Chapter 14
Climate Variability and Agricultural Modifications in Purulia and Bankura Districts of West Bengal

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14.1 Introduction

There are many variables that will shape worldwide food security as well as the farming business system in the forthcoming years. Weather and climate systems are the most crucial among them. As a result, agriculture is likely to be affected by climate change, which may pose a threat to established farming practises but also present opportunities for advancement. Climate change is viewed as a genuine danger to life, which unfavourably influences different frameworks on the planet, starting from primary activities to the psycho-social behaviour of human beings (Sivakumar et al., 2005; Mall et al., 2006; Lobell & Gourdji, 2012; Manyeruke et al., 2013; Salvo et al., 2013; Ladan, 2014; Mahato, 2014; Babar et al., 2015; Cherian & Khanna, 2018; Liu & Basso, 2020). Total population is supposed to increase roughly 10 billion by 2050 (Arora, 2019), which would enhance strain on agrarian terrains to fulfil the developing needs for food previously impacted by the environmental changes. Precipitation designs in many areas of the globe have been moved because of environmental change and fluctuation. Horticulture assumes a significant role in the general monetary and social prosperity in India. In the tropical nations, especially, the ranchers depend vigorously on normal precipitation for the creation of harvests (Aninagyei & Appiah, 2014). Indeed, even the slightest deviation from typical atmospheric conditions genuinely hinders the proficiency of food production. The variation methodology should be reinforced to reduce the effect of environment changeability. Current rural practises are viewed as unreasonable, on the

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grounds that they exploit important assets to degrade the ecological quality (Pareek et al., 2020). In a true sense, the farming action of an area is essentially constrained by the climatic state of that area, apart from the issue of irrigational water requirements, which is also a significant parameter for the growth of a great variety of crops. Water quality is also a significant issue for Indian farming. An exceptionally high pace of land debasement is brought about by environmental change, leading to desertification and supplementing soil deficiencies. Studies in regards to changes in events and the conveyance of precipitation are exceptionally essential for the appropriate administration of water assets and horticultural perspectives (Chakraborty et al., 2013). A huge portion of the world's total land area is comprised of dry terrains, where more than one billion individuals reside (Soro et al., 2016). Purulia and Bankura are the western-most districts of West Bengal, where precipitation is thought to be lacking to accomplish the ideal degree of rural efficiency. In any case, it could be brought up that the normal yearly precipitation of these two districts is in excess of 1200 mm, which is similar with different locale of the state (Goswami, 2019). The dryness of the region cannot be overlooked, where after precipitation there is high likelihood of surface run-off because of undulating nature of landscape of the area. Based on the proportion of precipitation to potential evapotranspiration (PET), it is noticed that in excess of 600 mm of precipitation after the satisfaction of the need of PET moves as overland flow during rainstorm coming about into dampness pushed soil (Bera et al., 2017; Goswami, 2019). The region is not viewed as reasonable for the development of long span assortment of rice all through the year due to presence of a quantities of restricting variables viz. dry spell inclination, limit of climate and environment, dry top soil, high surface run-off, and so on. The pre-rainy season is set apart by troublesome proportion of precipitation to PET. The precipitation in the pre-rainy months is likewise set apart by higher changeability. The intensity wave peculiarities during pre-storm additionally make a few dangers for the farming exercises in the locale. Thus, a broad examination is exceptionally important to present some modern cash crops and green items in the review region with the assistance of existing geo-climatic circumstances.

The study area gets in excess of 1300 mm of precipitation on a normal for the time span from 1976 to 2017. Much of this amount is concentrated in the four monsoon months from June to September. Because of non-appearance of any dependable wellspring of precipitation during pre-rainstorm, winter, and post-rainy seasons, the precipitation amount is small. The events of tempests and nor westers' in some cases make precipitation over the region during pre-rainy season. Be that as it may, a significant part of this water moves as surface run-off exploiting undulating territory of the area. In addition, PET is considerably higher than the precipitation amount during non-rainy seasons. However, the geo-climatic states of the locale have the possibility to help an extensive variety of customary and modern cash crops. Mishra (2008) proposed some transformation procedures in horticulture against environmental change for the 'western tract' of West Bengal and recommended taking on water preservation measures at all levels to build the water system capability of the plots. The current chapter is novel in that sense, as it has assessed the possibility of the current climatic state of the area and its ability to help a few customary and contemporary green items and cash crops apart from the

computation of water budget based on the complex relation between precipitation and PET. The present study is aimed at identifying the impact of climate variability on the agricultural prospects of two districts (Purulia and Bankura) in West Bengal based on both primary and secondary observations. The present chapter emphasizes the trend of climatic parameters, mainly temperature and rainfall, and the extremeness of climate through the computation of SPI and NDVI, and it also deals with the impact of these climatic extremes, including their trends, on the agricultural practices in the district. The study is also unique as it calculates the irrigation water requirement of some selected crops on the basis of the relation between photosynthetically active radiation (PAR) and stress degree day index (SDDI).

