Impact of shrimp cultivation on agriculture: A study in Parulia *union* of Satkhira district

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Abstract— *Transformation of land use pattern from agriculture to massive shrimp cultivation has been taking place in the coastal areas of Bangladesh. The present study attempts to find out various impacts associated with shrimp cultivation in Parulia union of Debhata upazila, Satkhira. A three months long field study was carried out in 2014 in twelve villages of the unions under study. The data were collected through a combination of qualitative and quantitative approaches: questionnaire surveys, focus groups discussions (FGD), field observation, key informants interview (KII) and secondary materials. The research revealed that shrimp cultivation has direct impact on agriculture in the study location. Though the traditional occupation of people in the area was agriculture (98%, N=102), however, after introduction of commercial shrimp cultivation (approximately 20 to 25 years ago) people in the area are overwhelmingly engaged in shrimp cultivation (86%, N=72). Due to encroachment of agricultural land by shrimp farm present land use strategies in the studied area have also changed drastically. Presently only 42.2 percent of respondents own agriculture land (N=102) whereas about 91.2 percent of respondents (N=102) own gher in the study area. Average agriculture land of respondent households in the area has also been reduced from 3.37 bigha to 1.45 bigha, whilst area and number of ghers of respondent households are increasing. Out of 44.16 km^2 of land in the study area 32.66 km^2 are under shrimp/bagda cultivation and only 4.19 km^2 (Boro cultivation = 3.50 km^2 and other crop cultivation = 0.69 km^2) are now being used for agriculture. With the increase of shrimp cultivation soil salinity is also increasing, as a result most the agriculture land becomes infertile and ultimately crop yields become reduced. Local rice varieties such as Patnai; Durgavogh; Kartikshail; Nagirshail; Chinikanai; Lalgati; Dhungati; Ashfali; Balam; Boran; Jamaibabu etc. are not able to cope with the excessive soil salinity, as a result farmers have to cultivate salinity tolerant high yielding varieties such as Jamaibabu 10; Aftab 1-10; BIRI 28, 30, 41, 47; BINA 7, 8, 10, 22, 28; Minikat; ACI 1, 2; Hira; Akhter 6; Sakti; Sathi; Aloron; Aata 70 etc.*

Keyword: Agriculture, shrimp farm, salinity, occupation, land use.

I. INTRODUCTION

Agriculture is a major sector of Bangladesh's economy and the coastal area of Bangladesh is very fertile for growing rice. It has also been identified that over thirty percent of the net available cultivable lands of Bangladesh are located in the coastal areas and about 40 million people of the coastal areas are depend on agriculture (BBS, 2011). But at present, it has been observed that all the coastal cultivable lands are not being utilized for crop production, largely due to soil salinity. To date, approximately 1-1.5 million *ha* of coastal low lands have been converted into shrimp ponds, comprising mainly of salt flats, marshes, and agricultural lands (Páez-Osuna, 2001). If this scenario continues rice production may fall by 10% and wheat by 30% by 2050 in Bangladesh (IPCC, 2007). Rice farming is said to have suffered from prolonged water logging from extended shrimp seasons (Bhattacharya et al., 1999; FFP, 1999). Increase in salinity intrusion and increase in soil salinity will have significant negative impacts on agriculture. The presently practiced rice varieties may not be able to withstand increased salinity. Approximately 2.8 million *ha* of coastal soil has become saline due to intrusion of seawater for shrimp culture in the country. The total saline area forms one third of the 9 million hectares of total national cultivated area in Bangladesh (ABSPII, 2006).

With these backgrounds, the present study is an attempt to assess the changes occurred due to introduction of shrimp cultivation in Parulia *union* of Debhata *upazila* in Satkhira district and its specific impacts on agriculture sector, land use pattern etc. The present study explored how unplanned development of shrimp aquaculture in the coastal areas of Bangladesh resulted many drawbacks in agriculture both in the reduction of agricultural land and crop yields.

1.1 Objectives

The broad objective of the present study is to assess the impact of shrimp cultivation on agriculture. The specific objectives are mentioned in the following:

- to identify the impact of shrimp cultivations on agricultural land;
- to assess the extent of changing land use pattern; and
- to examine the consequences of shrimp cultivation in context of changing rice varieties and crop production.

