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Study on scope and existing cropping pattern at south-western saline region of Bangladesh

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ABSTRACT

One of the major restrictions influencing crop production in Bangladesh's coastal districts is salinity. In order to better understand the specific conditions in the south-western region of Bangladesh, where significant salinity and problems in crop production prevail, this study took place in two districts, namely Satkhira and Khulna. Six upazila were selected for the current study: Satkhira Sadar, Kaligonj, and Dumuria in Satkhira, and Batiaghata and Dacope in Khulna. Among the selected farmers, about sixty six percent of farmers were small farmers. The average farm size was 0.83 ha. Most of the land of the saline area was covered by a single crop with T. Aman. Ninety percent of the farmer of Satkhira Sadar upazila cover T. Aman-mustard-boro, which was the main cropping pattern. T. Aman-mustard, T. Aman-wheat, T. Aman-grasspea etc., were the major existing cropping pattern. Different vegetables and other field crops such as bottle gourd, bitter gourd, ladies finger, garden pea, potato, sweet potato, maize, chili etc., were cultivated in the study area sporadically. Most of the cost involved for labor cost in T. Aman rice cultivation. If the farmer cultivates the land by sharecropping from the owner, then farmer gives half of the crop to his landowner. The highest total rice equivalent yield (TREY) was T. Aman-mustard-boro cropping pattern and it was 13.23 t ha^{-1}. Most of the farmers eager to cultivate more new crops. Saline water, water stagnant, insufficient irrigation water, late harvest of T. Aman rice, late 'joe' condition etc., were the main constraints to develop a new cropping pattern.

Key Words*: Cropping pattern, Salinity, Cost & return, Satkhira and Khulna*

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I. Introduction

Agriculture is a significant component of the Bangladesh economy and the country's coastal zone is ideal for rice production. Performance in this sector has a disproportionate impact on creating jobs, the alleviation of poverty, the advancement of human resources and the provision of food. About 20% of the total area in Bangladesh is in the coastal zone, with the majority (53%) affected by varying salinity levels (SRDI, 2010). In general, those who live in coastal districts have long been thought of as disadvantaged in four main ways: poverty, food insecurity, environmental fragility, and lack of job opportunities. The coastline of Bangladesh is 710 kilometers long. More than 98% of the country's coastal lands are inundated by tidal and estuary floodplains. Coastal and offshore areas have approximately 1.0 million hectares of soil salinity degree impact (SRDI, 2010). Approximately 35,440 hectares of new land (3.5%) in the southern and south-western coastal areas are affected by very low salinity at a rate of 0.74% each year (SRDI, 2010). In the season of Rabi, Kharif-I and Kharif-II, around 4.95 M ha, 7.37 M ha and 1.59 M ha of land remain fallow due to salinity and lack of fresh water. Moreover, most agricultural land is flooded during monsoon. Salt consistency, unique hydrology, waterlogging in Kharif II and early rabi seasons and lack of quality irrigation water (drought) during Rabi and Kharif I seasons and tidal storms were the main reasons for low land utilization in the area (Rahman and Ahsan, 2011).

Floodwaters typically begin to decrease from October until late December, although high tides frequently inundate the fields even in December. Hus, or the drainage of rice fields in tidal habitats, is delayed, and as a result, most places remain unsuitable for planting Rabi crops in that location even after the T. Aman rice harvest. Crop yields in the coastal zone have been reduced due to lower salinity-induced land productivity (Uddin and Nasrin, 2013). Farmers' livelihood choices are strongly influenced by salinity penetration. Excessive seawater intrusion is caused by the presence of environmental and human factors in southwest Bangladesh. Although sea-level rise and rising temperatures are projected to cause greater salinity, increased salinity is obstructed by increased salinity and less freshwater supply via canal siltation and sedimentation (Bhowmick et al., 2016). A large part of the agricultural land in the coastal area only grows crops in the wet season because the soil is too saline in the dry season. There was about three times as much soil salinity in the dry season as in the rainy season, but crop productivity is often lower during the dry season. An annual crop sequence on a parcel of land is called a crop pattern. The factors which influence it include everything from the physical, historical, social, institutional, economic, and government components. Climate, soil type, rainfall, insect pressure, other factors and the availability of irrigation, transportation, marketing and transit infrastructure all impact crop growth and change (Rashid et al., 2005).

