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A modified approach for determination of onset and withdrawal of monsoon

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ABSTRACT

Onset of monsoon is an important rainfall characteristic for drought management and crop planning. Morris and Zandstra method for onset was compared with observed values for a period of 20 years, which revealed a mismatch in the Bhilwara region in 40 per cent of years. The criteria for rainfall accumulation for both onset and withdrawal was modified in such a way that the determined and observed onset of monsoon showed a significant match. For early and late onset of monsoon and intermittent low /nil rainfall weeks. Withdrawals were adjusted and length of growing period for Bhilwara region was determined.

Key words: Onset of monsoon, withdrawal of monsoon, length of rainy season, crop planning

Farmers in rainfed areas are subjected to impact of rainfall variability on agricultural production. Consequently, the choice of well adapted cultivars, cultural practices and decision criteria for optimum utilization of natural resources and minimizing drought risks are crucial in monsoon dependent regions. Every year production oscillates with date of onset of monsoon, amount and distribution of rainfall and intervening critical dry spells. Out of these, onset of monsoon is of utmost importance which affects subsequent activities. In absence of precise information about the onset of effective monsoon, farmers undertake the sowing randomly and face crop failure. Onset of monsoon week is reported to have significant inverse correlation with monthly and monsoon season rainfall (Agnihotri and Murti, 2001). Further Stewart (1991) suggested identification and quantification of seasonal rainfall variability and its related risks with variability of onset of monsoon for managing the climatic risks in crop production. Deviation in time of onset of monsoon leads to different climatic environment for crop which demands for characterisation of water balance for each week after onset of monsoon. Precise information about onset of monsoon may prove useful for pro-active monsoon management for mitigation of drought effects (Swaminathan, 2005). In rainfed agriculture monsoon is considered as onset , when a sufficient amount of rainfall is accumulated from a reference week (Morris and Zandstra, 1979) and several workers have opted a fixed amount of 75 mm of rainfall accumulation for considering onset of monsoon as suggested them at different locations in India (Singh and Hazara ,1999, Jat *et al*., 2003 a ; Satpute, 2004; Deora,2005; Jat *et al*.,2005).The quantum of accumulated rainfall suitable for sowing of crops is dependent on time of onset of monsoon and on soil and climatic characteristics. Similarly, withdrawal of monsoon has been determined from backward accumulation of rainfall from last week (52nd week) of the year in Morris and Zandstra method, while the crop growth season is different from calendar year. The length of growth season needs to be related to crop species and cultivar grown in a region. The present study, applicability of Morris and Zandstra method was evaluated and modified for determination of effective onset and withdrawal of monsoon for semi arid region (zone IV-a) of Rajasthan state.

MATERIALS AND METHODS

Weekly rainfall data for a period of 20 years (1985-2004) were collected at Dryland Farming Research Station, Bhilwara situated in south east Rajasthan. The district lies at 25^{o} N latitude, 75^{o} longitude and altitude of 463.2 m above mean sea level. Mean annual rainfall is 608.4 mm which ranges from 277.2 mm to 1091.7 mm with a coefficient of variation of 31 per cent. Almost 90 per cent of annual rainfall is received during monsoon season (June to September). The soils of the region are sandy loam to clay loam in texture having shallow to medium depth. Principal crops of the region are maize, groundnut, pulses, sesame