1.2 Methodology

The present study is the outcome of both quantitative and qualitative research methods and uses both primary and secondary sources of information. Quantitative data were collected by semi-structured questionnaire survey and qualitative data have been collected through using focus group discussion (04), key informants interviewing (10), researcher's observation etc. Duration of field work was three months from January to March, 2014. In total 102 households were covered purposively in twelve villages namely, Chaltetola, Kholishakhali, Rangashishe, Koikhali, Polgadarchawk, Norarchawk, Choddogram, Chotosanta, Gucchogram, Patakhali, Uttor Parulia, Dokkhin Parulia from Parulia *union* of Debhata *upazila* within the Satkhira district. Several criteria were considered during this selection process including: areas that are mostly used for shrimp cultivation, areas still dependent on agriculture, farmers doing integrated shrimp, rice and vegetable farming. Study locations were selected through literature review and consultation with local experts. Documents, presented papers, articles, academic journals, books and related websites of government and non-government bodies were reviewed as a source of secondary information.

II. PROFILE OF THE RESPONDENTS' HOUSEHOLD

A total of 102 households were surveyed based on interviews with one of the senior household member (Total household members 476). Profiles of the respondents' households are presented in Table 1.

TABLE 1
PROFILE OF RESPONDENT HOUSEHOLDS

Items	Frequency (N)		Total	Percentage (%)		Total
	Male	Female		Male	Female	
Sex	266	210	**476**	55.9	44.1	**100**
Age				**Percentage (%)**		
0-5	13	5	18	3.78		
6-17	56	52	108	22.69		
18-25	57	41	98	20.59		
26-45	80	72	152	31.93		
46-60	34	27	61	12.82		
60^{+}	26	13	39	8.19		
Total	**266**	**210**	**476**	**100**		
Literacy level						
Illiterate	51	57	108	22.69		
Primary	78	53	131	27.52		
Secondary	65	60	125	26.26		
SSC	35	26	61	12.81		
HSC	25	8	33	6.93		
Above HSC	7	3	10	2.10		
Madrasa	5	3	8	1.68		
Total	**266**	**210**	**476**	**100**		

Monthly income	**Frequency (N)**	**Percentage (%)**
<5,000 BDT	36	35.3
5,000-10,000 BDT	47	46.1
10,000-15,000 BDT	10	9.8
15,000-20,000 BDT	5	4.9
20,000 BDT<	3	2.9
0 BDT (help in family *gher*)	1	1.0
Total	**102**	**100**

N= 102; *Source: Questionnaire survey, 2014

The average family size of the respondent households is five people, which is close to the national average of 4.4 persons (BBS, 2011). Average age of respondent households ranges from 40 to 50 years and percentage of male and female is found 56 and 44 respectively (Frequency (N) of male = 266 and female = 210). Regarding education status, a total of 108 respondents (22.69%) are found have no literacy or never attended school, the illiteracy rate remains high among adults whereas primary and secondary schooling are found among 131 (27.52%) and 125 (26.26%) household members respectively. Among the 476 household members only 61 (12.81%) and 33 (6.93%) members completed SSC and HSC level whereas only 10 (2.10%) of them are completed or studied in degree and master's level and 8 (1.68%) in madrasa level. In addition to illiteracy, both male and female education level of respondent household members in the study area is mainly limited to primary and secondary level; only a few of them have studied up to Secondary School Certificate (SSC) and Higher Secondary School Certificate (HSC) levels. The average monthly income of respondent households in the survey area was between taka (BDT) 5000–10000 (Table 1).

III. KEY FINDINGS OF THE STUDY

Agriculture was indicated as main traditional occupation in the area of study by 98 percent of respondents among 102 household surveyed (Table 2), of which 54.2 percent of them (who mentioned agriculture as their main traditional occupation) were directly depend on agriculture as their primary occupation along with other secondary occupations related to agriculture such as agriculture day labor (23.6%), fishing and freshwater fish cultivation (11.1%), small business (22.2%), ranching of livestock (5.56%), and a variety of other services (Table 3). Regarding present occupational status of the study area 95 and 32.4 percent of respondents (Table 2) respectively indicated shrimp farming and shrimp farming day labor as new occupation in their locality. The survey also revealed that 71 percent of respondents had changed their traditional occupation whereas only about 29 percent of them (N=102) still remain in their previous occupations (Table 3). Among 71 percent of respondents who had changed their occupation the highest number (86.1%) are presently involved in shrimp farming as their primary occupation and only 12.5 percent of them are depended on agriculture with other secondary occupations such as shrimp farming day labor (19.4%), teaching (1.39%), livestock ranching (1.39%), poultry (1.39%) etc (Table 3).