In Satkhira, single cropped area was 62 percent covered with a maximum land area followed by a double-cropped area was 29 percent and triple cropped area was only 8 percent (Table 01). In case of Khulna single cropped area was 64 percent of net cropped area, followed by double cropped area was 27% and triple cropped area was 10 percent. The cropping intensity of both districts was 146, which was less than the national cropping intensity (195) (BBS, 2019).

Table 01. Cropping area of Satkhira and Khulna during 2017-18

Cropping area (ha)	Satkhira	Khulna
Gross cropped area	224696	172065
Net cropped area	153441	117814
Single crop	95547 (62%)	74899 (64%)
Double crop	44939 (29%)	31579 (27%)
Triple crop	12551 (8%)	11336 (10%)
Cropping intensity	146	146

Source: BBS, 2019

Cropping systems dominate fallow-T. Aman-Fallow patterns in Bangladesh's south-west, particularly in the areas of Khulna, Bagerhat, and Satkhira. In Khulna, the single T. Aman crop pattern was the most prevalent, while the Boro-Fallow-T. Aman crop pattern was second in practically all upazilas (Rashid et al., 2017). Crop productivity and cropping intensity are about half of the national average in these areas. During the wet season (June-October), tidal flooding and direct inundation of salty water and the upward or lateral flow of saline groundwater during the dry season are linked to low productivity and reduced cropping intensity (November-May). In that case, it has great scope to develop a new cropping

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pattern for the economic development of the farmer in that region. For this reason, the study was conducted on the following objectives (i) to assess the existing cropping pattern and scope of developing new cropping pattern. (ii) to assess the constraints for developing an alternative cropping pattern.

II. Materials and Methods

For the present study, 180 samples farmer taking from two districts of the south-western saline region such as Khulna and Satkhira of Bangladesh, three upazilla from each district and 30 samples from each upazilla was purposively selected. Dumuria, Batiaghata and Dacope upazilla from Khulna district and Sadar, Kaligonj and Shyamnagar upazilla of Satkhira district were purposively selected for data collection. For purposive data collection, the Haraddah village of Sadar upazila of Satkhira was selected where various cropping patterns existed. Bharasimla village was select from Kaligonj upazila where excessive salinity existed, diversified and challenged cropping patterns. Mahmudpur, Jadabpur and Debipur village were selected from Shyamnagar upazila to collect data collection with high salinity. In another side Kalikapur and Senpara from Dumuria were select for data collection. Mohammadnagar, Sachibunia, Basurabad and Vennabunia were select from Batiaghata upazila. Kalinagar, Kamarkhola, Charnichab, Sutarkhali were select from Dacope upazila where high salinity exists. Focus group discussion (FGD) was done in each upazila with Upazila Agricultural Officer (UAO) with SAAO, local delegates and farmers to know the existing cropping pattern, problem of existing cropping pattern and scope of developing cropping pattern. FGD and individual surveys were done from February to April 2019.

Data were obtained from each farmer when the completed questionnaire was given to them. Descriptive statistics like averages, percentages and ratios were utilized to show the study results along with various statistical methods, including the t-Test, ANOVA and regression analysis. Gross return, gross margin, and benefit-cost ratio analyses were used to assess the profitability of crop production. The land use cost was based on the value of land each year. Based on the prevailing market price of each crop, yield was converted into the rice equivalent yield of rice (Ahlawat and Sharma, 1993).

Gross return	$GR_{ij} = Y_{ij}P_{ij}$	GR_{ij}= Gross return (Tk.ha^{-1}) Y_{ij} = Quantity produced (Kg.ha^{-1}) P_{ij} =Price of j^{th} crops received by i^{th} farmer (Tk.ha^{-1})
Net return=	gross return – total cost	
Gross margin=	gross return – variable cost	
Rice equivalent yield	REY (t/ha)=Yc * (Pc/Pr)	Yc = Yield of component crop (t/ha) Pc = Price of component crop Pr = Price of rice

