Impact of Climate Change on Lemon (*Citrus Limon*) Production in Sreemangal Upazila under Moulvibazar District, Bangladesh

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Abstract—*Lemon is very important citrus among many types of citrus fruits produced in Bangladesh. Soil and temperature of Bangladesh is favorable for lemon cultivation. In Bangladesh, about 54,613 M. ton of lime and lemon are produced annually in 4,083 hectares of land. Lemon contains large quantity of citric acid (4.52 percent to 5.82 percent). The study was conducted to determine the impact of climate change on lemon production in Moulvibazar district as the area is moderately vulnerable to climate change. The study sample consisted of 80 randomly selected lemon growers and the data were collected by using face to face interview schedules to identify their perceptions, social characteristics and impact of climate change on lemon production. The findings of the study indicated that the, grower's perception about climate change was reasonable as majority of the growers claimed about increased annual precipitation (48.75 percent), increased summer temperature (48.75 percent) and reducing winter temperature (46.25 percent). In case of extreme events, 56.25 percent growers mentioned that the intensity of storms was increased and 58.75 percent lemon growers told that the intensity of rainfall was increased. In recent times, however in case of the environmental hazards, the findings of the study indicated that excess precipitation, spread of pest, cloudy sky, hail storm and drought were the major problems regarding the production of lemon. On the other hand, it was found that extra cloudy sky mostly damages the lemon production. In addition to that, fertility of soil, pest and diseases, excess amount of temperature, sowing time of crop, duration of maturity and drought had the significant impact of climate change respectively for the lemon production in Sreemangal upazila of Moulvibazar district. Correlation analysis indicated that level of education and communication media exposure had negatively significant relation as young growers were mainly using chemical fertilizer to a great extent and age, occupation, family size, annual family income, farm size, communication media exposure, perception on climate change and environmental hazards had positive significant relation on the production of lemon (Citrus limon) in Sreemangal upazila under Moulvibazar district.*

Keywords: *Climate Change, fertility, horticultural crops, drought, society.*

Introduction

The climate of Bangladesh can be characterized by high temperatures, heavy rainfall, high humidity, and fairly marked three seasonal variations like hot summer, shrinking winter and medium to heavy rains during the rainy season. In general, maximum summer temperatures range between 38 and 41°C (100.4 and 105.8°F). April is the hottest month in most parts of the country. January is the coolest month, when the average temperature for most of the country is 16–20°C (61–68°F) during the day and around 10°C (50°F) at night. According to IPCC (2007) due to climate change effect sea level in the coastal region of Bangladesh has been predicted to rise up to 80 cm by 2100. Climate change in Bangladesh has become a threat to the rural farmers and agricultural workers. Lemon (*Citrus limon*) is one of the most important fruit crops in Bangladesh. It is mainly grown in tropical rain forests of southern China, Cochin and certain islands of Malay Archipelago. Although the lemon originated in the tropical regions but their performance is best in subtropical environment. The lemon produced in the lands possess the soil is more suitable for any horticultural crop rather than rice productivity. Among the horticultural crops like pineapple, banana, mango and other fruits, lemon required less cultural practices and hence reduced labors. So, lemon productivity is more profitable than other horticultural crops and obviously from rice. Actually the area now under the lemon productivity was remaining fallow earlier of lemon cultivation. It is very suitable for horticultural crops like lemon and other fruits. The reason behind the fallow condition may be due to the belongingness of land, it is government Khas property and hence it was difficult for anyone to cultivate. At the same time the people are engaged in lemon productivity, were landless, day labor and unemployed. Now the land has owned by these people in the name of enemy property and got for 99 years as lease. Lemon is very important citrus among many types of citrus fruits produced in Bangladesh. Soil and temperature of

