterstics of the area .

Human health impacts

The social movements against shrimp culture in Sirhazhi area of Tamilnadu have levelled charges saying that shrimp culture activities have resulted in emergence of various diseases causing threat to the health and hygiene of the local

population. However, the public reverted that shrimp culture industry is the only viable industry alternative to agriculture and the present water scarcity has been a major disaster to agriculturists and aquaculture has rendered a helping hand to them by providing better employment opportunities to the local labour including women folk. The public also pointed out that they are comfortable by the development of the industry and any effort taken to destroy these industries will make them homeless.

Socio-cultural Impacts

Shrimp culture is essentially a human activity which has varying socio-cultural and economic impacts on human communities involved. An appreciable number of rural people have found employment as owner operators or wage earners in shrimp farms, enhancing their economic standard. The state Government is leasing out sites to co-operatives or to poorer sections of society with a view to help the poor for earning cash benefits. Since market price of shrimp is very high, the overall socio cultural and economic standards of marginal and small scale farmers will be certainly improved. Shrimp farming suffers from lack of social acceptability. Indiscriminate conversion of agricultural lands into shrimp culture farms aggravated landlessness among farmers which has changed the land use patterns in the coastal areas. The ownership pattern has radically changed due to various reasons. About 20% of the coastal land holdings were sold due to small size of the land (less than one ha) 40 percent due to high price, 30 percent due to inadequate profitable crop production and 10% because of non-availability of labour. The traditional agriculturist in the coastal areas have profitably utilized the money realized from the sale of their lands to purchase interior fertile farm for shrimp farming, are from mostly from other regions.

The Sarvodaya leader Mr.Jagannathan's statement against unemploymentability in aquafarms is proved to be false since many employment opportunities are being offered to the local people and the agriculturists. Further, his statements that the land used for prawn farming could not be used for any purpose after a period of 10 -12 years also proved to be wrong since many agriculture farmers are converting

their paddy fields to aquaculture farms in TamilNadu. If this is the case in Tamilnadu, certain areas in Bheemavaram (AP) which were involved in aquaculture were converted again to agriculture fields to maintain rotation of crops and high yield both in aquaculture and agriculture and to prevent outbreak of diseases**.** It was also noted that only fallow lands and cultivable wastes area have been converted into prawn farms in Tamilnadu. It was noteworthy to mention that due to the persisting Cauvery water issue, farmers who were harvesting only one crop in Poompuhar area have given up agriculture and prawn farm companies / investors purchased fallow lands from them. In fact, it should be understood that the Prawn companies came to the rescue of the worried farmers.

Mitigation measures by farmers to prevent Pollution

a) The effluents are let out in a separate drainage canal where fishes are allowed to come to feed upon the feed waste and organic load present in the effluents. This flow of effluent discharge reaches the water source after taking a long route which tend to reduce the risk of pollution largely at the direct vicinity of water source.

b) In loose sandy soil areas and high percolation areas, farmers tend to pack the bunds with piles of sand bags one over another to prevent seepage of brackish water into the adjoining areas leading to soil and fresh water salinisation. This also saves them from high pumping cost resulting in loss of fuel and reduces the environmental conflicts due to soil/water salinisation.

c) Certain large scale farmers in Chennai zone are attempting to cleanse the effluents using chemical cleansers before discharging into the environment. However, it is important to mention at this juncture that farm levels mitigation measures can assure environmental quality to a large extent but social impacts like resources use conflicts, equity issues, salinisation and access needs strict government regulations.

Positive Impacts of aquaculture

Aquaculture has contributed to rural employment and economic development of coastal villages and helped to raise the foreign exchange earnings of the country. Shrimp farms have been constructed on variety of coastal lands, dry and saline fallow lands, unproductive and marginal agricultural land and to a lesser extent in wetlands like marshes and mangroves . Aquaculture has a positive impact on the environment and biodegradable wastes provide nutrition for agricultural production or otherwise it is mineralized by bacteria. Impacts of aquaculture on the environment include change in resources such as water and land and competition between users. Aquaculture can contribute positively to the environment in many ways, but this is seldom recognized in environmental forums. Further, the development of aquaculture attributes to many benefits of the country like

- Generation of employment opportunities
- Improved standard of living in rural areas
- Better infrastructure facilities in rural areas
- Increased revenue to government
- Benefits to coastal population
- Less pollution comparing to agriculture or any other industrial activity
- Appropriate modern technology
- No negative impact on coastal fishing activity
- Development of the coastal community.

Hedonic Pricing Model for Land Quality

The hedonic pricing approach is based on the assumption that the environmental factors are attributes of goods or factors of production that are traded in the markets. The benefits/damages, according to this approach, due to improvements/decrease in the environmental quality could be captured through the market price of the related goods. For instance, the economic impact of the deterioration in the soil quality resulting from aquacultural activities could be

captured through the price of land assuming *ceteris paribus* condition. However, *ceteris paribus* assumption does not hold true and therefore, the price of the land is influenced by so many factors including the soil quality. This may be modeled as follows:

$$P_L = f(X_1, X_2, X_3, X_4, \ldots\ldots X_n) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

The above model describes the relationship between the price of land and other independent variables affecting the land price, including the environmental quality. More precisely, P_L, the dependent variable, stands for the price of land and $X_1, X_2, X_3, X_4, \ldots\ldots X_n$ refer to the independent variables, including the soil quality, which are assumed to influence the price of land.