III. Results and Discussion

Socio-economic profile of the respondent farmers

The socio-economic profile of the farmers concerned must have an insight into current farms, possible opportunities for development and potential for more efficient agriculture. Information was therefore collected on the age of the respondents, on education, employment, the size of the family, farm size, land use pattern and farm expertise. Prominent farmers in the study areas were experienced and heritage farmers. Most farmers were young, meaning they were between 31 and 50 years of age. Again, old farmers also participated in agriculture (age < 50 years). Old-age farmers accounted for around 37 percent (Table 02). When they were young, they only cultivated young, they only cultivated one crop in their fields and it was aman rice only. However, now the situation changed; most farmers cultivate more than one crop or are eager to cultivate more than one crop. However, it was challenged to cultivate more than one crop. Most of the salinity region's land was not suitable for cultivated more than one crop. The main reason was salinity in the land and water, water crisis at rabi season, late harvest of aman rice, late joe situation of the land etc. Men and women ratio of the study areas were the same. An average family member was 4.54, which equal to the national average. When we notice their educational background, most of the farmer were literate and can sign everyone. Agriculture was the farmer's main occupation, and very few farmers took part in a different profession in the business and agricultural works, besides

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farming. About ninety percent of the farmer was more than ten years of experience in farming. A very few farmers were young and less experienced.

Table 02. Percent distribution of average age of the respondent farmers

Attributes	Categories	Satkhira	Khulna	Average
Age group (Year)	>30 years	12.22	2.22	7.22
	31-40	28.89	34.44	31.67
	41-50	21.11	26.67	23.89
	<50 years	37.78	36.67	37.22
Family member	Average family member	4.74	4.33	4.54
	Male	50.12	49.23	49.67
	Female	49.88	50.77	50.33
Level of education	Can sign	11.11	13.33	12.22
	Primary	40.00	35.56	37.78
	SSC	33.33	45.56	39.44
	HSC and above	15.56	5.55	10.55
Average farming experience		22.09	27.10	24.60

Source: Field survey data, 2019

Land and farming related information

Farmers were categorized into four categories according to their farm size. They were marginal farmer (0.01ha-0.18ha), small farmer (0.19-0.99ha), medium farmer (1.00ha-3.00ha) and large farmer (above 3.0ha). Most of the farmers were small and medium farmers (Table 03). About sixty six percent of farmers were small farmers. The average farm size was 0.83 ha. The average own cultivated land was 0.38 ha. Most of the farmers cultivated by sharecropping system and half of their crop were given to the landowner. Some farmers also cultivated by leasing the land from others and in that case, lease value varies from Tk.60000 to Tk.74800 per hectare for each year.

Table 03. Farmer's distribution percent according to their farm size category and land use pattern

Attributes	Categories	Satkhira	Khulna	Average
Farm category	Marginal	7.78	2.22	5.00
	Small	75.56	56.67	66.11
	Medium	15.56	41.11	28.33
	Large	1.11	0.00	0.56
Land use pattern (ha)	Average farm size	0.68	0.98	0.83
	Own cultivated land	0.36	0.40	0.38
	Share cultivated land	0.43	0.71	0.57
	Lease in cultivated land	0.48	0.63	0.55

Source: Field survey data, 2019

Cropping pattern

The pattern of cultivation refers to the percentage of area at various times under different crops. It also shows the time and spaces or series of the crops or their sequence in a certain region of the land. Most of the saline area land was covered by a single crop and it was T. Aman. Farmers generally cultivated only single T. Aman rice during the monsoon season in the south and south-western coastal saline areas (Saha et al., 2019). However, now a day's cropping pattern changed to a double cropped area and based on T. Aman rice based cropping pattern. T. Aman-mustard-boro was the main cropping pattern at Satkhira Sadar upazilla where three crops can easily cultivate in that area, and about 90 percent farmer's practice this cropping pattern (Table 04) preferred cropping pattern of Sadar upazilla was T. Aman-jute cropping pattern. T. Aman-mustard-sesame and T. Aman-mustard-mungbean was also preferable cropping pattern of Satkhira Sadar upazilla. On the other hand in Kaligonj upazila T. Aman-mustard and T. Aman-wheat were preferred cropping patterns. However, in the field survey, we get maximum farmers involved only on crop T. Aman due to long duration T. Aman rice and shortage of water in the rabi season. Excessive saline in land and water also a hindrance to cultivating crops during rabi season. Following this situation, Shyamnagar farmers were also cultivated a single crop only T. Aman. However, some farmer practice T. Aman-boro and T. Aman-T.aus where irrigation water was available. Some farmer also practiced T. Aman-grasspea where irrigation water was not available and this practice was

