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Research Report

Impact of Super Cyclone Amphan on Agriculture and Farmers' Adaptation Strategies in the Coastal Region of Bangladesh

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Impact of Super Cyclone Amphan on Agriculture and Farmers' Adaptation Strategies in the Coastal Region of Bangladesh



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Impact of Super Cyclone Amphan on Agriculture and Farmers' Adaptation Strategies in the Coastal Region of Bangladesh

Abstract

A super tropical cyclone named "Amphan" struck the Bangladesh coast on 22 May 2020, which caused widespread damage to rice and non-rice crops across 26 Districts. This study aims to (i) delineate the impact of Amphan on farming and livelihoods of coastal households; (ii) identify the farmers' coping and adaptation strategies to the cyclone; and (iii) delineate farmers' suggestions for increasing crops production and adaptive capacity. Fourteen villages of seven Upazilas of four most Amphan affected districts such as Satkhira, Khulna, Bagherhat and Patuakhali were selected for the study. Both the qualitative and quantitative data were collected through online interviews from 84 knowledgeable farmers and 25 expert personnel of the Department of Agriculture Extension (DAE) using a pre-tested semi-structured questionnaire. The results show that most boro rice in the coastal area escaped from the adverse consequences of Amphan as over 95% of total the crop of the region was harvested before struck the cyclone. Besides, The Aus area decreased in the range between 38-60% of the target area due mainly to (i) damage seedling in the nursery and (ii) stagnant water in the fields. Besides, the yield of the rice crop might lower in the range between 7-15% compared to last year Aus yield because of (i) delay transplanting due to cyclone and (ii) inadequate fertilizer application and weeding due to lack of money. Besides, T. Aman yield may decrease in the range between 10 – 18% as compared to the normal season because of (i) delay transplanting due to delay managing cash for hired in power tractor and labour, (ii) apply less fertilizers due to decrease income, and (iii) increase area of local cultivars as it needs less fertilizers. The major coping strategies of the households to smoothen consumption included (i) used food stocked at home, (ii) received reliefs in kinds, (iii) sold livestock and trees, (iv) caught wild fish from water-bodies, (v) temporary migrated for off/non-farm works. Most households had access to foods because of the government's relief programs. The farming adaptation strategies included (i) raised Aus seedling of local and modern cultivars (ii) planted vegetables in the home-yard and dike of *gher*, and (iii) stocked shrimp and prawn post-larvae in the *gher*. Farmers ability to invest in the farm decreased substantially due to (i) loss of farm income (BDT 50,000-130,000 per household) because of damage of crops and gone out shrimp and fish from *ghers*, and (ii) decreased off/non-farm incomes (BDT 18,000-26,000 per household) due to the outbreak of COVID-19. The government helped farmers by reducing T. Aman rice seed prices (BDT 10/kg). Due to lack of resources, DAE provided limited material supports to Amphan affected farmers in the Aman rice. Farmers and experts suggested following interventions to minimize the impact of Amphan cyclone to farmers: (i) ensuring easy access to bank credit at a low-interest rate, (ii) providing inputs and cash supports to small and marginal farmers (iii) reduced fertilizer price by 50% for Amphan affected areas to ensure a better harvest of T. Aman. Furthermore, farmers suggested for (i) re-excavation of the canals for better access to fresh-water for irrigation, (ii) raising 2-3 feet elevation of the Embankments, (iii) placing the RCC block on the Embankment for protecting the breakage by the tidal surge, (iv) repairing the old sluice gates and set some new sluice gates for protecting salinity intrusion and drainage out stagnant water, and (v) ensuring access to market and fair price of rice and non-rice crops, shrimp and fish for sustainable farm production.

1. Introduction

Bangladesh is a very densely (1,118 person per sq. km.) populated and small (147,570 sq. km.) agrarian country, inhabited by 169 million people (Kabir et al., 2020). The agriculture contributes 13.38% to the Gross Domestic Product (GDP), 4.69 % to the foreign exchange earnings (BER, 2019; Rahaman et al., 2020a) in 2017-18, 40.6% to the total labour force employment (Alam et al., 2020). Besides, agriculture outputs are the source of food security and nutrition, and are used as raw materials in agro-industries (BBS, 2018; Islam et al., 2020). Rice is the leading crop in Bangladesh covering 9.59%, 39.00%, and 51.41% cultivated areas in Aus, Aman, and Boro seasons, respectively (Rahaman et al., 2020b; Rahaman et al., 2020c; Rahaman et al., 2020d).

The government of Bangladesh has given due attention to sustainable development in the agriculture sector for ensuring food security and reducing poverty. For this, notable interventions such as adopting high yielding varieties (HYV), agricultural mechanization, crop diversification, optimum application of chemical fertilizers, judicious use of insecticides and pesticides, and access to irrigation have taken place in this country. At the same time, the cropping intensity of the country increased to 195% in 2017-18 from 148% in 1971-72. Over the last four decades, agricultural growth increased from 2.0% to 3.47%. Total food grain production in 2018-19 was 39.3 million tonnes, which is over three times higher than that of (12.56 million tonnes; only rice) in the year 1975-76 (BBS, 2019; Islam et al., 2019).

Although the country is self-sufficient in rice production, the food import of Bangladesh is increasing steadily due to a notable deficit in wheat, pulses, and oilseeds production (BBS, 2018). Besides, the population of the country anticipated to be about 215.4 million in 2050 (Kabir et al, 2020) and arable land has been converting into non-agricultural usages (e.g., 1.07 million hectares arable land has decreased from 1983 to 2008) (BBS, 2018). Thus, the country will be required 44.6 MT of clean rice to ensure food security for the growing population in 2050 (Kabir et al, 2020; Rabbi et al., 2020).

Climatic disasters are critical challenges to agriculture development in Bangladesh. Climatic extremes such as floods, droughts, salinity, cold, and cyclones frequently cause damage and instability in rice production (Rahman et al, 2020; Salam et al., 2019). Several studies predicted that climate variability and natural calamities might be more frequent and intense in the future, particularly in the coastal areas of Bangladesh (MoEF, 2009, Yu et al., 2010, WB, 2013). Therefore, the coastal farming and livelihoods would be affected extensively due to climatic disasters (Figure 1, study area is circled). In reality, we have observed several extreme weather events in the country in the past few years. For instance, a very damaging tropical cyclone "Bulbul" struck the coastal Bangladesh in November 2019, causing storm surge, heavy rains, and flash floods across the areas. Then, a super tropical cyclone "Amphan" struck the Bangladesh coast on 22 May 2020 that caused storm surge, heavy rains, and flash floods and widespread damage rice and non-rice crops across 26 districts in coastal and north-western regions in the country (Rahman et al, 2020). The main objective of this study is to evaluate the impacts of cyclone Amphan on farming and the livelihoods of the coastal dwellers in Bangladesh. The specific objectives of the study are as follows:

- (i) to delineate the impact of Amphan on farming and livelihoods of coastal households;
- (ii) to identify the farmers coping and adaptation strategies to the cyclone; and
- (iii) to delineate farmers suggestions for increasing crops production and adaptive capacity to extreme climate events.

2. Methodology

Multi stages sampling technique was applied for the study. First, four southern coastal districts namely Satkhira, Khulna, Bagherhat and Patuakhali were selected purposively because those were the most affected districts among 26 districts that were hit by Amphan. Then, seven Upazilas were selected purposively from the selected districts (Table 1) because those were most affected. Thereafter, two villages were selected purposively from each Upazila because the arable areas of the locations are intensively

used for (i) rice and non-rice cropping and (ii) shrimp/prawn farming (Table 1). Finally, six key informant farmers were selected from each village with the help of respective Upazila Agriculture Officer (UAO), Department of Agriculture of Extension (DAE) for online interview with the mobile phone (Table 1).

The key informant interviews were carried out with 42 knowledgeable farmers, results validation workshop with 42 knowledgeable farmers and 25 expert personnel of Department of Agriculture Extension (DAE) of the study locations. An online interview with the mobile phone was conducted using a pre-tested semi-structured questionnaire with the six key informant farmers from each village. The key informants were interviewed for collecting the data on (i) impacts of Amphan on farming and livelihoods, (ii) what were the coping and adaptation strategies of the village dwellers and (iii) what are their suggestions for increasing (a) rice and non-rice crops production in the upcoming season and (b) adaptive capacity of households to face harsher climate and extreme weather events in the future. Additionally, the impacts of COVID-19 on off/non-farm income of households were also collected. The collected data was validated separately by the two key informant farmers and a field level extension personnel i.e., Sub Assistant Agriculture Officer (SAAO) of the respective villages. Finally, expert interview was carried out with the Upazila and District level extension personnel to collect data on impacts and adaptation strategies of farm households and government program for enhancing adaptive capacity of Amphan affected farmers. Both the qualitative and quantitative data was collected during June, 2020 for the study and descriptive analytical technique was applied for analyzing the data. Besides, an online workshop was carried out for validation of the results with 3 knowledgeable farmers of each case study village.

The strength of the study was that data was collected from key informant farmers and fields level extension personnel. Besides, the results were validated through an online validation workshop with other key informant farmers. However, the limitation of the study including the report is based on the information collected from a limited number

of villages and respondents. Therefore, it is not representative of the whole coastal zone but gives idea about the impact of Amphan.

