EFFECT OF CLIMATIC VARIABLES ON RICE YIELD AND ITS FORECAST: A STUDY USING CROP WEATHER MODELING OVER THE NORTH EASTERN ZONAL DISTRICTS OF TAMIL NADU

Veera kumar M[1], Stella S.[2], Balasubramanian K.V.[3]

[1]Senior Research Fellow, Regional Meteorological Centre, Chennai-6, India
[2,3]Regional Meteorological Centre, Chennai-6, India
Email: [1]gururamkumar.m@gmail.com

Abstract

Weather parameters like temperature viz. maximum (T_x) and minimum (T_n), relative humidity (RH) in the morning (RH1) and evening (RH2) observation and weekly averaged total rainfall (RF) plays a vital role in the Crop yield. A study has been taken on the Crop yield forecast using crop weather model and about the impact of weather over the Rice yield during Rabi season for the North eastern zonal districts such as Salem, Dharmapuri, Nilgiris, Vellore and Tiruvallur. Weather parameters for the last twenty eight years (1985-2012), for the period 15th Sep to 30th Jan. have been taken for the study. Trend analyses have been done for the weather parameters viz. Tx, Tn, RH and weekly total rainfall over the region of study.

The study shows that during the period of study whenever the Tx and RH are in increasing trend, then the rainfall is also seen to be in increasing trend over the study region. This variability shows that there is some significant impact of Tx, RH and RF over Crop yield of Rice during the Rabi season. Increasing trend in Tx, RH and RF show increasing trend in Crop yield over the past few years. The yield forecast of rice shown from 2001 to 2009 gives significant figure of merit with the actual.

Key words: Maximum Temperature (T_x), Minimum Temperature (T_n), Relative humidity in the morning observation (RH 1), Relative humidity in the evening observation (RH 2), weekly averaged total rainfall (RF), Crop yield, Co-efficient of determination (r^2)

Objective

To forecast and validate the Rabi Rice yield for the North eastern zonal districts of Tamil Nadu, Statistical stepwise regression model has been used and to study the trend analysis of the weather parameters and its impact on crop yield.

Study Area

North Eastern Zonal Districts such as Salem, Darmapuri, Nilgiris, Tiruvallur, Vellore.

1.1 Data used

1. Weather parameters viz., Maximum Temperature (T_x), Minimum Temperature (T_n), weekly averaged total Rainfall (RF), observed morning relative humidity (RH 1) and evening relative humidity (RH 2) for the period Sep 15 to Jan 30th (1985 to 2013). The above weather data obtained from National Data Centre (Pune).

2. Rice yield data for the previous year's obtained from Tamil Nadu Agricuture University, Coimbatore.

1.2 Model used for yield forecasting

To explain the relationships among the variables in the model, Stepwise selection method has been taken for generating model equation for forecasting crop yield.

Fisher (1924) and Hendricks and Scholl (1943) have suggested models which require small number of parameters to be estimated while taking care of distribution pattern of weather over the crop season. Fisher utilized weekly weather data. He assumed that the effect of change in weather variable in successive weeks would not be abrupt or erratic but an orderly one that follows some mathematical law. He assumed that these effects as well as magnitude of the variable in successive weeks are composed of the terms of a polynomial function of time. Substituting these in usual. The Regression equation model becomes

$$Y = a + B_1X_1 + B_2X_2 + B_3X_3 + e \qquad [1]$$

Where:

a = the constant (point at which line crosses Y axis)

B_1 = slope (regression coefficient) for variable X_2

B_2 = slope for variable X_2

B_3 = slope for variable X_3

e = error (or residual) value

This model was used by Fisher for studying the influence of rainfall on the yield of wheat. Hendricks and Scholl (1943) modified Fisher's technique. They assumed that a second degree polynomial in week number would be sufficiently flexible to express the effects in successive weeks. Under this assumption, the model suggested by Hendricks and Scholl is

$$Y = Ao + ao \sum_w X_w + al \sum_w w X_w + a_2 \sum_2 w^2 X_w + e^{[2]}$$

In this model number of constants to be determined is reduced to four, irrespective of n. This model was extended for two weather variables to study joint effects. Since the data for such studies extended over a long period of years.

At Indian Agricultural Statistics Research Institute, the model suggested by Hendricks and Scholl has been modified by expressing the effects of changes in weather variables on yield in the wth week as second degree polynomial in respective correlation coefficients between yield and weather variables (Agrawal *et ai.* 1980, 1983; Agarwal and Jain 1982 and Jain *et ai.* 1980).

This is expected to explain the relationship in a better way as it gives appropriate weight age to weather in different weeks. Under this assumption, the models were developed for studying the effects of weather variables on yield using complete crop season data whereas forecast model utilized partial crop season data. These models were found to be better than the one suggested by Hendricks and Scholl.

1.3 Methodology

The methodology adopted in this study is represented in the Fig. 1. as follows.

2. RESULT & DISCUSSION

2.1 Climate Variability Over Salem District

Salem is the one of the commercial city of Tamil Nadu. Salem is located at 11.66°N 78.14°E. The average elevation is 278 m (912 ft). The city of Salem
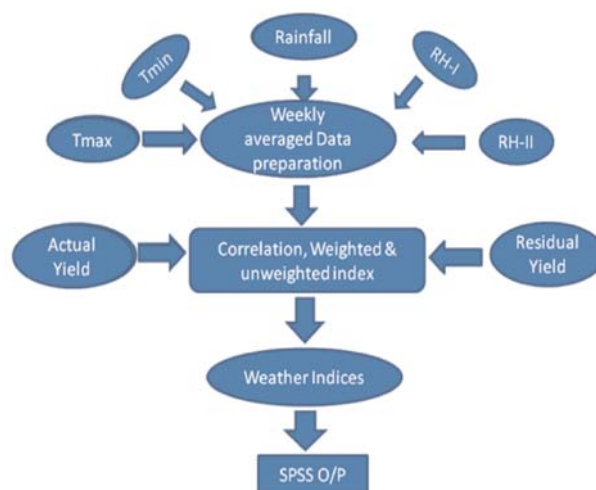

Fig. 1. Methodology for Yield forecasting

is surrounded by hills on all sides viz. Nagaramalai to the north, Jarugumalai to the south, Kanjamalai to the west, Godumalai to the east and the Shevaroy Hills to the north east.