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profitable. Grasspea seed was broadcasting on the wetland before harvest the T. Aman rice and it gave good results. T. Aman-boro was the main cropping pattern of Dumuria upazila and most of the farmers practice this pattern. On the other hand, single T. Aman rice cultivation was covered most of the area of Batiaghata and Dacope upazila of Khulna district. Some farmers cultivate mustard, grasspea, wheat, and sesame after harvesting T. Aman rice in Batiaghata upazila. In Dacope area, watermelon was cultivated after harvest T. Aman rice. But most of the land becomes fallow after harvest T. Aman rice due to lack of irrigation facilities. Some vegetables and other field crops such as bottle gourd, bitter gourd, ladies finger, garden pea, potato, sweet potato, maize, chili etc., were cultivated in the study area sporadically.

Table 04. Major cropping pattern of Satkhira and Khulna (% of farmer)

Cropping pattern	Satkhira Sadar	Kaligonj	Shyamnagar	Dumuria	Batiaghata	Dacope
T. Aman-mustard-boro	90.00	-	-	-	-	-
T. Aman-boro	-	-	-	100.00	-	-
T. Aman-fallow	-	73.33	90.00		83.33	100.00
T. Aman-mustard-mungbean	26.67	-	-	-	-	-
T. Aman-mustard-sesame	23.33	-	-	-	-	-
T. Aman-mustard	-	63.33	-	13.33	36.67	-
T. Aman-wheat	23.33	53.33	-	-	20.00	-
T. Aman-aus	-	26.67	33.33	-	-	-
T. Aman-sunflower	-	36.67	-	-	20.00	-
T. Aman-grasspea	-	-	40.00	-	23.33	-
T. Aman-Vegetable	-	-	-	56.67	26.67	16.67
T. Aman-Jute	36.67	-	-	-	-	-
T. Aman-water melon	-	-	-	-	-	36.67

Number of farmer, N=30; Source: Field survey data, 2019

Cost structure

Production costs relate to input levels, input prices, farming system and institutional elements such as finance and marketing costs. For this study, yield, cost and crop return data were collected to clarify production costs and evaluate profitability. Production costs were separated into two categories: variable and fixed. Variable costs are proportional to farm size at any given time. Land preparation, seed costs, labor, fertilizer, plant chemicals, irrigation costs and labor capital interest are all examples of variable expenses. T. Aman's average total cost was Tk. 71107 ha^{-1} (Table 05), whereas variable cost was Tk. 37197 ha^{-1} and fixed cost was Tk. 33909 ha^{-1}. Boro rice's average total cost was Tk. 86245 ha^{-1}, while variable cost was Tk. 50840 ha^{-1} and fixed cost was Tk. 35405 ha^{-1}. Total cost of rice was Tk. 67645 ha^{-1}, variable cost was Tk. 36728 ha^{-1} and fixed cost was Tk. 30917 ha^{-1}. Total cost of producing mustard was Tk. 50580 ha^{-1}, whereas variable cost was Tk. 24026 ha^{-1} and fixed cost was Tk. 26554 ha^{-1}. Total wheat production cost was Tk. 66500 ha^{-1}, variable cost was Tk. 37478 ha^{-1} and fixed cost was Tk. 29022 ha^{-1}. Total sunflower production costs were Tk. 78068 ha^{-1}, whereas variable costs were Tk. 35183 ha^{-1} and fixed costs were Tk. 42885 ha^{-1}. Total grass cultivation costs were Tk. 37870 ha^{-1}, whereas variable costs were Tk. 16303 ha^{-1} and fixed costs were Tk. 21567 ha^{-1}. After T. Aman rice harvest in study areas, grass pea was grown without tillage. Total cost of sesame cultivation was Tk. 44702 ha^{-1}, whereas variable costs were Tk. 22761 ha^{-1} and fixed costs were Tk. 21941 ha^{-1}. Total cost of manufacturing mungbean was Tk. 47771 ha^{-1}, whereas variable cost was Tk. 25331 ha^{-1} and fixed cost was Tk. 22440 ha^{-1}. Mungbean cultivation was required for soil health and sometimes mungbean utilized for green manure and soil incorporation. Boro rice Tk. 86245 ha^{-1} followed by sunflower, T. Aman, aus, wheat, mungbean, sesame and grass pea, which were Tk. 78068 ha^{-1}, Tk. 71107 ha^{-1}, Tk. 67645 ha^{-1}, Tk. 66500 ha^{-1}, Tk. 47771 ha^{-1}, Tk. 44,702 ha^{-1} and Tk. 37870 ha^{-1}, respectively. Most of the labor expenditure required in T. Aman rice growing. If the owner cultivates the land by share, the farmer provides his landowner half the yield. Thus, land-use costs boost manufacturing costs.