Table 1: Location and respondents of the study

District	Upazila	Village	Key informant farmers (No.)	Expert personnel at Upazila level, DAE	Expert personnel District level, DAE
Satkhira	Shyamnagar	Kashimari	6	UAO and two SAAO	DD
		Koikhali	6		
	Ashashuni	Kurikahonia	6	UAO and two SAAO	
		Ashashuni	6		
Khulna	Koyra	Doshhalia	6	UAO and two SAAO	DD
		Hazotkhali	6		
Bagherhat	Morrelganj	Sanshahi	6	UAO and two SAAO	DD
		Dona	6		
	Kachua	Moghia	6	UAO and two SAAO	
		Tangrakhali	6		
Patuakhali	Mirzaganj	Mirzaganj	6	UAO and two SAAO	DD
		Pouchim subidkhali	6		
	Bauphal	Dashpara	6	UAO and two SAAO	
		Ramnagar	6		

Note: Deputy Director (DD), Upazila Agriculture Officer (UAO), Sub Assistant Agriculture (SAAO) of Department of Agriculture Extension (DAE).

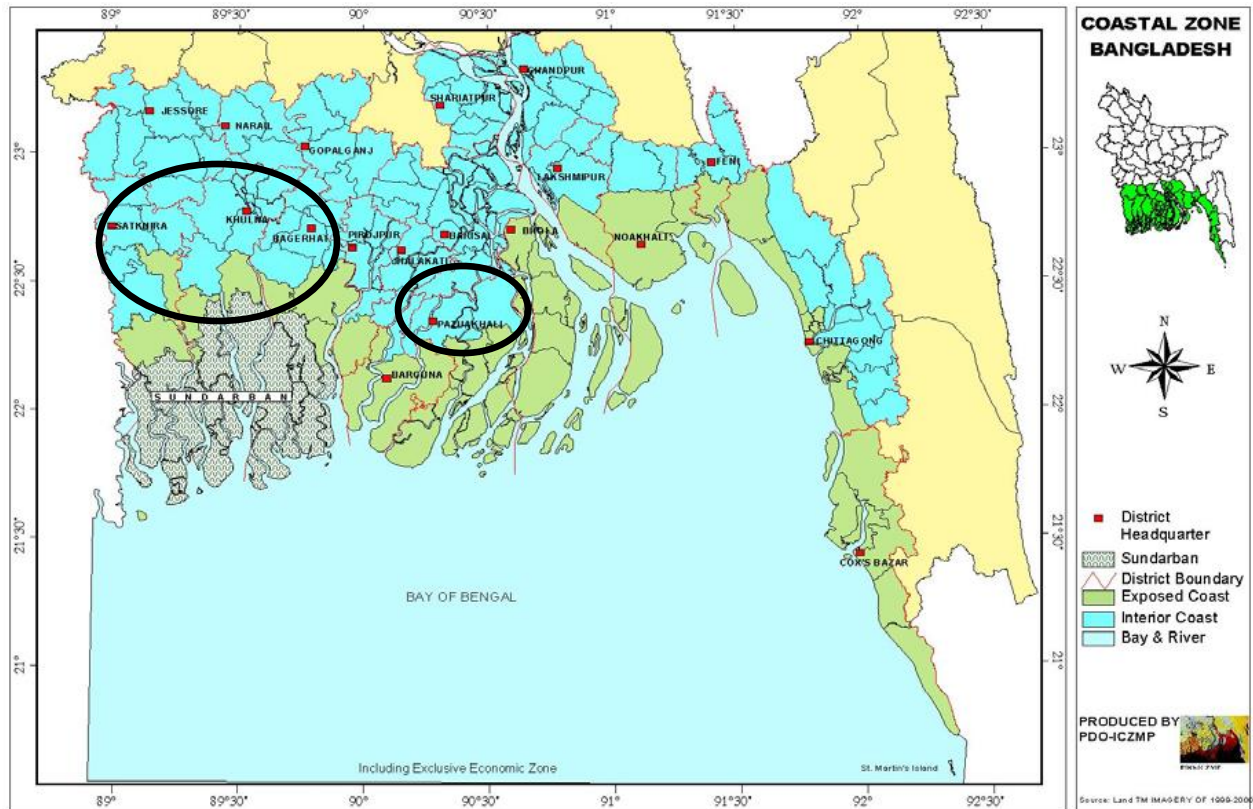


Figure 1: Coastal zone of Bangladesh, Source: PDO, ICZMP, study is circled.

3. Results and Discussion

3.1 Socio-demographic features of coastal dwellers

Table 2 presents the socio-demographic features of farm households in coastal Bangladesh. About 83% of total farm households are small farm type, of which 92% of the households undertake off/non-farm work for their livelihoods. The key informants said that male members of most small farm types undertake off/non-farm work at their villages, and some temporarily migrate to (i) other districts for off-farm work and (ii) cities and towns for non-farm work and self-employment activities for their livelihoods. The self-employment activities include pulling a manual rickshaw, driving power operated rickshaw, and vending commodities in the city and town streets; and catching shrimp post-larvae and fish from river and estuary of Sundarbans. The respondents said

that the off/non-farm income has a substantial contribution to household income, and is a vital source of cash income for paying farm expenses of small farm households.

Table 2: Socio-demographic features of farm households in the southern coastal Bangladesh

District	Upazila	Village	Large farm HH (% of total farm HH)	Medium farm HH (% of total farm HH)	Small farm HH (% of total farm HH)	% of small farm undertake off/non-farm wage work
Satkhira	Shyamnagar	Kashimari	4	18	75	90
		Koikhali	3	15	70	90
	Ashashuni	Kurikahonia	3	12	85	95
		Ashashuni	4	13	83	95
Khulna	Koyra	Doshhalia	5	15	80	90
		Hazotkhali	3	19	75	90
Bagherhat	Morrelganj	Sanshahi	2	18	80	90
		Dona	4	11	85	95
	Kachua	Moghia	3	12	85	80
		Tangrakhali	1	19	80	80
Patuakhali	Mirzaganj	Mirzaganj	3	18	75	85
		Pouchim subidkhali	5	15	80	90
	Bauphal	Dashpara	3	17	80	80
		Ramnagar	2	23	75	95

3.2 Impact of Amphan on homestead

The key informants in the interview said that despite prolonged storm for about 7-10 hours and torrential rain, the homestead area in 72% of the case study villages moderately affected by cyclone. Although the home-stead areas were flooded with 1-2 feet of water for 2 - 8 days, most people stayed at their place as the elevation of the rooms is about 2 - 3 feet higher than home-yard in the coastal villages (Figure 2). Moreover, there was no fatality of human lives and livestock in the survey villages¹ because of the timely initiative of the government through local government and civil administration. They mentioned

¹ The United Nations office in Bangladesh estimates 10 million people were affected, and some 500,000 people may have lost their homes. At least 20 people were killed, many houses were damaged and trees uprooted as severe cyclonic storm Amphan hit the coastal districts of Bangladesh. Total damage from the cyclone worth Tk1,100 crore. About 150 kilometres of embankments in 84 places have been either damaged or completely broke. Water that broke through the embankments affected 180,500 hatcheries and financial loss worth Tk325 crore. The cyclone damaged mangoes worth approximately Tk150 crore (<https://tbsnews.net/environment/weather/super-cyclone-amphan-moving-speed-220-230km-hour-83230>).

that local government and civil administration jointly managed the shifting of people with their cattle to the cyclone shelters, and provided food to all of them for the night. However, they reported that homestead area of Kashimari village of Shyamnagar, Ashashuni village of Ashashuni Upazila and Doshhalia and Hazotkhali villages of Koyra affected severely by tidal surge because of admitting tidal surge in those villages through breaking the Embankments.

Table 3 presents the impacts of Amphan on the homestead area in southern coastal Bangladesh. About 1-4% of total houses damaged, and about 10-25% of total houses affected partially in the most case study villages because of the storm. However, the majority of houses either damaged or partly affected by the 4-5 feet tidal surge in the case study villages of Koyra, Ashashuni village of Ashashuni and Kashimari of Shyamnagar because of breaking the Embankment (Figure 2). The respondents said that most inhabitants of the villages stayed on embankment or neighbours' place in the higher elevated areas for over a week. The key informants said that trees, in particular, the timber trees are a source of cash income to the coastal dwellers, and the impact of the storm on homestead fruit and timber trees was substantial, consequently incurred a notable farm income loss. On average, about 10 - 30% of the timber and fruit trees, including banana, were uprooted or/and broken fully or partially in the most case study villages. On the other hand, most trees were affected, and some died because of prolonging inundation underwater in case study villages in Koyra, Ashashuni village in Ashashuni, and Kashimari village in Shyamnagar.



