

## IMPACT OF DROUGHT ON CLIMATIC WATER BALANCE AND CROP YIELDS IN BASTAR DISTRICT OF MADHYA PRADESH

1. Bastar is the largest district of Madhya Pradesh with a geographic area of 3.91 million hectares with the district headquarters at Jagdalpur. The major area of the district is plateau ranging from 550 to 760 above msl.

1.1. The topography is undulating and the soil texture varies from the top upland called *Marhan* with shallow soils, poor in fertility, lower water retention capacity and with about 3-4% slope to the lowland called *Gabhar* which is well levelled and prone to impeded drainage. Inbetween these two lie Tikra and Mal (Rao 1992).

1.2. Rice is grown under rainfed conditions in all the topographic situations and upland rice cultivation is predominant. Though this region receives around 1400 mm of annual rainfall, drought situations do occur often mainly because of topographic characteristics and rice as a major crop.

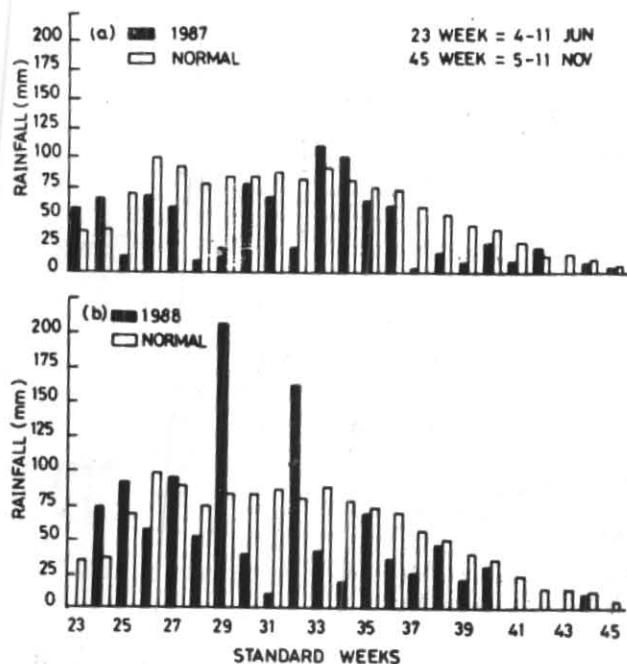
2. In order to examine the drought pattern under different toposequences and its impact on crop productivity, an analysis of the impact of drought on climatic water balance under the two extreme topographic situations and also on the rice productivity in this area was carried out. To

examine the effect of drought, the years 1987 and 1988 were chosen which happened to be severe drought years in the recent past.

3. The weekly rainfall pattern during the monsoon season at Jagdalpur starting from 23rd standard week (4-10 June) to 45th standard week (5-11 November) for the two years, viz., 1987 and 1988 alongwith the corresponding normal values are shown in Figs. 1 (a & b) respectively.

3.1. It can be seen from the figure that in 1987 only in five weeks, i.e., 23rd and 24th standard weeks (4-10 June and 11-17 June) which are coinciding with the starting of the kharif season and 33rd, 34th and 42nd standard weeks (13-19 August, 20-26 August & 15-21 October) the weekly rainfall exceeded normal values and during the rest of the weeks, the weekly rainfall remained below normal. It can also be observed that the rains almost ceased from 37th standard week (10-16 September) while the rice crop (mostly traditional varieties) matures by mid November in this area.

3.2. In 1988, on the contrast, rainfall above normal values occurred in five weeks (but not consecutive) and in early part of crop growth, i.e., 24th (11-17 June), 25th (18-24 June), 27th (2-8 July), 29th (16-22 July) and 32nd standard weeks (6-12 August). However, the excess rainfall quantity was higher than the same in 1987.

