ABSTRACT OF PAPERS PRESENTED AT THE 11th ANNUAL GENERAL MEETING HELD AT BANGALORE IN JANUARY 1958

1. *Distribution of the χ^2-Analogue for Normal Population with Class Intervals Defined in Terms of the Sample Median.* *Dr. A. R. Roy, Professor of Statistics and S. G. Mohanty, I.C.A.R., New Delhi.*

χ^2-Statistic with classes based on random variables has been defined by A. R. Roy in his thesis entitled 'On χ^2-statistics with variable intervals' and its distribution has been considered when the random variables defining the classes follow certain properties. These properties are essentially those satisfied by the maximum likelihood estimates. An attempt has been made in this paper to find the distribution of the χ^2-statistic when the random variables defining the classes do not possess the above properties. This has been done by considering normal population with class intervals defined in terms of the sample median. The distribution so obtained is different from that based on the classes defined by the sample mean which follows the properties mentioned above.

2. *Small Sample Power of the Tests* T*'s and* W*'s for Comparing Two Samples.* *Dr. P. V. Krishna Iyer, Defence Science Laboratory and Shri B. N. Singh, Indian Standard Institution, New Delhi.*

The paper gives the exact powers of some of the non-parametric tests of W's and T's developed by the authors recently with special reference to small samples, sizes 4 and 5 for H_0: rectangular distributions having range 0–1 as compared to H_1: rectangular distributions with the ranges Δ to 1 and also Δ to $1 + \Delta$ for single as well as double tailed tests.

3. *Testing of Two Binomial Samples.* *Dr. P. V. Krishna Iyer and M. N. Bhattacharyya, Defence Science Laboratory, New Delhi.*

In a *previous communication* the authors discussed the probability distribution of the statistics

$$X_s = \Sigma (x_r - y_r) + \sum_{i=1}^{s} \sum_{r=1}^{n-i} \{(x_r - y_{r+i}) + (x_{r+i} - y_r)\}$$

and

$$Y_s = \Sigma \mid x_r - y_r \mid + \sum_{i=1}^{s} \sum_{r=1}^{n-i} \{\mid x_r - y_{r+i} \mid + \mid x_{r+i} - y_r \mid\},$$

where x_r and y_r, assuming either of the characters A or B with probabilities p_1, q_1 and p_2, q_2 respectively, are the r-th observation of the binomial samples $\{x\}$ and $\{y\}$, when they are arranged according to the order of occurrence of the individual observations. The distribution of these statistics take the normal form as $n \to \infty$. Hence it has been suggested that the standardized deviates of these statistics could be used for testing the hypothesis, H_0: Two binomial sequences are random, independent and $p_1 = p_2$, against the alternatives, H_1: sequences are random and independent but $p_1 \neq p_2$ or H_2: sequences, either or both, are non-random. It may be noted that only for the alternative H_1 these statistics are comparable with the $2 \times 2 - X^2$ test used for comparing two binomial samples. The power of the statistics for $n = 30$, 100 and 200 for the hypothesis H_0 against the alternatives of type H_1 has been discussed. The power of X_s decreases with s up to $s < n/2$ but from $s = n/2$ the power increases with s and attains that of X_0 at $s = u - 1$. It was however noted during the investigation that the statistic X_0 and X_{u-1} are independent of order and their standardized deviates are identical with the $2 \times 2 - X^2$ test. In case of Y_s the power increases with s and reaches the maximum at $s = (n - 1)$ but the increase in power is not appreciable after $s = n/2$. These statistics are however locally biased for certain values of the hypothesis $p_1 = p_2 = p_0$.

The assumption of non-randomness for any of the sequences can be approximated to change in the value of the probabilities (p, q) for that sequence. Hence the same power tables as obtained above will provide the power for non-randomness also.

4. *Further Contribution to the Two Sample Problem. Dr. B. V. Sukhatme, Senior Research Statistician, I.C.A.R.*

Let $X_1, X_2, \ldots\ldots X_m$ and $Y_1, Y_2, \ldots\ldots Y_n$ be two samples of independent observations drawn from populations with cumulative distribution functions $F(x - \theta)$ and $G(x - \theta)$ respectively, θ being the unknown location parameter. It is assumed that F and G are the same in all respects except that they differ in the scale parameter only. The paper proposes non-parametric tests for testing the hypothesis that $F = G$ against the alternative that $F \neq G$ and discusses their distribution theory.