Figure 2(a). Broken Embankment, Koyra (May, 2020)



Figure 2(b). Inundated homestead area, Koyra (May, 2020)



Figure 2(c). Village dweller are reconstructing Embankment, Koyra (May, 2020)



Figure 2(d). Village dweller reconstructed Embankment, Koyra (June, 2020)

Figure 2: Villagers reconstructing broken embankment in Koyra, Khulna

Table 3: Impact of super cyclone Amphan on homestead area in the study villages in the coastal Bangladesh

District	Upazila	Village	Houses damaged fully (%)	Houses damaged partially (%)	Inundated homestead area (%)	Inundated under water (days)	Broken/died timber trees (%)	Broken/died fruit trees (%)
Satkhira	Shyamnagar	Kashimari	50	30	100	20	70	85
		Koikhali	1	20	-	-	20	22
	Ashashuni	Kurikahnna	2	15	-	-	20	15
		Ashashuni	2	50	100	5	45	60
Khulna	Koyra	Doshhalia	25	60	100	29*	60	65
		Hazotkhali	50	50	100	29*	55	62
Bagherhat	Morrelganj	Sannashi	2	15	100	5	15	10
		Dona	1	10	90	3	12	10
	Kachua	Moghia	2	10	-	-	15	20
		Tangrakhali	1	10	15	2	18	25

District	Upazila	Village	Houses damaged fully (%)	Houses damaged partially (%)	Inundated homestead area (%)	Inundated under water (days)	Broken/died timber trees (%)	Broken/died fruit trees (%)
Patuakhali	Mirzaganj	Mirzaganj	5	25	100	5	15	20
		Poschim Subidkhali	5	20	100	7	15	15
	Bauphal	Dashpara	4	25	90	6	15	20
		Ramnagar	3	22	85	8	10	15

*Farmers reported that their villages are inundated under water at the time of survey. Tidal water enters into villages every day and they were working to repair the embankments. The rest of the houses escaped from damage.

3.3 Impact of Amphan on farming

3.3.1 Impact of Amphan on arable area

The key informants said that arable areas of most case study villages inundated with 3-5 feet of water because of admitting tidal saline water through (i) breaking the Embankment or (ii) over the Embankment. Besides, arable areas in some villages flooded by the heavy rain due to depression in the Bay of Bengal (Figure 2 and Figure 3).



Figure 3 (a). Inundated arable areas in Koyra, Khulna (May, 2020)



Figure 3 (b). Inundated arable areas in Kashmiri, Shamnagar (May, 2020)

Figure 3: Inundated arable area in the Amphan affected areas in coastal Bangladesh

Table 4 presents the impact of Amphan on arable lands in the case study villages. The result shows that all sampled villages were inundated due to the cyclone except one village. It took 2-15 days to drain out the stagnant water from the most case study villages depending on the availability of drainage canals and the sluice gates. However, arable areas in case study villages of Koyra, Ashashuni village of Ashashuni and Kashmiri village of Shyamnagar remained inundated until 30 days after hitting by the cyclone Amphan because local dwellers initiated the repair of the Embankment late. The

respondents said that most people of the villages voluntarily contributed to repair the Embankment. The respondents of most case study villages expect that the flood caused by Amphan might not affect T. Aman area as the stagnant water drained out already. However, farmers in the case study village of Koyra, Ashashuni village of Ashashuni and Kashimari village of Shyamnagar have apprehension that the cultivation of T. Aman may not be possible in their villages. Besides, they thought that T. Aman rice might damage by the tidal surge through breaking the locally reconstructed Embankment in the monsoon months, in particular at a full moon and new moon time.

Table 4: Impact of Amphan on arable areas in the study villages in the coastal Bangladesh

District	Upazila	Village	Inundated arable land (yes/no)	Inundated arable land (%)	Inundated under water (days)	Reasons for inundation (i/ii/iii/iv)	Soil salinity (increase/same)
Satkhira	Shyamnagar	Kashimari	Yes	100	25*	II	Increase
		Koikhali	No	90	5-7	I	Increase
	Ashashuni	Kurikahonia	Yes	100	10-15	I	Same
		Ashashuni	Yes	100	29*	II	Increase
Khulna	Koyra	Doshhalia	Yes	100	22*	II	Increase
		Hazotkhali	Yes	100	29*	II	Increase
Bagherhat	Morrelganj	Sannashi	Yes	100	12-15	II	Increase
		Dona	Yes	100	10-12	III	Increase
	Kachua	Moghia	Yes	100	2-4	I	Same
		Tangrakhali	Yes	100	7-9	II	Same
Patuakhali	Mirzaganj	Mirzaganj	Yes	100	7-8	ii	Same
		Pouchim Subidkhali	Yes	100	8-10	ii	Same
	Bauphal	Dashpara	Yes	90	6-8	Ii	Same
		Ramnagar	Yes	95	7-8	Iii	Same

Note: reason for inundation: (i) heavy rainfall (ii) heavy rainfall and admit tidal water through broken embankment, (iii) heavy rainfall and admitting tidal water through over passing the embankment; and (iv) heavy rainfall and admitting tidal water through the area have no embankment.

The key informants reported that soil salinity might rise in some case study villages such as Koyra, Ashashuni village of Ashashuni and Kashimari village of Shyamnagar because of prolong inundation of arable areas with saline tidal water which will increase soil salinity. Both key informant farmers and expert extension workers mentioned that increased salinity will not be a threat for T. Aman rice; however, it will negatively impact on rice and non-rice crops in the dry season for the next 5-7 years.

3.3.2 Impact of Amphan on boro rice

The expert said that farmers trapped freshwater in the drainage canals by an earthen embankment between the Rivers and canals within December so that the saline water from the River cannot admit into the reserve freshwater in the canals. The trapped freshwater in the canals is the key source of irrigation for dry season crops, in particular for boro rice in most coastal villages. However, farmers in case study villages in Koyra and some villages in Satkhira have access to underground water for irrigation. Besides, boro rice is cultivated in the freshwater prawn *gher* using freshwater reserve in canals and ditches. They said that the availability of fresh water for irrigation in the coastal villages has been decreasing over time due to siltation in the freshwater reservoir canals. Therefore, a few arable areas (7-15%) across the canals are mainly used for cultivating boro rice in the coastal villages.

The key informants reported that boro rice is cultivated in most case study villages using surface water reserved in the canals, home-yard ponds and ditches of *gher* in the case study villages. About 2-25% of farm households grow boro rice in the range between 4-25% of net cropped area (NCA) of the most case study villages depending on the degree of access freshwater for irrigation. Besides, 35-80% of total farm households of case study villages of koyra, Kurikahonia of Ashashuni and Kashimari of shamnagar cultivate boro rice in the range between 25-60% of NCA using underground water. The respondents of the Moghia and Tangrakhali villages of Kachua Upazila said that boro rice cultivated about 25% and 65% of total arable areas, respectively. They grow boro in freshwater prawn *gher* that needs only 4-5 irrigations, and the prawn and whitefish were cultured in the *gher* instead of T. Aman in the monsoon and post-monsoon months. Besides, boro rice cultivated in the range between 4-8% of total arable areas in case study villages in Morrelganj and Bauphal, and Ashashuni village of Ashashuni. Furthermore, no boro rice cultivated in the case study villages in Mirzaganj Upazila due to lack of water for irrigation. The respondents said that the cultivation of medium growth duration non-saline tolerant cultivars such BRRI dhan28 and hybrids is common in the survey villages.

A few areas grow BRRI dhan29. New rice varieties such as BRRI dhan74, BRRI dhan58 and BRRI dhan67 are being experimented by DAE in the coastal Bangladesh.

Table 5 presents the impact of Amphan on the performance of boro rice in the study villages in the coastal region. The results show that most boro rice escaped from the adverse consequences of Amphan as the crop was mostly harvested before struck the cyclone. It was mainly because farmers in the case study villages transplanted boro rice from the third week of January to the first week of February. They transplant early to escape from (i) moisture and salinity stress at the maturity stage of the rice crop as there is inadequate freshwater for irrigation towards the crop flowering stage, and (ii) damage of heavy rain, hail and storm in the early wet season. The key informants said that irrespective of cultivars, those farmers who transplanted boro rice in the first to the second week of February due to delay to get fresh tidal water from the river were mainly affected by the Amphan. Even BRRI dhan28 was affected by Amphan where it was transplanted late. BRRI dhan67 and BRRI dhan74 were harvested before Amphan as the cultivars were transplanted early in the demonstration plots of DAE. Besides, the boro transplanting was delay under T. Aman-boro-fallow cropping pattern due to delayed harvesting of T. Aman (Table 6). About 2-25% of farm households grow boro rice in the range between 4-25% of net cropped area (NCA) of the most case study villages subject to the availability of freshwater for irrigation. It was also the case that 65-90% of total farm households cultivate rice the dry season in the range between 35-65% of NCA as either the villages have access to underground water for irrigation or the villagers grow boro in the freshwater shrimp *ghers* that required less irrigation. A small proportion of the boro rice area in some villages was not harvested, of which 3-11% encountered some yield loss in some study villages (Table 5 and Figure 4). However, the yield loss did not impact on national rice basket because over 95% of total boro rice of the coastal region was harvested before the cyclone (DAE, 2020). The key informants said that not only they incurred yield loss of boro rice in the affected areas, but also the quality of the harvested grain deteriorated substantially causing lower market demand and price for the grain.

They also mentioned that even the family does not like to eat the affected grain due to odour of cooked rice of the affected paddy.

