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Crop planning in relation to climate change in rain fed regions

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Uncertainty and variability of rains both space and time is the major constraints affecting agricultural production in rain fed farming. Scientific study on the quantum and distribution of rainfall would enable to farming community and researcher to adjust or modify the cropping pattern as well as the cultural operation to utilize the actual moisture available in the field for profitable crop production. The daily rainfall data for last 39 year were analyzed to study its variability and probability. In rain fed farming rainfall is the primary and most important factor affecting productivity and it is mostly uncertain and erratic. Thus, the change in the rainfall pattern and amount suggests adjusting or modifying the cropping pattern and cultural practices of agricultural crops in the region for achieving the sustainable productivity. Under short break of monsoon, repeated hoeing to prevent soil moisture loss and under long dry spell, agronomic management like mulching, relay cropping or re-sowing are advocated.

Key words: rainfall variability, dry spell, CDS, crop planning: India

Introduction

Amount, distribution and intensity of rainfall mainly determine the choice of any particular crop and agronomic practices in the rain fed agriculture. Study indicated that the mean annual rainfall for Akola location was 782 mm in 42 rainy days with 26 percent variability. More than 50 % of the years were observed to have less than normal rains and linear trend showed a decline trend in respect of annual rainfall. Decadal analysis of monthly rainfall shows curtailment in amount of rainfall in June, July and August while increasing in September and October month clearly indicates change in amount and pattern of rainfall. The annual rainfall received was based on the IMD specifications as Normal (particular year that received ± 19 per cent of mean annual rainfall), Excess (Year that received more than 19 per cent of mean annual rainfall) and

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Deficit (Year that received less than 19 per cent of the mean annual rainfall). An early recognition of risk and implementation of adaptation strategies is crucial as anticipatory and precautionary adaptation is more effective and less costly than forced, last minute, emergency adaptation or retrofitting (Eitzinger *et al*., 2007). Hence, a study of rainfall pattern was undertaken at Akola to understand the rainfall variability so as to identify suitable crops and varieties for early normal and later commencement of sowing rains. It could also help to identify and match intercropping system with the rain fed pattern and to determine optimum sowing period for different crops and cropping system.

Materials and methods

Daily rainfall data for 39 years (1971-2009) from Agromet observatory located at Gudhadhi block, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (20^{o} 42' N latitude, 77^{o} 02' E longitude an and altitude 282 meter (MSL)) were used for analysis of variability . The data were aggregated to weekly and annual totals and also for the mean rainfall, standard deviation and coefficient of variation for annual period were worked out as reported by Kulandaivelu *et al.* (1979 and 1980), Budhar and Ramasamy (1985) and P. Parasuraman *et al.* (2002). The annual rainfall received was classified based on the IMD specifications as

$$\text{Classified based on the IMD specifications } \pm 19 = \frac{\text{Actual (Rainfall)} - \text{Normal (Rainfall)}}{\text{Normal (Rainfall)}} \times 100$$

Normal (particular year that received ± 19 per cent of mean annual rainfall), Excess (Year that received more than 19 per cent of mean annual rainfall) and Deficit (Year that received less than 19 per cent of the mean annual rainfall).

As suggested by Dr. Pawade (1981) the critical value for Amravati station was considered as 10 days. Subsequent critical dry spells are also defined in a similar fashion. Critical dry spells were worked out as reported by Satpute *et al* (Anonymous 2008). Probable distribution of dry spells during rainy season will help for crop planning in rainfed region. To minimize the risk of dry spells during crop growing period, suitable crop sowing time can be identified and proper crop planning was based on the findings.

Results and discussions

Trends of rainfall variation

The rainfall showed a decreasing trend in annual (Y = -2.7853x + 837.67) R2 = 0.0238. Therefore, the annual trend analysis of over past 39 years reflects that a considerable decreasing trend. It is observed from Table 1 that earliest onset of monsoon is on 20th week (in 2009) while late onset is on 30th MW (in 2004) and on an average Southwest monsoon starts on 25th MW. It could be observed that there are variation in normal date of onset and withdrawal of monsoon in Akola and monsoon having 2 to 3 critical dry spells.