Cost and return of major cropping pattern

The profitability of major crops was lower in saline areas than non-saline areas (Uddin et al., 2019). The study found that T. Aman-mustard-sesame cropping pattern gain the highest net return Tk. 55811 ha^{-1} at three crops cropping pattern followed by T. Aman-mustard-boro (Tk. 46468 ha^{-1}) cropping pattern and T. Aman-mustard-mungbean cropping pattern was Tk. 44593 ha^{-1} (Table 06). T. Aman based two

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crops cropping pattern T. Aman-wheat was given highest return Tk. 41693 ha^{-1} followed by T. Aman-grasspea (Tk. 38123 ha^{-1}), T. Aman-mustard (Tk. 37914 ha^{-1}), T. Aman-boro (Tk. 37548 ha^{-1}), T. Aman-sunflower (Tk. 36425 ha^{-1}) and T. Aman-aus (Tk. 33448 ha^{-1}) respectively. Only single crop T. Aman cultivation net return was given Tk. 28993 ha-1 but its benefit-cost ratio (BCR) was highest (1.41) than other cropping patterns. The highest total rice equivalent yield (TREY) was T. Aman-mustard-boro cropping pattern and it was 13.23 tha^{-1}. Yield of many crops hampers in the dry season due to salinity (Kumar et al., 2019).

Table 05. Production cost of major crops cultivated in the study areas (Tk. ha^{-1})

Cost item	T. Aman	Boro	Aus	Mustard	Wheat	Sunflower	Grasspea	Sesame	Mungbean
Variable cost									
Cost of land preparation	5984	6732	5236	2992	5984	4488	-	5236	4488
Hired labor	20196	22440	17952	8976	13464	14960	7480	11968	14960
Cost of seed	1907	1850	2100	700	3200	4800	3500	800	2200
Cost of fertilizer	4121	8490	4361	8198	8535	7839	3777	3074	1646
Cost of pesticide	4200	6500	4800	1850	2500	1250	1200	1200	1500
Irrigation		3750	1500	800	3000	1100			
Interest on operating capital	789	1078	779	510	795	746	346	483	537
TVC	37197	50840	36728	24026	37478	35183	16303	22761	25331
Fixed cost									
Family labor	23936	25432	20944	19074	21542	32912	19074	15708	18700
Land use cost	9973	9973	9973	7480	7480	9973	2493	6233	3740
TFC	33909	35405	30917	26554	29022	42885	21567	21941	22440
TC	71107	86245	67645	50580	66500	78068	37870	44702	47771

Source: Field survey data, 2019, Author's calculation.

Table 06. Cost and return of major cropping pattern

Cropping pattern	TREY	Gross return	Total cost	Net return	BCR
T. Aman-mustard-boro	13.23	254400	207932	46468	1.22
T. Aman-Boro	10.26	194900	157352	37548	1.24
T. Aman-fallow	5.01	100100	71107	28993	1.41
T. Aman-mustard-mungbean	10.70	214050	169457	44593	1.26
T. Aman-mustard-sesame	11.11	222200	166389	55811	1.34
T. Aman-mustard	7.98	159600	121686	37914	1.31
T. Aman-wheat	8.97	179300	137607	41693	1.30
T. Aman-aus	9.48	172200	138752	33448	1.24
T. Aman-sunflower	9.28	185600	149175	36425	1.24
T. Aman-grasspea	7.36	147100	108977	38123	1.35