Table 5: Impact of Amphan on yield of boro rice in the study villages in the coastal Bangladesh

District	Upazila	Village	% HH grow Boro	% of total land used for Boro	Area harvested before cyclone (%)	Area affected by cyclone (%)	Inundated under water (yes/no)
Satkhira	Shyamnagar	Kashimari	35	25	95	5	Yes
		Koikhali	40	15	97	3	Yes
	Ashashuni	Kurikahonia	65	35	100	-	-
		Ashashuni	10	4	95	5	Yes
Khulna	Koyra	Doshhalia	35	25	95	5	Yes
		Hazotkhali	80	60	95	5	Yes
Bagherhat	Morrelganj	Sannashi	7	4	89	11	Yes
		Dona	12	8	92	8	Yes
	Kachua	Moghia	90	65	90	10	Yes
		Tangrakhali	80	25	90	10	Yes
Patuakhali	Mirzaganj	Mirzaganj	-	-	-	-	-
		Pouchim Subidkhali	-	-	-	-	-
	Bauphal	Dashpara	10	7	91	9	Yes
		Ramnagar	15	6	89	11	Yes

Note: HH= Households



Figure 4 (a). Submerged boro rice, Morrelganj (May, 2020)



Figure 4 (a). Submerged Aus nursery, Morrelganj (May, 2020)

Figure 4: Impact of Amphan on boro rice and Aus nursery, Morrelgank, Bagherhat

Table 6: Reasons for not harvesting Boro rice before Amphan area in the study villages in the coastal region of Bangladesh

District	Upazila	Village	Long duration cultivars (yes/no)	Delay transplanting (yes/no)	Three crops based cropping pattern (yes/no)
Satkhira	Shyamnagar	Kashimari	No	Yes	No
		Koikhali	No	Yes	No
	Ashashuni	Kurikahonia	No	No	No
		Ashashuni	No	Yes	No
Khulna	Koyra	Doshhalia	No	Yes	No
		Hazotkhali	Yes	Yes	No
Bagherhat	Morrelganj	Sannashi	No	Yes	Yes
		Dona	No	Yes	Yes
	Kachua	Moghia	No	Yes	Yes
		Tangrakhali	Yes	Yes	Yes
Patuakhali	Mirzaganj	Mirzaganj	-	-	Yes
		Pouchim Subidkhali	-	-	Yes
	Bauphal	Dashpara	Yes	Yes	Yes
		Ramnagar	Yes	Yes	Yes

3.3.3 Impact Amphan on Aus rice

The key informants said that small and marginal farmers in 93% case study villages cultivate transplanted Aus rice in rainfed conditions in some areas mainly for family subsistence as only the T. Aman is not sufficient for their family subsistence. It is also true that Aus rice is the source of cash for investing in Aman season. The key informants said that Aus area in most case study villages decreased to 5-15% of total arable area in 2016 from 20-55% of total arable area in 2010. It was due mainly to (i) low price of Aus rice and (ii) changes in rainfall pattern in particular drought at transplanting time and heavy rain at harvesting time. However, area of Aus has been increasing gradually since 2018 (i) in part because of government intervention through providing inputs supports including seed for BRRI dhan48 and chemical fertilizers and (ii) in part because BRRI dhan48 is shorter duration and gives higher yield than local cultivars.

Table 7 presents the impacts of Amphan on Aus area in coastal Bangladesh. It observed that Aus cultivated in the range between 20 - 30% of total arable land in most the case study villages except Mirzaganj where it was cultivated in 65-70%. A few areas of Aus

rice transplanted in the study villages before Amphan that mostly damaged because of inundation. Besides, the seedling in the nursery also wilted because of inundation of seedbeds. Therefore, the achievement of Aus cultivation was in the range of 38-60% of the targeted area in most case study villages. Besides, Aus rice cultivation was zero in Koyra and Kashimari Villages in Shyamnagar as the area was inundated because of not finishing the repair work of the broken Embankment. The key informants said that Aus area decreased in the range between 38-100% of the total targeted area due mainly to damage the seedling in the nursery as most farmers could not raise seedling after the cyclone due to unavailability of seeds (Figure 4). It was also the case that some farmers (5-10%) could not transplant Aus due to lack of money for tillage due to decrease farm income because of damaging crops by the cyclone and off/non-farm income because of COVID-19.

Table 7: Impact of Amphan on Aus rice area in the study villages in the coastal region of Bangladesh

District	Upazila	Village	% of total HH grow Aus	% of total arable area					Area decreased (% of target area)
				Target area for Aus	Area TP before cyclone	Damaged TP area	Area TP after cyclone	Total area achieved	
Satkhira	Shyamnagar	Kashimari	1	2	2	2	-	-	100
		Koikhali	2	5	3	1	1	3	40
	Ashashuni	Kurikahonia	-	-	-	-	-	-	-
		Ashashuni	1	0.25	-	-	-	-	100
Khulna	Koyra	Doshhalia	5	5	-	-	-	-	100
		Hazotkhali	20	20	-	-	-	-	100
Bagherhat	Morrelganj	Sannashi	35	30	2	2	20	12	60
		Dona	15	20	5	5	10	10	50
	Kachua	Moghia	20	25	10	-	5	15	40
		Tangrakhali	70	35	10	7	15	18	49
Patuakhali	Mirzaganj	Mirzaganj	70	65	5	-	40	25	47
		Pouchim Subidkhali	70	70	-	-	30	40	43
	Bauphal	Dashpara	35	30	1	1	15	15	50
		Ramnagar	30	32	0		20	20	38

Note: HH= Households, Note: Reason for area decrease, damage seedling (5-8%) and lack of money for tillage and purchasing fertilizer, 90% seedling was damaged in the nursery.

The key informants said that Aus rice area in the case study villages not only decreased considerably, but the yield of the rice crop also may decrease slightly due mainly to decreased most farmers' ability to invest in the farm inputs. It was in part because of loss farm income due to damaged crops and other enterprises (e.g., fish and shrimp) by cyclone Amphan and in part because of decreased off/non-farm income due to countrywide lockdown for about two months caused by COVID-19. Besides, their access to NGOs credit postponed. Table 8 presents the impact of Ampahn and COVID-19 on the performance of Aus in coastal Bangladesh. It was observed that the projected grain yield of Aus rice in the current year might be in the range of 7 - 15% lower than last year. The respondents said that the yield of Aus rice might decrease due to (i) delay transplanting because of cyclone Amphan and (ii) inadequate fertilizer application and weeding because of lack of money.

Table 8: Impact of Ampahn and COVID-19 on performance of Aus in southern coastal Bangladesh

District	Upazila	Village	Grain yield (mound /acre) in 2019	Projected yield decreased in 2020 compared to 2019 (%)	Reasons of yield decrease			
					Delay TP (yes/no)	Apply less fertilizer and pesticides (yes/no)	Inadequate weeding (yes/no)	Increase adoption of LVs & HH seed (yes/no)
Satkhira	Shyamnagar	Kashimari	-	-	-	-	-	-
		Koikhali	35	8-12	Yes	Yes	Yes	No
	Ashashuni	Kurikahonia	-	-	-	-	-	-
		Ashashuni	36	-	-	-	-	-
Khulna	Koyra	Doshhalia	-	-	-	-	-	-
		Hazotkhali	-	-	-	-	-	-
Bagherhat	Morrelganj	Sannashi	46	10-15	Yes	Yes	Yes	Yes
		Dona	34	7-10	Yes	Yes	Yes	Yes
	Kachua	Moghia	38	10-15	Yes	Yes	Yes	No
		Tangrakhali	38	10-12	Yes	Yes	Yes	Yes
Patuakhali	Mirzaganj	Mirzaganj	41	8-10	Yes	No	Yes	No
		Pouchim Subidkhali	37	10-12	Yes	No	Yes	No
	Bauphal	Dashpara	42	7-10	Yes	Yes	Yes	No
		Ramnagar	42	10-12	Yes	Yes	Yes	No

Note: HH= Households, 1 mound = 40 kg.

3.3.4 Impact of Amphan on T. Aman rice

The key informants said that Amphan will have a minimal impact on Aman rice cultivation. The respondents said that T. Aman area might be the same in the upcoming season in most case study villages as the tidal water has drained out from the field. The respondents mentioned that despite a lack of capital for investment in the farm, most farmers will transplant rice in the wet season as it is the source of staple food for family subsistence. However, farmers have apprehension about cropping T. Aman in all arable areas because of the frizzle condition of locally repaired smashed Embankments in some villages in Khulna and Satkhira. The expert also opined similar views to that of key informants. The water development board and local government remain alert about the reconstruction of the broken Embankment within the earliest possible time across the coastal regions.

Table 9 presents the impacts of Ampahn and COVID-19 on Aman rice production in the study villages. The key informants project that grain yield of T. Aman in the current year may decrease in the range of 10 – 18% than the normal year in most case study villages; the yield loss will range 20-25% than the normal year in Koyra and Shamnagar. The yield decrease is mainly due to (i) delay in transplanting because of lack of cash to hire power tractor and labour, (ii) applying less fertilizers, and (iii) increasing area of local cultivars as it needs less fertilizers. The respondents mentioned that farmers ability to (i) hire power tractor for tilling land and labour for transplanting and weeding and (ii) apply adequate inputs decreased substantially because of (i) damage crops and other enterprises by the Amphan and (ii) reduced off/non-farm income due to widespread outbreak of COVID-19. As a result, the yield of T. Aman may decrease. The key informants mentioned that the non-rice dry season crops such as mungbean and vegetables, as well as shrimp and fish, are the source of cash income for the coastal dwellers to invest in the farm; however, the crops were mostly damaged by cyclone Amphan. It was also the case that most small and even some medium farmers of coastal villages undertake off/non-farm work for cash income to invest in the farm and paying

family expenses. However, the off/non-farm income of the households also decreased due to COVID-19.