Table 1. Variability in onset and withdrawal of monsoon for Year 1971 to 2009

Onset of Monsoon			**Withdrawal of Monsoon**		
Earliest	Late	Mean	Earliest	Late	Mean
20th M.W	30th M.W	25th M.W	33rd M.W	46th M.W	40th M.W

While in case of withdrawal of rainfall it early ceases as early as on 33rd MW (in 1981, 1986 and 1991) while it could be remain up to 46th MW (in 2004) on an average withdrawal of monsoon is on 40th MW.

The data on mean annual rainfall, coefficient of variation, probability and its classification are given in table 2. The mean annual rainfall was 782 mm with coefficient variation of 26 per cent. Out of 39 years of study, the rainfall was normal for 23 years and for another 8 years was deficit and for the remaining eight years it was excess (Parasuraman and Suresh, 2002).

Table 2 : Annual rainfall analysis and classification at Akola Location 1971 to 2009

Sr. No.	Year	Annual Rainfall (mm)	Percent to Average	*Classification
1	1971	599.3	-23.36	Deficient
2	1972	644.8	-17.54	Normal
3	1973	1092.9	39.76	Excess
4	1974	638.7	-18.32	Normal
5	1975	847.2	8.34	Normal
6	1976	804.0	2.82	Normal
7	1977	1003.9	28.38	Excess
8	1978	941.0	20.34	Excess
9	1979	895.4	14.51	Normal
10	1980	684.0	-12.53	Normal
11	1981	917.8	17.37	Normal
12	1982	631.5	-19.24	Deficient
13	1983	819.3	4.78	Normal
14	1984	523.6	-33.04	Deficient
15	1985	719.5	-7.99	Normal
16	1986	811.3	3.75	Normal
17	1987	759.0	-2.94	Normal
18	1988	1336.6	70.93	Excess
19	1989	712.0	-8.95	Normal
20	1990	1091.2	39.55	Excess
21	1991	457.7	-41.47	Deficient
22	1992	900.0	15.10	Normal
23	1993	956.9	22.37	Excess
24	1994	908.0	16.12	Normal
25	1995	670.8	-14.22	Normal
26	1996	696.3	-10.95	Normal
27	1997	851.3	8.87	Normal
28	1998	803.6	2.77	Normal
29	1999	1013.8	29.65	Excess
30	2000	545.0	-30.30	Deficient
31	2001	731.2	-6.49	Normal
32	2002	651.9	-16.63	Normal
33	2003	360.3	-53.92	Deficient
34	2004	470.0	-39.89	Deficient
35	2005	772.1	-1.26	Normal
36	2006	1192.5	52.50	Excess
37	2007	779.8	-0.28	Normal
38	2008	562.7	-28.04	Deficient
39	2009	699.5	-10.55	Normal
Annual mean rainfall (1971 to 2009)				781.96 mm
Annual Standard Deviation				203.33
Annual Coefficient of Variance				26.0

* Excess if rainfall is more than 19 % of mean, Deficient if rainfall is less than 19 % of mean and Normal if rainfall is not more or less than 19 % of mean.

It is observed that there was high variability of rains a shown in Table 3 which revealed the lowest amount of rainfall is 360.3 mm (in 2003) while highest amount of rainfall was 1337 mm (in 1988) and mean amount of rainfall was 782 mm. The number of rainy days was lowest up to 29 days (in 1991) and highest up to 55 days (in 2006) on an average 42.4 number of rainy days were observed in 39 years. In case of duration of monsoon the shortest as 8 weeks (in 1995) while stable up to 21 weeks (in 1998) on an average duration of monsoon was 14.8 weeks.

Table 3. Variability of amount and duration of rainfall year 1971 to 2009

Rainfall (mm)			Number of Rainy days		
Lowest	Highest	Mean	Lowest	Highest	Mean
360.3	1337	782	29	55	42.4

Monsoon duration (weeks)		
Shortest	Longest	Mean
8	21	14.8

Water availability period

Water availability period depends upon rainfall and potential evaporation, humid (when rainfall exceeds potential evaporation) and moist (when rainfall was less than potential evaporation but exceeds potential evpotranspiration) period together provides congenial weather for active crop growth. It is observed that there were three critical dry spell observed during southwest monsoon, among those first started on 17th of July and ended on 2nd of August with 16 days period while second critical dry spell started on 14th of August and ended in 1st of September with 18 days period and third critical dry spell started on 11th of September and ended on 3rd of October which have longest dry period of 22 days (Anonymous, 2008) as shown in Table 4. If the duration of break is more than 4 week and frequency is more than three time, usually results in failure of crops. When onset is late the sowing of crops are delayed resulting in poor yield, as the rain may cease very early in the season exposing the crop to drought during flowering and maturity stages.

