ABSTRACT OF PAPERS PRESENTED AT THE 19TH ANNUAL GENERAL MEETING HELD AT CUTTACK IN DECEMBER, 1965

1. *Estimation of bias involved in making the assumption that the average household size remains constant over all the villages in a state* by P.B. Rao.

In large-scale sample surveys where a stratified two-stage design might have been adopted it may be possible to make the design self-weighing after making assumptions as in the case of rural household surveys where the first stage units, namely, villages are selected with probability proportional to the population as enumerated in the latest Census and the survey was commenced in a period very near to the Census Year and the second stage units, namely, households are selected by simple random sampling and the number of first stage units selected from a stratum was made proportional to the rural population of a stratum, by making the assumptions, namely, (1) the number of households in a village is proportional to its population for all villages in a stratum and (2) these constants of proportionality are same over all the strata. The two assumptions together could be interpreted to mean that the average household size of a village remains the same over all the villages in a State especially when the time lag between the Survey Year and the Census Year is not much. In the paper estimates of some selected characteristics have been worked out for one State according to the two methods, namely, the one without making any assumptions and another after making the assumptions by taking the experience of the All India Rural Debt and Investment Survey 1961-62, conducted by the Reserve Bank of India in the year 1962 and the extent of difference between the two sets of estimates was studied.

2. *Agricultural production functions and their economic analysis in I.A.D.P. districts* by S.S. Narula.

In some of the I.A.D.P. districts, a remarkable progress has been achieved in yield rates and production of various crops covered

under the programme during the operation of the programme by using various inputs like manures, fertilizers, insecticides and pesticides, improved seeds and adoption of practices like seeds rates, number of irrigations and ploughings, time and method of application of manures and fertilizers, crop rotation, etc. It is of considerable interest to find out the suitable functional models describing the relationship between yield and various inputs.

Attempt has been made to fit various production functions for wheat crop in Ludhiana district ; various schemes for classification of the data were tried to improve the value of coefficient of multiple correlation.

It has been found that the coefficient of multiple correlation for functions fitted for each soil type at block level are giving higher values than those in other schemes of stratification. Economic analysis for a few functions has also been carried out.

3. *On factors determining movements of agricultural prices—wholesale and retail* by D.C. Dutta.

Price level of agricultural commodities depends both upon the demand and supply positions of the commodities and those of the commodities in the non-agricultural sector. For a particular agricultural commodity, the price is determined on the basis of demand-supply position of that commodity and other commodities of the agricultural sector. Wholesale and retail prices are distinct in some ways in their respective relationship to different features of economy. To find out the nature of such relationships and the relationships between them the data on indices of prices—wholesale and retail—of wages and of employment are examined.

The wholesale price (general) explains 81% of the variation in the retail price (general) but 59% of the variation in the rate of change of retail price is explained by that of wholesale price. In the case of food, rate of change of wholesale price explains as high as 86% variation of the rate of change of retail price. The rate of change in the wholesale price has hardly any effect on the trend in the retail price. This is true both for general indices of prices and for indices of prices for food. In order to control the movement of prices of food grains in the wholesale market, the steady flow of marketable surplus of agricultural products to the market is essential. A higher rate of change in the agricultural production tends to be associated with the lower rate of change in the wholesale price indices for food.

The trends in wages and in extent of employment indicative of demand of consumer goods are separately related to the movements in the wholesale and in the retail prices. Each of the indicators— wages and employment has more intimate relationship with the retail price than with the wholesale price. This re-emphasises the importance of demand on the movement of retail price indices. The retail price movements of agricultural commodities need closer study and as factors determining their trends, demand is as important a factor as the wholesale price.

4. *Measuring growth rate in agriculture for non-observable factors* by D.K. Bhattacharya, New Delhi.

We observe the agricultural activities in terms of area, production and yield rate. Often we face the problem of measuring growth in the aggregate data for the developmental efforts. But the changes in aggregate data are due to simultaneous effect of several factors where developmental activities are only a part. Considering that the factors other than developmental efforts are quite satisfactorily measurable and identifiable, we find the growth rates from the residuals for developmental efforts as discussed below.

Let y_t $(t=1, 2, \ldots n)$ denote either area, production or yield rate, Let $x_{it}, \ldots x_{pt}, (t=1, 2, \ldots n)$ be the exogenous variables, which do not include variables measuring development, acting on y_t in the form.

$$Y = XB + E.$$

Then we define the residual,

$$\overset{\Lambda}{Y} = Y - X\overset{\Lambda}{B} \cong \text{Developmental effort} + \text{error}.$$

calculating growth rate from the residuals, as linear function of time or exponential function of time, instead of the observed variable y_t, we gain in information.

Since $\text{Var}(Y_t) > \text{Var}(\overset{\Lambda}{Y_t}).$

5. *On household consumption pattern of flock owners in Mandi district of Himachal Pradesh* by U.G. Nadkarni and C.L. Verma.