The Fig. 2.1. (a) Shows the variability of Maximum temperature (Tx) for the period 1985 to 2012 which gives the decreasing trend in the Rabi season (Sep-Jan). The trend shows the average T_x is 31.71 ° C and the temperature decreases by 0.043 ° C. The co-efficient of determination (r^2) in this case is 0.123 which is showing slight decrease in the values of maximum temperatures over Salem during 1985 to 2012.
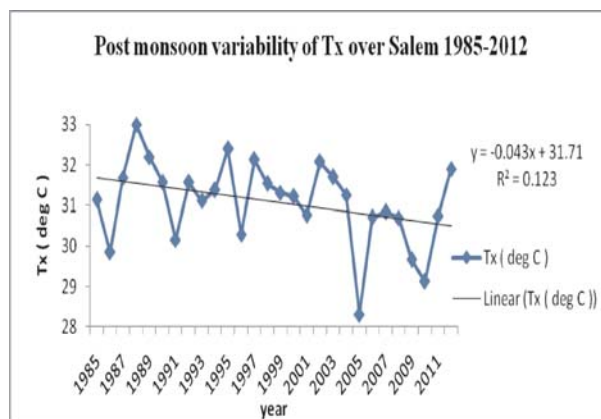

Fig. 2.1. (a) Variability of Maximum temperature

The Fig. 2.1. (b), Shows the variability of minimum temperature (Tn) for the period 1985 to 2012 shows the increasing trend in the Rabi season (Sep-Jan). The trend shows the average Tn is 19.19

° C and the Tn increased by 0.034° C. The r^2 value in this case is 0.045 which is showing increase in the values of Tn over Salem during 1985 to 2012.
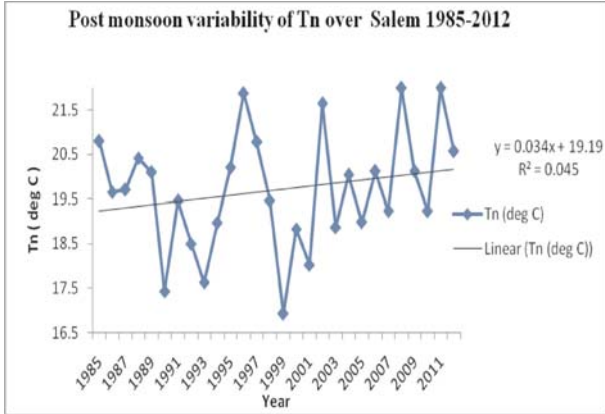

Fig. 2.1. (b) Variability of minimum temperature

The Fig. 2.1. (c) shows the variability of Relative humidity in the morning observation (RH I) for the period 1985 to 2012 shows the increasing trend in the Rabi season (Sep-Jan). The trend shows the average RH 1 is 74.55% and it is increased by 0.272%. The r^2 value in this case is 0.186 which is showing increase in the values of RH 1 over Salem during 1985 to 2012.
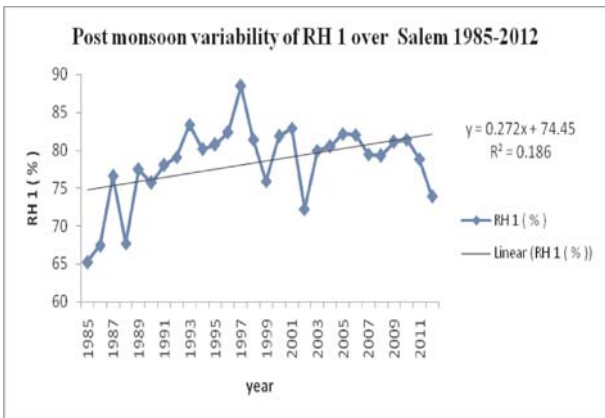

Fig. 2.1. (c) Variability of Relative humidity - I

The Fig. 2.1. (d), Shows the variability of Relative Humidity in the evening observation (RH 2) for the period 1985 to 2012 shows the increasing trend in the Rabi season (Sep-Jan). The trend shows the average RH 2 is 56.37% and the it is increased by 0.24%. The r^2 value in this case is 0.111 which is showing increase in the values of RH 2 over Salem during 1985 to 2012.
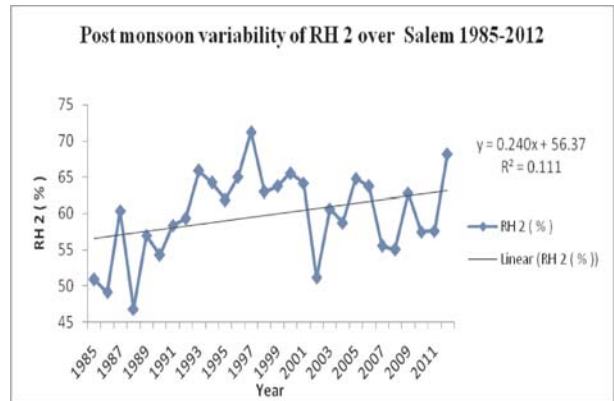

Fig. 2.1. (d) Variability of Relative humidity - II

The Fig. 2.1. (e), Shows the variability of total rainfall (RF) for the period 1985 to 2012 shows the decreasing trend in the Rabi season (Sep-Jan). The trend shows the average seasonal RF is 570.8 mm and the RF decreases by 0.783 mm. The r^2 value in this case is 0.123 which is showing decrease in the values of RF over Salem during 1985 to 2012.
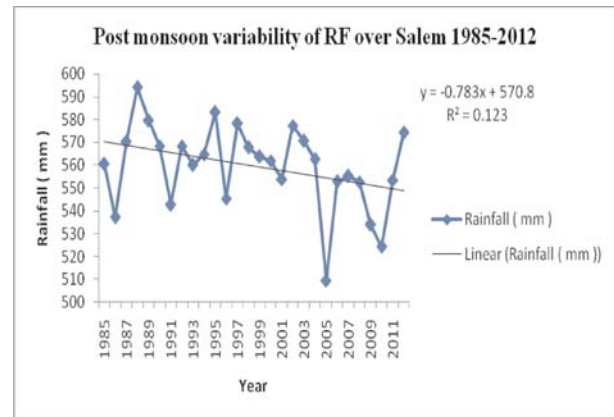

Fig. 2.1 (e) Variability of weekly total rainfall

2.2. Climate Variability Over Dharmapuri District

Dharmapuri is situated in the northwestern corner of Tamil Nadu and is bounded by Tiruvannamalai and Viluppuram districts on the east, Salem district on the South, Krishnagiri district on the north and the river Kaveri on the west. It is located between latitudes 11. 47° N and longitudes 77.02° E. The total geographical area of Dharmapuri district is 4497.77 km which is 3.46% of Tamil Nadu.

