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Assessment of cropping region against yield factor with reference to temperature and rainfall variability

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Abstract

The product that individuals develop for sustenance and business need particular climatic conditions to show better execution in perspective of monetary yield. A changing climate could have both gainful and hurtful consequences for crops. Remembering the above perspective, this study is embraced to explore the effects of environmental change (viz. changes in average temperature, precipitation, potential evapotranspiration) on the yield and cropping area of two noteworthy monetary products (viz. tea and pineapple) in Islampur and Chopra block, Uttar Dinajpur, West Bengal. Heteroskedasticity and Autocorrelation Cons istent standard error (HAC) and Feasible Generalized the Least Squares (FGLS) strategies were utilized to decide the climate-crop interrelations utilizing local level time series data for the period of 2005-2015. Findings uncovered that the impacts of all the climatic variables have had critical observations to the yield and cropping region of real sustenance crops with distinct variety among them.

Keywords: *Climate change; yield and cropping area; economic crops; food security; sustainable agricultural development.*

1 Introduction:

In Bengal, history of little tea developing began from the North-Bengal territory, changing customary pineapple fields into tea because of an absence of preparing units, icy stockpiling an issue of interest and market. Most of the pineapple cultivators of north-bengal exploited this circumstance and changed over their territory from pineapple to tea manors (Hannan, 2013). Some paper tries to assess the withdrawal of rainstorm in the farming area is a much more progressive procedure than it onset (Biswas Roy et.al., 2015). Money related item has been constantly defenseless to unfavorable climatic conditions and atmosphere occasions. Notwithstanding innovative advancement, (for example, enhanced harvest assortments, and irrigation possibilities), climate and atmosphere are still key determinants of agrarian profitability and supportability. Development of this item

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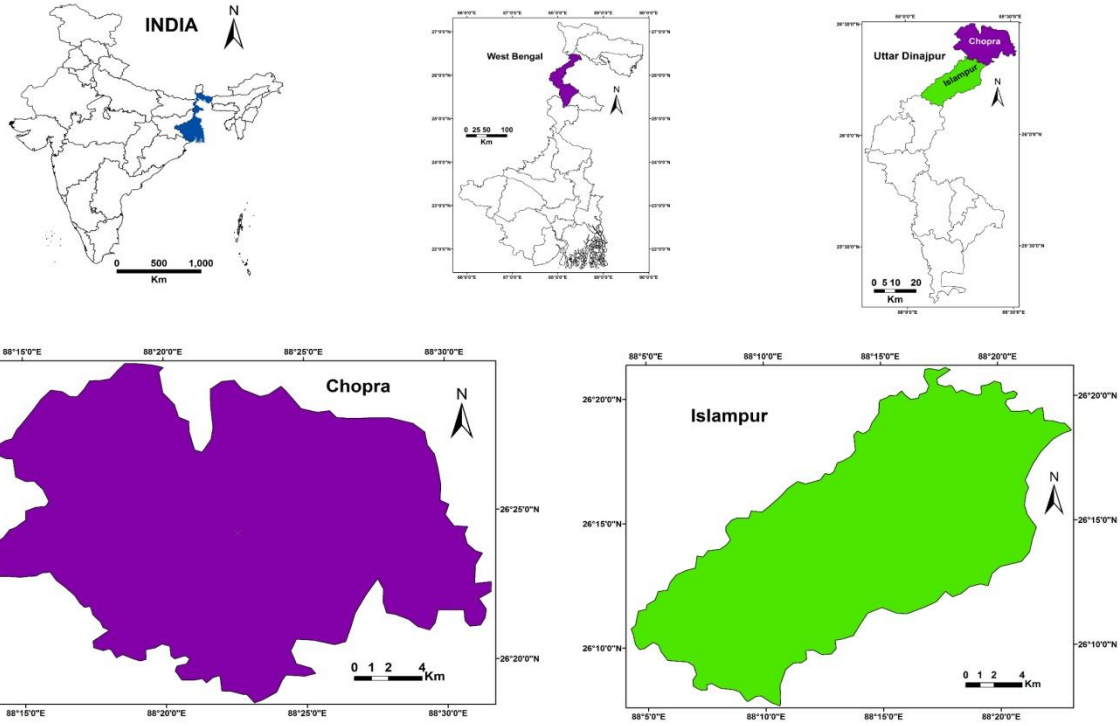
in Uttar Dinajpur area in West Bengal has been as of now underweight, both from immense and expanding requests for sustenance and from deterrents identified with the debasement of agrarian land and water enrichment. Sometimes the connection between these key variables and generation misfortunes are self-evident, yet frequently the relations are less immediate (Roy, 2014). The main reason behind the selection of these two crops is the profitable nature towards local populace. Subsequently, the main objective of this study is to analyze the effect of precipitation and temperature variability and yield and in addition, trimming range of major fiscal products in Uttar Dinajpur area, extraordinarily Islampur, and Chopra block, using local level time series data over the span from 2005-2015.