In a survey undertaken by Institute of Agricultural Research Statistics for the estimation of the cost of production of sheep and

wool in the hilly areas of Himachal Pradesh, data were also collected on the household expenditure, in order to study the economic status of the families. One hundred and-twenty five flocks of Mandi district, taken up for the study, have been divided into two major groups on the basis of monthly expenditure of less or more than Rs. 125/-.

Percentages of per capita household expenditure for the different commodities and for different expenditure groups have been given separately for each class. Concentration curves have also been fitted and to estimate the elasticities of expenditure on different commodities, the expenditure curves

$$y_i = ax_1^{\beta_i} x_2^{\gamma_i}$$

where y_i represents the expenditure on a particular commodity, x_1 the total expenditure and x_2 the family size in adult units have been fitted and comparisons made.

6. *Analysis of crop rotations when cycle is incomplete and design augmented* by K.N. Agarwal.

In long term trials when the experiment is in progress the examination of data of individual years sometimes indicates either modification in some of the crop sequences or inclusion of some new sequences. Similarly, the experimenter may be interested in the results of such trials in the middle of the experiment when the cycle is incomplete. Moreover, the data for some of the years are not available either due to failure of crops or negligence on the part of the experimenter. In such circumstances the analysis of data over years not only becomes non-orthogonal but also loses its symmetry.

In the present paper the data of a few such crop rotations have been analysed and results so obtained have been discussed in detail in relation to (a) yield, (b) effects on the fertility of soil and (c) economics.

7. *Curvilinear study of yield as product of functions of crop-characteristics—Sugarcane* by A. N. Basu.

To find out yield of sugarcane as a joint function of crop-characteristics, namely, height, mid-girth and the number of canes per clump, curvilinear technique has been employed. This study shows that yield increases with height and mid-girth and takes a constant value when these characteristics exceed certain values. These values

vary from 372 cm. to 419 cm. in the case of height and 9·5 cm. to 9·6 cm. in the case of mid-girth. It shows also that there should be some optimum value of the number of canes per clump to get maximum yield. These values vary from 2·0 to 2·3. From this study yield may be predicted two to three months before the harvest. The regression equation of yield on crop-characteristics accounts for 86 to 88 per cent of the variations in yield.

8. *Frost in India* by K. S. Ramamurti.

A study is made of the climatological conditions associated with occurrence of frost especially in north-western parts of India. Since data regarding radiation minimum temperatures are not available for all the stations nor for all the years, the relationship between screen temperatures (recorded in Stevenson Screen) and the radiation minimum has also been analysed.

In general the radiation minimum is about 3°C lower than the screen minimum.

Maximum number of frosty days occur in the more northerly foot-hill stations in January. This occurs in association with an average screen minimum of 1·9°C. afternoon relative humidity of 37·8% or 5·6 mb of vapour pressure and about 9 hours of bright sunshine (indicative of lack of cloudiness).

Light, moderate or severe frosts occur in association with screen, temperatures of 2·5°, 2·2° and 0·9°C with vapour pressures 5·8 mb., 5·6 mb. and 4·9 mb. respectively.

Occurrence of prior rain does not seem to have any effect on the nature of frost occurrence.

9. *Assessment of progress in sheep and wool extension centres in the plains of Punjab State* by Gurbux Singh Mahal and Sudarshan Kumar.

The Punjab State established 35 sheep and wool extension centres in the plains by the end of 3rd Plan period for effecting improvement in the village flocks and increased production of wool and mutton through the introduction of improved rams at the centre. With a view to estimate the improvement in wool output in each centre by the constant use of improved rams, a study was conducted during July 1965 to September 1965 in 16 sheep and wool extension centres selected at random.

A sheep and wool extension centre covers an area with a sheep population of about 5,000 to 10,000. The area within a radius of 16 km. was divided into two strata.

Strata 1. The villages covered by the extension centre.

Strata 2. The villages uncovered by the extension centre.

From each of these two strata, 4 villages were selected at random. The data about number of sheep in each flock their breedwise and age-wise distribution, the average wool yield, total wool production and body weight of the sheep were recorded. The results of this investigation are discussed in the present paper.

10. *Analysis of covariance for incomplete block design in bioassays* by G. A. Kulkarni.

