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Status and Environmental Impact of Shrimp Aquaculture in East Godavari District, Andhra Pradesh

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In India area under shrimp culture and production increased by 234% and 325%, respectively from 1990-91 to 2002-03. A comparison on status of shrimp farming between 1999 and 2004 was made and studies were conducted on water and soil quality from different sources, their effect on soil salinisation to assess the impact of shrimp culture on the environment in East Godavari District, Andhra Pradesh. During 2004 the shrimp culture was in 18 *mandals* compared to 13 *mandals* in 1999. The number of farmers and area under shrimp culture has increased from 4814 and 6207.2 ha, respectively in 1999 to 10479 and 9252.82 ha, respectively during 2004. About 92.6 percent of farmers are having less than 2 ha area under shrimp farming during 2004 compared to 82.2 percent in 1999, reflecting the increase in number of marginal farmers. Shrimp farmers were practising improved/modified extensive farming of tiger shrimp with stocking density of 4-10 nos. of post-larvae per sq m. No adverse social or economic impacts have been reported by the local population excepting conversion of rice fields into shrimp farms in a few cases. The pollution indicators like ammonia N and chemical oxygen demand were well within the permissible limits indicating no adverse impact in the external source water. The electrical conductivity values of soil ranged between 1.0 and 1.89 dS m^{-1} in various agricultural fields adjacent to shrimp farms indicating that the soil salinity was not affected by the shrimp farming activities in the areas surveyed.

*(**Key words:** Shrimp aquaculture, Water and soil quality, Environmental impacts)*

Scientific shrimp farming in India developed as an off-shoot of the traditional filtration system and has been given the "Extreme Focus" status among the fisheries development programmes of the country. The potential area for aquaculture is estimated around 1.2 m ha. Shrimp culture area and production increased from 65,100 ha and 35,500 m tons, respectively during 1990-91 to 1,52,080 ha and 1,15,320 m tons, respectively during 2002-03. The contribution of cultured shrimp production to the total shrimp production in the country increased from 56.9 % during 1990-91 to 79.1 % during 2002-03. Early 90s witnessed a quantum jump in the development of shrimp farming without much control or planning. Shrimp contribution to total seafood export was 29% out of 4,67,297 tonnes contributing 67% earnings of US$ 1425 million in 2003 (Anon., 2004). Among the coastal states Andhra Pradesh occupies vanguard position by contributing more than half of the shrimp farming area and production. Development of shrimp farming in Andhra Pradesh was at a phenomenal rate during the years 1990-1996. In 1990, a total of 6000 ha was under shrimp farming which rose to 88,290 ha during 1997-98 and presently it hass declined to 53,246 ha.

Commercial shrimp culture has gained global attention not only on account of the role it played in strengthening the economy of a country but also by the sudden collapse the industry registered in certain countries. The issues related to aquaculture and environment belongs to two broad categories; impact of aquaculture on environment and impact of environment on aquaculture. Aquaculture utilises the resources and causes slight environmental changes. Many reviews lead to the conclusion that aquaculture had both positive and negative impacts, but occasionally negative impacts have received wide publicity (Lee and Wickins, 1992, Csavas, 1994). Unfortunately, the issue of salinisation because of shrimp farms has been, blown out of proportion without any substantiating data. Most of these issues are site specific and are localised in nature. The present status of shrimp farming was compared with 1999 data and the environmental impacts of shrimp farming are discussed in the present paper.

MATERIALS AND METHODS

Study area

East Godavari district is situated on the North East of Andhra Pradesh at 16° 30' and 18° 20' northen latitude and 81° 30' and 82° 36' of eastern

longitude. The district is bounded on the north by Visakhapatnam district and the State of Orissa, on the east by Bay of Bengal, on the south by West Godavari District, and on the west by Khammam district. The map of the district along with the boundaries is given in Fig. 1.The district has an area of 10807 sq km, with a population of 49,01,420 (2001 census). There are about 59 *mandals* in the district. It is a major rice producing State with 52% of the total area of the district under rice cultivation.