Bangladesh is favorable for lemon cultivation. In Bangladesh, about 54,613 M. ton of lime and lemon are produced annually in 4,083 hectares of land (BBS, 2011). Lemon contains large quantity of citric acid (4.52 percent to 5.82 percent). It is one of the most important fruits in international trade as fresh fruit and processed product. Roughly, 10 percent of the citrus produced in the world enters into international trade as fresh fruit. With globalization of world trade and establishment of world trade organization (WTO) the export opportunities of citrus fruits increase significantly. Therefore, citrus grower faced increase competition in the world market level. Lemon is used as raw materials of shampoo, soap, medicine and various delicious items like salad, drink, jam, etc. Day by day lemon demand is expanding for which it is necessary to know the current method of productivity as well as the climate change impact over lemon productivity. In Bangladesh, the productivity per unit area and overall productivity need to be increased considerably in order to stand in international competition. The study area is mainly affected by different types of climatic hazards. So impact is very much essential for this area for all the sectors of agriculture, specially for lemon cultivation. Thus, in this situation it is necessary to know the extent of climate change perception and impact of climate change on lemon productivity. That is why this study was drawn over this area with the following objectives: To determine the perceived impact of climate change on lemon productivity; to analyze the selected characteristics of the lemon growers; to explore the relationship between the selected characteristics and the impact occurred in lemon productivity due to climate change as perceived by the growers; and to ascertain the environmental hazards faced by the lemon growers.

Material and Methods:

This study employed both quantitative and qualitative research approaches in order to get a comprehensive view of the perceived impact of climate change on lemon productivity of Bangladesh. Qualitative method as Key Informant Interviews (KII) was used and the quantitative survey approach was used. The key informants were the Agriculture Extension Officer (AEO) and model farmers of the unions under Sreemangal upazila. Thus, a mixed method research design was applied to determine the impact of climate change on lemon productivity in Sreemangal upazila of Moulvibazar district. The researcher himself with the help of local leaders and concerned Sub Assistant Agriculture Officer (SAAO) prepared an updated list of lemon growers of the selected upazila. A total number of 320 lemon growers were listed, where 36 were from Mirzapur, 48 were from Sindurkhan, 72 were from sreemangal, 40 were from kalighat, 60 were from Asidron and 64 were from Rajghat union, which constituted the population of the study. The sample size was determined as 80. Out of 320, 25 percent was taken as sample size. However, data were collected from the sample rather population. Most of the lemon growers in the study areas are businessmen and entrepreneur. Most of the growers have day-labors in their lemon field to maintain the

necessary activities. That's why, researcher sometimes needed to meet with the lemon growers outside of the field or their respective residence. An interview schedule was prepared for collection of data from the respondents keeping the objectives of the study in mind. The questions and statements contained in the schedule were simple, direct and easily understandable by the respondents. Appropriate scales were also developed to operationalize the selected characteristics of the farmers. An organized research usually contains at least two identical elements viz. independent and dependent variable. An independent variable is that factor which is manipulated by the researcher in his attempt to ascertain its relationship to an observed phenomenon. The independent variables of the study were age, education, occupation, farm size, annual income, family size, communication media exposure. According to the relevant research area, the researcher selected seven characteristics of farmers as the independent variables and overall impact of climate change regarding lemon productivity as the dependent variables. A dependent variable varies as the experimenter introduces, removes or varies the independent variables (Townsend, 1953). The extent of overall lemon productivity in response to climate change is the depended variable of this study. A climate change impact index (CCII) was developed to fulfill this objective using the formula (Rahman, 2005). This section contains procedures of measurement of the dependent and all independent variables of the study. Tabulation was done on the basis of different categorization developed by the researcher and transferred into SPSS (Statistical Package for Social Science) software package (16.0 Version). In order to develop conceptual basis of the study, secondary information were collected from different organizations, office records, reports, related journals and other relevant sources and utilized when necessary. For analysis of data, different descriptive and inferential statistical tests will be used. Among the inferential statistics Person's Product Moment Correlation Coefficient (r) would be computed to explore the relationships between socio-economic characteristics of lemon growers and their impact of climate change on lemon productivity. In order to test the formulated hypotheses of the study, Pearson's product Moment Correlation Co-efficient (r) was used. Through this statistical treatment, nature of relationship between the dependent and independent variables was determined. Pearson's correlation is used when we have two quantitative variables and the research hypothesis predicts whether there is a linear bivariate relationship between these two quantitative variables. It was performed to explore the relationship between farmer's socio-economic characteristics and their extent of lemon productivity against impact of climate change.

