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BRACKISH WATER SHRIMP CULTIVATION RESTRICT THE COASTAL AGRICULTURE

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Abstract: Impact of brackish water shrimp culture on agriculture was studied in the Rampal Thana of Bagerhat district. Evidences for serious land degradation were obtained through surveys on the land use patterns, areas of land available for agriculture and level of production in various field crops covering a period of about two decades since 1975 when shrimp cult ure began in the area. The progressive accumulation of salt in the soil threatens permanent loss of soil fertility and has restricted the crop production in the area. The negative impacts of brackish water shrimp cultivation in the area is substantial in totality. Shrimp cultivation needs proper legal framework for providing check on furthering deterioration.

Key words: Shrimp culture; Agriculture; Brackishwater; Soil fertility; Crop production

Introduction

In Bangladesh over thirty per cent of the net cultivable area is in the coast. Out of 28.5 million hectares of coastal and offshore areas about 0.833 millions hectares are arable lands, constituting about 52.8 per cent of the net cultivable land available in 64 Thanas of 13 districts of the coastal area. Most of the land in the coast is affected by varying degrees of soil salinity (Karim *et al*., 1990). Agricultural use of the land is very poor.

The coastal region of Bangladesh, particularly the southwestern part (Satkhira, Khulna and Bagerhat) is the most promising area for shrimp cultivation due to two major factors (MOFL, 1997). Firstly, the low gradient of the land allows greater areas for suitability of brackish water farming. Secondly, the world's largest continuous mangrove forest, the Sundarbans is situated in the region, which provides good nursery areas and food source for the offshore fishery together with shrimp.

The predominant method of shrimp culture in Rampal areas is gher culture. *Gher* means enclosed area. This includes encirclement of land along the banks of tidal rivers with dwarf earthen dikes to control the free entrance of saline water into the enclosed areas

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controlled by small wooden sluice boxes. From February to April, sluice gates are opened to allow the entry of saline water with varieties of fish and post larvae of shrimp, which breed in the sea and the estuarine waters. In the traditional type of *ghers*, where juveniles of fish and shrimp are allowed to enter into the *ghers* with tidal water during spring tides through sluices, a number of shrimp and fish would be available inside the *gher*. This practice of natural stocking in the *gher* is being progressively replaced by artificial stocking of the *ghers* with the young of desired species of shrimp. Fig. 1 shows the brackish water shrimp and fish culture and cropping pattern in the coastal areas of Bangladesh.

Shrimp culture has been developed extensively in the coastal fisheries for more than a decade due to availability of abundant natural fry in the brackish waters of the estuaries of the Bay of Bengal. At present, there are 15,987 large and small size shrimp farms consisting of 147,000 ha of land in Bangladesh (Karim and Khandaker, 1997). More than 90% of the farms still practice a traditional and extensive system, the yield of which range from 50-200 kg/ha/year (ASCC, 1996). The statistics of shrimp cultivation area developed in different time and production of shrimp in metric tonnes is given in the Fig. 2.

