ABSTRACT OF PAPERS PRESENTED AT THE 13TH ANNUAL GENERAL MEETING HELD AT POONA IN JANUARY 1960

1. *Estimation of Area and Yield of Crops in the Hilly District of Uttar Pradesh. K. Kishen, Department of Agriculture, Lucknow.*

Unlike the other districts, the hilly districts of Uttar Pradesh are non-reporting, and the existing estimates of area and production of agricultural crops for these regions are seriously defective and unreliable. However, as these regions are cadastrally surveyed, a random sampling technique has been developed for estimation of area and prduction of principal crops for these regions with an acceptable degree of precision. In this paper are discussed the plan of sampling adopted and the formulæ for estimates of area, production and average yield. Formulæ for variances of these estimates are also given when sampling of the primary sampling units (*i.e.*, villages in the present survey) is done with or without replacement, along with the sample estimates of the variances. As an illustrative example, these formulæ have been employed for estimation of area, production and average yield for one of the tehsils of the hilly districts, and for computation of the standard errors of these estimates.

2. *On the Estimation of Loss of Tea Crop due to Pests and Diseases. A. R. Sen, Tocklai Experimental Station, Shillong, Assam.*

A sample survey of pests and diseases was undertaken on a pilot scale during 1958 by the Scientific Department of the Indian Tea Association in some of the tea estates of the Assam Valley.

A two-stage sampling system was adopted with Indian Tea Association (I.T.A.) Circles as strata, tea estates as first stage units and affected sections (a section is a portion of a tea estate) as second stage units. The data were collected from estate managers through mailed questionnaires with the help of trained investigators.

The data have been utilized to obtain, amongst others, a statistical relationship between yield of crop and the area affected due to pests and diseases. This paper will discuss the loss of yield due to Red Spider mite.

3. *On Problems of Estimation when Sampling is done from Incomplete Sampling Frames. C. S. Grewal, N.S.S., New Delhi.*

In large sample survey the precision of estimates depends upon the reliability of the sampling frames used. The sampling frames used are often found incomplete or inaccurate later on with the result that the estimates obtained are inflated with non-sampling errors. This paper deals with the evolving of expression of unbiased estimates along with its estimate of variance from the sample in cases where incomplete sampling frames have been used and sampling design adopted is a multistage one with p.p.s. selection at first stage.

An expression to know the extent of bias in using the usual method of estimation appropriate to multistage designs with p.p.s. selection at first stage has also been evolved.

The unbiased estimate suggested above requires the knowledge of correct sizes of all primary units which sometimes is not possible to collect in the course of the survey. An alternative estimate which is not unbiased but consistent has been suggested. It has been shown that bias in using this estimate is negligible. The mathematical expression for the sampling variance of this estimate has also been obtained so as to compare the efficiency of different estimators.

4. *On Some Estimation Problems in Yield Surveys in India. K. S. Avadhany, C.S.O., New Delhi.*

In sample surveys for estimation of crop yields in India, though the number of crop-cutting experiments planned is the same for each selected village, due to unforeseen and extraneous causes, an experiment here and there is lost, and in developing the relevant formulæ, two cases need to be considered:

(1) Equal number of observations in each of the sample villages.

(2) Unequal numbers.

In the previous treatment of case 1, the within village variance in the population of the stratum has been assumed to be constant from village to village, while in the development of formulæ for case 2, not only has this assumption been made but also that of equality of the size of the first-stage units, that is, equality of the total number of fields in all the villages of the population. Both these assumptions do not accord with the actual situation obtaining in our surveys and this paper attempts to remove these from the proofs of formulæ.

Secondly, while in case 1, formulæ have been developed for the two situations met within our surveys, *viz.*, (1) the finite correction factors at both stages of sampling being negligible, (2) the finite correction factor at the second stage of sampling alone being negligible, in case 2 above, only the first of these situations has been covered. The paper seeks to remedy this defect.

Thirdly, in case 2 above, since, in addition to the general mean (of all observations in the stratum) which is a biased estimate and which is at present being used in our surveys, there is another biased estimate, *viz.*, the mean of village means in the sample, bias being identically the same in both the cases, the variance expressions for the two estimates have been compared to show that the variance of the former is likely to be less and for this reason the former estimate is to be preferred.

Lastly, the need for undertaking the demonstration of the smallness of the bias from time to time is stressed and the methods to be adopted for this purpose, discussed.