Results and Discussion:

Characteristics Profile of the Lemon Grower's in Study Area

The results indicate that highest proportion 48.8 percent of the respondents were middle compare to 32.4 percent young and 18.8 percent old aged. Most of the middle aged growers

involved with lemon productivity, on the other hand young growers mostly relay on modern technologies and they were involving in this lemon cultivation as a family tradition. 1.2 percent of the respondents had primary education, 57.5 percent had secondary education, 28.8 percent had higher secondary education, and 12.5 percent were Graduate. The literacy rate of our country is 69 percent (Anonymous, 2003). The highest proportion 41.2 percent of the respondents were businessmen, 37.4 percent were entrepreneur and 21.2 percent were agro- farmer. Lemon productivity needs huge field and profit is high, that's why most the businessmen were involved with lemon productivity. The medium family size constituted the highest proportion 55 percent and the lowest 12.5 percent in large family size and 32.5% were small family size. The medium farm holder constituted the highest proportion 78.8 percent and the lowest 7.4 percent in small farm holder and 13.8 percent had large farm. Mostly lemon cultivation requires vast land area for productivity. The majority 43.7 percent of the respondents had high annual family income, 42.5 percent had medium annual family income, and 13.8 percent had low annual family income. The annual family income of the growers of the study area was medium to high. The highest proportion 58.7 percent respondent of the study area had medium media exposure, while 23.8 percent had very low media exposure and 17.5 percent had high media exposure.

Table 1: Distribution of the respondents based on their perception of climate change

Sl. No	Name of the statement		Extent of perception							
			Increased		Decreased		No changed		Don't know	
			No	%	No	%	No	%	No	%
1	Precipitation	Annual	39	48.75	6	7.5	25	31.25	10	12.5
		In rainy season	16	20	18	22.5	34	42.5	12	15
		In dry season	32	40	10	12.5	24	30	14	17.5
		Length of rainy season	21	26.25	13	16.25	36	45	10	12.5
		Length of summer season	11	13.75	38	47.5	24	30	7	8.75
2	Temperature	Annual	15	18.75	11	13.75	42	52.5	12	15
		Winter season	9	11.25	37	46.25	21	26.25	13	16.25
		Summer season	39	48.75	13	16.25	18	22.5	10	12.5
3	Extreme events	Intensity of storms	45	56.25	8	10	16	20	11	13.75
		Intensity of hotness	13	16.25	36	45	25	31.25	6	7.5
		Intensity of rainfall	47	58.75	9	11.25	13	16.25	11	13.75

Relationship between the Selected Socio-economic Characteristics of the lemon growers and their impact of climate change on lemon productivity

Relationship between the age of the respondents and their impact of climate change on lemon productivity

The relationship between the age of the lemon growers and their impact of climate change was measured by testing the null hypothesis. There is no relationship between the age of the lemon growers and their impact of climate change on lemon productivity. The calculated value of ('r'= .516**) was found greater than both the tabulated value ('r'= 0.197) at 0.05 level and ('r'= 0.257) at 0.01 level of probability as shown in table 3. It was concluded that there was positively significant relationship between age of the lemon growers and their impact of climate change on lemon productivity. Old aged lemon grower's perception about climate change is higher than the young aged lemon growers. The young aged grower mostly relay on applying fertilizers and pesticides to lemon field. However the old aged lemon growers feel more conscious about climate change impact.