Table 4. Critical Dry Spells observed in monsoon period

Critical Dry Spell	Start	End	Period
I	17 July	2 Aug	16 Days
II	14 Aug	1 Sept	18 Days
III	11 Sept	3 Oct	22 Days

Control measures

There are many problems of rain fed farming like in adequate and uneven distribution of rainfall, late onset and early cessation of rains and prolong dry spell during the crop period all these effect ultimately reduces crop growth and yield. It is very important to maintain the proper plant stand to ensure the better yield after dry spell occurs immediately after sowing. If severe dry spell occurs immediately after sowing at that condition is better for re-sowing the crop with subsequent rains than to continue with inadequate plant stand. In case of long break in monsoon or late season drought at that condition sowing of short duration is essential simultaneously application of field operation like mulching, frequently irrigation wherever facility available, weed control etc. are essential to save the crops (Table 5).

Table 5 : Proposed action plans according to contingencies

S.N	Nature of the contingencies	Action plan proposed
1)	Stress within 10 DAS	Re-sowing with subsequent rains
2)	Stress at 40 to 50 DAS	i) Thinning ii) Urea spray 2 to 3 % on arrival of rains. iii) Drop top dressing or reduce the dose
3)	Short break in monsoon	Repeated hoeing to create soil mulch to prevent soil moisture loss
4)	Long break in monsoon	i) Mulching ii) May adopt relay cropping iii) Re-sowing of land with *rabi* and semi *rabi* crops
5)	To heavy rainfall leading to water logging	i) Improve drainage ii) Hoeing after the suitable field condition (Vapsa condition) iii) Apply fresh dose of fertilizer Double cropping after harvesting of *kharif* crop

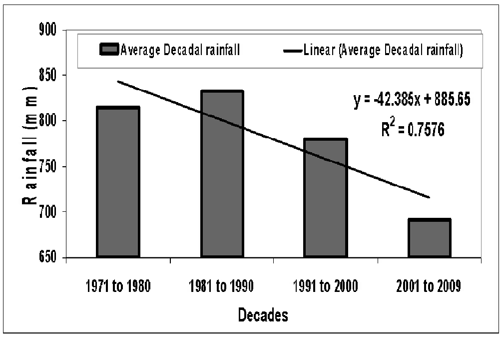

Fig. 1. Decadal average of annual rainfall.

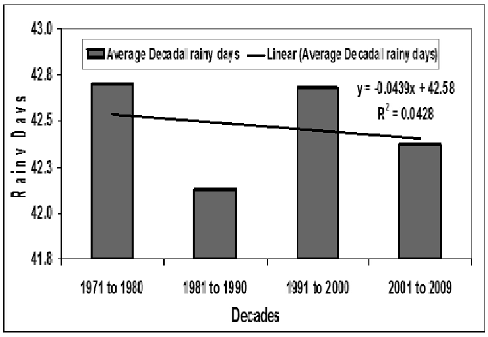

Fig. 2. Decadal averages of annual rainy days.

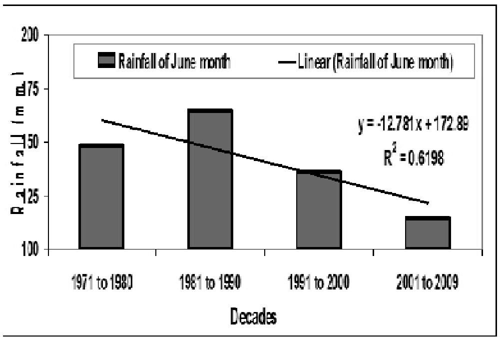

Fig. 3. Decadal average monthly rainfalls for June month.

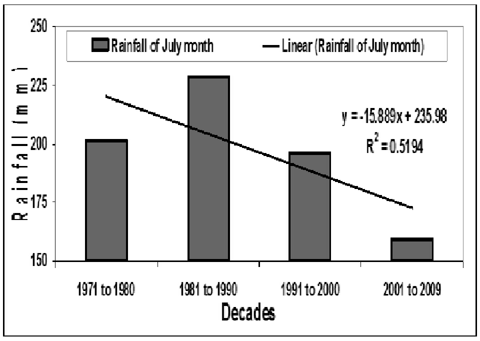

Fig. 4. Decadal average monthly rainfalls for July month.

