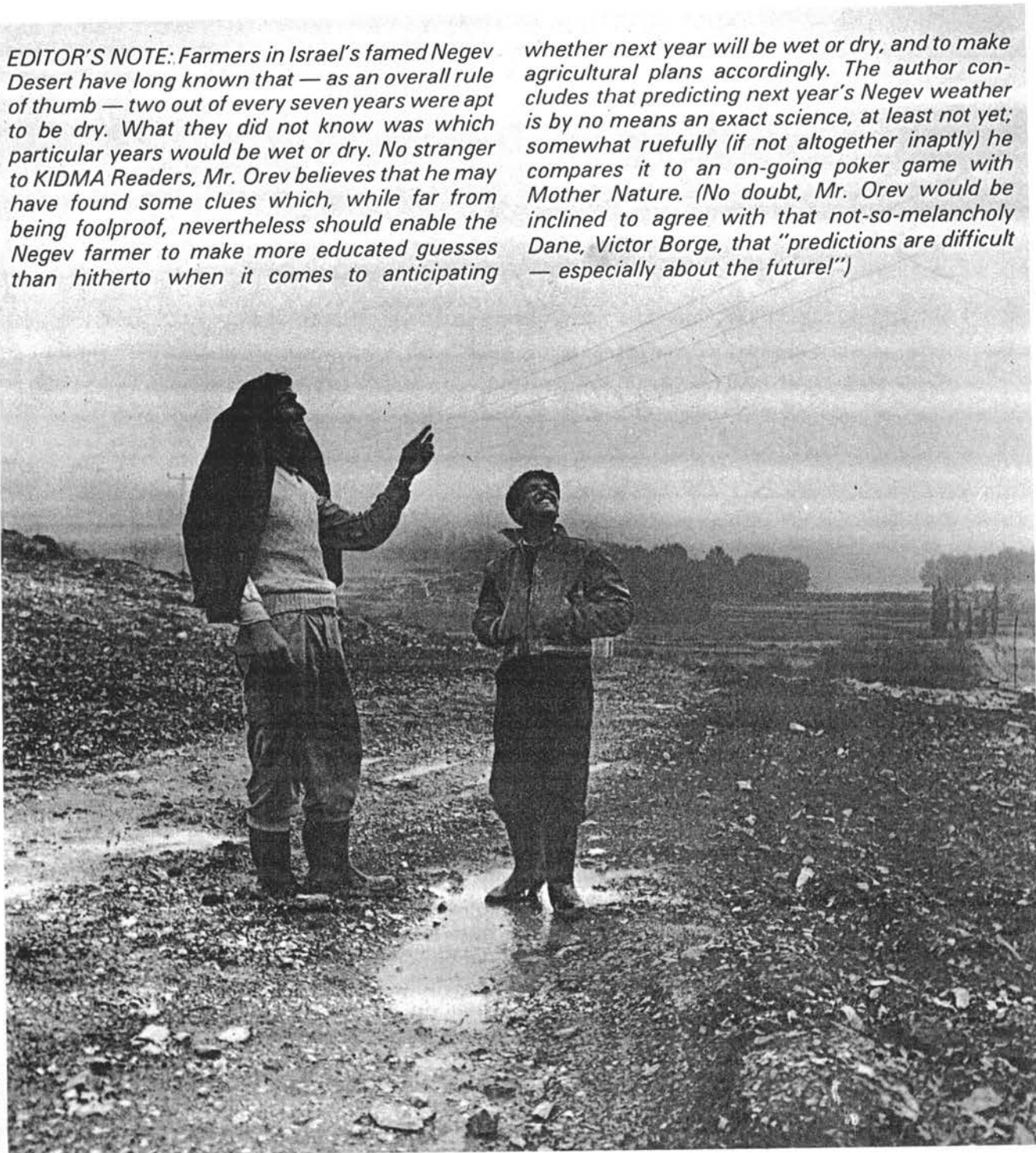


# ON THE PREDICTABILITY OF WET AND DRY WEATHER IN THE NEGEV

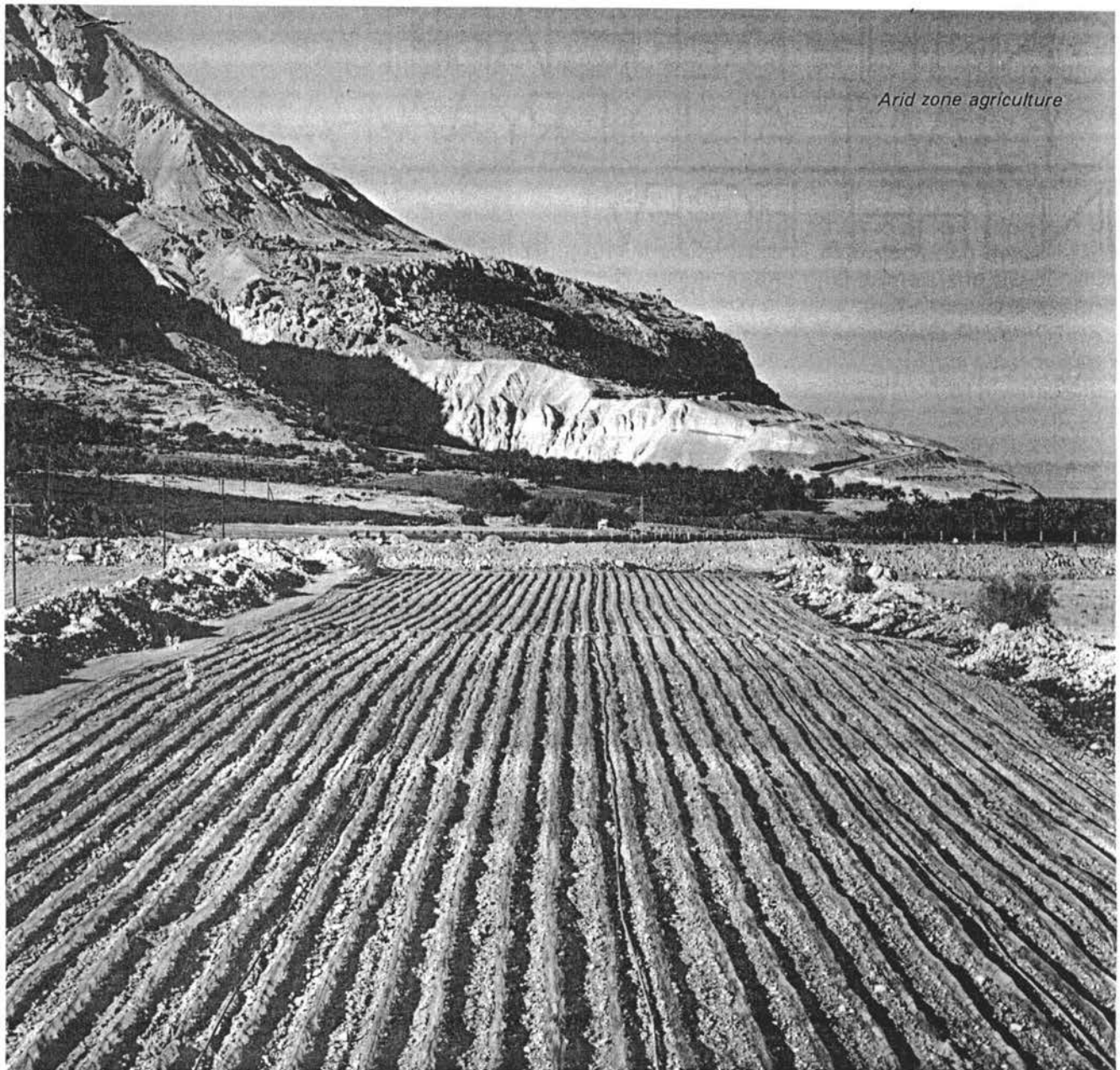
By YAACOV OREV

*EDITOR'S NOTE: Farmers in Israel's famed Negev Desert have long known that — as an overall rule of thumb — two out of every seven years were apt to be dry. What they did not know was which particular years would be wet or dry. No stranger to KIDMA Readers, Mr. Orev believes that he may have found some clues which, while far from being foolproof, nevertheless should enable the Negev farmer to make more educated guesses than hitherto when it comes to anticipating*

*whether next year will be wet or dry, and to make agricultural plans accordingly. The author concludes that predicting next year's Negev weather is by no means an exact science, at least not yet; somewhat ruefully (if not altogether inaptly) he compares it to an on-going poker game with Mother Nature. (No doubt, Mr. Orev would be inclined to agree with that not-so-melancholy Dane, Victor Borge, that "predictions are difficult — especially about the future!")*



Werner Braun



*Arid zone agriculture*

R. Milon

From the mid-1950s until 1962 I was busy planting saltbushes (*Atriplex halimus*) for range revegetation in the Negev Desert.\* The seedlings were planted in the Beersheva area which has an average annual rainfall of 200 mm, with lows of 42 mm and highs of 330 mm. Various improvements in planting practice made possible a good survival even in years of as little as 130 mm rainfall; indeed the plants survived even lower rainfall amid heavy browsing.

