Rainfall study for dry land areas of selected districts of Tamil Nadu for crop planning

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सार – इस शोध पत्र में तमिलनाडु के तीन चुनिंदा जिलों (धर्मापुरी, तिरुनेलवेली और विलुपुरम) की शुष्क भूमि की स्थिति के लिए वैकल्पिक फसलों का उपयोग करने के लिए भारत मौसम विज्ञान विभाग से 1911 से 2000 तक की 90 वर्षों की अवधि के मासिक वर्षा आंकड़े इकट्ठे किए गए ओर उनका विश्लेषण किया गया। भौगोलिक स्थितियों के आधार पर इन तीन चुनिंदा जिलों की वार्षिक माध्य वर्षा में परिवर्तनशीलता रही जिससे तमिलनाडु में वर्षा की स्थानिक परिवर्तनशीलता का पता चला है। बढ़वार की अवधि के समय का विश्लेषण तीन विभिन्न पद्धतियों नामत: हरग्रीव की आर्द्रता उपलब्धता सूचकांक, जीवानन्द रेड्डी, 14 सप्ताहों का गतिमान औसत और FAO जल संतुलन मॉडल से किया गया। स्थैतिक संभाव्यता सूचकांक का आकलन भी इन तीन जिलों के लिए खरपतवार और पौधे के संरक्षण के उपायों के लिए किया गया। शुष्क भूमि स्थिति में थोड़े पैमाने पर साप्ताहिक वर्षा के विश्लेषण से धर्मपुरी जिले में 16 सप्ताहों की वढ़वार अवधि का पता चला है और मक्का, रागी व शोरघम का मिश्रण, अरहर और बीन फसलों को सजेस्ट करती है। तिरुनेलवेली जिले के बारे में बात करें तो बढ़वार को पहचाने गए 12 सप्ताह और विज्ञान के आधार पर दालों ओर बाजरा जैसी फसलों के लिए कम वाष्प वाष्पोत्सर्जन विलुपुरम जिले के लिए बढ़वार का समय 16 सप्ताह का है। हालांकि कपास की बजाय मूँगफली, तिल, मक्का, वारागू, सोयाबीय फसलों का विकल्प दिया गया है।

ABSTRACT. Monthly rainfall data for 90 years from 1911 to 2000 and recent years weekly rainfall data from 1981 to 2010 for 30 years were collected from India Meteorological Department and used for analysis to propose alternate crops under dry land situation of three selected districts of Tamil Nadu (Dharmapuri, Tirunelveli and Villupuram). Based on the geographical location, the annual mean rainfall of the three selected districts did vary indicating spatial variability of rainfall in Tamil Nadu. The length of growing period was analysed employing three different methods namely Hargreave's Moisture Availability Index, Jeevananda Reddy 14 weeks moving average and FAO water balance model. Conditional probability index was also computed for weeding and plant protection measures for the three districts. Under dry land situation, the shorter scale weekly rainfall analysis revealed 16 weeks growing period for Dharmapuri district and suggested crops were maize, ragi and mixture of sorghum, red gram and mochai. In respect of Tirunelveli district, the identified growing weeks were 12 and scientifically lesser Evapo-Transpiration requirement crops like pulses and minor millets had been suggested. For Villupuram district, the growing period was 16 weeks and hence groundnut, sesame, maize, varagu and soybean had been suggested against cotton.

Key words – Length of growing period, Conditional probability, Rainfall, Crops.

1. Introduction

Rainfall is a discrete atmospheric hydrological event and gets differed in space and time (Dar, 2011). Its variability has major implications on the economy of any country in the world including India (Yadav *et al.*, 2014). The extent and magnitude of the variability in seasonal rainfall in a country limits the country's growth and development. In India the Gross Domestic Product (GDP) is mainly dictated by monsoon rainfall rather than by any other means. Out of 329 million of hectares of geographical area in India, 142 million hectares are under cultivation and within this cultivable area about 68 per cent is either under dry or under rain fed situation. This farming system contributes about 44 per cent to the total food production in India.

