ABSTRACT OF PAPERS PRESENTED AT THE 12th ANNUAL GENERAL MEETING HELD AT GWALIOR IN JANUARY 1959

1. *On Adjustment to Components of Second Order Interaction Confounded in a 3^3 Design. Shri G. A. Kulkarni, Indian Council of Agricultural Research, New Delhi.*

Cochran and Cox (1957) have obtained adjustments to the linear × linear × linear component in a 3^3 design with nine plots per block and confounding in 4 replications different sets of 2 degrees of freedom. In estimating this component they have assumed that all the other seven components of the 2nd order interactions are negligible and further they have suggested that the procedure of adjustments to the above component is similar in case of replications less than four.

It has been shown that the above assumption is not necessary since all the 8 contracts of the adjusted components are orthogonal to one another. The procedure of adjusting these components requires not only the block totals but also the part of unconfounded 2nd order interaction totals in case of replications less than four.

2. *A Note on the Analysis of 3^N Factor, Fractional Replication. Shri P. N. Bhargava, Indian Council of Agricultural Research, New Delhi.*

The procedure of obtaining the S.S. due to the main effects and interactions in 2^n design suggested by Yates (1937) has been extended to the case of fractional replication of 3^n design by omitting some factors from the given set of treatment combinations. The method of finding the S.S. of the two factor interactions as I and J components, from the four components of the two factor interactions, *viz.*, linear × linear, linear × quadratic, quadratic × linear and quadratic × quadratic has also been given. It is also extended for more than two-factor interaction.

3. *On a Class of Resolvable Partially Balanced Incomplete Block Designs. Dr. K. Kishen, Chief Statistician, Department of Agriculture, Lucknow and Shri J. N. Srivastava, Indian Council of Agricultural Eesearch, New Delhi.*

Considerable work has been done in the past among others by Bose, Nair, Roy and Laha, etc., on P.B.I.B.D's with two associate classes

and on P.B.I.B.D's involving only two or three replications. Relatively less attention has however been paid on resolvable P.B.I.B.D's. This paper presents a number of series of such designs all of which have been derived from the corresponding asymmetrical factorial designs and the link between the two has been clearly pointed out. The method of analysis of the P.B.I.B.D's obtained has also been indicated.

4. *On the General Theory of Construction and Analysis of Asymmetrical Confounded Factorial Designs. Dr. K. Kishen, Chief Statistician, Department of Agriculture, Lucknow and Shri J. N. Srivastava, Indian Council of Agricultural Research, New Delhi.*

The use of the concept of hypersurfaces in finite geometries for the construction of the general asymmetrical factorial design has recently been introduced by the authors. The same method has been further developed in this paper and has been compared with certain other methods of construction of the above designs, and found to be most powerful among them. It has been used to obtain what has been called 'Non-simple confounded designs' which are not derivable from the ordinary s^m series. The problem of balancing has been dealt with at length. All the useful cases arising out of the general asymmetrical designs, including symmetrical designs involving factors at non-prime levels have been particularly discussed and the method of their statistical analysis has been given.

5. *A class of P.B.I.B. Designs. Shri M. N. Das, Indian Council of Agricultural Research, New Delhi.*

It has been shown that there is a class of designs which satisfies the definition of a P.B.I.B. design but for which no solution is possible. A condition has been obtained which the P.B.I.B. design with two associate classes must satisfy for having a solution. It has been shown that by reinforcing the design without solution a class of designs with good efficiency can be obtained.

6. *Generalized Staircase Designs. Shri C. Sahai, Indian Council of Agricultural Research, New Delhi.*

In progeny row trials as also in experiments with animals as the experimental units, it becomes necessary to adopt design with unequal number of replications as also unequal blocks. Graybill and Prauitt (1958) introduced a design called Staircase design which provides for different block sizes and replications. These designs are thus suitable for the above types of experiments. One drawback in this design is that it does not provide for block sizes which can be greater than the

number of treatments. Hence in experiments on littermates for which alone, they say, these experiments are more useful, all the animals in those litters of which the size is greater than the number of treatments, cannot be utilized and this may lead to some wastage of animals. In order to remove the drawback a class of generalized staircase designs has been defined. A method of its analysis, which does not follow from their method, has been worked out together with expressions for finding the variance of treatment differences.