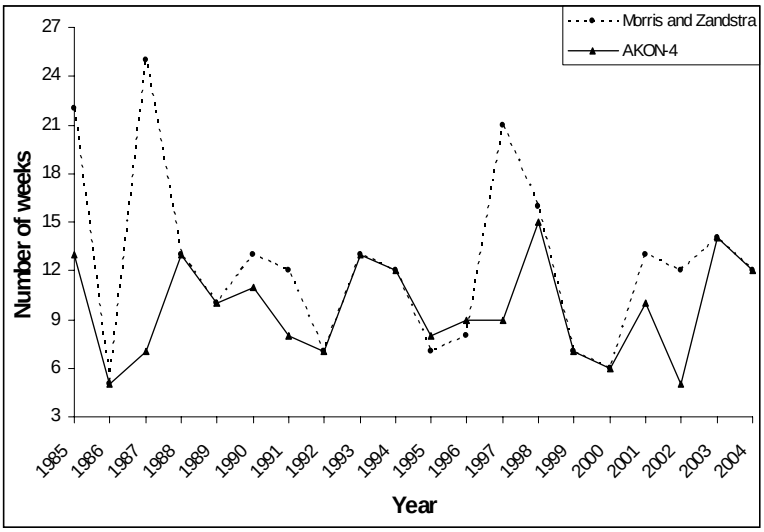

Fig. 1.: Observed length of crop growing season

and sorghum fodder during *kharif* season and wheat, barley, mustard & chick pea during *rabi* season under limited irrigation.

The onset of monsoon standard weeks were computed by using Morris and Zandstra (1979) method, using of 75 mm accumulation as the threshold (Rath *et al*, 1996; Babu and Lakshminarayana, 1997; Panigrahi and Panda, 2002; Jat *et al*., 2003 b; Satpute ,2004; Deora,2005). Withdrawal of monsoon is determined by backward accumulation of rainfall from 52nd SMW accounting to an amount of 10 mm (Singh and Hazara ,1999; Jat *et al*., 2003 b ; Jat *et al*.,2005) . The results obtained from aforesaid method have been validated form the observed onset and withdrawal of monsoon in a SMW "observed" at the research station for a period of 20 years (1985-2004). The "observed onset" during a year was derived from the date of sowing of crops. Withdrawal of monsoon in a SMW was compared with harvesting of groundnut crop which has maximum growing period and sown in most of the experiments at Bhilwara research station (Anonymous, 2004). Modifications in threshold values for rainfall accumulation were suggested in such a manner that the computed onset week showed a close match with the observed standard week in each year of the study period.

RESULTS AND DISCUSSION

Results on Morris and Zandstra (1979) method for onset of monsoon compared with observed values (Table 1) revealed that they are mismatched in 40 per cent of years (8 years). The reasons for this mismatch could be as follows

a. The accumulation of rainfall for considering the onset of monsoon has to be related with its time of occurrence within the season in the sense that even a small quantity lower than a predetermined quantity (<75mm) may be perceived as adequate for delayed conditions while a large quantity will be required for an early onset conditions as compared to normal onset of monsoon.

b. Accumulation of rainfall over a period ignoring the intermittent dry weeks (weeks having nil rainfall) may not be fully justified for considering the onset of monsoon since the rainfall received during the intermittent breaks is likely to be lost due to evaporation., actual evapotranspiration .

Therefore, in order to match the estimated onset of monsoon with observed values, the Morris and Zandstra method has been modified in such a way that threshold values for forward accumulation of rainfall amount varies with time of arrival of monsoon. Thereby, amount of rainfall accumulation considered for onset of monsoon was relatively higher for early and less for late onset of monsoon as compared to normal conditions in the following manner:

Table 1: Onset of monsoon determined from different criteria.

Year	Observed onset, SMW	Estimated onset of m		
		Morris and Zandstra method	AKON-1	A
1985	28	29	28	
1986	28	28	27	
1987	28	25	26	
1988	26	26	26	
1989	25	25	25	
1990	27	26	26	
1991	28	28	28	
1992	29	29	28	
1993	26	26	26	
1994	26	26	26	
1995	28	29	28	
1996	28	29	28	
1997	28	28	27	
1998	27	26	26	
1999	29	29	28	
2000	28	28	28	
2001	27	24	26	
2002	31	29	27	
2003	25	25	25	
2004	27	27	27	
Chi square value		1.053	1.007	
Number of year of data mismatched		8 (40)	9 (45)	4

- ***Figure in parenthesis indicates value in per cent***

i. AKON-1 : Sum up to 25th SMW =100 mm, Sum up to 26 SMW =75 mm and sum onward >26 SMW = 30 mm rainfall