2 Study area:

Islampur is a region and home office of Islampur subdivision in Uttar Dinajpur District of West Bengal. Chopra, a Community Development (CD) Block of Uttar Dinajpur District bears sound verifiable foundation. The Block has a place with a standout amongst the most in reverse regions of West Bengal, which has at first experienced fast thrive of pineapple ranch. The Small tea gardens of Islampur block are mainly located in Satvita, Beejbari, Kathuvita, Baroghoria, Bochavita, Godoktola, Tikapara, Baragachia, Rabivita and Derkamri etc villages of Panditpota-II Gram Panchayet. The pineapple farm of Chopra block mainly located in Kalagachh, Charghoria, Kachakali, Kunjamore and Bhirubasti villages of the Kalagachh gram panchayat (Fig.1)



3 Methodology:

Local level yield data of tea and pineapple in the time traverse 2005-2015 were gathered from different renditions of the yearbook of horticultural measurements and region insightful arranging book of West Bengal. Yield information was found as the monetary year premise, for example, 2004-2005, 2005-2006 and so on. At that point, these financial year information were changed over to yearly information, for instance, 2004-2005 was considered as 2005. Total level month to month information on climatic parameters was obtained from the IMD, Kolkata for the same era. This year-wise month to month information were then changed to regular information as per the developing time of this item. For the most part, the life traverse normal has been mulled over for all the climatic parameters aside from precipitation. The creation time frame, the aggregate has been figured for precipitation. Accordingly, the study got to the meaningful part that, with a specific end goal to make a consistency between climatic variables and yield (and additionally trimming territory) information, 2004's climatic information was utilized against 2005's yield and cropping zone especially for tea and pineapple. The gathered information is broken down by taking

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the assistance of Heteroskedasticity and Autocorrelation Consistent standard blunder (HAC) and Feasible Generalized Least Squares (FGLS) to know the climate crop interrelation.

3.1 Descriptive Statistics

The elucidating insights were exhibited in Table 1, which portrays the fundamental properties of the considerable number of variables under study. In perspective of normal (mean) cropping region and production, tea positioned higher position than pineapple. On account of climatic variables, the most astounding greatest and least temperature were seen in the pineapple developing season. On account of precipitation, pineapple gets higher precipitation than tea. In the perspective of moistness, the most astounding rate of stickiness was distinguished in the pineapple season, however, the most noteworthy daylight was seen in the tea developing season.
Table 1: Descriptive statistics (2005-2015)

Variables	Monetary Crops	Statistics					
		Mean	Std.deviation	Min.	Max.	Skewness	Kurtosis
Cropping area ('000 ha)	Tea	147.9	180.01	0.3	283.4	-0.52	0.09
	Pineapple	3.8	4.2	2	8.41	-1.36	0.67
Production ('000 ton)	Tea	78.5	82.5	45.3	117.4	-0.12	0.77
	Pineapple	52.8	54.6	31.3	73.2	-0.69	1.02
Yield (kg/hec)	Tea	1907	191.1	165.6	204.2	-0.08	5.81
	Pineapple	108.7	118.5	43.2	157.9	-1.09	0.45
Max temp	Tea	34.2	34.2	35.4	32	0.11	14.11
	Pineapple	37.2	37.3	35.8	38.8	0.26	13.84
Min temp	Tea	18.6	18.7	20.2	17.1	1.05	7.13
	Pineapple	22.6	22.6	24.4	18	0.62	5.6
Rainfall mm/year	Tea	128.2	129.3	159	114.12	0.46	2.73
	Pineapple	232.5	234.3	279.41	188.1	0.3	2.83
Humidity %	Tea	65.49	2.56	62.82	68.71	-0.15	1.32
	Pineapple	74.36	1.83	81.56	68.32	-0.35	2.43
Sunshine (hrs/day)	Tea	7.83	0.63	6.81	9.23	0.69	2.86
	Pineapple	5.44	0.37	4.65	6.37	0.42	3.03

