

Full Length Research Paper

The effects of climate change- blessings or curse? Insights from the perception of pineapple growers in hilly region of Bangladesh

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Abstract

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Climate change plays a very significant role in the production of pineapple. As one of the main cash crops in the hilly region of Moulvibazar district, pineapple played a pivotal role in gaining livelihood. The focus of the study was to determine the impact of climate change on this crop in this hilly region through the perception of pineapple growers about the changing climatic parameters and their effects on pineapple production. A total of thirty statements covering seven most important climatic parameters were constructed, those that had direct influence on growth, yield and production of the crop. Data were collected from the sampled respondents of four Unions of Sreemangal Upazila under Moulvibazar District using pre-tested interview schedule from 12 August to 28 September 2019. The results revealed that overwhelming majority (76%) respondents perceived climate change as blessings because they gained high profit with moderate yield. A number of climate change parameters, including a rise in temperature, rainfall, sunlight and wind speed, acted as blessings to increase pineapple production. The socio-economic profile of the respondents showed that the respondents belonging to middle age, large family, medium farm holding, neutral attitude and medium annual family income had significant positive influence in boosting pineapple production in the terraces.

Key words: Climate change, pineapple, production, pineapple growers, hilly regions, perception, impact.

INTRODUCTION

In Bangladesh, pineapple is one of the most important commercial fruit crops and stands fourth position in terms of total cropping area that was first cultivated in Sylhet in the twentieth century (BBS, 2016). This plantation crop is now commercially cultivated in the Districts of Tangail, Mymensingh, Gazipur, Sylhet, Moulvibazar, Chattogram, Bandarban, Khagrachari and Rangamati. Although Bangladesh is not a tropical country, the subtropical mon-

soonal climatic condition and the soil of many parts of Bangladesh are highly suitable for pineapple production (BBS, 2019). The production and demand of pineapple has been expanding rapidly within the country because of its contribution to Bangladesh's national economy as well as GDP by involving a large number of people in the production and marketing of this crop (Datta et al., 2020). About 45,685 ha of land are now under pineapple cultivation with a total production of about 2,34,865 m tons (Prosad et al., 2017).

In Sreemangal, the native farmers have achieved a bumper production of pineapple at 30 villages that is known as 'pineapple village' (Deshwara, 2015). Among them, 80 percent of the farmers have been cultivating Honey Queen and the rest 20 percent of the farmers have been producing Giant Kew. Few years ago, there was no expectation among the growers to make profit out of the pineapple production. But, with the changing situation, the local farmers have been cultivating it on a large scale and in a well-constructed way. Honey queen has been cultivated on a massive scale, because of its good taste, size, and aroma which enhances its public demand and helps the farmers to get an expected price of it. Pineapples can be grown throughout the year, but November-December-January is preferable and is mainly grown through a sucker. Basically, from March to May, flowering starts, and fruiting commences from June to September. The months June, July and August are the optimum time for pineapple harvesting, although a few pineapples are harvested during September and October (Hossain and Islam, 2017). Many processes of food systems are directly and indirectly affected by climate change (Davis et al., 2021) but the primary effects often occur in crop production (Hasegawa et al., 2022). Bangladesh remains 7th most vulnerable countries in the world to climate change (Eckstein et al., 2021). There are some parameters through which climate change can be measured. These parameters of climate change include temperature, rainfall, relative humidity, cyclones, drought, wind, sunlight, and storm. Climatic events like temperatures and rainfall changeability patterns have significant impact on pineapple production (Williams et al., 2017). For instance, throughout the flowering and fruit growth stage, excessive rainfall or severity of cold temperatures reduce production and can subject to physiological disorders in pineapples (Datta, 2013). In case of climate change, it is necessity for the farmers to perceive that climate is changing and need to take effective action in support of this perception to mitigate negative effects. (Fierros-González and López-Feldman, 2021). The aim of this study, therefore, was to assess the perception of pineapple growers on how the climate change is affecting pineapple production in Sreemangal Upazila of Moulvibazar district in Bangladesh.