5. *On Some Aspects of Sampling with Varying Probabilities. D. Singh and K. V. Desikan, I.A.R.S., New Delhi.*

Selection of sampling units with probability proportional to some measure highly correlated to the character under study improves the efficiency of the estimates considerably. However, if more than one character are to be studied from the same unit, choice of selection probability is not easily determinable. This problem for two characters has been considered in this paper initially and it has been shown that the results can be extended to more than two characters. The compromise probability with which the unit should be selected for a multipurpose survey is arrived by using appropriate weights and having a combined function of the variances. The probability function is fully examined, with different cost functions under consideration.

The loss in efficiency in using the arrived probability function by the method under consideration as compared to the one when the characters are studied separately is calculated, and it has been observed that this loss will be minimum when a linear relation exists between the probability measures for the different characters. Also, the total number of primary units should be less, thereby increasing the number of elements within each primary unit, and this helps in making the difference minimum. The percentages of the costs that should be utilised for the multipurpose survey in terms of the individual surveys is being given, and the gain in cost in terms of the percentage is also

considered. The results arrived so far have been illustrated with some data.

6. *Some Aspects of Successive Sampling in Multistage Designs. D. Singh and O. P. Kathuria, I.A.R.S., New Delhi.*

At the last Annual Meeting of the Indian Society of Agricultural Statistics, the first author had read a paper on the estimate in successive sampling in the multistage design considering that the investigation is repeated twice or thrice. In the present investigation the work has been extended to any number of occasions. The estimates of the change between two consecutive occasions and its variance have also been obtained. The results obtained have been applied to the data collected on a scheme for the study of milk yield and management practices of bovine in Punjab in 1956–57 conducted by the Indian Council of Agricultural Research. The cost function has also been studied with reference to the data collected in Punjab. The optimum size of the sample for estimating the average milk yield has also been obtained.

7. *Capture-Mark-Recapture Sampling. K. V. N. Prasad, I.A.R.S., New Delhi.*

The problem considered in this paper is that of capture-mark-recapture sampling for the estimation of natural mortality in the case of fish populations taking into account the age groups for each of which the rate of natural mortality is different.

The estimates of the natural mortality and the population sizes at a particular time of the individuals belonging to a particular age group has been derived and it has been shown that the result obtained previously is a particular case of the more general result that has been obtained through the present investigations. Also the variances of the different estimates have been obtained.

8. *Satistical Analysis of the Data of Simple Manurial Trials on Paddy in Cultivators' Fields of Thana District, Bombay State,* 1954 *and* 1955. *D. S. Ranga Rao, O. G. Kundalkar and P. N. Satbhai, Department of Agriculture, Bombay State.*

Simple manurial trials on paddy in cultivators' fields were conducted, under a joint project of the Indian Council of Agricultural Research and the State Government, in Thana District during 1954 and 1955. The results of these trials have been summarised in the present paper.

Based on topographic, soil and rainfall features, Thana District can be divided into two distinct zones (1) the coastal region and (2) the interior region. The trials have brought out that the responses of paddy to the treatments tried are quite distinct in the two zones.

The analysis of the data showed that 20 lb. N + 20 lb. P_2O_5 per acre, in the form of sulphate of ammonia and superphosphate respectively is the most economic dose for manuring the paddy fields.

In the coastal region, the increase in yield with the above dose was as high as 933 lb. per acre over cultivators' normal practice with a standard error of 79·7 lb. In the interior region, the corresponding increase was 513 lb. per acre with a standard error of 53·0 lb.

In the coastal region the response to P_2O_5 was much larger than in the interior. Further, there was $N \times P_2O_5$ interaction which was approaching significance at 5% level. In the presence of 20 lb. N, the response to 20 lb. P_2O_5 was as high as 551 lb. per acre, while in the presence of 60 lb. N, it was 345 lb. The corresponding responses in the interior region were 163 and 102 lb. respectively and there was no $N \times P$ interaction.

The analysis of variance of the data has been made use of in estimating the minimum number of villages and the optimum number of trials per village, required to be planned for similar future trials.

9. *A Sampling Technique to Estimate the Incidence of Pests and Diseases. D. S. Ranga Rao and V. N. Panditrao, Department of Agriculture, Bombay State.*

A survey to ascertain the damage to food crops by insect pests and diseases in cultivators' field was undertaken, during 1952–53 in Bombay State. Pest chosen for the survey was stem-borer on kharif jowar. The survey was carried out in East Khandesh and Surat Districts.

