ABSTRACTS OF PAPERS PRESENTED AT THE 30TH ANNUAL CONFERENCE HELD AT BHUBANESWAR, 1976-77

1. On Duals of Some Tm-Type PBIB Designs

By A. D. Das and G. M. Saha,
J.A.R.I., Barrackpore and I.S.I., Calcutta.

Ogasawara (1965) introduced, as a generalisation of triangular (T_2) association scheme, an m-class association scheme, called the m-dimensional triangular (T_m) association scheme. Recently, Saha (1973) constructed several series of partially balanced incomplete block (PBIB) designs based on T_m association scheme. In this note, the duals of these designs are studied.

2. Balanced and nearly balanced n-ary Designs with Varying Block-Sizes and replications

By S. K. Mehta, A. K. Nigam and S. K. Agarwal,
P.A.U., Ludhiana, I.A.R.S., New Delhi and University of Jodhpur, Jodhpur.

In the present paper the method given by Kulshreshtha *et al* (1972) for obtaining balaneed n-ary designs with more than two block sizes and varying replications has been generalised. Nearly balanced designs which may serve as a substitute whenever a suitable balanced design is not available for a given number of treatments have also been suggested.

3. On Construction of a Class of PBIB Designs.

By R. Chakravarty,
Haryana Agricultur al University, Hissar.

Rao (1966) defined a family of $(m+1)$ class association schemes, called Group Divisible Family of association schemes in the following manner :

There are $v=ut$ symbols indexed by the pair (α_1, α_2) $\alpha_1=1\ldots, t$; $\alpha_2=1,\ldots, u$. A pair of symbols (α_1, α_2) and (β_1, β_2) are i-th associates if $\alpha_1=\beta_1$ and α_2 and β_2 are mutually i-th associates according to some known association scheme, $i=1, 2,\ldots\ldots m$; they are $(m+1)$-*st* associates, if $\alpha_1 \neq \beta_1$.

Rao (1966) gave a method of construction of PBIB designs based on these schemes. In a recent paper, Dey and Midha (1974) also gave new method of construction of such designs. The method of Dey and Midha (1974) however, requires too many blocks for $t>2$. In this paper another method of construction of $GD/(m+1)$ designs, involving smaller number of blocks has been proposed.

4. Some Results on Extended Triangular Designs

By K. R. Aggarwal,
P.A.U., Ludhiana.

This paper contains the following results on the extended triangular [$ET(u)$] designs of P.W.M. John (1966).

Theorem 1. If an $ET(u)$ design with the parameters $v=u(u-1)(u-2)/6, b, r, k, \lambda_1, \lambda_2, \lambda_3$, satisfies the condition $r+(2u-9)\lambda_1+(u-4)(u-9)\lambda_2/2-[(u-4)(u-5)\lambda_3/2]=0$, then $3k$ is divisible by u. Further every block of that $ET(u)$ design contains $3k/u$ treatments from each of the sets of $[ijk(j,\ k=1, 2, \ldots\ldots, u;\ j\neq k),\ i=1,\ 2,\ldots,\ u]$ where treatments ijk, ikj, jik, jki, kij and kji are taken as identical.

Theorem 2. The existence of an $ET(u)$ design with the parameters

$$v=u(u-1)(u-2)/6,$$
$$b=(u-1)(u-2)(u-4)(u-5)/4,$$
$$r=(u-4)(u-5)/2,$$
$$k=u/3,\ \lambda_1=0,\ \lambda_2=0,\ \lambda_3=1$$

implies the existence of the $ET(u-1)$ design with the parameters

$$v'=(u-1)(u-2)(u-3)/6,$$
$$b'=b,\ r,$$
$$k'=(u-3)/3,$$
$$\lambda_1'=0,\ \lambda_2'=0,\ \lambda_3'=1.$$

Theorem 3. The dual of an $ET(u)$ design with the parameters

$$v=u(u-1)(u-2)/6,$$
$$b=u(u-1)/2,$$
$$r=3,$$
$$k=(u-2),$$
$$\lambda_1=1,\ \lambda_2=0,\ \lambda_3=0$$

is a triangular PBIB design with the parameters

$$v=u(u-1)/2,$$
$$b=u(u-1)(u-2)/6,$$
$$r=(u-2),$$
$$k=3,\ \lambda_1=1,\ \lambda_2=0.$$

5. Confounding in Triallel Experiments

By K. R. Aggarwal,
P.A.U., Ludhiana.

This paper contains the application of extended triangular [$ET(u)$] designs with $v=u(u-1)(u-2)/6$ treatments of P.W.M. John (1966) as confounded triallel experiments involving $u(u-1)(u-2)/6$ crosses of the type $ijk(1\leqslant i<j<k\leqslant u)$ assuming a fixed effects model.

6. A Study of Favourable Environmental Conditions for Obtaining Homogeneity of Error Variances in Groups of Similar Experiments on Paddy Crop

By P.P. Rao,
I.A.R.S., New Delhi.

In the analysis of groups of experiments, heterogeneity of error variances is a major hurdle. A preliminary study of environmental factors in relation to the heterogeneity of error variances in groups of experiments on various crops generally gave indications that experimental errors in groups of experiments tend to be homogeneous under certain environmental conditions.

In the present study 444 groups of experiments, conducted on paddy crop all over the country on different types of soils under both irrigated and unirrigated conditions, have been examined. Various block sizes, number of plots per block, number of experiments in a group, etc. have been studied with reference to their association with homogeneity of error variances under both irrigated and unirrigated conditions and different soil types.

