ROTHAMSTED RESEARCH

Report for 1933

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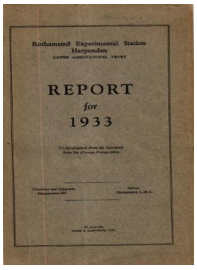

Statistical Methods and Results

Rothamsted Research

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STATISTICAL METHODS AND RESULTS

(Department of Statistics)

(*a*) Mathematical Theory

XIX. R. A. Fisher. "*The Sampling Error of Estimated Deviates, together with Other Illustrations of the Properties and Applications of the Integrals and Derivatives of the Normal Error Function.*" Mathematical Tables, 1931, Vol. I, pp. xxvi-xxxv.

The mathematical properties of the Hermite functions H_n and the closely related functions G_n are summarised, together with their relationship to the integrals I_n of the probability integral. The definition of I_n is extended to include positive and non-integral values of n.

It is shown that if the deviate of the mean of a normal distribution from a fixed value is estimated by the deviate of the mean of a sample and this deviate is expressed as a fraction t of the estimated standard error of the sample, then the distribution of t can be obtained in terms of I functions.

The moments of the truncated normal distribution about its terminus are easily expressed in I functions. The method of moments, when applied to estimating the parameters of the distribution, is in this case efficient, giving the same solution as the method of maximum likelihood.

If the parameter m of a simple Poisson series is a variate, then with certain distributions of m the resultant modified distributions of the variate x of the Poisson series are expressible in terms of the I functions.

XX. F. Yates. "*The Analysis of Multiple Classifications with Unequal Numbers in the Different Classes.*" Journal of the American Statistical Association, 1934, Vol. XXIX, pp. 51-66.

A type of problem which frequently confronts the statistician is the analysis of data which can be classified simultaneously in two or more different ways, as, for example, the analysis of the incidence of disease in different towns, where the towns might be classified according to population and also according to geographical position.

The statistical procedure appropriate to the case where the numbers in the various sub-classes are equal is specially simple, and has been very fully developed in connection with the replicated field trials in agriculture. The procedure is a special case of the method known as the analysis of variance. When analysing tables in which the numbers of the various sub-classes are unequal the procedure appropriate to equal numbers requires considerable modification. This paper considers the general case of a $p \times q$ table, as well as the more special case of a $2 \times q$ table, and is largely a fuller exposition of the methods advocated in a previous paper.

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XXI. CH. ZINZADZE. "*Bibliography of Statistical Methods, chiefly on the Application of the Analysis of Variance.*" Duplicated copies, Rothamsted Experimental Station, 1933.

In the last few years the application of statistical methods to biology has grown considerably, and the new methods associated with the name of R. A. Fisher have spread far afield. But it has already become very difficult to find the widely scattered papers published on this subject in many countries and different journals. Therefore it has become necessary to arrange a classified bibliography.

There are two objects in view in presenting this bibliography : (*a*) to introduce the beginner to the study of the analysis of variance ; and (*b*) to supply the advanced research workers with the principal publications up to the end of 1933.

The following are the classes in which the bibliography has been arranged : (1) Field Experimentation ; (2) Horticulture ; (3) Plant Physiology ; (4) Soil Science and Soil Bacteriology ; (5) Meteorology ; (6) Fisheries ; (7) Books and General Works in Statistics.

(*b*) TECHNIQUE OF FIELD EXPERIMENTS

XXII. F. YATES. "*The Formation of Latin Squares for use in Field Experiments.*" Empire Journal of Experimental Agriculture, 1933, Vol. I, pp. 235-244.

The value, as a means of eliminating fertility differences, of square arrangements of plots, satisfying the conditions of the Latin square, was early recognised. When first introduced, however, the importance of an unbiased estimate of error was not realised, and the arrangements adopted were all systematic, usually of some specially simple type, or alternatively of a type which was believed would remove most completely the soil differences ordinarily existing.

Randomisation has now been practised for some years, but the exact procedure of randomisation appropriate to a Latin square has never been clearly defined. In this paper it is shown that the randomisation of rows and columns, or either and letters, among themselves, will provide an unbiased estimate of error, but that there is something to be said when using squares of small size for making a random selection from all possible squares of that size.

The squares up to size 6×6 have now been completely enumerated and are here presented in a form suitable for making a random selection from all possible squares. Specimen squares from 7×7 to 12×12 are also given from which by randomisation of rows, columns and letters, or any two of these, squares may be obtained for experimental use.

XXIII. F. YATES. "*The Analysis of Replicated Experiments when the Field Results are Incomplete.*" Empire Journal of Experimental Agriculture, 1933, Vol. I, pp. 129-142.