TABLE 2
DIFFERENT TRADITIONAL AND NEW OCCUPATIONS IDENTIFIED BY THE RESPONDENTS IN THE STUDY AREA

Occupation	Traditional occupation		New occupation	
	Frequency (N)	Percentage (%)	Frequency (N)	Percentage (%)
Agriculture	100	98	2	1.96
Shrimp farming	4	3.9	97	95.1
Livestock ranching	74	72.5	3	2.9
Small business	20	19.6	4	3.9
Agricultural day labour	28	27.5	4	3.9
Shrimp farming day labour	1	1.0	33	32.4
Homestead gardening	8	7.8	2	1.96
Fresh water fisheries	9	8.82	1	1.0
Others	0	0	2	1.96
(Gov.t service, madrasa teacher etc.)				

N=102, Note= Occupations identified by the respondent's shows multiple frequency; *Source: Questionnaire survey, 2014

TABLE 3
PREVIOUS AND PRESENT OCCUPATION OF RESPONDENTS WHO HAVE/HAD CHANGED THEIR OCCUPATION

Occupation	Response	
	*Frequency (N)	Percentage (%)
Previous occupation		
Agriculture	39	54.2
Agriculture day labor	17	23.6
Business	16	22.2
Fresh water fisheries	8	11.1
Livestock ranching	4	5.56
Service	3	4.17
Crab culture	1	1.39
Ayurvadic physician	1	1.39
Teaching	1	1.39
Housewife	1	1.39
Present occupation		
Shrimp farming	62	86.1
Shrimp farming day labor	14	19.4
Agriculture	9	12.5
Teaching	1	1.39
Livestock ranching	1	1.39
Poultry	1	1.39

**** Respondents are counted for only those who have changed their occupation, here N=72;*Source: Questionnaire survey, 2014***

Surveyed respondents mentioned some reasons of shifting from their traditional occupation agriculture to shrimp cultivation and to other occupation. In this perspective, 49 percent of respondents opined that due to more benefit from shrimp cultivation they involved in this occupation whereas the second highest percentage of respondents (46.1%) indicated water salinity as main reasons of their shifting from agriculture to shrimp cultivation and to other occupations. Respondents also identified excessive soil salinity (33.3%), lower crop production (31.4%), loss of agricultural land (27.5%) and more frequent hazards (2%) as reasons of their shifting occupation (Table 4). Same result were also obtained from FGD and information of key informants that most of the people in this area were changed their traditional occupations due to lower agriculture production caused by excessive soil salinity.

TABLE 4
REASONS OF CHANGING OCCUPATION IDENTIFIED BY THE RESPONDENTS

Characters	Response	
	Frequency (N)	Percentage (%)
Reasons of changing occupation		
Excess soil salinity due to shrimp farming	34	33.3
Water salinity	47	46.1
Loss of agricultural land	28	27.5
Lower crop production	32	31.4
More benefit from shrimp culture	50	49.0
More frequent hazards	2	1.96

N=102, Note: Reasons of changing occupation shows multiple frequency;*Source: Questionnaire survey, 2014

IV. IMPACT ON AGRICULTURE LAND

Due to availability of saline water and instant cash back farmers in the study area are more interested in shrimp cultivation rather than agriculture. Hectares and hectares of land have been used for shrimp cultivation as a result soil salinity in this locality is also increasing day by day. Parulia *union* is comprised of 4384 ha of land with a cultivable area of 1228 ha which comprise only 28 percent of total land area. The survey revealed that at present approximately 42 percent of respondent households in Parulia *union* own agriculture land whereas 58 percent (Table 5) do not own any agriculture land. Though 42 percent of respondent households owned agriculture land but they do not use this land for agriculture purpose, most of this land is converted to shrimp farm, according to them shrimp cultivation is more profitable than agriculture. Survey also revealed that a remarkable numbers of respondent households are landless and resided in "*Khash"* land (Government-owned).