7. On the Efficiency of Block Designs

By A. Dey and G. M. Saha,
I.A.R.S., New Delhi and *I.S.I., Calcutta.*

Consider a block design in v treatment and b blocks, the i-th treatment being replicated r_i times and the j-th block containing k_j treatments. Let $\underset{\sim}{r}=(r_1,\ldots, r_v)'$, $\underset{\sim}{k}=(k_1,\ldots,k_b)'$, $\underset{\sim}{R}=$diag. $(r_1,\ldots,r_v)$, $\underset{\sim}{K}=$diag. $(k_1,\ldots,k_b)$ and $\underset{\sim}{N}$ be the $v\times b$ incidence matrix of the design. If $\underset{\sim}{T}$ is the vector of treatment totals then $\underset{\sim}{s}'\ \underset{\sim}{T}$ is a contrast of treatment totals if $\underset{\sim}{s}'\ \underset{\sim}{r}=0$. Jones (1959, J.R.S.S., B) defined $\underset{\sim}{s}'\ \underset{\sim}{Q}$ as the 'intra-block' component of $\underset{\sim}{s}'\ \underset{\sim}{T}$ where $\underset{\sim}{Q}$ is the vector of

adjusted treatment totals. Jones states that if $\underset{\sim}{s}$ is an eigen vector of $\underset{\sim}{M} = \underset{\sim}{R}^{-1}\ \underset{\sim}{N}\ \underset{\sim}{K}^{-1}\ \underset{\sim}{N}'$ corresponding to an eigen value μ then the "loss of information" on $\underset{\sim}{s}'\ \underset{\sim}{Q}$ is μ and thus the "efficiency-factor" of $\underset{\sim}{s}$ is $1-\mu$.

Since $\underset{\sim}{s}'\ \underset{\sim}{Q}$ is a function of observations, the "loss of information" of $\underset{\sim}{s}'\ \underset{\sim}{Q}$ does not appear to be meaningful when viewed from the classical definition of loss of information (according to which, the loss of information refers to the loss in estimating a certain linear parametric function, *e.g.*, a contrast of treatment effects). In the first part of the paper, an attempt has been made to resolve this anomaly by deriving the result of Jones through the classical approach. In the second part, an upper bound for the efficiency-factor of a contrast (a lower bound for the loss of information) has been obtained and it is shown that the upper bound of the efficiency-factor is attainable by any contrast if the design is variance-balanced.

8. **On Efficiency Balanced Row-and-Column Designs**

By P. D. Puri, *H.A.U. Hissar*, and
A. K. Nigam and R. A. Gupta,
I.A.R.S. New Delhi.

In the present note, some useful efficiency balanced (*EB*) row-and-column designs have been constructed. The balanced design of Nigam (1975) can be obtained as particular cases of these designs. Some *EB* designs for simultaneous estimation of the effects of two non-interacting sets of treatments for two way elimination of heterogeneity are also obtained.

9. **Analysis of PBIB and Augmented PBIB Designs**

By P. D. Puri,
H.A.U., Hissar.

The main task of analysis of incomplete block designs is to obtain the inverse of $\underset{\sim}{\Omega}^{-1}$ matrix (Tocher, 1952). Calinski (1971) gave a general iterative procedure of inversion of matrix $\underset{\sim}{\Omega}^{-1}$ and investigated patterns that makes the formula more convenient for the analysis. He has used the matrix $\underset{\sim}{M}_0$ and shown that the problems

of analysis reduces to obtaining the idempotent matrices $[\underset{\sim}{L_i}]$ which may be regarded as linear operators projecting treatment contrasts onto disjoint subspaces, the eigenspaces of $\underset{\sim}{M_0}$ $(\underset{\sim}{M_0}=\Sigma_i \mu_i \underset{\sim}{L_i})$.

In the present note, the idempotent matrices $\underset{\sim}{L_i}$ of, almost all PBIB designs except cyclic and triangular have been obtained and a simplified practical method of their intra-block analysis which is very simple to handle as compared with the presently available procedure is given. A class of augmented block designs by adding supplementary treatments to every block of these PBIB designs have been constructed. The augmented designs so obtained are partially efficiency balanced designs (Puri, 1975, Puri and Nigam, 1976) and the simplified analysis of these designs is also presented.

10. Analysis of Experiments Involving Rankings in Triad Comparisons

By Kyi Win and S.C. Rai,
I.A.R.S., New Delhi.

Analysis of experiments based on ranking items has received considerable attention in statistical methodology. Ranking methods are generally used where quantitative observations cannot be obtained easily. Sometimes it is employed in reducing the computational labour and getting rapid result.

In sensory test, the number of samples a judge can assess is often limited by sensory fatigue. The difficulties of obtaining satisfactory qualitative measures of treatment effects usually entail assessment of rankings in complete block designs. In the paper the method of triad comparison is discussed. The design resembles the usual BIBD with the following parameters :

$$D: (v, b, r, k, \lambda;\ k=3,\ \lambda=v-2);\ b=\frac{v(v-1)(v-2)}{6};$$

$$r=\frac{(v-1)(v-2)}{2}$$

A model for triad comparison is postulated. Procedures for estimation of parameters and test of significance were given. Formulae for the variances and covariances of estimates of treatment ratings have been obtained. Combinations of results when treatments are performed in groups are also discussed. A test for the appropriateness of the model is also given.

11. Analysis of Covariance when the Relationship between Variable under Study and Concomitant Variable is Non-linear

By Kiran Arora and K. C. George,
H.A.U., Hissar.