Table 9: Impact of Ampahn and COVID-19 on performance of Aman in the study villages in the coastal region of Bangladesh

District	Upazila	Village	Grain yield (mound /acre) in 2018	Projected yield decreased in 2020 compared to 2018 (%)	Reasons of yield decrease			
					Delay TP (yes/no)	Apply less fertilizer and pesticides (yes/no)	Inadequate weeding (yes/no)	Increase adoption of LVs and HH seed
Satkhira	Shyamnagar	Kashimari	29	25	Yes	Yes	Yes	Yes
		Koikhali	35	10	Yes	Yes	Yes	No
	Ashashuni	Kurikahnia	43	10	Yes	Yes	Yes	No
		Ashashuni	43	25	Yes	Yes	Yes	Yes
Khulna	Koyra	Doshhalia	44	25	Yes	Yes	No	Yes
		Hazotkhali	40	25	Yes	Yes	Yes	Yes
Bagherhat	Morrelganj	Sannashi	46	15	Yes	Yes	Yes	Yes
		Dona	43	18	Yes	Yes	Yes	Yes
	Kachua	Moghia	43	15	No	Yes	Yes	Yes
		Tangrakhali	41	15	Yes	Yes	Yes	No
Patuakhali	Mirzaganj	Mirzaganj	44	10	Yes	Yes	Yes	No
		Pouchim Subidkhali	40	10	Yes	Yes	Yes	Yes
	Bauphal	Dashpara	46	15	Yes	Yes	Yes	No
		Ramnagar	50	18	Yes	Yes	Yes	No

Note: HH= Households, the projected performance of T. Aman in 2020 was compared with the performance of the rice crop in 2018 as the performance of T. Aman was substantially affected by cyclone Bulbul in 2019.

3.3.5 Impact of Amphan on non-rice crops

Tables 10 and 11 present the impact of Ampahn on the performance of the first and second major non-rice crops in the study villages in coastal Bangladesh. It was observed that 3-23% of total arable areas is used for the cultivation of several non-rice crops, including okra, eggplant, chillies, bitter gourd, sweet potatoes, etc. in rain-fed condition. It is also observed that mungbean is cultivated in the range of 60-80% of total arable areas in the case study villages in Patuakhali. On the contrary, grass pea covered about 35-40% of arable land in Morrelganj and Bagherhat that was harvested before the cyclone. Besides, irrigated maize cultivated in some areas in the case study villages in Bagherhat. The key informants reported that some farmers grow Indian spinach, water gourd,

eggplant, mungbean, okra, groundnut, chillies, snake gourd, sponge gourd, ridge gourd, cucumber, watermelon, amaranths and pumpkin in the range between 5-10 decimal. They said that the non-rice crops are a source of family nutrient and cash income for investing in the farm and paying family expenses, including the cost of education for the children. However, the performance of the rainfed non-rice crops substantially varied due to seasonal weather variation. For instance, the rainfed non-rice crops gave a good harvest if there is some rain in late March and late April. The yield of the non-rice crop notably decreased due to moisture stress because of drought or mostly damaged by heavy rain. The respondents reported that the Amphan not only largely damaged the non-rice crops in the current year in most case study villages but also it will hamper the production of non-rice crops in some case study villages in particular in Koyra and Shyamnagar in the next 5-7 years due to increasing soil salinity because of inundation of arable lands with tidal saline water for about a month (Figure 5). It was observed that total loss per household for damaging the first and second most dominant non-rice dry season crops was in the range between BDT 9,000 - 30,00 (Table 10 and 11).



Figure 5(a). Farmers harvested immature groundnut due to water stagnated in the fields in Morrelganj (May 2020)



Figure 5 (b). Damaged maize due to water stagnated in the fields in Koyra (May, 2020)

Figure 5: Impact of Amphan on non-rice dry season crops in coastal Bangladesh

Table 10: Impact of Ampahn on the performance of first major non-rice crop in the study villages in the coastal region of Bangladesh

District	Upazila	Village	Name of crop	% HH grow	Area (% of total area)	Area (dec. / hh)	% area damaged (fully and partially)	Yield loss (%)	Loss (BDT/ hh)
Satkhira	Shyamnagar	Kashimari	Okra	30	2	20	100	100	5,000
		Koikhali	Okra	20	3	20	35	25	1,500
	Ashashuni	KuriKahnua	Okra	35	7	20	65	75	8,000
		Ashashuni	Okra	20	2	7.5	100	100	7,000
Khulna	Koyra	Doshhalia	Eggplant	25	13	18	100	100	5,500
		Hazotkhali	Okra	20	12	20	100	100	6,000
Bagherhat	Morrelganj	Sannashi	Maize	10	7	33	50	80	8,000
		Dona	Maize	8	7	40	70	65	12,000
	Kachua	Moghia	Papaya	10	8	20	75	80	10,000
		Tangrakhali	Banana	20	10	50	80	90	15,000
Patuakhali	Mirzaganj	Mirzaganj	Mungbean	75	60	42	100	20	18,500
		Pouchim Subidkhali	Mungbean	70	60	65	70	67	20,000
	Bauphal	Dashpara	Mungbean	78	75	50	90	90	15,000
		Ramnagar	Mungbean	80	80	60	85	95	18,000

Note: HH= Households

Table 11: Impact of Ampahn on performance of second major non-rice crop in the study villages, in the coastal region of Bangladesh

District	Upazila	Village	Name of crop	% HH grow	Area (% of total area)	Area (dec. / hh)	% area damaged (fully and partially)	Yield loss (%)	Loss (BDT/ hh)
Satkhira	Shyamnagar	Kashimari	Sesame	5	1	15	100	100	4,000
		Koikhali	Watermelon	2	0.5	10	-	-	-
	Ashashuni	KuriKahnua	Eggplant	40	7	10	15	10	5000
		Ashashuni	Eggplant	15	0.5	3	100	100	4000
Khulna	Koyra	Doshhalia	Okra	20	10	12	100	100	3500
		Hazotkhali	Eggplant	15	10	10	100	100	4500
Bagherhat	Morrelganj	Sannashi	Okra	10	0.5	15	80	70	5,000
		Dona	Sweet potatoes	3	2	10	100	100	10,000
	Kachua	Moghia	Eggplant	80	-	-	90	50	8,000
		Tangrakhali	Papaya	5	3	15	70	80	5,000
Patuakhali	Mirzaganj	Mirzaganj	Groundnut	45	15	23	100	60	15,000
		Pouchim Subidkhali	Groundnut	40	15	28	50	50	9,000
	Bauphal	Dashpara	Chillies	25	4.5	15	60	65	15,000
		Ramnagar	Chillies	30	5	20	70	70	12,000

3.3.6 Impact of Amphan on shrimp/prawn and Aquaculture

The key informants said that both the brackish water shrimp and freshwater are cultured in the saline coastal Bangladesh. The farm enterprise is a source of cash income of farm households and generating employment for wage workers, in particular in Koyra of Khulna, Shyamnagar and Ashashuni of Satkhira and Morrelganj and Kachua of Bagherhat. Besides, cropping high-value cash crops, i.e., vegetables on the dike of *gher* of freshwater prawn is also a source of cash income and nutrients for the dwellers.



Figure 6 (b) Inundated shrimp *gher* in Koyra (Khan May 2020)



Figure 6 (b) shrimp *gher* in Shamnagar (Hasan 22/05/ 2020)

Figure 6: Inundated shrimp *gher* in Amphan affected area in coastal Bangladesh

Table 12 presents the impact of cyclone Amphan shrimp and prawn culture and dike crops in the the study villages in coastal Bangladesh. It was observed that the total loss for shrimp/prawn and dike crop was higher in Kashimari, Shamnagar (BDT 76,500/hh), followed by Koyra (BDT 45,000-50,000/hh) as the *ghers* inundated under 4-6 feet of water for about a month, consequently, all shrimp of the *gher* were gone away from farmers' *ghers*. The farmers in the case study villages in Morrelganj of Bagherhat expect that despite setting net around the Embankment of *gher*, about 35-40% of shrimp and prawn have gone out for *ghers* as the *gher* inundated for 2-3 days. The key informants of Kachua, Bagherhat and Ashashuni, Satkhira said that their *gher* did not affected by the cyclone as

the tidal water did not admit into the villages. The key informants in the interview said that every coastal farm households have a pond on the home-yard and they culture fish in the ponds. The ponds are the source of (i) water for regular domestic activities, (ii) protein diet and (iii) cash income. The respondents of some case study villages in particular in Koyra of Khulna, Morrelganj of Bagherhat and Shyamnagar of Sathkhira and Mirzaganj of Patuakhali reported that total loss per households due to loss of fish from the home-yard ponds was in the range of BDT 5,000 – 10,000.

