

Dry spell sequences in south coastal Andhra

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(Received 30 January 1986)

संक्षेप — कृषि योजना तथा इसके संबंधित अनेक कार्य शुष्क और आर्द्र दौरों की सफलता पर बहुत निर्भर करते हैं। दक्षिण तटीय आंध्र प्रदेश के चार स्थानों पर 1954-1984 के दौरान शुष्क और आर्द्र दौर की अवधि में साप्ताहिक वर्षा की आरम्भिक और सगर्त सम्भावनाओं के अध्ययन के लिये प्रथम कोटि मार्कोव श्रृंखला मॉडल का प्रयोग किया गया है। शुष्क सप्ताहों के प्रतिमान आकाशीय और कालगत परिवर्तन काफी मात्रा में दिखाते हैं। यह जानकारी स्थान विशेष के लिये उपयुक्त फसल अथवा किस्म का निर्धारण करने और उचित कृषिजन्य कार्यों को अपनाने के लिये कृषि योजनाकारों के लिये उपयोगी है।

ABSTRACT. Agricultural planning as well as many operations depend considerably on the success of dry and wet spells. A first order Markov chain model has been utilized to study the initial and conditional probabilities of weekly rainfall, in terms of dry and wet spells during 1954-1984 at four locations in south coastal Andhra Pradesh. The patterns of dry weeks show considerable spatial and temporal variations. The information is useful to agricultural planners in determining the suitable crop or variety for a particular location and in adopting the appropriate agricultural practices.

1. Introduction

Projection of future rainfall through probabilities making use of past rainfall records, would be of immense use in crop planning. In rainfed agriculture the importance of rainfall overrides that of all the other climatic factors which determine yield. The shortest period that can be considered for crop yield modelling is a day. However, the measurable growth of a plant is almost negligible on the daily basis. The soil water holding capacity can usually buffer moisture availability for one week or more, so that weekly rainfall can be used in crop weather models. Thus, short duration rainfall analysis was carried out by Sarker *et al.* (1982) & Mondal *et al.* (1983). However, many agricultural operations revolve around the probability of receiving given amount of rainfall.

In the first order Markov chain, the probability of an event that would occur on any week depends only on the conditions during the preceding week and is independent of events of further preceding weeks.

When this model is used in simulating rainfall, it preserves many important characteristics and serves many application oriented objectives well (Stern and Coe 1982). Rainfall amount is involved only in the definition of occurrence or non-occurrence of rain.

The Markov chain probability model has been found suitable to describe the long term frequency behaviour of wet or dry weather spells (Gabriel and Neuman 1962, Victor and Sastri 1979, Virmani *et al.* 1982). Hayhoe and Baier (1974) applied the theory of Markov chain to analyse the field work-day probabilities. Robertson (1976), Khambete and Biswas (1984) used this model in determining drought frequencies. In the present paper, an attempt has been made to study the initial and conditional probabilities of dry and wet weeks at four stations in the south coastal Andhra Pradesh.

2. Materials and method

Daily rainfall data collected from the records of Government of Andhra Pradesh for the months June

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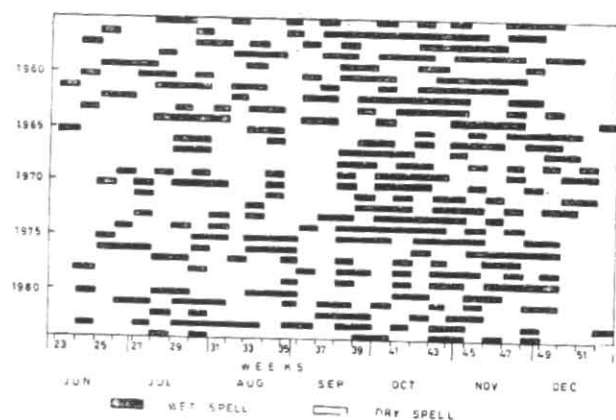


Fig. 1. Weekly dry and wet spell sequences at Rapur

to December for Chirala ($15^{\circ}50'N$, $80^{\circ}22'E$), Darsi ($15^{\circ}47'N$, $79^{\circ}41'E$), Rapur ($14^{\circ}12'N$, $79^{\circ}32'E$) and Udayagiri ($14^{\circ}53'N$, $79^{\circ}18'E$) for 31 years from 1954 to 1984 have been utilised in the present study. The daily data has been pooled into standard weekly data. The degree of dryness or wetness has been defined in terms of weekly rainfall.

A threshold of 20 mm per week is considered, to demarcate dry weeks based on the experimental evidence (Seshgiri Rao *et al.*) and theoretical studies (Rao *et al.* 1971). Rainfall of 20 mm per week is adequate for all the growth stages of all the crops grown in the region. Thus, in a given week the rainfall receipt is less than 20 mm, that week has been designated as a dry week and *vice versa*.

Based on the theory of Robertson (1976) as reported by Oldeman and Frere (1982), the initial and conditional probabilities of weekly dry and wet spells were analysed.