In our study, we assume that the price of the land in the affected areas is lower than that of the non-affected areas by aquacultural activities. This can be described as follows:

$$P_{ag}(X, X_1, X_2, X_3, X_4, \ldots\ldots X_n) > P_{ab}(X_1, X_2, X_3, \ldots\ldots X_n) \quad \ldots\ldots\ldots(2)$$

Apart from the soil quality, as we have already seen, the land price is affected by N number of other variables described in the model. To understand the nature of influence of these variables, including soil quality, we run a following log-linear regression model:

$$P_L = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \ldots\ldots + \beta_n X_n + z$$

In this model, α is the constant and β is the coefficient and **z** is the error term. If we substitute **X** value with the variables derived from the farmers' survey, we would be able to predict the nature of the influence of the independent variables on the land prices in affected and non-affected areas.

The Empirical Model

The empirical model basically looks into how the difference in the land price is influenced by certain important factors. Before going to the details of the correlation between the land prices and the factors influencing the prices of land, let us discuss briefly the extent to which the lad price differed between two time periods –i.e. 'before and after' the aquacultural activities have taken place in the study areas. It should be noted that the price of the land shows a significant difference when we consider the before-and-after situation. The following table reveals that before the aquacultural activities have taken place in the study areas, the mean value of the land price stood at Rs.37271.00 and this has increased to Rs. 59781.54 after the aquaculture farms have come in.

Table. 15: The Average Value of the Land in the Study Area, Before and After Aquacultural Activities.

Land Value	Mean	Std Deviation	Std. Error
Before Aquaculture	37271.00	16254.55	901.64
After Aquaculture	59781.54	27263.66	1512.31

Source: Computed

One of the aspects to be noted is that even though the mean value of the price of the land differs between the two time periods, we are not sure whether the difference is 'statistically significant'. Testing the statistical significance in the land price is a necessary condition because, if the difference in the land price were not statistically significant, then the underlying assumption in the hedonic pricing model would become meaningless. To understand the statistical significance of the difference in land price, we have used 'Paired Samples T–Test", the results of which are indicted in the following table 12:

Table 16

Mean	Std. Deviation	Std. Error	95% Confidence Interval		t-value	Significance (2 tailed)
			Lower	Upper		
22510.8	21430.85	1188.77	24849.50	20172.10	18.94*	.000

* Significance at 1 percent level.

Source: Computed.

The mean value of the difference in the land value between the two time periods under consideration stands at Rs. 22510.8. Since we are interested in understanding the statistical significance of the difference in the land values, the t-value is worth noting here. It should be noted that the t-value is significant at one percent error level This means that the difference in the land value between the two time periods is highly significant.

The important point to be noted is that the price of the land, rather than declining due to the environmental impact of the aquaculture, has indeed increased in between the two time periods. As we have already seen, the difference in the land price might have been caused by other factors as well. In other words, the negative influence of the environmental impact on land price might have been offset by the positive impact of the other factors. This needs to be investigated further so as to understand the nature and extent of the influence of various factors on land price. This kind of influence is analyzed in terms of an empirical model, which takes the following form:

$\mathbf{P_L} = \alpha + \beta_1$ Paddy + β_2 Source + β_8 Cultivation + β_4 Category+ β_2 Income+ β_5 Potential + β_6 Damage + β_7 Distance +β_9 Salinity.

$\mathbf{P_L}$: The difference in the land price

α : Constant

Paddy : Whether the land is conducive for paddy cultivation (Yes –1;

No – 2)

Source : Sources of irrigation (Canal irrigation – 1; Otherwise – 2)

Cultivation : Frequency of cultivation of land per year

Category : Category of farmers (Small – 1; Medium – 2; Large – 3)

Income : The gross annual income for the land

Potential : Whether land could be potentially developed for aquaculture (Yes – 1; No – 2)

Damage : The farmer's awareness about the possible damage by aquacultural operations (Aware – 1; Otherwise – 2)

Distance : The distance between the land and the aquacultural farm

Salinity : The environmental impact measured in terms of EC value of the soil

Table 17. Factors Influencing the Difference in the Land Prices

Dependent Variables	Coefficient	t-value
Constant	-63617.8*	-7.183
Paddy	.15318*	3.454
Source	.6095.49**	1.764
Cultivation	.45170.43*	4.761
Category	-.129.936	-.081
Income	. 306**	2.862
Potential	.3211.689**	2.128
Damage	.4011.708***	1.583
Distance	-.3175.411***	-1.235

Salinity	.9.658	.044
R^2 Value	**.570**	
Adjusted R^2 Value	**.325**	

* Significance at 1 percent level
** Significance at 5 percent level
*** Significance at 10 percent level.

Regression Results

In this section, let us discuss the nature and magnitude of the influence of the variables included in the hedonic pricing model. A general historical phenomenon observed is that the land conducive for cultivating the paddy is supposed to fetch higher price in many parts of Tamil Nadu. This is because of the reason that the paddy is the major crop cultivated in the state and a larger percent of the farmers are small and marginal farmers in nature. The marginal and small farmers have the tendency to cultivate only the short-term food crops like paddy and therefore, their willingness to pay the land price depends mainly on the suitability of the land for paddy cultivation. As expected, the variable **Paddy** does positively and significantly influences the difference in the price of the land in the study area. More precisely, the sign and the magnitude of the variable **Paddy** suggests that if the land is more conducive for cultivating the paddy crop then the price of the land is also higher.