The plan of sampling for the survey was one of stratified multi-stage random sampling and the different sampling units corresponded with the sampling units of the crop-cutting experiments in progress in the State except for the ultimate units of sampling which, in the present survey, consisted of a plot of two consecutive rows each 30′ long. The selected plots were visited twice by the field workers—the first visit being sometime in the month of September or October and the second one at the time of harvest in the month of December or January—in order to record the total number of tillers and dead-hearts in the plots. The average incidence of the pest was estimated from

the ratio of the average number of dead-hearts to the average number of tillers per row in each stratum. The ratio for the district was built up by weighting each stratum ratio with its corresponding area under the crop during that year. For estimating the sampling error of the district ratio, mean squares at the district level were used, as the stratum mean squares were not based on sufficiently large number of degrees of freedom and hence not well determined.

A comparison of the figures of average incidence of pest in the two districts shows that the incidence was considerably less in Surat. It is also seen from the taluka figures that the intensity of the infestation varied considerably in different talukas in both the districts. In East Khandesh, it varied from as low as 2% in Parola and Jamner Talukas to 48% in each of Jalgaon and Bhusawal Talukas. In Surat, there was no infestation in two talukas while it ranged between 4 and 15% in the remaining talukas.

10. *Assessment of Extent and Causes of Fallow Areas by Sample Survey.* *D. S. Ranga Rao, V. N. Panditrao and N. P. Joshi, Department of Agriculture, Poona.*

In order to ascertain the accuracy of the reported area under total fallows and of its classification in different categories a sample survey was undertaken in 1958–59 in Kolaba District where large area was reported under fallows.

The plan of the survey was a unistage stratified sampling with talukas as strata and villages as units of sampling. A sample of 75 villages was selected and distributed in the different talukas approximately in proportion to the average fallow area of the past three years. For ascertaining the causes for the lands going fallow, in each selected village, a subsample of 50 entries from all the entries under fallows was chosen and the concerned cultivators interrogated for keeping the lands fallow. For these very survey numbers, the land was classified by spot inspection, on the basis of (*a*) depth of soil, (*b*) slope, and (*c*) extent of soil erosion, into four classes. The lands under the worse two categories covering about 81% of fallow area were considered unsuitable for cultivation being highly eroded and having slope of more than 8%, and were only suitable either for growing grasses or afforestation. In addition, for all the survey numbers of the selected villages, the area under fallows as recorded by the Patwaris in the Crop Inspection Register and in Village Form I–A, and the cultivable area were also collected. The results of the survey are based on the data of 59 out of the 75 selected villages.

Ratio method of estimation was employed in estimating the district area under fallows. The main conclusions from the survey are as under when ratio method of estimation was adopted for estimating the district area:

The estimated area under fallows was 2,82,315 acres with a sampling error of 5% when the talatis area was used as the auxiliary variate and was 3,23,412 when cultivable area was used as auxiliary variate. The official area was 3,29,679 acres.

The fallow area was classified into: (*a*) current fallows, (*b*) other fallows, and (*c*) culturable waste, and showed 2, 11 and 87 % respectively under the above categories, while the corresponding official estimates were 12, 66 and 22%. This suggests that the classification of the fallows by the reporting agency under different categories was rather arbitrary.

The important causes for keeping the lands fallow were also investigated and have been included in the paper.

Design of Experiments

11. *On the Analysis of Asymmetrical Factorial Designs through that of Symmetrical Factorial Designs. M. N. Das, I.A.R.S., New Delhi.*

It has been shown by the author elsewhere that asymmetrical factorial designs can be constructed as fractional replicates of a suitable symmetrical factorial design. It was then suspected that in the analysis also there may exist some sort of correspondence. It has now been shown in the present investigation that the different *S.S.* in the asymmetrical factorial designs can be obtained from an analysis of variance of the corresponding fractionally replicated symmetrical designs.

12. *A Series of Designs for Parallel Line Bio-assays with Two or More Preparations. M. N. Das and G. A. Kulkarni, I.A.R.S., New Delhi.*

Following a suggestion made by M. J. R. Healy (1952) while discussing on the paper by Tocher (1952) for obtaining designs suitable for bio-assays the authors have obtained a series of incomplete block designs particularly suitable for parallel line bio-assays, involving two or more preparations with the help of these designs the two contrasts due to 'Preparations' and 'Regression' which also enter into estimation of relative potency of the unknown preparation, can be estimated

without any loss of information. Hence these designs enjoy the property of R–B designs so far as the estimation of potency is concerned.