3.2 Examination of quantitative straight pattern in climatic variables

It is clearly genuine that the above elucidating measurements couldn't reflect the environmental change and variability in climatic parameters. In this manner, a further check was done to watch accurate patterns in climatic variables by evaluating a direct pattern model with time (t) as a logical component over the entire time frame. Both t-qualities and p-values uncovered that the greater part of the climate variables indicated detectable noteworthiness of patterns. In any case, experimental discoveries showed that greatest temperature, least temperature, precipitation (especially in the pineapple developing season) and stickiness seemed to demonstrate an upward (expanding) pattern over the whole time frame, 2005-2015. Conversely, daylight showed a descending (diminishing) pattern for money related product developing periods.

3.3 Trend graph

In addition to inspecting expressive insights and examining straight pattern amongst time and climatic variables, charts were additionally developed with time (t) as a logical variant to watch the fabulous impression about the varieties and changes in the pattern (upward or descending) among the five climatic variables over the entire time frame (2005-2015). The most extreme temperature varied incredibly, yet the general pattern was seen to increment for every one of the seasons (Figure 2). Fewer varieties were seen in the least temperature; notwithstanding, the pattern still seemed, by all accounts, to be expanding (Figure 3). Precipitation in the tea and pineapple rice developing seasons indicated upward patterns with particular and most prominent changes (Figure 4). Stickiness additionally showed an expanding pattern with minor deviations (Figure 5). Strikingly, daylight showed a diminishing (descending) pattern for every one of the seasons with more noteworthy vacillations (Figure 6). Be that as it may, the examination was done to affirm whether these climatic patterns and changes influenced crop yield in the latter area.

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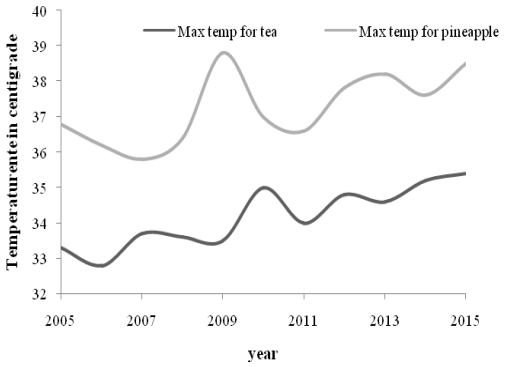


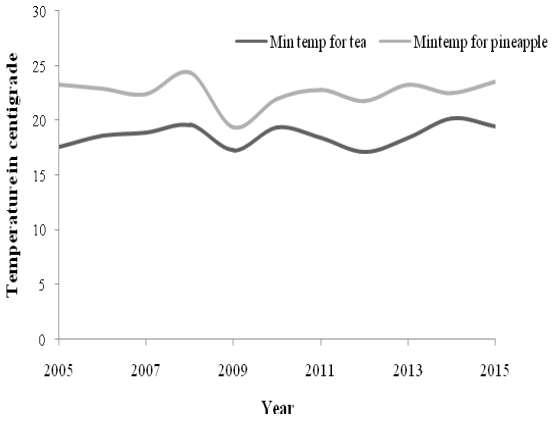
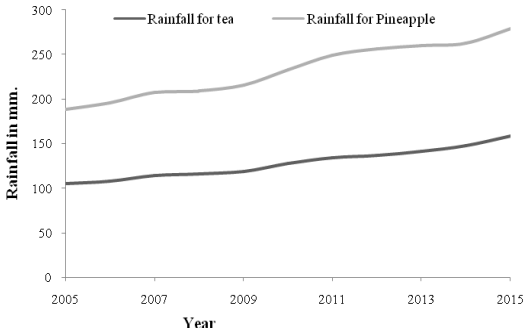
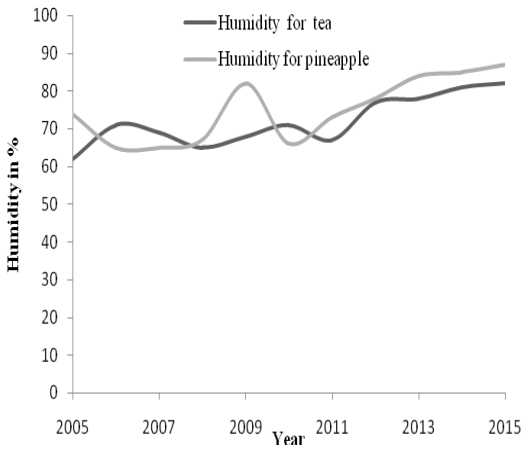