TABLE 5
OWNERSHIP WITH PAST AND PRESENT AVERAGE AGRICULTURE LAND OCCUPIED BY THE RESPONDENT HOUSEHOLDS IN THE STUDY AREA

Ownership of agriculture land				Ownership of agriculture land (*bigha*/HHs) from past to present	
Owner		Not owner		Before (Mean±SD)	Present(Mean±SD)
N	%	N	%	3.37±9.0	1.45±3.95
43	42.2	59	57.8		

N=102; *Source: Questionnaire survey, 2014

Agriculture Officer in Debhata *upazila* claimed that after harvesting of *Bagda*, the entire cultivated land has been used for Transplanted *Aman* (*T. aman*) cultivation which was about 15-20 years ago. However presently, *T. aman* cultivation in shrimp cultivated land has become limited due to long term effects of salinity in *Bagda* cultivated land.

Data from Development planning 2013-14, Parulia *union parishad* and Fisheries Department, Debhata, Satkhira found that soil pH in this area ranges from 6.5 to 7.0 and soil salinity level ranges from 4-12 dS/m in dry season; clearly indicating that the soils of this *union* are not suitable for agricultural activities with the exception of certain areas where salinity is slightly lower and still used for agriculture.

Apart from that, however, some of the respondent farmers appealed that they do not want to involve in this occupation anymore, because according to them shrimp aquaculture does not bring any visible benefit to them. Farmers in the study area expect that Government would take necessary steps by facilitating proper drainage system and other relevant activities so that they can start their traditional agriculture activities again.

V. IMPACT ON LAND USE PATTERN

Rapid land use changes have been observed in the Parulia *union*, the land once used for agriculture purpose is now being occupied by shrimp farm. The dominant land use of this *union* is shrimp cultivation (*bagda* and white fish). Transplanted *Aman* is cultivated in rain fed conditions and *Boro* (High Yielding Variety/HYV) crops are cultivated in few areas due to scarcity of irrigation water.

According to *Upazila* Development Planning report (2013-2014) during 1994-1995 total agriculture land area in Debhata *upazila* was 8279 *ha* whereas during 2013-2014 the land area is reduced to 6800 *ha*. From Table 6 and Table 7; it is found that total agriculture land of Parulia *union* is 1228 *ha* at present whilst the shrimp farm area is about 1956.75 *ha* with around 527 shrimp *ghers*; most of the land areas in this *union* are converted to shrimp *gher* and a clear indication of changing land use pattern. According to shrimp farmers due to availability of saline water they become more interested to shrimp cultivation. As a result area of *gher* in the study area have been increasing dramatically and eventually reducing agriculture land.

TABLE 6
INFORMATION RELATED TO AGRICULTURE LAND

Total agricultural land (*ha*)	*Gher*+*Boro* land (*ha*)	*Gher*+*Aman* land (*ha*)	Mono-crop land (acre) (fish/paddy)	Double crop land (acre) (fish+paddy)	Triple crop land (acre) (fish+paddy+mustard)
1228.00	27.62	1200.38	337	3030	0

**Source: Development planning 2013-14, Parulia union parishad and Fisheries Department, Debhata, Satkhira*

TABLE 7
INFORMATION RELATED TO SHRIMP AQUACULTURE LAND

Total shrimp/Fish culture land *(ha)*	Total number of *gher*	Average area of *gher (ha)*	*Bagda gher* (acre)	*Galda gher* (acre)	Culture method	Source of water
1956.75	527	3.27	2693	674	Bagda+Paddy+White fish and Bagda+Galda+White fish	River, khal, beel

**Source: Development planning 2013-14, Parulia union parishad and Fisheries Department, Debhata, Satkhira*

Figure 1 shows the process how shrimp culture occupies the agriculture land so fast in the area of study where the respondent households had an average of 3.37 *bigha* of agriculture land previously which is reduced with an average value of 1.45*bigha*/HHs at present (Table 5). From the observation and respondents response, it is found that not only the agriculture

lands but also the homestead forest area in this *union* is also been used for shrimp cultivation. Some of the farmers converted all of their land area into *gher* and resides in small house along the *gher* embankment.