7. *Augmented Fields and Factorial Designs in General. Shri M. N. Das, Indian Council of Agricultural Research, New Delhi.*

Augmented galois fields have been defined utilizing such fields it has been shown that it is possible to construct factorial designs, both symmetrical as also asymmetrical, with any number of levels for the factors. The investigation has been carried further to obtain orthogonal sets of latin squares of any order as also to find their maximum number.

8. *Statistical Inference Regarding the Equality of the Value of the Parameter in Two Discrete Geometric Populations with Particular Application to Redrot Lesion on Sugarcane Leaves. Shri J. N. Srivastava, Indian Council of Agricultural Research, New Delhi.*

The distribution of the maximum likelihood estimate of the parameter in a discrete geometric population has been given by Srivastava (1958). With the help of that, the distribution of the statistics corresponding to a uniformingly most powerful test of the hypothesis of equality of the values of the parameter in two such populations, has been derived in this paper. Tables for using the test so derived has also been prepared. Their use in studies on susceptibility of sugarcane leaves to redrot disease has also been indicated.

9. *A Note on the Distribution of Some Products. Shri U. G. Nadkarni, Indian Council of Agricultural Research, New Delhi.*

Using some properties of special functions the distributions of the product of two independently distributed γ variates and also of a γ and a β variate are obtained. As a particular case of the latter, the distribution of the product of a rectangular variate and γ variate is deduced. The *d.f.* and *m.g.f.* are also given in each case. *Inter alia*, it has been shown that the probability integrals for contagious distributions of a normal variate with different variances can be expressed in terms of a tabulated integral.

10. *Economic Amount of Experimentation for Deciding between Two Alternatives. Shri A. H. Manwani, Indian Council of Agricultural Research, New Delhi.*

The problem of choice of the size of experiment, designed to decide between two alternate courses of action, has been viewed in the light of minimum loss function criterian. Having defined the loss function in terms of cost of experimentation and the total expected loss due to the wrong decision, taking into account the scale on which the experimental result will be applicable; the solutions obtained under Normal distribution assumption are:

(*i*) a minimax solution for the single-stage experiments when exact value or an upper-bound of the variance σ^2 is known;

(*ii*) an admissible solution for double-stage experiments with known σ^2; and

(*iii*) a sequential non-trincated Bay's and minimax solution with reference to various weights attached to the two kinds of error, with known σ^2.

11. *Study of Genetic Models with Linkage in Quantitative Inheritance. Shri P. S. Puri, Indian Council of Agricultural Research, New Delhi.*

The most important problem in plant breeding is to determine the speed of genetic advance under selection. This was investigated by Panse, who introduced the method of genetic models which he considered with independently segregating factors. In the present investigation following the statistical approach given by him a similar study has been made of genetic models with linked factors. The effect of linkage on the speech of genetic advance and various F_3 statistical properties after making selection in F_2, has been studied for models with one linked pair and with two independent pairs of linked factors. The various factors have been taken to be equal in genotypic value. In one set of these models effect of linkage has been studied keeping the genotypic value of each factor fixed, while in the other set the effect of keeping the F_2 genotypic variance in the start (before selection) fixed, has been studied. The various values of the recombination fractions have been so chosen, as to cover tight, intermediate and loose linkages.

Broadly the results are as follows:

In models with fixed genotypic values of factors, genetic advance increases with closer linkage but variance between as well as within

F_3 progenies decreases with closer linkage, when only one pair of linked factors is considered, while it increases when two pairs of linked factors are segregating. In models with the initial genotypic variance fixed, the results are consistent for one and two pairs of linked factors. The genetic advance decreases with closer linkage, while the variance between and within F_3 progenies decreases with closer linkage.

The possibility of using a single index for linkage when more than one pair of linked factors is segregating has also been considered.

12. *The Problem of Ties. Dr. B. V. Sukhatme, Indian Council of Agricultural Research, New Delhi.*

In non-parametric testing theory, it is usually assumed that the samples involved are drawn from continuous distributions and that tied observations can therefore be ignored or treated in any convenient way without affecting the performance characteristic of the test. In practice, however, this is not a realistic assumption and the distributions involved are to be regarded as discontinuous. Ties will therefore occur with positive probability and the manner in which the ties are treated will affect the performance characteristic of the test.

