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Climate Change and Food Security at Salinity Prone Area in Southwest Coastal Region of Bangladesh

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Abstract: The availability, accessibility, utility and stability of food production and consumption interrupted due to the climatic transformation and intensity of salinity in the southwest salinity prone area of Bangladesh. 96.7% of the respondents can perceive climate change explicitly, among the 120 respondents of whom the mean age of the respondents was 50.6 years. 40.8% of the respondents responded that crops became more limited from 20 to 25 years ago. 43.3% of the respondents argued that salinity was responsible for the degradation of soil fertility. The problems of drinking water prevails that 29.79% of the respondents spent 61 taka to 80 taka monthly for water. 96.22% of the respondents availed microcredit facilities from NGO and 22.0% of the respondents used microcredit for purchasing food products. 64.2% of the respondents don't consume nutritional foods and the day to day consumption highly depends on purchasing which was domestically produced few years ago.

Keywords: Salinity Intrusion, Shrimp Cultivation, Agricultural Production, Rainfall, Seasons, Nutritional Attainment

1. Introduction

Climate change affects agricultural system more or less directly and agriculture is important for food security; and it provides the primary source of livelihood for people's workforce sectors. In populous countries like Bangladesh highly depend on agricultural labor and the agricultural system which is highly depends on natural blessing. If agricultural production is adversely affected by climate change, the livelihoods of large numbers of the rural poor will be put at risk and their vulnerability to food insecurity will be increased. The ultimate impact of climate change being observed day to day and researches show that poor countries are the most vulnerable. Bangladesh is the most vulnerable in measure of the loss through climate change among all other countries, with the Intergovernmental Panel on Climate Change (IPCC) affirming that its effects have already been observed, and scientific findings indicating that precautionary and prompt actions are necessary to address its impending threats [1]. Climate change is also increasingly being foreseen as the crisis of global proportions, with the IPCC further noting that its impacts will fall disproportionately upon developing countries and the poorer sections of the society. Changing patterns of rainfall, for example, threaten to agricultural activity in reducing the viability of rain-fed agriculture. Urban runoff and sea water intrusion also could be an important obstacle in the coastal belt for the presence of high level of K^+, Ca^+ , Na^+ and Ca^+ along with the presence of NO_3^- SO_4^{2-} , $PO_4^{3-}$and Cl^- [2].

Bangladesh is an agricultural country, mostly dependent on nature. It is clear as daylight that agricultural production is always vulnerable to unfavorable weather events and climatic conditions. The impacts of climate change on agricultural food production are global concerns, and those are too much important for Bangladesh. Agriculture is the single most and the largest sector of Bangladesh's economy which accounts for about 22% of the GDP and about 55% of the labor force [3]. Agriculture in Bangladesh is already under pressure both from huge and increasing demands for food, and from problems of agricultural land and water resource depletion. The prospect of global climate change makes the issue particularly urgent for Bangladesh and its southern part which is affected by extreme soil salinity. Deleterious impacts of climate change on agriculture could have profound effect to poor and under class people whose are

very near to agricultural mode of production. Despite technological advances such as improved crop varieties and irrigation system, weather and climate are still key factors in agricultural productivity. The rise of CO_2 level in the atmosphere and the concomitant climate change will have a direct impact on agriculture. It is generally well accepted that this increase will have beneficial effects on plant productivity. Thus it is difficult to predict the combined impact on agricultural productivity. The people of disadvantaged strata of society become more or less vulnerability to bear higher hazardous effects due to frequent occurrences of climatic calamity. So it is crying need to illustrate the actual situation of deteriorated human existence of southwestern people and whether how to overcome the problem and how to ensure sufficient solutions.

Now it would be formulated effective relationship to show the situation of climate change and food production and consumption of people in salinity prone southwestern coastal region of Bangladesh along with identifying the livelihood pattern of people that is changing with climatic change.

2. Methods and Materials

An interview schedule administered to present on the respondents aged above 40 years who have some sorts of connection in food production and better knowledge about local climatic change from two villages of Khulna district was appeared as arbitrary geophysical orientation for the study. Although use of simple random sampling, the reconnaissance field visit from November 2009 to February 2010, 436 households were identified where 120 respondents (although it result 112) was selected as a sample size at a 95 % confidence level and 8% margin of error by using the *Creative Research Systems'* Sample Size Calculator and The Research Advisors' Sample Size Table [4]. Data were computerized, analyzed and interpreted using *SPSS* and other statistical technique also applied.