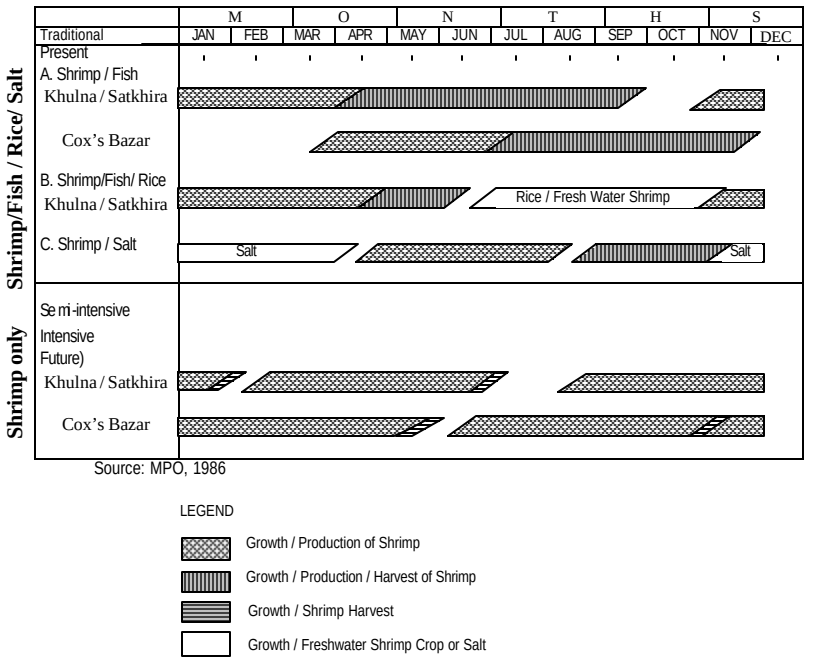


Fig. 1. The brackish water shrimp and fish culture and cropping pattern in the coastal areas of Bangladesh (Note: Brackish water requirement throughout growth and production period is 15% of the total water volume exchanged/day).

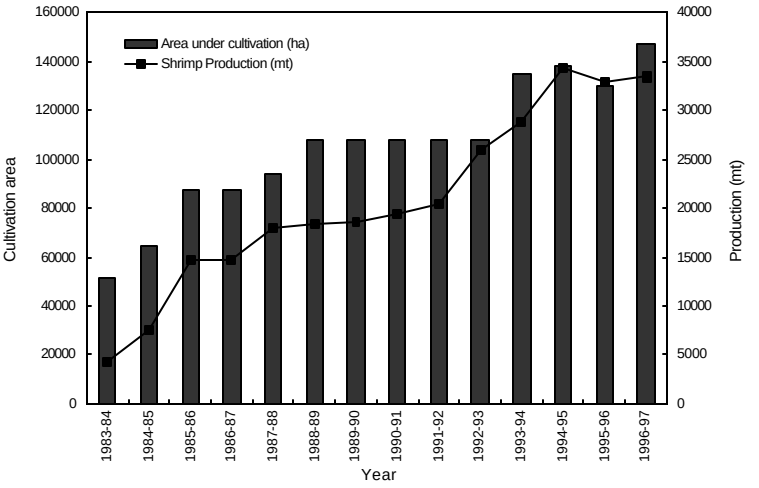


Fig. 2. Area under cultivation (ha) and production (mt) of shrimp in Bangladesh.

The cultivation is mainly based on traditional technology and as such the increase in output levels are attained by expansion of acreage, rather than rise in productivity (Siemelink, 1982; DDP, 1983 and Guimaraes, 1989).

Primevera (1989) reported that salt intrusion and salinization of fresh water aquifers in Taiwan, the Philippines and Thailand have resulted in the degradation of potable and agricultural water supplies, which, combining with land inundation with saline water, caused significant conflicts with local shrimp farmers and residents in the coastal shrimp farming areas.

In the southwestern zone particularly in Satkhira, Khulna, and Bagerhat, the encroachment in the area and salt water intrusion to the shrimp farms adjacent to homestead and agricultural land have now emerged as the great problems to the common people in the form of crop damage. It has damaged the crop and caused fresh water scarcity and outbreak of gastrointestinal diseases in some areas. As shrimp farming increased, salt load has replaced the useful soil nutrients. Year round inundation of land prevents free nitrogen fixation; mineralization in the soil is halted and fertility drops down accordingly within 1-2 years (Hart and Nandy, 1990). As a result, land use in these areas is changing from agricultural use to shrimp farming.

Mahmood and Saikat (1995) reported that large areas of our tropical wetlands, in Satkhira and Cox's Bazar, which were predominantly mangrove swamps, have been cleared (350 ha in Chakaria and 2000 ha in Khulna) and converted to shrimp ponds and '*Ghers*'. The process of converting mangrove areas to shrimp farming led to formation of acid sulphate soil (Mahmood and Saikat, 1995), low yields and crop failure, etc.