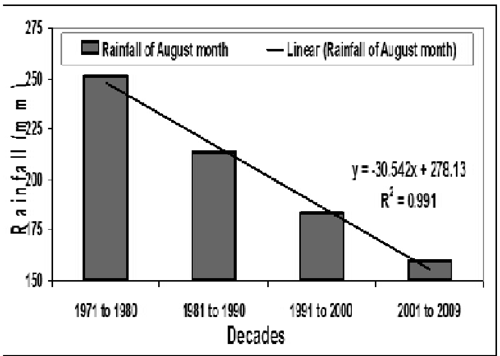

Fig. 5. Decadal average monthly rainfalls for August month.

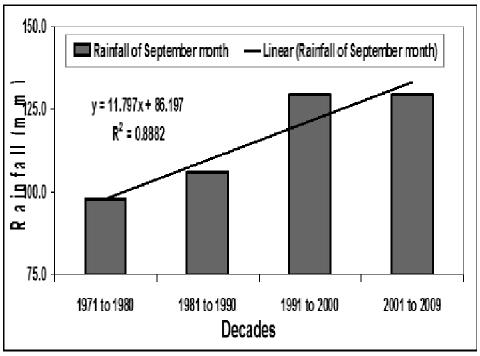

Fig. 6. Decadal average monthly rainfalls for Sept. month

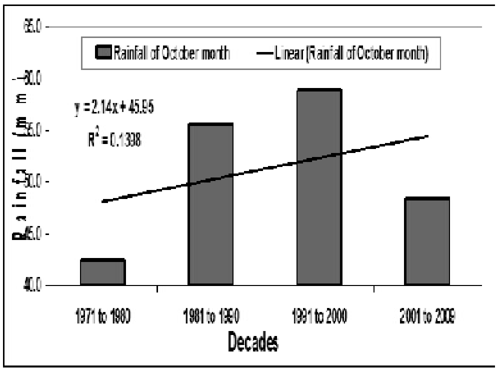

Fig. 7. Decadal average monthly rainfalls for October month.

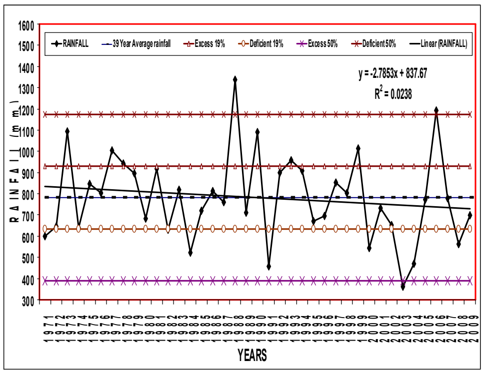

Fig. 8. Year wise Normal, Excess and Deficient rainfall.

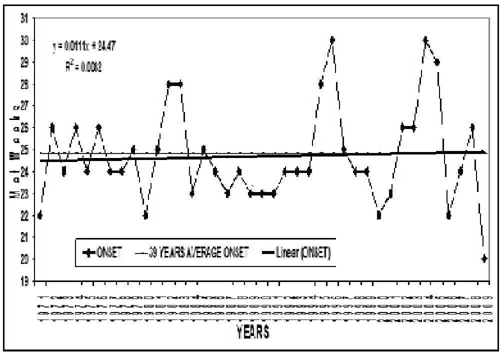

Fig. 9. Year wise onset of monsoon for Akola Location.

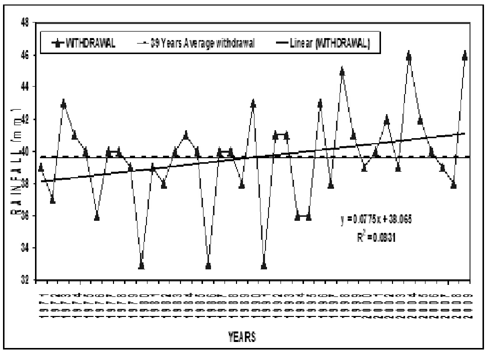

Fig. 10. Year wise withdrawal of monsoon for Akola.