The Fig. 2.2 (a), Shows the variability of Tx for the period 1985 to 2012 shows the increasing trend in the Rabi season (Sep-Jan). The trend shows the

average Tx is 27.82 ° C and the it is increases by 0.056 ° C. The r^2 value in this case is 0.115 which is showing increase in the values of Tx over Dharmapuri during 1985 to 2012.
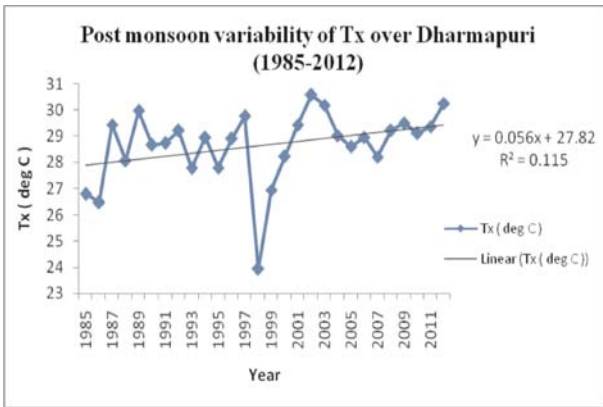

Fig. 2.2 (a) Variability of Maximum temperature

The Fig. 2.2 (b) Shows the variability of Tn for the period 1985 to 2012 shows the increasing trend in the Rabi season (Sep-Jan). The trend shows the average Tn is 17.96 ° C and it is increased by 0.056 ° C. The r^2 value in this case is 0.094 which is showing increase in the values of Tn over Dharmapuri during 1985 to 2012.
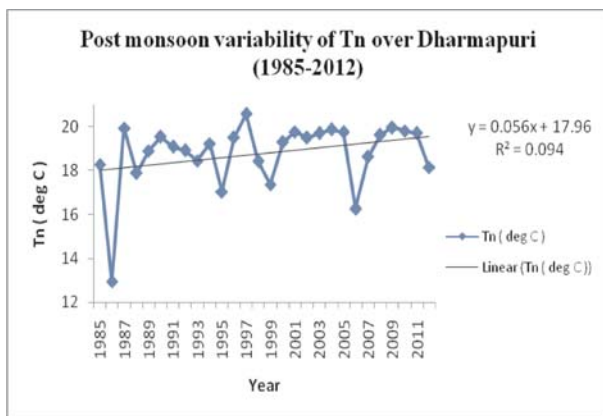

Fig. 2.2 (b) Variability of minimum temperature

The Fig. 2.2 (c) shows the variability of RH 1 for the period 1985 to 2012 shows the increasing trend in the Rabi season (Sep-Jan). The trend shows the average RH 1 is 73.07% and the RH 1 increased by 0.308%. The r^2 value in this case is 0.144 which is showing increase in the values of RH 1 in the morning observation over Dharmapuri during 1985 to 2012.
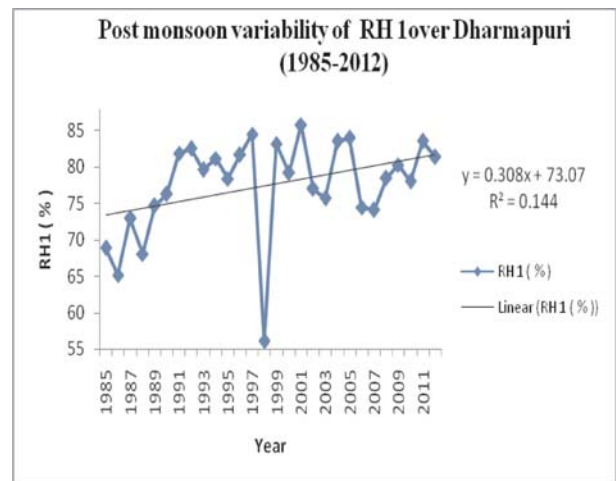

Fig. 2.2 (c) Variability of Relative Humidity - I

The Fig. 2.2 (d) Shows the variability of RH 2 for the period 1985 to 2012 shows the increasing trend in the Rabi season (Sep-Jan). The trend shows the average RH 2 is 58.01% and the RH 2 is increased by 0.145%. The r^2 value in this case is 0.027 which is showing slight increase in the values of RH 2 in the evening observation over Dharmapuri during 1985 to 2012.
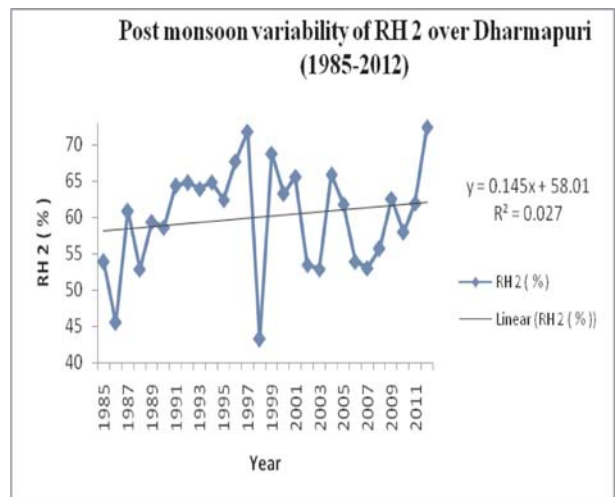

Fig. 2.2 (d) Variability of Relative Humidity - II

The Fig. 2.2 (e) shows the variability of RF for the period 1985 to 2012 shows the increasing trend in the Rabi season (Sep-Jan). The trend shows the average RF is 500.9 mm and the RF increases by 1.018 mm. The r^2 value in this case is 0.115 which is showing increase in the values of RF over Dharmapuri during 1985 to 2012.
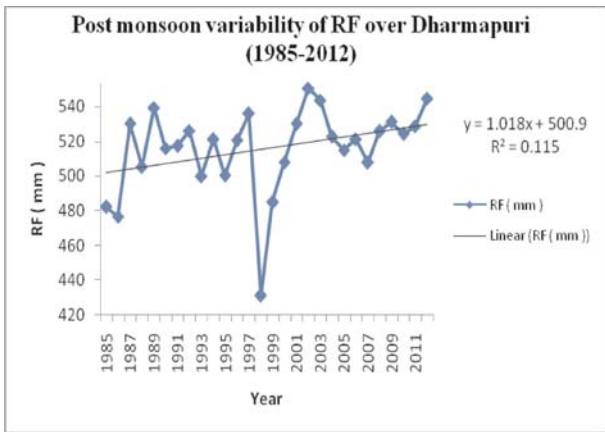
Fig. 2.2 (e) Variability of weekly total Rainfall

2.3 Climate Variability over Nilgiris District

The Nilgiri often referred to as the Nilgiri Hills, are a range of mountains with at least 24 peaks above 2,000 metres (6,600 ft), in the westernmost part of Tamil Nadu state at the junction of Karnataka and Kerala states in southern India. It located in the latitude of 11.4° N and longitude of 76.7° E. They are part of the larger Western Ghats mountain chain making up the southwestern edge of the Deccan Plateau.