The technique of analysis of covariance was developed by R.A. Fisher (1952) for correcting an observation measure for variations in one or more correlated variables. Scheffe (1959) used the analysis of covariance technique when there are more than one 'say h' concomitant variables under the assumption that the relationship between the main character and the concomitant variable is linear. So far no systematic work has been done in the case of analysis of covariance for adjustment of non-linear relationships between the main character and the concomitant variable. This paper deals with a systematic study of analysis of covariance when the relationship between the main character and the concomitant variable is non-linear. The complete derivation of the testing of hypothesis concerning the regression coefficients and that of the other parameters involved in the two-way classification model with one observation per cell, when the relationship of the main character with the concomitant variable is an hth degree polynomical is explained here. The comparative efficiency of this technique with the corresponding analysis of variance technique is also discussed here. A deduction of the case when the relationship is quadratic is also made. Finally, an illustrative example of the above technique is also given.

12. Experimental Design as Viewed in Applied Economic Research

By L.K. Pati,
Orissa University of Agriculture and Technology, Bhubaneswar.

Experimental design is viewed in the frame work of production theory in economics. While considering the design of experiment as a resource allocation problem the author points out several criteria of optimality in selecting designs for the estimation of crop-response relationships. Another meaningful criterion based on economic considerations has been suggested also.

13. A Row and Column Design

By P.N. Bhargava and J.K. Kapoor,
I.A.R.S., New Delhi.

Designs for two way elimination of heterogeneity have been considered by many authors of which special mention may be made of Srikhande and Youden. Youden has used the symmetrically balanced incomplete block designs and Srikhande has generalised

these to include the case of balanced incomplete block designs (BIBD) having $b=mv$, where v, b, r, k and λ are the parameters of the designs and has obtained balanced designs eliminating the positional effects. Hira Lal Agarwal (1966) constructed some designs of two way elimination of heterogeneity. Subsequently, Federer, Nair and Raghav Rao (1975) also suggested some augmented row and column designs. In the present paper utilising the concept of orthogonal partitioning of Latin Square given by Finney (1945) a series of row and column designs have been suggested. Finney defined the orthogonal partitioning of a Latin Square in general form as the partitioning of s^2 cells of a $s \times s$ Latin Square (LS) into k sets of sn_1, sn_2....., sn_k cells where $n_1+n_2+.....n_k=s$, in such a way that the i^{th} set has n_i cells in each row, n_i cells in each column and n_i cells corresponding to each letter. Each such set is an orthogonal portion of the LS. If the orthogonal partitioning of a LS of size $s \times s$ is done into two groups (s^2-s, s). The analysis for the row and column design obtained by not filling s cells by another treatment is discussed. In the second case the number of treatments will be $s+1$.

14. On the Construction of Partially Balanced Weighing Designs

By Kishore Sinha, *Kharagpur* and
G.M. Saha, *I.S.I., Calcutta.*

Some series of partially balanced weighing designs with triangular association schemes have been constructed, and in the process, some new series of partially balanced incomplete block designs with triangular association schemes have been obtained.

15. Some Qualitative-cum-Quantitative Designs

By Basant Lal & P.N. Bhargava,
I.A.R.S., New Delhi.

In factorial experiment one is very often faced with the problem of testing the efficacy of different forms of substance at different levels. Along with this factor he might be interested to investigate the interaction of different forms of the substance with other nutrient or a substance of its different levels. The designs where the experimenter is having these types of factors that is one or more of qualitative nature while the others are of quantitative nature, such experiments are known as qualitative-cum-quantitative experiments.

In the past some investigations over the constructions and analysis for such type of designs had been carried out but they do not have systematic method of construction and there analysis is very cumbersome. In the present paper an attempt has been made

to provide some confounded designs for qualitative-cum-quantitative experiments when one or two qualitative factors and several quantitative factors are involved. The designs for such type of situations are obtained by utilising the existing designs available for quantitative factors. It has been shown that these designs when adopted for qualitative-cum-quantitative experiments have easy method of analysis and provide all information on important interactions. The other advantage of the designs so formed is that number of replications is minimum (generally two).

16. On Growth Rates of Food Crops in Himachal Pradesh

By R.P.S. Malik, A.S. Guleria, *H.P. University, Simla* and D.K. Aggarwal
I.A.R.S., New Delhi.

Growth rates of an economy, at national or regional level describes the progress of economy over a period of time. Planning for achieving a particular rate of growth requires the knowledge of rates of growth for periods immediately preceding it. The growth rates of the various sectors of an economy indicates the growth process in that sector.

There are several factors which contribute for the differential growth of productivity. The productivity of different crops over a period of time may change due to the use of several factors such as improved seeds, new technology, level of fertilizer use, availability of irrigation facilities, etc. This leads us to believe that there exist potentials for increasing the total agricultural production by taking efforts to transmit the experiences of higher productivity areas to those of lower productivity.

The economy of the Hilly regions of the country depends solely on agriculture in contrast to plains whose economy depends both on agriculture as well as industries. However, the hilly areas are still lagging behind even in this respect. Practically not much attention has been paid to uplift the economy of these regions. In order to improve upon the agriculture in these areas the formulation of proper plans is very essential. Hence in order to plan properly a study of growth rates of various agricultural crops of these regions becomes indispensable.

The present study is an attempt to enhance the existing knowledge in the field of growth rates of areas, production and productivity of different food crops in Himachal Pradesh, over period of time. The study also attempts to compare the growth rates of different food crops.

17. Human and Bullock Energy Consumption on Different Sizes of Farms in Paonta Valley of Himachal Pradesh

By Rakesh Sharma and T. V. Moorti,
Himachal Pradesh University, Simla.