5. *Partitioning of Variance under Full-sib Mating. Shri M. Rajagopalan, I.C.A.R., New Delhi.*

In this paper, starting with a randomly bred population, the genetic composition of the population obtained by continued full-sib mating in *n*-generations, the partitioning of the heritable portion of the variation within inbred lines into additive genetic and dominance variations and further into the parts contributed by the variations between non-sibs, half-sibs and full-sibs among the progeny are considered.

6. *Efficiency of Family Selection. Shri M. Rajagopalan, I.C.A.R., New Delhi.*

Lush (1947), Lerner (1950) and Osborne (1957) have obtained the expressions for efficiency of different selection procedures for the case of equal numbers of dams being mated to each sire and each dam producing equal number of offspring. But in actual practice such a condition is rarely satisfied. In this paper the expressions for efficiency when unequal numbers are involved and when dominance is taken into consideration are obtained. A practical example is provided as an illustration.

7. *A Study of the Nature of Lactation Curve. Shri N. C. Khandekar, I.C.A.R., New Delhi.*

The problem of estimating total milk yield given during a lactation from a sample of daily records is of importance in the context of assessing the lactation production of group of animals in villages under development such as in a key village scheme.

In the present investigation the daily records of a number of Hariana cows in their first lactation were studied for expressing the relation between the rate of milk secretion and the advance in lactation by means of suitable mathematical curve with a view to utilizing this information in increasing the efficiency of the procedure of estimation of the lactation yield from a sample of milk records of a cow. A fourth degree polynomial and a quadratic-*cum*-log curve of the type

$$y = k_1 + k_2 t + k_3 t^2 + k_4 \log t$$

were found to be satisfactory for all cows having lactation period less than 330 days.

8. *Sampling of Milk Records for Estimating Lactation Yield. Shri B. S. Gill, I.C.A.R., New Delhi*

In this paper different methods of estimating (1) the lactation yield of a single cow and (2) the average lactation yield of a group of

cows have been considered. Under (i) Simple random sampling of daily milk yields and arithmetic-estimate, (ii) Systematic sampling and arithmetic estimate and (iii) Systematic sampling and estimate obtained by utilizing the knowledge regarding the nature of the lactation curve have been discussed. The number of cows required for estimating a herd average with a desired degree of precision and for various intervals of recording have been obtained.

9. *Variance of the Coefficient of Genetic Correlation Estimated in Plant Breeding Experiments. Shri A. V. K. Sastry, Directorate of Economics and Statistics, New Delhi.*

The usefulness or otherwise of selection based on one or more ancillary characters other than the character in which improvement is desired, depends on the nature and magnitude of genetic correlation between the ancillary character and the principal trait under improvement. In this paper an approximate formula, for large number of observations, for the variance of genetic correlation estimated from plant breeding experiments, has been presented. The procedure has been illustrated with the data on halolength and fineness of 19 strains of cotton tried in a randomised block design. The results showed a genetic correlation of $-0{\cdot}84$ with an estimated standard error $0{\cdot}50$.

10. *Response to Selection under Super-Dominance. Shri A. V. K. Sastry, Directorate of Economics and Statistics, New Delhi.*

In this paper an attempt has been made to predict response to selection when over-dominance is assumed in the genetic models. The model considered here assumes two equal factors with dominance of arbitrary degree producing F_2 genotypic variance equal to $0{\cdot}5$ units and environmental variance equal to 2 units. It is seen from the results that in the presence of super-dominance the genotypic advance of the selected will be lower than that would be expected when there is complete dominance. But, however, the mean genotypic variance within F_3 progeny means are higher in the presence of super-dominance than those in the case of complete dominance.