The Fig. 2.3 (a), Shows the variability of Tx for the period 1985 to 2012 which shows the decreasing trend in the Rabi season (Sep-Jan). The trend shows the average T_x is 21.33 ° C and the Tx decreases by 0.056 ° C. The r^2 value in this case is 0.327 which is showing decrease in the values of Tx over Nilgiris during 1985 to 2012.
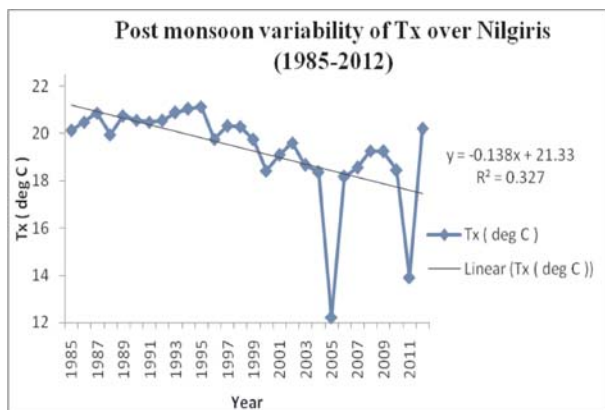

Fig. 2.3 (a) Variability of maximum temperature

The Fig. 2.3 (b) Shows the variability of Tn for the period 1985 to 2012 shows the increasing trend in the Rabi season (Sep-Jan). The trend shows the average Tn is 7.870 ° C and the Tn increases by 0.047 ° C. The r^2 value in this case is 0.219 which is showing increase in the values of Tn over Nilgiris during 1985 to 2012.
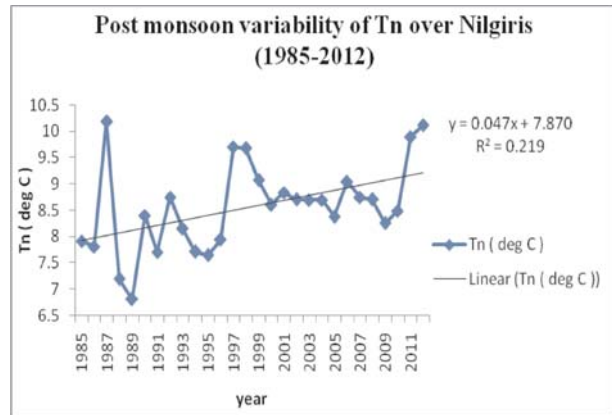

Fig. 2.3 (b) Variability of minimum temperature

The Fig. 2.3 (c) Shows the variability of RH 1 for the period 1985 to 2012 shows the increasing trend in the Rabi season (Sep-Jan). The trend shows the average RH 1 is 79.11% and it is increased by 0.127 %. The r^2 value in this case is 0.033 which is showing slight increase in the values of RH 1over Nilgiris during 1985 to 2012.
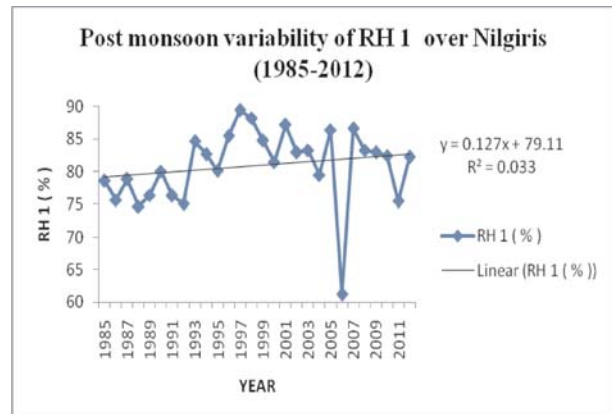

Fig. 2.3 (c). Variability of Relative humidity - I

The Fig. 2.3 (d), shows the variability of RH 2 for the period 1985 to 2012 shows the increasing trend in the Rabi season (Sep-Jan). The trend shows the average RH 2 is 72.60% and the RH 2 is increased by 0.341%. The r^2 value in this case is 0.426 which is showing increase in the values of RH 2 over Nilgiris during 1985 to 2012.

Post monsoon variability of RH 2 over Nilgiris (1985-2012)
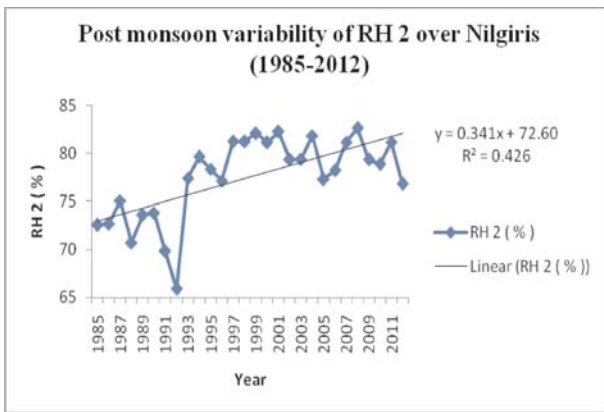
$y = 0.341x + 72.60$
$R^2 = 0.426$

Fig. 2.3 (d) Variability of Relative humidity-II

The Fig. 2.3 (e) Shows the variability of RF for the period 1985 to 2012 shows the decreasing trend in the Rabi season (Sep-Jan). The trend shows the average RF is 384.0 mm and the RF decreases by 2.498 mm. The r^2 value in this case is 0.327 which is showing decrease in the values of rainfall over Nilgiris during 1985 to 2012.
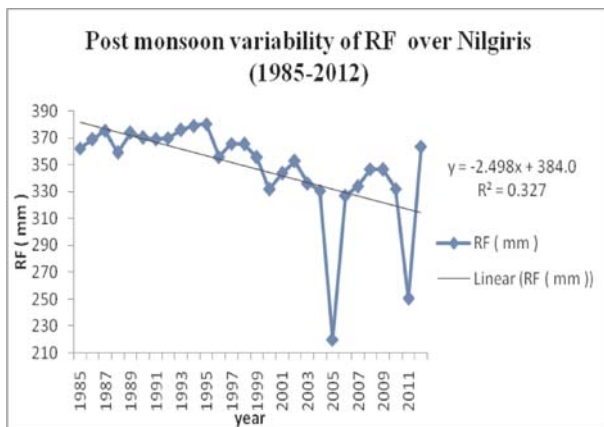
Post monsoon variability of RF over Nilgiris (1985-2012)

$y = -2.498x + 384.0$
$R^2 = 0.327$

Fig. 2.3 (e) Variability of total rainfall

2.4 Climate Variability Over Tiruvallur District

Tiruvallur is a temple town in Tamil Nadu. It is located on the banks of Cooum river about 42 km (26 mile) northwest of Chennai District (Madras), the capital city of Tamil Nadu. It located in the latitude of 13.13° N and longitude of 79.90° E.

The Fig. 2.4 (a) Shows the variability of Tx for the period 1985 to 2012 shows the increasing trend in the Rabi season (Sep-Jan). The trend shows the average Tx is 29.10 ° C and the Tx increases by 0.069 ° C. The r^2 value in this case is 0.561 which is showing

increase in the values of maximum temperature over Tiruvallur during 1985 to 2012.