The specific objectives of this paper are (1) to examine the human energy consumption of different sizes of farms and (2) to examine the bullock energy consumption on different sizes of farms. The study was undertaken in Paonta Valley of Himachal Pradesh. By probability proportional sampling method 120 farmers were selected as follows: 63 farms with land below 1 ha, 32 marginal farmers with land between 1 and 2 hectares, 12 medium farmers having holding between 2 and 3 hectares, and 13 large farmers having holding above 3 hectares. The data pertaining to kharif of 1975-76 and rabi of 1974-75 regarding human and bullock labour inputs for all the crops for various farm operations were collected by survey method. The human and bullock labour have been converted into horse power days by assuming one man as equal to 0.1 H.P. and a pair of bullocks as equal to 1 H.P. One day was assumed as equal to 8 hours of work both for human and bullock labour.

The study revealed that, the total human energy consumption on marginal and small farms was 12.44 and 11.18 horse power days per hectare respectively as against 7.41 and 6.99 horse power days per hectare on medium and large farms respectively. The human energy consumption on land preparation was estimated as 4.50, 3.19, 2.44 and 2.10 horse power days per hectare on marginal, small, medium and large farms respectively. The lower energy consumption on large size farms could be attributed to the use of tractors by these farms. The consumption of human energy for harvesting which was the next important farm operation was 1.93, 2.14, 1.49 and 1.73 horse power days per hectare on marginal, small, medium and large farms respectively. The human energy input for threshing and winnowing operations was 2.71, 2.03, 1.26 and 1.15 on marginal, small, medium and large farms respectively, thereby indicating that medium and large farms had lower human energy consumption which could be attributed to the use of mechanical threshers and winnowers by these farms.

The empirical analysis further revealed that, the human energy input for Rs. 1,000 of gross farm returns was 4 horse power days on marginal, small and large farms as against 3 horse power days on medium farms. Thus, from the point of view of gross farm returns no significant differences were observed in the human energy input, due to variations in the size of farms.

As regards the consumption of bullock energy, the investigation revealed that, on marginal, small, medium and large farms the total bullock energy input was 56.86, 45.32, 33 03 and 28.55 horse power days per hectare respectively, thereby indicating, that, with the increase in the farm size the bullock energy input decreased. It was further found that more than about 60 per cent of the bullock energy consumption accounted for land preparation. The lower bullock energy input on medium and large farms was due to the use of mechanical threshers and winnowers either owned or hired. It was further observed that the bullock energy consumption was 18, 17, 14 and 17 horse power days per Rs. 1,000 of gross farm returns on marginal, small, medium and large farms respectively. Thus no significant differences were found in the bullock energy consumption so far as the gross farms returns were concerned due to variations in the size of farms.

18. Tenural System, Resource Endowment and Household Incomes of Himachal Farmers

By J.P. Bhati and A.S. Guleria,
Himachal Pradesh University, Simla.

The present paper is an attempt to highlight the tenurial system, resource endowment and household incomes of different sizes of farms in Kangra district of Himachal Pradesh. The study is based on the data pertaining to the agricultural year 1973-74 obtained from 98 cultivating households selected from 10 villages of Bhawarna and Rait blocks. The study revealed that 52 per cent households were full owners of land, 43 per cent owner-cum-tenants and rest 5 per cent pure tenants. Proportion of owner-cum-tenants and pure tenants had inverse relation with the size of holding. Average size of operational holding was 1.29 hectares only. Average value of total resources possessed by a household in the holding size below 1 hectare, 1-2; 2-3; 3-4, and 4 and above hectares was Rs. 17,165, Rs. 29,096, Rs. 45,721, Rs. 63,651 and Rs. 1,47,365 respectively. Overall average value was Rs. 33,801. Absolute value of each type of resource increased with the farm size. The proportional share of land in the resource-mix increased with the size of farms. However, share of animals and building decreased with the increase in the holding size. Per household annual income varied from Rs. 1,620 on the below 1 hectare farms to Rs. 9,797 on the above 4 hectare farms. Overall per household annual income was Rs. 2,807. Sourcewise break-up of income depicted that 67.5 per cent of total household income accrued from agricultural activities and rest from other

sources. Income through animal husbandry was highest, *i.e.* 31.5 per cent, followed by field crops which contributed 28 9 per cent, of the total income. Remittances and salary/wages accounted for 24.8 per cent and the rest—horticultural crops, business, etc.—had negligible share in the total household income.

19. **Production Functions and Concentration in Milk Production for Haryana Cows and Murrah Buffaloes in Rural Areas around Karnal.**

By S.B. Aggarwal, R.K. Patel and P. Kumar
N.D.R.I., Karnal.

The paper deals with the relative importance of various inputs in increasing the productivity of animals. Further, the concentration in milk production according to order and stage of lactation has been studied with a view to analyse inequalities in milk production. The data for the study were taken from the survey conducted by National Dairy Research Institute, Karnal to estimate the cost and production of milk during 1971-73 in rural areas around Karnal. The average daily milk yield decreased from first to fourth lactation for cows, whereas in the case of buffaloes, it increased upto third lactation whereafter, it declined. The milk yield declnied both for cows and buffaloes, according to stage of lactation.

The average expenditure on green fodder was the maximum followed by that on dry fodder and concentrates. The expenditure on feeds and fodders to produce one kg. of milk was 71 and 69 paise for cows and buffaloes respectively.

The importance of various inputs in milk production was studied on the basis of production function analysis. The milk yield was taken as dependent variable and expenditure on green fodders, dry fodders and concentrates separately, management index and stage of lactation were taken as explanatory variables. Linear and cobb-Douglas type production functions were tried for each lactation for cows and buffaloes. The linear production equations explained maximum variation in all the cases, and were therefore used for economic analysis. The percentage variation in milk yield ranged from 41 to 43 per cent for cows and 42 to 55 per cent for buffaloes.