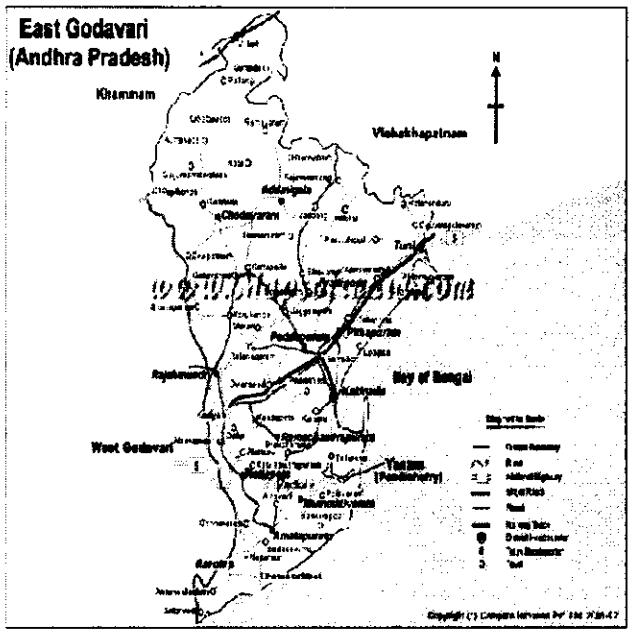

Fig. 1. Map showing the location of East Godavari districts and its boundaries

The *mandal*-wise area details on shrimp farming, farm size distribution and the location and extent of farming area with reference to coastal regulation zone were collected from the State Fisheries Department and the present status of shrimp farming in the district was compared with 1999 data. Thirty shrimp farms were chosen in 8 *mandals* for the detailed study regarding the cultural practices. Water and soil samples from the farm, source creek, irrigation canal and the bore were collected to study the environmental impacts. The samples were analysed for various parameters following the standard methods (Piper, 1966; Jackson, 1967, Strickland and Parsons, 1972, APHA, 1989).

Soil salinisation studies

The associated villages around the shrimp farms were selected randomly to assess the impact of the shrimp farming on salinisation of land, if any. Soil samples were collected from the adjoining paddy fields in triplicate at a distance of 50, 100, 250 and 500 m away from the farms in a straight line and analysed for pH and electrical conductivity in 1:2.5 soil-water suspension.

RESULTS AND DISCUSSION

Status of shrimp farming

East Godavari district ranks third as of now with respect to shrimp farming area compared to fourth position during 1999. Shrimp farms were located in 18 *mandals* in two fisheries divisions, viz. Kakinada and Amalapuram compared to 13 coastal *mandals* in two fisheries divisions, i.e. Kakinada and Rajahmundry division during 1999. The mandal-wise details of shrimp farms during 1999 and 2004 are presented in Table 1 and the farm size distribution and location and extent of coastal farms in relation to CRZ in the district are presented in Tables 2 and 3.

There was a tremendous increase in the area over the last five years. The district has developed about 10085.17 ha of actually brackishwater area into shrimp ponds compared to 7800.55 ha during 1999 (Table 1). Uppalaguptam *mandal* followed by the Tallarevu *mandal* had maximum shrimp farming area in the district. The percentage of actually developed area for the shrimp culture in the district has increased form 79.36 in 1999 to 91.75 in 2004 (Fig.2). About 82.23% are small farmers having less than 2 ha of water spread area in 1999 compared to 92.6 % in 2004 (Table 2). As per the CRZ rules out of 10085.17 ha area developed, 7242.95 ha area was developed within CRZ and 2842.22 ha area outside CRZ (Table 3).

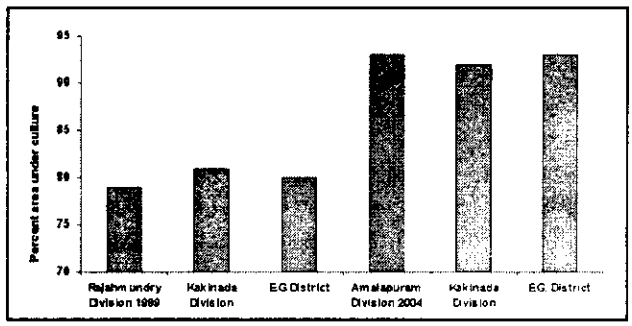

Fig. 2. The percentage of developed area under shrimp culture in East Godavari district

Farming practices

Shrimp farmers of this area are practising improved/modified extensive farming of tiger shrimp with stocking density of 4-10 nos. post larval per m^2.