Tamil Nadu is one among the states of India and has 3.1 million hectares of dry land out of seven million hectares of cultivable land. Out of seven agro climatic zones of Tamil Nadu, the dry land area distribution is wide spread in North eastern zone (26%), North western zone (24%) and Southern zone (24%) (Kannaiyan *et al.*, 2001).

The traditional subsistence farming system still exists with the dry land farmers of Tamil Nadu due to many obvious reasons and one among them is variability in seasonal rainfall. Over years this forced the farmers to lose interest in dry land farming leaving their land fallow. This may in long run may trigger socio-economic turbulence in the state of Tamil Nadu, unless the fallow dry land must be brought back under greenery. The only solution left is to support farmers to sustain dry land productivity by providing viable, scientific and practicable dry land farming recommendations along with providing meteorological information to take weather based farm decisions. In dry land agriculture, proper understanding of rainfall climatology is very important and it is one of the single largest factors which determine success of the dry land farming. Hence the study was made with an attempt to critically analyze the historical rainfall data of selected districts of Tamil Nadu, where the distribution of dry land area is wide spread.

2. Data and methodology

Purposeful sampling was done to select three agro climate zones based on the larger distribution of dry land area for the study. Accordingly all agro climate zones were ranked based on the distribution of dry land area and the top three zones of North eastern zone, North western zone and Southern zone were selected. In each agro climate zone, random sampling procedure was adopted to select one district and accordingly Dharmapuri district from North western zone, Villupuram district for North eastern zone and Tirunelveli district for Southern zone were selected. Dharmapuri is situated in the North-Western agro-climate zone of Tamil Nadu State and positioned at 10.12° N latitude and 77.59° E longitude with an elevation of 465.15 m above mean sea level. The region receives 853.1 mm of annual rainfall. Tirunelveli is situated in the Southern agro-climate zone of Tamil Nadu State and positioned at 8.73° N latitude and 77.70° E longitude with an elevation of 46.67 m above mean sea level. The region receives 736.9 mm of annual rainfall. Villupuram is situated in the North-Eastern agro-climate zone of Tamil Nadu State and positioned at 11.93° N latitude and 79.49° E longitude with an elevation of 47.58 m above mean sea level. The region receives 1029.4 mm of annual rainfall.

Monthly rainfall data for 90 years from 1911 to 2000 were collected from India Meteorological Department in respect of Dharmapuri, Villupuram and Tirunelveli districts. Before doing analysis the quality of the data was assessed and found valid. The potential evapo-transpiration data for these three districts were collected from the published report (Rao *et al.*, 1971).

To understand and to support crop production it is necessary to analyse shorter scale rainfall data also and hence recent years weekly rainfall of these three districts have been collected for 30 years from 1981 to 2010. By utilizing the monthly and weekly rainfall data, the following meteorological exercises were done to develop farm decision products for making dry land agriculture sustainable.

(a) *Ninety years monthly data*

Eight datasets as given below had been developed and used for analysis to find out mean and co-efficient of variation which are very critical to venture any crop planning process under dry land situation (Veeraputhiran *et al.*, 2003).

1. Annual rainfall data for a block of 90 years from 1911 to 2000

2. Seasonal rainfall data for a block of 90 years from 1911 to 2000

3. I block of annual rainfall data for 30 years from 1911 to 1940

4. I block of seasonal rainfall data for 30 years from 1911 to 1940

5. II block of annual rainfall data for 30 years from 1941 to 1970

6. II block of seasonal rainfall data for 30 years from 1941 to 1970

7. III block of annual rainfall data for 30 years from 1971 to 2000

8. III block of seasonal rainfall data for 30 years from 1971 to 2000

In addition both linear trend curve and five years moving average curve were also drawn for 90 years annual data set. The trend for seasonal rainfall namely Cold Weather Period (CWP), Hot Weather Period (HWP), South West Monsoon (SWM) and North East Monsoon (NEM) seasons in respect of three districts by utilizing Ms-excel programme was inferred.

(b) *Weekly data set*

Considering the availability of the weekly data, weekly rainfall data of recent years for 30 years from 1981 to 2010 were collected from IMD and used for developing the following farm decision making tools.