14.2   Materials and Methods

14.2.1   Study Area

These two districts are marked by varying climatic conditions and hydro-geological properties. The low-lying alluvial plains to the east and north-east are similar to the predominant rice lands of the southern tip of West Bengal (Fig. 14.1a). The land gradually rises to the west, becoming undulating with rocky hillocks scattered throughout. There are forests covering a lot of the districts. In the western part of the region, the soil is poor and the beds are hard lateritic, with scrub forests and sal woods. Seasonal cultivation is evident on long, broken ridges with irregular patches of more recent alluvium. The eye always rests in the eastern region on vast expanses of rice fields that are green in the rain but dry and parched in the summer. The climate is much drier in the upland areas to the west than in the eastern or southern tracts, especially. The agro-climatic conditions are ideal for horticultural and plantation crops. Though the region is marked by a dry climate and a lot of wasteland, it has the potential for plantations and horticultural activities. Both traditional and non-traditional plantations, such as mango, guava, cashew nut, jackfruit, banana, papaya, and others, can be grown on a large scale.

14.2.2   Trend Analysis of Rainfall and Temperature Using Mann-Kendall Test

As a matter of some importance, test for the pattern in yearly series is made to get a general perspective on the potential changes in information processes. To decide whether the patterns found are critical, the Mann-Kendall pattern test has been utilized. In the Mann-Kendall trend statistics, S variance is given as (Eq. 14.1);

$$S = \sum_{n-1}^{i=1} \sum_{n}^{j=i+1} sgn\left(Xj - Xi\right) \qquad (14.1)$$

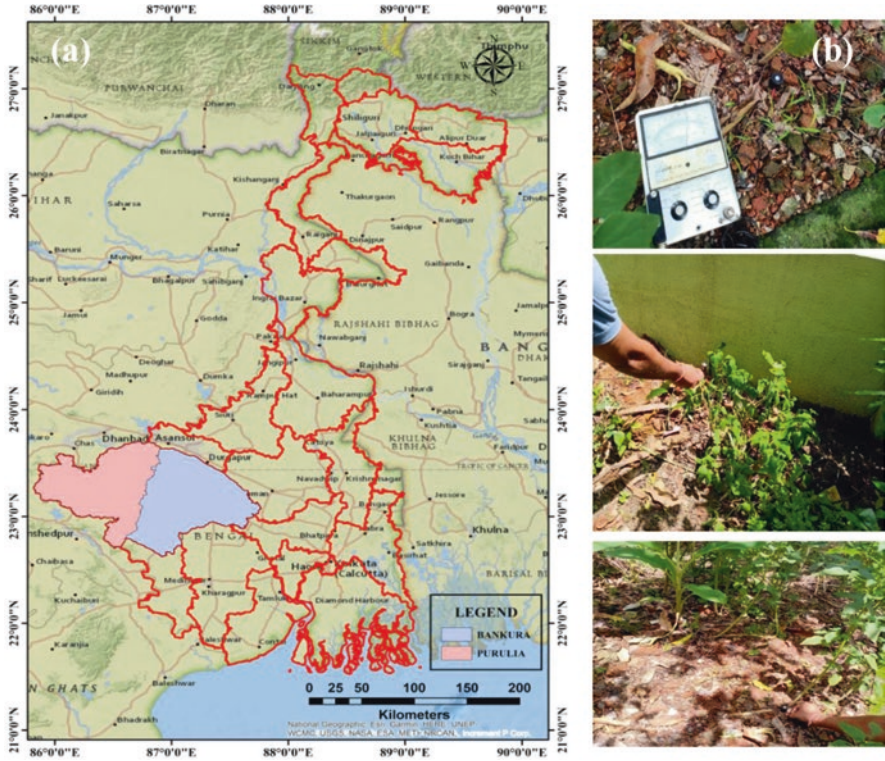**Fig. 14.1** (**a**) Location map of the study area and (**b**) measurement of top, bottom, and intercepted incident PAR (from left)

It is without appropriation and not impacted via occasional changes (Eq. 14.2). The applicability of the trend test rely heavily on the time series estimation that has been ranked from $i = 1, 2... n - 1$ and xj; furthermore, ranking has been done from $j = i + 1, 2,..., n$. The present equation employs individual data point xi as a point of reference, and it is compared with the remaining point observation xj (Eq. 14.2) so that,

$$\text{Sgn}(Xj - Xi) = +1, > (Xj - Xi).0, = (Xj - Xi). -1, < (Xj - Xi) \qquad (14.2)$$