Table 1. *Shrimp farming area details in East Godavari district during 1999 and 2004*

Mandal	1999			2004		
	No. of farmers	Potential area (ha)	Area under culture (ha)	No. of farmers	Potential area (ha)	Area under culture (ha)
	Kakinada Division			Kakinada Division		
Tallarevu	961	2335.6	1905.2	1684	2280.74	2018.55
Kajuluru	14	85.06	56.71	295	308.76	308.76
Karapa	46	138.88	101.71	225	222.30	207.62
Kakinada rural	10	27.44	18.34	10	27.5	27.5
U. Kothapalli	122	155.55	125.24	142	261.03	261.03
Thondangi	-	-	-	8	13.85	13.85
Total	1153	2742.53	2207.18	2364	3114.18	2837.11
	Rajahmundry Division			Amalapuram Divisioin		
Sakhinetipalli	516	656.08	524	769	324.76	324.76
Malikipuram	247	254.2	190.09	938	479.53	479.52
Razole	38	51.3	38	453	173.05	172.96
Mamidikuduru	310	375.54	313.75	984	469.77	442.08
Allavaram	738	1094.41	782.09	1465	1175.50	1174.60
Uppalaguptam	1079	1482.02	1244.3	1858	2713.45	2713.40
Katrenikona	513	616.09	493.32	552	745.07	497.05
I. Polavaram	220	528.38	414.43	508	536.03	358.31
Amalapuram	-	-	-	47	40.20	40.20
Inivilli	-	-	-	7	5.80	5.80
P.Gannavaram	-	-	-	101	37.76	35.96
Mummidivaram	-	-	-	433	270.07	170.87
Total	**3657**	**5058.02**	**4000.02**	**8115**	**6970.99**	**6415.51**
Total for the district	**4814**	**7800.55**	**6207.2**	**10479**	**10085.17**	**9522.82**

Table 2. *Farm size distribution in East Godavari district during 1999 and 2004*

Year	Farm < 2 ha		Farm 2-5 ha		Farm > 5 ha		Total	
	No.	WSA (ha)	No.	WSA (ha)	No.	WSA (ha)	No.	WSA (ha)
1999	3959	3530.95	737	1339.59	118	1350.56	4814	6221.10
2004	8750	6434.65	650	2324.2	54	493.97	9454	9552.8

Table 3. *Details of shrimp farming area (ha) as per the CRZ rules in East Godavari district during 2004*

	Actual BW area developed into ponds			Actual BW area under culture		
	Amalapuram	Kakinada	Total	Amalapuram	Kakinada	Total
Within CRZ	6627.99	614.96	7242.95	6095.51	452.77	6548.28
Outside CRZ	343	2499.22	2842.22	320.00	2384.54	2704.54
Total	6970.99	3114.18	10085.17	6415.51	2837.31	9252.82

They were raising two crops, one in summer (Feb-Mar. to Jun-July) and the other in winter (Sep-Oct. to Dec.-Jan). They were of the view that the former was successful and the latter was uncertain due to heavy rain, severe cyclone, non-availability of required salinity and outbreak of disease. Interestingly during summer farmers of this area mixed godavari canal irrigation water with creek water for culture and in winter the former was mixed with borewell water (20-25 ppt) to lower the water salinity to 10-15 ppt which they felt optimum for shrimp culture. All the farmers followed similar pond preparation procedures. Most of the farmers tested the quality of the seed before buying them. Most of

the farmers reported that disease menace particularly white spot virus and poor seed quality were the major constraints in 1999, whereas during 2004, low market rate of shrimp and poor seed quality were the major constraints. Labourers from local villages were engaged. The production varied across the farms from 0.8 to 2 tonnes per ha per crop of 30 g size *Penaeus monodon* in 120-150 days, during summer. The successful winter crop yield was 0.5 to 1 t ha^{-1} but it was uncertain.