Incomplete block designs useful for bio-assays were introduced by Das and Kulkarni (1963). In these designs for parallel line assays the contrasts 'Preparation' (L_p) and 'Regression' (L_1) which enter into the estimate of relative potency are kept free of block effects. In case of slope ratio assays also, one degree of freedom out of two due to regression is saved, with the help of new designs. The analysis of covariance, when the information on concomitant variates such as body weight of animals etc., recorded prior to start of the experiment are available, will often increase the precision of the estimate of relative potency. Expressions for sums of squares for various contrasts and their divisors are worked out for different incomplete block designs mentioned earlier, when multiple covariance with p covariates is considered with the model—

$$y_{ij} = \mu + \delta_i + l_j + \sum_{w=1}^{p} B_w x_{ij}^{(w)} + e_{ij}$$

where μ is the general mean, δ_i the ith dose effect $(i = 1, 2, \ldots 2k)$, l_j, the jth litter effect B_w is the regression coefficient for wth concomitant variate $(w = 1, 2, \ldots p)$, $x_{ij}^{(w)}$ is the wth concomitant variate for (i, j)th observation associated with y_{ij} and l_{ij} is the error of (ij) experimental unit distributed $N(0, 6^2)$.

11. *Construction of balanced incomplete block designs by using confounded factorial designs* by M. N. Das and A. C. Kulshreshtha.

The paper discusses an alternative approach through confounded factorial designs to construct the two series of BIB designs which are obtainable through the Euclidian and projective geometries

(Bose, R. C. 1939). Let a confounded s^n factorial in s^k blocks of size s^{n-k} each, where s is a prime or prime power, be obtained by using all possible replicates through all possible ways of confounding. Then treating the interactions as varieties, $\frac{s^k-1}{s-1}$ interaction components confounded in each replication as the varieties in a block, the total number of replicates as the number of blocks, we get a series of BIB design. This series is the same as the series of designs obtainable from projective geometry. Again, treating the treatment combinations in the above design as varieties and all the blocks of the confounded design as blocks of the BIB design, we get another series of BIB design. This series is identical with the series obtainable from Euclidian geometry. Further if only the key block in each replication of the above confounded factorial design be taken and the control treatment is omitted from each such block together with all those treatment combinations of which the first non-zero element is other than 1, then we get another series of BIB design where the varieties are all the treatment combinations whose first non-zero element is 1. This series is identical with the series obtainable from projective geometry.

12. *Balanced n-ary designs and their alternative uses* by M. N. Das and S. V. S. P. Rao.

Defined by Tocher (1952) the *n*-ary designs consist of v treatments arranged in b blocks such that the i-th treatment occurs in the j-th block n_{ij} times where n_{ij} takes n different integral values. These designs are balanced when $\sum_j n_{ij}\,n_{mj}$ is constant for all pairs of treatments i and m.

When n_{ij} takes the values 0 and 1 we get the binary designs which are the ordinary incomplete block designs. Tocher obtained some ternary designs by trial and error. In the present paper we have given a systematic method of construction of balanced *n*-ary designs by using the ordinary balanced incomplete block designs. These designs can be used to obtain a new series of weighing designs. Several series of BIB designs could also be obtained from the balanced *n*-ary designs.

13. *Various types of m-associate PBIB association schemes* by Basudeb Adhikary.

A method based on direct product of abelian groups has been expounded to generalize two-associate PBIB association schemes to

m-associate classes. This opens up the possibility of having various types of higher associated PBIB designs. The general association scheme has been formulated and the three associate generalisation of L_i and triangular designs and the four associate generalisation of rectangular association scheme has been studied in some details.

Usefulness of some geometrical configurations for the purpose of being used as association scheme or generalisations of association schemes has been discussed.

14. *An exercise on application of crop insurance to the rice crop at Raipur district in M. P.* by Shri A. G. Khare.

Crop Insurance as a means of mitigating the losses to the cultivators for reasons beyond their control, has been accepted in principle by the Government. In this regard some basic work was done in the Punjab under the auspices of I.C.A.R. in the Institute of Agricultural Research Statistics.

An effort is made in the paper to work out the total effect of the scheme giving retrospective effort from 1955-56 to 1963-64. Different rates of premia and also different levels for indemnities have been worked out to arrive at the profit no loss level. It may be seen that with premium @ 3% of the yield per acre at the far harvest prices and indemnities payable at the crop of 2/3rd of the actual loss on the basis of insured value of 75% of the 10 years average yield the balance sheet indicates profits at the end of 10 years.

15. *Structure of populations under mixed random mating and sib mating* by G. L. Ghai.

In population genetics extensive investigations have been made in respect of various properties of the populations under different mating systems like random mating, selfing, sib mating, etc. But the situation where there is complete random mating or complete inbreeding in the population may not always be found and the population may not be bred exactly in the manner postulated in the breeding procedure, *i.e.*, the population may be bred by the mixtures of breeding systems. It would, therefore, be of interest to examine populations under such situations when a mixture of breeding systems obtains in the population in varying degrees. The present investigation relates to such populations when in a certain proportion of the population random mating obtains and in the remaining proportion there is sib mating.