Relationship between education level and their impact of climate change on lemon productivity

The relationship between the education of the lemon growers and their impact of climate change was measured by testing the null hypothesis. There is no relationship between the age of the lemon growers and their impact of climate change on lemon productivity. The calculated value of ('r'= -.627**) was found smaller than both the tabulated value ('r'= 0.197) at 0.05 level and ('r'= 0.257) at 0.01 level of probability as shown in table 3. Thus it was concluded that there was a significant relationship between education of the lemon growers and their impact of climate change on lemon productivity. Therefore, they are intending to take risks to increase their agricultural productivity only which may lead them to overlook the climate change impact. It seems to be the educated lemon growers had more knowledge about climate change but they only focusing on lemon productivity. This might consider destructive to environment. The negative trend, however, indicated that as the education level increased the trend of using chemical fertilizer is increased.

Relationship between occupation and their impact of climate change on lemon productivity

The relationship between the occupation of the lemon growers and their impact of climate change was measured by testing the null hypothesis. There is no relationship between the age of the lemon growers and their impact of climate change on lemon productivity. The calculated value of ('r'= .408**) was found greater than both the tabulated value ('r'= 0.197) at 0.05 level and ('r'= 0.257) at 0.01 level of probability as shown in table 3. It was concluded that there was positively significant relationship between occupation of the lemon growers and their impact of climate change on lemon productivity. That means the lemon growers impact about climate change and lemon productivity affected by their occupation.

Table 2: The rank order of climate change of lemon productivity

Impacts	Growers (N=80)				CCII (Impact of Climate Change Index)	Rank Order
	High	Medium	Low	Not at all		
Due to excess temperature, the amount of lemon productivity increased than before	25	28	16	11	147	4th
Fertility of the soil has decreased compared to before	35	28	10	7	171	2nd
The sowing time of lemon has changed	26	22	18	14	140	5th
Crop productivity takes longer than before	20	30	15	15	135	6th
Extra cloudy sky cause damage to lemon productivity	38	25	12	5	176	1st
Drought on citrus growth and productivity	10	15	25	30	85	7th
New pest and diseases are seen in lemon fields	30	23	13	14	149	3rd

Relationship between family size and their impact of climate change on lemon productivity

Data in the table 3, indicate that the computed Correlation co-efficient value of ('r'=.570**) was found greater than both the tabulated value ('r'= 0.197) at 0.05 level and ('r'= 0.257) at 0.01 level of probability was statistically positively significant. Hence the null hypothesis was rejected and it was concluded that family size had positively significant relationship between the family size and their impact of climate change on lemon productivity. When the family size was large, most of the family members did not found the minimum facilities to lead the life. Most of the members had less education and communication facilities.

Relationship between farm size and their impact of climate change on lemon productivity

The relationship between the farm size of the lemon growers and their impact of climate change was measured by testing the null hypothesis. There is no relationship between the age of the lemon growers and their impact of climate change on lemon productivity. The calculated value of ('r'= .440**) was found greater than both the tabulated value ('r'= 0.197) at 0.05 level and ('r'= 0.257) at 0.01 level of probability as shown in table 3. Growers having large farm size expected to have higher productivity of lemon. They were very much sincere about climatic parameter which can damage to productivity. It

was concluded that there was positively significant relationship between farm size of the lemon growers and their impact of climate change on lemon productivity.

Relationship between family income and their impact of climate change on lemon productivity

Data in the table 3, indicate that the computed Correlation co-efficient value of ('r'=.567**) was found greater than both the tabulated value ('r'= 0.197) at 0.05 level and ('r'= 0.257) at 0.01 level of probability was statistically positively significant. Hence the null hypothesis was rejected and it was concluded that annual family income could vary positively with the variation of climate change impact.