Note: Yield: T. Aman (4.85 t ha^{-1}), boro rice (5.10 t ha^{-1}), aus rice (4.35 t ha^{-1}), mustard (1.30 t ha^{-1}), wheat (3.50 t ha^{-1}), grasspea (1.175 t ha^{-1}), sunflower (1.90 t ha^{-1}), mungbean (0.99 t ha^{-1}) and sesame (1.228 t ha^{-1}). Price: T. Aman (Tk. 20 Kg^{-1}), boro rice (Tk. 18 Kg^{-1}), aus rice (Tk. 16 Kg^{-1}), mustard (Tk. 45 Kg^{-1}), wheat (Tk. 22 Kg^{-1}), grasspea (Tk. 40 Kg^{-1}), sunflower (Tk. 45 Kg^{-1}), mungbean (Tk. 55 Kg^{-1}) and sesame (Tk. 50Kg^{-1}).
Source: Field survey data, 2019, Author's calculation.

Farmer's perception on technology dissemination

Farmer's perception of interest in new crops was primarily positive. About eighty two percent of farmers answered yes and were kin to interesting in accepting new crops (Table 07). But their interest level varies from farmer to farmer. Seventy percent of farmers strongly interest in new crops cultivation. Some farmers give positive, but they think they have no scope for cultivating more crops than their existing crops. About seventy percent farmer gets training on different crop production more than once from a different organization. Among them, forty seven percent of farmers get training from the Department of Agricultural Extension (DAE), followed by research organizations (BARI, BRRI, BINA, SRDI etc.) and NGOs. Sixty one percent of farmers get agricultural kinds and cooperation such as seed, fertilizer, pesticide etc., from different organizations. Farmers get input to help from DAE (39.44%) followed by research organizations (28.33%) and NGOs (10.00%). Different organizations gave

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different crops such as rice, wheat, maize, sunflower, mungbean, mustard, sesame, and vegetables to cultivate in farmers' fields. Almost eighty percent of farmers continue cultivating such crops, but 20 percent of farmers did not continue the new technology. If they get more and more training, inputs and promotional activities were done, new technology may survive.

Table-07. Farmer perception on technology dissemination (% of farmer)

Categories	Attributes	Satkhira	Khulna	Average
Interest new technology	Yes	84.44	78.89	81.67
	No	15.56	21.11	18.34
Interest level of new crops	Interest	71.11	68.89	70.00
	Less interest	3.33	11.11	7.22
	Not interest	3.33	8.89	6.11
	Interest but not scope	18.90	6.67	12.79
	No knowledge at new crops	3.33	4.44	3.89
Get training	Yes	82.22	56.67	69.44
	No	17.78	43.33	30.56
Get training from	DAE	56.67	37.78	47.22
	Research	35.56	21.11	28.33
	NGO	3.33	22.22	12.78
Get agricultural input	Yes	73.33	48.89	61.11
	No	26.67	51.11	38.89
Source of agricultural kinds and cooperation	DAE	46.67	32.22	39.44
	Research	37.78	18.89	28.33
	NGO	3.33	16.67	10.00
Technology continuation	Yes	81.82	77.27	79.55
	No	18.18	22.73	20.45

Source: Field survey data, 2019

Problems of existing cropping pattern

Salinity creates a disadvantageous and hydrological condition that limits ordinary cultivation throughout the whole year. Tide flooding (June-October), direct flooding of saltwater and up or lateral movement of saline groundwater in dried seasons are key factors for the growth of saline soils (November-May) (Haque, 2006). There were many problems faced by Satkhira and Khulna farmers in which the FGD depicted problems with SAAO, local delegates and farmers of those areas. The existence of saline water was the main problem for developing new cropping patterns. About seventy eight percent of farmers opined that soil and water salinity was the most concern for developing alternating cropping patterns in the saline regions (Table 08). Water stagnant at paddy planting time was hampered for T. Aman rice cultivation at timely. So that T. Aman rice planting and harvest time were delay.