METHODS

Sreemangal Upazila was selected purposively for the study. There are thirty villages under nine Unions where pineapples have been cultivated on massive scale in Sreemangal. This study was conducted in four Unions under Moulvibazar District of the country. At first four Unions namely Sreemangal, Ashidrun, Kalighat and Kalapur selected randomly. Through focus group discussion (FGD), an initial perception was measured based on 30 statements, which were furnished

based on seven most important climatic parameters such as temperature, rainfall, humidity, drought, wind, sunlight, and storm. Data were collected from the 50 sampled respondents of four villages using pre-tested well-structured interview schedule from August to September 2019. Each respondent was asked to indicate his extent of agreement or disagreement against each statement along a 5-point rating scale: 'strongly agree', 'agree', 'undecided', 'disagree' and 'strongly disagree' which were identified by the rank of order 5, 4, 3, 2 and 1, respectively. Perception Index (PI) was also determined for each of the 30 perception statements to rank them. Perception Index (PI) = 5×SA + 4×A + 3×U + 2× DA + 1×SDA

SA= Total number of respondents expressing their opinion 'Strongly Agree' for the statement A= Total number of respondents expressing their perception 'Agree' for the statement U= Total number of respondents expressing their perception 'Undecided' for the Statement DA= Total number of respondents expressing their perception 'Disagree' for the statement SDA= Total number of respondents expressing their perception 'Strongly Disagree' for the statement.

RESULTS

This section presents the area under pineapple production and the distribution of pineapple growers based on their perceived effects of climate change. It also reports on the farmers' perceived changes in the climatic factors and the effects of those changes on pineapple production. Finally, it elaborates the socio-economic traits of the pineapple growers who participated in this study.

1. Area under pineapple production from 2010 to 2018 of Sreemangal Upazila

Ten years data on area and production of pineapple were collected from BBS 2010 to 2018 reveal the fact that area under pineapple production increased gradually from 303 ha in 2009 to 410 ha in 2018. About 30% production increased in last 10 years (Productions were 85.05 thousand tons and 66 thousand tons in 2009 and 2016, respectively).

2. Category of pineapple growers based on their perception about the extent of climate change

Perception scores of pineapple growers about the impact of climate change on pineapple production ranged from 84 to 131 against the possible range of 30-150 with the mean and standard deviation of 119.76 and 8.64, respectively. Based on perception scores, the pineapple growers were classified into three categories as presented in Table 2.

The change in climatic factors like precipitation patterns and extremeness of temperature were marked as moderate to high

Table 1. Data on area under cultivation and production of pineapple from 2009 to 2018 of Sreemangal Upazila, Moulvibazar.

Years	Area (ha)	Pineapple Production (.00 Metric Ton)	Years	Area (ha)	Pineapple Production (.00 Metric Ton)
2009	303	66.00	2014	400	84.02
2010	290	59.45	2015	402	84.42
2011	325	68.25	2016	405	85.05
2012	325	68.25	2017	409	81.80
2013	400	84.00	2018	410	82.00

Source: BBS, 2010 to 2018.

Table 2. Distribution of pineapple growers based on their perceived climate change scores.

Categories	Respondents		Mean	Standard deviation
	Number	Percent		
Low change (up to 111.12 scores)	7	14.0		
Moderate change (111.13-128.4 scores)	38	76.0	119.76	8.64
High change (above 128.4 scores)	5	10.0		
Total	50	100.0		

by the overwhelming majority (86%) of the respondents.

3. Farmer's perceived changes in the climatic factors

Farmer's perception about the changes in the climatic factors deals with seven climatic factors namely temperature, rainfall, humidity, drought, wind, sunlight, and storm. On the basis of the extent of their opinion, calculation of perception index (PI) and depending upon PI perceptions were ranked as follows in the Table 3.

4. Farmers perceived impacts of climatic change on pineapple production

Perceived impacts of climate change on various aspects of pineapple production with the extent of agreement or disagreement, perception index (PI) and rank order are shown in the Table 4.

5. Socioeconomic profile of the respondents

Ten characteristics specifically age, level of education, family size, area under pineapple production, annual family income, type of land ownership, housing condition, extension contact, knowledge and attitude of the farmers were selected as socio-economic profile of the respondents. This section represents

the socio-economic traits of the pineapple growers who participated in this study (Table 5).