Present land use data (Table 8) of Parulia *union* is also collected from the Center for Environmental and Geographic Information Services (CEGIS), 2014 to support study findings. The data presented in Table 8 showed how agriculture land in the studied *union* is occupied by shrimp farm or *gher*. From the table it is also found that more than two third areas (32.66 km^2 out of 44.16 km^2) of Parulia *union* are now being used for *bagda* cultivation whereas only 3.50 km^2 and 0.69 km^2 are used for *Boro* and other agriculture crops cultivation respectively.

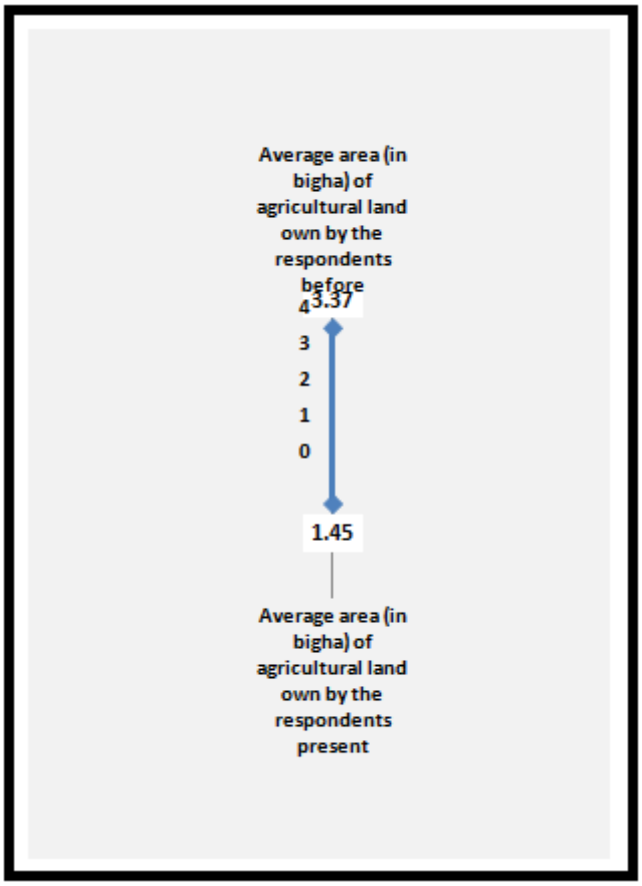


FIGURE 1: DEGRADATION OF AGRICULTURE LAND IN THE STUDIED UNION

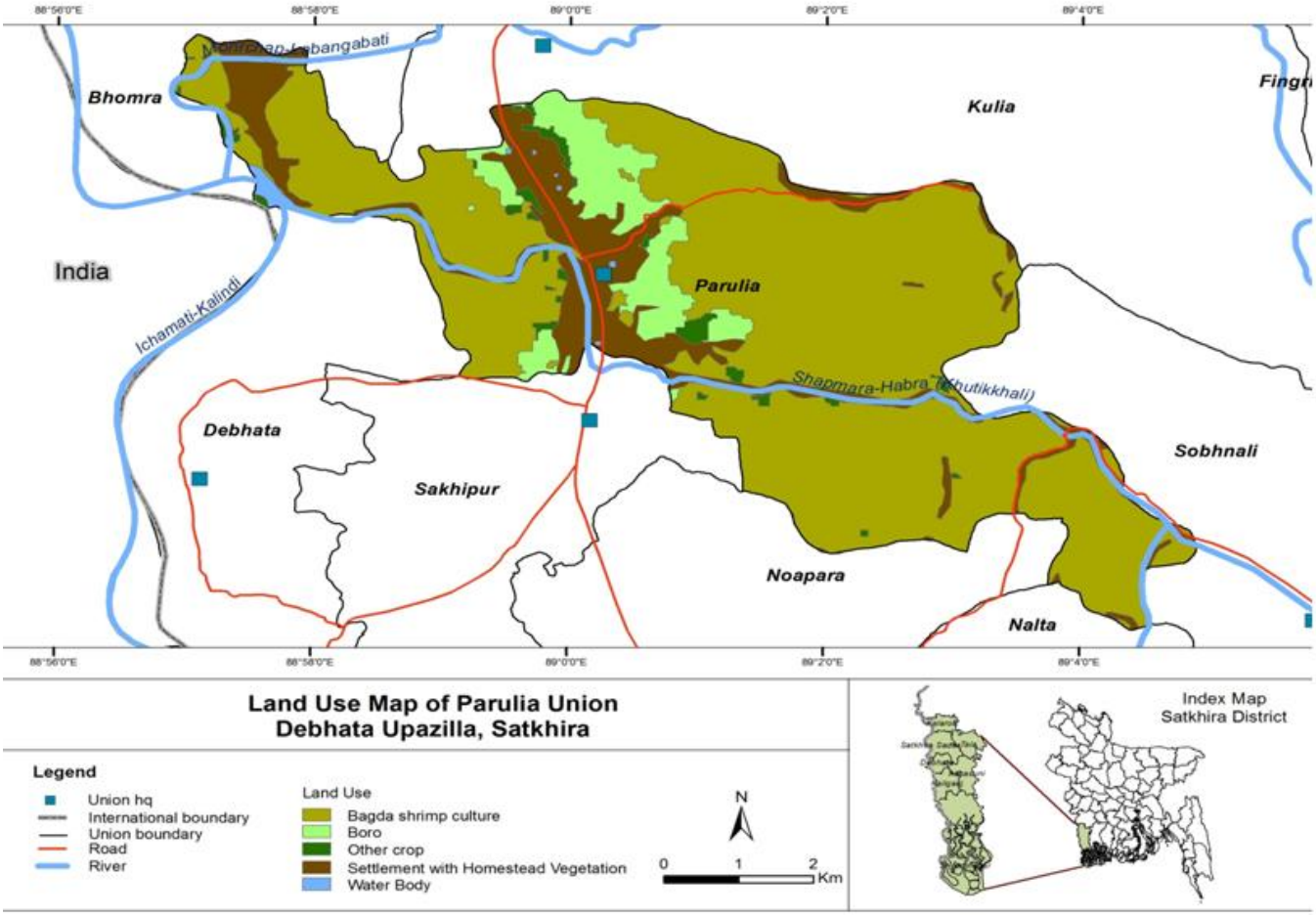
TABLE 8
PRESENT LAND USE PATTERN OF PARULIA *UNION*

Land use pattern	Area (km^2)
Bagda shrimp culture	32.66
Agriculture/*Boro*	3.50
Other crop agriculture land	0.69
Settlement with homestead vegetation	6.95
River/Canal	0.30
Water body	0.02
Grand total	**44.16**

Source: CEGIS, 2014

Using data presented in Table 8, a map (Map 1) on present land use pattern of Parulia *union* has also been developed. The map shows, *Boro* or agriculture cultivation is mostly practiced in the middle part of Parulia *union* that is in the uttor and dokkhin Parulia; which also supports the study findings from questionnaire survey.

MAP 1: PRESENT LAND USE PATTERN OF PARULIA *UNION*, DEBHATA, SATKHIRA (SOURCE: CEGIS, 2014)



VI. IMPACT ON RICE VARIETIES

From the survey and observation, it is also revealed that many local rice varieties that were once very common in the study area are not cultivated anymore as these varieties are not able to cope with excessive soil salinity. Not only the soil salinity but the water salinity in this area is also very high, as a result farmers have to depend on either rain water or shallow or deep tube well water for irrigation. But this process is not always cost effective as majority of farmers in the study area are very poor and not always able to effort shallow machine or deep tube well for irrigation. As a result the previously used rice varieties such as *Patnai; Durgavogh; Chinikanai; Lalgati; Balam; Boran* etc are completely disappeared and replaced by new hybrid and high yielding *Boro* and *Aman* varieties such as *Aftab, BIRI 28, 30 (Boro); BIRI 41 (Aman); BINA 7, 8, 10, 22, 28 (Aman); Minikat; ACI 1, 2; Hira; Akhter 6; Laltia; Sakti; Sathi; Aata 70* etc. A list of local and hybrid paddy varieties are presented in Table 9.