The size of pattern was anticipated by the Sen's assessor. For direct pattern, the slant was generally assessed by figuring the least squares gauge utilizing direct relapse (Eq. 14.3).

$$\frac{n(n-1)(2n+5) - \sum\limits_{i=1}^{m} ti(i)(i-1)(2i+5)}{18} \qquad (14.3)$$

If $S > 0$: then

$$Zc = \frac{S - 1}{\sqrt{\mathrm{Var}(S)}} \qquad \text{If } S < 0: \text{ then} \qquad Zc = \frac{S + 1}{\sqrt{\mathrm{Var}(S)}}.$$

14.2.3   Standardized Precipitation Index (SPI)

The standardized precipitation index (SPI) is a somewhat new dry season record based just on precipitation. Since the SPI is standardized, wetter and drier environments can be addressed similarly, and wet periods can likewise be observed utilizing the SPI. Following formula is used to detect the SPI (Eq. 14.4):

$$\mathrm{SPI} = \left(Xi - \bar{X} \right) / \mathrm{SD} \tag{14.4}$$

where Xi = precipitation, $\bar{X}$ = mean value of precipitation and SD = Standard Deviation However, the computation of SPI has a few intricacies. For this situation, long haul precipitation record is fitted with likelihood circulation to change it into a typical dispersion to get the mean SPI for the area along with the ideal time frame zero. For the said reason, following equation is utilized (Eq. 14.5);

$$\mathrm{SPI} = \left(a - b \right) / \mathrm{SD} \tag{14.5}$$

where a = individual gamma circulation, b = mean worth, SD = Standard Deviation; In the current research, this precipitation-based list has been utilized to demonstrate the events of dry spells on fluctuates timescales (one month, 90 days, a half year, and a year).

For the said reason, precipitation information has been gathered from the site (http://archive.indiawaterportal.org/metdata) and state agricultural department, Government of West Bengal. DrinC programming has been utilized for the calculation of SPI on 3 months timescales.

14.2.4   NDVI

NDVI is determined as the proportion of the red (RED) and near infrared (NIR) groups of a sensor framework. Following formula is used to determine the NDVI (Eq. 14.6). The target of this chapter is to identify agricultural drought in the two districts with rural terrains where biomass concentration is habitually low. The districts in the review region with the most noteworthy biomass thickness mass are the forested and the flooded horticulture regions.

$$\text{NDVI} = (\text{NIR} - R) / (\text{NIR} + R) \tag{14.6}$$

14.2.5 Water Budget

In the present study, an attempt has been made to identify the water budget of the said districts on the basis of the difference between precipitation (P) and potential/ possible evapotranspiration (PET). In the first stage, it is very essential to ascertain the yearly value of the intensity list (I) in view of the month-to-month heat file (j) also, adding all the yearly heat indices data (Eq. 14.7 and 14.8).

$$j = (T_A / 5)^{1.51} \tag{14.7}$$

$$I = j1 + j2 + \ldots + j12 \tag{14.8}$$

T_A is the monthly average value of temperature. In the second stage with $a = 67.5 \times 10\text{-}8\text{I } 3 - 77.1 \times 10\text{-}6\text{I } 2 + 0.0179\text{I} + 0.492$, unadjusted PE' value (mm) is computed utilizing the accompanying condition (Eq. 14.9).

$$\text{PET} = 16(10.T_A / I)^a \tag{14.9}$$

In the third stage, assuming the sunlight span information is known, the accompanying condition can be utilized to compute the changed PET (Eq. 14.10).

$$\text{PET} = PE'(d / 12)(N_d / 30) \tag{14.10}$$

where N_d is the quantity of days in a month and d is sunlight duration (in hour).

14.2.6 Stress Degree Day Index (SDDI), Photosynthetically Active Radiation (PAR), and Irrigation Water Requirement (IWR)

Covering temperature was estimated at 10.00 hours with the assistance of infrared tele-thermometer (AG-42Telatemp infra-red thermometer, Australia). Stress degree day index (SDDI) has been determined with the accompanying equation (Eq. 14.11):

$$\text{SDDI} = T_C - T_A \tag{14.11}$$

where T_C and T_A represent canopy and air temperatures, respectively. Three extensively produced crops in particular tomatoes, green beans, and small vegetables have been chosen from the said districts of West Bengal to recognize the variety in radiation circulation among the three yields in the pre-monsoon and monsoon seasons, 2019 to 2022 (Fig.14.1b). The relation between PAR and SDDI has been utilized for the detection of irrigation water requirement. For the calculation of irrigation water requirement (IWR), CROPWAT 8.0 model has been utilized, which is a choice help program in view of a few numerical conditions. This model was created and customized by FAO for the computation of reference evapotranspiration (ET0), irrigation water requirement (IWR), and water system utilization employs the information of soil, environment, and yield. Assessment of harvest water necessity (crop water requirement (CWR)) is another more capability of this model. Crop water necessity is acquired from crop evapotranspiration (ETC), and it is determined by the accompanying equation (Eq. 14.12)

$$KTC = KC \times ET0 \tag{14.12}$$

where ETC = Crop evapotranspiration; KC = Crop co-productive and ET0 = Reference evapotranspiration. IWR can be designated as the distinction between successful precipitation (mm) and harvest water prerequisite (mm).