TABLE 1

Moisture availability index *versus* moisture deficit

MAI	Category
0.00- 0.33	Very deficient
0.34-0.67	Moderately deficient
0.68-1.00	Deficient
1.01-1.33	Adequate moisture
>1.34	Excessive moisture

1. Moisture Availability Index – (MAI) (Hargreaves, 1971)

2. Length of Growing Period (Jeevananda Reddy, 1983)

3. FAO water balance model (Higgins & Kasam, 1981)

4. Conditional Probability Index for carrying out weeding and plant protection measures (Veeraputhiran *et al*., 2003)

Moisture Availability Index is the weekly ratio between assured precipitation (30 per cent probability) and potential evapotranspiration. The classification given by him (Table 1) was used for the present study.

Jeevananda Reddy (1983) used this method as a simple tool to compute the length of growing period for semi arid tropics based on mean weekly Rainfall (R) and weekly PET (PE). R/PE is worked out in which R is the mean weekly rainfall (mm) and PE is weekly Potential Evapo-transpiration (mm). As the growing season is limited to less than 90 days in drylands, 14 weeks moving average was suggested and based on this R/PE ratio, the following six climatic variables have been identified as reported by Jeevananda Reddy (1983).

Available Effective Rainy Period (G)

The number of consecutive weeks in which the 14 weeks moving average of R/PE ratio is ≥ 0.75 and the initial week of this effective rainy period should be with simple R/PE ratio of ≥ 0.5. This is otherwise known as growing period.

Sowing Rain (S)

The week before the beginning of the available effective rainy period is taken as the week of commencement of sowing rain. Here the simple R/PE ratio should be ≥ 0.5.

TABLE 2

Climatic variables for LGP by Jeevananda Reddy method, 1983

Climate variable	14 weeks moving average R/PE	Simple weekly R/PE
G	≥0.75	≥0.50
S	-	≥0.50
Ps	≥0.50	≥0.25
W	-	≥1.50
D	-	≤0.50

Presowing Cultivation (Ps)

Pre sowing cultivation and seed bed preparation (Ps) get started when the 14 week moving average curve for R/PE ratio crosses 0.5 limits and when the particular week has simple R/PE ratio of ≥ 0.25.

Wet spell (W)

Within G, if the simple R/PE ratio is ≥ 1.5, the week is called as wet spell.

Dry spell (D)

Within the growing period if the simple R/PE ratio is < 0.5, the week is said to be called as dry spell.

Crop failure (A)

If the 'G' period (in any year) is ≤ 5 weeks the possibility of growing any crop is limited.

These climatic variables can be summarized as follows as given in Table 2 and this was followed in the present study.

In respect of FAO water balance model, the growing period started when precipitation exceeds 0.5 PET and terminated with the utilization of assumed quantum of stored soil moisture (100 mm) after precipitation fell below 0.5 PET.

Conditional Probability Index was computed to carry out weeding and intercultural operations as per the procedure (Veeraputhiran *et al*., 2003).

CPI = Mean – X / SD

where,

CPI = Conditional Probability Index;

TABLE 3

Rainfall statistics of three districts

Years	Annual		Cold Weather Period (Jan - Feb)		Hot Weather Period (Mar - May)		Southwest Monsoon (Jun - Sep)		Northeast Monsoon (Oct - Dec)	
	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV
Dharmapuri										
1911-2000	869.6	19.5	20.8	129.8	157.5	35.8	370.1	30.4	321.3	37.7
1911-1940	839.1	17.6	27.6	119.8	163.0	35.6	343.7	32.7	304.8	37.6
1941-1970	897.3	21.0	19.8	113.4	165.0	38.3	369.8	28.6	342.6	36.0
1971-2000	872.6	19.6	14.9	157.0	144.4	31.8	396.9	29.5	316.5	39.8
Tirunelveli										
1911-2000	857.2	23.0	78.2	82.4	156.0	41.2	135.4	42.3	487.5	36.6
1911-1940	949.3	20.5	95.7	62.6	150.8	44.0	149.7	45.9	553.1	34.8
1941-1970	808.8	20.3	75.2	79.4	174.1	36.5	127.1	34.8	432.5	30.6
1971-2000	813.4	25.2	63.7	111.7	143.3	42.5	129.6	42.7	476.8	39.5
Villupuram										
1911-2000	1054.3	22.9	40.3	138.5	85.6	99.0	403.3	25.1	525.2	36.1
1911-1940	1131.4	17.9	58.4	123.4	93.0	65.2	389.0	22.3	591.0	30.1
1941-1970	1056.0	24.4	37.5	104.0	102.5	121.9	409.4	25.3	506.7	40.0
1971-2000	975.5	24.7	24.9	189.8	61.4	69.1	411.5	27.6	477.8	36.4

