

Impact of droughts on productivity of pearl millet in Rajasthan

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सारांश— राजस्थान में 1970-79 के दशक के दौरान विभिन्न सूखा वर्षों में बाजरे की उत्पादकता का अध्ययन किया गया था। इसमें देखा गया कि पश्चिमी राजस्थान में मध्यम दर्जे से लेकर अत्यधिक सूखे की स्थितियों से उत्पादकता काफी प्रभावित होती है। बाजरे की वर्षा-जल उपयोग क्षमता पूर्वी राजस्थान की अपेक्षा पश्चिमी राजस्थान में बहुत कम है। अध्ययनों से पता चलता है कि बेहतर प्रबन्ध कार्य द्वारा पश्चिमी राजस्थान में मंद-सूखा परिस्थितियों में उत्पादन में सुधार लाया जा सकता है।

ABSTRACT. The productivity of pearl millet in Rajasthan during different drought years in the recent decade 1970-79 was studied. It was found that the productivity gets affected considerably as a result of moderate to severe drought conditions in western Rajasthan. The rain water use efficiency of pearl millet was very much less in western Rajasthan compared to eastern Rajasthan. The study indicates the possibility of improving yield under mild drought conditions in western Rajasthan through better management practices.

1. Introduction

Pearlmillet (*Pennisetum typhoides*) is one of the major cereal crop grown under rainfed conditions in Rajasthan State. According to Mann and Singh (1975), Rajasthan contributes nearly 26 per cent of the pearl millet produced in India. The arid region of western Rajasthan covers 62 per cent of Indian arid region and produces 76 per cent of pearl millet in the State. However, the average productivity of pearl millet is only 267 kg/ha and 231 kg/ha in Rajasthan and western Rajasthan respectively compared to an average yield of 452 kg/ha in the country, as the yields are often affected by drought conditions in Rajasthan. Though several efforts were made by George and Ramasastry (1975), Chowdhary *et al.* (1977), Appa Rao *et al.* (1981) and Appa Rao and Vijaya Raghavan (1983) on various aspects of droughts with reference to agriculture, no efforts were made to quantify the influence of drought on overall production of different crops either regionwise or nationwide. A method of classification of agricultural droughts based on the water availability conditions during different phenophases of crop growth was suggested by Ramana Rao

et al. (1981) and the influence of agricultural droughts of different intensities on the productivity of pearl millet and short duration pulses, the major rainfed crops in the Indian arid zone, was reported by Sastri *et al.* (1982 a). In the present paper, an attempt has been made to assess the impact of droughts on the productivity of pearl millet in Rajasthan during the recent decade, 1970 to 1979.

2. Material and methods

Moderate to severe drought conditions prevailed in Rajasthan during the years 1972, 1974 and 1979 in the recent decade, 1970 to 1979. Average weekly rainfall totals were computed for all the 26 districts in Rajasthan using daily rainfall records of all the taluks for these years. The potential evapotranspiration (PE) values were computed using Penman's (1948) method. The weekly actual evapotranspiration (AE) values were estimated using the water balance procedure of Thornthwaite and Mather (1955). The ratio of weekly actual evapotranspiration to the potential evapotranspiration (AE/PE) values were calculated during different weeks of the growing season. The intensities of agricultural drought. Accordingly, the years 1972, 1974

TABLE 1

Total area, production and yields of pearl millet in Rajasthan

Year	Area (ha)	Production (tonnes)	Yield (q/ha)
1970	5136148	2676641	5.2
1971	5100005	1363747	2.7
1972	5236691	864519	1.7
1973	5722830	2186783	3.8
1974	4224456	421633	1.0
1975	3715775	1128942	3.0
1976	3627992	1323372	3.6
1977	4074157	803600	2.0
1978	4530628	1148500	2.5
1979	5262404	380249	0.9
Average	4563109	1229798	2.7

Source : (1) *Statistical Abstracts of Rajasthan*,
(2) *Agricultural Situation in India*.

and 1979 for pearl millet were classified using the method adopted by Sastri *et al.* (1982) based on water availability conditions during different phenophases of crop growth. Years with fall in production rates of pearl millet by more than 25 per cent compared to average production rates was considered as year with agricultural drought. Accordingly, the years 1972, 1974 and 1979 have been identified as drought years during the decade 1970-1979. The area and production of pearl millet and other principal rainfed crops during the drought years and productivity obtained during a good rainfall year 1970 were taken from *Statistical Abstracts of Rajasthan and Agricultural Situation in India*.