Assuming the initial population to be panmictic, expressions have been derived which give the genotypic frequencies in the nth generation of mixed mating in terms of the initial frequencies. If there is a constant amount of sib mating in each generation the population will eventually reach an equilibrium state. If H_n is the frequency of heterozygotes in the nth generation of mixed mating, the recurrence relation in the case of single factor segregation is obtained as—

$$H_{n+3} = \left(1 + \frac{x}{2}\right)\left(\frac{H_{n+2}}{2}\right)\left(\frac{x}{4}\right)H_{n+1} - \frac{x}{4}H_n$$

where x is the proportion of sib mating and $(1-x)$ that of random mating in the population.

The loss of heterozygosity in successive generations of mixed random mating and sib mating has also been examined for various amounts of sib mating.

16. *Diallel and partial diallel analysis of some yield factors in Linum Usitatissimum L.* by B. R. Murty, V. Arunachalam and I. J. Anand.

A comparison of the estimates of combining ability obtained from a full diallel and from partial diallel sets for all possible values of s, involving Indo-gangetic exotic, and peninsular lines of linseed is attempted. The parents represent different degrees of divergence as measured by D^2 statistic. Six characters, *viz*, flowering time, height, height at branching, number of fruit bearing branches, number of capsules per plant, number of seeds per five capsules which contribute to yield as well as fitness under human cultivation were examined in the two years 1963-64 and 1964-65.

The analysis has indicated that the magnitudes of the variation due to general and specific combining ability are significant for all characters and all values of s in both the years. The predominant role of non-additive gene action was reflected in both the full and all partial diallel sets for all the characters.

The general combining ability effects tend to be over-estimated with the decrease in s particularly when s is less than $n/2$ (n being the number of parents) in this investigation for all the characters although the order of the parents remained essentially the same in their g.c.a. effects for different values of s.

The average S.E. $(\hat{g}i - \hat{g}j)$ increased with the decrease in s with a steep rise in the slope for $s < n/2$ for all the characters. This was also confirmed by the changes in $\sigma s^2/\sigma e^2$ with changes in s.

From the results it is concluded that even with limited samples, a partial diallel with $s = n/2$ may be adequate for screening the parents for their general combining ability effects. The possible saving in cost as compared to the full diallel appear to be as high as 40% or more since the saving is proportional to $n-2/2(n-1)$ with a rate of change of $1/2(n-1)^2$. The likelihood of further reduction in the size of the partial diallel with the increase in n was discussed in relation to rapid screening of lines for g.c.a. in self-pollinated crops with limited seed number per poltination.

17. *Size, shape and arrangement of plots for trials in range lands* by M. B. Jain.

With a view to studying the suitable size and shape of plots and blocks for field experiments on range lands an uniformity trial was conducted on about 1/6th of an hectare of a 'poor' condition class, natural pasture of arid zone of Western Rajasthan. Air dry forage yield from 1728 plots, each one metre by one metre in size, were recorded. These yields from adjacent plots were then suitably combined to form plots and blocks of different possible sizes and shapes.

The coefficient of variation (C.V.) decreases with the increase in plot size. With the increase in plot size from 1 to 36 square metres, C.V. falls to about half its value but with the further increase in plot size, there is no appreciable fall in C.V. The mean squares (V_x) per unit area among plots of size X units are found to follow very closely the well known law of—

$$V_x = \frac{V_t}{X^b} \; ; \qquad 0 \leqslant b \leqslant 1.$$

The weighted estimate of b works out to 0·4025 which indicates that there is a moderate correlation between adjacent yields.

Plots of size 144 square metres are required to detect at the 5% level of significance a true difference of 30 per cent in 80 per cent of the cases using at least six replications. For any plot size, the long and narrow plots have indicated the least variability as compared to other shapes of the plot.

Among the four sizes, *viz.*, 4, 6, 8 and 12 of blocks considered, blocks of size 4 have shown the highest efficiency, for all the plot sizes. In general, with the increase in block size, the block efficiency decreases indicating thereby advantage of using confounded or incomplete block designs as against randomized blocks for such trials for testing more than four treatments. Square or just square blocks with the arrangement of plots across the length or breadth of the block have resulted in least variability.

18. *On a model of nonresponse* by A. R. Kokan.

In a large-scale sample surveys some proportion of nonresponse is inevitable. Several authors have proposed different procedures to reduce this proportion. Hansen and Hurwitz (1946) have suggested interviewing a subsample of the nonrespondents. In this paper the above idea is generalised Information can be collected by repeated callbacks. A part of the total resources is allocated to a number of callbacks each time subsampling a fixed proportion of the number of nonrespondents at the previous call until at the mth call all of the same fixed proportion of the nonrespondents at the $(m-1)$th call are interviewed. An unbiased estimate of the population mean is proposed and the variance of this estimate is derived. Certain recurrence relations which are required for building up the variance are established. The optimum values of the initial sample size and of the fixed proportion are obtained. It is found that the latter does not depend on the former. Further, the relative cost factors and not their absolute values are important.