Another factor, which is positively, and significantly influencing the land price is the source of irrigation. More precisely, if the land comes under canal irrigation then it fetcher relatively greater value than the land being irrigated by other sources such as bore-wells, etc. This is explained by the variable **Source** in the model. This may be attributed to the fact that the irrigation by the canal sources involves lesser amount of cost of irrigation at the farmer's level and therefore, the willingness to pay for the land irrigated by canal irrigation is more.

The land price difference is also influenced significantly by the frequency of cultivation of land. If a land is cultivated, for instance, three times a year then this

land fetches higher price in the market compared to the land cultivated less frequently, as explained by the variable **Cultivation**.

It should be noted that the variable **Category** indicates that the price of the land owned by the small and marginal farmers is found to be greater than that of the land owned by the large farmers. However, this factor does not significantly influence the price.

Another most important factor influencing the land price is the annual income from the land under consideration. The sign and magnitude of the variable **Income** suggest that the annual gross income derived from the land does positively and significantly influence the price of the land.

The variable **Potential** refers to whether the land under consideration could be potentially developed for aquacultural activities in near future. It is assumed that if the land could be potentially developed for aquacultural activities then the potential aquacultural entrepreneurs would be willing to purchase the land and this would influence the price of the land positively. As expected, the sign and the magnitude of the variable **Potential** indicate that the possibility of developing the land for aquacultural farms does influence the land price positively.

To understand the influence of the farmers' knowledge about the possible damage, if any, caused by the aquacultural activities on the price of the land, we incorporated the farmers' awareness as one of the variables. Interestingly, this variable (i.e. **Damage**) influences the land price positively and significantly as against our expectation. Many of the farmers reported that the salinity would be the major problem caused by aquacultural activities. However, the sign and magnitude of this variable suggest that there is no correlation between the farmers' awareness about the damage and the price of the land. This may be attributed to two different factors: (i) the farmers, though aware of the possible damages, are not the potential buyers of the land but only the potential sellers and therefore, they might not have related the damage to the price of the land; and (ii) even if the farers are aware of the damages, they may not be capable of establishing a link between the damage and the land price. Another variable that

is found to influence the land price positively and significantly is **Distance.** This variable suggests that more the distance from the aquacultural farms, lesser is the price of land. This may be attributed to the fact that the farmers may have a 'rational expectation' of rise in the price of land especially after all the potential lands in the areas are developed for aquacultural activities, in the long run.

The **Salinity** as a measure of negative impact of the aquacultural activities does influence the land price positively but the influence is not significant. It should be noted that the nature and influence of the 'environmental' variables provides us different kinds of conclusions: (i) the environmental impact is not considered in the land market in the study areas; (ii) the farmers are aware of the environmental impacts but this awareness does not get reflected in the process of fixing the land prices; and (iii) despite the negative effects of the existence of aquacultural farms, the positive impact of the aquacultural farms on the price of the land are dominating.

Willingness to Pay (WTP) for Pollution Control - the Model

As in the case of hedonic pricing model discussed above, the WTP value for the pollution control measures at the farm level by the owners of the farm depends on different kinds of factors. This can be described as follows:

$$WTP_{PC} = f\ (PC_{0i}, PC_{1i}, Y_i, S_i) + z_i$$

WTP_{PC} stands for the WTP value of the i^{th} farm owner, PC_{0i} refers to the prouder surplus <u>without</u> pollution control measure, PC_{1i} refers to producer surplus with pollution control measure, Y_i, income of the farm owner, S_i refers to other variables affecting the WTP value and z stands for the error term. To understand the influence of each variable on the WTP value, the following log-linear regression model will be used:

$$\text{Log}_{WTP} = a + \text{Log}\ b_1 X1 + \text{Log}\ b_2 X2 + \text{Log}\ b_3 X_3 + \ldots\ldots + \text{Log}\ b_n X_n + z$$

Substituting X with the actual variables derived from the survey, we would obtain the following model:

Log WTP = $a + b_1$ Size + b_2 Capital + Log b_3 Operational + b_4 Volumeff + Log b_5 Anincome + b_6 Borrowed

Log WTP : Logarithmic value of the WTP value

a : Constant

Size : Size of the farm

Capital : Value of fixed capital employed

Operational : Logarithmic volume of the variable cost

Volumeff : Volume of effluents released from the farm

Anincome : Log value of annual income from the farm

Borrowed : Whether the finance is borrowed or comes from own sources (Borrowed – 1; Owned – 2)

Table. 18. Factors influencing the WTP for treating the effluents from the Aqua Farms

Independent Variables	Coefficient	t- Value
Constant	-3356.489	-.778
Size	2742.722	8.974*
Capital	-4.37E-04	-.024
Operational	-2.29E-02	-3.203*
Volumeff	7.690E-02	.858
Anincome	7.52E-03	3.446*
Borrowed	474.783	.344
R^2 Value	**.829**	
Adjusted R^2 Value	**.687**	

* Significance at 1 percent level.