Relationship between communication media exposure and their impact of climate change on lemon productivity

The relationship between the communication media exposure of the lemon growers and their impact of climate change was measured by testing the null hypothesis. There is no relationship between the age of the lemon growers and their impact of climate change on lemon productivity. The calculated value of ('r'= -.450**) was found smaller than both the tabulated value ('r'= 0.197) at 0.05 level and ('r'=0.257) at 0.01 level of probability as shown in table 3. Grower's communication with the media exposure is very essential to know the climatic factor and lemon productivity. However, it had been seen a negative relation between the communication media exposure and impact of climate change. Thus, it was concluded growers mainly rely on their experiences on lemon productivity and often consult with AEO.

Table 3: Correlation Co-Efficient between the Selected Characteristics of the Respondents and their Impact of Climate Change on Lemon Productivity.

Dependent variable	Independent variable	Correlation co-efficient (r) values with 98 d.	Tabulated value of 'r'	
			0.05 level	0.01 level
Impact of Climate Change on Lemon Productivity.	Age	.516**		
	Level of education	-.627**		
	Occupation	.408**		
	Family size	.570**		
	Annual family Income	.567**	0.197	0.257
	Farm size	.440**		
	Communication Media Exposure	-.450**		

Conclusion

Lemon (*Citrus limon*) needs average temperature and high sunshine for maximum productivity, excess precipitation or cloudy sky can hamper the quality and spread pest respectively. It was found from the study that the climatic parameters have changed within the study period. The tendency of monthly temperature found increasing in winter season whereas remained same in summer season. In one hand the trend of annual and monthly rainfall was increasing in the

study period. Growers of the study area are more or less concerned about the impact of climate change on lemon productivity in Sreemangal upazila. For the last few years lemon is cultivating vastly as a consequence of adopting strategies to climate change. However, most of the growers rely most on applying fertilizer for high productivity. Co-operation and coordination of DAE and NGOs is required for the success. A balance is to be maintained among the quality and supply of planting materials, maintaining sustainability of the environment and natural resources to cope with the climate change.

Reference:

[1]. Aggarwal P.K, and Mall P.K. 2002: Climate change and rice yields in diverse agroenvironments of India. II. Effect of uncertainties in scenarios and crop models on impact assessment. Climatic Change.**52** 331-343.

[2]. Asaduzzman M, Ahmed A.U, Haq E, and Chowdhury SMZI 2005: Climate Change and Bangladesh: Livelihood Issues for adaptation, Dhaka, Bangladesh. Bangladesh Institute for Development Studies (BIDS). pp. 39-54.

[3]. Babbie E 2010: The practice of social research, Belmont, CA: Wadsworth. (301.072_BAB)

[4]. BBS 2011: Statistical Yearbook of Bangladesh. Bangladesh Bureau of statistics, Ministry of planning Dhaka, Bangladesh.

[5]. DAE 2018: Temperature data of Sreemangal upazila under Moulvibazar district.

[6]. FAO 2005: Final Report- Study on livelihood systems assessment, vulnerable groups profiling and livelihood adaptation to climate hazard and long term climate change in drought prone areas of NW Bangladesh. Rome, FAO and CEGIS. pp. 31-46.

[7]. Hossain M.A 2010: Global Warming induced Sea Level Rise on Soil, Land and Crop Productivity Loss in Bangladesh. Dhaka: SRDI (Soil Resource Development Institute).

[8]. Rahman M.M 2005: A thesis on Agricultural adaptation to climate change in selected drought prone area of Bangladesh, Department of Environmental Science, Bangladesh Agricultural University, Mymensingh. pp. 38-47.

[9]. Wang J, Hang j, Yang J 2009: Climate Change, Water Security and Agricultural Development in 3H Region. Report Submitted to the World Bank (in draft). p. 70.

[10].Wolfe D.W, Schwartz A.N, Lakso Y, Otsuki R.M, Pool N, Shaulis 2005: Climate change and shifs in spring phenology of three horticultural woody perennials in northeastern USA. Int. J. Biometeorol. 49:303–309.

[11].World Bank 2000: "Bangladesh: Climate Change and Sustainable Development. Report No. 21104-BD" Rural Development Unit, South Asia Region, The World Bank (WB), Dhaka. p. 95.