AN INDEX OF AGRICULTURAL DROUGHT*

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An index computed on a weekly basis of a network of 100 stations in the country during 1971 monsoon is used to demarcate agricultural drought areas. In the 1971 monsoon season, there was a belt of agricultural drought covering several weeks over the peninsula stretching from Tamil Nadu to Marathwada. This is corroborated by Newspaper and crop reports of the area.

The paper provides agricultural drought index based on the water balance computation by taking into account factors like rainfall, evapotranspiration, soil moisture and climate of the place and is, therefore, a suitable one to indicate agricultural drought possibility.

The limitations of the method are mainly due to lack of realistic values of some of the parameters required for the water balance computation.

INTRODUCTION

Thornthwait's technique (1948, 1957) of computing water balance gives for each interval of computation the moisture status of a place either as surplus or deficit. If there is moisture deficit, there is aridity. Because of seasonality of our rainfall, every place will have aridity in some period or other. Normally, crops grown at a place are acclimatized to this climatological aridity. What is harmful to the crop is aridity more than the normal. So, aridity in excess of the climatological value can be taken as an index of agricultural drought. This concept is used to study the drought of 1971 southwest monsoon season. As crops are sensitive to short period variations in weather and changes of soil moisture, water balance computation is done on a weekly basis.

PARAMETERS FOR COMPUTATION OF INDEX

The parameters required for water balance computation are (*i*) rainfall, (*ii*) potential evapotranspiration, and (*iii*) water-holding capacity of the soil. As far as rainfall is concerned, there is no problem. This is, however, not the case with potential evapotranspiration. Literature on the subject is extensive. Still we are far away from the goal of having a method acceptable to all for computing this parameter. Penman's method takes into account a number of factors which influence evapotanspiration. On this consideration, potential evapotranspiration for this study has been computed by Penman's (1948, 1963, 1971) method.

Another controversial parameter required for computation is the water-holding capacity of the soil and the rate of desiccation of moisture from the soil. In the absence of representative experimentally measured values of these parameters, an empirical

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table given by Thornthwaite and Mather (1957) is used. This table gives water-holding capacity for different types of soil and crop. Using this table, water-holding capacity of each station is determined on the basis of its soil type and crop taken as cereal grains. Soil moisture desiccation is assumed to take place at an exponential rate i.e., moisture loss becoming less as soil moisture decreases.

Index Computation

Water balance computations are done on a weekly basis (Standard Weeks) of a representative network of 100 stations in India for the monsoon season of 1971. Aridity value of the station for the week is calculated from the weekly moisture deficit. Normal aridity value of the station of the week is also calculated from climatic water balance computation. The difference between actual and climatological aridity values, when positive, is taken as agicultural drought index. These values are plotted on a map for each week. The areas, where index has some value, are hatched to indicate agricultural drought.

Results

Figure 1 shows each week's rainfall deficit percentage and agricultural drought index value of 4 representative stations of 1971 monsoon season.

(i) *Masulipatam* (16° 11′ N, 81° 08′E)—This station situated in Krishna district has semi-arid climate. Rainfall deficit shows a spell of continuous below-normal rainfall from 25th week. However, the index shows drought conditions from 29th week only. This is because in 22nd and 24th weeks, there was good rainfall with the result soil had carry-over moisture, which was reflected in the index value.

'Crop and Seasonal Conditions' report issued by Andhra Pradesh Government shows:

District	*Week ending*	*Remarks*
Krishna	3–7–1971 (26th week)	Seasonal conditions in general are satisfactory.
–do–	17–7–1971 (28th week)	Kharif crops are reported to have been affected by pests in upland areas.
–do–	31–7–1971 (30th week)	Kharif crops withering for want of rains and the seasonal conditions in general are not satisfactory.
–do–	14–8–1971 (32nd week)	Dry crops are reported to have been badly affected as there is no sufficient rainfall and the yields are expected to be much below normal.

Though there was continuous below-normal rainfall from 25th week (18–24, June) onwards, withering of crops is reported much later, i.e., after the middle of July. The index showed drought conditions only from the middle of July (29th week).