Thus, it is evidenced, the process of use of saline water for cultivating shrimp in the long run deteriorates the fertility of soil for producing traditional agricultural crops, the land

being substantially converted from crop production to shrimp production. Further, change in land use means making different use of land considering local socio-economic and other factors from one use to another. Essentially, this type of unplanned changes of land use should be addressed with effective planning approach.

The broad objective of the study is to know the extent of changes of land use from crop production to shrimp farming and the impacts of shrimp farming on crop production. The specific objectives of the study are as follows:

- To review the land use changes over a period of twenty-four years in 1975, 1985 and 1999).
- To identify and assess the effects of salinity on soil fertility and
- To identify and assess the effects of salinity on agricultural farming.

Materials and Methods

The study was aimed at assessing the causes and extent of salinity, change of cropping pattern and consequences of shrimp production over time. With a view to achieving these and to fulfilling the objectives, the broader methodology was chosen to include land use study, perception study information based on and data on environmental study. The nature of the impacts was obtained by examining the baseline conditions with that of the amount of change occurred due to shrimp farming. The Environmental change was calculated by deducting post project (existing shrimp cultivation) situations from that of the pre project (before shrimp farming) conditions.

In selecting the sample area, certain sets of criteria were looked into, such as (a) Extensive shrimp cultivation in and around the area. (b) Long time shrimp cultivation provides better results than immediate culture practices. Thus, shrimp cultivation was being practiced in the area for not less than ten years considered in the study. (c) The change in the physical environment in the area was geographically homogenous. (d) Whether shrimp was the main crop and major share of the farmers' income. Considering all these criteria the Rampal Thana of Bagerhat district was found to satisfy all and consequently selected as the study area (Fig. 3). Information relating to the socio-economic aspect was made through field observation, questionnaire survey and RRA method. All 44 mauzas were covered in the survey. Information were collected from 373 respondents belonging to five landowner categories of the households.

Results and Discussion

Agricultural Practice and Cropping Intensity in Rampal Upazila: According to BBS (1984-85) the intensity of cropping pattern in the study area is much lower than the country's average (151%); the figures has being 128 per cent in Bagerhat district and 104 per cent in Rampal Upazila. The same has been shown in Figure 4. In the present study however, the cropping intensity in the study area has been found to be 100 per cent in 1999 (Table 1). The double-cropped area was found to be at 13 per cent in 1975, while in