X = Required rainfall to carry out farm operations (15 mm for weeding and 10 mm for plant protection measures)

SD = Standard deviation of the data set.

Since the resultant value does not fall under normal distribution it has to be referred in 'Z' table and multiplied by 100 to find out the actual probability in percentage. Two riders are to be considered in this process

(*i*) If the resultant value of the formula given above is positive, the corresponding value may be referred to 'Z' table and multiplied by 100. This gives conditional probability index in percentage.

(*ii*) If the resultant value is negative, the corresponding 'Z' table value is deducted from unity (1) and multiplied by 100. This gives the conditional probability in percentage.

3.   Results and discussion

The rainfall statistics for the three districts are presented in Table 3.

In respect of Dharmapuri district, the mean annual rainfall for 90 years was 869.6 mm, while for the first block of 30 years (1911-1940) it was 839.1 mm (-31 mm from the mean of 90 years). In respect of II block (1941-1970), it was 897.3 mm (+27 mm over the mean of 90 years) and for the III block (1971-2000) it was 872.6 mm (+3 mm over the mean of 90 years).

In respect of Tirunelveli district, the mean rainfall for 90 years was 857.2 mm, while for the first block of 30 years (1911-1940) it was 949.3 mm (+92 mm over the mean of 90 years). In respect of II block (1941-1970), it was 808.8 mm (-48 mm from the mean of 90 years) and for the III block (1971-2000) it was 813.4 mm (-44 mm from the mean of 90 years).

In respect of Villupuram district, the mean rainfall for 90 years was 1054.3 mm, while for the first block of 30 years (1911-1940) it was 1131.1 mm (+77 mm over the mean of 90 years). In respect of II block (1941-1970), it was 1056.0 mm (+2 mm over the mean of 90 years) and for the III block (1971-2000) it was 975.5 mm (-78 mm from the mean of 90 years).