It turned out that the best season for planting was December to February; the efficiency of trans-

planting, at first manual but later semi-mechanised, reached a new peak. In my quest for further improvements and cost-cutting I turned my attention to direct seeding, eventually reaching the conclusion that, for best results, the seeding should be done in early January, because of a need for a minimal soil moisture depth for germination, a good chance of subsequent rains, and a fair stretch of cool and moist days for establishment and growth before the hot and dry days of late March and beyond.

I had to find out how often there was a *good chance* that the soil moisture depth in early January would amount to about 30 cm, requiring a prior rainfall of about 60 mm. In 1964, the Meteo-

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\* Cf. Y. Orev, RANGE DEVELOPMENT IN THE NEGEV DESERT, in KIDMA No. 18/1979 (Vol. 5, No. 2)

rological Service made available a set of complete monthly records of rainfall in the Beersheva region since 1921/2, and I noted that in more than half of the years there had been at least 60 mm of rainfall by the end of December.

The records already revealed one intriguing feature: there had not been any instance of *more* than two rainy years in a row, and there had been a total of six such rainy years back-to-back. This was to become important later on.

Primarily because of a foreign assignment, there was a gap of several years in my work on salt-bushes, but I reverted to the idea in 1968. As an aid to that work, I prepared a rainfall chart of Beersheva. On it I drew a smaller column of October, November, December total rainfall (OND), alongside each year's *total* rainfall column; the *total* was inked in red, the OND subtotals in blue.

The chart was on my wall for several years, and I looked at it quite often until one day (in January 1971), it suddenly struck me that when the blue column was low — so also was the red column. There and then I tried to find a threshold and I drew a line at the 70 mm height. That, however, was too low, and there were too many exceptions. I erased the 70 mm line and drew a new one at 75 mm. This time there were very few exceptions, suggesting the following general rule: "When OND rainfall exceeds 75 mm, the season usually turns out to be wet, i.e. with rainfall in excess of 211 mm. When OND rainfall does not reach 75 mm, the season usually turns out to be dry, with rainfall totalling less than 190 mm. *There were only five exceptions to this rule by 1971, i.e. over a fifty year period, meaning only a 10% rate of exception.*

The year 1971 itself conformed to the rule, in spite of bad distribution; so did the next one, 1971/2, which turned out to be one of the rainiest and best on record.

We now had two rainy years in a row (1970/1 and 1971/2), and I remembered the observation that there had *never* been three rainy years in a row. Now there was a record of eight such rainy pairs of years, followed by dry years, and so I plucked up enough courage to publish the figures, forecasting a dry season for the Beersheva area for 1972/3. The forecast was published in August 1972, in the agricultural Israeli monthly "*Has-sadeh*". I was very tense throughout that winter, especially when it looked for a while like an exception to the rule "Two wet years, one dry" by January 1973. But by the end of March 1973 there was no longer any doubt: there was a drought in the area and the rule had proven itself for the ninth time.

The published forecast was discovered by the daily press and widely publicised. It caused some furore, but no action was taken by the authorities to moderate the effects of the correctly anticipated drought.

It so happened that the 1972/3 season was one of widespread drought *throughout the country*. I was on a foreign assignment again and received a letter from a farming friend in the north of the country, in Nahalal, saying that he had taken heed of my warning, irrigated regardless of supposedly good early rains and had thus avoided losses.

I replied that my forecast dealt *only* with the Negev, and that I did not know anything about the rest of the country. But when I came back home in 1974, something made me look into the problem of what happened in other rain-gauging stations when Beersheva had a dry year following two wet ones. At that time I had at my disposal only the records of Jerusalem and Kibbutz Degania. With growing excitement I noticed that out of the nine occurrences recorded at Beersheva, *both Jerusalem and Degania also registered rainfalls seven times below the median, i.e. experienced climatic droughts.*

Curious, I went to the Meteorological Service and obtained rainfall records of several additional stations, extending from south of Beersheva to Mitzpeh in the Lower Galilee of Northern Israel. *All of them showed the same phenomenon: when Beersheva had a dry year following two wet ones, the rest of the country tended to follow suit, actually doing so at the rate of seven times out of nine.* That was in 1975. Since it appeared that there was much in common between Beersheva and the rest of the country, and since I already had the records, I tried to find out whether it also conformed to the "threshold rule", i.e. that if the OND rainfall was above a certain threshold, a wet season followed, the reverse being true if the OND figures were below the threshold value. It turned out that each station was found to have its own threshold; and that a *climatic* drought did not necessarily mean an *agricultural* drought. But the second rule held: OND rainfall above the local threshold tended to foreshadow a season above the median, and vice versa, with exceptions not exceeding 20%. In other words: the forecasts based on the rule were correct four times out of five.