19. *Combined use of stratification and regression technique in three-phase sampling* by G. R. Seth and M. G. Mittal.

Neyman (1938) introduced the concept of double sampling or two-phase sampling. He has shown that by spending a part of the resources on collecting information for some other correlated character it is possible to increase the precision of the estimate of the population value of the character under study. He has utilized the information on auxiliary character either for stratifying the population or for developing regression ratio estimates.

In the present paper the concept of 'three-phase sampling' has been introduced where use has been made of both stratification and regression technique for increasing the precision of the estimate of

character under study. The estimation procedure and optimum design in 'three-phase sampling' has been developed, in which simple random sampling has been adopted at each phase. The results can be generalized to other systems of sampling design including multi-stage sampling.

20. *A study on the behaviour of growth of electricity in India* by B. N. Sahu.

In the present paper, an attempt has been made to study the trend of growth of electricity in India with the help of the data relating to the installed plant capacity released in the "Public Electric Supply All India Statistic-General Review" by the C.W. & P.C., Government of India. On examination of the plotted data of installed plant capacity in India for the period 1947 to 1963-64, it is noticed that the trend is taking an upward concave shape. This provides an adequate basis to assume that the trend values can be reasonably obtained by fitting the log values of installed plant capacity over years. It has also been observed that about 88% of the first differences of log of installed plant capacity in India reported for the years under reference, lie in the range of 1.070 to 1.123, which is more or less constant. This gives further support to our contention that the exponential curve of suitable degree of the type,

$$Y = ab^x \ c^{x^2} \ d^{x^3} \ ex^4$$

where Y is the installed plant capacity in India, and a, b, c, d and e are constants, may be a satisfactory description of the trend of growth of installed plant capacity in India.

21. *Analysis of transformation in the "analysis of variance"* by M. Mishra.

In the analysis of variance transformation is applied to observations, if they are not independently normally distributed with constant variance and with expectations specified by a model linear in a set of parameters. In this paper inferences are drawn about the transformation of dependent variables for the "random effects model." The contribution of normality, homoscedasticity and additivity to the transformation are separated and discussed by computing the likelihood function.

22. *Estimation of parameters in discreate distributions from double samples* by M. V. Deshpande.

In biological experiments, where the Binomial and Poisson distributions are most frequent, we often have information about the parameters on the basis of previous experiments. When the experiment is repeated and the estimates are formed without using the previous information we may get estimates which are incompatible with expectation. Since there is possibility that this may be due to sampling error, a second chance needs be given. An attempt has been made to give appropriate methods for these two distributions. We construct a region on the basis of previous information such that the error mean square is minimum when the guessed estimate is the true value. The procedure then consists in taking a first sample of size n_1 and the estimate is based on this sample only, if the estimate obtained from it belongs to region constructed and if not, a second sample of size n_2 is drawn and the estimate is obtained by using both the samples of sizes n_1 and n_2. The procedure followed is similar that S.K. Katti (1962) for the normal distribution. The efficiency of these estimates is compared with that of usual estimates.

23. *On a generalised class of distributions through the "Laplace differential equation"* by L. B. S. Somayazulu.

A class of frequency functions which are solutions of the differential equation

$$\frac{d \log f}{dx} = \frac{P_n(x)}{Q_n(x)}$$

where P_n, Q_n are polynomials of the nth degree in x have been introduced. A frequency function of this class has a characteristic function which is a solution of the Laplace differential equation of order n, *viz.*,

$$(a_o z + b_o)\phi^{(N)}(z) + (a_1 z + b_1)\phi^{n-1}(z) + \ldots + (a_n z + b_n)\phi(z) = 0$$

Examples of certain known types of frequency functions which are solutions of particular cases of the above general equation are discussed.

24. *Some investigations on the use of successive sampling in pest and disease surveys* by T. P. Abraham, R. K. Khosla and O. P. Kathuria.

Application of the techniques of successive sampling in a sample survey to estimate the incidence of pests and diseases of rice has been investigated. The survey was carried out in the Cuttack district of Orissa State during the years of 1959-60 to 1961-62 adopting stratified

multi-stage sampling design with villages and fields within villages constituting the primary sampling units (psu's) and the second stage units (ssu's) respectively. A proportion q of the psu's taken on the preceding occasion is replaced on the current occasion and a proportion $(p+q=1)$ retained. Further among the ssu's within each of the retained psu's a proportion s of the units taken on the preceding occasion is replaced and a proportion $r, r+s=1)$ retained. It has been observed that the efficiency of estimate of mean incidence of major pests and diseases is increased by taking matched samples. Further, for a set of values of the correlation co-efficients between the psu's and ssu's, the optimum value nature of the replacement factors q and s have been obtained. Estimate of change in incidence from first occasion to the second has also been studied.