3. Results

The demographic composition of subjects expounds among the 120 household heads in the table 1 that there were highest 28.3% of the respondents belonged to the age group 44-47 years, second majority 22.5% of them were made the age group between 52-55 years, and only 3.3% of the respondents were in the age group 64-67 years. The mean age of the respondents is 50.6 years. The educational attainments of the respondents indicates that majority 40.8% of the respondent attended class 3 to class 5 following by second highest 23.3% of them had joined class one to two. 14.2% of the respondent completed their primary education while 10.8% and 4.2% of the total respondent completed their S.S.C and H.S.C. Only 4.2% of them were illiterate. It is explicit that the illiterate people have a lower level of knowledge about climatic hazard. The data in the illustrate that majority 47.5% of the respondent were as primarily depend on agricultural fisheries as their occupation while 15% of the respondent engaged to shrimp fry collection followed by 11.7% and 10.8% of the respondent related to agricultural crops and business as occupation whereas 8.3% of the respondents were day laborer and 4.2% and 2.5% of them depended on handicraft work and rent of land to earn their livelihood.

Table 1. *Demographic composition and socio-economic distribution of the subjects.*

Characteristics	Number	Percentage
Age (in year)		
40-43	12	10.0
44-47	34	28.3
48-51	23	19.2
52-55	27	22.5
56-59	12	10.0
60-63	8	6.7
64-67	4	3.3
Mean Age = 50.6		
Educational Qualification		
Illiterate	5	4.2
Class 1-2	28	23.3
Class 3-5	49	40.8
Class 6-8	17	14.2
SSC	13	10.8
HSC	5	4.2
Graduate	3	2.5
Type of Occupation		
Agricultural, Crops	14	11.7
Agricultural, Fisheries	57	47.5
Shrimp Fry Collection	18	15.0
Business	13	10.8
Rent of Land	3	2.5
Handicraft Work	5	4.2
Day Labour in Non-Agricultural Sector	10	8.3

Table 2. *Climate change and Concern of People.*

Perceptions	Number	Percentage
Knowledge regarding Climate Change		
Yes	116	96.7
No	4	3.3
Difference of Agricultural Production from 20-25 Years Ago to Present		
Reduce Agricultural Production	37	30.8
Limited Crop Varieties	49	40.8
Increase Production Cost Roughly	34	28.3
Respondents Understanding the Presence of six seasons at the locality		
Yes	7	5.8
Medium	17	14.2
Partial	83	69.2
Fully Absence	13	10.8
Sources of Water for Consumption		
Pond	56	46.7
Rain-Water	14	11.7
Public-Filter	50	41.7
Cost for Purchasing Portable Drinking Water at Dry Seasons (N = 47)		
40-60 TK	13	27.66
61-80 TK	14	29.79
81-100 TK	7	14.89
100-120 TK	3	6.38
121-140 TK	7	14.89
150 or more TK	3	6.38

Table-2 expounds that 96.7% of the respondents have knowledge regarding local climate change while 3.3% of them have no idea regarding this. It describes that 40.8% of the respondents responded that crops become limited than it was before 20 to 25 years while 30.8% of them argued that agricultural production were reduced than before it was and 28.3% of them told that the agricultural production cost increased abruptly comparing with the past. It illustrates that for the explicit example of adversely changing of local climate and its far-reaching impact from the respondents responses which shows that 69.2% of the respondents have knowledge partially understanding the presence of six seasons in their locality while 14.2% have understanding medium presence, 5.8% of them fully aware of this but 10.8% of the respondents confess that they have no presence of six seasons at present. The table-2 illustrates that about 46.7% of the respondents collected water from pond followed by 41.7% drinking water from public filter where only 11.7% of the respondents used the rain water as their main sources of water consumption. The acute salinity and climatic phenomena extended the burden of purchasing of water of the community's people made as extra consumption budget which indicates that majority 29.79% of the respondents spent 61 taka to 80 taka per month for water while 27.66% of them used up 40 to 60 taka monthly. Both 14.89% of the respondents usually exhausted 81 to 100 taka and 121 to 140 taka as well. Again exactly 6.38% of the respondents spent 100 taka to 120 taka each month for water and rest of 2.5% of them used up 150 taka or more monthly for water at the dry season.

Other important factors for climate vulnerability expound from climatic literature that the building of dams on several upstream to downstream flowed rivers by neighboring country and their reservoirs motivate the migration of species and matter from upstream to downstream; imbalance the turbidity in downstream that leads to soil and embankment corrosion; generates large organic debris; watering terrestrial and wildlife vegetation; huge loss of riverbank forest; disruption of population maintenance; impaired the wetland biodiversity; raise the exotic, weeds and diseases-prone microorganisms condition; sedimentation and heavy metal levels enhancement; seasonal variability of flow and flood plains; changes of water table characteristics; abiotic changes; changes in in land deltas; impacts on salinity, nutrients and reproduction [5, 6].