(ii) *Bijapur* (16°49′N, 75°43′E)—This station has also semi-arid climate. Rainfall deficit shows a continuous spell of below-normal rainfall from 26th week. The

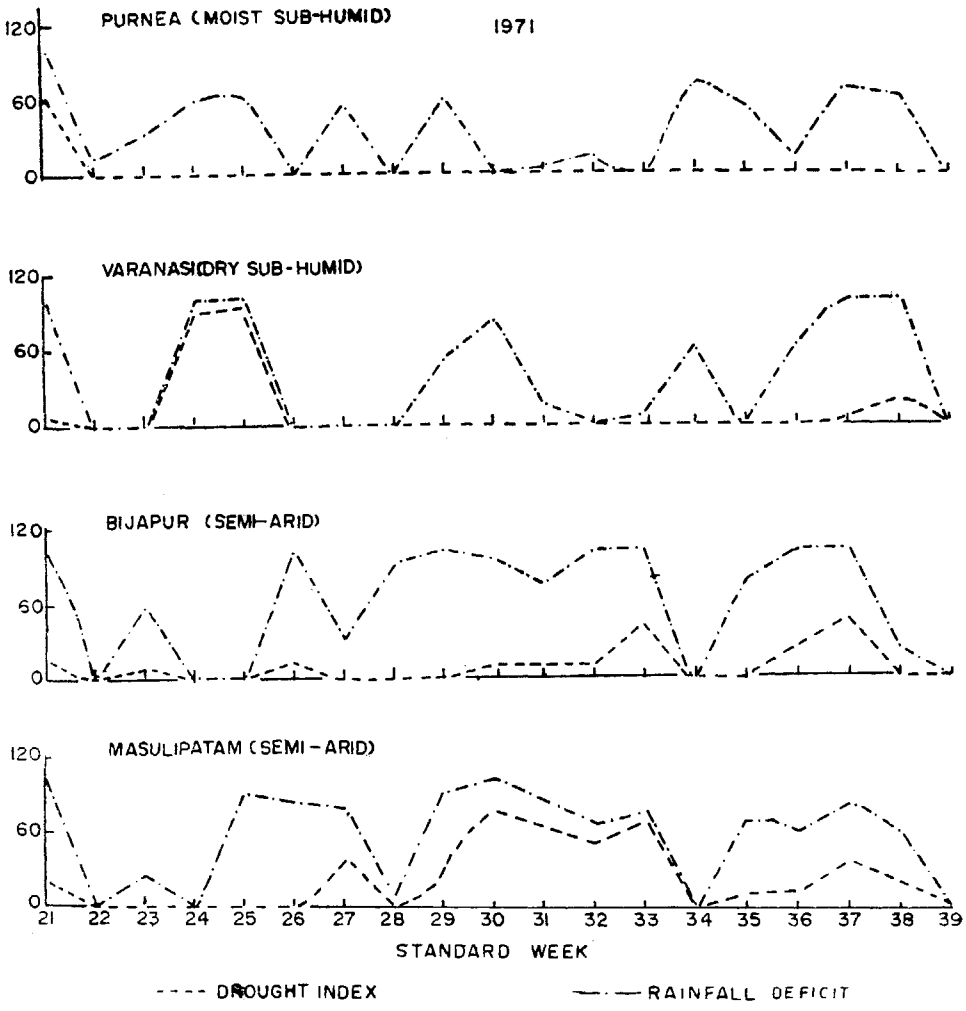

FIG. 1. Agricultural drought index and rainfall deficit percentage. (Base line indicates nil deficit or excess rainfall)

index value, however, shows drought conditions from 30th week only. This is because there was good antecedent rainfall in 22nd, 24th and 25th weeks.

The weekly weather and crop report issued by the Mysore Government shows crop withering as indicated by index value.

(iii) *Varanasi* (25°18′N, 83°01′E)—This station has dry sub-humid climate. Between 29th and 38th weeks, there were many below-normal rainfall weeks but the index did not indicate drought conditions except in 37th and 38th weeks.

(iv) *Purnea* (25°46′N, 87°28′E)—This station has moist sub-humid climate. The index did not show any drought condition although there were many weeks of below-normal rainfall.