It should be noted that the WTP value for the treatment of effluents emanating from the aqua farms is influenced by certain factors. Some of these factors influence the WTP value more strongly and the influence of some other factors is only minimal.

The variable **SIZE** does positively influence the WTP and the influence is highly significant. This suggests that the larger the size of the farm owned by the respondent, the higher is the WTP value. In the case of initial investment made by the respondent, represented by the variable **CAPITAL,** the influence is negative which means that if the size of the initial investment made is greater the willingness to pay for treatment is less and vice versa. However, the influence of the size of the initial investment on the WTP value is not significant. But the size of the variable cost (**i.e. OPERATIONAL**) influences the WTP value negatively and significantly. It means that if the variable cost in running the farms at present is high then the WTP value, which would add to the existing variable cost, would be lesser and vice versa. The volume of effluent represented by the variable **VOLUMEFF,** positively influences the WTP value but not significantly. Another important variable which influences the WTP value significantly is the annual income. The sign and the magnitude of this variable suggest that the respondents who derive more amount of annual income from the aqua farms are willing to pay more for treating the effluents.

Another factor that potentially determines the WTP value is whether the capital employed is borrowed or owned. The sign of the variable suggest that if the capital is borrowed then the level of WTP value is lesser and if it comes from their own sources then the WTP value is higher. However, the influence is not significant.

The regression model for the agricultural productivity

$Y = a + b_1$ paddy $+ b_2$ fertilizer $+ b_3$ source $+ b_4$ category $+ b_5$ existence $+ b_6$ awareness $+ b_7$ frequency $+ b_8$ salinity $+ z$

In the above equation,

a – constant;

paddy – cropping pattern;

fertilizer – amount of fertilizer used in value;

source – sources of irrigation (ground water – 1, surface water – 2);

category – category of farmers (1 – marginal, 2 – small, 3 – medium and 4– large);

existence – existence of aquaculture farms with in 3 Km (if yes – 1, no – 2);

awareness – whether farmers are of the opinion that aquacultural activities are causing damage to crops (if yes –1, no – 2);

frequency – No. of times the land under cultivation in a year;

salinity – the EC value of the soil (i.e., above 3).

Table 19

Variables	Beta	Std. Error	T	Sig.
Constant	-63617.8	8856.72	-7.183	0.000
Paddy	15318.312	4434.68	3.454	0.001
Fertilizer	0.306	0.107	2.862	0.004
Source	1456.89	1245.69	1.895	0.021
Category	6096.49	3456.139	1.764	0.079
Aquaculture	4011.706	2533.73	1.583	0.114
Awareness	3175.411	2571.104	1.235	0.218
Frequency	45170.42	9487.5	4.761	0.000
Salinity	9.658	220.420	0.044	0.965
R^2 value	0.325			
Adj. R^2 value	0.305			

The productivity of the land is the dependent variable.

1. The cropping pattern (indicated by the variable Paddy) is found to positively influence the productivity. It means that the productivity is found

to be grater in those areas where paddy is being cultivated rather than other crops.

2. The amount of fertilizers used (expressed in value term) is found to significantly influence the productivity. Other things remaining same, more the amount of fertilizer used, the greater are the productivity in the study area.

3. The source of irrigation is also found to positively influence the productivity. The productivity is found to be higher if the crop is irrigated with surface water rather than the ground water.

4. The level of productivity also depends on the farmer's category. The productivity is higher for the large farmers category to the small farmers;

5. Existence of aqua farms with in 3 km circle positively influences the productivity but not significantly.

6. If farmers are more aware of the environmental damages caused by aqua farms, then the productivity is found to increase. This may be due to the fact that the farmers may take up some defensive measures against for ill effects of aquacultural farms;

7. The frequency of cultivation is also found to increase the productivity;

8. There is no correlation between the general soil salinity and the productivity. This may be due to the fact that farmers may apply more amounts of fertilizers to mitigate the ill effects of soil salinity.

Table 20. Productivity difference in terms of net farm income

Distance	Mean Value
	Net farm income (Rs.)
< 1 Km	12,316
1 – 3 Km	13,773
> 3 & above	13,992

Source: computed by the researcher

The productivity measured in terms of net farm income, is expressed in terms of average net farm income between different areas in the aqua farm region. It may be noted that the average net farm income in the three areas i.e., less than 1 km, 1 – 3 km and above 3 km – does not differ much. However, the difference between less than 1 km distance and above 1 km distance is greater than that of 1 – 3 km and above 3 km distance. Nut this simple analysis much about the statistical significance of the difference in the net farm income. Hence, we have used a regression analysis to find out the productivity difference caused by the distance between the location of the agricultural land and the aquaculture farms.

6. Environmental policies for aquaculture

Environmental degradation manifests itself through bio-indicators, but it is not easily understood by many stakeholders. There are many reasons for this. Firstly, the boundaries of adverse environmental impacts are not easy to demarcate as they do not respect the jurisdiction of states or state pollution control boards (SPCBs). It is also difficult to access the extent of the damage. Another major problem for the regulatory agencies is sourcing mixed effluents and emissions. Thus, the easy way out for the resource-constrained government agencies is to be a “stock holder” like others, instead of talking proactive steps to undo the damage.