13. *Applications of the Type of Designs Based on Constant Frequency Differences. M. N. Das and P. N. Bhargava, I.A.R.S., New Delhi.*

One of the authors evolved a type of designs based on constant frequency differences. The application of such designs in particular fields of research has not yet been examined closely. In the present investigation it has been examined how the designs are suitable for bio-assays. It has been found possible to select from such designs a series of designs which are particularly suitable for bio-assays. Through such designs, even though they are of the class of the incomplete and unequal block size designs, the relative potency can be estimated without any loss of information.

14. *Generalisation of Yates' Method for Analysing the Factorial Designs of any Type. G. A. Kulkarni, I.A.R.S., New Delhi.*

Yates (1937) gave a method known as 'sum and difference' method to obtain the effect totals directly in a factorial design of the type 2^n. The method has been generalised by Davis (1954) for the design 3^n. The present paper generalises the method for the asymmetrical factorial designs of the type $p \times q \times r \cdots x$'s by making use of the orthogonal polynomial coefficients given in Fisher and Yates' tables.

15. *Augmented Symmetrical and Asymmetrical Factorial Design. S. S. Narula, I.A.R.S., New Delhi.*

The need of including additional treatments in factorial designs was felt in planning experiments to meet different requirements of the experimentalist. Usually they are included as controls, treatment combinations with doses higher than the experimental one, new set of treatments and repetition of existing treatments in order to obtain direct responses, an extra point in the response curve, more information on certain treatments and to ascertain effiiciencies of new treatments tried as exploratory measure. In this paper, a general method of exact analysis for symmetrical and asymmetrical designs with additional treatments for various types of confounding has been discussed. An important feature of such designs is that the confounded effects can be recovered. Comparison between, additional treatments on one hand and the factorial treatments on the other, becomes also readily available. Further the efficiency of error variance is increased due to the augmentation of *d.f.* in the exact analysis of such designs.

16. *Analysis of Covariance for a Split-Plot Design-Average Variances for Comparisons of Adjusted Means.* *G. Ramachandran, Hyderabad.*

In the case of analysis of covariance, say Randomised Block Design, the value of the variance for the difference of a pair of adjusted treatment means differs from pair to pair for the square of the difference in the corresponding means of the auxiliary variates x also comes into play. But it has been shown that the average of such variance values for all the possible pairs will suffice for all practical purposes as the basis for comparing any pair of means. The same concept has been extended to the split-plot design also in this paper. Formulæ have been obtained for the average variances for the different types of comparisons of adjusted means in the margins as well as in the body of the two-way take of main and sub-treatments. The general case when the sub-treatments are factorial has also been dealt with for each type. The formulæ required for substitution in them are only the sums of squares already obtained in the analysis of covariance table and so readily available. The usefulness of the average variance lies in the fact that it can be used for comparing any pair of means and not merely a particular pair.

17. *Analysis of Generalised Non-orthogonal Design with Recovery of Interblock Information.* *K. C. Raut, I.A.R.S., New Delhi.*

After the generalised balanced design was introduced, generalised partially balanced design was subsequently defined and its method of analysis worked out. For such designs only intrablock analysis have been obtained. The present paper contains an investigation for obtaining the analysis after recovering the interblock information suitable for generalised non-orthogonal designs.

18. *On Circular Designs.* *A. S. Chopra, I.A.R.S., New Delhi.*

There is a method of constructing incomplete block designs by taking one or more initial blocks and then adding to each treatment number in the block 1, 2, $\cdots v-1$, mod (v), where v is then umber of treatments to get $v-1$ more blocks for each initial block. So far the technique has been adopted to get B.I.B. and P.B.I.B. designs by developing as above suitably obtained initial blocks. It has been found that the technique gives P.B.I.B. designs for any initial block, the number of associate classes being related with v in many cases. Evidently the analysis of such designs is not easy if the usual method of analysing P.B.I.B. designs be adopted. Special technique of systematic analysis

for designs with $K = 2, 3$ and 4 with constant difference between any two consecutive treatments when arranged in an ascending order, have been obtained together with the preparation of tables necessary for the analysis of such designs for all v's up to 50.

19. *Some Methods for Study of Response Surfaces. P. J. Thaker, I.A.R.S., New Delhi.*

The factorial experiments conducted at research stations are analysed mainly to estimate the main effects and interactions of the various factors. No attempt is usually made to explore response surfaces by utilizing the data collected from these experiments.