Environmental impacts

Aquaculture being a biological production activity, the interaction of inputs such as shrimp seed, feed etc. with the ambient water resulted in growth and production of shrimp and changed water quality (Gupta *et al.*, 2001).

Water quality

The average water quality condition of creeks, borewell, irrigation canal and river and shrimp ponds are given in Tables 4, 5, 6, and 7, respectively. The water quality characteristics of the pond and creek revealed that that there was no serious nutrient loading in the creek water. The salinity levels in the creek were low in most of the cases and the farmers were using saline water from the borewell to raise the salinity levels. Wherever the salinity of the creek was higher, water from irrigation canal was used to reduce the salinity. Borewell waters registered high values of total ammonia nitrogen (TAN), nitrite N (NO_2 - N) and chemical oxygen demand (COD) than those in the creek, irrigation canal and river waters. The pH, salinity, TAN, NO_2 - N and COD values ranged from 6.97-7.29, 2-24 ppt, 0.007-0.138 ppm, 0.007-0.023 ppm and 8.7-96.5 ppm in creeks; 6.97-7.05, 17-32 ppt, 0.059-2.539 ppm, 0.012-0.588 ppm and 68.7-112.1 ppm in bore wells and 6.74-8.13, 5-23 ppt, 0.011-0.197 ppm, 0.015-0.187 ppm and 5-67.5 ppm in pond waters, respectively.

The pollution indicators like ammonia-N and chemical oxygen demand (COD) were well within the

Table 4. *Water quality characteristics of creeks in different pond clusters in East Godavari district*

Site	pH	Salinity (ppt)	Total NH_3-N (ppm)	NO_2-N (ppm)	Phosphate (ppm)	Total phosphorus (ppm)	Alkalinity (ppm)	COD (ppm)
Pathirajaram	7.27	4	0.035	0.007	0.036	0.046	162.4	10.1
G. Mollapalem	7.09	24	0.095	0.018	0.016	0.042	152.4	84.9
N. Kothapalli	7.32	3	0.126	0.019	0.042	0.073	172.8	6.7
Katrikona	7.10	6	0.037	0.008	0.016	0.062	160.8	40.3
Bodasakuru	7.21	3	0.091	0.015	0.019	0.054	168.4	2.6
Ponamanda	7.10	3	0.054	0.023	0.021	0.042	198.8	55.9
Korangi village	7.29	8	0.040	0.023	0.028	0.044	144.4	15.9
Korangi creek drain	7.16	2	0.138	0.022	0.009	0.064	165.2	8.7
Ramanaleapeta	6.97	18	0.007	0.012	0.016	0.053	161.6	96.5

Table 5. *Water quality characteristics of borewells in the study area*

Site	pH	Salinity (ppt)	Total NH_3-N (ppm)	NO_2-N (ppm)	Phosphate (ppm)	Total phosphorus (ppm)	Alkalinity (ppm)	COD (ppm)
Yeduralenka	6.97	32	0.059	0.588	0.028	0.088	219.6	91.8
Uppudi	7.05	20	0.70	0.012	0.011	0.021	324.8	68.7
Lutukuru	7.02	17	2.539	0.548	0.041	0.079	308.8	112.1

Table 6. *Water quality in the irrigation canal and river*

	pH	Salinity (ppt)	Total NH_3-N (ppm)	NO_2-N (ppm)	Phosphate (ppm)	Total phosphorus (ppm)	Alkalinity (ppm)	COD (ppm)
Vainatha river	7.14	25	0.032	0.023	0.065	0.070	134.8	77.4
Uppudi irrigation canal	7.44	4	0.126	0.015	0.037	0.123	245.2	34.2

Table 7. *Water quality in ponds from different villages in East Godavari district*