14.2.7 Cobb Douglas Production Function

For concentrating on the information yield relationship of developing various harvests, Cobb-Douglas creation capability has been fitted by utilizing the given underneath (Eq. 14.13).

$$\log Y = \log a + b1 \log XL + b2 \log Xc \tag{14.13}$$

where Y = yield, XL = temperature, Xc = rainfall, $b1$ and $b2$ = elasticity coefficients, a = constant term. In this theory, it is investigated the capability application in development plan crashing and project risk examination connected with span of development projects.

14.3 Results and Discussion

14.3.1 Trend Analysis of Rainfall and Temperature

Obviously, all seven agro-meteorological stations show declining patterns of precipitation for the long periods of February and March; however, the processed R2 values shift over time from one month to another and from one station to the next.

Table 14.1 Non-parametric trend statistics of rainfall for the Purulia and Bankura districts of West Bengal

Stations	Statistics and significance	Months											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Hatwara	Trend statistics	−0.077	−0.222*	−0.074	−0.137	0.213*	−0.120	0.006	−0.022	0.001	0.044	−0.187	−0.123
	Significance	0.484	0.042	0.493	0.204	0.047	0.264	0.957	0.837	0.991	0.680	0.101	0.285
	R^2	0.0033	0.06	0.026	0.029	0.1446	0.022	0.028	1E-05	0.0028	0.013	0.033	0.026
Santuri	Trend statistics	0.068	−0.207	−0.001	0.083	0.215*	−0.071	0.173	0.006	0.171	0.169	−0.179	−0.037
	Significance	0.541	0.057	0.991	0.441	0.045	0.509	0.106	0.957	0.111	0.116	0.110	0.748
	R^2	0.002	0.0181	0.0239	0.0223	0.0471	0.0346	0.0279	0.01	0.0112	0.0084	0.0095	0.021
Jhalda	Trend statistics	−0.078	−0.220*	−0.085	−0.048	0.072	−0.069	0.148	0.084	0.131	0.015	−0.058	−0.210
	Significance	0.490	0.045	0.433	0.656	0.502	0.523	0.169	0.435	0.221	0.888	0.608	0.071
	R^2	0.0131	0.0114	0.0395	0.0273	0.0843	0.0164	0.0375	0.0592	0.0005	0.0684	0.019	0.0251
Barabazar	Trend statistics	−0.077	−0.053	−0.105	−0.108	0.171	−0.034	0.069	0.062	0.027	−0.017	−0.172	−0.173
	Significance	0.501	0.633	0.338	0.322	0.111	0.753	0.523	0.566	0.803	0.871	0.132	0.142
	R^2	7E-05	0.0203	0.0202	0.019	0.0354	0.0285	0.0195	0.0105	0.0007	0.008	0.0189	0.0239
Joypur	Trend statistics	−0.271*	−0.205	−0.180	−0.26*	0.057	−0.187	0.016	−0.166	0.146	0.051	−0.267*	−0.137
	Significance	0.017	0.064	0.099	0.019	0.595	0.081	0.879	0.121	0.178	0.633	0.020	0.254
	R^2	0.023	0.117	0.0078	0.0097	0.77	0.0057	0.666	0.0014	0.015	0.069	0.0032	0.022
Taldangra	Trend statistics	−0.086	−0.092	−0.028	−0.172	0.163	0.082	0.110	0.175	0.066	0.176	−0.104	−0.13
	Significance	0.452	0.411	0.794	0.113	0.129	0.442	0.303	0.102	0.537	0.102	0.359	0.264
	R^2	0.0022	0.0524	0.018	0.0062	0.034	0.0006	0.035	0.0133	0.0167	0.0049	0.0001	0.0838
Barjora	Trend statistics	−0.092	−0.118	−0.097	−0.093	0.137	−0.15	0.073	0.002	0.022	0.051	−0.135	−0.15
	Significance	0.415	0.285	0.390	0.390	0.201	0.169	0.495	0.983	0.837	0.633	0.228	0.203
	R^2	0.402	0.055	0.1006	0.0615	0.0034	0.0542	0.0145	0.0278	0.0045	0.0033	0.0301	0.0188