Post monsoon variability of Tx over Tiruvallur (1985-2012)

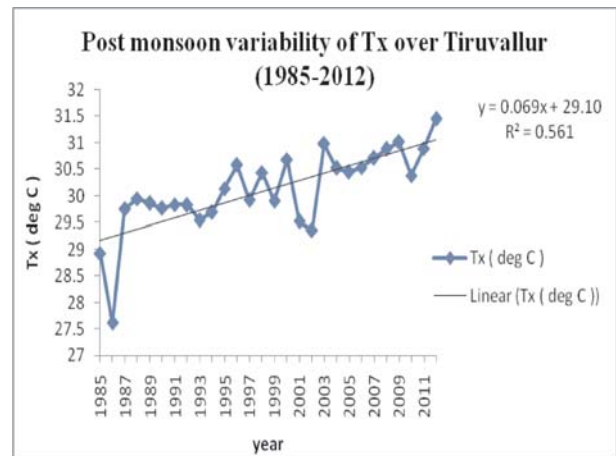$y = 0.069x + 29.10$
$R^2 = 0.561$

Fig. 2.4 (a) Variability of maximum temperature

The Fig. 2.4 (b) Shows the variability of Tn for the period 1985 to 2012 shows the increasing trend in the Rabi season (Sep-Jan). The trend shows the average Tn is 22.24 ° C and the Tn increases by 0.020 ° C. The r^2 value in this case is 0.089 which is showing slight increase in the values of Tn over Tiruvallur during 1985 to 2012.

Post monsoon variability of Tn over Tiruvallur (1985-2012)
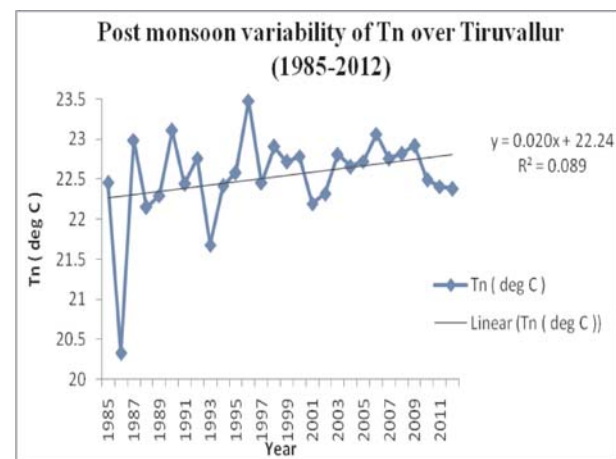
$y = 0.020x + 22.24$
$R^2 = 0.089$

Fig. 2.4 (b) Variability of minimum temperature

The Fig. 2.4 (c) Shows the variability of RH 1 for the period 1985 to 2012 shows the increasing trend in the Rabi season (Sep-Jan). The trend shows the average RH 1 is 81.46% and the RH 1 increased by 0.015%. The r^2 value in this case is 0.001 which is showing very slight increase in the values of RH 1 over Tiruvallur during 1985 to 2012.
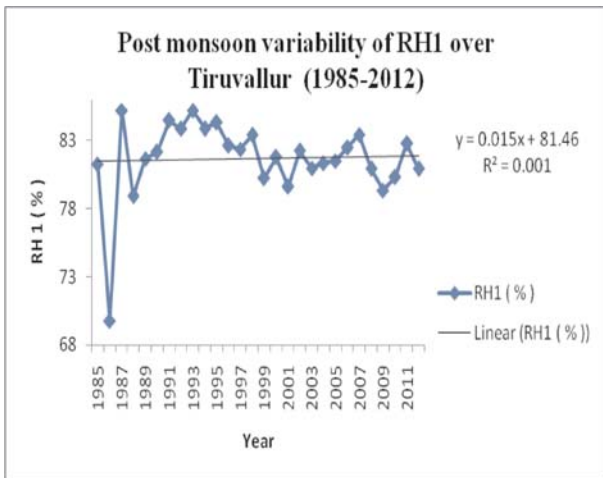
Fig. 2.4 (c) Variability of Relative humidity - I

The Fig. 2.4 (d) Shows the variability of RH 2 for the period 1985 to 2012 shows the increasing trend in the Rabi season (Sep-Jan). The trend shows the average RH 2 is 72.18% and the RH 2 increased by 0.005%. The r^2 in this case is 0.000 which is showing very very slight increase in the values of RH 2 over Tiruvallur during 1985 to 2012.
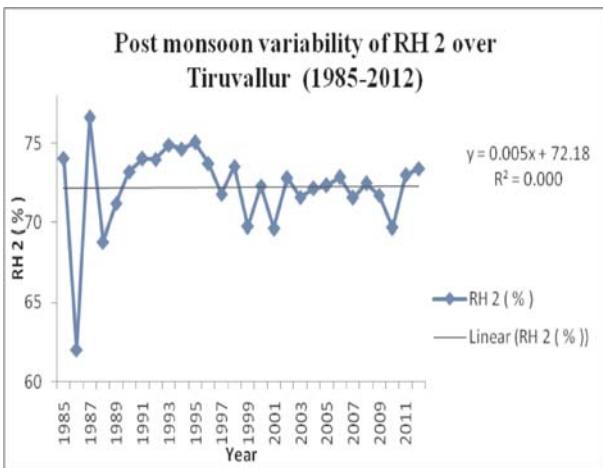

Fig. 2.4 (d) Variability of Relative humidity - II

The Fig. 2.4 (e) Shows the variability of RF for the period 1985 to 2012 shows the increasing trend in the Rabi season (Sep-Jan). The trend shows the average RF is 523.8 mm and the RF increases by 1.254 mm. The r^2 value in this case is 0.561 which is showing increase in the values of rainfall over Tiruvallur during 1985 to 2012.
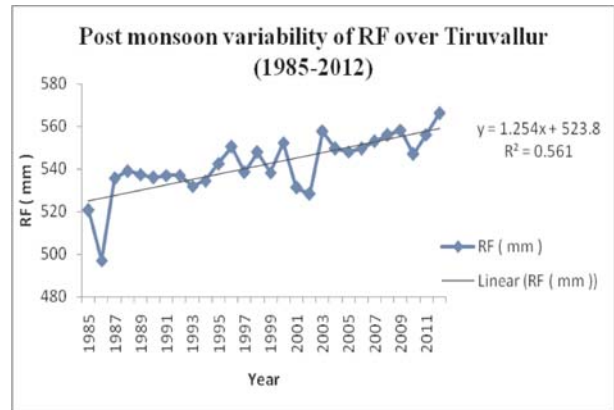

Fig. 2.4 (e) Variability of total rainfall

2.5 Climate Variability Over Vellore District

Vellore is a municipal corporation in the Vellore district of the Indian state of Tamil Nadu. Vellore is located in the latitude of 12.92° N and longitude of 79.70 ° E and lies on the banks of the Palar River. The city is located between Chennai, Bangalore and the temple towns of Thiruvannamalai and Tirupati. Vellore has a tropical wet-and-dry climate, reaching high temperatures during summer. The city experiences wet winters and dry summers. It has an elevation of about 224 meters, with the northeast monsoon the highest contributor to rainfall. The mean maximum and minimum temperatures during summer and winter vary between 38.5°C and 18.95°C. The highest temperature ever recorded is 45°C, and the lowest is 10°C.
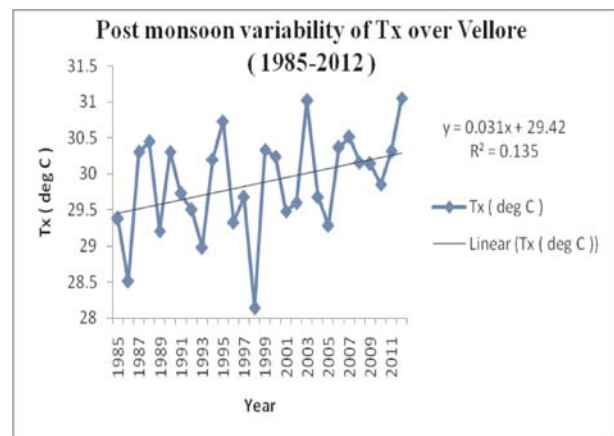

Fig. 2.5 (a) Variability of maximum temperature

The Fig. 2.5 (a) Shows the variability of Tx for the period 1985 to 2012 shows the increasing trend in the Rabi season (Sep-Jan). The trend shows the average T_x is 29.42 ° C and the temperature increases

by 0.031 ° C. The r^2 value in this case is 0.135 which is showing increase in the values of maximum temperature over Vellore during 1985 to 2012.