The principles of randomisation and replication, recently introduced into the design of agricultural field trials, have greatly increased their accuracy, and have rendered possible valid tests of significance and estimates of the experimental errors. But as in all experimental work, it sometimes happens that accidental causes

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upset the original design, so that the methods of analysis which are ordinarily appropriate require modification. In general, replicated field trials are so arranged that the mean yield of all the plots receiving a given treatment provides the best estimate of the effect of that treatment, free from any extraneous effects, such as fertility differences, which are allowed for in the design.

If the yields of some plots are lost, or unreliable, the balance of the original design disappears. The simplest method of obtaining unbiased estimates of the treatment effects, and making tests of their significance, is to estimate the yields of the missing plots, and then perform the analysis of variance on the completed set of values. The formulæ appropriate to the case of a single missing plot of a randomised block or Latin square were first given by Miss Allan and Dr. Wishart. A simpler method of deriving these formulae is here described, and the procedure appropriate to the case where several values are missing is developed. The validity of the ordinary tests of significance is also examined, it being shown that there is no serious disturbance.

A new use of the missing plot technique is suggested for analysing interactions which are believed to be due to a few anomalous values.

XXIV. R. K. S. MURRAY. "*The Value of a Uniformity Trial in Field Experimentation with Rubber.*" Journal of Agricultural Science, 1934, Vol. XXIV, pp. 177-184.

Sanders' method of utilising previous crop records to correct experimental results by means of a linear regression is briefly described.

The method is applied to yield figures from rubber trees in Sumatra, and the precision of a dummy experiment is thereby increased nearly four-fold when the "preliminary" and "experimental" years are consecutive. When the "experimental" year is three years later than the "preliminary" year the error of the adjusted yields is reduced to about a half.

It is concluded that not only has the method of correction been of value in the particular instance investigated, but that a uniformity trial utilised in this way should be of practical value in any major field experiments with rubber.

XXV. F. YATES AND D. J. WATSON. "*Observer's Bias in Sampling Observations on Wheat.*" The Empire Journal of Experimental Agriculture, 1934, Vol. II, pp. 174-177.

An experiment carried out at Rothamsted to determine the bias of different observers in making plant and shoot counts of wheat is described. The observers were those making sampling observations on wheat at various centres, under the scheme of the Agricultural Meteorological Committee, in order to determine the principal events which mark the progress of the wheat plant from germination to maturity. The experiment is of interest in showing that large biases in plant counts can occur (due to the difficulty of deciding what are plants and what are tillers), and emphasises the need of arranging comparative trials for observers who have to take measurements liable to bias.

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(*c*) GENETICS

XXVI. R. A. FISHER. "*The Evolutionary Modification of Genetic Phenomena.*" Proceedings of the Sixth International Congress of Genetics, 1932, Vol. I, pp. 165-172.

The possibility of explaining observed genetic phenomena in terms of evolutionary modifications is reviewed. It is shown that the phenomena of dominance and recessiveness, of multiple allelomorphism and other genetic phenomena, together with many apparent anomalies, may be satisfactorily accounted for by the processes of natural selection as the result of evolutionary modification of the whole gene complex which conditions the manifestations of the particular genes being studied.

XXVII. R. A. FISHER. "*Selection in the Production of the Ever-Sporting Stocks.*" Annals of Botany, 1933, Vol. XLVII, pp. 727-733.

An outline of Winge's theory of doubleness in stocks is given, and of its implications.

A simple method of diagrammatic representation applied to Miss Saunders' data of 1911, shows both that the observed excess of doubles is due solely to their greater viability, and that one family there reported was exceptional in giving only one quarter doubles, as should the progeny of a plant freed from the pollen lethal.

The close linkage between the pollen lethal and the factor for doubleness is due to selection acting automatically in the propagation of the ever-sporting lines, which has thus built up the ever-sporting character.

XXVIII, H. J. BUCHANAN-WOLLASTON. "*Some Modern Statistical Methods. Their application to the Solution of Herring Race Problems.*" Journal du Conseil International pour l'Exploration de la Mer, 1933, Vol. VIII, pp. 7-47.

The form of the distribution of vertebral count of herrings has been used by Schnakenbeck as a criterion of racial difference.

It is here shown that the observed changes of form can be wholly accounted for by differences in the mean vertebral number. The vertebral numbers in a shoal may be regarded as highly grouped normal data, any apparent skewness or other differences of form being due to variation of the mean in relation to the boundaries of the grouping interval. Moreover the variance does not differ significantly from shoal to shoal.

Methods of fitting the normal curve to highly grouped data by the method of maximum likelihood have been developed (the method of moments being inefficient).

A discussion of the general principles of the analysis of variance is included, in connection with the analysis of the geographical distribution of the mean vertebral number of the different shoals.