Lesser Coefficient of Variation (CV) up to 20 per cent for annual rainfall data set would indicate that the
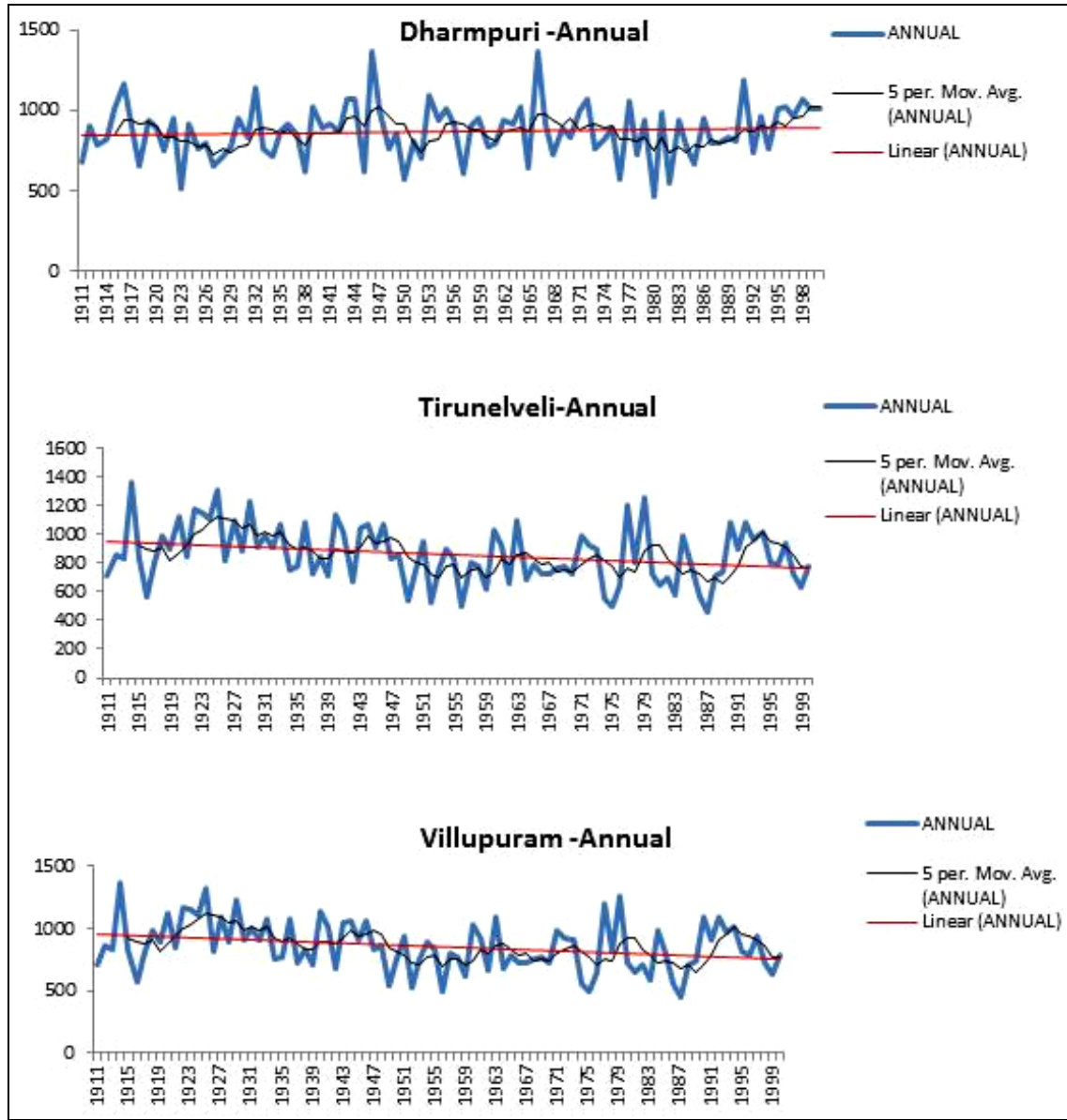
Fig. 1. Annual five year moving average from 1911-2000

TABLE 4

*Linear trend and five years moving average curve

Districts	Linear trend (1911-2000)					Five years moving average (1911-2000)				
	Annual	CWP	HWP	SWM	NEM	Annual	CWP	HWP	SWM	NEM
Dharmapuri	+	-	-	+	+	+	-	-	+	+
Tirunelveli	-	-	N	-	-	-	-	N	-	-
Villupuram	-	-	-	-	-	-	-	-	-	-

* - with reference to base year (+) : increase, (-) : decrease and (N) : No change

TABLE 5

Moisture availability index for three districts by Hargreaves method

Dharmapuri		Tirunelveli		Villupuram	
Standard week	Category	Standard week	Category	Standard week	Category
33	Adequate moisture	39	Adequate moisture	33	Adequate moisture
34	Excessive moisture	40	Deficit	34	Excessive moisture
35	Adequate moisture	41	Adequate moisture	35	Adequate moisture
36	Excessive moisture	42	Excessive moisture	36	Excessive moisture
37	Excessive moisture	43	Excessive moisture	37	Excessive moisture
38	Excessive moisture	44	Excessive moisture	38	Excessive moisture
39	Excessive moisture	45	Excessive moisture	39	Excessive moisture
40	Excessive moisture	46	Excessive moisture	40	Excessive moisture
41	Excessive moisture	47	Excessive moisture	41	Excessive moisture
42	Excessive moisture	48	Excessive moisture	42	Excessive moisture
43	Adequate moisture	49	Adequate moisture	43	Excessive moisture
44	Excessive moisture	50	Moderately deficit	44	Excessive moisture
45	Excessive moisture			45	Excessive moisture
46	Moderately deficit			46	Moderately deficit
47	Moderately deficit			47	Moderately deficit
48	Moderately deficit			48	Moderately deficit