The Fig. 2.5 (b) Shows the variability of Tn for the period 1985 to 2012 shows the increasing trend in the Rabi season (Sep-Jan). The trend shows the average Tn is 19.07 ° C and the temperature increases by 0.015 ° C. The r^2 value in this case is 0.011 which is showing slight increase in the values of minimum temperature over Vellore during 1985 to 2012.
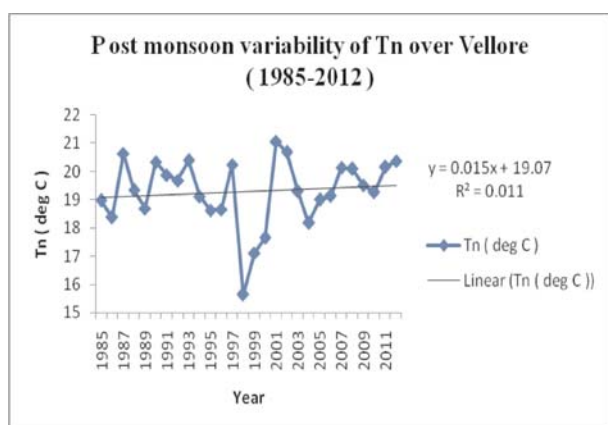

Fig. 2.5 (b) Variability of minimum temperature

The Fig. 2.5 (c) Shows the variability of RH-1 for the period 1985 to 2012 shows the increasing trend in the Rabi season (Sep-Jan). The trend shows the average RH is 78.33% and the RH increased by 0.288%. The r^2 value in this case is 0.411 which is showing increase in the values of RH-1 over Vellore during 1985 to 2012.
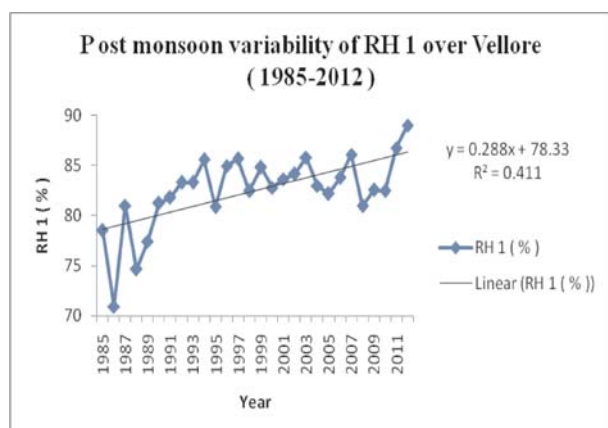

Fig. 2.5 (c) Variability of Relative humidity - I

The Fig. 2.5 (d) Shows the Variability of RH-2 for the period 1985 to 2012 shows the increasing trend

in the Rabi season (Sep-Jan). The trend shows the average RH is 59.85% and the RH increased by 0.379%. The r^2 value in this case is 0.365 which is showing increase in the values of RH-2 over Vellore during 1985 to 2012.
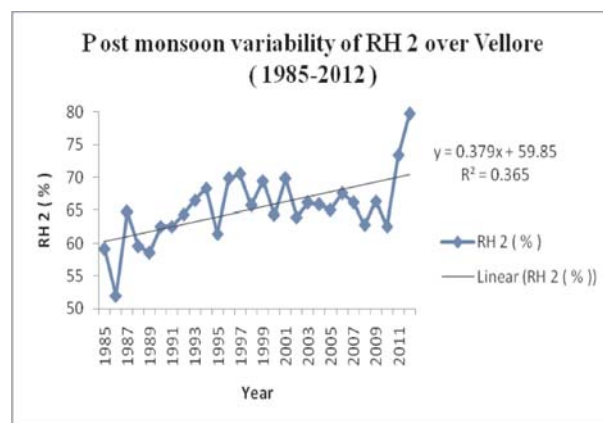
Fig. 2.5 (d) Variability of Relative humidity - II

The Fig. 2.5 (e) Shows the variability of RF for the period 1985 to 2012 shows the increasing trend in the Rabi season (Sep-Jan). The trend shows the average RF is 531.5 mm and the RF is increases by 0.423 mm. The r^2 value in this case is 0.077 which is showing increase in the values of rainfall over Vellore during 1985 to 2012.
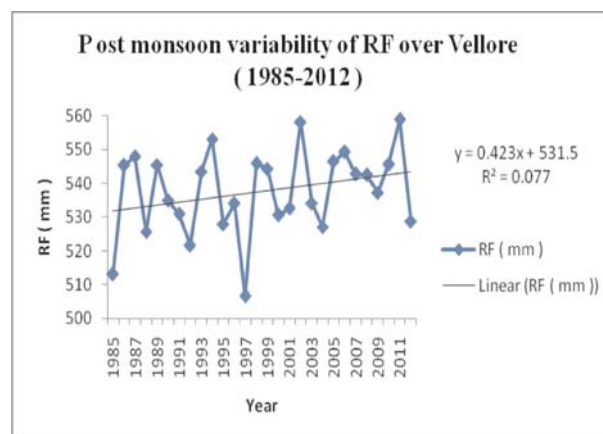
Fig 2.5 (e) Variability of total rainfall

2.6 Rice Forecast From 2001-2009

The following tabulations show the actual yield and forecasted yield with corresponding error percentage for the North eastern zonal districts of Tamil Nadu from the year 2001 to 2009. These output obtained from Statistical model based on the Regression equation which was quoted in the section

(1.2). Some of the district shows the variable error percentage. But, Dharmapuri district shows the abnormal error percentage, it may due to drought condition. Still need further study regarding this issue.

1. DHARMAPURI DISTRICT

The following tabulation 2.6 (a) shows the actual and forecasted Rice crop yield with the error percentage for the years 2001-2009.

Table 2.6 (a) Rice Yield forecast for Dharmapuri

S. No	Year	Actual yield Kg/ha	Forecasted yield Kg/ha	Error percentage
1	2001	3413.04	4311	26
2	2002	3487.87	4468.69	28.21
3	2003	2573	3490.079	35
4	2004	2426	5694.78	23.4
5	2005	2772	2826	1.9
6	2006	3236.677	3163.877	2.2
7	2007	3612.76	2410.22	33
8	2008	3744.21	2263.99	39.59
9	2009	3816	4075.001	6.7

The following fig 2.6 (b) shows the Rice yield versus Rainfall for the Dharmapuri district from 2001 to 2009. In that graph shows the decreasing trend in Rainfall and increasing trend in the Yield.