25. *Factorial stratification in survey on more than one Character* by A. H. Manwani.

The paper deals with the problem of stratification and deter-mination of the optimum points of stratification in a single state sampling design involving more than one character. The method suggested here envisages division of the population into s^k or $s_1 s_2 \ldots s_k$ strata by properly choosing the points x_{ij}, $(i=1, 2, \ldots k, j=1, 2\ldots s)$, '$k$' being the number of characters under study and 's' or s_i, $(i=1, k)$ the number groups into which each character is to be classified. The optimum choice of the division points x_{ij} for given s_i, $(i=1,2\ldots k)$ has also been considered and solution obtained under some general conditions. The theory has been illustrated with the help of example from surveys on more than one fruit crop.

26. *Ratio and regression methods of estimation in controlled simple random sampling* by M. S. Avadhani and B. V. Sukhtame.

The authors have introduced earlier the method of controlled simple random sampling with a view to reducing the chance of occurrence of non-preferred samples from the population and have shown that this technique would, in general, provide at least as effi-cient estimates as in the case of simple random sampling. If a simple random sample is available and information on some ancillary character is available for all the units in the population, it is customary to utilize this knowledge by adopting either the ratio or regression method of estimation to obtain more efficient estimate of the character under study. It is shown in this paper that the ratio and regression estimators in controlled sample random sampling are at least as efficient as those in the case of simple random sampling.

27. *An alternative multivariate ratio estimate for finite population* by G. K. Shukla.

An alternative to Olkin's multivariate ratio estimate has been defined as

$$\bar{y}R = \bar{y}. \frac{w_1\bar{X}_1 + w_2\bar{X}_2 + \dots + w_p\bar{X}_p}{w_1\bar{x}_1 + w_2\bar{x}_2 + \dots + w_p\bar{x}_p}$$

where (i) $\bar{x}_i$'s are population means of p auxiliary variables, (ii) $\bar{x}_i$'s are the corresponding sample means, (iii) $\bar{y}$ is the sample mean of the character under study, (iv, and w_i's are the weights obtained by minimising variance. Expressions for the variance and bias have been derived. On comparison with Olkin's estimate it has been found that the variance is same for both estimates when n is taken large. The present estimate has smaller bias than Olkin's estimate if all the weights are positive, which may be true in many cases in practice.

28. *On the problem of optimum allocation in two-stage sampling* by P. B. Rao.

Generally in large-scale sample surveys where a two-stage design is adopted, one faces the problem of allocating the total number of first stage units (which will be usually decided in advance so as to attain a desired precision) to various states and the number of second stage units to be selected within each first stage unit of a state so that the total cost is minimised and at the same time a desired precision is attached. When the States are divided into a number of compact homogeneous regions termed as strata four schemes are possible, viz., (1) common number of second stage units in each first stage unit (m) and common number of first stage units per stratum (n) for all the states, (2) common m for all the states but different n's for the states, (3) common n for all the states but different m's for the states and (4) different M's and n's for the states. Obviously the last scheme gives rise to the lowest minimal cost among the four. In the paper the States of Madhya Pradesh and Kerala have been studied with reference to two characteristics namely debt and capital formation after assuming for the two states simple cost function the constants of which are taken from the All-India Rural Debt and Investment Survey, 1961-62 based on the tour reports of the field investigators. Corresponding to 5% variation in the combined average optimum values of m and n, the total sample size, the minimal cost and cost per sample household in respect of the four schemes have been obtained.

29. *Field trends of rice and wheat in first two Five Year Plans in Madhya Pradesh* by M. N. Parchure.

In the present paper an attempt has been made to study the change in yield levels of rice and wheat in different divisions of the State of Madhya Pradesh during Second Five Year Plan period as compared to yield levels of these two crops during First Five Year Plan period.

It is a well known fact that the yield is subject to profound influence of climate. With favourable weather condition the yield level in one district may be higher even with poor plan efforts while in another district the yield level even with best plan efforts may be lower as a result of unfavourable weather conditions prevailing in that district. Thus yearly comparisons are likely to mislead. The quinquennial averages of the yields have therefore been compared rather than the annual yields. Further, technique of analysis of variance to ascertain even this small fraction of variance has been used in the present study.

The significance of impact of plan efforts on the yield levels was ascertained by applying two tests :

In the first test the variation between plan periods was tested against the natural variation among different districts of division within each Five Year Plan period as a measure of the influence of climate over the actual period of ten years under study. But it cannot be said to be significant against annual climatic variation in the divisional yield, such as are likely to be met with normally. To ascertain this, more rigorous test was made by testing the mean square between plan periods against the mean square for years within plan periods after removing any possible trend in the latter.

30. *Construction and analysis of $p \times 2^2$ confounded a symmetrical factorial designs where p is odd* by M. N. Das and K. C. Raut.