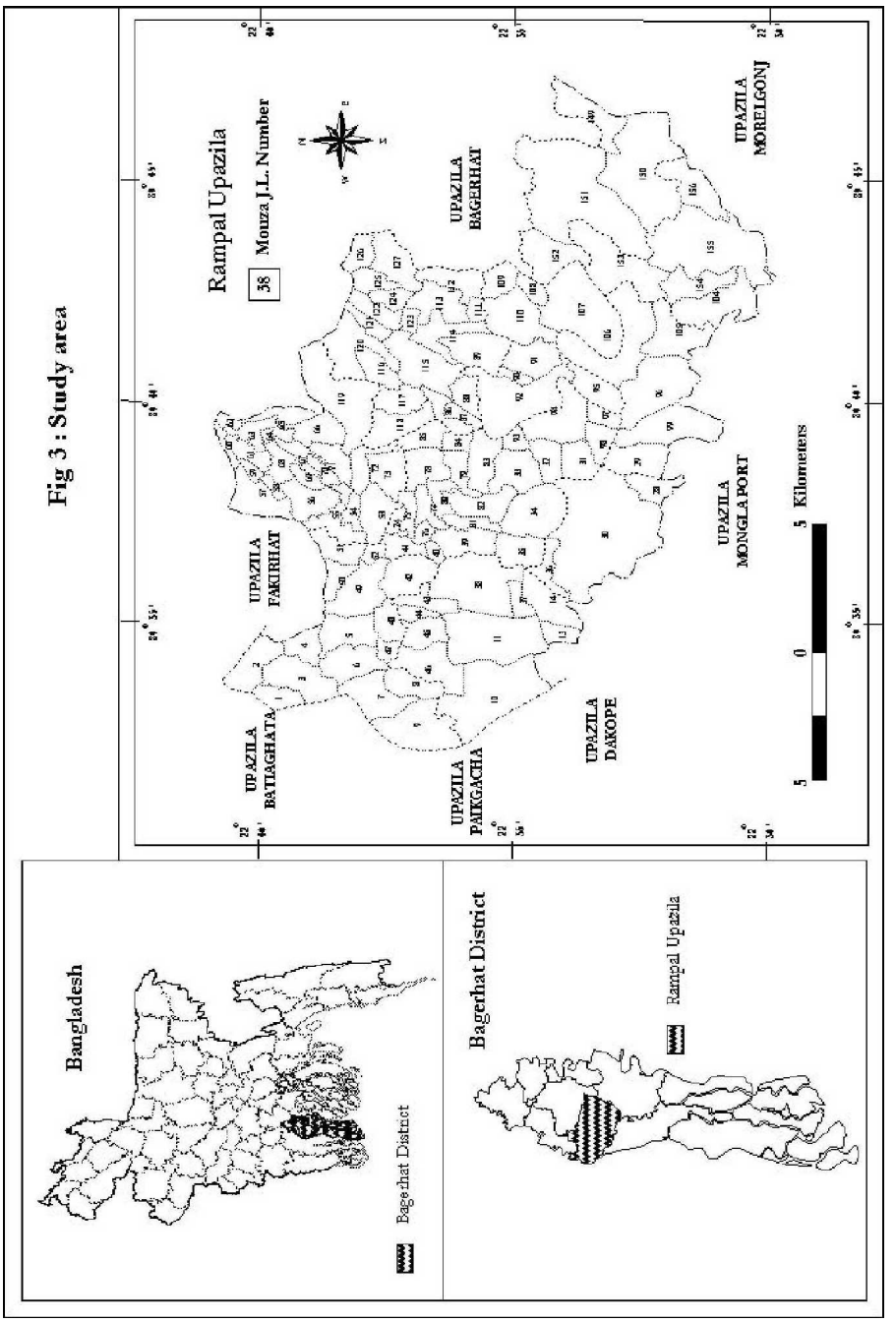


Fig. 3. Rampal Upazilla in context of Bangladesh and Bagerhat district.

1985 the figure had been decreased to 5.3 per cent and in 1999, there was no land available at all for double cropping.

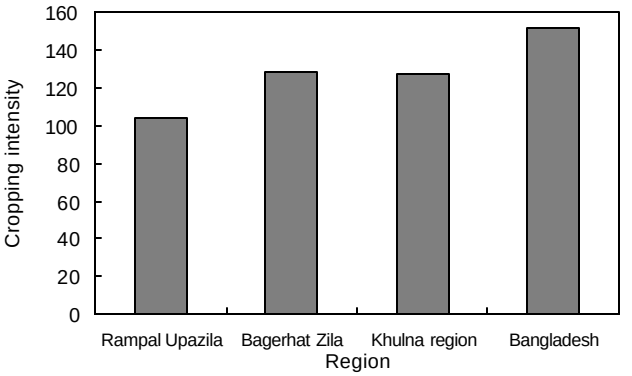


Fig. 4. Cropping intensity of Rampal in comparison with district, region and country.

Different types of rice-based cropping pattern were observed in the study area. The most common practice is to grow single stage transplanted *aman* rice. Some farmers at higher elevations grow broadcasted *aman* followed by transplanted *aman*. The cultivation of modern varieties are very poor in the area. The Table 2 (BBS, 1982) shows the areas available for growing rice, wheat and jute before 1980. After 1980s when the areas for brackish water shrimp cultivation had substantially increased the respective areas had gradually diminished and ultimately there was no land available for growing jute and wheat cultivation Fig. 5 and 6.

