

On Criticisms Concerning the Israeli Experiment

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In a recent publication, Dr. Neyman (1977) questioned a stated opinion regarding the Israeli rainfall stimulation experiment (Mielke, 1975). An evaluation supporting this opinion of the Israeli experiment is made suspect and the credibility of the well-known Israeli experiment (cf. Gabriel, 1967; Gabriel and Neumann, 1978) could be mistakenly doubted. Clarification of this issue is in order because for some inexplicable reason Dr. Neyman's assessment of this opinion apparently missed (or failed to acknowledge) some crucial and previously published statements. The importance of sound statistical procedures and preciseness among statisticians involved in weather modification have led to this presentation of additional scientific information on the evaluation so as to reveal the facts about the question raised by Dr. Neyman.

To begin, it is useful to quote Neyman's (1977, see p. 15) remarks at some length: "In his recent article [22] Mielke asserts: 'The Israeli experiment is an example of a highly successful experiment employing the cross-over configuration (Gabriel, 1967).' . . . on the surface, everything seems in order, including the final result of the experiment indicating 15 percent increase in rainfall ascribable to seeding. However, if Mielke looked at the paper a little more closely, he would have found good reasons for not quoting the Israeli experiment or, at least, for not quoting it in the manner he did. The point is that the Israeli experiment was evaluated in what appears to be an unprecedented manner. There were three periods of the experiment in which the day's precipitation used in the evaluation was measured differently. During the first period, the day's precipitation was measured from 8:00 a.m. of the given day to 8:00 a.m. of the next. Then there was a substantial period when the day's precipitation . . . was measured from 8:00 p.m. to 8:00 p.m. and it is not quite clear whether this period began the day before that in question or in the evening of the day in question. . . . The interesting thing is that, after a few years of this second method the experimentalists returned to the first method, 8:00 a.m. to 8:00 a.m. Why?"

This criticism overlooks the following statement, which was made in an earlier paper (Mielke, 1974, see pp. 15-16): "Documented data of the Israeli artificial rainfall experiment . . . is utilized in this example. . . . The specific data for this example consist of precipitation amounts on all actually seeded days from January 9, 1964 through April 15, 1965 when the Buffer zone

had rain and 700 mb temperatures were -4°C and colder. . . . Also the time period restriction placed on these documented data . . . was dictated by the use of a different experimental design prior to January 9, 1964."

This oversight is surprising, since the earlier paper (Mielke, 1974) was in the references of the paper cited by Dr. Neyman (Mielke, 1975). The earlier paper explicitly stated that the evaluation was confined to just one of the three periods of the Israeli experiment. Moreover, these data are contained in the Fifth Berkeley Symposium proceedings (LcCam and Neyman, 1967, see pp. 426-428, 438-444). Careful analysis of the symposium proceedings shows that only one time period—8:00 a.m. to 8:00 a.m.—is used in analyzing the data, which were restricted to the period from January 9, 1964 through April 15, 1965.

A point that Dr. Neyman does not raise, but which might well be clarified, is that the data used in the example (Mielke, 1974) involved only 55 out of 85 declared experimental units in which seeding actually occurred. Seeding did not occur on any of the 30 additionally declared experimental units having 700 mb temperatures -4°C and colder during the January 9, 1964 through April 15, 1965 period. Of the 30 additional experimental units, 15 were randomly assigned to each of the two cross-over seeding categories, *viz.*, the decision to seed either the North or Center area. If the squared rank and Wilcoxon tests had been applied to the complete set of 85 declared experimental units in question, the normalized test statistic and one-sided p -value for the squared rank test are 1.41 and 0.08, respectively, and the normalized test statistic and one-sided p -value for the Wilcoxon test are 1.59 and 0.06, respectively. With the exception of an anticipated dilution due to the inclusion of 30 declared experimental units which omitted the seeding treatment, these results are similar to the previously obtained results based on the 55 declared experimental units.

In addition, corrections to the Climax I column heading frequency discrepancies mentioned by Dr. Neyman (1977, see pp. 17-18) and a few other additional discrepancies which we also failed to find until fairly recently had been previously published in July 1976 (Mielke *et al.*, 1971). Unfortunately, it was not possible to correct analogous discrepancies which have occurred in conference preprint volumes.

It is hoped that this answers the questions raised by

Dr. Neyman and puts the Israeli experiment in the proper perspective.

REFERENCES

- Gabriel, K. R., 1967: The Israeli artificial rainfall stimulation experiment. Statistical evaluation for the period 1961-65. *Proceedings Fifth Berkeley Symposium on Mathematical Statistics and Probability*, Vol. 5, University of California Press, 91-113.
- , and J. Neumann, 1978: A note on the 1961-67 Israeli rainfall stimulation experiment. A rebuttal of criticisms of its analyses. *J. Appl. Meteor.*, **17**, III-III.
- LeCam, L., and J. Neyman, 1967: A collection of data from cloud seeding experiments in five countries. *Proceedings Fifth Berkeley Symposium on Mathematical Statistics and Probability*, Vol. 5, University of California Press, 399-451.
- Mielke, P. W., 1974: Squared rank test appropriate to weather modification cross-over design. *Technometrics*, **16**, 13-16.
- , 1975: Some design and evaluation considerations for the Sierra Nevada wintertime orographic cloud seeding project. *Preprints Special Regional Weather Modification Conference: Augmentation of Winter Orographic Precipitation in the Western U.S. (San Francisco)*, Amer. Meteor. Soc., 179-183.
- , L. O. Grant and C. F. Chappell, 1971: An independent replication of the Climax wintertime orographic cloud seeding experiment. *J. Appl. Meteor.*, **10**, 1198-1212; corrigendum, **15**, 801.
- Neyman, J., 1977: Experimentation with weather control and statistical problems generated by it. *Applications of Statistics*, P. R. Krishnaiah, Ed., North-Holland Publ. Co., 1-25.