TABLE 6

Length of growing period by Jeevananda Reddy method

Dharmapuri			Tirunelveli			Villupuram		
Standard week	Simple R/PE	14 weeks moving average	Standard week	Simple R/PE	14 weeks moving average	Standard week	Simple R/PE	14 weeks moving average
31	0.71	0.85	39	0.70	0.83	33	1.01	0.83
32	0.57	0.98	40	0.44	0.92	34	1.13	0.90
33	0.77	1.08	41	0.59	0.96	35	0.79	0.93
34	1.15	1.17	42	1.06	0.99	36	0.92	1.05
35	0.91	1.22	43	1.79	1.01	37	1.23	1.19
36	1.27	1.27	44	1.95	1.05	38	0.99	1.34
37	1.82	1.34	45	2.52	1.05	39	1.18	1.43
38	1.73	1.36	46	1.29	1.03	40	1.52	1.46
39	2.09	1.39	47	1.20	1.01	41	1.16	1.45
40	1.83	1.39	48	0.73	0.98	42	0.79	1.48
41	1.48	1.33	49	0.61	0.90	43	2.24	1.52
42	1.46	1.3	50	0.56	0.79	44	2.40	1.52
43	1.3	1.23				45	2.63	1.49
44	1.61	1.12				46	1.84	1.41
45	0.97	1				47	1.44	1.31
46	0.9	0.86				48	0.97	1.23
						49	1.20	1.17
						50	1.48	1.02
						51	1.16	0.85

TABLE 7

Length of growing period by FAO water balance model

Dharmapuri			Tirunelveli			Villupuram		
Standard week	50% PET (mm)	30% RF (mm)	Standard week	50% PET (mm)	30 % RF (mm)	Standard week	50% PET (mm)	30 % RF (mm)
33	14.9	32.4	39	13.6	31	33	16.8	43
34	14.9	41.0	40	12.3	18	34	16.8	53
35	14.8	35.2	41	12.3	24.6	35	16.5	38
36	14.6	40.8	42	12.3	36	36	15.7	39
37	14.6	64.0	43	12.3	54	37	15.7	72
38	14.6	70.4	44	12.1	62	38	15.7	38
39	14.6	91.4	45	11.9	76	39	15.7	52.1
40	13.1	62.2	46	11.9	35	40	13.6	54.8
41	13.1	48.4	47	11.9	41	41	13.6	55.5
42	13.1	41.0	48	12.3	31	42	13.6	31.5
43	13.1	31.4	49	13.3	26	43	13.6	66.5
44	13.0	46.4	50	13.3	10	44	13.1	99
45	13.0	39.6	51	13.3	22	45	12.8	127.5
46	13.0	16.2				46	12.8	30.9
						47	12.8	41
						48	12.8	33.9
						49	13.0	23
						50	13.0	20
						51	13.0	29

variability is lesser with an indication of getting assured annual rainfall amount. Similarly for season rainfall data the CV must be lesser than 50 per cent (Veeraputhiran *et al.*, 2003).

In respect of Dharmapuri district, the CV of 90 years data set, I and III blocks of 30 years data set did show lesser CV indicating the assuredness of rainfall receipt. Among seasons, except cold weather period, in all the three seasons, *i.e.*, hot weather period, southwest monsoon season and northeast monsoon season, the CV was lesser than 50 per cent indicating assuredness of rainfall amount to be received. In respect of Tirunelveli district except during cold weather period in all other season the CV was with in the threshold level of < 20 per cent for annual rainfall and the threshold level of < 50 per cent for seasonal rainfall. For Villupuram district there was assured rainfall based on CV for south west and north east monsoons rain fall for 90 and 30 years data analysis.

The variability in annual rainfall in the three districts was mainly due to their geographical position in Tamil Nadu and accordingly due to bi-model rainfall, the annual rainfall was higher in Villupuram district followed by Dharmapuri district as compared to Tirunelveli district, wherein the annual rainfall was mainly influenced by North east monsoon rainfall. As reported by (Kamble *et al.*, 2014), the CV would be higher for scarce rainfall region as compared to region with high annual rainfall.

The five years moving average and linear trend curve, drawn for annual data set of 90 years (1911-2000) are presented in Table 4 and Fig. 1.