Table 1. Cropped area in Rampal Upazila.

Types of	Per cent of total area			Total cultivable land		
Cropped area	1975	1985	1999	1975	1985	1999
Single cropped area	87.0	94.7	100.0	87.0	94.7	100.0
Double cropped area	13.0	5.3	0.0	26.0	10.6	-
Triple cropped area	0.0	0.0	0.0	00	00	-
Total	100	100	100	113.0	105.3	100.0
Cropping Intensity				113.0	105.3	100.0

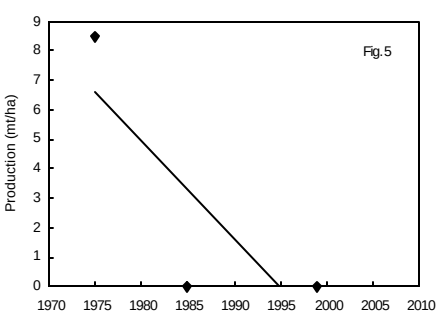
Source: Field survey, 1999.

Effect of salinity on the crop production: During the survey conducted in the present study, most of the respondents in the area confer that the land which was once very productive and used to give high production has now become unproductive due to salinization as the result of prolonged retention of saline water for shrimp growing. Rahman, *et al*. 1992 suggested that the soil characteristics in the coastal area have been substantially deteriorated due to gradual accumulation of salt over the years. The process of water retention and salinity build up has drastically reduced the fertility of the land (Mahmud, 1988) and resulted the cropland to remain fallow (Rahman, *et al*., 1992).

Table 2. Areal extent of rice, wheat and jute cultivation in the Rampal Upazila.

Year	Area in Acre								
	Aus		Aman		Boro		Wheat		Jute
	Local	HYV	Local	HYV	Local	HYV	Local	HYV	
1974-75	-	219	97456	830		130	2	1	58
1975-76	50	50	96645	1765	15	126	-	-	71
1976-77	-	-	89290	1450	-	80	-	-	134
1977-78	-	-	91239	920	-	150	-	-	77
1978-79	-	-	87131	1718	90	43	-	-	71
1979-80	-	-	82460	6000	179	80	-	25	73
1980-81	-	-	75100	3500	100	700	-	-	-
1981-82	-	-	72600	500	100	1300	-	-	-
1982-83	-	-	79800	1600	-	-	-	-	-
1983-84									
1984-85			56522	1000	-	-	-	-	-
1985-86									

Note: (-) Data not available. Source: BBS, 1982.



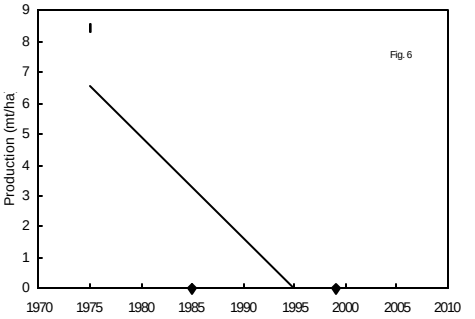


Fig. 5. Change in jute production from 1975 and 1999.
Fig. 6. Change in wheat production from 1975 to 1999.

Crop yield: Data on the production of different field crops and vegetables over the years were recorded during the survey. There have been phenomenal changes over the years in the rate of production of the major field crops and vegetables in the area. Table 3 reveals the amount of production of different crops in various recording years; the differences obtained over 1975-1999 period is alarming (Fig. 7).

The dominant cropping pattern in the area is the transplanted *aman* rice and shrimp cultivation. Mostly the traditional tall varieties of rice with low yields ranging from 1-3 ton/ha are cultivated in the area. As the yield levels have gone down drastically, the farmers have lost the interest of growing paddy any longer in the area. The survey revealed that although some minority of the farmers were trying hard to produce a mono-crop of transplanted *aman*, they were not even interested in harvesting rice from the fields because of very poor production.