In some cases, T. Aman rice was harvested in the last week of December, which hampers cultivating another crop. Most of the farmers cultivated long duration T. Aman rice which causes late harvest of T. Aman rice and late 'Joe' condition of land for rabi crops. At rabi season, there was insufficient irrigation water for planting rabi crops. Even due to insufficient water at rabi season, germination did not happen (Chanda et al., 2019). These problems identify with the group discussion were not the same for all the selected upazila of Satkhira and Khulna district. Satkhira Sadar upazila farmer did not so much problem.

Table 08. Percentage of problems of developing new cropping pattern

Problems of new cropping pattern	% of farmer	Ranking
1. Existence of saline water	77.78	I
2. Water stagnant	76.50	II
3. Insufficient irrigation water in rabi season	75.56	III
4. Late harvest of T. Aman rice	70.00	IV
5. Late 'Joe' condition	65.56	V
6. Lack of knowledge of improved crop production technology	45.56	VI
7. Lack of improved variety of seeds	40.44	VII

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When upazila wise problem was identified, it was noticed that Satkhira Sadar upazila had fewer problems than other upazila (Table 09). In this upazila more or less two to three crops could be cultivated easily. Kaligonj upazila had constraints on saline water, insufficient irrigation water, late harvest of T. Aman rice, late 'joe' condition etc. Other upazila such as Shyamnagar, Dumuria, Batiaghata and Dacope upazila had the same salinity, insufficient irrigation water, late harvest T. Aman rice, and late 'joe' condition etc. Late 'joe' condition occurs due to submergence of flood or monsoon water. During the rainy season, the land was inundated a long time; thus, T. Aman rice could not be transplanted in due time. Inundate water could not spread out due to a lack of drainage and canal. Lack of knowledge of improved crop production technology and crop variety seeds also constraints some upazila for improving alternate cropping patterns. They cultivated those varieties of rice, which was continued and cultivated for a long time in their region, especially the local variety of rice which was long duration crop. Cultivating vegetables in remote areas was faced a marketing problem due to lack of transport facilities and market linkage. So they discourage cultivated a considerable amount of vegetables which increases their likelihood and cropping intensity.

Table 09. Constraints of developing alternative cropping pattern

Constraints	Satkhira Sadar	Kaligonj	Shyamnagar	Dumuria	Batiaghata	Dacope
Water stagnant	0.00	33.33	100.00	66.67	33.33	100.00
Existence of saline water	33.33	100.00	100.00	36.67	50.00	100.00
Insufficient irrigation water in rabi season	20.00	93.33	93.33	0.00	90.00	96.67
Late harvest of T. Aman rice	16.67	90.00	96.67	86.67	73.33	93.33
Late 'Joe' condition	33.33	83.33	100.00	73.33	76.67	100.00
Lack of knowledge in improved crop production technology	30.00	86.67	90.00	70.00	70.00	76.67
Lack of improved variety of seeds	40.00	40.00	53.33	30.00	43.33	80.00

Source: Field survey data, 2019

IV. Conclusion

Most of the land of the salinity region was not suitable for cultivating more than one crop. However, two to three crops were cultivated in different Upazila but maximum land was covered by fallow-T. Aman-fallow cropping pattern. Besides T. Aman rice, other crops such as wheat, jute, grasspea, mustard, sunflower, watermelon, mungbean, sesame and different vegetables were cultivated in the study areas. Though farmers of that region T. Aman were eager to cultivate more than one crop besides T. Aman rice, they faced some problems. The main reason was salinity in the land and water, irrigation water crisis at rabi season, late harvest of T. Aman rice, late joe condition of the land etc. Most farmers T. Amans cultivate long duration T. Aman rice and harvest at the last week of December to January, so they have less scope to cultivate rabi crops or second crops. Some recommendations were given below:

- Saline and drought-tolerant rabi crops variety should be introduced.
- Grasspea, mustard, sunflower, maize etc. crop would be cultivated relay crop with or after harvest of T. Aman rice without tillage.
- Farmer should be trained with modern crop production technology.
- Pit-based vegetables such as bottle gourd, bitter gourd; pumpkin etc. should cultivate as a field crop.
- Water reservoirs should be prepared to preserve the rainwater.
- Canal should be prepared so that inundated water can provide drainage in due time.
- Agronomic management practices such as relay crop, dibbling, pit-based culture, sack culture, mulching etc. would be introduced to increase cropping patterns.

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