3. Results and discussion

The average rainfall in the State was decreased by 32, 18 and 7 per cent during the years 1972, 1974 and 1979 with the percentage areas affected by drought conditions being 84, 68 and 86 respectively. The corresponding fall in production rates in the State to that of average production rates (Table 1) are 33, 63 and 67 per cent respectively. During the decade pearl millet yields varied between 3.0 & 5.2 q/ha in some years with good rainfall distribution (1970, 1973, 1975 and 1976). Sastri and Rama Krishna (1982) have reported that surplus water occurred due to heavy

TABLE 2

Contribution of major rainfed crops of Rajasthan to the country's production during drought years compared to an year with good rainfall

Crops	Production in the country ($\times 10^3$ tonnes) (1970)	Production in Rajasthan during 1970 ($\times 10^3$ tonnes)	Production in Rajasthan during drought years ($\times 10^3$ tonnes)		
			(1972)	(1974)	(1979)
Pearlmillet	8029	2676	864	422	380
		(33)*	(22)	(13)	(9)
Pulses	4736	555	159	138	614
		(12)	(13)	(3)	(4)
Sorghum	8105	477	300	308	146
		(6)	(5)	(3)	(1)
Maize	7486	843	630	461	530
		(11)	(10)	(8)	(9)

*Figures in parenthesis are the percentage contribution of rainfed crops to the country's productivity.

Source : (1) *Statistical Abstracts of Rajasthan*,
(2) *Agricultural Situation in India*.

rainfall causing floods during the early part of the monsoon season in 1979 though severe drought conditions prevailed over most of the regions in western Rajasthan. The onset of monsoon was delayed by two weeks which was followed by a heavy rainfall spread over a period of 3 days (15 to 17 July 1979) due to the stagnation of monsoon depression in central and in some western districts of the State. Flash floods occurred in some parts of Jodhpur, Pali, Nagaur, Barmer and Jalore districts. Sowing of pearl millet was, therefore, possible only towards the end of July.

The annual production of pearl millet, pulses, sorghum and maize during a good rainfall year 1970 in the country as well as in Rajasthan and the annual production of these crops in Rajasthan during the years 1972, 1974 and 1979 along with the percentage contribution of the production to the country's production during the corresponding years are given in Table 2. The importance of pearl millet in Rajasthan can be appreciated by the fact that 33 per cent of the country's production came from Rajasthan during a good rainfall year like 1970, while there was considerable decrease during the drought years 1972, 1974 and 1979.

The annual production and productivity of pearl millet during the years 1970, 1972, 1974 and 1979

TABLE 3

Production (tonnes) and yield (q/ha) of pearl millet in Rajasthan State during different drought years and during a good rainfall year (1970)

Region	1970		1972		1974		1979	
	Production	Yield	Production	Yield	Production	Yield	Production	Yield
Eastern Rajasthan	681780	7.5	434426 (36)	5.2 (31)	1886667 (73)	2.9 (61)	172327 (75)	2.4 (68)
Western Rajasthan	1993733	4.7	429454 (78)	1.0 (79)	235261 (88)	0.7 (85)	207922 (90)	0.6 (87)
Total	2675513	5.2	863880 (68)	1.6 (69)	421928 (84)	1.0 (81)	380249 (86)	0.4 (92)

Figures in brackets indicate the percentage decrease in production compared to the production during 1970.

Source : (1) *Statistical Abstracts of Rajasthan*, (2) *Agricultural Situation in India*.

along with the percentage decrease in production during the drought years compared to production during 1970 in eastern Rajasthan, western Rajasthan and for the State as a whole are given in Table 3. The productivity of pearl millet during the year 1970 was found to be 4.7 q/ha in western Rajasthan compared to 5.2 q/ha in the State. Though the decrease in State's average rainfall was only 7 per cent during the year 1979, the decrease in total State production in pearl millet was very high to the tune of 86 per cent. The highest fall in production during this year can be attributed to two factors : (1) delay in sowing of the crop by nearly one month in the flood affected districts of Jodhpur, Pali, Nagaur, Barmer and Jalore. The crop in these districts was also subjected to severe stress conditions during reproduction stage in the month of September, (2) In the eastern and north-eastern districts comprising Sikar, Jhunjhunu, Churu, Bharatpur and Jaipur, the pearl millet crop experienced severe water stress conditions during both vegetative & reproductive stages, which might have adversely affected the plant growth and finally the production. The decrease in production was higher in western Rajasthan compared to eastern Rajasthan during all the drought years.

