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THE LIKELIHOOD OF DROUGHT YEARS IN SOUTH-WESTERN AUSTRALIA

How often can droughts such as that of 1969 be expected in Western Australia’s farming areas?

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Because of the serious consequences of drought to individual farmers and to Western Australia’s economy, it is worth making an early appraisal of the 1969 rainfall conditions that led to the State’s most recent drought in an attempt to estimate how often such seasons might be expected in the agricultural areas.

For many centres in the south-western part of the State long term rainfall records are available in a form allowing early analysis with a digital computer. It was therefore possible to study these records with the aim of assessing the frequency of drought years.

The area included is south of Geraldton and west of Esperance, as shown in Fig. 1.

Interest is concentrated on the risk of having within any one year a deficiency of rainfall over the late autumn to mid-winter period. Acute shortages of rainfall at that time are particularly important in establishing a potential for a serious drought condition later in the year. Whether or not a serious drought does actually exist at the onset of the following summer will, of course, depend also on late winter and spring rains. Nonetheless, it is useful to assess the likelihood of shortages in rainfall from the break of season progressively to a time when the chances of having substantial relief from drought are clearly diminishing.

Except for a narrow coastal strip in the extreme south, the season breaks on average between April 1 and May 31.* In the farming areas, the trend of average rainfall is steadily downward after July. The April-July or May-July interval is therefore vital insofar as the establishment of a potentially serious drought position is concerned.

Extracted from a paper entitled “The Expectancy of Deficient Winter Rainfall and the Potential for Severe Drought in the Southwest of Western Australia” Institute of Agriculture, University of Western Australia, Agronomy Department Miscellaneous Publication 70/1.

In this study, monthly data from long runs of years were analysed to determine how frequently deficiencies in rainfall comparable with those of the 1969 season can be expected on average. Specifically, an answer is sought to a question that should interest all farmers in any year that a drought situation appears to be developing:

“In what percentage of years would the total rainfall since the break of season be as low as, or lower than, that received in this year?”

By obtaining an answer to this question at many locations within this area, an objective criterion for assessing the possibility of drought developing can be established, and the development of the 1969 drought can be compared with that of earlier years, both in terms of severity and the extent of the area affected.

Methods

Monthly rainfall data for years up to and including 1966 were supplied by the
Using the computer, progressive sums of rainfall from April to October and from May to October were obtained. From these rainfall totals arranged in ascending order, the percentage of years having rainfall from April 1 and from May 1 less than that of 1969 (or of any other individual year) could readily be determined.

As this study is concerned with the most severe and infrequent rainfall deficiencies it was necessary to use the longest possible rainfall records. On the other hand, to compare the risks of drought at different locations, it was important to make all assessments from an identical sequence of years for as many stations as possible.

To meet the first of these requirements, 10 stations representing major parts of the wheatbelt and coastal areas, and having records longer than 70 years, were selected. These are referred to here as principal reference stations.

To meet the second need, stations having records for at least 48 years within the 50-year interval, 1917-66, were selected. These are called network stations. A total of 124 network stations were available, as shown in Fig 1.

For each principal reference station, the number of years having rainfall totals less than that received in 1969 within six overlapping intervals, increasing by one month from April to September, was determined separately from the long-term records (greater than 70 years) and from the 50-year period, 1917-66. These frequencies were expressed as percentages of
the total number of years concerned, that is, as the relative frequencies. Similarly, the number of years with rainfall totals lower than those of 1969 for five overlapping intervals from May to September was determined for each station, and the corresponding relative frequency from long-term and 50-year records was calculated.

Plotting the sets of relative frequencies from long-term records against the corresponding values from the 50-year period, 1917-66, provides an indication of the extent to which the period 1917-66 is truly representative of long-term experience. The graphical analysis shown in Fig. 2 for six principal reference stations representing different parts of the wheatbelt shows that in general, the relative frequencies derived from the 1917-66 period underestimate those determined from complete records dating back before the turn of the century. In other words, they underestimate the frequency of seasons as dry as the 1969 season.

A separate analysis applied to data from four principal reference stations representing coastal areas also revealed that relative frequencies obtained from the 50-year period underestimated the long-term values.

This obvious bias for the whole area reflects the large proportion of very low rainfall years in the late 1800's and early 1900's not included within the 50-year period.

Unless it can be clearly established that a real and lasting change in rainfall has occurred within this area, the conditions before 1917 cannot be validly ignored in assessing the likelihood of severe deficiencies of rainfall. Such a change may not be impossible, but because of the consequences of drought any procedure that underestimates the likelihood of drought is unacceptable.

To eliminate the effect of underestimation, a mathematical method was used for adjusting the 50-year relative frequencies upward to give overall agreement with the long-term values. The required adjustment is based on the separation of the broken and solid lines in Fig. 2. The broken line represents the case of equivalence between the long-term and 50-year relative frequencies, and the solid line is mathematically fitted to the actual values of relative frequency as determined from these data.

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Fig. 2.—Relationship between the long-term and 50-year (1917-1966) relative frequencies for six stations in the wheatbelt.

The 50-year relative frequencies underestimate the frequency of years as dry as 1969 because of the high proportion of low rainfall years in the late 1800's and early 1900's. To overcome this the 50-year figures were mathematically adjusted to give agreement with the long-term values.