From the (Fig. 1), it is interpreted that for Dharmapuri district the annual rainfall data of 90 years did show increased trend in rainfall at the end of the study period (2000) as compared to base year of the study period (1911). The increase in annual rainfall over years was due to increase in both southwest and northeast monsoon rainfall as noticed in the present study. In general the increase in south west and northeast monsoon rainfall might be due to shift of rainfall from cold weather period and hot weather period.

For Tirunelveli district the information from (Fig. 1) showed decreased trend in 90 years annual rainfall data set and this was supported by the seasonal analysis also. The decrease in annual rainfall was due to light decrease in both southwest and northeast monsoon rainfall.

In respect of Villupuram district there was decrease in annual rainfall of 90 years and this was 14 per cent at the end of the study period (2000) as compared to the base year (1911). In the case of both south west and northeast monsoon season; in general there was decrease in rainfall which amounted to 26 per cent and 27 per cent respectively. The decrease was not so significant to affect crop production. The change in annual rainfall and as well as change in seasonal rainfall for different regions of India has been reported by (Yadav *et al*., 2014).

The length of growing period computed through Hargrerve's MAI, Jeevananda reddy 14 weeks moving average method and FAO water balance method are given from Tables 5 to 8. It is inferred from the Table 8 that the length of growing period was from 14 to 16 weeks for Dharmapuri district, 11 to 13 weeks for Tirunelveli district and 16 to 19 weeks for Villupuram district based on the three model used.

Among these three methods, length of growing period calculated through 14 weeks moving average method was the best (Veeraputhiran *et al*., 2003). The quoted reason was adopting moving average seems to be a better technique to smoothen dataset and provides a valuable result (Hannen and James, 1970). The other best method followed by 14 weeks moving average would be Hargrerve's MAI where probable rainfall of 30 per cent and 100 per cent weekly PET was taken into account. In respect of FAO water balance model, though 30 per cent probable weekly rainfall was taken into account, only 50 per cent PET was considered to arrive the length of growing period. Hence, the growing weeks derived from Jeevananda Reddy and Hargrerve's model were considered for this study.

Sixteen weeks for Dharmapuri, 12 weeks for Tirunelveli and 16 weeks for Villupuram districts have been considered for crop planning. For crop planning discussion, the length of growing period from Hargreaves method has been considered because of the identification of the different categories of the moisture status.

In Dharmapuri district, adequate moisture was available from Standard Meteorological Week (SMW) 33 to 45 (SMW) with 3 more weeks up to 48 (SMW) under moderately deficit category (16 weeks / 112 days). In these growing weeks, three categories of moisture availability had been found namely adequate moisture,

TABLE 8

Length of growing period derived from three different methods for three districts

Districts	Hargreaves MAI (weeks)	Jeevananda Reddy (weeks)	FAO water balance (weeks)
Dharmapuri	33 to 48 (16)	31 to 46 (16)	33 to 46 (14)
Tirunelveli	39 to 50 (12)	39 to 50 (11)	39 to 51 (13)
Villupuram	33 to 48 (16)	33 to 51 (19)	33 to 51 (19)

excessive moisture and moderately deficit. The adequate moisture always favours crop production while the excessive moisture though meets the crop Evapo-Transpiration (ET), it always restricts crop growth because of the inundation of roots with soil moisture (Kanwar *et al*., 1988). When excess moisture is found in the soil profile, it replaces air including oxygen which is very vital for growth of both below ground and the above ground parts of the plant. Hence, the weeks with excess moisture must be provided with adequate drainage in the cropped field. In the third category of moderately deficit came at the terminal part of the growing period and this period was beyond the physiological maturity of the crop which do not require any moisture support from the soil (Ransom, 2013). Considering the 16 weeks of growing period, crop planning must accommodate growing of maize of 100 days in duration, ragi of 110 days in duration and a crop mixture of sorghum, redgram and mochai for harvesting potential yield under dry land situations as like that of crops raised under irrigated agriculture.