Site	pH	Salinity (ppt)	Total NH_3-N (ppm)	NO_2-N (ppm)	Phosphate (ppm)	Total phosphorus (ppm)	Alkalinity (ppm)	COD (ppm)
Yedurulanka	6.74	10	0.041	0.187	0.011	0.095	108.4	27.2
Pathirajaram	6.93	13	0.032	0.016	0.004	0.064	117.2	39.8
Pathirajaram	6.92	10	0.14	0.018	0.037	0.045	143.6	41.9
Bodasukuru	7.12	17	0.089	0.015	0.058	0.089	138.4	59.8
Lutukuru	6.96	23	0.109	0.017	0.075	0.094	103.6	65.7
Korangi	7.77	5	0.063	0.022	0.018	0.048	179.6	15
Lakshmipathipuram	7.52	15	0.087	0.018	0.056	0.07	169.2	63
Ramanaleapeta	7.05	20	0.034	0.018	0.037	0.062	149.6	67.5
G. Mollapalem	6.93	15	0.131	0.015	0.043	0.019	129.6	49.6

Table 8. *Soil quality in creek, shrimp ponds and agricultural fields near to shrimp farms*

Parameter	Creek	Shrimp ponds	Agrl. fields near to shrimp farm
pH	7.34 - 8.33	7.53 - 8.75	6.75 - 7.52
Electrical conductivity (dS/m)	0.83 - 4.08	0.58 - 5.95	1.06 - 1.89
Organic carbon (%)	0.555 - 1.722	0.258 - 1.311	1.218 - 1.593

permissible limits (MoEF, 1993) indicating no adverse impact in the external source water. In most of the cases, the creek acted as the intake as well as outlet, thereby increasing risk of cumulative loading of nutrients, but due to the improved traditional system of culture practiced reduced the possible pollution load was reduced.

Soil quality

The pH and organic carbon content in creek and pond soil ranged from 7.34-8.33 and 0.56-1.72 % and 7.53-8.75 and 0.258-1.809%, respectively (Table 8).

Soil salinisation

The soil quality of the agricultural lands located adjacent to the shrimp farms were tested for salinity. The electrical conductivity in various agricultural fields ranged between 1.06 to 1.89 dS m^{-1} (Table 8), which indicated that the shrimp farming activities in the areas surveyed does not affect the soil salinity. Agricultural fields were located very close to the shrimp farms and the creeks and there was no complaint from the agriculturists regarding the shrimp farming activities. Practically there was no soil salinisation even at a distance of 50 m away from the farm except in four villages out of 14 villages studied in Nellore District and Tamil Nadu (Muralidhar et al., 2000). NEERI's study also reported that salinity of the soil did not change at a distance of about 25 m (Chandran, 1998). In Cuddalore district of Tamil Nadu, during a study period of 18 months, the soil beyond 250 m was suitable for agriculture as the EC values ranged from 1.1 to 3.9 dS m^{-1} (Gupta *et al.*, 2002).

Conversion of agricultural land

In East Godavari district, conversion of agricultural fields into shrimp farms was reported in a few case. It was found that rice fields had been converted as shrimp farms due to the highly profitable nature of shrimp farming Recently conversion of shrimp farms back to paddy fields has been observed in some of the places.

CONCLUSION

Shrimp aquaculture has contributed significantly to employment generation and infrastructure development for the welfare of the coastal community and development in the district. Shrimp farming is continued in East Godavari District although with some constraints. The mixing of borewell and creek waters with fresh irrigation water, use of extensive and intensive feeds during the yearly and later period of culture, and shrimp + coconut + paddy farming system are the unique features of shrimp farming being practised in this district. There are no adverse impacts on the environment due to shrimp farming and in many places the positive impacts have outweighed the negative impacts, if any, like conversion of

agricultural lands into shrimp farms and others. The type and scale of any environmental change will depend on the method of culture, the level of production, and characteristics of the coastal area. Unless the pollution load in pond wastewater exceeds the assimilative capacity/carrying capacity of a water body that is seldom known (Muralidhar *et al.*, 2004), adverse environmental changes will not occur.

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