Technology or market forces do not favour the environment. Hence, to save the environment from degradation, what are needed is policy interventions. Physically this would mean getting priorities organized. It would mean choosing

reduce industrial effluents, for instance, at the source itself rather than encourage construction of common effluent treatment plants and disposal facilities.

The age-old conflict between development and environment, which was acknowledged by the west, is yet to be understood in India. Economists are often looked upon suspiciously by environmentalists. Micro – economic approaches have never been thought of one such approach is the safe minimum standard, which explicitly states that we should avoid irreversible environmental damage unless the social cost of under taking the project is infinity.

Defining short-term measures therefore becomes an exercise in proactive environmental management, using micro economic approaches as close as possible to the scene of environmental impact. To begin with, we should use available laws and systems, suitable economic models and applicable technology. It will involve hands on training and empowering the directly affected stockholders.

Strategies

- Develop a broad environment policy and support it with a plan for above 20 years, set mile stones to achieve parameters;
- Internalize environmental considerations in all state policies, plans, programs and projects;
- Establish locally – relevant standards;
- Decentralize monitoring and legal action, centralize technology and expertise support; and
- Implement annual action plans, meet all costs internally and monitor progress on a monthly basis.

The union should enforce another budget applying the ‘Polluter pays’ principle to reduce damage to environment. Pay for the damage if you pollute. Pay more if you pollute more. This, in simple terms, is the ‘Polluter pays’ principle. The Indian government chooses to ignore the message emerging from countries

across the world and from Indian research and the cost of damage to environment. European nations are designing fiscal instruments to develop a sustainable environmental policy. The fiscal instruments include taxes on fuel, vehicles and infrastructure use. This European Union (EU) is now using market-based instruments not only to control vehicular pollution but also to address related issues like growing number of vehicles, mobility and congestion. 'Polluter pay ' principle may be suggested to local bodies to tax or fine for pollution wherever conflict arises. Further, subsidy may be provided to establish bio-treatment. The concept of Pigouvian tax-subsidy criteria can be adopted here.

Future Programmes

The strategies for future development of aquaculture especially shrimp culture should focused attention on both the technique and non-technique aspects. Although in the earlier years it was only the aquaculturists and administrators who were involved in the development of this sector the need for involving expertise in other related disciplines has been well realized as the sector has progressed. A comprehensive regulatory framework for shrimp culture has become the need of the hour with the inclusion of other crucial matters such as environmental conservation, public health, legal support, economic incentives, risk insurance, information dissemination, international cooperation and coordination of production, marketing and the management measures. Legislation and regulations are required for prevention, reduction or elimination of hazards created by aquaculture with clear cut legal framework on property rights to farm sites and cultured stocks, protection of water quality, prevention of environmental degradation and disease spread. A participatory approach with a harmonious blend of technology, organizational development, institution building and human resource development should therefore, be developed in order to streamline the new strategies that are more responsive to the felt needs of this sector. Such an effort would provide the required encouragement to transform the programmes to enable the achievement of sustainable shrimp culture development with the target group kept in the fore front.

Policy measures

1. Aquaculture is a form of agriculture and therefore should be allowed within the CRZ.

2. Activities dependent on the seacoast should legally operate within the CRZ.

3. National and state exechequer and the banking sector will be severely affected with far reaching consequences if the industry is banned and therefore the industry should be given careful priority to form a sustainable and eco-friendly environment.

4. Aquaculture should continue but with a check on environment degradation. The environmental protection authorities could prioritize their work on environmental quality, environmental impacts, environmental politics and environmental economics. High environmental quality is essential for consumer acceptability and premium market price.

5. The possibilities of creating an environmental value added tax (EVAT) is also on the anvil and the polluters should be made to pay for it if they don't follow the environmental criteria.
6. Legislation should be accompanied by economic disincentives that penalize polluting industries.

7. Appropriate legal and administrative framework to facilitate the development of responsible aquaculture should be established .

8. The country should produce and regularly update aquaculture development strategies and legal measures to ensure that aquaculture development is ecologically sustainable and to allow the rational use of resources shared by aquaculture and other activities.

9. The country should ensure that the livelihoods of local communities, and their access to fishing grounds are not negatively affected by aquaculture developments.

10. The country should establish effective procedures specific to aquaculture to undertake appropriate environmental assessment and social consequences resulting from water extraction, land use, discharge of effluents, use of drugs and chemicals and other aquaculture activities.

11. The country should establish databases and information networks to collect share and disseminate data related to aquaculture activities to facilitate cooperation on planning for aquaculture development at the national level.

12. Fiscal instruments should be designed to develop sustainable aquaculture policy.

13. Market based instruments should be used to address environmental issues like quantity of wastes discharged, salinization and ground water contamination.

Strategies to be adopted

Aquaculture Economics

a. Economic evaluation of each aquaculture production system to identify economically viable systems.

b. Economic evaluation of aquaculture inputs, viz. seed, feed, fertilizers etc.,

c. Study of socio-economic impact of aquaculture.