The regression coefficients of expenditure on green fodder, concentrates and management index were positive and significant whereas those for stage of lactation were negative and significant, showing that the green fodder, concentrates and management were the major factors influencing milk yield. The regression coefficients

of management index indicate that improved husbandry practices be initiated for increasing productivity of animals.

The cumulative percentages of milking animals and their corresponding share in total milk production were worked out for different levels of milk production for estimating the concentration ratios to analyse the inequalities in milk production pattern for cows and buffaloes in different orders and stages of lactation. Inequalities in milk production were observed both for cows and buffaloes. These were higher for cows as compared to those buffaloes which suggests that to obtain precise estimates of supply of milk and cost of milk production due weightage should be given to milch stock with respect to species and order and stage of lactation.

20. Estimates of feed fed to cattle and buffaloes

By D.V. Subba Rao, M. Rajgopalan and
J.S. Maini, *I.A.R.S., New Delhi.*

The Institute of Agricultural Research Statistics (ICAR) has carried out a series of investigations in different breeding tracts of the country with the objective of developing a suitable sampling technique for the estimation of milk production and for collecting reliable information of feeding and management practices of bovines These surveys were conducted during the years 1960-61 to 1968-69. In addition to the data on daily milk yields of selected animals, data on feed intended to be given to all the bovines on the selected households on the day of visit were also recorded by actual weighment. These data were utilised to estimate the green fodder, dry fodder and concentrates given to a bovine in a day for different seasons of the year 9 (summer, rainy and winter) in all the States.

As these surveys were conducted around the year 1966, the year of quinquennial livestock census and assuring the same supply of feed. All India Estimates of average feed given to a bovine in a day as in 1966, were worked out for animals in milk, dry, working animals and youngstock separately for cows and buffaloes.

Further an attempt is made in this paper to estimate the total feed given to bovines (excluding grazing) in the year 1972. It is estimated that the total quantities of green fodder, dry fodder and concentrates fed to bovines during the year 1972 were 294.0, 345.9 21.6 million tonnes respectively which are closely comparable with the projections made by Panse, Amble and Abraham for the year 1970-71 while preparing a plan for improvement of nutrition of India's population.

21. Estimation of Population Ratio on two Occasions

By Ajit Kumar Das,
Indian Statistical Institute, Calcutta.

We consider the problem of estimating ratio $R = \frac{\bar{Y}}{\bar{X}}$ of population means of character y to that of x (or of population totals) on second occasion, under simple random sampling without replacement using scheme of partial-replacement. A regression-type ratio estimator is considered based on matched portion and an usual ratio estimator is considered based on replaced (unmatched) portion and then both are combined suitably to give an estimator for population ratio R. The mean square error of the proposed sampling strategy, the optimum proportion to be matched and resulting optimum mean square are found. Our proposed estimator is shown to be more efficient than that of Tripathi and Sinha (1976) in all situations and that of Rao (1957) under some conditions. We have found that when all correlations are same the optimum matched proportion is 50 per cent. Under other moderate conditions it is found that we can match 24 per cent to 50 per cent units without bothering for the values of correlation coefficients.

22. A Note on Optimum Stratification for Equal Allocation with Ratio and Regression Methods of Estimation

By Ravindra Singh,
P.A.U., Ludhiana.

When the information on a highly positively correlated auxiliary variable x is used to construct stratified regression (or ratio) estimate of the population mean of the study variable y, the paper considers the problem of determining approximately optimum strata boundaries (AOSB) on x when the sample size in each stratum is equal. The form of the conditional variance function $V(y/x)$ is assumed to be known. A numerical investigation into the relative efficiency of equal allocation with respect to the Neyman and proportional allocations has also been made. The relative efficiency of equal allocation with respect to Neyman allocation is found to be nearly equal to one.

23. Ratio-cum-Product Type Estimators in two-Stage Sampling Design over two Occasions

By C.L. Agarwal and P.C. Gupta,
University of Rajasthan, Jaipur.

It is well-known fact that the suitable use of auxiliary variable results in considerable reduction in the variance of the estimators.

The ratio or product estimators are popularly used in unistage sampling design, and are known to show smaller variances than conventional unbiased (mean per unit) estimator if the variates are highly positively or negatively correlated. This has been discussed in detail by Cochran (1963), Murthy (1967) and Sukhatme and Sukhatme (1970).

Gupta (1970) has obtained some ratio-cum-product type estimators in unistage sampling design and their efficiencies have been discussed by taking a linear cost function. In practice, however, the population generally consists of multistage units. In the present investigation, some ratio-cum-product type estimators are build up for two-stage sampling design. Further these estimators are used to develop the theory of successive sampling on two occasions. The efficiencies of the various estimators considered in this paper, are compared taking into account a suitable linear cost function.

24. A Procedure of Sampling with Inclusion Probabilities Exactly Proportional to Size

By Padam Singh,
I.A.R.S., New Delhi.

The precision of an estimate can be considerably increased by properly utilizing an auxiliary variable x which is highly correlated with the character under study y. The case of selecting a sample of size 2 is the most important in practice where the population is stratified to the maximum extent. In this paper a procedure of selection with inclusion probability proportional to size for sample size two has been suggested. The suggested procedure provides in addition a stable and non-negative variance estimator. Further, the relative efficiency of the suggested procedure as compared to some of the known procedures has been examined empirically and it has been observed that the performance of the suggested procedure is the best of all the procedures considered.

25. On Balanced Random Sampling

By Padam Singh and J.N. Garg,
I.A.R.S., New Delhi.