It has been mentioned by the Focus Group Discussion's (FGD) participants of uttor Parulia that *Aman* is mainly cultivated in high land area where soil salinity is much lower as in uttor and dokkhin Parulia, crop production in these two villages are also higher than other villages of the study area. In addition, all the paddy varieties such as *Aus, Aman* and *Boro* are cultivated in dokkhin Parulia. But in uttor Parulia *Boro* production remains at the highest rate. Paddy is not cultivated in eastern part of Parulia *union* whilst a very minor amount of paddy is still cultivated with shallow and deep tube well water in the western part of this *union*.

TABLE 9
LIST OF SOME LOCAL AND HIGH YIELDING RICE VARIETIES OF STUDY AREA

Respondents response	
Local/native rice varieties	**Salinity tolerant high yielding rice varieties**
Patnai; Durgavogh; Kartikshail; Nagirshail;Chinikanai; Shorukamini; Datshail; Lalgati; Dhungati; Ashfali; Katarani; Holdibota; Machranga; Rogarbat; Balam; Boran; Jamaibabu.	*Jamaibabu 10; Aftab 1-10, 70, 106; BIRI (Boro) 28, 30, 47, 49, 50, 55; BIRI 41 (Aman); BINA 7, 8, 10, 22, 28 (Aman); Minikat; ACI 1, 2; Hira; Akhter 6; Tejdhan; Laltia; Sakti; Sathi; Aloron; Sonar bangla 6; Aata 70*.

Source: Questionnaire survey, FGD & KII; 2014

VII. IMPACT ON CROP PRODUCTION

Due to intrusion of saline water into the *gher*, level of soil salinity in the study is increasing day by day and thereby reducing crop yields. During monsoon as water salinity of *gher* becomes dilute by rain water shrimp farmers keep using extra salt to ensure better growth of shrimp. This extra salt eventually gets stored in the field and adds to the level of soil salinity; as a result soil quality is degraded completely for further use in agriculture purpose and constraint agriculture production. Majority of respondents mentioned that they have observed very remarkable changes in the reduction of crop yields (90.3%), vegetable production (61.1%) and of homestead gardening (23.6%) in their locality over the last thirty years. From the survey and observation, it is found that vegetables, pulses and fruits are not cultivated in this locality now-a-days, as their production is reduced day by day due to high level of soil salinity. Table 10 shows some threatened crops of the study area, of which various varieties of vegetables, paddy and fruits are ranked high with the percentage of 74.5, 59.8 and 43.1 respectively. However, potato (28.4%), sesame (24.5%), mustard (15.7%), jute (15.7%) and various varieties of pulses such as *arahar* (7.8%), *khesari* (27.5%) and some other crops such as wheat, maize are also identified as threatened (Table 10). Respondents have also mentioned that though jute and wheat are now cultivated in a small scale but they were produced abundantly before beginning shrimp cultivation in their locality. During the survey, most of the respondents conferred that after 1980s; the areas for shrimp cultivation increased substantially whilst jute and wheat production decreased gradually together with rice, and ultimately made the land unsuitable for cultivation.

TABLE 10
THREATENED LOCAL CROP VARIETIES IDENTIFIED BY THE RESPONDENTS

Character	Response	
	Frequency (N)	**Percentage (%)**
Threatened crops identified by the respondents		
Paddy	61	59.8
Wheat	7	6.9
Mustard	16	15.7
Maize	4	3.9
Tobacco	4	3.9
Arahar	8	7.8
Sesame	25	24.5
Khesari	28	27.5
Jute	16	15.7
Fruits (Mango, litchi, coconut etc)	44	43.1
Potato	29	28.4
Onion	5	4.9
Vegetables	76	74.5
Source: Questionnaire survey, FGD & KII; 2014		

VIII. CONCLUSION

Unplanned Shrimp cultivation has multifarious impacts in terms of salinity increase. The present study attempts to find out various impacts of shrimp cultivation on agriculture in one of the coastal belts in Bangladesh. Salinity is a severe problem in Parulia *union* of Debhata *upazila*, Satkhira district which is not only reducing the agricultural potential, but also creating impacts on livelihood strategies of farmers. Most significant impacts of salinity is the changes in land use activities, constraints rice cultivation, declines many local crop varieties, vegetables, spoil the soil and ultimately the whole agricultural set up. Future study focusing on salinity issue might highlight to derive such a solution for long term sustainability and land management strategy. Further research also required on the adaptation options and thereby lends policy in addition to the findings and suggestions of the present study.

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