The rain water use efficiency of pearl millet in Rajasthan was reported to be 56 metric tonnes for million cubic metres of rain water by Maun *et al.* (1981) based on the productivity of the crop in Jodhpur district which falls in the arid region. The rain

TABLE 4

Production of pearl millet (tonnes) per million cubic metres of water used (AE) in eastern and western parts of Rajasthan State

Region	Pearlmillet		
	1972	1974	1979
Eastern Rajasthan	196.3	94.1	100.3
Western Rajasthan	53.3	48.0	38.9

water use efficiency of pearl millet during the drought years in eastern and western Rajasthan are given in Table 4. The rain water use efficiency of pearl millet is higher in eastern Rajasthan even during drought years. However, there is scope for improving the rain-water use efficiency of the crop in western Rajasthan during the years 1972, 1974 and 1979 are shown in management practices such as (1) inter row water harvesting techniques (Yadav *et al.* 1978), (2) runoff collection and recycling it for irrigation purposes (Singh 1980), (3) use of organic mulches (Gupta 1978), (4) using subsurface barriers for improving soil moisture status (Gupta 1980; Singh 1980) as indicated by Mann and Ramana Rao (1981), Mann *et al.* (1981).

The intensities of agricultural droughts along with the isolines of productivity of pearl millet in Rajasthan

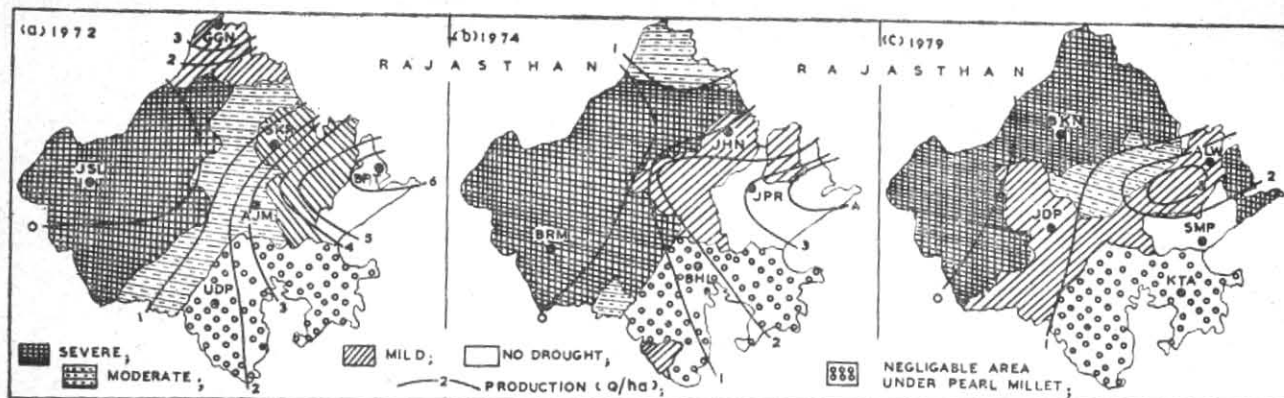


Fig. 1. Agricultural droughts and productivity of pearl millet in Rajasthan State