Table 12: Impact of Ampahn on performance of shrimp and prawn and dike crops in southern coastal Bangladesh

District	Upazila	Village	<i>Gher</i> inundated (%)	% of area used for shrimp	<i>Gher</i> size/ HH (dec.)	% of shrimp/ prawn went away from <i>gher</i>	Loss (BDT/ HH) for shrimp/ prawn	Loss (BDT / HH) for dike crops	Total loss for <i>gher</i> (BDT /HH)
Satkhira	Shyamnagar	Kashimari	100	45	120	100	70,000	65,00	76,500
		Koikhali	0	30	180	10	3,000	-	3,000
	Ashashuni	Kurikahonia	0	55	150	-	-	5,000	5,000
		Ashashuni	100	85	100	150	90,000	10,000	80,000
Khulna	Koyra	Doshhalia	100	60	20-66	100	45,000	-	45,000
		Hazotkhali	100	45	33-66	100	50,000	-	50,000
Bagherhat	Morrelganj	Sanshahi	100	25	50-75	40	20,000	5,000	25,000
		Dona	100	5	33-66	35	10,000	8,000	18,000
	Kachua	Moghia	-	50	50-75	-	-	7,000	7,000
		Tangrakhali	-	-	-	-	-	-	-
Patuakhali	Mirzaganj	Mirzaganj	-	-	-	-	-	-	-
		Pouchim Subidkhali	-	-	-	-	-	-	-
	Bauphal	Dashpara	-	-	-	-	-	-	-
		Ramnagar	-	-	-	-	-	-	-

Note: HH= Households. - or no loss from shrimp indicates either the *gher* did not inundated under tidal water or the farmers do not culture shrimp in the villages. The net loss of shrimp was calculated considering the value of shrimp went away from the *gher* minus the value of wild fish/shrimp admit into *gher* with tidal water.

3.3.7 Impact of Amphan on household income

The loss of income due to boro rice damage did not calculate as it was not widespread. The key informants estimated the loss per household for non-rice crops, shrimp, prawn and fish, home-yard & dike crops, trees, and fruits based on the gravity of damage of the farm enterprises by storm, tidal surge and torrential rain. They also estimated the decreased off/non-farm income per household for the last three months. The off/non-

farm income decrease because of (i) decreasing opportunities for self-employment and employment opportunities for off/non-farm work at villages and cities because of lockdown for out breaking the COVID-19 virus, and (ii) unwillingness to take part in the off/non-farm work to avoid the risk of affected by COVID-19 virus.

Table 13 presents the total loss of household income, including farm and off/non-farm income due to cyclone Amphan and an outbreak of COVID-19 in Bangladesh. The approach of loss estimation of farm and off/non-farm income is presented in the footnote of the Table 13. The loss of income per household varied notably in the range of BDT 43,000 - 148,000 due to the adverse consequences of cyclone. Similarly, loss of income per household from crops (7-61%), homestead gardening (7-33%) and shrimp, prawn and fish (6-68%) also varied largely between the case study villages based on gravity of damage and availability of crops in the fields. It was observed that farm income loss per household was higher (BDT 148,000/hh) in Kashimari, Shyamnagar, followed by Doshhalia and Hazotkhali, Koyra (BDT 123,400 - 85,000) due to prolong inundation of the arable areas of the villages by the saline tidal water. The loss of income per household was over BDT 60,000, except Kurikahonia and Koikhali villages of Ashashuni as neither non-rice crops nor the shrimp/fish was affected in the village by Amphan. The key informants reported that the outbreak of the COVID-19 virus substantially affected cash income flows of small farm households through reducing the opportunities for off/non-farm income employment and self-employment opportunities (e.g., manual or power operated rickshaw pulling). The key informants in the interview highlighted that not only the wellbeing of the households substantially affected but also the ability of the farmers for investing in the farm decreased notably because of reducing household income.

Table 13: Impact of Amphan and COVID-19 Virus on household income in coastal Bangladesh

District	Upazila	Village	Loss for non-rice crops (BDT/ HH)	Loss for shrimp, prawn and fish (BDT/ HH)	Loss for home-yard & dike crops, trees and fruits (BDT/ HH)	Decreased off/non-farm income (BDT/hh)	Total loss of household income (BDT/hh)
Satkhira	Shyamnagar	Kashimari	10,000	90,000	30,000	18,000	148,000
		Koikhali	3,500	7000	7000	26,000	43,500
	Ashashuni	Kurikahonia	14,000	-	10,000	20,000	44,000
		Ashashuni	11,000	80,000	9,000	18,000	118,000
Khulna	Koyra	Doshhalia	12,000	49,000	28,900	24,000	85,029
		Hazotkhali	17,000	54,000	28,400	24,000	123,400
Bagherhat	Morrelganj	Sannashi	17,000	24,000	10,000	24,000	75,000
		Dona	26,000	17000	13,000	18,000	74,000
	Kachua	Moghia	22,000	-	20,000	20,000	62,000
		Tangrakhali	23,000	-	20000	18,000	61,000
Patuakhali	Mirzaganj	Mirzaganj	42,500	6400	5000	24,000	77,900
		Pouchim Subidkhali	42,000	4000	5000	24,000	69,000
	Bauphal	Dashpara	32,000	12000	5000	20,000	69,000
		Ramnagar	32,000	13000	5000	20,000	70,000

Note: The loss of income for damaging boro rice did not calculated as it was not widespread. The key informants estimated the loss per household for non-rice crops, shrimp, prawn and fish, home-yard & dike crops, trees and fruits based on the gravity of damage of the farm enterprises by storm, tidal surge and torrential rain. They also estimated the decreased off/non-farm income per household for the last three months. The off/non-farm income decrease because of (i) decreasing opportunities for self-employment and employment opportunities for off/non-farm work at villages and cities because of lockdown for out breaking the COVID-19 virus, and (ii) unwillingness to take part in the off/non-farm work to avoid the risk of affected by COVID-19 virus.

3.3.8 DAE supports to Amphan affected farmers

The experts unanimously agreed that farmers' ability to invest in the farm and support their family expenses notably decreased due to (i) adverse consequences of Amphan on farming and (ii) reduce off/non-farm income due to COVID-19. They also agreed with the farmer's projection that the yield of Aus and T. Aman rice might decrease slightly because of inadequate fertilizer application and poor agronomic management due to most small and marginal farmers' reduced ability to invest in the farm. The experts said that until mid-June, DAE did not get any resource allocation from the government to provide cash or kind supports to the Amphan affected small and marginal farmers for Aus and T. Aman rice cultivation. Table 14 presents the limited support programme of

DAE for farming adaptation in the Amphan affect southern coastal Bangladesh. It was observed that DAE provided Aus seed to a few Amphan affected farmers in Kachua and Mirzaganj. Besides, seed supports for T. Aman rice cultivation in most Upazila was the same as last year, except Koyra, Shyamnagar and Ashashuni. The UAO of the Upazila said that they got some seed from BRRI and BINA for supporting Amphan affected farmers. Besides, DAE will provide seed and fertilizer to 20-30 farmers of an Upazila for demonstration modern T. Aman cultivars in 33 decimal areas under some projects.

The expert highlighted that they got an allocation of resources from the government to provide supports to Amphan affected farmers through home-yard vegetable cultivation. DAE will provide cash, inputs and technical supports for demonstration Kalikapur model on one decimal area at the homestead of 32 Amphan affected farmers per Union under the program. Furthermore, DAE provided different vegetable seeds to a few farmers (1-1.5%) for growing summer vegetables (e.g., pumpkin, bitter gourd, teasle gourd, ribbed gourd, ash gourd, okra, yard-long bean, and Indian spinach) in the home-yard under different projects and programme.

Table 14: DAE supports to Amphan affected farmers in the study villages in the coastal region of Bangladesh

Extension supports	Satkhira		Khulna	Bagherhat		Patuakhali	
	Shyamnagar	Ashashuni	Koyra	Morrelganj	Kachua	Mirzaganj	Bauphal
Provide Aus seed to the farmers after Amphan (% of total FHH)	-	-	0	-	1.3	1.66	-
Amount of seed (kg/farmers)	-	-	0		5	5	5
Provide Aman seed to the farmers in 2019 (% of total HH)	-	0.01	1.5	1.23	0.82	1.43	1.25
Amount of seed (kg/farmers)	-	5	5		5	5	5
Provide fertilizers for T. Aman to the farmers in 2019 (% of total HH)	-	-	-	-	-	-	-
Provide seed to the farmers for T. Aman 2020 (% of total HH)	-	0.02	1.6	1.23	0.82	1.43	1.25
Provide fertilizer to farmers for T. Aman 2020 (% of total HH)	-	-	-	-	-	-	-
Number of farmers per Union get supports for to demonstration Kalikapur model	32	32	32	32	32	32	32
Cash for seed (BDT/farmers)	400	400	400	400	400	400	400
Cash for inputs (BDT/farmers)	1,935	1,935	1,935	1,935	1,935	1,935	1,935
Provide vegetable seed to farmers (% of total)	-	1.2	-	-	-	-	2.5

3.3.9 Farmers' coping and adaptation strategies

Table 15 presents coping strategies of households to recover from the adverse consequences of cyclone Amphan. The key informants said that family members in the range of 15 - 50% of the total of households were temporarily moved to cyclone shelters along with their cattle to avoid unexpected fatalities of human and cattle lives. Some people also moved to the neighbour's pucca and semi-pucca houses for that night. The majority of households in the case study villages mainly relied on stocked food at home, home-yard vegetables and pond fish for family subsistence, and they sold the stocked farm commodities for paying family and farm expenses. Besides, a few households (3 - 5% of total affected) of case study villages of Bagherhat, Patuakhali and Satkhira relied on reliefs in kinds for survival. However, about 50- 90% of total households of case study villages in Koyra of Khulna and Assashuni and Shamnagar of Satkhira relied on reliefs for survival as the villages were inundated for about a month. The key informants reported that (i) some households of the case study villages sold livestock, (ii) a few were rented out the land and (iii) some were borrowed money from relatives and neighbour to maintain family and farm expenses as the micro-credit program of all the NGOs temporarily postponed due to COVID-19. Besides, none of the farmers from the case study villages received credit from the Bank after Amphan neither under usual scheme nor under the prime minister' special allocation (BDT 5,000 crores) for farmers at 5% percent interest rate. It was also the case that some households sold the broken timber and fruit trees to support family and farm expenses. Besides, some families of case study villages caught fish from the open water both for family consumption and cash income. Amid in the apprehension of affected by COVID-19, the male member of some small farm and landless wage workers migrated to cities or towns for non-farm work or pulling the rickshaw, and some took off/ non-farm works from the villages to afford family and farm expenses. The respondents said that because of the government's relief programs, few households have had one to two meals per day in the worst affected case study villages.