For Tirunelveli, the growing period started from 39th SMW and terminated at 50th SMW (12 Weeks / 84 days) with four categories of moisture status and those were adequate moisture, deficit, excess moisture and moderately deficit. Adequate moisture started with 39th SMW followed by deficit moisture week and hence, if sowing was taken on 39th SMW, the population of the sown crops would get affected (Hosseini *et al*., 2009). Under these situations, two options could be considered.

(*i*)   Using the adequate moisture available during 39 SMW, preparatory cultivation may be done followed by sowing on 41st SMW skipping 40th SMW.

(*ii*)   If sowing was taken on 39th SMW the sown crops must be covered with mulch to conserve soil moisture to protect the growing seeds during moisture deficit week of 40th SMW (Shirish *et al*., 2013). Under this available growing period of 12 weeks, crop planning has to be done to include lesser ET requirement crops like pulses and minor millets for sowing (Manikandan *et al*., 2014) to harvest potential yield under shorter growing period.

TABLE 9

Conditional probability for weeding and plant protection measures for three districts

Dharmapuri			Tirunelveli			Villupuram		
Standard week	CP 10 mm (plant protection measures)	CP 15 mm (weeding)	Standard week	CP 10 mm (plant protection measures)	CP 15 mm (weeding)	Standard week	CP 10 mm (plant protection measures)	CP 15 mm (weeding)
31	58.71	54.78	39	63.68	54.78	33	69.15	65.91
32	59.84	52.39	40	56.00	41.68	34	77.23	67.72
33	64.8	61.03	41	64.06	55.17	35	68.44	62.17
34	68.44	65.17	42	66.28	62.55	36	68.79	62.55
35	66.64	61.79	43	75.17	77.23	37	73.24	70.19
36	71.9	67.36	44	78.23	74.54	38	72.24	64.8
37	73.24	70.88	45	82.12	79.39	39	69.85	65.91
38	76.73	73.89	46	68.79	63.31	40	73.57	70.19
39	81.33	78.81	47	69.85	65.91	41	71.9	66.64
40	77.64	74.54	48	67.36	59.1	42	70.54	62.17
41	79.95	75.49	49	64.06	55.17	43	76.11	73.57
42	71.57	67.72	50	54.38	46.02	44	77.64	75.17
43	69.5	65.17				45	77.34	75.49
44	72.57	69.85				46	65.17	63.31
45	67.72	61.03				47	68.08	65.54
46	58.71	53.19				48	67.36	64.43
47	58.32	53.19				49	66.64	62.93
48	57.14	50.00				50	60.64	59.1
						51	64.8	61.4

In respect of Villupuram district, the growing period started from 33rd SMW and terminated with 48th SMW (16 weeks / 112 days) with two categories of moisture namely adequate moisture and excessive moisture.In order to maneuver, the excessive moisture weeks, it is suggested to provide drainage facilities. In this growing period of 16 weeks, considering the soil under dryland situation, groundnut, sesame, maize, varagu and soybean could be grown potentially.

Against the length of growing period identified in these three districts scientifically, in ground reality farmers grow longer duration crop like cotton and they get lesser productivity. This was mainly due to growing of crops beyond the growing period identified.

The computed conditional probability index for different farm operations namely weeding and planting protection are presented in Table 9.

Based on the result, it is interpreted that weeding at 30 days after sowing and plant protection measures based on Hargreaves model can be taken with CPI of values more than 60 per cent for all the three districts.

4.   Conclusion

Monthly rainfall data of 90 years (1911 - 2000) and recent years weekly data for 30 years (1981 - 2010) were analysed for mean and co-efficient of variation (90 years data set), length of growing period and conditional probability index (recent 30 years of data set) in respect of selected three districts (Dharmapuri, Tirunelveli and Villupuram) of Tamil Nadu Under dry land situation, the shorter scale weekly rainfall analysis revealed 16 weeks growing period for Dharmapuri district and suggested crops were maize, ragi and mixture of sorghum, red gram and mochai. In respect of Tirunelveli district, the identified growing weeks were 12 and scientifically lesser Evapo-Transpiration requirement crops like pulses and minor millets had been suggested. For Villupuram district, the growing period was 16 weeks and hence groundnut, sesame, maize, varagu and soybean had been suggested against cotton. It is suggested to test these proposed crops under on-farm trails in these three districts.

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