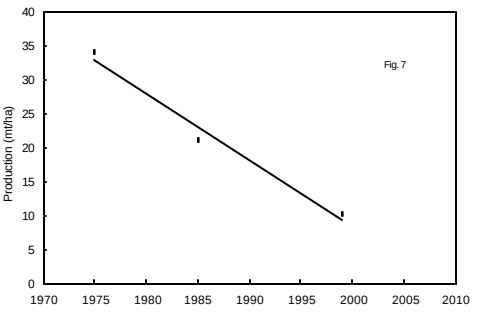
The scenarios for the production of vegetables in the area are also very gloomy; the area extent and the level of production have remarkably gone down in the area over the years.

Table 4 shows the percentages of land available for vegetable cultivation in the homesteads and in the elevated areas around the shrimp farms. It shows that the percentage of land used for vegetable cultivation during 1975 was quite higher. Ten years and 19 years after, during 1975-85 and 1975-99 respectively, however, the percentage of land had gradually gone down. The production of cauliflower, cabbage, *patal*, cucumber, bean, sweet potato and arum had been seriously affected in the area. Fig. 8 shows the changes of vegetable production during 1975-99 and the projected change has been estimated by a presumed regression trend line.

Table 3. Trend of major crop yields in m. ton per hectare from 1975-99.

Scientific name	Types of Crops	Production (Mt/ha)			Difference (Mt/ha)		
		1975	1985	1999	1975-85	1985-99	1975-99
Oryza sativa	Paddy	3.42	2.12	1.04	-1.3	-1.1	-2.39
Triticum sativum	Wheat	0.84	0.00	0.00	-0.8	0.0	-0.84
Corchorus capsularis	Jute	0.85	0.00	0.00	-0.8	0.0	-0.85
Brassica napus	Mustard	0.73	0.57	0.36	-0.2	-0.2	-0.37
Saccharum officinarum	Sugarcane	0.99	0.00	0.00	-1.0	0.0	-0.99
Pisum Sativum	Beans	0.66	0.59	0.53	-0.1	-0.1	-0.13
Capsium annuum	Pepper	1.44	0.76	0.62	-0.7	-0.1	-0.82
	Vegetables	2.74	1.20	0.83	-1.5	-0.4	-1.91
	Fruits	2.54	1.19	0.78	-1.3	-0.4	-1.76

Source: Field Survey, 1999.



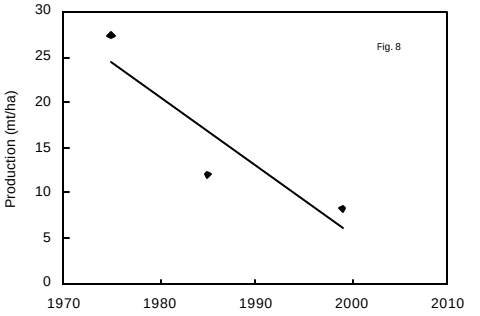


Fig. 7. Change in paddy production from 1975 to 1999.
Fig. 8. Change in vegetable production from 1975 to 1999.

Karim (1990) reported the germination and early vegetative stages of growth of most crops to be highly affected by salinity. Soil salinity of $EC_{extract}$ 8 dSm^{-1} largely affects the field crops at germination stage. The accumulation of salt in the soil is leached below the land and affects the root zone of the crops. Ayers and Westcot (1976) provided that the production of rice is reduced to 10 per cent when salinity tolerance limit exceeds 2000 micro-mhos and at 4000 micro-mhos the yield reduction is 50 per cent. Karim *et al*. 1990

classified five different categories of soil on the basis of salinity and plant growth condition. The salinity determining the soil types and the consequent plant growth conditions being varied at the range of less than 2 Ec x 10^3 dS m^{-1} to 16 Ec x 10^3 dS m^{-1} (Table 5).