Simple random sampling is the basic selection procedure adopted in sampling enquiry and other procedures can be viewed as its modifications from practical considerations and efficiency point of view. Of all the other sampling procedures systematic sampling

is particularly more attractive on account of its simplicity in adoption. But there is serious objection to the use of systematic sampling that it is not possible to obtain unbiased estimate of the variance of the estimate of the population mean or total from the sample itself. This is a great disadvantage. Variance of simple random sampling is independent of the arrangement of units in population whereas in case of systematic sampling the variance of the estimate is very much dependent on the arragement of the units in the population. The dependence of the sampling variance on the arrangement of the units is both an advantage and disadvantage in the sense that by effecting a good arrangement we can get better estimates of the population parameters whereas a bad arrangement may lead to inefficient estimates.

In the present paper, a new sampling procedure is suggested which has the advantage of both simple random sampling as well as systematic sampling in the sense that a part of the sampling variance depends upon the arrangement of theun its in the population and the other is independent of it. The relative efficiency of the suggested procedure has been examined as compared to simple random sampling and systematic sampling in different situations.

26. **A Note on the Use of Incomplete Multi-auxiliary Information in Sample Surveys**

By Randhir Singh,
I.A.R.S., New Delhi.

In sampling theory, the precision of estimates may be improved substantially by the use of auxiliary information available for some character x, highly correlated with the character under study.

Frequently, there may arise situations where we may possess information about several auxiliary variables but which may not be known for every unit of the population instead, each variable may be known for some part of population only. In the present note a method of estimation for such a situation is provided.

27. **An Alternative Method of Utilizing Ancillary Information**

By Padam Singh and Vijay Kumar,
I.A.R.S., New Delhi.

In this paper an alternative method of utilizing the auxiliary information has been suggested. The suggested procedure provides the probability for estimating the mean of the character under study within a specified margin of error. It has been seen that this probability increases monotonically with the sample size, the correlation

coefficient and the margin of errors. The numerical values of this probability has also been computed for various ranges of parameters. It has been observed that the suggested procedure provides satisfactory results in practical situations.

28. An Integrated Sampling Approach for Estimation of Principal Livestock Products

By J.N. Garg and B.B.P.S. Goel,
I.A.R.S., New Delhi.

The past experience of the surveys in livestock products indicated the possibility of collecting data on more than one livestock products at a time. Integrated approach for estimation of livestock products aims at devising a sampling technique so that in each year study on one product can be undertaken in an intensive scale so as to provide estimates with adequate precision whereas other products are studied from a sub-sample so as to provide indices of changes from year to year. With this object in view the Institute of Agricultural Research Statistics had conducted two pilot investigations one in the Northern region comprising the States of Punjab, Haryana and Himachal Pradesh during 1969-72 and the other in Andhra Pradesh during 1971-74. This paper gives the salient features, details of the sampling design adopted under the survey in the Northern region and resuls on milk and egg production obtained from this survey for all the three years.

29. On Two Schemes of Unequal Prabability Sampling

By S.K. Agarwal,
University of Jodhpur, Jodhpur.

The new method of sampling suggested is as follows :

Two units are selected with replacement, one with *pps* and the other with revised probabilities. When the same unit is drawn twice, the selection is rejected. The procedure is repeated until two different units are selected. This method leads to the same π_i and π_{ij} as Yates and Grundy (1953) method. Thus, this method is equivalent to that of Yates and Grundy with respect to variances and variance estimators.

30. An Efficient Estimator of Mean

By K, Alagaraja,
Central Inland Fisheries Research Institute, Barrackpore.

While considering an estimate of population mean 'μ' from a random sample of size. 'n' Searls (1964), Khan (1968) and Govin-

darajulu and Sahai (1972) have given estimates wherein the population coefficient of variations c is assumed to be known. Upadhyaya and Srivastava (1976) have given another estimator where it is assumed that (*i*) population variation 'σ^2' is known and (*ii*) the sample mean $\bar{x}$ is not near zero. While developing the estimator they have made some more assumptions and obtained optimum mean square error. This *m.s e.* becomes negative unless $n\mu^2 \geqslant \sigma^2$. These restrictions do not allow their estimator for wider usage. In this note we shall introduce an estimator assuming the knowledge on σ and c where c is population coefficient of variation.

31. Use of Ranks in Analysis of Variance

By S.C. Rai,
I.A.R.S., New Delhi.

Ordinarily the technique of analysis of variance is employed to isolate the factors which account for variation in the variables under study and also to estimate their impacts. Some times the data do not satisfy the basic assumptions necessary for valid application of analysis of variance technique. This is particularly true in the case of social, economic and psychological studies. A method of analysis for such data has been developed by arranging each set of the values of the variate in order of size and giving them rank as 1, 2 and so on. A mathematical model has been proposed and maximum likelihood estimates of treatment preferences have been obtained. Procedures for analysing such data when the experiments are conducted at different places or over different time periods have been developed. A method for testing the appropriateness of the model is also proposed. Some of the procedures described in the paper have been demonstrated by a numerical example.

32. Problem of Crop Insurance Under Indian Conditions''

By D.K. Agarwal and M. Rajagopalan,
I.*A.R.S., New Delhi.*

In this paper the methods of calculating premium rates in U.S.A. and Japan have been discussed. A better procedure for determining premium rates, taking into account the variation in seasonal yield over a long period of years, has also been discussed.

In a country like India where farming is done on very small scale by vast number of farmers who are mostly illiterate, it could not be possible to obtain information on the yield rate of each

individual holding. To secure such information for all the holdings is not only very costly but practically not feasible. Therefore, resort has to be taken to have the unit of insurance as a homogeneous area comprising a large number of holdings. Practical considerations indicate that a community development block could be taken as a unit of insurance under Indian conditions. For such unit of insurance, it could be far easier to determine seasonal yields and assess losses based on crop cutting surveys.