From the graph it can be seen that

The average RF of the area is 539.4 mm and it decreases by 2.387 mm. The r^2 value in this case is 0.240 which is showing slight decrease in the values of rainfall over Dharmapuri during 2001 to 2009.

(b) The average Rice yield of the area is 2792 kg/ha and it increases by 87.85 kg/ha. The r^2 value in this case is 0.216 which is showing slight increase in the values of Rice yield over Dharmapuri during 2001 to 2009.

2. NILGIRIS DISTRICT

The following tabulation 2.6 (c) shows the actual and forecasted Rice crop yield with the error percentage for the years 2001-2009.
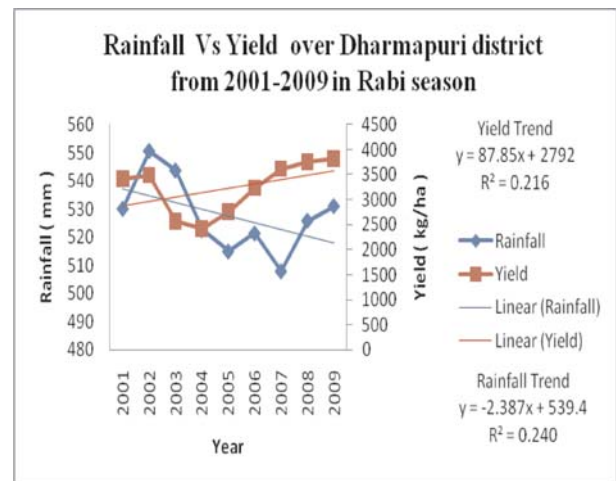
Fig. 2.6 (b) Rice yield versus Rainfall for the Dharmapuri district.

Table 2.6 (c) Rice Yield forecast for Nilgiris.

S. No	Year	Actual yield Kg/ha	Forecasted yield Kg/ha	Error percentage
1.	2006	3298	3355.82	1.75
2.	2007	3199	3474.437	8.6
3.	2008	3862.	3712	3.8
4.	2009	3931	4039.75	8.8

The following fig. 2.6 (d), shows the Rice yield versus Rainfall for the Nilgiris district from 2001 to 2009. In that graph shows the increasing trend in both Rainfall and the Rice Yield.

From the graph it can be seen that

Fig. 2.6 (d) Rice yield versus Rainfall for the Nilgiris district.

(a) The average RF of the area is 320.8 mm and it increases by 7.08 mm. The r^2 value in this case is 0.89 which is showing increase in the values of rainfall over Nilgiris during 2001 to 2009.
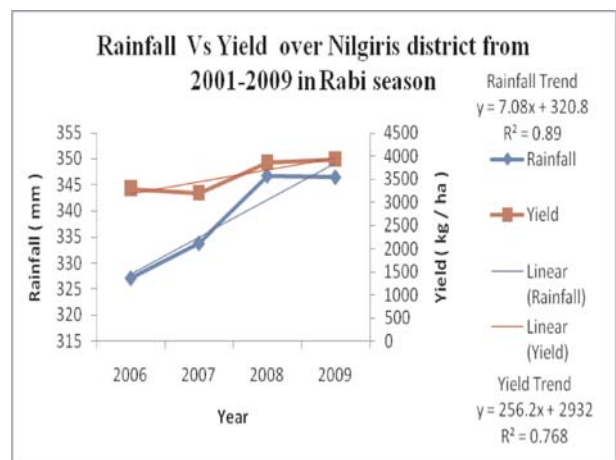
(b) The average Rice yield of the area is 2932 kg/ha and it increases by 256.2 kg/ha. The r^2 value in this case is 0.768 which is showing slight increase in the values of Rice yield over Nilgiris during 2001 to 2009.

3. SALEM DISTRICT

The following tabulation 2.6 (e) shows the actual and forecasted Rice crop yield with the error percentage for the years 2001-2009.

Table 2.6) (e) Rice Yield forecast for Salem

S. No	Year	Actual yield Kg/ha	Forecasted yield Kg/ha	Error percentage
1.	2001	4378.15	3837.004	12.35
2.	2002	4418.15	4239.38	4.06
3.	2003	3531	3679.79	4.21
4.	2004	3213	2959.24	7.89
5	2005	3539	3723.339	5.2
6	2006	3678	3831.72	4.17
7.	2007	3639.73	3759.4052	3.2
8.	2008	3320.11	3985.58	20
9.	2009	4022	3934	9.2

The following fig 2.6 (f), shows the Rice yield versus Rainfall for the Salem district from 2001 to 2009. In that graph shows the decreasing trend in both Rainfall and the Rice Yield.

From the graph it can be seen that

(a) The average RF of the area is 568.1 mm and it decreases by 3.232 mm. The r^2 value in this case is 0.194 which is showing slight decrease in the values of rainfall over Salem during 2001 to 2009.

(b) The average Rice yield of the area is 4085 kg/ha and it decreases by 67.27 kg/ha. The co-efficient of determination (r^2) in this case is 0.181 which is showing slight decrease in the values of Rice yield over Salem during 2001 to 2009.
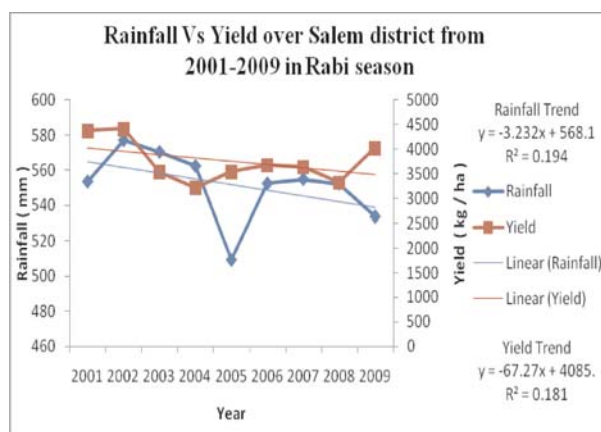

Fig. 2.6 (f) Rice yield versus Rainfall for the Salem district.

4. TIRUVALLUR DISTRICT

The following tabulation 2.6 (g) shows the actual and forecasted Rice crop yield with the error percentage for the years 2001-2009.

Table 2.6 (g) Rice Yield forecast for Tiruvallur

S. No	Year	Actual yield Kg/ha	Forecasted Yield Kg/ha	Error percentage
1.	2001	3538.539	3531.79	0.19
2.	2002	3302.8	3528.117	6.8
3.	2003	3406.09	3523.73	3.4
4.	2004	2609.16	3536.35	35
5	2005	2397.2	3500	46
6	2006	3840.76	3107.64	19.08
7.	2007	3551.67	2931.39	17
8.	2008	3347	3526.075	5.35
9.	2009	3840	3883.30	1.1

The following fig 2.6 (h), shows the Rice yield versus Rainfall for the Tiruvallur district from 2001 to 2009. In that graph shows the increasing trend in both Rainfall and the Rice Yield.