11. *On the Maximum Number of Factors that can be Accommodated in A 2^m Design with Fixed Block Size to 2^5. Dr. K. Kishen, Chief Statistician, Department of Agriculture, Lucknow.*

Using the geometrical theory of confounding developed by Bose and Kishen (1940), Bose (1947) has investigated the problem of determining the maximum number of factors that can be accommodated

in the case of the general symmetrical factorial design S^m, in which each block is of size s^r, so that no degrees of freedom belonging to a main effect or an interaction involving 't' or a lesser number of factors are confounded. Denoting this number by m_t (r, s), he has shown that this equals the maximum number of points which can be chosen in $PG(r-1, S)$, so that no 't' points should be conjoint. He has, in particular, shown that $m_3(r, 2) = 2^{r-1}$. Using Bose's method, the degrees of freedom confounded in the $(2^{16}, 2^{11})$, $(2^{15}, 2^{10})$, $(2^{14}, 2^{9})$, etc., have been enumerated and the confounding intra-block subgroups given.

12. '*Note on the Analysis of Confounded Factorial Designs*'. *Shri V. N. Murty, Assistant Director, C.S.O., New Delhi.*

In this note a method of obtaining the treatment sums of squares of confounded interactions without identifying which particular components are confounded is presented.

13. *Missing Plots in Asymmetrical Factorial Designs. Shri P. N. Bhargava, I.C.A.R., New Delhi.*

Though expressions for estimating a single missing plot are available in literature for most of the symmetrical factorial designs with complete or partial confounding, these do not cover the cases of asymmetrical designs. A general technique has been suggested to solve the problem of missing plots in asymmetrical designs. Expressions for one missing plot have actually been obtained in the paper in the cases of most of such designs in use. In cases of more than one missing plot it has been found that Bartlett's technique is more advantageous than that suggested by Yates.

14. *A New Type of Design. Shri M. N. Das, I.C.A.R., New Delhi.*

If in any two-way classification the cell frequency in the i-th class of one factor and j-th class of the second be denoted by n_{ij}, then it can be shown that if $(n_{ij}-n_{jk})$ for any i and k be constant for all j, an algebraic solution of the normal equations becomes possible. Utilizing this property a type of design with unequal block sizes has been developed. These designs are particularly suitable for experiments with animals as the experimental units, for eliminating the effects of litters, breeds, lactation stage, etc. and thus they help for better and more economic use of animal resources.

15. *On Inter-block Analysis of Some P.B.I.B. Designs having a Missing Block. Shri N. C. Giri, I.C.A.R., New Delhi.*

Marvin Zelen (1954) discussed the intra-block analysis of partially balanced incomplete block designs with two associate classes such that all treatments in the missing block are the same associates of each other. The inter-block analysis of such designs has been obtained in this note.

16. *On Generalized Designs. Shri K. C. Raut, I.C.A.R., New Delhi.*

A generalised partially balanced design has been defined. The randomised block designs, the partially balanced incomplete block designs with or without some extra treatments which are present in every block and different partially balanced super-complete block designs, come out as particular cases of the general design. The design is particularly helpful for single plant progeny row trials with variable amount of seed available from the different progenies and for animal experiments involving smaller number of treatments with elimination of litter effect as in Bioassays and other animal husbandry experiments. The method of analysis, together with the expressions for finding the standard errors of treatment differences, has been presented.

17. *Design and Analysis of Some Confounded Qualitative-*cum*-Quantitative Experiments. Shri M. G. Sardana, I.C.A.R., New Delhi.*

Confounding in qualitative-*cum*-quantitative experiments involving dummy treatments and their analysis present some novel features not ordinarily met with in experiments involving only levels of different factors. These features have been studied in detail by discussing possible types of confounding and presenting the analysis, both under the additive and proportional models for the following types of symmetrical and asymmetrical designs:

1. 3 levels of 'n', 3 qualities of 'n', 3 levels of 'p'.
2. 3 levels of 'n', 2 qualities of 'n', 2 levels of 'p'.
3. 3 levels of 'n', 3 qualities of 'n', 2 levels of 'p'.
4. 3 levels of 'n', 3 levels of 'p', 2 qualitles of 'N'
5. 4 qualities of 'n', 3 levels of 'n', 2 levels of 'p'.