It was also possible to designate a *lower* OND threshold which forecast an agricultural drought *without a single exception.*

My curiosity now thoroughly aroused, I wanted to ascertain whether the rule also applied to other parts of the world with a winter rainfall regimen of

the Mediterranean type, i.e. parts of S. Africa, Australia, USA and Chile; as well as to countries bordering on Israel, especially the Damascus region of Syria which lies in the lee of Mount Hermon whose melting snow supplies a significant part of the water flow of the Jordan River. The result was the discovery that *all the stations examined* (whose records had been supplied to me on request) from S. Africa, S. Australia, California and Chile, lying between 30° and 35° latitude North or South and having a winter rainfall regimen, *conformed to the threshold rule*; provided only that, in the *southern* hemisphere where there is some measurable rainfall even in summer, the January-July rainfall also had to be taken into account.\* The Damascus area records also showed that it additionally conformed to the rule of Beersheva "one dry after two wet years", six times out of nine, 66% of the time. This was in 1977.

Let me now retrace my steps to 1973, when, as noted, my drought forecast turned out to be correct. As already mentioned, I was then abroad, and at the end of that summer, wrote a *private* letter to the editor of the farming monthly in which my prediction had been published. In the letter I mentioned that, as a rule, in Beersheva a dry year was followed by a wet one; therefore a wet season should be expected for 1973/4. To my surprise, he published the letter and I found myself publicly on the spot for the second time. For me there thus followed another tense winter, because 1973/4 did *not* conform to the threshold rule; but heavy rains started in mid-January 1974, and the season ended very wet; so I had been right for the second time.

From then on I felt obliged to go on forecasting, and set myself a target span of ten years. I knew that weathermen accept three correct predictions out of four as a good record, so I began aiming at that.

What would 1974/5 be like? In Beersheva there is a better than 2:1 chance of a wet season being followed by another wet. But I felt uneasy and often looked at the chart (which I took with me abroad), to find some clue. Suddenly, one early afternoon in May, I saw a pattern of alternating dry and wet years in the 1940s and '50s repeating itself in the '60s and '70s. The pattern had already been in evidence for ten years and if it continued now, in the 1970s as it did in the '50s, the next year *should* be dry. Therefore I decided that my forecast for 1974/5 would be: dry. Also according

\* In the Southern Hemisphere, July is the peak winter-month, corresponding to the month of January in the Northern Hemisphere.

to the pattern of the 1950s, we should expect two wet years followed by a long dry spell of several years' duration, as had been the case between 1957 and 1963.

My forecast turned out to be *half-right* in 1974/5: the OND figure was one of a dry year, but there was a heavy rainstorm in late February and a smaller one in early March, bringing the total to just under 200 mm — 198.8 mm, an exceptional occurrence, right in the middle of the 190-211 mm zone which until then had remained quite blank on the chart. But agriculturally, the season was a drought, the more so since immediately after the early March rains, there was a 13-day period of a continuous hot and dry east wind which took the moisture right back; and, so it was a drought after all, as anticipated.

This brought my score to 3:0. Now, after a dry year I confidently predicted a wet one for 1975/6, especially since this would have conformed to the pattern mentioned before. The season started well, the necessary threshold was achieved early enough, and I expected a good (rainy) season to follow. I also bet on it heavily by sowing several hundred acres of safflower. But I was in for a shock and a substantial loss: after a good January, the rains nearly stopped and we had a second dry year in a row. Down went my score to 3:1. During the period which had passed since the end of the last dry cycle, 1963-74, there had been seven wet and four dry years, an excess of wet years.

I began to suspect that the second dry year in a row might signal the early advent of another dry cycle, perhaps of six or seven years' duration. So for the 1976/7 season I predicted — correctly, as it turned out — another dry season. My score: 4:1. The previously recorded dry cycles in Beersheva had lasted six years, and so I expected the current one to last just as long. Therefore for the years 1977/8 and '78/9 I again predicted dry seasons. Both predictions turned out to be right and my score stood at 6:1.

The dry cycle had now lasted five years and was nearing its end. Would it continue for a year or two? Various calculations led me to believe that we had not yet "paid back" the excess moisture received in the seven wet years of the previous wet cycle. Therefore I predicted another dry season for 1979/80 — *and was quite wrong*: the season was one of the wettest and agriculturally best on record reducing my score to 6:2.