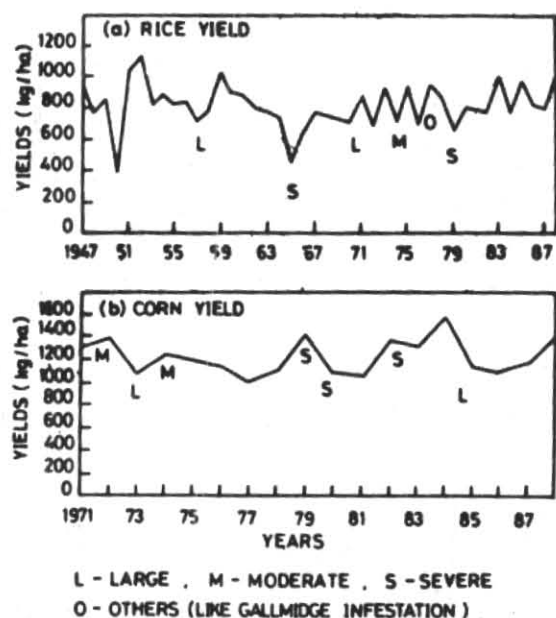


Figs. 1 (a & b). Rainfall pattern during the monsoon season of (a) 1987 and (b) 1988 as compared to normal values at Jagdalpur (District Bastar)

3.3. The climatic water balance during these two years under *marhan* and *gabhar* situations was carried out using the book-keeping procedure of Thornthwaite and Mather (1955) and the potential evapotranspiration values required for the water balance computations was carried out using Penman's (1948) equation. The water balance diagrams for the years 1987, 1988 and normal values under the two topographic situations are shown in Figs. 3 (a-c & d-f) respectively.

3.4. It can be seen from Fig. 3 (a-c) that under normal condition in *gabhar* situation, the rainfall in excess of PET demand is accumulated as soil moisture recharges till 30th standard week & thereafter any rainfall over the PET value goes as water surplus (WS). A part of water surplus will be lost as deep percolation and remaining as run-off. However, the water balance of 1987 reveals that during that year, the process of soil moisture accumulation or soil moisture recharge continued upto 32nd standard week and water surplus occurred only for 3 to 4 weeks. In a normal year, water surplus occurs for about 11 weeks.

3.5. In the year 1988 in the same *gabhar* situation, the surplus water occurred in splits like 29th standard week and from 31st-39th standard week. In this year, in between for about one week (30th week), there was soil moisture use. However, it has been found from water balance calculations, that the quantum of surplus is higher in 1988 (420.7 mm) as

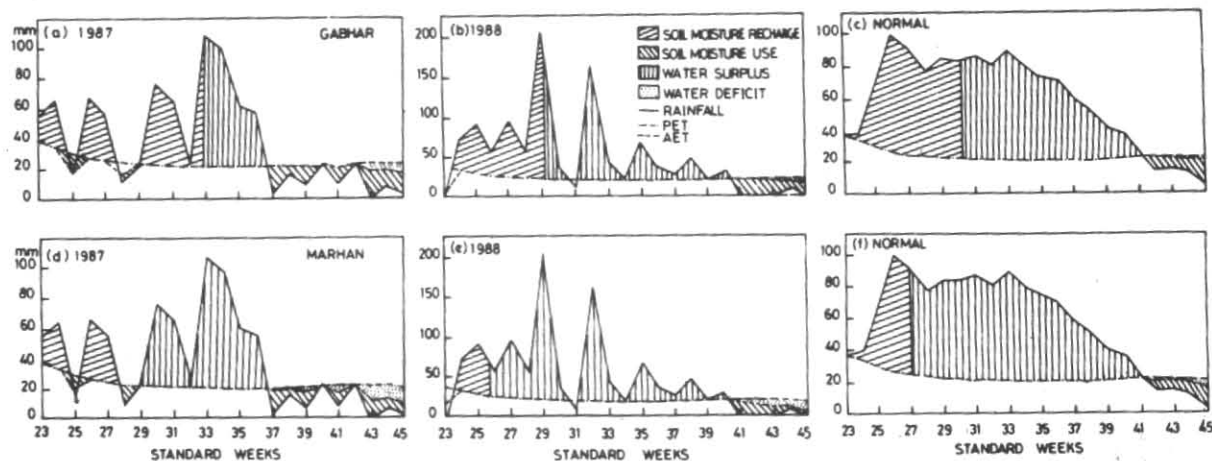


Figs. 2 (a & b). (a) Rice yields since 1947 and (b) corn yields since 1971 at Bastar and corresponding degrees of drought intensities