6. The Relationship between the Selected Characteristics of Pineapple Growers and Their Perceived Climate Change Impact

Pearson Product Moment Correlation Coefficient was computed to find out the extent of relationship of each of the selected characteristics of the pineapple growers with their perceived climate change impact. A 0.05 and 0.01 level of probability was used to reject or accept the null hypothesis. When the computed value or 'r' was greater or smaller than the tabulated value, a statistically significant and non-significant relationship was observed in the Table 6.

DISCUSSION

In this section, the probable discussion was made based on the findings that is presented in results portion with justifiable interpretation and logical explanation.

1. Farmer's Perception about climate changing factors and their impact on pineapple production

Perception about temperature and its impact on pineapple production

Table 3. Farmers' perceived changes in the climatic factors.

Sl. NO	Statements	Extent of Opinion					PI	Rank Order
		Strongly agree	Agree	Undecided	Disagree	Strongly disagree		
Temperature								
1.	Temperature has increased remarkably in summer season	25	15	5	3	2	208	2
2.	Severity of cold has been extended in winter	20	12	9	7	2	191	7
Rainfall								
1.	The amount of precipitation has been increased over the periods	18	20	6	4	2	198	3
Humidity								
1.	Humidity has slightly been decreased	20	15	5	7	3	192	6
Drought								
1.	Prevalence of drought has been escalated due to irregular distribution of precipitation	19	15	7	4	5	189	8
Wind								
1.	Wind speed has been slowed down	15	22	7	3	3	193	5
Sunlight								
1.	Scorch sunlight and shiny days have been increased	14	24	6	6	0	196	4
Storm								
1.	Intensity of storm has been raised significantly	15	15	10	5	5	180	9
2.	Striking expansion of thundering and lightning	26	18	3	3	0	217	1

Most of the pineapple growers of Sreemangal Upazila opined that extremeness of temperature had gradually been increased in both ends of a scale; in summer there were intolerable hot and moist weather, and bone shaking cold in the winter seasons in the following years. The overwhelming majority (70%) of the respondents reported that increased temperature was good for plant growth, fruit size and quality of pineapple, but prolonged winter had negative impact on production. This observation quashed the findings that pineapple was a temperature sensitive crop (Williams et al., 2017), and the rising of temperature has yet to be reached 4°C for affecting horticulture industry [Deuter, 2008].

Perception about change in the pattern of rainfall and its impact on pineapple production

Like other horticultural crops, pineapple production is sensitive to climate variability and change; untimely rains during drought stress periods or above normal temperatures during flowering and fruit growth reduce yields and can cause physiological

disorders (Williams et al., 2017). Moisture availability is important to the pineapple plant at critical periods of growth of the crop and deficits, or excesses can have detrimental effects on production (De Mondonca, 2015). For pineapple cultivation, peak balance of water requirement happens in the month of August, when there was adequate moisture in soil as this area was blessed with high and well distributed rainfall throughout the year, especially in the month of August, which favored healthy growth and high yield of the pineapple. Despite having heavy showers during the monsoon, no water logging occurred in pineapple farm due to high slopes of lands.

Perception about Humidity and its impact on pineapple production

Humidity levels directly control the rate of transpirational water loss and stomatal aperture of plants. Thus, humidity regulates photosynthetic rates, tissue temperatures, plant water potentials, and concentrations of Ca in certain tissues. Humidity also controls water taken in by tissues through

Table 4. Farmers perceived impact of climatic change on pineapple production.