** Significant at 1% level, *Significant at 5% level

The figured R2 values for the long stretch of February are viewed as 0.06, 0.117, 0.0524, 0.0181, 0.055, 0.0114, and 0.0203 for the stations Hatwara, Santuri, Jhalda, Barabazar, Joypur, Taldangra, and Barjora separately (Table 14.1). For the three stations, specifically Hatwara, Joypur, and Taldangra, the pattern of precipitation in the long stretch of January is viewed as expanding with the registered R2 upsides of 0.0033, 0.023, and 0.0022, respectively. In spite of the fact that the majority of the stations show declining patterns of precipitation in the pre-rainy season of March and April, the precipitation pattern in the period of May is viewed as expanding, with the computed R2 values of 0.14, 0.77, 0.034, 0.0471, 0.0034, 0.0843, and 0.0354 for the stations Hatwara, Joypur, Taldangra, Santuri, Barjora, Jhalda, and Barabazar, separately. Chosen stations show rising patterns of precipitation in the month of July. The figured R2 values for the month of July fluctuate from 0.666 for the station Joypur to 0.0145 for the station Barjora (Table 14.1). The depressions and deep depressions subsequent to those originating from the Bay of Bengal move towards the western part of the state (West Bengal) and stay fixed over Chhota Nagpur level to cause heavy precipitation over the eastern edge of the plateau. A greater part of the stations shows declining patterns of precipitation in the rainy month of June (however, this is not critical). The station Para shows a declining pattern of precipitation in the post-rainy month of November, which is critical at a 5% level (Table 14.1).

The studied stations show expanding patterns of most extreme temperatures from 1979 to 2014 with the registered R2 upsides of 0.0196, 0.0155, 0.0182, and 0.0222 for the stations Barabazar, Joypur, Taldangra, and Barjora, respectively. The stations show expanding patterns of maximum temperatures for the period of March and April with the differing rates. For the stations Barabazar, Joypur, Taldangra, and Barjora, the most extreme temperatures in the period of March increment at the paces of 0.0315 °C/year, 0.0335 °C/year, 0.0316 °C/year, and 0.0282 °C/year, respectively (Table 14.2). Another pre-rainy month, May, shows declining patterns of the most extreme temperatures for every station in the stretch of time from 1979 to 2014 (Table 14.2).

Table 14.2 Slope of maximum temperature during pre-monsoon season

| Stations	March	April	May
Barabazar	0.031545689	0.026258687	−0.011936937
	Slight increase	Slight increase	Slight decrease
Joypur	0.033509653	0.025402831	−0.020682111
	Slight increase	Slight increase	Slight decrease
Taldangra	0.031619048	0.027351351	−0.014646075
	Slight increase	Slight increase	Slight decrease
Barjora	0.028213642	0.030480051	−0.012302445
	Slight increase	Slight increase	Slight decrease
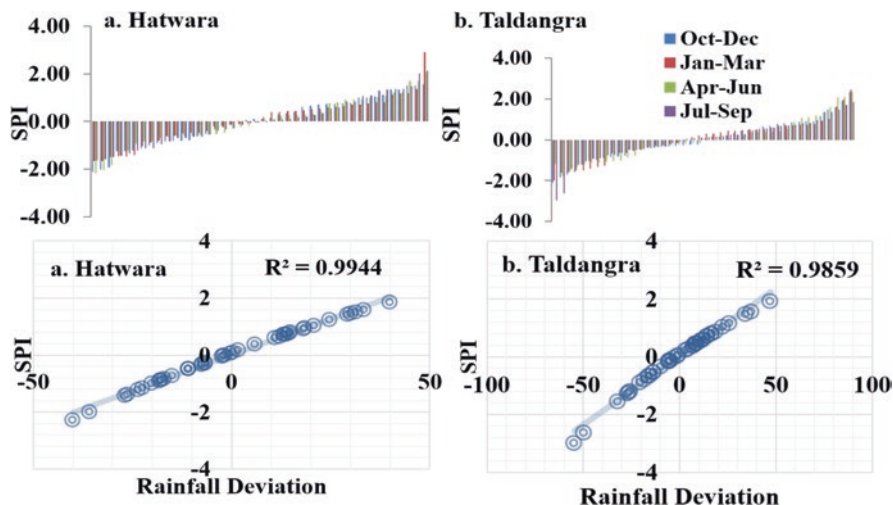
Fig. 14.2 Correlation between rainfall deviation and SPI

14.3.2   SPI

The station Hatwara has encountered a less number of dry spell occasions during the winter, pre-rainy, and post-rainy seasons (Fig. 14.2). The absolute quantities of dry spell occasions are viewed as 9, 13, and 24 during post-monsoon, pre-monsoon, and monsoon, separately. The station has revealed very wet circumstances in the years 1979, 1987, 1991, 1998, 2007, 2013, 2015, 2016, and 2017 with SPI values of 2.0 or more. The station Taldangra likewise encounters occasional varieties in dry and wet circumstances (Fig. 14.2). For this station, the winter, pre-monsoon, and post-monsoon seasons have encountered fewer dry spell occasions when contrasted with the monsoon season.