Table-3 discusses that the problem occurred by salinity and here 43.3% of the respondents argued that salinity was responsible for the degradation of soil fertility. 27.5% of the respondents told that salinity hindered the paddy production where as 11.7 % of them said that it also hampered the production of other crops followed by 10.8% of the total respondents argued that salinity also acted as a barrier of fresh water shrimp cultivation and only 6.7% of the respondents told that due to salinity the average production was decreased. It reveals as multiple responses of the respondents that majority 75.83% of the respondents condemn acute soil salinity whereas 72.5% of them argued that the lower levels of precipitation while 73.33% of the respondents told high temperature burn paddy and 39.17% of respondents respond the tidal surge or inundate saline river water as rise its level. Table-3 illustrates that about 22.0% of the respondents among the 50 respondents used loan for purchasing food products while 16.0% of them spent loan money for cultivating shrimp whereas both 14.0% of the respondents argued that they exhausted the loan money for purchasing non-food and used in non-agricultural business whereas exact 10.0% of the respondents used loan money on education sector of the children and purchasing land respectively. Only 6.0% of the total respondents used the loan money for agri-business purposes.

Table 3. *Status of Local Food Production.*

Natures	Number	Percentage
Kinds of Barrier Faced for Agricultural Production		
Reducing Soil Fertility	52	43.3
Losing Average Production	8	6.7
Hindering Production of Paddy	33	27.5
Hampering Production of Other Crops	14	11.7
Fresh Water's Shrimp Cultivation	13	10.8
Effect of Climatic Change on Agriculture (Multiple Responses)		
Lower Level of Precipitation	87	72.5
Acute Soil Salinity	91	75.83
Tidal Surge / Inundate Saline River Water as Rise its Level	47	39.17
High Temperature Burn Paddy	88	73.33
Sectors of Using of the Loan (Whose engaged with crediting)		
Purchasing Food Products	11	22.0
Purchasing Non-Food Products	7	14.0
Cultivating Shrimp	8	16.0
Cultivating Rice	4	8.0
Agricultural Business	3	6.0
Non-Agricultural Business	7	14.0
Education of The Children	5	10.0
Purchasing Land/Property/House	5	10.0

Study shows that climate change imposes higher level of vulnerability mostly in crop agriculture sector and then fisheries and livestock. Yield of most of the crops would be negatively impacted by rise in temperature and erratic rainfall, flooding, droughts, salinity, etc. During the dry months of March and April, salinity problems, resulting from seawater intrusion, are more acute and lands are commonly let fallow as crop productions restricted by the presence of salt. More than 50% of the potential yields of most crops are reduced when the salinity is above 5 dS m^{-1} (EC). Normally, rice can tolerate EC value up to 3.0 dS m^{-1} [7].

Table-4 describes that about 64.2% of the respondents don't consume nutritional foods as they response where 14.2 % of the respondents consumed moderately nutritious food, 15.8% respondents' consumed food contain partially nutritious ingredient as the perceived and 5.8 % of the respondents get well dietary food. It also reveals that about 39.17% of the respondents reared the livestock where as 60.83% of the respondents disagreed regarding this question. It reveals that about 52.50% of the respondents' rear poultry where as 47.50% of the respondents disagreed regarding this question. In this salinity prone area has mostly small scale vegetation regarding winter and rainy seasons only in their

homestead for consumption. 53.33% of the respondents consumed vegetables which were cultivated by the homestead land whereas 46.67% of them disagreed regarding this question.

Table 4. *Status of Nutritional Attainment of the community people.*

Nutritional Aspects	Number	Percentage
Containing Nutritional Ingredients in Consumed Food		
Yes Contained	7	5.8
Moderately Contained	17	14.2
Partially Contained	19	15.8
Not Contained	77	64.2
Status of Rearing Livestock by Household		
Yes	47	39.17
No	73	60.83
Status of Rearing Poultry by Household		
Yes	63	52.50
No	57	47.50
Status of Homestead Seasonal Vegetation and Consumption		
Yes	64	53.33
No	56	46.67

Table 5. *Relationship between Containing Nutritional Ingredients and Poverty Status.*

Status of Nutritional Ingredients	Poverty Status		Total
	Poor	Non-Poor	
Yes Contained	0	7	7
	.0%	11.7%	5.8%
Moderately Contained	1	16	17
	1.7%	26.7%	14.2%
Partially Contained	5	14	19
	8.3%	23.3%	15.8%
Not Contained	54	23	77
	90.0%	38.3%	64.2%
Total	60	60	120
	100.0%	100.0%	100.0%

$X^2 = 36.979$ df (3)

Data of Table-5 indicates that the respondents had to suffer more different kinds of lower nutritional intake by consumption for poverty situation as 90.0% among the poor household food consumption didn't contained any nutritious ingredients and only 1.7% of poor households confess that their household could produce moderately nutritious ingredients in household regular dietary intake. On the other hand the 60 non-poor household; who have more or less nutritious dietary intake as 61.7% where less than the poor households of 38.3% non-poor household can't consume required nutritious diet. These problem of nutritious intake in household diet trends more food insecurity among the poor household than the non-poor household due to their unavailability to consume required level of nutritious diets. Here the calculated value of chi-square is-36.979, at 3 degree of freedom which is greater than table value (11.341)at 0.01levels of significances. The result of Chi-square (χ^2) indicates that poverty situation creates more unavailability in nutritional intake.