Table 4. Percentage of vegetable cultivation in the study area.

Scientific name	Local name	Percentage			Differences of Percentages		
		1975	1985	1999	1985-75	1999-85	1999-75
Lagenaria vulgaris	Lau	98.1	83.7	50.5	-14.4	-33.2	-47.6
Cucurbita maxima	Kumra	85.3	54.3	24.3	-31.0	-29.9	-61.0
Amranthes gangeticus	Lal Shak	94.4	45.2	12.3	-49.2	-32.9	-82.1
Aloe indica	Sabuz Shak	95.7	46.5	19.0	-49.2	-27.5	-76.7
Brassica oleracea var. botrytis	Ful Kopi	77.5	9.4	2.9	-68.2	-6.4	-74.6
Brassica oleracea var. capplitta	Badha Kopi	79.1	7.0	1.1	-72.2	-5.9	-78.1
Brassica oleracea	Oal Kopi	83.7	10.2	3.5	-73.5	-6.7	-80.2
Solanum melongena	Begun	90.1	43.6	20.1	-46.5	-23.5	-70.1
Soalanum tuberosum	Alu	86.6	27.0	10.4	-59.6	-16.6	-76.2
Lycopersicum esculentum	Tomato	91.2	24.1	6.4	-67.1	-17.6	-84.8
Trichosanthes dioica	Patol	35.3	8.0	2.4	-27.3	-5.6	-32.9
Luffa acutangula	Zhinga	78.9	11.8	2.1	-67.1	-9.6	-76.7
Dolichos loblab	Shim	81.3	17.6	4.3	-63.6	-13.4	-77.0
Momordica cochinchinensis	Kushi	80.5	8.8	5.6	-71.7	-3.2	-74.9
Abelmoschus esculentus	Dherosh	79.4	14.2	9.4	-65.2	-4.8	-70.1
Cucumis sativus	Sosha	73.3	6.1	0.8	-67.1	-5.3	-72.5
Capsicum frutescens	Morich	91.7	31.0	9.9	-60.7	-21.1	-81.8
Vigna catiog	Borboti	75.7	3.7	2.1	-71.9	-1.6	-73.5
Batatas edulischoisy	Misti Alu	77.3	3.5	1.1	-73.8	-2.4	-76.2
Amorphophallus campanulatus	Oal Kochu	79.4	5.3	0.8	-74.1	-4.5	-78.6

Source: Field Survey, 1999.

Table 5. Soil salinity classification on the basis of plant growth condition.

Salinity Class	Ec x 10^3 dSm^{-1}	Plant growth condition
None saline (S_0)	<2	Salinity effects mostly negligible
Slightly saline (S_1)	2 – 4	Yields of very sensitive crops may be restricted
Moderate saline (S_2)	4 - 8	Yields of many crops are restricted
Saline (S_3)	8 - 16	Only tolerant crops yield satisfactorily
Highly saline (S_4)	> 16	Only very tolerant crops yield satisfactorily

Source: Karim *et al*., 1990.

Early vegetative growth of the plants are highly sensitive to high salinity. An increase in salinity from 8 to 14 causes 75 per cent reduction in production of paddy (Table 6).

Table 6. Percentage of paddy yield decrease due to different level of soil salinity.

Stages	% of paddy yield decreases by $EC_{extract}$ Values (dSm^{-1})			
	3	8	14	21
Early growth stages	0	50	75	96
Reproductive stages	0	0	10	52

Source: Karim *et al*., 1990 (Compiled from Das and Mehrota 1971; BRRI 1983;BARC 1981-82, 1982-83).