The complete quantities of dry spell occasions are identified as 25, 21, and 6 during the monsoon, pre-rainy, and post-rainy seasons, respectively. Also, extremely high negative deviations of precipitation address SPI values varying between −1.50 and −1.99. Positive precipitation deviations are related to the positive SPI values demonstrating the absence of a dry spell. Extremely high sure deviations of precipitation are found to be related to the SPI values going somewhere in the range of 1.50 and 1.99. The extremely high precipitation occasions coincide with SPI upsides of +2.0 or more. Be that as it may, for the station Hatwara, negative deviations of precipitation range between −39.9% in 1979 and −0.5% in 1994 (Fig. 14.3).
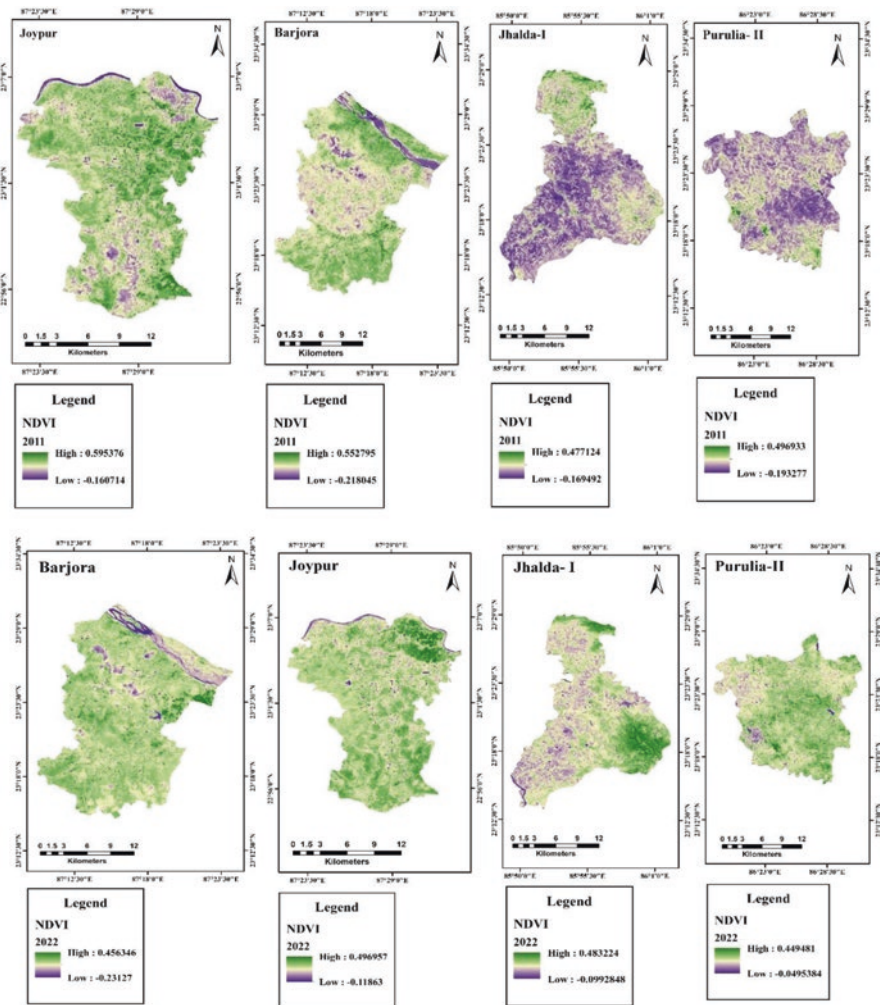
Fig. 14.3 NDVI maps of some selected CD blocks of Purulia and Bankura in 2011 and 2022

14.3.3 NDVI

The computed NDVI maps can truly explain the moisture status of the vegetation for the pre-monsoon month of May. The maps computed for some selected CD blocks in the Purulia and Bankura districts of West Bengal indicate a better moisture status in the vegetation (Fig. 14.3). The moisture potentialities within the vegetation are found to be declining in the year 2022, as indicated by the declining NDVI values (Fig. 14.3). The declining NDVI values can be interpreted as a result of the downward movement of the rainfall values.