The onset of monsoon determined from this modified assumption (AKON-1) is presented in Table 1. The Chi Square value decreases due to AKON-1 as compared to Morris and Zandstra method, which revealed that modification in assumption is in right direction. Hence, thereafter the assumptions for not considering the week / weeks having nil rainfall were adopted in the following manner

i. AKON-2 : AKON-1 + From 22 to 25 SMW ,if Consecutive two week have nil rainfall then restart accumulation of rainfall from that SMW

ii. AKON-3 : AKON-1 + if Consecutive two weeks have nil rainfall then restart accumulation of rainfall from that SMW

iii. AKON-4 : AKON-1 + any week having 0.0 mm rainfall then restart accumulation of rainfall from that SMW

The aforesaid modifications introduced in Morris and Zandstra (1979) criteria resulted in three different criteria viz.; AKON-2, AKON-3 and AKON-4, which were used to determine the onset of monsoon and results are presented in Table 1. The determined onsets of monsoon were same as those observed in each year due to the criterion AKON-4 whereas deviations by 10 and 20 per cent years in modified criteria were noted due to AKON-3 and AKON-2 respectively. The threshold for AKON-4 are justified because the early onset of monsoon certainly requires more amount of accumulated rainfall so that crops may not suffer from moisture in case of delay in succeeding rains. Moreover,

Table 2: Withdrawal of monsoon and length of available crop growing season determined from different criteria

Year	Withdrawal of monsoon, SMW		Length of rainy season, weeks	
	Morris and Zandstra method	Modified method, AKON-4	Morris and Zandstra method	Modified method, AKON-4
1985	51	41	22	13
1986	33	33	5	5
1987	50	35	25	7
1988	39	39	13	13
1989	35	35	10	10
1990	39	38	13	11
1991	40	36	12	8
1992	36	36	7	7
1993	39	39	13	13
1994	38	38	12	12
1995	36	36	7	8
1996	37	37	8	9
1997	49	37	21	9
1998	42	42	16	15
1999	36	36	7	7
2000	34	34	6	6
2001	37	37	13	10
2002	41	36	12	5
2003	39	39	14	14
2004	39	39	12	12
Mean	39.5	37.2	12.4	9.7
Deviation	6 (30)		10 (50)	

** Figure in parenthesis indicates value in per cent*

intermittent week having nil rainfall necessitates for restart of rainfall accumulation as the evaporation demand shoots as high as 40 mm per week during this period, which clearly indicates that the previously accumulated rainfall will be lost to meet out the evaporative demand.

Withdrawal of monsoon

Withdrawal of monsoon is determined by backward accumulation of rainfall accounting to an amount of 10 mm from 52nd SMW as suggested in Morris and Zandstra method (1979) and is presented in Table 2. The results reveal that the determined withdrawal of monsoon was observed in 51st SMW during the year 1985, while the crop growth period terminates in 41st SMW considering the observed onset of monsoon (22nd SMW) and groundnut crop (crop having maximum length of growing season, 18 weeks). On appraisal of rainfall data during the year 1985, it is also observed that rainfall in post monsoon season has been considered as week of withdrawal of monsoon. Similarly, delayed withdrawal was estimated during the years 1987, 1997 and 2002 due to rainfall during post monsoon season. Therefore, it is observed that rainfall during the whole post monsoon season, considered for withdrawal of rainy season, is not justified. Therefore,

backward accumulation of rainfall should be considered from 47th SMW rather than 52nd SMW considering mono cropped area having maximum crop growth duration of 18 weeks and extreme week of onset of monsoon having reasonale frequency of 10 percent (29th SMW). This modification was also included in suggested approach AKON-4 and results obtained from this modified approach are presented in Table 2. The results revealed that normal withdrawal of monsoon was observed in 39th week as per Morris and Zandstra method as compared to 37th week as per modified approach (AKON-4). The results also reveal that the week of withdrawal of monsoon mismatch in 30 per cent of the years (6 years) due to these aforesaid two approaches.

