SOME BASIC IDEAS ABOUT DESIGNS AND ANALYSIS OF EXPERIMENTS*

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THE practice of applying certain statistical methods, however simple they may be, is a critical social need for all. In order to make the best use of these, it is highly essential that we should know the basic principles underlying them. statistics may be broadly classified into pure and applied statistics. In pure Statistics we develop certain research tools with the aid of methematics and the theory of probability, which are then applied to specific problems in different fields in applied statistics. As in mathematics, the same set of tools are applied in all the diverse fields of application. Of late, statistical techniques have become very popular in almost all branches of sciences. Since 1920 the statistical approach has been accepted and welcomed by a steadily increasing circle of scientific workers and it is probably one of the most important characteristic features of modern science. Recent years have brought amazing

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changes in statistics and much of the recent development in the theory and application of statistics arose to meet the need for improved tools designed to handle problems in agricultural and biological research. There was a long felt need in these fields not only for interpreting observational data but also for planning experiments efficiently. Modern statistical methods based on the theory of probability provide a most powerful means for efficient planning of observational and experimental programmes and unambiguous summarisation and interpretation of the resulting data.

Approach to the Problem

Statistics enters primarily into three phases of research project. The three phases are clarification and logic of objectives, identification and control of the sources of variation and the analysis and interpretation of results. Thus the first step in designing any experiment is to define the purpose of the experiment. A lucid statement of the objectives will be most helpful. The objectives may be, say, finding out best suited varieties for propagation in different tracts, optimum manurial doses, best insecticides for pest control, etc., as the case might be. Normally the second step in setting up an experiment is to guage the probable accuracy of the results likely to be obtained from the experiment. The value of the experimental error gives a measure of the precision or accuracy attained. When the experimental error is large, only such treatment differences as are larger can be detected and even this may be subject to considerable uncertainty. Hence it is highly essential that the error in any experiment should be kept controlled within allowable limits. A knowledge of the sources of error will be of much help in this. The first is the inherent variability in the experimental material to which the treatments are applied. The second source of error is the lack of uniformity in the physical conduct of the experiment or in other words, failure to standardise the experimental techniques.

Randomisation

The simple precaution of randomisation in design of experiments is an important safeguard against error from the second source mentioned above. Randomisation is somewhat analogous to insurance, in that it is a precaution against disturbances that may or may not occur and that may or may not be serious if they do occur. In doing so, the experimenter is protected against unusual events that might upset his expectations. Randomisation justifies the assumption that if discrimination of the kind under test is absent, the result of the experiment will be wholly governed by the laws of chance, and thus will suffice to guarantee the validity of the test of significance by which the result of the experiment is to be judged.

Replication

The yardstick by which the significance of the treatment comparisons in any experiment is to be judged is the error of the experiment. The main purpose of replication or repetition of an experiment is to get an estimate of the error. In fact, there is no alternative method of constructing this yardstick. Under conditions of randomisation, besides providing an unbiassed estimate of error, replication renders the experiment more sensitive.

Local Control

Regarding the first source of error mentioned above, the application of the principle of local control (based on such points as plots of land resemble one another more nearly in fertility the closer together they lie, that plants of the same stock are generally more alike than plants of different stocks, etc.) can go a long way in minimising it and thereby increasing the precision of the experiments.

Interpretation of Data

Analysis and interpretation of the data from any experiment or research project often leads to estimation of certain quantities or estimation and test of significance for their departure from the expected values formulated under the null hypothesis. Testing of the underlying assumptions, the drawing of inferences from sample to population, etc., are all based upon intelligent statistical analysis. The inference drawn from sample to population though uncertain can be rigorous because it is possible to get a measure of the uncertainty involved. Any observed quantity is likely to deviate from its expected value for either of two reasons. In the first place it may deviate because of sampling error arising from the necessary use of finite number of observations; secondly it may deviate because the premises on which the expectation is based are invalid. The purpose of the test of significance in its broader aspects is to effect a distinction between these two types of deviations.

Some Designs

If the experiment or investigation is to lead to explicit, unequivocal and convincing results, it must be planned so that the data are capable of clear-cut statistical analysis. The availability of a number of designs, both simple and complicated, to suit to different situations makes the choice of a proper design all the more easy. Randomised blocks, latin squares, split-plots and factorial designs are a few of the more common types and provide accurate methods of dealing with the majority of experimental situations. However, a number of other designs such as sequential experiments, incomplete blocks, etc., have also been developed to meet specialised situations. Taking into consideration the nature of the problem, the resources available for experimentation and the accuracy desired an intelligent choice of a design should be made. It should be borne in mind that the results of any experiment follows solely from the value of the material utilised for drawing inference.