compared to 1987 (156.3 mm). In the normal year, value of water surplus is found to be 510.2 mm. Therefore, the water surplus is very low in the year 1987 as compared to the year 1988.

3.6. The picture under *marhan* situation is somewhat different as can be seen from Fig. 3 (d-f). Under *marhan* situation in a normal year, soil water accumulates till 27th standard week (as the water holding capacity is low) and water surplus occurs continuously for about 14 weeks. In the year 1987, surplus water occurred from 29th standard week for about 7 weeks while in 1988, surplus water started accumulating right from 26th standard week. Thus, during the year 1988, surplus water occurred for about 12 weeks up to 39th standard week except during 31st week while in 1987, surplus water occurred for about 7 weeks. Therefore, the quantum of surplus water is higher in 1988 (612.9 mm) compared to 1987 (342.5 mm).

4. For examining the fluctuation of rainfall and their water balance parameters on crop yields, an analysis of the rice yields from 1947 to 1988 and maize (corn) yields since 1971 to 1988 are analyzed as shown in Figs. 2 (a & b) respectively. The intensity of the meteorological drought is categorized as Moderate (M), Large (L) and Severe (S). The years of drought are categorized by using the parameter of aridity index derived from climatic water balance by Thornthwaite and Mather (1955). Aridity index is the ratio of annual water deficiency to the annual



Figs. 3 (a-f). Climatic water balance during the crop season of (i) 1987, (ii) 1988 and (iii) Normal years in farming situation in (a-c) Gabbar and (d-f) Marhan at Jagdalpur

water need. Drought years are categorized by percentage departure of aridity index from median value of aridity index in the individual years (Subrahmanyam and Sastry, 1969). If departure in a year is less than half standard deviation, it is termed as moderate drought year. If departure is inbetween half to one standard deviation, it is a large drought year. If departure is inbetween one to two standard deviation, it is termed as severe drought year.

4.1. It is interesting to note from the figure that under a given intensity of drought, the productivity has increased over the years. For example in 1950, the productivity of rice was 361 kg/ha under the large drought while in 1957, under the same large drought, the productivity has increased to 702 kg/ha. Similarly, during the severe drought year of 1965, the productivity of rice was 428 kg/ha while in the year 1979 with the same intensity, productivity of the crop has increased to 654 kg/ha. Year 1976 was the severe gallmidge year and it is denoted by the 'O' (other) in the figure. The increase in the yield over the years under the same drought intensity can be attributed to technological changes like increase in fertilizer application/pesticides/improved seeds etc.

4.2. The maize yields since 1971 to 1988 have been shown in the Fig. 2 (b). In the year 1973 which was large drought year, the yield of maize was 1075 kg/ha while in the year 1985, under the same large drought situation, the yields of maize increased to 1136 kg/ha. In the year 1980, the yield of maize was 1078 kg/ha under the severe drought situation, while

in the year 1982 under the same severe drought, the yields have increased to 1366 kg/ha.

5. Thus, it is observed that even in tribal dominant district, like Bastar, with slow pace of modern technologies, the productivity of rice and maize showed increasing trend over the years in a given drought intensity. This can largely be attributed to modern technologies in this district, though at a slower pace. However, there is a need to assess the productivity pattern of all crops comparing with the potentials of each of the crop.

#### References

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J. L. CHAUDHARY

Indira Gandhi Agricultural University, Raipur  
16 November 1993, Modified 4 March 1994