Sl. NO	Statements	Extent of Opinion					PI	Rank Order
		Strongly agree	Agree	Undecided	Disagree	Strongly disagree		
Impact of Temperature								
1.	High temperature is good for the quality, size, and growth of pineapple	29	15	4	2	0	221	2
2.	Severe cold reduces the growth of pineapple	15	20	6	6	3	188	17
3.	Very negligible negative impact on pineapple production	23	12	5	6	4	194	16
Impact of Rainfall								
1.	High rainfall causes soil erosion	25	20	5	0	0	220	3
2.	High rainfall is good for the growth and development of pineapple	22	15	10	3	0	206	10
3.	High yield	28	10	5	5	2	207	9
Impact of Humidity								
1.	Less disease and insect infestation	17	21	12	0	0	205	11
2.	Enhance water requirement	22	20	6	2	0	212	5
3.	Less impact on yield	20	19	5	3	3	200	15
Impact of Drought								
1.	Irrigation is required if the rainfall is not frequent	10	24	10	4	2	186	18
2.	Increase in the physical damage and stunt the growth of crops	10	10	15	10	5	160	21
3.	Less productivity if the required water is not provided	20	17	10	2	1	203	13
Impact of Wind								
1.	Less soil erosion	10	12	14	9	5	163	20
2.	Less breakdown of stem and root	20	20	10	0	0	210	7
3.	Positive impact on yield	15	27	5	3	0	204	12
Impact of Sunlight								
1.	Intense sunlight cause sunburn damage to pineapple	21	19	8	2	0	209	8
2.	Pineapple plants need direct sunlight	20	25	5	0	0	215	4
3.	Direct sunlight facilitates development of plant and productivity	25	15	7	2	1	211	6
Impact of Storm								
1.	Thunderstorm put the pineapple grower's life at stake	30	15	5	0	0	225	1
2.	Hailstorm cause damage to pineapple fruit	10	19	15	6	0	183	19
3.	Minor impact on productivity	14	28	4	4	0	202	14

condensation and direct vapor uptake (Tibbitts, 1979). Most of the farmers think that humidity has reduced slightly over the periods. Due to the reduction in humidity, the pineapple plant is subjected to face less disease and insect infestation and it also increases the water requirements of the plants. As Sreemangal is blessed with frequent rainfall, additional irrigation is not highly required for pineapples.

Perception about Drought and its impact on pineapple production

Crop growth, development and production are undesirably affected by drought conditions because of physiological interruptions, physical damages, and biochemical modifications in plants because of the extreme and swift

variations in worldwide climatic conditions (Iqbal et al., 2020). According to the farmers of Sreemangal, an increase in the physical damage stunts the growth of crops as the incidents of drought have increased in the recent years and farmers had to face loss in pineapples production although persistent rainfall in that region helping a lot to cope up with these drought situations. Need-based extension services in this regard (Kamruzzaman et al., 2020) may reduce the negative effects of drought conditions and storm on pineapple production.

Perception about Wind and its impact on pineapple production

If the wind is too strong, the plants oscillate and sway until the roots or stem fail. The mechanisms of root and stem failure

Table 5. Salient features of the selected socio-economic characteristics of the respondents

S.L. No.	Characteristics	Unit of measurement	Observed range	Mean	Standard deviation
1.	Age	Year	23 to 90	45.20	1.57
2.	Level of education	Year of schooling	1 to 12	6.42	3.58
3.	Family size	No. of persons	3 to 18	6.22	2.59
4.	Area under pineapple production	Hectare	0.10 to 4.46	1.11	0.898
5.	Annual family income	'000' Taka	30 to 1050	3.00	2.05
6.	Type of land ownership	Scale	0 to 2	0.98	1.27
7.	Housing condition	Scale	0 to 2.	0.50	0.54
8.	Extension contract	Scale	7.87 to 21.41	14.64	6.77
9.	Knowledge	Scale	29.09 to 39.43	34.26	5.17
10.	Attitude	Likert scale	29.26 to 40.10	34.68	5.42

are very similar in different plants although the exact details of the failure may be different (Gardiner et al., 2016). Farmers reported that the pineapples had to face less breakdown of stem and root because of the wind speed has been reducing in Sreemangal as well as decrease in soil erosion and the totality have positive contribution towards high yield.

Perception about Sunlight and its impact on pineapple production

Solar radiation is essential for plant growth due to the absorbance of sunlight and using it for the energy source for photosynthesis by plants (McKenzie, 2017). Crop production increases with the increment of the amount of the captured radiation energy. Majority of pineapple growers also stated from their observation that sunlight intensity has risen because of climate change, which is absolutely come out as a benefit for the growth and production of pineapples because it needs direct sunlight. On the other hand, intense sunlight also causes sunburn damage to the pineapples.