Table 15: Coping strategies of households to recover from adverse consequences of cyclone Amphan, study villages, Coastal Bangladesh.

Coping strategies	Satkhira	Khulna	Bagherhat	Patuakhali
	% of total households			
Moved to cyclone shelter	30	50	20	15
Repair broken embankment	80	80	-	-
Relied on food stock at home	80	20	75	70
Received cash reliefs	-	20	-	-
Received kind relief (e.g., rice, salt and edible oil)	50	90	5	3
Capture open water fish	30	80	30	20
Sale livestock	10	30	15	15
Rented out land	5	8	5	3
Received credit from Bank	-	-	-	-
Received credit from NGOs	-	-	-	-
Borrow money from relatives or neighbour	5	30	25	30
Migrated for off/no-farm work	15	35	15	15
Off/non-farm work at village	15	-	10	20
Sold trees	15	10	20	20
Have had a meal in a day	0.25	15	0.25	0.25

Note: % figures of the Districts are average of four case study villages of two Upazila except Khulna that is average of two villages of Kora Upazila.

Table 16 presents post-Amphan farming adaptation strategies of households in southern coastal Bangladesh. The key informants said that most farmers drain out the stagnant water from the Aus nursery, transplanted Aus plots and non-rice crops fields through cutting the bands. However, 60-90% of Aus seedling in the nursery, 50-100% of transplanted Aus and 25-100% of non-rice crops were mostly damaged in most case study villages because of stagnant water. Therefore, some farmers in the case study villages of Morrelganj, Mirzaganj and Bauphal bought the local and modern cultivars seed of Aus rice from neighbouring farmers at 2-3 times higher price and a few farmers of Morrelganj and Mirzaganj got Aus seed from DAE, and raised seedling again. Besides, some farmers purchased seedling from neighbouring villages that raised in relatively higher elevated areas. The respondents also reported that some farmers planted vegetables in the home-yard and dike of *gher* both for family consumption and cash income. They also mentioned that some farmers placed net on the dikes of *gher* and embankment of ponds

to protect the shrimp and fish from going out. Besides, some farmers stocked shrimp and prawn post-larvae in the *gher* as well.

Table 16: Post Amphan farming adaptation strategies of households in southern coastal Bangladesh

District	Upazila	Village	Drain out stagnant water from crop fields	Grow new seedling (yes/no)	Decrease Aus area (%)	Planting home-yard and dike crops (yes/no)	Set net on the dike of <i>gher</i> and ponds (yes)	Stock shrimp post-larvae (yes/no)
Satkhira	Shyamnagar	Kashimari	Yes	No	N/A	Yes	No	Yes
		Koikhali	Yes	No	N/A	Yes	No	Yes
	Ashashuni	Kurikahonia	Yes	No	N/A	Yes	No	Yes
		Goyaldanga	Yes	No	N/A	Yes	No	Yes
Khulna	Koyra	Doshhalia	No	No	100	No	No	No
		Hazotkhali	No	No	100	No	No	No
Bagherhat	Morrelganj	Sannashi	Yes	Yes	67	Yes	Yes	Yes
		Dona	Yes	Yes	50	Yes	Yes	Yes
	Kachua	Moghia	Yes	No	55	Yes	Yes	Yes
		Tangrakhali	Yes	No	56	Yes	Yes	
Patuakhali	Mirzaganj	Mirzaganj	Yes	Yes	53	Yes	N/A	N/A
		Pouchim Subidkhali	Yes	No	57	Yes	N/A	N/A
	Bauphal	Dashpara	Yes	Yes	63	Yes	N/A	N/A
		Ramnagar	Yes	Yes	Yes	53	N/A	N/A

Note: HH= Households

3.3.10 Farmers' suggestion for increasing crop production and enhancing adaptive capacity

The key informants said that T. Aman is cultivated in most arable areas, and is the most important crop in the coastal villages, in particular for family subsistence and cash income as only a few areas are used for Aus and Boro cropping. However, the key informants projected that the grain yield of T. Aman rice might decrease in the range between 5 – 20% compared to the normal seasonal conditions. It is due mainly to decreased farmers', especially the small farmers (e.g., over 80% are small farmers) ability to invest in the farm because of decrease farm and off/non-farm income due to Amphan and COVID-19. Thus, 93% of the respondents suggest that ensuring easy access to bank credit at a low-interest rate and providing inputs and cash supports to small and marginal

farmers is essential for protecting the unexpected yield loss of T. Aman crop in the Amphan affected areas. Besides, some key informants suggested that fertilizer prices for the Amphan affected areas reduced by 50% to ensure a better harvest of the source of food of coastal dwellers. Furthermore, most key informants suggested for ensured access to market and fair price of the rice and non-rice crops for ensuring sustainable production (Table 17).

Table 17: Farmers' suggestions for busting crops production in the kharif-1 and kharif-2 season in the Amphan affected areas in Coastal Bangladesh

Coping strategies	Satkhira (yes/no)	Khulna (yes/no)	Bagherhat (yes/no)	Patuakhali (yes/no)
Easy access to bank loan at low interest rate	Yes	Yes	Yes	Yes
Provide seed on free of cost to the affected small and marginal farmers	Yes	Yes	Yes	Yes
Provide fertilizers on free of cost to the affected small and marginal farmers	Yes	No	Yes	Yes
Provide pesticides on free of cost to the affected small and marginal farmers	Yes	Yes	Yes	Yes
Provide cost of supplementary irrigation to the affected small and marginal farmers	Yes	No	No	No
Provide cash supports for tillage to the affected small and marginal farmers	Yes	Yes	Yes	
Ensure fair price of rice and non-rice crops	Yes	Yes	Yes	Yes
Reduced fertilizer price for coastal areas	Yes	Yes	Yes	Yes

The key informants perceived that the frequency and intensity of extreme weather events, such as droughts, floods, tidal surge, cyclone, and storm surge have been increasing over time. The rice and non-rice crops, especially the rainfed non-rice dry season crops frequently affected by moisture stress due to droughts, and damaged by heavy rain due to depression in the Bay of Bengal in the coastal villages. Most key informant (84%) also reported that the majority of arable areas remain fallow in the dry season due to lack of freshwater for irrigation. Besides, they also mentioned that even rain-fed non-rice cropping and partially irrigated boro areas are underutilized as the yield of the crops is 20-40% lower than that of irrigated conditions. The key informants mentioned that the reserve freshwater in the canals is not adequate to cultivate boro in a large area and even

to irrigate Boro rice for the whole season even in a small area. Therefore, the yield of the rice crop notably varied due to seasonal variation of rainfall patterns. For example, a couple of moderate rainfall days during the reproductive stage of the rice facilitate to harvest good yield. On the contrary, the rice crop gave low yield due to the combined impact of salinity and moisture stress if no rain during the reproductive stage. Thus, the key informants suggested that the re-excavation of canals for ensuring access to adequate fresh water for irrigation in the drainage canals is vital for enhancing cropping system intensification and boosting crop production in coastal Bangladesh.

Besides, they suggested to raise the elevation of the Embankments to 2-3 feet for protecting the tidal water from admitting into arable lands by surpassing the embankments. Moreover, the Reinforced Cement Concrete (RCC) blocks with an iron net needs to put on the Embankment of the mighty rivers for protecting the breakage of the Embankment by the tidal surge of super cyclones. The key informants mentioned that there was no embankment on the bank of the river in some case study villages and hence Embankments need to be constructed for protecting the areas from tidal surge. Besides, some farmers suggested for repairing the old sluice gates and set some new sluice gates on the Water & Power Development Authority (WAPDA) Embankments so that the stagnant water can drain out quickly to the river from arable areas (Table 18).

Table 18: Farmers' suggestions for increasing cropping intensity and adaptive capacity of costal dwellers under harsher climate conditions in the coastal Bangladesh

Coping strategies	Satkhira (yes/no)	Khulna (yes/no)	Bagherhat (yes/no)	Patuakhali (yes/no)
Re-excavate canals	Yes	Yes	Yes	Yes
Raise height of the embankment	Yes	Yes	Yes	Yes
Improve quality of the embankment	Yes	Yes	Yes	Yes
Construct new embankment		Yes	Yes	Yes
Social forestry on embankment/roads	Yes	Yes	Yes	
Set new sluice get/repairing sluice gate	Yes	Yes	Yes	Yes
Easy access to bank loan at low interest rate	Yes	Yes	Yes	Yes
Crop insurance	Yes	Yes	Yes	Yes

Data source: Authors' survey (2020)

Furthermore, the respondents suggested easy access to bank credit at a low-interest rate should be ensured for boosting crop production. This is important because (i) the coastal farm households lack financial capital and (ii) the area is a hot spot for extreme weather events. Finally, they suggested for ensuring access to market and fair price of rice and non-rice crops, shrimp and fish for sustainable farm production (Table 18).