33. Re-Insurance Contracts for Crop Insurance Scheme

By D.K. Agarwal and M. Rajagopalan
I.A.R.S., New Delhi.

In India when several states participate in a scheme of crop insurance it may so happen that in a state in a particular year there could be heavy damage when crop is insured and the state government would not be able to bear the entire burden. A support to crop insurance scheme is most desirable through the establishment of re-insurance organisation. The Central Government could appropriately establish a re-insurance organisation and come into agreement with the state government for receiving the part of the premia collected from farmers by the state government. The insurance contract may lay down when Centre could come to help of the state government when crop loss in any given year exceeds certain limit.

In this paper two models for such a re-insurance have been suggested. The share of premium between Centre and state and indemnities payable by them are also obtained by utilising the data collected on the yield rates of high yielding and local varieties in a few IADP districts.

34. On Taste Quality of Different Brands of Bread

By M.R. Zurmati and S.C. Rai,
I.A.R.S., New Delhi.

A taste-testing experiment was conducted using four variety of bread namely Modern Bread Britania Bread, Nandi Bread and Milk Bread. The quality of these breads were compared in pairs by ranking on their overall qualities comparing of flavour, sweetishness, texture etc. The design adopted for the experiment was *BIB* design with the following parameters :

$$v=4, \quad b=6, \quad r=3, \quad k=2, \quad \lambda=1.$$

The experiment was repeated two times. Six judges, three males and three females were selected by conducting a duo-taste trial where a taster was requested to discriminate a particular sample from a set of two, a standard sample and a given sample. Breads were presented to the judges in pairs and they were asked to rank their preferences after tasting the sample. The following mathematical model was used for analysing the data :

$$P(T_i > T_j) = \frac{\pi_i}{\pi_i + \pi_j}$$

where $P(T_i > T_j)$ stands for prefering i-th treatment over j-th treatment and π_i and π_j are the preference coefficients associated with i-th and j-th treatment respectivly. The preference coefficients for different varieties of bread ere culculated.

35. **Assessment of the Influence of Various Factors Causing wide Fluctuations in Yields of High Yielding Dwarf Rice Varieties, Satya, Soorya and Suhasini in Maharashtra State**

By P.V. Sukhatme, M.S. Pawar and V.R. Karandikar

One of the outstanding results of research in agriculture relates to the development of new varieties of paddy of great potential yield *viz.* Satya, Soorya and Suhasini in Maharashtra State. Although the achievements are impressive the fact remains that it has not been possible to translate in practice the full potential observed at the research stations when these varieties are grown by the large number of cultivators. In the present study, the observed variation in yield was analysed by regressing on various inputs and other management and soil factors. The soil-test values accounted for 9 to 13 per cent of variation in yield and were not found to have significant influence on yield. The input factors like application of nitrogen, phosphate and the management factors like plant population, seed rate and other factors like extent of damage and type of soil accounted for 30 to 60 per cent of explained variation in yield. The performance of these varieties was quite impressive and these varieties surpassed the other improved and local varieties by giving 20 to 57 per cent more grain yield in Pune, Nasik and Kolhapur districts.

36. **A Methodology for Trend Curve Selection**

By T.A. Ramasubban,
Punjab Agricutural University, Ludhiana.

The paper presents a methodology which would help to make the selection of a trend curve out of a number of competing curves

more objective than what has hitherto been achieved by R^2 etc. The procedure is applied to two time series, foodgrains production and agricultural production to choose one (or possibly two) trend equation out of seven alternatives fitted for each one of the five time-periods for the two series. Besides R^2, two other criteria are employed *viz.* Gregg, Hossell and Richardson (GHR) technique and Durbin-Watson (DW) test. It is found that while the employ of R^2 alone would have invariably picked out one single curve (the Gompertz curve) as the line of best fit in all cases, the GHR technique seems to be more sensitive in that it eliminates the possibility of the Gompertz curve as also that of a few others in many instances. This once again establishes the unreliability and insensitivity of R^2 as a sole and leading criterion. Finally, the super-imposition of one other important consideration namely the DW test reduced the ultimate choice to a single curve in most cases. The strategy of trend curve selection thus appears to be to make a preliminary list as decided by the GHR technique, from which curves having DW values non-significant (and preferably closest to the value 2.0) are chosen next ; and from amongst these, the curves with highest R^2 is (are) finally selected. It is of course presumed throughout that the curves originally contemplated to begin with, are all tenable from the specification point of view.

37. Mathematical Models for Cost Analysis of Procurement of Milk in a Milk-Shed Area

By K.N.S. Sharma, C. Jaganmohan Rao and R.K. Patel,
N.D.R.I., Karnal.

The working of the dairy industry revolves round the triangle — procurement, processing and marketing—of milk and its products. Among these, procurement is the base of the industry, on which the efficiency and development of the industry lies. Very few empirical studies have been conducted in India on the operational efficiency of milk procurement. The present study attempts to standardise the methodology for costing and develop mathematical models for cost analysis of milk procurement in a milk-shed area by using the data maintained at the plant. The method has been illustrated taking a typical plant dealing in both market milk and milk products.

The important components of milk procurement are collection, chilling and transportation of milk. For brevity, the costing methodology has been divided into following sections :

(*i*) Cost of production of utilities and services; (*ii*) Allocation of utilities and services to different sections; (*iii*) Cost of collection of milk; (*iv*) Cost of chilling, quality control and miscellaneous costs; (*v*) Cost of transportation of milk (*a*) From collection centres to chilling centres; (*b*) From chilling centres to central dairy ; (*vi*) Losses in handling and losses due to spoilage ; and (*vii*) Cost of procurement.