From other study, it is found that size of family and consumption variable multiplied by education level which are negatively related with landownership. That means 1 unit increase in household size and consumption variable multiplied by education level land ownership decreased by 6 and 12 units respectively, which increase the level of food insecurity [8].

4. Discussion

This study aims to conclude the situation of climate change and food security at salinity prone area in Khulna district of Bangladesh. The findings of this study explicate that the majority of the household of study area, based on sample investigation, are badly detached from cultivation of food grains and almost each of the product of household consumption consumed through purchasing from market. The respondents stated that the difference of their agricultural production due to the climate change as majority of 40.8 % of the respondents responded that crops become limited than it was before 20 to 25 years. The impacts on climate change in Bangladesh from different perspectives firstly of which is the six seasons in Bangladesh which are disappearing due to climate change. Infrastructures in Bangladesh, 93 disasters have occurred over the period from 1991 to 2000 and incurred the loss of US$ 590 crore in agriculture and infrastructure sectors. Saline water intrusion about 830,000 hectors cultivable land has damaged by saline water intrusion from Bay of Bengal [9]. 14.2% of the respondents migrated from the study area as responded by the respondents and 9.2 % of the total respondents have future plan to migrate due to the effect of climate change. 100% of the respondents perceived that decrease precipitation, deteriorated quality of surface water, increase intensity of salinity, increase river level or sea level, increase temperature on earth surface which clearly indicate the change of climate start to blatant. 49.17% respondents agreed with increased risk of flood, cyclone, tidal surge etc. as natural calamity in the locality, where some respondent perceived that it was also presence at past. The salinity and problems of drinking water of the people is the most concerning matter of the study area people. The majority of 46.7% of the respondents' main source water is pond main. The highest of 81.7 % of the respondents used rain water as their secondary source. Situation of farming and the livelihood pattern of the people are affected by the climatic factors and salinity intrusion where 43.3% of the respondents argued that salinity was responsible for the degradation of soil fertility. The reduction of precipitation affects the major crops cultivation of *amon (rainy season's paddy cultivation)* cultivation. The situation of cultivation expounds too much as 66.7 % of respondent didn't directly related with cultivation or domestic production. The majority of 64.2 % of the respondents don't consume nutritional foods and only 5.8 % of the respondents get well dietary food as the respondents' perceived. The poverty status suffers more insufficiency of nutritional intake as 90.0% among the poor household food consumption don't contain any nutritious ingredients. The production based consumption highly deprive to the poor as 93.3% among the poor households hadn't any kind of self-production and only 6.7% of the poor households produced nearly 10% of rice for annual household consumption. The

picture of consuming fish from home production reveals that 31.7% among the poor household haven't any kind of self-production and only 5.0% of poor households produce nearly 70% of fish for household consumption. The climate change adversely affects the marginal classes mainly the living conditions of farmers, fishers and forest-dependent people who are already vulnerable and food insecure. Hunger and malnutrition will increase. Rural communities dependent on agriculture in a fragile environment will face an immediate risk of increased crop failure and loss of livestock. Mostly at risk are people living along coasts, in floodplains, mountains, dry lands, and the arctic. In general, poor people will be at risk of food insecurity due to loss of assets and lack of adequate insurance coverage [10].

5. Conclusion

Bangladesh is belonging at the top of the risk due to the foreseeing impact of global climate change for her existence on world map. Bangladesh bears the vertical risk but produce very little of the inevitable risk. The agricultural production system of Bangladesh is highly depending on the mercy of nature. The great deltaic fertile plain land of her is interrupted critically by the catastrophic climatic calamity and makes far behind form self-sufficiency in food production. The findings of this study explicate that the majority of the household of the study area, based on sample investigation, are involved in non-agricultural activities and shrimp cultivation oriented. They are fully depending on the imported food consumption from nearby community and make themselves as non-producing consumer people. The salinity induces barren land for cultivating paddy, vegetable, fruits and other nutritional plants as well as hinder to rearing livestock, poultry which were contributed for household food availability and play important role for securing healthy as well as wealthy life leading of the rural people.

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