18. *Economic Analysis of Fertilizer Trial Data on Rice and Wheat. Shri T. P. Abraham and Shri V. Y. Rao, I.C.A.R., New Delhi.*

An economic analysis of the data of simple manurial trials conducted in cultivators' fields recently under T.C.M. programme, has been con-

sidered in the paper. Second degree response surface has been fitted to the data and the fitted surface was analysed to study:

(1) Optimum dose under different price levels with no restriction on available supply,

(2) Optimum dose with a given outlay,

(3) Least cost combination of nitrogen and phosphorus for desired targets of production, and

(4) Optimum allocation of a limited supply of fertilizers between rice and wheat

19. *Fertiliser Response Surfaces and Economics of Manuring.* *Shri V. Y. Rao, I.C.A.R., New Delhi.*

Investigations on the nature of fertilizer production functions were carried out using the data of a large number of fertilizer trials with nitrogen and phosphorus carried out in India. Five different functional models of two variable response surfaces were considered to study their relative suitability. Economic analysis of fertilizer data using response surfaces and some considerations in the planning of experiments for estimating production function have been discussed.

20. *An Examination of the Effect of Matched Sampling on the Efficiency of Estimators in the Theory of Successive Sampling.* *Dr. B. D. Tikkiwal, Karnatak University, Dharwar.*

The general theory of successive sampling has been studied for one character independently by Patterson (*J.R.S.S.*, **12:** 241–55, 1950) and the author (unpublished thesis for Diploma, I.C.A.R., New Delhi, 1951) both arriving at similar results. Later, the author (A paper under publication in *A.M.S.*) has also given results for the study of several characters on each occasion. The sampling scheme used in arriving at these results is one that of matched sampling. This paper examines the effect of matched sampling on the efficiency of various estimators from occasion to occasion. It is shown that the effect, of using matched sampling to estimate the time-conditioned characters of population from occasion to occasion, is to improve the efficiency of the various estimators, based on matched sampling, of the characters with increasing occasions reaching a limiting value. This is in addition that it gives more efficient estimators of the various parameters on an occasion as compared to the corresponding simple estimators based on no matching on that occasion. The two checks are given for the computation of ϕ_h, the weighting coefficient used in the estimators and the behaviour of its limiting value is discussed. It is shown that the

rapidity of convergence of the weighting coefficient decreases with increasing absolute value of the correlation coefficient between two consecutive occasions. This is expected as the occasion, on which the limiting efficiency due to matched sampling is reached, should occur later in the case when the correlation between successive occasions is higher.

21. *Farmer's Opinion Survey*—1957–58. *Shri D. M. Rao, The Fertiliser Association of India, New Delhi*

The purpose of the Survey is to obtain first-hand information from the farmer regarding:

1. The present rate of consumption of different types of fertilisers and the result he obtained by applying these fertilisers;
2. The farmer's knowledge about the use of fertiliser and the benefits he noticed in their use;
3. The difficulty experienced by him in obtaining the fertiliser and its effect on consumption;
4. The reason for not applying fertilisers in case he is not using fertilisers;
5. The source of farmer's information such as visits to Research Stations, Farm Demonstrations, Farm Bulletins, etc.

The results of the Survey, when properly tabulated and analysed, will throw light on the future line of action for popularising fertiliser use.

Method of Survey.—In the first instance, the Survey will be conducted, on a pilot basis, in one district of a State, where fertiliser use is prevalent. 2–3 villages will be selected in each tahsil depending on their size. In each village 10 farmers will be selected, care be taken to see at least 4 of them being either users of fertilisers or non-users of fertilisers.

22. *On Estimation of Variance Components in Finite Population. Shri D. Singh, I.C.A.R., New Delhi.*

In multistage sampling, if the sampling method is not simple, if the sizes of the sampling units are not equal, if the population is finite, and if the number of samples to be selected from each selected unit is not the same, the procedure for estimating the different stage variance components is not straightforward. In this paper it has been shown how the method of analysis of variance can be suitably used for studying these variance components. It has also been shown how a fairly good approximation of these estimates can be obtained without undertaking detailed computation.