

# DISCUSSION OF REPORTS ON CLOUD SEEDING EXPERIMENTS

FRANK YATES

ROTHAMSTED EXPERIMENTAL STATION, HARPENDEN

## 1. General

The work on cloud seeding which has been described in this Symposium is new to me. I find it extremely gratifying to encounter such well designed and carefully conducted experiments in which the principles of randomization have been scrupulously adhered to.

A few of the speakers appear to think that there is some conflict between a "statistical" experiment, fulfilling the requirements of experimental design, and an experiment which because it ignores these requirements can be conducted with greater freedom. I think this is a misconception. Any experiment dealing with variable material should have built into it the appropriate random elements. If this is not done, confusion and false conclusions will ensue, and there will be endless arguments as to what the results really mean.

The real contrast, I think, is between a series of detailed short term experiments on single clouds and the like, undertaken solely with the object of gaining a better understanding of the physical processes involved, and long term experiments designed to determine the benefit, if any, resulting from some already determined method of seeding (or alternative methods). It should not be thought, however, that the latter type of experiment is incapable of throwing light on the underlying physical processes. If sufficiently objective and refined physical measurements are taken it may be very revealing.

Detailed short term experiments must, however, be properly designed, with appropriate randomization. Physicists, accustomed in much of their laboratory work to handling material with little variability, often neglect this requirement. The head of our own physics department at Rothamsted, Dr. Penman, talks of "getting the Fisher out of physics." I think he is mistaken, as, I may say, do the Rothamsted biologists.

## 2. Concomitant observations

One reason, I think, why there is this conflict between physicists and statisticians is that it is insufficiently realized that much more can often be elucidated from an experiment than is obtained by the mere comparison of crude means. Given concomitant observations on various physical and meteorological phenomena the results can be examined to see whether, singly or jointly, they influence the