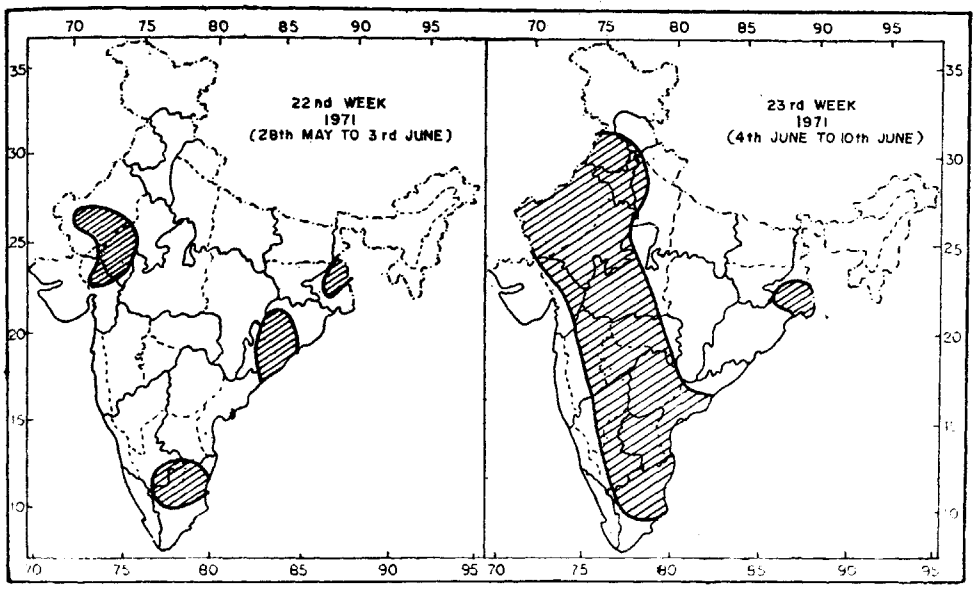

FIG. 2(a). Drought areas (hatched) shown by above normal aridity index.

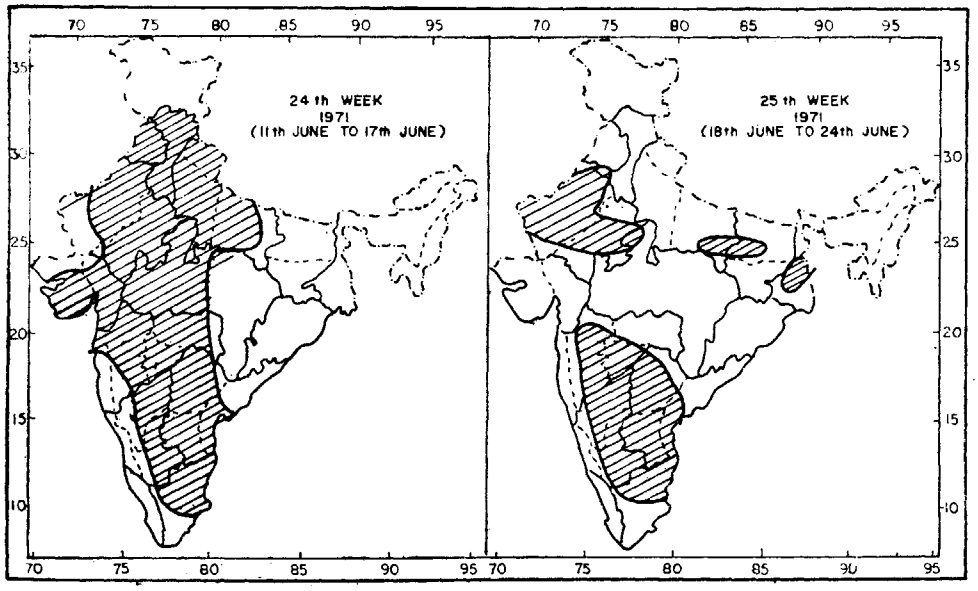

FIG. 2(b). Drought areas (hatched) shown by above normal aridity index.

The above two stations did not experience any significant drought conditions in the monsoon season of 1971.

Figures 2 (a and b) show drought areas on a network basis of 22nd, 23rd, 24th and 25th weeks. In 22nd (28 May–3 June) week, drought areas comprise small pockets. In 23rd week, drought is seen spreading and extends from Tamil Nadu

in the south to the Punjab in the north. During next week (24th), the belt showed further spread and extension eastwards. However, by the next week (25th week, 18–24 June) the belt broke up.

The main agricultural drought belt of the 1971 monsoon season revealed by the index was over the Peninsula covering areas of Tamil Nadu, Interior Mysore, Rayalaseema, Coastal Andhra Pradesh, Telangana, Marathwada and Madhya Maharashtra. This drought belt persisted almost during the whole season from 23rd week (4–10 June) to 38th week (17–23 September) with a break of only one week namely 34th (20–26 August). The prevalence of persistent drought conditions in the areas mentioned above had been very well corroborated by Newspaper and 'Crop Reports' of the period.

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