4. Summary, conclusions and recommendations

4.1 Summary and conclusions

(i) At least 20 people were killed as severe cyclonic storm Amphan hit the coastal districts of Bangladesh. However, there was no fatality of human lives and livestock in the survey villages because of the timely initiative of the government through local government and administration. A few houses (1-4%) damaged, and some (10-25%) affected partially, and about 10 - 30% of timer, fruit, or other trees broken fully or partially in most case study villages. About 52-100% of houses damaged fully or partly by the 4-5 feet tidal surge, and most trees affected or died because of prolonging stagnant water of tidal saline water in some villages of Koyra, Ashashuni and Shyamnagar.

(ii) The reserve freshwater in the canals is the prime source of irrigation for cropping dry season crops, in particular, boro rice in most coastal villages. Besides, farmers have access to underground water for irrigation in case study villages in Koyra, and some areas in Satkhira. However, the availability of fresh water for irrigation has been decreasing over years due to siltation in the drainage canals. Therefore, the majority of arable lands remain fallow in the dry season. Rice and non-rice crops, especially the rainfed non-rice dry season crops frequently affected by moisture stress due to droughts, and damaged by heavy rain due to depression in the Bay of Bengal in the coastal villages. Besides, the area used for rain-fed non-rice and partially irrigated boro rice were underutilized the productivity potential as the yield of the crops is 10-15% lower than that of irrigated conditions. The frequency and intensity of extreme weather events, such as droughts, floods, tidal surges, cyclones, and storm surge has been increasing over time.

(iii) Over 95% of total boro rice in the coastal region was harvested before stuck cyclone Amphan. About 3-11% of total unharvested area of boro rice in some case study villages encountered some yield loss. Besides, the flood affected rice not only became unsuitable for family consumption due to odour of cooked rice as a result of deteriorated grain quality but also the grain fetched lower price or lost market demand because of discolouration.

(iv) The Aus area in the study villages not only decreased in the range of 38-100% due mainly to damage the seedling in the nursery and stagnant tidal saline water in the fields, but the yield of the rice crop also may decrease 7-15% compared to last year's Aus yield. It is due mainly to (i) delay transplanting because of cyclone Amphan and (ii) inadequate fertilizer application and weeding because of lack of money.

(v) The stagnant water drained out from most villages so that T. Aman area might be the same as last year. Besides, the increased salinity because of inundation with tidal saline water might not be a threat to the performance of T. Aman. However, farmers in some villages in Koyra, Ashashuni and Shyamnagar have apprehension that T. Aman cropping might not be possible in all arable areas of the villages because of stagnant water. Besides, the tidal water may damage the T. Aman rice by again breaking the temporarily reconstructed Embankment in the monsoon. The grain yield of T. Aman in most case study villages might lower in the range of 10 – 20% compared to the normal seasonal conditions; the yield decrease could be higher to 30-35% in case study villages of Koyra, Ashshuni and Shamnagar. The reasons for yield decrease are (i) delay transplanting because of lack of cash for hired in power tractor and labour, (ii) applying less fertilizers, and (iii) increasing area of local cultivars as it needs less fertilizers.

(vi) The non-rice dry season crops such as mungbean and vegetables, as well as shrimp and fish, are the source of cash income for the coastal dwellers to invest in the farm. However, the crops mostly damaged by inundation, and shrimp and fish went out from *ghers* and ponds. Besides, respondents perceive that cropping rice and non-rice crops in the dry season may not be possible in some study villages, in particular, Koyra,

Ashashuni, Shyamnagar and Morrelganj for the next 5-7 years because of rising salinity due to admit tidal saline water.

The total loss of income per household varied notably in the range of BDT 43,000 - 148,000 due to the adverse consequences of cyclone. The loss of farm income per household for damaging non-rice dry season crops in the fields, dikes and homestead and gone out the shrimp/prawn and fish from ponds and *ghers* was in the range between BDT 50,000-130,000. Besides, the loss of non-farm income per household for the last three months was in the range between BDT 18,000-26,000 due to reducing off/non-farm employment and self-employment the opportunities due to the outbreak of COVID-19 Virus. About 83% of total farm households of the case study villages are small farm type, of which 92% undertake off/non-farm work for their livelihoods. Thus, not only the wellbeing of the households substantially affected but also the ability of the farmers for investing in the farm decreased notably because of reducing household income.

(vii) DAE did not launch any major programme to provide cash or kind supports to the Amphan affected small and marginal farmers for Aus and T. Aman rice cultivation except providing Aus seed to a few Amphan affected farmers in Kachua and Mirzaganj. Besides, seed supports for T. Aman rice cultivation in most Upazila was the same as last year, except Koyra, Shyamnagar and Ashashuni as they got some seed from BRRI and BINA. The government helped Amphan affected farmers by reducing T. Aman seed price (BDT 10/kg). DAE will provide cash, inputs and technical supports for demonstration of Kalikapur model about homestead vegetable production in one decimal area to 32 Amphan affected farmers per union. Furthermore, DAE provided different vegetable seeds to a few farmers (1-1.5%) for growing summer vegetables (e.g., pumpkin, bitter gourd, teasle gourd, ribbed gourd, ash gourd, okra, yard-long bean, and Indian spinach) in the home-yard under different project and program.

(viii) The major coping strategies of the Amphan affected households to smoothen income and consumption included (i) use of food stocked at home, (ii) receive reliefs in kinds, (iii) sell livestock and trees, (iv) rented out the land, (v) borrow money from

relatives and neighbor, (vi) caught wild fish from water bodies, and (vi) temporarily migrated to other districts, cities, or towns for off/non-farm work. Most households had access to foods because of the government's relief program. However, few people reduced their food consumption to one to two meals per day in the worst affected case study villages. None of the farmers received micro-credit as the credit program of NGOs temporarily postponed due to COVID-19. Besides, none of the farmers received credit from the Bank after Amphan neither under usual scheme nor under the prime minister's special allocation (BDT 5,000 crores) for farmers at 5 percent interest rate.

(ix) Farming adaptation strategies in agriculture included (i) drain out the stagnant water from the Aus nursery, transplanted Aus plots and non-rice crops fields, (ii) raised Aus seedling of local and modern cultivars (iii) planted vegetables in the home-yard and dike of *gher*, (iv) stocked shrimp and prawn post-larvae in the *gher*.

4.2 Recommendations

Short term interventions

(i) Easy access to bank credit at a low-interest rate. Also, create an enabling environment for farmers access to microcredit.

(ii) Inputs and cash support for T. Aman should be provided to the Amphan affected small and marginal farmers. Besides, fertilizers should be given to farmers at reduced price in the Amphan severely affected areas to avoid the unexpected yield loss of T. Aman.

(iii) Extension supports for large scale dissemination of HYV rice for Aman, as well as saline tolerant rice (e.g., BRRI dhan67) and non-rice crops for dry season should be strengthened.

(iv) Supply of Aman rice seeds as many farmers lost seeds, promote community seedbeds, increase availability of high yielding varieties for Aman.

(v) Temporary employment programs to smoothen income and consumption, and social safety net programs to ensure food security of the vulnerable groups.

Medium to Long term interventions

- (i) The access to the market and fair price of the rice and non-rice crops, and shrimp and fish should ensure for sustainable intensification of farming systems.
- (ii) The drainage canals across the coastal areas should re-excavate or deepen for adequate reserve of freshwater to enhance cropping system intensification and boosting crop production in coastal Bangladesh.
- (iii) Sluice gates should be constructed between river and canal for protecting intrusion of salinity in the freshwater reservoir canals for irrigation. Besides, the old sluice gates should repair, and new sluice gates should set on the WAPDA Embankments so that the stagnant water can drainage out quickly to the river from arable areas. A regulation should pass against saline tidal water admission in the freshwater reservoir canals for capturing wild fish and shrimp.
- (iv) The elevation of the Embankments should increase by 2-3 feet so that tidal surge cannot admit into arable areas over the Embankments. Moreover, the RCC block with an iron net needs to put on the Embankment of the mighty rivers for protecting the breakage of the Embankment by the tidal surge of super cyclones. Besides, new Embankment should construct in some villages where is no Embankment to protect tidal water from admitting into arable areas.
- (v) Promote community seedbeds in high lands to reduce damage from floods; develop community seed banks and store some rice seeds for emergency so that seeds are available during crisis period; promote short duration HYVs so that they can escape from climactic disasters.
- (vi) Ensure coordination between BWDB and DAE for synchronization of sluice gate operation and agricultural operations so that early planting and early harvesting of dry season crops can be achieved which is critical to escape cyclone damage at the time of harvesting.

- (vii) Provide climate early warning information to rural households so that lives and livelihoods can be protected.
- (viii) Develop and disseminate climate smart agricultural technologies and practices in the coastal areas.
- (ix) Allocate adequate resources in agricultural research and development with a focus on climate resilience.
- (x) Maintain good conditions of shelter houses to keep people during emergencies.

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