From the graph it can be seen that

(a) The average RF of the area is 532.8 mm and it increases by 3.025 mm. The co-efficient of determination (r^2) in this case is 0.574 which is showing increase in the values of rainfall over Tiruvallur during 2001 to 2009.

(b) The average Rice yield of the area is 3076 kg/ha and it increases by 47.68 kg/ha. The r^2 value in

this case is 0.067 which is showing slight increase in the values of Rice yield over Tiruvallur during 2001 to 2009.
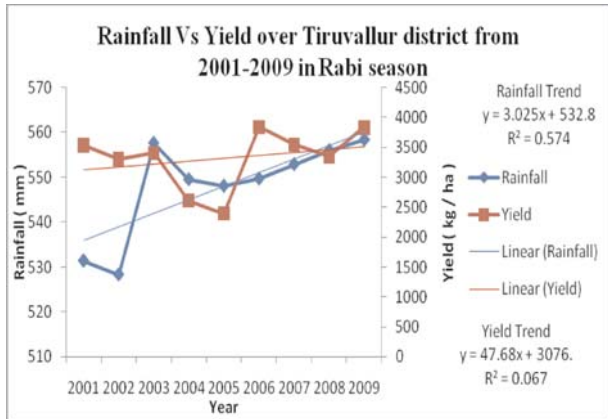

Fig. 2.6 (h) Rice yield versus Rainfall for the Tiruvallur district

5. VELLORE DISTRICT

The following tabulation 2.6 (i) shows the actual and forecasted Rice crop yield with the error percentage for the years 2001-2009.

Table 2.6 (i) Rice Yield forecast for Vellore

S. No	Year	Actual Yield Kg/ha
1.	2001	4040.36
2.	2002	3894.83
3.	2003	3418.53
4.	2004	3499.66
5	2005	6651.79
6	2006	2879
7.	2007	3099.
8.	2008	3347
9.	2009	3225

The following fig. 2.6 (j), shows the Rice yield versus Rainfall

for the Vellore district from 2001 to 2009. In that graph shows the increasing trend in Rainfall and decreasing trend in the Rice Yield.

From the graph it can be seen that

(a) The average RF of the area is 540.3 mm and it increases by 0.177 mm. The r^2 value in this case is

0.002 which is showing slight increase in the values of rainfall over Vellore during 2001 to 2009.

(b) The average Rice yield of the area is 4297 kg/ha and it is decreases by 102.7 kg/ha. The r^2 value in this case is 0.061 which is showing slight decrease in the values of Rice yield over Vellore during 2001 to 2009.
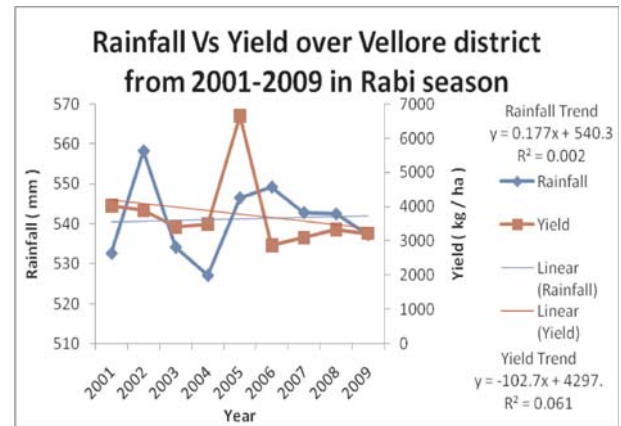

Fig. 2.6 (j) Rice yield versus Rainfall for the Vellore district.

2.7 Forecasted yield for Rabi Rice crop- 2013

The following table 2.7 (a) Shows the forecasted Rabi season Rice crop yield with the error percentage for the years 2013.

Table 2.7 (a) Rice Yield forecast for North Eastern zonal districts

No	Districts	Forecasted yield Kg/ha	Error percentage
1	Dharmapuri	2770.17	6.7
2	Nilgiris	4039.75	8.8
3	Salem	4762.54	9.2
4	Tiruvallur	3883.30	9.1
5	Vellore	3394.87	9.1

The following fig. 2.7 (b), shows Forecasted Rabi Rice yield for the year 2013. In that graph shows the increasing trend in the Rice YieldFrom the graph it can be seen that the North eastern zonal districts viz., Dharmapuri, Nilgiris, Salem, Tiruvallur and Vellore in the average Rice yield of the area is 3642 kg/ha and it increases by 23.63 kg/ha. The r^2 value in this case is 0.004 which is showing slight increase in the values of Rice yield over the above said areas.
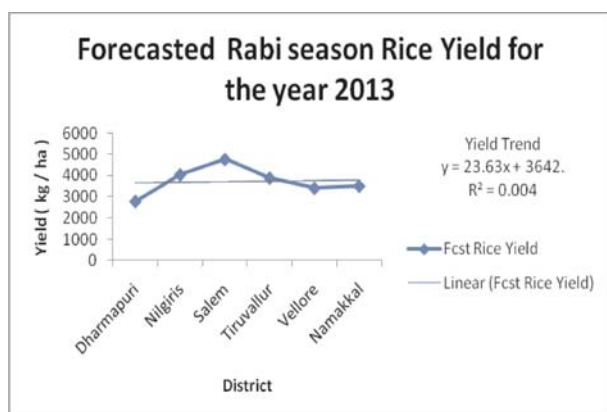
Fig. 2.7 (b) Forecasted Rabi Rice yield for the year 2013.

2.8 Conclusion

- The trend of the climatic parameters has been calculated for the North eastern zonal districts of Tamil Nadu viz. Salem, Dharmapuri, Nilgiris, Tiruvallur, Vellore etc. The trend analysis shows that where ever maximum temperature there is an in increasing trend. Rainfall at that place also also increasing. The following districts have that scenario viz. Dharmapuri, Tiruvallur, Vellore etc. Where ever maximum temperature has a decreasing trend at that place is Rainfall also decreasing. The following districts having that scenario viz. Salem, Nilgiris etc same as any other districts. The similar way Salem also covered by Servorayan hill. It is also having the same scenario like Nilgiris. So, further study to be carried out on these Districts.

- Statistical stepwise regression model output for the North eastern zonal districts of Tamil Nadu has been validated for Rice crop yield for Rabi season and the error percentage also calculated for the periods from 2001-2009 and the current year yield has been forecasted. The rainfall versus yield graph showing the relationship among the correlation between them. The crop yield of Rice over the NE zonal districts showing increasing trend.

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M Veera Kumar working as a SRF in the Regional Meteorological Centre (IMD), Chennai to study the Impacts of weather variability over the crop yield forecasting. He is interested in Remote sensing and GIS application in NWP, Meteorology, Agrometeorology and air sea interaction studies.