Length of crop growing season

The change in onset and withdrawal of monsoon also affects the length of rainy season available for crop growth. Therefore, the length of rainy season determined from the onset and withdrawal of monsoon computed using the Morris and Zandstra method (1979) and modified method (AKON-4). The results (Table 2) reveal a mismatch in 50 per cent of the years due to both the approaches. The observed normal length of rainy season was decreased by 2.7 weeks due to criterion AKON-4 as compared to Morris and Zandstra method (12.4 weeks). The march of length of rainy season determined from Morris and Zandstra method and AKON-4 (modified method) are shown in Fig.1. Keeping this in view, 9.7 weeks rainy season should be considered for selection of crops and their cultivars and cropping systems in the region. Jat *et al* (2003 a) have also suggested crop planning considering 12.7 weeks length of available crop growing season obtained from Morris and Zandstra method in this region.

CONCLUSION

The modified Morris and Zandstra method (AKON-4) was most appropriate for determination of onset and withdrawal of monsoon in agro-climatic zone IV-a of Rajasthan. The method is useful for timely sowing of crops, pro-active monsoon management and to suggest crop planning based on onset of monsoon. Hence, suitability of Morris and Zandstra method (1979) for determination of onset and withdrawal of monsoon should be validated for each agro-climatic zone for its wider application.

REFERENCES

Agnihotri, Y. and Ram Murti. (2001). Relationship between onset of monsoon with sowing weeks and monthly/ seasonal rainfall at Chandigarh. *J. Indian Water Resou. Soc.,* 21(2): 60-64.

Anonymous.(2004). Annual reports from 1985-2004, AICRP on Dryland Agriculture, Dryland Farming Research Station, Arjia, Bhilwara (Rajasthan).

Babu, P. N. and P. Lakshminarayana. (1997). Rainfall analysis of a dry land watershed-Polkepad: A case study. *J. Indian Water Reso. Soc*., 17 (3):34-38

Deora, B.S. (2005). Modelling of Drought under different Agro-climatic Zones of Gujarat Maharashtra. Unpublished *Ph. D. Thesis*. Deptt. of Soil and Water Engg. CTAE, MPUAT, Udaipur. pp.264

Jat, M.L., R.V. Singh, B.S.Kumpawat and J.K. Balyan. (2003b). Rainy season and its variability for crop planning in Udaipur region. *J. Agromet.,* 5(2):82-86.

Jat, M.L., R.V. Singh, J.K. Balyan and L.K. Jain.(2003a). Dry and wet spells for agricultural planning at Bhilwara. *Indian J. Soil Cons*. 31(3):291-294

Jat, M.L., R.V. Singh, J.K. Balyan and L.K.Jain. (2005). Rainfall analysis for crop planning in Udaipur region. *Indian J. Soil Cons*., 33(3):264-266.

Morris, R.A. and H.G. Zandstra, (1979). Land and climatic in relation to cropping patterns. In rainfed low land rice, selected papers from 1970. *Int. Rice Res. Conf. IRRI*. , pp. 255-274.

Panigrahi, B. and S.N.Panda. (2002). Dry spell probability by Markov Chain model and its application to crop planning. *Indian J. Soil Cons*., 30(1):95-100

Rath, H., G.N. Jena, and P.C. Senapati. (1996). Forecasting of dry and wet spells at Boudh for agricultural planning. *Indian J. Soil Cons*., 24(1):28-36

Satpute, G.U. (2004). Characterization of Drought under different Agro-climatic Zones of Maharashtra. Unpublished *Ph. D. Thesis* Deptt. of Soil and Water Engg. CTAE, MPUAT, Udaipur. pp.199

Singh, J.B. and C.R.Hazra. (1999). Rainfall characteristics of Jhansi for crop planning under rainfed condition- A decadal change. *J. Soil Water Conser*, 43: 25-34.

Stewart, J.I. (1991). Principles and performance of response farming. In Proc. of International symposium on Climatic Risk in Crop Production: Models and Management for the Semiarid Tropics and Subropics, Edited by Russell C. Muchow and Jennifer A. Bellamy. PP 361-382.

Swaminathan, M.S. (2005). Pro-active monsoon management plan is needed. Frontline, vol. 17 (11), may 27-june,2000, pp 25-32.In.Compendium of Training Programme on "Management of Agricultural in Drought Prone Area" 4-9 July, Edited by Ch. Radhika Rani and M.R. Girish, National Institute of Rural Development, Hyderabad, p.92.

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