Mathematical models appropriate to the above sections have been developed and tested. The actual data from 5 randomly selected chilling centres and direct milk collection unit at the central dairy of milk product factory was collected for the financial year 1974-75. The average cost of production of utilities such as Electricity, Water, Steam and Can sterilisation were 44.07 paise/KWH, 110.37 paise/1000 litres, 7.25 paise/kg. and 48.34 paise/can respectively. The average cost of collection per litre of milk was worked out to be 10.18 paise, transportation from collection centre to chilling centre 8.46 paise, cost of transportation from chilling centres to central dairy 5.07 paise cost of chilling 6.22 paise, quality control 0.54 paise, miscellaneous cost 2.61 paise. The total cost of procurement was 33.08 paise per litre of milk.

38. Changing Prices and Farmer's Response

By B.S. Kulkarni, N.Y. Palimkar and K.D. Rajmane,
Marathwada Agricultural University, Parbhani.

It is essential to study the nature of agricultural system—traditional, under-developed, etc., regionwise in agricultural planning. This is usually based on the area allocation of crops depending on the necessities (requirements) and profitability. Keeping this in view, the Nerlovian price lag model was applied to Jowar (Kharif and Rabi), Cotton, Groundnut, Sugarcane and Wheat crops at Parbhani for the period 1960-61 to 1974-75. The response of Jowar (Kharif and Rabi), Wheat (Food crops) and Sugarcane was non-significant, whereas Cotton and Groundnut (cash crops) showed a significant response, to the given model. It is observed that the area allocation for these crops is based on previous years yield and area respectively. The low values of short-run, long-run elasticities and the coefficient of adjustments reveals a poor response of these crops to price fluctuations and leads to existence of traditional and under-developed agriculture in this region.

39. Linear-Plateau Models for Evaluating Crop Response to Fertilizer Nutrients in Dryland Agriculture

By C.K. Ramanatha Chetty,
All India Co-ordinated Research Project for Dryland Agriculture, Hyderabad.

Analysis of yield data collected at different Co-operating Centres of the Dryland Agriculture Project from 1971 to 1975 showed that in an overwhelming majority of significant responses, linear fit was the best except a few cases where quadratic gave the best fit.

When Linear-Plateau Models (developed by Nelson and Anderson in 1975) were adopted, they often gave better fit than linear and quadratic models. The Linear-Plateau models also helped in arriving at economic optima whereas this was not possible in the case of linear models. The cases where quadratic model over-estimated the economic optima have also been identified.

40. A Study of Efficiency of Marketing of Apple in Uttar Pradesh

By Jagmohan Singh,
I.A.R.S., New Delhi.

Apple fruit being delicate needs very careful handling from picking to marketing stage. Data collected from various fruit markets selected for Pilot Sample Survey for Estimation of Cost of Cultivation of Apple and study of its Marketing Practices in hilly areas of Uttar Pradesh have been utilized in this case-study to show that proper grading and packing of Apple-Crop in boxes bring better return to an apple-grower for his investment and labour. The study also indicates that 20 to 25% of Apple-Crop was marketed in gunny-bags in certain fruit markets of Uttar Pradesh in peak season of 1975.

The amount realised through sale of apple-fruit when marketed in packed boxes is 117 to 330% more per 100 kg of apple sold than when marketed in gunny-bags.

41. Projection of Livestock Population in Rajasthan

By S.N. Sarraf,
Rajasthan Secretariate, Jaipur.

Animal husbandry is one of the principal primary sectors of an economy next in importance only to agriculture. Scientific

exploitation of livestock resources in an essential ingredient of economic development. The development of livestock can be planned both as a supporting sector to agriculture and as an independent sector. The uneconomic agriculture lands can be exclusively cultivated with fodder crops and livestock husbanded on them.

The contribution of animal husbandry sector from the state income is estimated at about 12%.

For the perspective plan of livestock, population growth rate at various levels say,

Five years, Ten years, Sixteen years and Twenty-one years have been worked out.

With the help of population growth rate, population projections have been worked out for the years 1978, 1983 and 1988.

42. Impact of New Farm Technology on Income Distribution in Aligarh District

By R.K. Pandey,
I.A.R.S., New Delhi.

The new farm technology was introduced in Aligarh District in the form of package programme in the year 1960-61, for providing guidelines and some vital inputs needed for agricultural production. The items such as fertilizer and new seed technology was intended to be neutral to scale but in practice it was not so because of imperfections in the input and output markets. Besides providing enough foodgrains to the society, it was expected to generate substantial income and employment in rural areas.

The main objective of this paper is to study the distribution of income accrued from crop production in Aligarh District based on the data collected in a survey during 1973-74. In all 480 farmers were randomly selected from 10 blocks. Selected farmers were divided into three groups based on the adoption of new strategy of crop production.

The incomes from crop production were estimated and the Lorenz Curves were fitted for Progressive, Less Progressive and Traditional Farmers as well as for all cultivators combined together. The income distribution of progressive and less progressive farmers could not be compared because Lorenz Curves intersected each other. However, the distribution of income in the case of traditional farmers was relatively more equal. Curve for all the groups combined together was uniformly higher than that of the traditional farmers. Thus the study showed that the application of the new farm technology has improved income distribution which is one of the goals of planning in India.

43. On Variance Estimation

By M. N. Deshpande,
Institute of Science Nagpur.

In the present paper an interesting observation on variance estimation is presented. Also a new sampling scheme called as "Two-way Systematic Sampling Schemes" is presented and it is shown that the observation is valid for the variance of mean for new sampling schemes. Some open problems arising out of it are presented at the end.