Confounded asymmetrical factorial design of the form $p \times 2^2$ in blocks of size $2p$ are available in two replications when p is even. But no such designs seem available when p is odd. We have given in the present paper a method of construction together with the analysis of confounded asymmetrical designs of the type $p \times 2^2$ with two replications using blocks of size $2(p+1)$. These designs have been obtained from the $p \times 2^2$ designs in 2 replications with blocks of size $2p$ where p is even. In these designs only two contrasts belonging to three factor interaction are confounded with the block differences, but each one of them can be estimated with some loss of information.

31. *Inter-relationships among asymmetrical factorials* by N. S. Sastry.

In mixed series several authors have attempted in the past theconstruction of confounded arrangements. But few of them concentrated on the "inter-relationships among different asymmetrical confounded factorials". What happens if a level of a factor is missing in (or purposely cut down from) each block of an asymmetrical design ? In certain cases, the remainder is again another asymmetrical confounded factorial. The author has come across an actual experiment with a $3 \times 3 \times 2$ design in 6 plot blocks and 4 replications, confounding ABC and AB (A and B each at 3 levels and C at 2 levels) in which, on the field, due to some administrative reason a level of B missed. The remainder of the experiment was similar to a $3 \times 2 \times 2$ factorial in 4 plot blocks and 4 replications, confounding ABC, AB, AC and A, except that here the 4 experimental plots in a block might not be contiguous. Taking a clue from this, the author has been able to deduce several known asymmetrical confounded designs from one or two asymmetrical factorials by cutting down step by step or simultaneously the levels of their different factors. Also simple rules have been evolved to identify the effects confounded and those unconfounded in the process of cutting down the levels. In addition other interesting observations have been made, a list of the designs so obtained, from the two parent designs (i) $5 \times 3 \times 2$ in 15 plot blocks and 21 replications, confounding ABC, AC, BC and C, and (ii) $5 \times 3 \times 2$ in 10 plot blocks and 8 replications confounding ABC, AB, BC and B has been prepared.

32. *An alternative method of construction of symmetrical confounded fractionally replicated designs* by M.N. Das and C.P. Kartha.

Das (1964) introduced a new approach for constructing confounded symmetrical factorial designs. A method of constructing confounded fractionally replicated symmetrical factorial designs using the same method is discussed. The method first provides the identity group of interactions as required and then the required number of independent treatment combination in the key block of the fractionally replicated design saving all interactions up to a desired level. The method is discussed for fractions of 2^n and 3^n series in particular and is supplemented with examples. It eliminates,

to a great extent, difficulties of the trial and error method and the key block can be constructed in a simpler and convenient manner.

33. *Use of ancillary information in improving the efficiency of cluster sampling* by B. V. Sukhatme and G. K. Mishra.

It is well-known that cluster sampling is ordinarily less efficient than simple random sampling. If, however, ancillary information in the form of values of the character under study on a previous occasion is available, cluster sampling may very well prove efficient. This is because the correlation between the character under study and the ancillary character may improve with the size of the cluster. This is especially the case when the ancillary character is the value of the character under study on a previous occasion as shown by Zarkovich and Krane (1965). This paper discusses the conditions under which cluster sampling when used in conjunction with appropriate methods of estimation, such as, ratio method of estimation, regression method of estimation, etc., is more efficient than simple random sampling. If cost factors are also taken into account, the gain in efficiency may be substantial.

34. *On the construction and analysis of a class of balanced asymmetrical factorial designs* by K. Kishan and B. N. Tyagi.

In experimentation in the biological, physical, chemical and other sciences, when a number of factors have to be tested simultaneously in a factorial scheme, situations arise when the number of levels of the factors to be tested are not all equal. Asymmetrical factorial designs in which the number of levels of the various factors are not all equal, which are required under such experimental situations, are, therefore, of importance to experimenters in the various sciences.

This paper presents a method of construction, by the use of finite geometries, of the confounded balanced asymmetrical factorial (BAF) design $s^2 \times t$, where s is a prime positive integer or a power of a prime and t any positive integer less than s, and also the method of analysis of this design by fitting constants by the method of least squares. The design and analysis of $5^2 \times 2$, $5^2 \times 3$, $5^2 \times 4$, $7^2 \times 2$, $7^2 \times 3$, $7^2 \times 4$, $7^2 \times 5$ and $7^2 \times 6$ designs, which are particular cases of this general design, have been presented.

35. *On the asymptotic minimum variance property of least squares estimators in time-series regression* by Mrs. V. Mukherjee.

Durbin (1960) has given various properties of the least square estimators of the parameters β in the regression equation

$$y = x\beta + \epsilon$$

in time-series regression. In this paper a further property of asymptotic minimum variance is proved for the least squares estimators of β in the case of non-normal errors with finite moments.