Prevention of environmental degradation due to aquaculture

a. Standardization of procedure for environmental impact assessment (EIA)

b. Carrying out appropriate EIA on mandatory basis before embarking on large aquaculture projects

c. Standardization of techniques to prevent environmental degradation through effective treatment and management of the farm effluent. Every farm should have an extensive settling tank to receive and retain the effluent over a period of time, after which the supernatant water could be let off into a natural drain or re-used in the farm after further treatment. There should be buffer areas between farms.

d. Internalise environmental considerations in all state policies, programmes and projects;

Discussion

The wastewater discharged from the shrimp farms is supposed to be the most significant factor that contributes to the degradation of the environment and to cause self-pollution within the culture system. However, there is no systematic investigation on the total organic load released by the shrimp farms into the estuaries / creeks / sea. The constituents of the wastewater under different farming conditions and the extent of damage it causes to the ecology and biology of the estuaries / sea have to be quantified.

Salinization of the adjacent areas and surface / ground water contamination , and prevalence of disease problems are diagnosed as the other major conflicts contributing to the productivity gap in aquaculture. These impacts have been aggravated by the rising conflicts between aqua farmers and the vulnerable groups on the fact that salinity of agricultural lands are largely due to excessive use of irrigation water by aqua farms resulting in threat to the productivity growth of agriculture wherein it is reported that the expanding inland salinity is much

more serious than the static coastal salinity. Therefore, it is important to modernize the drainage system in aqua farms and waterlogged areas along the development and enforcement of social mechanism at community level for judicious use of water should be given maximum attention among the development activities.

With regard to the charge that agricultural lands are being utilized for aquaculture, it is imperative to say that most of the shrimp farms have been setup only on barren and fallow lands on the coastal stretch and that the environmental threat of soil degradation and drinking water sources turning saline or baseless, their opponents assert that there is an unabated spree to buy fertile lands for conversion to shrimp farms. It was noticed that shrimp farming suffers from lack of social acceptability. Indiscriminate conversion of agricultural lands into shrimp culture farms in the areas of Sirhazhi (Nagai district) and the adjoining areas of the Cauvery delta aggravated landlessness among farmers which has changed the land use patterns in the coastal areas. But, the fact understood is that many farmers in the Cauvery delta had sold their lands due to less production and water scarcity to maintain their crops.

Due to this conflict, the ownership pattern has radically changed due to various reasons. About 20% of the coastal land holdings were sold due to small size of the land (less than one ha) 40 percent due to high price, 30 percent due to inadequate profitable crop production and 10% because of non-availability of labour. The traditional agriculturist in the coastal areas have profitably utilized the money realized from the sale of their lands to purchase interior fertile farm for shrimp farming, are mostly from other regions.

The conflicts of aquaculture has also reached its momentum by the opposition led by the Sarvodaya leader Mr. Jagannathan whose statement against unemploymentability in aqua farms proved to be false since many employment opportunities are found to be offered to the local people and the agriculturists by the farm owners. In fact, the current situation in the Cauvery delta and the adjoining areas of Nagai district is that many agriculturists and the local

unemployed folks are being offered jobs in aqua farms due to the persisting water scarcity in the river Cauvery for cultivation. In Tamilnadu, the aqua culture industry has developed rapidly which contributes significantly to the export/ economic sector of our country. But many conflicts arising from aquaculture developments are attributed to the environmental disturbances claimed by the public.

Environmentalists say that while the sweeping “blue revolution” in the state has ushered in economics prosperity to shrimp farm promoters in general and a few corporate giants in particular, it has wrought an ecological disaster, with the deserticification of fertile lands in villages abutting the shrimp farms. This according to them, possess a danger to the very livelihood of farm labour and fishermen in the coastal belt of Thanjavur and Nagapattinam districts, considered the granary of the state.

They regret that despite a ban on the setting up of shrimp farms in cultivable lands, nearly 1,200 acres of fertile land have so far been taken over by shrimp farm promoters in Sirkazhi taluk of Nagai district and in the Thanjavur coastal belt. This is addition to the 5000 acres, already cornered by some big companies and others by offering small and marginal farmers money nearly twenty to thirty times of the land cost.

With reference to the pollutory effluents from the shrimp farms it could understand that the effluents contain only biological materials unlike other industries where the impact is high. However, Dr. M. Sakthivel, President of the Aquaculture Foundation of India (AFI) asserts that aquaculture is not a polluting industry like chemical, heavy metal and leather industries. The major inputs in coastal aquaculture is sea water and feed prepared mainly from fish meal, Soya meal, oil cakes, minerals and Vitamins. Antibiotics such as oxytetracycline are used in low dosages, which does not have any residual affects either on the shrimps or soil. Since the faecal wastes were bio-de-gradable and recycled in the form of nutrients, there was absolutely no pollution by the aquaculture industry. The processed waste of shrimps and other fish was used as an ingredient in the

feed industry and the wastewater was treated before being discharged, as per prescribed norms.

The numerous estuaries and creeks, which extended several kilometers in land from the sea, carried high tide saline water and hence the groundwater in these areas where bound to be saline, Dr. Sakthivel said, implying that hatcheries could not be blamed for the degradation in the quality of ground water. He also refuted the charge that the discharge of untreated effluents in to the sea affected marine life. He said fish get attracted to the point of effluent discharge as it contained a lot of uneaten food. He claimed that aquaculture presented a golden opportunity to usher in a “revolutionary change” in the life of costal villages.