Table 14.3 Difference between P (mm) and PET (mm)

Stations	December	January	February	March	April	May	June	July	August	September	October	November
Taldangra	-23.5926	-18.5471	-42.8849	-118.485	-255.925	-352.318	-126.613	68.084	72.85943	60.94829	-45.4209	-54.9129
Barjora	-21.5311	-17.576	-43.6694	-140.384	-291.936	-366.805	-155.701	61.656	87.012	52.72171	-24.3954	-55.9243
Hatwara	-21.0871	-16.664	-41.0931	-123.521	-253.077	-316.81	-109.344	76.37943	88.18971	78.82286	-26.1126	-49.8986
Jhalda	-22.4454	-16.1766	-40.9811	-118.099	-252.481	-309.613	-92.6671	95.29057	126.0957	83.70057	-22.9997	-42.4711

The typical month-to-month PET for the station Hatwara fluctuates from at least 28.6 mm in the period of January to a limit of 396.36 mm in the long stretch of May. The typical month to month PET qualities are viewed as 343.29 mm, 219.64 mm, 182.4 mm, and 157.91 mm for the long stretches of June, July, August, and September (rainy months), respectively. However, because the region as well as the stations gets higher measures of precipitation during storms and the sky is practically loaded with clouds, a lot of PET is not yet recognised during this season. The higher measure of insolation combined with the small cloud sum is responsible for the higher PET qualities during the pre-rainstorm. The month-wise contrasts of precipitation (P) and PET qualities for the station Hatwara show that during the non-rainy months, the PET qualities are viewed as higher than the P values (Table 14.3). Indeed, even in the rainy month of June, the precipitation amount is found to be less than the PET amount (P < PET = 109.34 mm). Dew is considered as a solid wellspring of dampness during the winter. Accordingly, the contrast between precipitation and PET during the winter is viewed as lower contrasted with the pre-rainy and rainy months. Assuming precipitation as water pay and PET as water loss, it is seen that 243.39 mm of precipitation moves as surface pursue off fulfilling the need for PET during the monsoon. In the event that a significant part of this sum (243.39 mm) is captured, the issue of water shortage can be settled to an impressive degree. However, for the station in general, the aggregate sum of PET is viewed as higher than the aggregate sum of precipitation (P < PET = 714.214 mm) (Table 14.3).

14.3.4 SDDI and PAR

During the monsoon period, the typical TA is viewed as higher than the typical TC because of slanted radiation demonstrating ample dampness in the plants; however, this present circumstance (TA > TC) is brief (Table 14.4). The dampness balance proportion of green beans changes totally in the pre-rainstorm period in contrast with the monsoon. Because of the continuous rain, the yields are sufficiently dampened during rainstorms. However, the inconsistent precipitation during the pre-rainstorm makes dampness stress inside the harvests more explicit.

The connection between various sorts of PARs and SDDI of the three harvests and their degree of importance have been worked out and introduced in tables (Table 14.4), which show areas of strength for a connection among SDDI and top occurrence PAR during summer with the computed R2 value of 0.770. The connection between these two is additionally observed to be huge at the 1% level. Additionally, during the monsoon, the connection between top occurrence PAR and

Table 14.4 Significance of correlation between PARs and SDDI for the three crops during pre-monsoon and monsoon

Season	PARs	R^2 value	t-value	p-value	Seasons	Tomatoes	Small vegetables	Green beans
Pre-monsoon	Top	0.77	4.844582	0.001868**	Pre-monsoon	0.421	0.253	0.457
	Bottom	0.455	2.416667	0.046318*		0.247	0.246	0.698
	Transmitted	0.4	2.162301	0.067379		0.302	0.359	0.584
	Intercepted	0.275	1.627981	0.147554		0.278	0.822	0.258
Monsoon	Top	0.647	4.281876	0.001607**	Monsoon	0.377	0.345	0.368
	Bottom	0.379	2.472256	0.032977*		0.356	0.678	0.47
	Transmitted	0.252	−1.83365	0.096597		0.453	0.577	0.680
	Intercepted	0.507	−3.20924	0.009344**		0.257	0.675	0.175

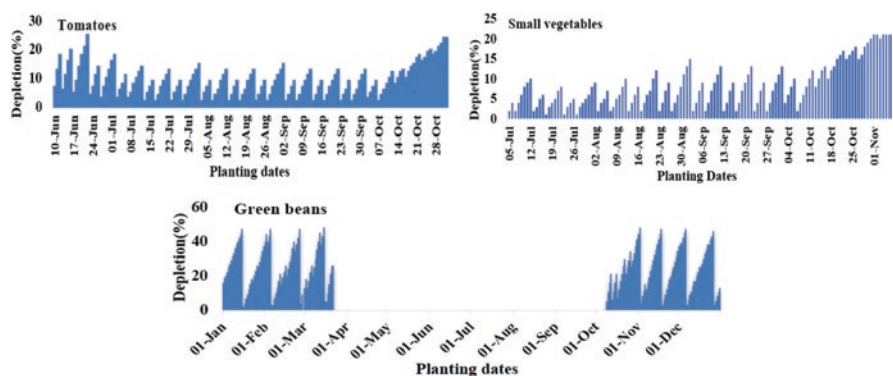** Significant at 1% level; * Significant at 5% level