3. Results and discussion

Out of the total geographical area of 30,678 sq. km, only 31.2% under cultivation and about 61.0% of the net area is under rainfed cultivation, in the Prakasam and Nellore districts of coastal Andhra Pradesh. The mean annual rainfall of the selected locations varied from 706 mm (Darsi) to 1116 mm (Chirala). About 90% of the annual rain is received from June to December. The influence of northeast monsoon rains during October-November are evident for Udayagiri and Rapur of Nellore district. Further the distribution

of weekly rainfall is a good indicator for the selection of suitable crops in different moisture regimes.

Persistent dry weeks during the rainy season may cause moisture stress at critical crop growth periods and have deleterious effects on yield. In many of the tropical crops, stress during the flowering stage is usually the most critical, causing a reduction in grain formation. Intense rain may also have adverse effects on crop yields (*e.g.*, rice), particularly during the ripening period. However, certain plants (*e.g.*, sugarcane) require moisture stress before ripening. Thus, the duration of dry period during the crop season may be considered as an index of the frequency and severity of moisture stress (Archer 1981).

The sequential phenomena of dry and wet weeks were illustrated in Fig. 1. It can be seen that the rainfall distribution is erratic and unpredictable, which is the general feature of the tropical climate. In some years, only a few weeks are having wet period, cause disastrous drought situation in the region. The failure of monsoon showers during June and July results in adverse seasonal conditions and then the need arises to alter the existing cropping pattern.

3.1. Initial probability $[P(D)]$

The distribution of initial probability of a dry week, $P(D)$, in four locations are shown in Fig. 2. It can be seen that, although the frequency of dry weeks is same in the southwest monsoon period (June-September) at Rapur and Udayagiri of Nellore district,

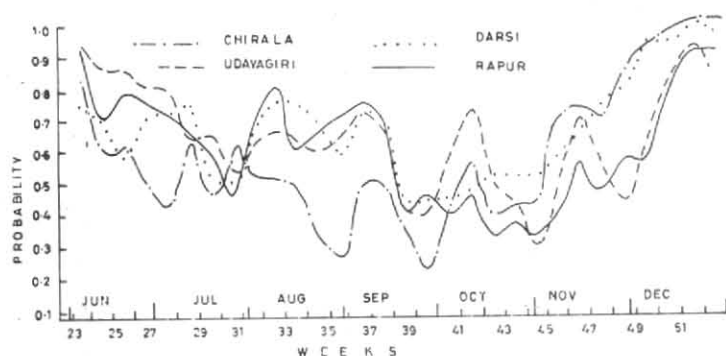


Fig. 2. Initial probability of the week become dry $P(D)$ over south coastal Andhra

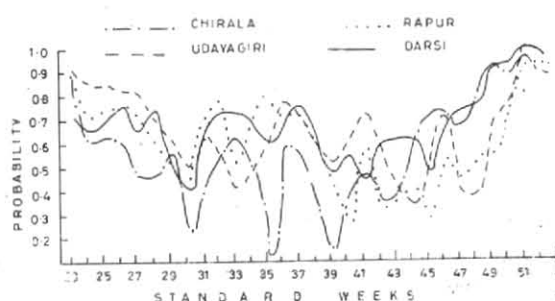


Fig. 3. Conditional probability of dry week followed by dry week $P(D/D)$ over south coastal Andhra

later the frequency changes. Whereas at Chirala and Darsi in Prakasam district, the pattern is different. The figure also indicates that in the 39th week (24-30 September) and 35th week (27 August-2 September) the occurrence of dry period is least (20-25%) at Chirala, whereas, at Darsi four out of the ten years, the period 38th to 40th week is dry. This behaviour shifts to 42nd to 44th week (35%) at Rapur and 44th week (30%) at Udayagiri.

The occurrence of moisture stress period in once in two years is least in all the locations during 29th and 30th weeks, i.e., later half of July and the other safe period for crop growth is between 38th week and 45th weeks, i.e., middle of September to the middle of November. Thus, the length of dry weeks in the region exhibits the spatial and temporal variations.

3.2. Conditional probability $[P(D/D)]$

The conditional probability can indicate whether the chance of getting rainfall in succession is more or less. The conditional probability of dry week followed by a dry week $[P(D/D)]$ is shown in Fig. 3. It can be seen that the occurrence of dry week followed by dry week at Chirala is less during 30th, 35th and 39th weeks. At Darsi, the distribution is different from Chirala and the expected frequency is around 50 per cent. Similar features are observed at Rapur and Udayagiri of Nellore district. However, Rapur experiences dry spell very frequently than Udayagiri. Further, the initial

rains during June and early July are unpredictable compared to the middle of the crop growing season. Similar conditions during late November and December are also evidenced.

When the crop phenological calendar is super-imposed on these sequences, it provides the insight into the crop water stress periods in various pheno-stages. Based on these conditions, the alternative strategies (for fertilizer application, pesticides etc) are recommended to the farmer.

4. Conclusion

In a given crop growing season, many decisions have to be taken based on the probability of receiving certain amount of rainfall during a given week. Hence, a first order Markov chain has been fitted to four selected locations of south coastal Andhra, to obtain sequences of dry and wet weeks.

The initial probability of occurrence of dry week during the different stages of crop growth, the conditional probability which take into account the sequential events provides the basic information on rainfall distribution characteristics necessary for agricultural operations; such as irrigation scheduling, choice of transplanting time, fertilizer application etc. Thus, the present study provides an operational tool to the farmers of the south coastal Andhra region for improving productivity.

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