Was this the end of the dry spell, or had it just been an odd rainy year in the midst of a prolonged dry cycle? I had seen it happen before: in Jerusa-

lem, there was a dry cycle lasting 13 years in the 1920s, broken in the middle by a single wet year; and in Botswana there had been a dry cycle of 11 years in the 1960s, likewise broken in the middle by a single wet year.

I already had a score of 6:2. Should I aim at 8:2, with a risk of being wrong two more times ending with an unimpressive ten year score of 6:4? Or play it safe and aim at 7:3? To clarify matters: if I forecast a wet year and failed, it would mean a score of 6:3 and I'd be in the dark as to the next one; whereas if I predicted a dry year and failed, it would mark the second wet year in a row, meaning that the next year would almost certainly be dry, giving me an overall score for the 10 year period of 7:3. If, on the other hand, my forecast would prove to be right and it was a dry year, I would obtain a 7:2 score, so that the tenth year could not possibly make my score worse than 7:3. I predicted a dry year for 1980/1 — *and was wrong*. It was another wet year — but only by a very small margin: the rains were hardly above the definitional 211 mm limit of a wet year (in fact, 215 mm). On 26 March 1981, I wrote for the 10th time to the agricultural monthly "*Hassadeh*" (in which all my forecasts had been published), predicting a dry season for 1981/2, with a probability of 98% for Beersheva and the Negev, 77% for the rest of the country and a 66% probability of a reduced flow in the Jordan River.

Later on it occurred to me that I could check the actual gauging of the Jordan waterflow in all those years. I went to the Hydrological Service, obtained the records, put them on a graph and found that there was a below-median flow in the Jordan eight times out of the nine tabulations of "two wet years — one dry" in Beersheva; so the probability was in excess of 66%. Even if the current hydrological year (which ends in September) ends with an above-median flow, it would still amount to 8 out of 10.

Altogether, since 1921, there have been 33 drought years in Beersheva; with the 2:1 pattern it would have been possible to detect 30% of them almost a year before the event, as will assuredly be possible from now on.

Can some practical use be made of the facts discovered? I would not expect anyone to sow or refrain from sowing just on my say-so, but the "threshold rule" has now proven right for Beersheva 53 times out of 60 (89%) so perhaps winter grain growers could adjust the sowing times to sow with 89% certainty (or at least 80% if we go by the less regular stations). This would surely be better than the method they follow now, in which they

risk an *average* of two crop failures in every five years.\* If we add the 2:1 pattern, there can develop a practice of sowing in wet years and fallowing in dry ones, which should do much to stabilise grain farming. The last word will of course have to be with the grain farmers.

As regards irrigation, foreknowledge of a dry year will mean less recharging of underground water. Perhaps the water authorities could anticipate impending scarcity of water, and plan accordingly: it depends on whether they wish to use the new knowledge, and how.

Anyhow — my ten year score is now 7:3 and the trial and ordeal are things of the past. Moral: Even in this computer age of ours, it is still possible to discover new and exciting things from data which are already available: paper and pencil and a pair of eyes...

#### POSTSCRIPT (October 1982)

The last, tenth year of the trial behaved as a classical drought — the 31 December 1981 rainfall figure was 20 mm, auguring a sure drought. There were some rains in February and March 1982, bringing the figure up to 170 mm by 1 April. There were no rains in April to speak of and the May figure stood at 170.4 mm.

In the Negev there is always a chance of *some* rain falling up even as late as 15 May. So when there were 3.3 mm on 10 May, the picture remained true to form. Then, on 13 May, Mother Nature showed her capacity to confound "the best laid schemes of mice and men": no less than 40 mm of rain fell in 25 minutes, plus a little more in the hours which followed, carrying the total to 217.7 mm for the season, just past the lower definitional limit of a wet year (211 mm).

What are we to make of it? Can it be classed as a wet year, the first exception in 60 years to the "two wet — 1 dry year" rule? If so, it still remains within the limits calculated by statisticians: two exceptions in 100 years.

*Agriculturally, 1981/2 undoubtedly remains a dry year:* the rain storm was localised to the Beersheva area and did not extend to the main grain farming areas; what is more, the plants were already far too mature to make proper use of any moisture; besides, the moisture did not penetrate more than 5 cm into the soil.

And so, the poker game with Mother Nature goes on... ●

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\* The *actual* number of crop failures during the past 14 years — as reflected in the number of drought compensation payments to growers in marginal areas — came to ten.