The coastal area is invariably saline because of its proximity to the sea, creeks and estuaries. Therefore, the coastal zone is not a preferred area for agricultural and in some coastal areas that have been reclaimed for rice cultivation the yields have been very low because of the salt-water ingress. Other large tracks have been laying follow for decades. Thousands of acres of land are lying idle in several states without being put to any use. Therefore, these lands can be utilized for shrimp culture, which can bring in high economic input into our country. Export of marine products from the state had fetched around Rs. 350 crores last year with shrimps accounting for over Rs. 200 crores and this is expected to double this year.

The incidence of salt-water seepage has been exaggerated as if all of agriculture and all the drinking water wells along India’s coastline have been affected by aquaculture. The total area affected by saltwater seepage is insignificant. Moreover, the so-called damage should be set off against the large quantity of food that aquaculture can produce. Just for this reason – which can in case by easily tackled – one should not attempt to sabotage this sector. Out of 1.4 million hectares available in the country, aquaculture has developed on only 7% of the area. Of this area – 1,00,000 ha – the productive agricultural land which is next to the aquaculture farms is not even 2% or 2,000 ha. And out of these 2000 ha the land, which is really affected by saltwater seepage, is negligible.

As long as costal aquaculture is restricted to the shores, saltwater seepage and salinisation are not serious problems. It is when the farms are set up more than 500 m from the high tide line that the problem of saltwater seepage can become severe.

The population of drinking water wells should also be examined similarly. There are aquifers in selected pockets along the coastline and no survey has been conducted to assess the number, location and size of these aquifers, the quantity of fresh water available during the year, its quality, etc. based on a few complaints a picture has been created as if all the drinking water wells along the coast line have become saline due to coastal aquaculture. According to the National Environmental Engineering Research Institute (NEERI), there is no damage to the drinking water sources. Hence the allegation of water pollution is only a bogus raised by the anti-aquaculturists and the media.

Based on these conflicts, the productivity rate of aquaculture in some areas of Tamil Nadu and Pondicherry areas met a downfall mainly due to the havoc caused by the opposition groups against aquaculture. Therefore, these issues were analyzed to identify the areas for increased productivity and for appropriate research, development and policy interventions.

Evolving appropriate polices and development of sustainable shrimp farms in India is handicapped by the non-availability of quantitative and qualitative scientific data on the factors responsible for degradation of the environment. Therefore, the environmental impacts remain largely speculative and unproven. For instance, it is generally stated that uncontrolled increase in the number of shrimp culture units / ponds per unit area / coastline has gone much beyond the carrying capacity of the ecosystem and has led to the collapse of the system (Kutty, 1999). While in the case of individual units / ponds or farms much can be recovered by improved management of the systems and in collective development of the ecosystem, the development should be restricted to an overall plan on density of units / farms (water area) and their distribution based on Environment Impact Assessment studies.

It is also inferred that intensification / diversification of farming systems has hardly received attention in spite of technological possibilities for productivity advance and rural income and employment generation. Further, the envisaged growth cannot be achieved through technological intervention alone in the absence of development efforts and benign public policies. Sustainability from both ecological and economic angles is important, so that the country could lead in the progressive export trade of aqua products. Development and extensive adoption of location specific farming aiming at higher productivity, better returns and year round employment would help to improve the quality of life of inhabiting the long coastal areas.

High investment in research and development coupled with favourable public policies are important for achieving sustainable growth in production of shrimps, when the existing base and technological strength would be too inadequate to meet the future production challenges. The contemplated research and development strategies towards achieving the production goals should be ecologically and economically viable causing the least damage to our fragile natural ecosystems/ foundations. Adequate consideration given to legal and social aspects, policies lay out, enforced through legislation, will ensure the carrying capacity of the ecosystems and prevent violation of socio-economic norms (Bagarino & Flores, 1995). Our country has the potential of keeping pace with the increasing food demand of the growing population for many more decades to come, provided the planners and the governments are serious about tapping the already identified under and unexploited niches / situations, which require substantial investment on relevant research and development.

There is increasing concern about the long term sustainability of the development paths followed and the feasibility of maintaining the tempo of growth that the country has been able to attain in the coming years to meet the increasing demand for food products in view of the growing population and improved per capita incomes. As agricultural production systems become increasingly more complex interacting with markets on larger and larger scale, several kinds of

issues come to the fore. As a result, there has been significantly increasing demand for different types of food products like milk and dairy products, poultry and marine /aqua products.

Guidelines for Best Management Practices in Shrimp Farming

The guidelines for sustainable development and management of brackishwater aquaculture issued by the Ministry in 1995 is very comprehensive; however after the Supreme Court's directives on shrimp culture these need considerable revision since the apex court has observed that any aquaculture activity including intensive and semi-intensive which has the effect of causing environmental degradation shall not be allowed. Keeping in view the long-term sustainability of this activity suitable management practices should be evolved in tune with the international standards and hygienic requirements. The Aquaculture Authority is already seized of the matter and an Expert group is set up to formulate the guidelines.

Recommendations

1. The environmental management plan (EMP) should be approved by the State Pollution Control Board and the Ministry of Environment and Forests.

2. The existing criteria for site selection should be reviewed and consideration should be given to long-term capacity of the area to sustain aquaculture development.