The usual method of least squares proves very laborious for such investigation. An attempt has been made in the present investigation to find simplified method for obtaining the response surface from such data. It has been also possible to express the different coefficients involved in the response surface as functions of different main effects and interactions.

MISCELLANEOUS

20. *Bounds for the Expected Sample Size in a Sequential Probability Ratio Test. M. N. Ghosh, I.A.R.S., New Delhi.*

The approximate value of the expected sample size in a sequential probability ratio test has been given by Wald in 1945 (*Ann. Math. Stat.*, Vol. 16) where the approximation is supposed to be good if the mean and variance of Z,

$$Z = \log \frac{f(x,\ \theta_1)}{f(x,\ \theta_a)}$$

are small. This is true for the normal distribution as shown by Wald but in general no result has been proved to show that this approximation is valid, although the expected value has been shown to be bounded by Stein (*Ann. Math. Stat.*, 1946, Vol 17). An expression for an upper bound has been derived in this paper which holds for all distributions. In the case of the normal distribution and a class of similar distributions a bound has been given which is an improvement over Wald's approximation when the mean and variance of Z are not small. A bound has also been obtained for the first passage time n for a random walk problem with normal variables $Z_1, Z_2, \cdots$ with $E(Z) < 0$, and where there is only one boundary $B < 0$. The approximate distribution of

n has been obtained by Wald but this does not imply the boundedness of $E(n)$. The validity of the equation

$$E(n) = \frac{E(Z_n)}{E(Z)}$$

thus follows from Blackwells theorem (*Annals of Math. Stat.*, 1946, Vol. 17).

21. *Sampling Variance of the Genetic Correlation Coefficient Estimated from Sib Analysis. A. V. K. Sastri, Directorate of Economics and Statistics, New Delhi.*

Reeve (1955), Tallis (August, 1959) have derived expressions for the variance of the genetic correlation coefficient estimated from dam-daughter relationship and from analysis of variance and covariance respectively. In this note, the variance of the genetic correlation coefficient estimated from sib analysis, when there is variation due to dominance deviations also from the additive scheme, has been derived.

22. *A Plan for Evolving a New Breed of Dairy Cattle. V. N. Amble and J. P. Jain, I.A.R.S., New Delhi.*

The Indian Council of Agricultural Research is considering a proposal for a scheme aiming at evolving a new breed of dairy cattle by crossing an Indian breed with a foreign breed such as Jersey and inter-breeding and selecting among the F_2 and subsequent generations. A scheme of this nature is necessarily of a long duration and very expensive. It is essential, therefore, that the plan of work is drawn out with extreme care taking into account both the resources available and the relative efficiencies in terms of the rate of genetic improvement achieved through alternative programmes. The basic ingredients of such a plan which involve both genetic and statistical considerations are discussed in the paper.

23. *Discrete Models in Branching Processes. U. G. Nadkarni, I.A.R.S., New Delhi.*

In discrete branching processes discussed by different authors it is assumed that the probabilities of division of an organism in any generation into $0, 1, \cdots n$ organisms are independent of the generation size. Some modified models where the probabilities of fission into r organisms are dependent upon the size of the population in a generation, due to some natural limitations, are discussed.

24. *Use of Bivariate K-Statistics in Fixing Quality Standards for Market Milk.* *M. V. Rama Sastry, I.A.R.S., New Delhi.*

Market milk is often not the product of a single animal but is a collection pooled from several animals. Standards fixed for milk from individual animals need not apply to such 'bulked' milk. In fact, standards set on the basis of samples from individual animals will be less stringent when applied to 'bulk' milk and thus there is a danger that substandard milk will be accepted more often than provided under those standards. It is then necessary to develop standards for market milk. A method for obtaining such standards has been given. The method has been illustrated with the help of the data collected under a Milk Composition Scheme of I.C.A.R.

25. *Further Investigations on Economic Amount of Experimentation.* *A. H. Manwani, I.A.R.S., New Delhi.*

A new criterion based on minimax principle for determining the size of experimental programme designed to demonstrate the gain accruing from a change-over to some new production process has been discussed for a simple type of cost function and the risk function comprising of the cost of experiments and the expected loss due to wrong decision.