Fig 2 & 3: Trends and Variation in Maximum and Minimum Temperature on Tea and Pine apple





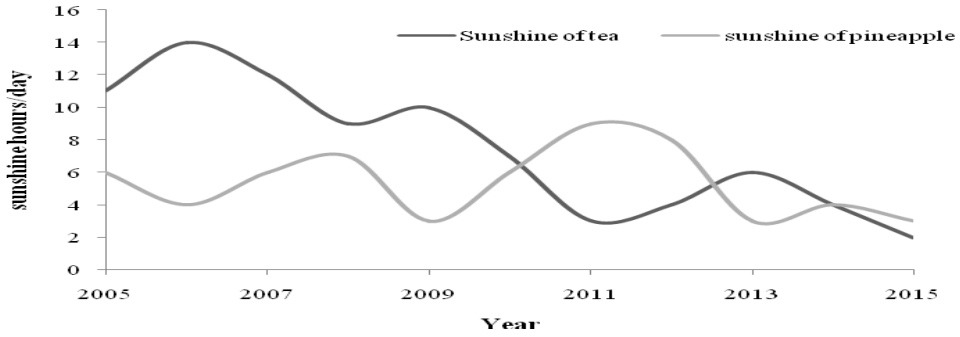


Fig 4,5 & 6:

Trends and Variation in Rainfall, Humidity and Sunshine on Tea and Pine Apple

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3.4 Stationarity and unit root

As the information arrangement of this present study contained more than 10 years of perceptions, this has implemented confirming for stationary before executing the relapse. For deciding the stationary of a period arrangement, an extremely mainstream formal technique is the Augmented Dickey-Fuller (ADF) test. Thusly, the Augmented Dickey–Fuller (ADF) test was performed for all the time arrangement to check the nearness of unit roots and the yield was exhibited in Table 2. In the perspective of ward variables, the exact results uncovered that tea has coordinated of request I(0), in this way, this arrangement was stationary in their level structure. In any case, pineapple yield has coordinated of request I (1), that showed non-stationary of these two information sets.

Table 2: Augmented Dickey-Fuller (ADF) test for checking the stationarity of the data series,

Variables	Integration of order for tea	Integration of order for pineapple
Yield	I (0)	I (1)
Maxt	I (0)	I (0)
Mint	I (0)	I (0)
Rainfall	I (0)	I (0)
Humidity	I (0)	I (0)
Sunshine	I (0)	I (0)

3.5 Exact model particulars

The reliant variable of this study was yield and editing range of tea and pineapple and the free variables included five-atmosphere variables (maximum temperature, least temperature, precipitation, dampness, and daylight). The real distinction was that the developing season is diverse by harvest, which is the most valuable time for deciding the effects of environmental change in the yield and the editing territory of products. Numerous direct relapse demonstrating was the manual for deciding nexus between atmosphere variables and product yield and as well as cropping area (harvested area) of various, harvests under the study. In light of the properties of ward variables and intrinsic autocorrelation that existed among the autonomous variables, the Heteroskedasticity and Autocorrelation (HAC) reliable standard mistake and Feasible Generalized Least Square (FGLS) were the most appropriate technique contrasted with Ordinary Least Square (OLS) strategy. As needs are, the accompanying configuration for relapse demonstrating was utilized for tea and pineapple.

$$Y_{it}/CA_{it} = \alpha_{i0} + \alpha_{i1}Maxt_{it} + \alpha_{i2}Mint_{it} + \alpha_{i3}Rainfall_{it} + \alpha_{i4}Humidity_{it} + \alpha_{i5}Sunshine_{it} + \alpha_{i6}Year_{it} + \varepsilon_{it}$$ **(Amin et.al., 2015)**

Where, Y = yield (kg/acre) and CA = cropping area (in thousand hectares) of respective crop, i = 1, 2, ……4; 1 means pineapple, 2 means tea, Maxt = Growing season average daily maximum temperature (°C), Mint = Growing season average daily minimum temperature (°C), Rainfall = Growing season total daily rainfall (mm), Humidity = Growing season average daily humidity (%), Sunshine = Growing season average daily sunshine (hours/day), t = time (year), ε = Error term.