Fig. 14.4 Irrigation water requirement for some selected crops

SDDI is distinguished by areas of strength with the computed R2 and p upsides of 0.647 and 0.002 (p < 0.01), respectively. During the pre-monsoon stage, the changeability of radiation is viewed as a lot higher. Because of stable precipitation in the upper east, the base occurrence of PAR is fundamentally connected to the SDDI values (critical at the 5% level). The occurrence of a considerable amount of rainfall is responsible for the lower water demand during the monsoon, most particularly for the green beans (Fig. 14.4). However, for the other two crops, the water needed during the monsoon can be fulfilled by the heavy downpour during the season. During the non-rainy season, the dew deposited on the ground also acts as a reliable source of moisture.

14.3.5   Cobb-Douglas Production Estimation

To analyse the effect of various information assets (especially temperature and rainfall) on gross and net returns, the upsides of R2 are determined for each ranch size. For maize, the assessed coefficient of normal temperature (0.342) is viewed as

Table 14.5 Cobb-Douglas production estimation of different crops

Crops		Temperature (°C)	Rainfall (mm)
Maize	R square	1.000	
	Coefficients	0.342	2.685
	t Stat	13.109*	2.375
Aman paddy	R square	0.634	
	Coefficients	2.004	-1.254
	t Stat	1.070	-0.224
Potato	R square	1.000	
	Coefficients	-0.020	2.098
	t Stat	-0.546	82.376**
Cotton	R square	1.000	
	Coefficients	2.988	-0.303
	t Stat	60.019*	-0.247
Soybean	R square	0.989	
	Coefficients	-0.373	13.936
	t Stat	-3.628	9.267
Rose	R square	1.000	
	Coefficients	0.010	0.052
	t Stat	25.053*	6.173

Significant at **1% level and *5% level

certain and critical at the 5% level. The assessed coefficient of rainfall for potatoes is viewed as 2.098, and this worth is exceptionally huge at the 1% level. For maize and potatoes, almost 100 percent of the variety result can be explained by the relapse condition.

Cotton is considered a cash crop, and the review region is viewed as having potential for its growth. For the cotton likewise, almost 100 percent of the variety result can be explained by the relapse condition, dissimilar to the case with aman paddy, where only 80% of the variety result can be explained by the relapse condition. For the tomato crops, the coefficients of temperature and rainfall are determined as 0.134 and 0.205, respectively (Table 14.5). These qualities are viewed as significant at the 5% and 1% levels, respectively. In this situation, 100 percent of the variety result can be explained by the relapse condition. Dissimilar to tomatoes, the 't' values for temperature (−3.628) and rainfall (9.267) of soybean are not viewed as significant; however, the majority of the variety result of this yield can be explained by the relapse condition (Table 14.5).

14.4   Conclusion

For successful agricultural growth in an area, several key factors must remain in the region, such as sufficient rainfall, a good temperature regime, bright sunshine, and fertile soil. Although the area receives a significant amount of precipitation, the coarse-grained soils in the study area are characterised by a low water-holding capacity, and the top layer of the soil has little moisture retention capacity after very heavy rainfall. It moves more than surface runoff along terrain gradients. The rugged terrain, highly variable soils, and harsh climatic conditions are some of the factors that do not support the cultivation of long-lived crop varieties. Appropriate agricultural development in the region, therefore, must contain large amounts of

runoff and focus on the introduction of new, short-lived cultivations; providing climate information to the agricultural community is also very important. Otherwise, the desired level of productivity cannot be achieved.

This study is of great importance in this sense, as it identifies the agricultural development of this region from an ecological point of view. Analysis of crop evaporation-to-precipitation ratios suggests that soybean, maize, and tomato are some of the crops that do not require irrigation water for cultivation. Even after heavy rain showers during monsoon and non-monsoon seasons, water migrates along the slopes of the area and exerts pressure on the top layer of soil in very short spans. Precipitation-to-PET ratios suggest that over 800 mm of excess precipitation would run off as overland flow during these three months of the monsoon (July, August, and September) after the PET demand had been met. In other non-monsoon months, the amount of PET is higher than the amount of precipitation. Therefore, much of this flow should be prevented in order to minimise water scarcity problems in the region. Water stored during the monsoons can be used for non-potable purposes during the dry season. Water conservation and runoff control in agricultural plots and the construction of dams and reservoirs are some of the techniques proposed for water conservation in the study area. Some CD blocks in the study area are practising water-saving techniques, but they need to be implemented throughout the district, especially in the south-western part.

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