36. *Analysis of growth components and method of constructing the index number of agricultural production under constant cropping pattern* by Ashok Parikh.

The construction of aggregate index numbers of agricultural production under constant cropping pattern is attempted using the available index numbers of agricultural production (crop-wise and aggregate) and area (cropwise and total). It is also attempted to isolate two components, namely, the contribution of changes in productivity per acre in the absence of changes in cropping pattern and the contribution of changes in cropping pattern in the absence of changes in productivity per acre from the composite index of agricultural production under prevailing crop pattern. The analysis of growth components for Maharashtra State on the basis of data for the decade is undertaken.

37. *The generalised moments and their application to type III, type VII and exponential curves* by M. Mishra.

The application of generalised moments in estimating the parameters of the exponential curves and type VII pearsonian curves and its efficiency under certain conditions is discussed in the paper. By this method a gain in efficiency of about 25% is obtained as compared with that of the method of moments for estimating the location and scale parameters.

Generalised moment estimator is more efficient than maximum livelihood for type III curves of the pearsonian system in a certain region but estimates the parameter 'p' with very low efficiency. The frequency moment estimator estimates the scale parameter more efficiently than the generalised moment and ordinary estimator, when the shape parameter 'p' is known for type III population. But for low values of 'p' the ordinary moment estimator is better than the other two.

38. *Sources of variation and estimation of their components in birth weight of lambs* by G.C. Taneja.

Data on birth weight of 183 ram and 221 ewe lambs of Marwari sheep born during 1957 to 1962 at Sheep Breeding Farm, Mandore, Rajasthan, were used for the purpose of this study.

The following algebraic model was used for the analysis of data and estimation of components of variances :

$$m_{ijkl} = u + y_i + s_{ij} + p_{jk} + e_{ijkl}$$

Where m_{ijkl} is the birth weight of lth offspring born during k^{th} period from the jth sire-mating in the ith year ; u is constant which all observations contain, and y_i, s_{ij}, p_{ijk} are random variables normally and independently distributed with zero mean and variances σ_y^2 (Between years), σ_s^2 (Between sires) σ_p^2 (Between periods) and σ_q^2 (Between full sibs), respectively.

There were highly significant differences between years within sex. Percentage of total variation attributed to year was 16·5 and 7·9% for male and female, respectively.

The differences between sires within year were not significant. Portion of total variation due to sires was 0 and 1% for male and female respectively.

The month during which the lambs were born within sire-family in any year had no effect on the birth weight. Variation due to month of birth accounted for 4·7 and 6·4% of the total variation for male and female respectively.

The portions of the total variation among individuals were 78·8 and 84·7% for male and female, respectively. The error variances between sexes were heterogeneous.

The heritability estimates were 0 and 4% for male and female, respectively.

39. *Analysis of pennisetum typhoids, varietal trials with fertilizers in series of experiments in Western Rajasthan* by Dr. D. K. Misra and R.P. Goswami.

A trial on five Bajra varieties with two improved, *viz,.* R.S.K., R.S.J., improved ghana and two local varieties with three doses of ammonium sulphate was conducted in 10 different habitats in the arid zone of western Rajasthan to study the plant performances and grain yield. The study of plant height indicated that the two improved varieties of Bajra R.S K. and R.S·J. were significantly taller than the local Bajra plants.

The bajra grain yield was significantly higher at Jodhpur, Sardarshahr Narhad and Shri Dungargarh as compared to other localities *viz.*, Pali, Churu, and G. Road.

The plant height and grain yield showed inter-dependence whereas at three centres there existed significant correlation between grain yield and number of tillers per plant. The study indicated that both improved varieties were suitable for the regions covered by the study.

40. *Determination of optimal crop pattern using linear programming techniques* by T. V. Avadhani.

The aim of the paper is to indicate how a technique of Operations Research, namely, the technique of Linear Programming is useful in the determination of what is defined as 'An Optimal Crop Pattern'. An optimal crop pattern can be worked out either for a region or for a group of farmers having the same average size holding. The assumptions and limitations in the application of this technique in short term agricultural planning are also indicated. Lastly, the need for a constant reappraisal and continuous research with regard to the input output coefficients of different crops under changing technologies, and of new crops, taking into account the soil and other irrigational factors has been stressed. A practical example of the application of this technique of Linear Programming to the results obtained in the Socio Economic Survey of the Nagarjunasagar Project Area is indicated and the main conclusions obtained are detailed.

41. *Configuration of clusters of flue-curved virginia tabacco grades using D^2-Statistics* by D. M. Gopinath and C. L. Narayana.

An attempt has been made to see the justification of Tabacco Agmark grades by studying their relationship with respect to the chemical constituents of leaf which are fundamentally the quality characters, by the technique of group constellation using D^2-Statistic. The study reveals the similar divergence as in Agmark grades.