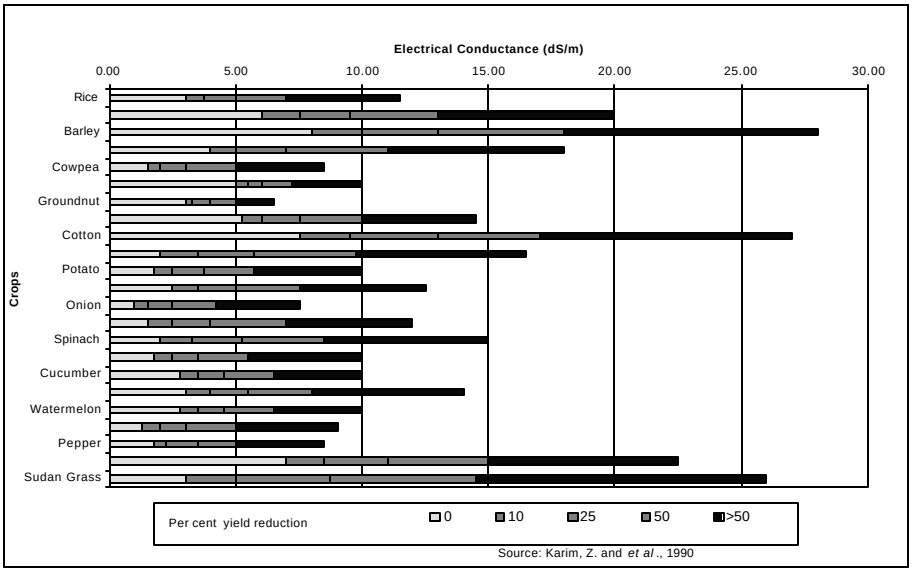


Fig. 9. Salinity tolerance of most commonly grown field and vegetable crops in Bangladesh and some potential crops which could be cultivated in the saline zone.

Fig. 9 (after Karim *et al*., 1990) presents the tolerance of most commonly grown field crops and vegetables of Bangladesh and some other potentially grown crops in the saline areas.

The cropping intensity, the areas available for production of the various field crops, crops at the homesteads and the rates of production all are indicative of a very negative impacts of the horizontal increase of brackish water shrimp cultivation in the study area. The negative impacts of salinization to the agricultural lands may be paid off by the high priced shrimp commodity, however, if the increasing negative social, and environmental issues which, it is hoped will be dealt in a latter issue, are considered, the damage that has been made in the area after the advent of the activity is simply enormous. Further deterioration in the sector would require legal framework on zonation, type of culture and integrated social economic and environmental planning on the sector as a whole.

Conclusions

The results of this study indicate that shrimp cultivation in Rampal Upazila causes several inter-related problems which arise from both inappropriate and environmentally unsound shrimp culture and pond management system. The conversion of paddy field into shrimp ponds and pumping in or introductions of seawater into shrimp ponds have caused salinization of nearly all paddy fields in the area. Despite the environmental consequences, the income from shrimp ghers remains to be relatively profitable, which draws an interest to invest more in shrimp cultivation rather than in traditional agriculture. As a result, severe land use conflicts concerning utilization ownership of land, water, space and other resources. Conversion of agricultural land into shrimp farm and increased soil salinity have been created problems for poor crop yields, reduction of grazing land that has an influence for decreasing livestock and poultry also. Development activities produced in the study area reflect little benefit to a large section of the local community. On the other side, it has caused for destroying the life and livelihood of the larger section of people.

Hence, Shrimp farming should be allowed to expand in the line of proper resource management and environmentally accepted way, which ensures a sustainable social and economic welfare. Horizontal expansion of extensive shrimp cultivation should be stopped by introduction of semi-intensive and intensive shrimp farming in a small area. So, it is the high time to take appropriate measures and planning approaches to promote systematic development of shrimp culture to reduce its negative impacts on society and environment.

Thus, there should be a strong planning, implementation, monitoring and evaluation committee to be set up by the government for the effective planning and controlled management of the coastal resources. This committee will look after the development of shrimp farming in a controlled manner and will propose a highly potential land use plan separating shrimp farm from other valuable resources by land use zoning. Construction of shrimp farm area outside the proposed area should be strictly prohibited for regulatory purpose.

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