Perception about Storm and its impact on pineapple production

In Bangladesh, the frequency and intensity of the extreme events have increased significantly in recent decades due to climate change and global warming (Dastagir, 2015). Severe lightning starts from March and remains active up to October-November, but in May the lightning frequency, lightning injury and lightning death is the highest in Bangladesh (Farukh et al., 2017). Sreemangal is one of the major lightning affected areas in Bangladesh. The farmers of Sreemangal also reported that the intensity of storm has increased dramatically, and lightning storm highly put the pineapple grower's life at stake and many farmers are dying due to it. Moreover, hailstorm causes damage to the pineapple fruits. Despite these climatic hazards, farmers are highly interested in pineapple production as they are making high benefit out of it with the abundant production.

2. Socioeconomic profile of the respondents and their correlation with the perceived impact of climate change

Table 6. Correlation co-efficient between the selected characteristics of the respondents and their perceived climate change impact.

Focus variable	Selected characteristics of pineapple growers	Value of co-efficient correlation, r	Tabulated value	
			0.05 level	0.01 level
Perceived impact of climate change	Age (45.20)	.060	0.273	0.325
	Education (6.42)	.674**		
	Family size (6.22)	.315*		
	Area under pineapple production (1.11)	-.133		
	Annual family income (3.00)	-.072		
	Type of land ownership (0.98)	.023		
	Housing condition (0.50)	-.023		
	Extension contact (14.64)	.186		
	Knowledge (34.26)	.339*		
	Attitude (34.68)	.594**		

Age

Age is the indicator of biological maturity of an individual from birth to the time of interview. From Table 4 it was found that most of the farmers were middle aged so they can do a lot of hard work and contribute highly to the pineapple field compared to the young and old age people which also helps in increasing pineapple production in that region (Table 5). Based on the above findings, it was found that age of the respondents had non-significant positive relationship with their perceived impact of climate change on pineapple production.

Level of Education

Data in Table 5. stated that primary education category constitutes the highest proportion with a mean & standard deviation of 6.42 and 3.58 respectively. Most of the farmers had primary education level, so they were not fully concerned about the climatic variations and its consequences on their livelihood and crops. The level of education of the pineapple growers also showed significant positive relation with their perceived impact of climate change on pineapple production. So, if the farmers get proper education, they will have better concept of climate change adaptation and can take effective measures to carry out different farm activities properly on time for pineapples and other crops as well as to balance secure daily life from the extreme climatic events like lightning storm, hailstorm etc.

Family Size

The average family size of the respondents was 6.22 which indicated most of the respondents belong to large family. As most of the pineapple growers come from a large family

background, it become a blessing for them which was also represented through the significant positive relationship between family size and perceived impact of climate change of the respondents. Because growing and harvesting pineapples is a labor-intensive process as pineapples can take anywhere between 12 and 14 months to grow and mature completely. So, all the family members can contribute from growing to the harvesting of the crops and save the labor cost for pineapple production.

Area under Pineapple Production

Following the categorization of DAE (1999), the respondents were classified into four categories namely marginal (up to 0.20 ha), small (0.201-1.0 ha), medium (1.01-3 ha) and Large (above 3.0). It was found that the medium farm holder constitutes the highest position having average farm size of 1.11 ha. Although Table 6. indicated that farm size of pineapple was not an important factor in terms of correlation coefficient between the selected characteristics of the respondents and their perceived climate change impact as most of the farmers are using unused land for their farming, they are not only improving their livelihood and national economy but also contributing several environmental health benefits by creating more green spaces as well as resisting with the adverse climatic condition.

Annual Family Income

Annual family income of the respondents was measured by their yearly income from the services, agricultural farming, and other sources. It was expressed in TK. with a mean of 3.00 and standard deviation of 2.05 which showed that most of the

farmer's family belongs to medium level of income. Table 6 concluded that annual family income had non-significant negative relationship with their perceived effect of climate change. Because of every year the production of pineapple is increasing, the farmers will get more benefit if any cold storage and food processing facilities will be installed in that region as ripe pineapples can be stored at room temperature for about only three days.