3. The use of ground water for aquaculture should be banned and the rights of the coastal communities should be protected.

4. A minimum distance of 50-100 mts should be maintained between the aquaculture site and the near by agricultural land.

5. Aquaculture farms should be located at least 100 mts away from a smaller village and 300 mts. away from a village of higher population.

6. Management of waste water from shrimp ponds should be treated taking into consideration the design of the following Effluent Treatment System (ETS) –

Pollution Cost Abatement using ETS

To over come the environmental constraints of disposing the farm effluents in a safe manner without conflicts, the Aquaculture Authority has made it mandatory that all shrimp farms of 5.0 hectare water spread area and above located within the CRZ and 10 hectares water spread area and above located outside CRZ should have an effluent treatment system should install a effluent treatment system (ETS) or effluent treatment facility so that the shrimp farms effluent's effect could be minimized within the prescribed standards and mitigate any adverse impact on the ecology of the open waters.

For aqua farms, an Effluent Treatment System (ETS) is proposed recently which consists of 3 types of ponds viz., settlement ponds, bio-ponds and aeration ponds. The basic concept of this ETS is to first pass on the effluents into the settlement or sedimentation pond where 5-10% of the suspended solids such as feed, plankton and other organic materials are trapped and settled. It is found that 90% of the solid loads get sedimented in the harvest discharge in the settlement ponds. Thus, the most polluting organic matter load will be reduced in the first step. In the next step this water from the settlement pond will be allowed to flow to a bio-ponds where aquatic plants and animals will be used to reduce further nutrient load in the discharge. The biological treatment consists of utilization of seaweeds or waterweeds / duck weeds to reduce N and P levels significantly, mollusks like oysters /clams /mussels which reduces the suspended particulate matter and fishes that feeds on the available phytoplankton and controls the algal biomass. The third step of the ETS is the aeration pond where

the water from the bio-ponds will be passed on to the aeration pond where the water will be aerated continuously to increase the dissolved oxygen level in the water before it is pumped out or for recirculation. Besides, it also helps to oxidize any left over ammonia and organic matter in the water that comes out of the bio-pond.

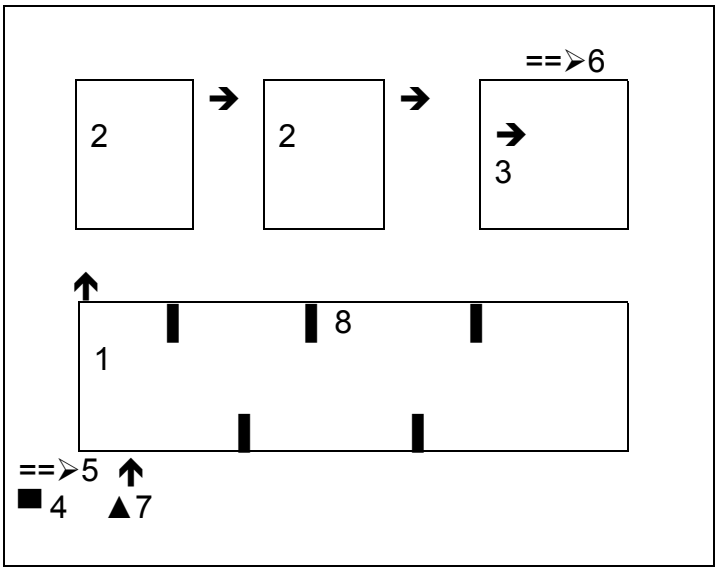
Cost Estimate for ETS

The cost estimate for the construction of a 0.5 ha. proposed ETS is given below

S.No	Particulars	Quantity	Unit rate(Rs.)	Amount (Rs.)
1.	Earth work excavation and construction	4700cu.m	60 /-	2,28,200 /-
2.	Sluice gate –main -secondary	1.no 3.no.s	30,000 /- 15,000 /-	30,000/- 45,000/-
3.	Sump pit			35,000/-
4.	Installation of MF pumps-10hp	1. no.	60,000 /-	60,000/-
5.	Installation of paddle wheel aerators	2. no.s	30,000 /-	60,000/-
6.	Pump shed and electric works			50,000/-
7.	Miscellaneous			40,000/-
	Total			**5,48,200 /-**

- The cost are indicative and may vary from region to region

Lay out of the proposed ETS



1. Sedimentation Pond (size 90 m x 24m –375 sq.m) 2. Bio ponds (size 30 m x 36m)
3. Aeration Pond (size 19 m x 36 m) 4. Sump pit 5. inlet of ETS 6. outlet of ETS
7. Pump house 8. Baffle walls

The implementation of this ETS can be made by making suitable modifications while adopting them. The organic waste accumulated in the settlement pond can be used as manure for plants. This type of adopting a 3-tier system of ETS is relatively simple and will help to a large extent in development of sustainable shrimp farming, without causing adverse impacts to the environment and the ecosystem. While sharing the common ETS facility, care should be taken to prevent the spread of diseases while recirculating the treated wastewater.

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APPENDIX

1. *Supreme Court Judgement Details*
2. *Land value at the advent of aquaculture*
3. *Employment & Income of labours in Agriculture sector*
4. *Employment & Income of labours in Aquaculture sector*
5. *Changes in employment & income*
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