ROTHAMSTED RESEARCH

Report for 1931

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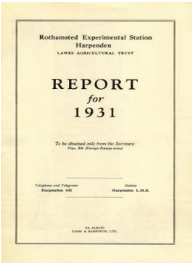

Statistical Methods and Results

Rothamsted Research

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toxic than dicyanodiamide to nitrifying organisms, although in soils the toxic action of the former is relatively less because of its much more rapid disappearance.

XVII. H. L. RICHARDSON. "*Studies on Calcium Cyanamide. III. Storage and Mixing with Superphosphate.*" Journal of Agricultural Science, **1932**, Vol. XXII, pp. 348-357.

There was no appreciable loss of nitrogen from Calcium Cyanamide during storage under good farm conditions for two years, and only slight changes in the forms of the nitrogen present. Less than 1 per cent. was converted to dicyanodiamide after one year. Mixing Calcium Cyanamide and superphosphate caused changes that varied greatly with the conditions ; in a farm mixture spread in a thin layer after mixing, one-sixth of the nitrogen was changed to dicyanodiamide within a day, and one quarter in a month. In a series of laboratory mixtures the proportion of nitrogen converted to dicyanodiamide varied regularly with the composition, a maximum of 50 per cent. being reached in the mixture containing 20 per cent. of Calcium Cyanamide.

Both this paper and the first in the series contain appendices describing the special analytical methods used in the investigations.

STATISTICAL METHODS AND RESULTS
(Statistical Department)

(*a*) MATHEMATICAL THEORY

XVIII. R. A. FISHER. "*The Moments of the Distribution for Normal Samples of Measures of Departure from Normality.*" Proceedings of the Royal Society of London, A, **1930**, Vol. CXXX, pp. 16-28.

Two methods are given for discussing the distribution of the ratios of the symmetric functions k_3, k_4 . . . obtained from samples from a normal distribution to the powers of k_2 of the same degree.

The first method consists in the development of recurrence relations expressing the ratios from a sample of n in terms of the corresponding ratios from a sample of n—1 observations, and of a parameter distributed independently in a known distribution. Theoretically, all the properties of the general distribution could be obtained from these relations in conjunction with a study of samples of 3, 4, 5 . . . observations.

The relations are used to derive the exact values of the first three even moments of the simplest ratio γ, and of the simpler non-vanishing moments of the simultaneous distribution of all the ratios. It is observed that these moments are very simply related to the corresponding moments of the distribution of k_3, k_4 . . . given in a previous paper.

The second method is an application of the method of symbolical operators developed by the author, which confirms the generality of the relationship found. The moments of the one distribution may thus be inferred directly from that of the other for which the combinatorial procedure is available.

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XIX. J. WISHART. "*The Mean and Second Moment Coefficient of the Multiple Correlation Coefficient, in Samples from a Normal Population.*" Biometrika, 1931, Vol. XXII, pp. 353-361.

The exact distribution of the multiple correlation coefficient was given in the Proceedings of the Royal Society, A (Vol. CXXI, pp. 654-673) in 1928. From this any required property of the distribution may be directly obtained. In the present paper the mean and variance of R^2 for $n_2=2$, 4, and 6 are calculated, and the general formula inferred. It is pointed out that the moments of R itself do not seem to be capable of simplification.

XX. J. WISHART. "*Notes on Frequency Constants.*" Journal of the Institute of Actuaries, 1931, Vol. LXII, pp. 174-177.

A note on the notation and use of statistics derived from sums of powers of the observations, with especial reference to previous discussions by Lidstone and Steffenson on the moments of Pearson and the semi-invariants of Thiele.

XXI. R. A. FISHER AND J. WISHART. "*The Derivation of the Pattern Formulae of Two-way Partitions from those of Simpler Patterns.*" Proceedings of the London Mathematical Society, 1931, Series 2, Vol. XXXIII, pp. 195-208.

A method is developed of calculating the function of n to be associated with any two-way partition in the evaluation of the cumulants of the sampling distribution of the appropriate moment statistics k, by expanding it in terms of the functions of partitions having simpler patterns. When columns of two or three entries occur the simplification is extremely rapid. The method is, however, generalised for all cases.

A proof is given of the vanishing of the functions corresponding to all patterns in which the rows may be divided into two groups having only a single column in common.

XXII. J. WISHART. "*The Analysis of Variance Illustrated in its Application to a Complex Agricultural Experiment on Sugar Beet.*" Archiv für Pflanzenbau, 1931, Vol. V, pp. 561-584.

A description is given of a complex experiment on the manuring of two varieties of sugar beet, carried out at Rothamsted in 1929. The special experiment described is of a complex type, but is treated by determining a number of standard errors appropriate to special comparisons. While there is less certainty in such a case as to the genuine validity of these errors in their appropriateness for all the comparisons possible, the great advantage in precision to be obtained by combining diverse enquiries in large and complex experiments seems at this early stage to outweigh the convenience of simply demonstrable estimates of error.

XXIII. J. O. IRWIN, "*Mathematical Theorems involved in the Analysis of Variance.*" Journal of the Royal Statistical Society, 1931, Vol. XCIV, pp. 284-300.

In this paper proofs are given of the essential theorems involved in the "analysis of variance" method which R. A. Fisher has inven-

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ted. An endeavour has been made to treat them in an elementary manner, so as to make them available in one place for the mathematical-statistical student of average ability, or any others interested in the subject. For this reason somewhat full proofs have been given and points dealt with in detail which will appear obvious to the highly trained mathematical statistician.

(*b*) GENETICS

XXIV. R. A. FISHER. "*The Evolution of Dominance.*" Biological Reviews, 1931, Vol. VI, pp. 345-368.

The theory that the genetical phenomenon of dominance is itself a product of the evolutionary process rather than a necessary consequence of the biochemical organisation of the nucleus, was first put forward in 1928, in connection with the facts which are now known about mutations in species bred in large numbers for genetical purposes such as *Drosophila* and *Gammarus*. Since this publication very numerous groups of genetical facts have been brought to the attention of the author respecting the domesticated species, and species showing polymorphism in nature, which strongly confirm and amplify the original proposition, and in conjunction with it, throw much light upon the genetic situations in these forms. This paper draws together the evidence from various fields, and indicates the special cases in which the theory may be tested by further experiment.

XXV. R. A. FISHER, F. R. IMMER AND OLOF TEDIN. "*The Genetical Interpretation of Statistics of the Third Degree in the Study of Quantitative Inheritance.*" Genetics, 1932, Vol. XVII, pp. 107-124.

A genetical interpretation is given for various second and third moment statistics which are of use in studying quantitative inheritance.

Published data taken from lettuce and maize, and unpublished data from barley crosses are used to illustrate how the problem may be attacked. The special needs of data adequate for this purpose are illustrated, and certain possible precautions in planning the experiments are pointed out.

A study of the skewness of seven distributions for strains of mice selected for high and low tailring number indicated that the theoretical negative association between the statistics k_1 and k_2 in selected strains could probably be evaluated.

Formulae are given by which the effect of the dominance bias in the heterozygote in relation to the measurable characters of the homozygotes in F_2 or F_3 distributions or various types of crosses may be calculated.

The two common sources of bias (metrical and dominance) are discussed and data from a barley cross used to illustrate the results obtained when the former is of major importance.

Since the combined effect of the dominance and metrical biases may be obtained experimentally in many different ways, an empirical test of the consistency of the genetical interpretations is available, as well as an opportunity of evaluating and eliminating the metrical bias.

Standard errors are given for the different statistics used.

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