Type of Land Ownership

The respondents were classified into three types based on land holding as owned land area (0), area of land received on lease (1) and area of land taken from others on barga (2). The land holding of the respondents ranged from 0-3 with the mean and standard deviation of 0.98 and 1.27 respectively and the owned land area category of pineapple farmers of Sreemangal Upazila comprised of the highest proportion with 52 percent. According to Table 6, land holding had non-significant positive relationship with the farmers perceived impact of climate change. Majority of the farmers are cultivating in their own land, so they don't need to pay lease to Government or other owners and can spend their profit for the betterment of their way of living and farm.

Housing Condition

The housing condition of the respondents were ranged from 0-2 with the mean of 0.50 and standard deviation of 0.54. Considering the housing condition, the farmers were classified into three types of namely kutcha (0), semi-pucca (1) and pucca (2). The kutcha housing condition constitute the highest position with 52 percent respondent followed by the semi-pucca of 46 percent which is quite normal as per the village condition of Bangladesh.

Extension Contact

Respondents were classified into three categories namely low extension media contact (up to 7.87), medium extension media contact (7.88-21.41) and high extension media contact (21.41) with the mean and standard deviation of 14.64 and 6.77 respectively. It was found that medium extension media contact category of pineapple farmers comprised of the highest proportion and as well as it had non-significant positive relationship with the farmers perception of climate change. If the extension media like contact with Agricultural Extension Officer, arrangement of different training regarding pineapple production and adverse impact of climate change, distribution of agricultural books, magazines, posters, leaflets etc. increased, the pineapple growers will get more useful and effective information from it.

Knowledge

Knowledge of the pineapple growers ranged from 21 to 40 against the possible range 0-40. The mean and standard

deviation of agricultural knowledge score was 34.26 and 5.17 respectively. On the basis of knowledge score, the respondents were classified into three categories namely low (up to 29.09), medium (29.1-39.43) and high (above 39.43). The medium knowledge category of pineapple farmers comprised of the highest proportion with 80 percent and the lowest portion was made by high knowledge category of 4 percent. Table 6, stated that knowledge is an essential factor in terms of facing the challenges of critical climatic effects. Knowledge is one of the key elements for the farmers to realize and deal with the consequence of changing climate and inspire them to change their perception and mindset towards adaptation.

Attitude

The pineapple growers were classified into three categories namely unfavorable attitude (up to 29.26), neutral attitude (29.27-40.10) and favorable attitude (above 40.10) where score of attitudes was obtained for 10 statements which ranged from 10-50. Table 5, and 6, indicated that neutral attitude constitutes the highest position with a mean of 34.68 and besides that attitude of the farmers had very significant positive relation with their perceived impact of climate change. Such finding reveals that most of the farmers are quite interested in pineapple production as they are getting high benefit from it.

CONCLUSION

Climate change plays a very significant role in the production of plantation crops including pineapple. The aim of this study was to assess the perception of pineapple growers about the effects of climate change on pineapple production in Sreemangal Upazila of Moulvibazar District in Bangladesh. The findings indicated that the intensity of climatic parameters, such as temperature, rainfall patterns, sunlight, and storm, have increased over the periods. Conversely, a few climatic parameters, such as drought conditions and wind speed, have shown decline in trends. The study revealed that farmers identified almost all the changes in climatic parameters acted as favorable conditions for the growth and production of pineapples except for drought conditions and storm. Pineapple growers perceived the negative effects of climate change as negligible because they have been gaining high profit with the increased production of pineapples.

This study has several policy implications. Policy makers can utilize the positive effects of climate change on pineapple production in the hilly area like Moulvibazar District and prioritize this district to secure national demand and profit opportunity of pineapple production. Moreover, the government and non-government organizations should come forward to establish food processing facilities as the production is growing faster and there is a huge scope of

making benefits by both parties- the entrepreneurs and the growers. Extension Service Agencies may provide various need-based services as noted in Kamruzzaman et al (2020) to pineapple growers for reducing the negative effects of drought conditions and storm on pineapple production. This research has some limitations, which can be addressed in the future research. An important research avenue would be to conduct the same research with many respondents and a wider geographical area to achieve research findings with more validity and reliability.

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