This paper considers the problem of ties with special reference to a two-sample non-parametric proposed earlier by the author (1957) by treating the ties as random variables. Ties are treated in two different ways and it has been shown that randomization reduces the asymptotic efficiency of the test.

13. *The Use of Quasi-Range in Some Statistical Tests. Shri S. K. Banerjee, Delhi University, Delhi.*

P. B. Patnaik has studied the use of range (for small samples) and mean of ranges (of sub-samples of a large sample) in place of sample standard deviation in t-test and analysis of variance test. Cadwell has shown that the higher order quasi-ranges become more efficient estimates for S.D. when sample size increases. In this paper the author studies the behaviour of the first quasi-range or the mean of first quasi-ranges in place of mean range for t and F tests. For example, he has shown, when the sample size is 30, the first quasi-range instead of the mean of ranges (of 3-sub-samples of 10 each) can be substituted for sample S.D. t-test without much loss of power. A χ-approximation for the distribution of the quasi-range has been found and powers for corresponding t-test and F-test are calculated.

14. *The Distribuiton of Different States in a Conditioned Two-State Markoff Chain and Their Applications. Dr. P. V. K. Iyer and and D. Ray, Defence Science Laboratory, New Delhi.*

For a two-state Markoff Chain whose probabilities are given by the following matrix:

		Preceeding	
		A	B
succeeding	A	p_1	p_2
	B	q_1	q_2

the probability of any point r being A, say $Pr(A)$, or being B, say $Q_r(B) = 1 - p_r(A)$, when nothing is known about the previous observation is

$$p_r(A) = \frac{p_2}{1-\delta} + \frac{pq_1 - Qp_2}{1-\delta}\,\delta^{r-1}$$

$$Q_r(B) = \frac{q_1}{1-\delta} - \frac{pq_1 - Qp_2}{1-\delta}\,\delta^{r-1},$$

where P and Q are the probabilities of the initial observation to be A or B and $\delta = p_1 - p_2$.

In this paper the expectation for A's and B's and also for the joint occurrence of AB's and AA's under the condition that the last observation is A or B have been worked out. It is indicated how these results can be used for discussing Wilcoxon's statistic for two samples obtained from a sequence based on Markoff Chain.

15. *Study of Frequency Distributions of the Characters Relating to Milk Yield and the Consequences of Non-normality on the Standard Tests of Significance. Shri Om Prakash, Indian Council of Agricultural Research, New Delhi and Shri Y. P. Mahajan, Shimoga, Bangalore.*

The subject of this paper was to study the distributions of milk yield data and its related characters like lactation yield, lactation length, age at first calving the calving interval. The data related to four herds, *viz.*, Tharparker, Kangayam, Sindhi Hosur and Sindhi Bangalore. The distributions of these characters were mostly found to be non-

normal. Among the 38 sets of data studied, 14 were found to be Pearsonian type I, 15 to be type IV, 3 type VI, one each of type V and VII and 4 are normally distributed.

Effect of these non-normal distributions on standard tests of significance such as Standard Normal Deviate Test, Student's 't' test, χ^2-test and F-test was studied empirically. This study was made in respect of the sampling distributions of these statistics, the level of significance and the power of the standard tests. It was found that S.N. Deviate test and 't' test were insensitive to normality while χ^2 and F-tests were affected significantly.

16. *Recent Trends in the Yield of Rice and Wheat in India.* *Dr. V. G. Panse, Indian Council of Agricultural Research, New Delhi.*

Data for yield per acre from large-scale crop-cutting surveys on rice and wheat in India for ten years, 1946–47 to 1955–56, have been examined in the present paper in order to study the trend in the yield of these two most important food crops. The yield data analysed extend over 65% of the area under these crops in the country and the States concerned are Uttar Pradesh, Bihar, West Bengal, Assam, Madhya Pradesh, Bombay, Andhra and Madras for rice and Panjab, Uttar Pradesh, Bihar, Madhya Pradesh and Bombay for wheat; strictly comparable yield data from crop-cutting were available only in these states for the period under study. The main interest of the analysis was the comparison of average yield during the First Five-Year Plan period, 1951–52 to 1955–56, with the average for the immediately preceding five years treated as a control. Results showed that the average yield per acre was higher by 5·4% for rice and 11·8% for wheat in the plan period than in the preceding quinquennium. The increase in rice yield was contributed by three States, Madras, Andhra and West Bengal and that in wheat by all the five States, although the increase in Bihar was not satisfactorily significant.