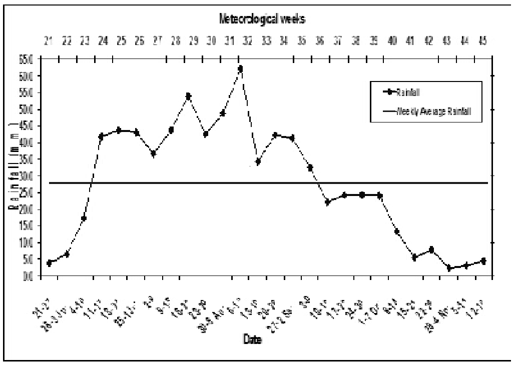

Fig. 11. Week wise Average Rainfall for Akola Location.

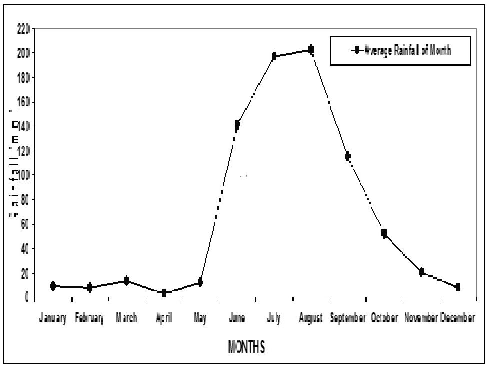

Fig. 12. Month wise Average Rainfall for Akola Location.

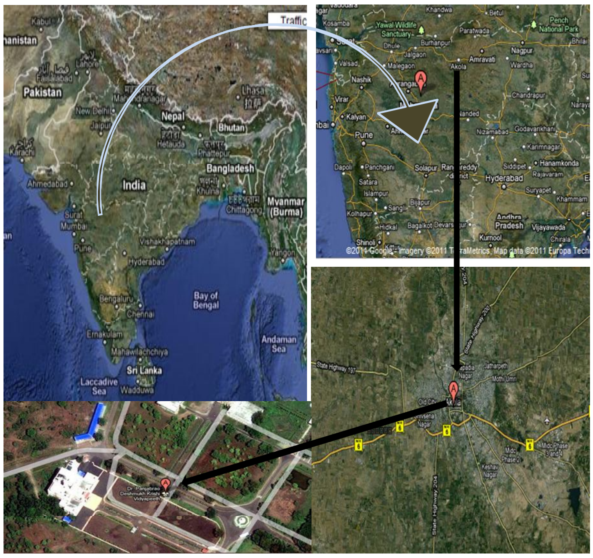

Fig. 13. Study area. Dr. PKV, Akola, Maharashtra, India.

Conclusions

Under the uncertain with delaying trend of decadal rainfall, long duration crops are needed to be replaced by other short duration. Therefore, the reduced duration of crop growing season and amount of rainfall in recent decade indicates lesser water availability period, there by indicating possible climatic shift in the region. The above results also indicate that reduction of 75 percent in amount of rainfall it could be dangerous for ecology in rain fed regions. Negative impact of variability of rainfall pattern on agricultural production could be avoided or reduced significantly by applying appropriate adaptation measures. There are biological measures or agronomic practices and Mechanical measures to reduce or prevent either water erosion or wind erosion while achieving desired moisture for sustainable production.

References

Budhar, M.N. Ramaswamy, R. (1985). Influence of rainfall on cropping systems in drylands of pennagaram taluka of Dharmapuri District. Madras Agril. J. 72: 213-217.

Eitzinger, J., Utset, A., Trnka, M.., Zalud, Z., Nikolaev, M and Uskov, I. (2007). Weather and climate and optimization of farm technologies at different input levels. India: Managing Weather and Climate Risks in Agriculture, 554, Sivakumar, M. V. K. and Moth, R. (eds.). Springer, Berlin, ISBN 3540727442.

G.U. Satpute and R.C Bhuyar (2008). Anonymous 2009. Dr. PDKV, Akola (MS).

Kulandaivelu, R.R., Kumpuchetty, N., Rajendran, P. and Morachan, Y.B. (1979). Rainfall pattern and cropping system in Kinathukkadavu block, Coimbatore district. Madras Agril. J. 66:520-525.

Kulandaivelu, R.R., Kumpuchetty, N. and Morachan, Y.B. (1980). Rainfall pattern and cropping system in Coimbatore district . Madras Agril. J. 67: 171-176.

P. Parasuraman and M. Suresh (2002). Study on the rianfall climatology of regional research station, Prier for planning Madras Agril. J. 89 (7-9): 469-473.

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