Such a solution for the number of experiments to be conducted on cultivators' fields in each of the k regions, where n villages are selected first and in each village m_i experiments are conducted, has been obtained under the cost function of the form:

$C = C_0 \sum_{i=1}^{k} c_i n_i + \sum_{i=1}^{k} c_i' m_i n_i$ and the additive risk function. The values of n_i's and m_i are given by

$$m_i = \sqrt{\frac{C_i \sigma_2^2}{C'_i \sigma_1^2}}, \quad n_i = \frac{16\left(\frac{\sigma_1^2 + \sigma_2^2}{m}\right)}{\Delta_i^2} \times \left[\log \lambda_i - \log \frac{16\left(\frac{\sigma_1^2 + \sigma_2^2}{m}\right)}{\Delta_i^2}\right]$$

where $2(\sigma_1^2 + \sigma_2^2/m)$ is a known upper bound of the variance of the estimate of net gain from each village, $\lambda_i = A_i \Delta_i / c_i + c_i m_i$.

A_i is the total area in the i-th region on which the use of fertilizer will be recommended and Δ_i the minimum benefit from the use of fertilizer; $(i = 1, 2, \cdots k)$.

Some concrete examples have also been considered.

26. *A Method of Estimating Heritability of Sex-linked Characters.* *M. Rajagopalan, I.A.R.S., New Delhi.*

For sex-linked characters the usual method of intra-sire regression gives a biased estimate of heritability. This bias arises due to the fact that sex affects the gene expression in a marked way. A method of obtaining the estimate of heritability by analysis of variance is dealt with in this paper taking male to be heterogametic and female to be homogametic.

27. *On Lehmann's Two-Sample Two-sided Non-parametric Test.* *M. V. Deshpande, I.A.R.S., New Delhi.*

Lehmann (1953) has given an optimum non-parametric test for testing whether two samples come from the same population for a given two-sided alternative. This test is derived using Neyman and Pearson's Fundamental Lemma in parametric theory. The test criterion differs from that of Wilcoxen's in having two more additional terms. The purpose of this paper is, therefore, to compare the new test with Wilcoxen's two-sided rank test. The recurrence relation for this test is derived and using this probability tables and first three moments have been calculated. The distribution of the test statistics is proved to be x^2 with one degree of freedom. The test is compared with Wilcoxen's test under normal, rectangular and exponential alternatives and is found to be more powerful than Wilcoxen's test.

28. *Partial Selection from a Mixed Population.* *S. N. Sen, Patna.*

In cases of plants where either selfing or natural cross-fertilization or both are present and the recessive phenotypes are completely eliminated as undesirable to the breeders, the estimation of the amount of heterozygosity present in any generation can be estimated from the previous generation. An iteration relation is obtained which is of the form: $h_{n+1} = \phi(h_n)$ where h_n = the proportion of heterozygosity at the n-th generation. The proportions of heterozygosity at any generation for different values of the rate of natural crossing (varying from 0 to 1) are calculated (upto the 40th generation) for both the cases when $h = 0{\cdot}5$ and $h = 1{\cdot}0$ respectively.

29. *A Study of Plant Populations Practising both Self-Fertilization and Random Mating.* *G. L. Ghai, I.A.R.S., New Delhi.*

The genetical studies have so far mainly concerned themselves with the inheritance of Mendelian characters and quantitative characters under only one system of mating such as complete cross-fertilization or inbreeding such as complete self-fertilization. In plant populations of interest to the breeder, complete self-fertilization or complete cross-fertilization is seldom found. There are crops like rice and wheat which are highly but not completely self-fertilized, crops like cotton which are moderately self-fertilized and crops like maize which are largely cross-fertilized. A study of such plant populations practising both self- and cross-fertilization in varying degrees, regarding their genotypic composition, variability and mean values in successive generations in the general case of k-independently segregating factors was undertaken because of its theoretical as well as practical interest in relation to breeding.

30. *Some Sequential Estimators in Random Sampling from a Finite Population.* *S. G. Prabhu Ajgaonkar and B. D. Tikkiwal, Karnatak University, Dharwar.*

Let $n\,(\geqslant 1)$ be the units common to two independent random samples of fixed sizes N_1 and N_2 drawn without replacement from a finite population of size N to estimate its mean. This paper considers estimators of the form $an\bar{x}_n$ for different value of a. It is shown that, for $a = 1/n$, the estimator $\bar{x}_n$ is less efficient than the classical sample mean based on the fixed number of observations equal to the expected value of n. However, for $a = E(1/n)/\{nE(1/n) - 1\}$, the estimator gives shorter confidence interval for the mean than in case of classical procedure in some special cases, *e.g.*, when $N = 8$, $N_1 = 4$, $N_2 = 4$ and $n = 2$.