The comparison of average yields over several years, as is done in the present study, is a safeguard against undue influence of weather which is liable to vitiate comparisons of annual yields. Even so, it is not possible to rid the average yields based only on five years completely from serious disturbances such as a rust, epidemic on wheat in one or two years. Making a rigorous allowance for the multitude of weather factors on crop yield is extremely difficult but an attempt was made to adjust the yields of both rice and wheat for inequalities of rainfall over the series of years under study by means of a regression analysis. This analysis was without any effect on wheat; but

the adjusted rice yields showed an overall increase of 8·0% during the plan period as compared to the pre-planned period. This indicated that the rainfall was slightly less favourable generally during the plan period. An interesting conclusion derived from this analysis was that irrigation can be introduced in some rice areas as a positive measure for increasing yield by supplementing the normal rainfall of the area and not merely as a protection against the vagaries of rainfall.

17. *Estimation of Area and Yield of Crops under Terraced Cultivation in the Hills. Dr. R. S. Koshal, F.A.O. Statistician, Cairo, U.A.R.*

The estimation of area and yield of crops in the hills presents many difficulties as there are a large number of small fields of irregular shape at different levels. A stratified multi-stage sampling design suited to such condition has been developed and is illustrated with reference to survey on paddy conducted in the hilly tracts of Ceylon.

18. *A Study of Statistical Methodology in Farm Cost and Management Survey. Shri S. K. Raheja, Indian Sugarcane Committee, Delhi.*

Some of the major problems that we come across in applying statistical methodology to farm management and other surveys of its like are discussed in this paper. The Statistical Methodology relevant to three such problems has been developed and illustrated with the help of data collected from various sources. The three problems discussed are: (i) The design of the survey and its efficiency; (ii) A comparison between the Cost Accounting (the Farm Recording) and survey methods of collecting the primary data; (iii) The functional relationship existing between the factors of input per acre on the one hand and output per acre on the other.

19. *Estimates in Successive Sampling of Multi-Stage Design. Shri Daroga Singh, Indian Council of Agricultural Research, New Delhi.*

In this investigation a general approach for estimating the mean over a given period on the basis of repeated surveys as well as estimating the mean of the current occasion has been indicated when the sampling design is multi-stage. The partial replacement policy has also been shown. The efficiency of partial replacement approach has been calculated. Although the approach can be extended to any number of occasions the results have been calculated only for the surveys repeated twice or thrice.

20. *A Note on Double Sampling.* *Dr. B. V. Sukhatme, Indian Council of Agricultural Research, New Delhi and Dr. R. S. Koshal, F.A.O., Cairo, U.A.R.*

For estimating the population total of a character y under study by means of ratio method of estimation, it is usually assumed that the population total of the ancillary character x is known. When this is not so, the usual practice known as double sampling is to take a large sample for estimating the population total of x and a sub-sample of this sample is used to observe both the characters. Cochran gives the appropriate formulæ in this case for single-stage designs. This note extends these results to multi-stage designs. The results are illustrated with reference to a sample survey on paddy.

21. *Classification of Natural and Plantation Teak* (Tectona grandis) *Grown at Different Localities of India and Burma with Respect to its Physical and Mechanical Properties.* *Dr. K. R. Nair, Statistician, Forest Research Institute, Dehra Dun.*

The paper discusses the results of a multi-variate analysis of the data on four important strength properties, namely, specific gravity, modulus of rupture, modulus of elasticity and maximum crushing stress for samples of teak consignments obtained from natural forests in eleven localities and from plantation forests in nine localities of the India-Burma region and tested for physical and mechanical strength properties at the Forest Research Institute, Dehra Dun. C. R. Rao for farming group-constellations on the basis of Mahalanobis D^2 statistic it was found that the localities of natural grown teak could be classified into five groups and the localities of plantation-grown teak into three groups.

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