4 Results and Discussion

The HAC strategy was managed to distinguish the environmental change sways on the yield and cropping area of tea and pineapple. The discoveries are exhibited in Table 4, which uncovered that climatic variables influenced the cropping area more than yield.

Table 4: The regression results of tea and pineapple,

Independent variables	Tea		Pineapple	
	Yield (t-value)	Cropping area (t-value)	Yield (t-value)	Cropping area (t-value)
Growing season average daily maximum temperature	−46.69* (−2.69)	−157.4 (−0.93)	12.33 (1.12)	-124.5 (-1.71)
Growing season average daily minimum temperature	−30.19 (−1.72)	−325.3 (−1.86)	20.17 (1.21)	124.3 (1.03)
Rainfall	−0.02 ** (−2.92)	−0.254 ** (−2.32)	-0.03 (-1.25)	0.187 *** (2.87)
Humidity	13.54 * (1.83)	112.6 (1.00)	8.86 (1.85)	-121.3 (-2.91)
Sunshine	−2.87 (−0.09)	−156.2 (−0.76)	0.02 (.000)	81.51 (0.37)
Trend	11.45 *** (10.76)	−6.874 (−0.57)	-0.56 (-1.18)	-61.81 (-11.62)
Intercept	-267.6 (-0.24)	143.2 (13.32)	-361.3 (-0.33)	153.7 (17.12)
Model R^2	0.87	0.38	0.21	0.93
Adjusted R^2	0.84	0.26	0.10	0.94

*, ** and *** represents the 10%, 5% and 1% level of significance respectively.

The yield and cropping zone are both contrarily influenced by the precipitation at the 5% hugeness level in tea. Correspondingly, both most extreme and least temperature and daylight additionally contrarily added to the yield and cropping zone of this harvest, albeit just greatest temperature demonstrated measurably noteworthy impact on the yield at the 10% level. In both the cases (yield and editing range), humidity contributed decisively with a factually noteworthy impact on yield. In any case, the balanced R^2 esteem communicated that 84% variety on yield and 26% variation in trimming zone of tea is clarified by the climatic components, which firmly legitimized the climatic impact of this product.

In both the cases, humidity indicated measurably critical impact. Shockingly, the commitment was observed to be sure to yield, yet negative for cropping zone. Correspondingly, most extreme temperature additionally showed beneficial outcome on yield and negative for trimming region, however, the impact was measured not noteworthy in both the cases. Contrasting, while precipitation irrelevantly influenced the yield, it indicated factually noteworthy and positive impact on the cropping region. At last, the least temperature and daylight communicated positive impact on the yield and cropping area of pineapple, in spite of the fact that the impacts were not critical. The balanced R2 esteem inferred that 10% of the yield variance and 94% of the variance in editing range of pineapple is impacted by the climate variability and change.

5 Conclusion

The most extreme exertion of this study was to analyze the effects of environmental change in the yield and the cropping zone of major fiscal harvests in Islampur and Chopra block of Uttar Dinajpur. The HAC and FGLS strategies were connected to fulfill the target. Results showed that the cropping range of pineapple was impacted significantly by the climatic varieties contrasted with the yield of this product. The most powerful climatic variables for tea generation in Islampur block were seen to be the greatest temperature and precipitation. The discoveries affirmed that the temperature (both greatest and least) and precipitation increments past their ideal necessity might destroy to the yield and be trimming territory of tea and pineapple. Conversely, moistness emphatically impacted the yield and cropping territory of pineapple and this is reasonable on the grounds that this product develops in sodden conditions amid the storm months. In any case, the experimental confirmation built up solid validity that, generally speaking, temperature and precipitation variability antagonistically affected yield and cropping zone of tea and pineapple.

Acknowledgements

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