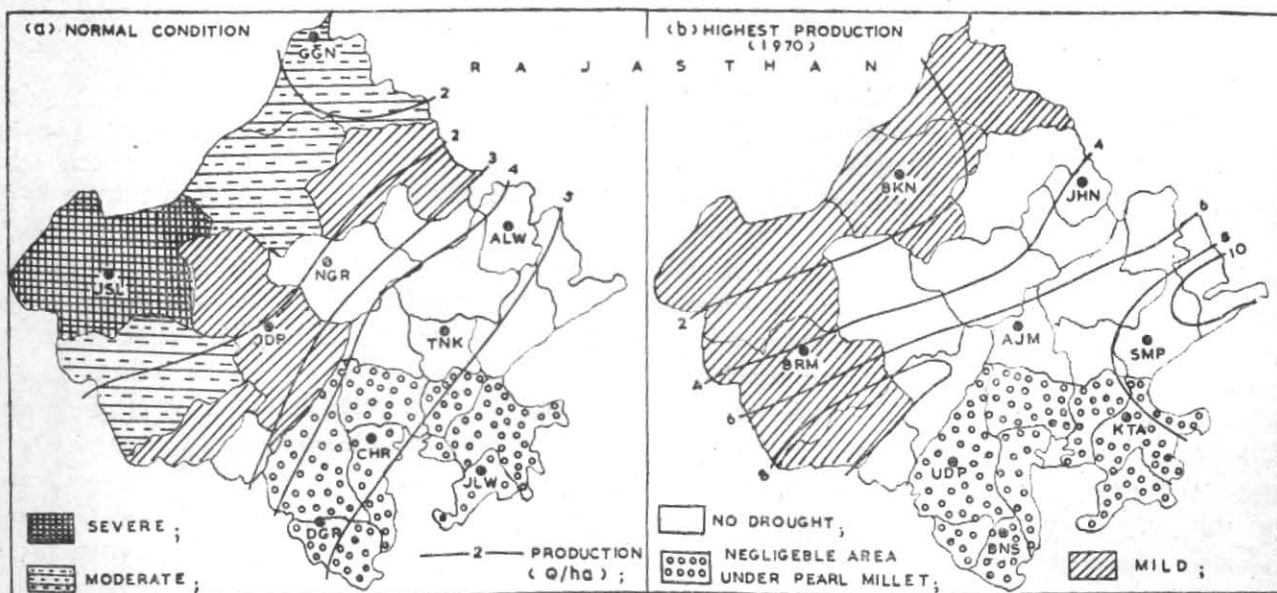


Fig. 2. Agricultural drought conditions of pearl millet in Rajasthan : (a) Normal conditions & (b) In a year of highest production (1970)

during the years 1972, 1974 and 1979 are shown in Fig. 1. During the year 1972 severe agricultural drought conditions prevailed in Jaisalmer, Barmer, Jodhpur and Bikaner districts and moderate drought conditions prevailed in Churu, Nagaur, Ajmer, Pali, Jalore and Sirohi districts resulting in poor productivity of pearl-millet of less than 1 q/ha. The productivity was of the order of 5 to 6 q/ha in drought free districts like Bharatpur and Sawai Madhopur. During the year 1974, vast region in western Rajasthan was subjected severe drought conditions resulting in almost total failure of the crop. During the year 1979, severe drought conditions prevailed in Barmer, Jaisalmer, Bikaner, Ganganagar, Churu and Jhunjhunu districts resulting in failure of the crop. Though mild to moderate drought conditions prevailed in central districts of Rajasthan, the yields were very low as a result of localised floods due to high intensity rainfall received during the month of July thereby delaying the sowings as reported by Sastri and Rama Krishna (1982).

The fall in production during drought years was compared with the productivity under average conditions of drought during the decade. The average agricultural drought conditions in each district were worked out and presented in Fig. 2. Agricultural drought conditions that were existing in each district during 1970 when highest production was observed is also presented in Fig. 2. Under average conditions, moderate to mild drought exists in western arid district with severe drought in Jaisalmer, where only 3 to 4 per cent of the land is put under cultivation. No drought conditions exist in eastern districts of Rajasthan which comes under semi arid regions. The production rates varied between 5 q/ha in the eastern parts to less than 2 q/ha in the arid districts. In the year with highest production (1970) the intensity of agricultural drought was less in western districts compared to average conditions. Only mild drought conditions prevailed in these districts and the production rates varied between 2 to 6 q/ha. During this year the area under no drought increased, with district like Churu, Jhunjhunu, Jodhpur and Pali falling under no drought conditions. The production rates in these areas under no drought conditions varied between 4 to 10 q/ha with highest production rates in Bharatpur district.

These studies indicate that the productivity of pearl-millet in Rajasthan was adversely affected by moderate to severe drought conditions in western Rajasthan

during the drought years. The productivity under mild drought conditions is higher in eastern Rajasthan compared to western Rajasthan thereby indicating the scope for increasing productivity in western Rajasthan through better management practices.

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