ABSTRACTS OF PAPERS PRESENTED AT THE 33rd ANNUAL CONFERENCE HELD AT TRICHUR

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1. Use of Multivariate Auxiliary Information in Estimating the Population Ratio

BY T.P. TRIPATHI AND D.K. CHATURVEDI

Indian Statistical Institute, Calcutta

We consider a class of sampling strategies, consisting of SRSWOR and a class of estimators.

$$\tilde{R}=[\bar{y}-\mu'_{(1)}\ \bar{Z}^*]/[\bar{x}-\mu'_{(2)}\ \bar{Z}^*],$$

for population ratio $R=\bar{Y}/\bar{X}$ $(=Y/X)$, using the apriori knowledge on the means $\bar{Z}_1, \ldots, \bar{Z}_p$ of p-auxiliary characters, where

$$\bar{Z}^*=(\bar{z}_1-\bar{Z}_1, \ldots, \bar{z}_p-\bar{Z}_p)' \text{ and } \mu_{(1)} \text{ and } \mu_{(2)}$$

are vectors of suitably chosen constants. The optimum estimators in $\tilde{R}$ are found to be better than the usual estimator $R=\bar{y}/\bar{x}$, the estimators by Singh (1965, 1967) and Rao and Pereira (1968) and same other estimators. For $p=1$, the optimum estimators in R are found to be equally efficient to the estimators

$d_1=R\ (\bar{z}_1/\bar{Z}_1)^\alpha$ and $d_2=[\bar{y}-b_{y(1)}\ (\bar{z}_1-\bar{Z}_1)\ ]/[\bar{x}-b_{x(1)}\ (\bar{z}_1-\bar{Z}_1)\ ]$

given by Singh (1969) and Tripathi (1970, 1978) respectively. Some interesting non-optimum estimators from $\tilde{R}$ are also identified and shown to be better than $\hat{R}$ under some moderate conditions.

2. A Class of Estimators for Population Mean when the Mean of an Auxiliary Character is Known

BY AJIT KUMAR DAS AND T.P. TRIPATHI

Indian Statistical Institute, Calcutta

In this paper we present a very wide class of estimators for $\bar{Y}$, the population mean of a character y, using the knowledge on $\bar{X}$, the population mean of an auxiliary character x. A large number of known estimators for $\bar{Y}$ are identified as particular members of the class proposed by us. We obtain an optimum sub-class and identify some other subclasses of the estimators whose members are always better than usual mean, ratio and product estimators. Finally we identify some other estimators which are better than $\bar{y}$, the usual mean estimator, under the conditions less restrictive than those under which the usual ratio and product estimators are better than $\bar{y}$.

3. Use of Prior Information of some Parameters in Estimating Population Mean

BY PULAKESH MAITI AND T.P. TRIPATHI
Indian Statistical Institute, Calcutta

The problem of estimating population mean $\bar{Y}$ of a character y using information on some other parameters of y has been considered. We present a class of estimators and obtain an optimum sub-class whose estimators are always better than usual sample mean estimator $\bar{y}$. We also identify some estimators from the class which are better than $\bar{y}$, Searl's estimator (1964) and estimators by Pandey and Singh (1978) and Hirano (1972) under very moderate conditions depending on the prior knowledge on the quantities which are smaller or greater than actual values of some population parameters.

4. Unbiased Product Type Estimators

BY D.N. SHAH AND S.M. SHAH
Sardar Patel University, Vallabh Vidyanagar

In this paper the authors obtain an unbiased product estimator for estimating population mean considering sampling from finite population and using the technique employed by Rao (1966) for unbiased ratio estimator. The variance of the estimator is derived using the expectations of symmetric functions of sample observations. The authors' derivations agree with those of Robson (1957), who employ the technique of multivariate polykays. The results are extended in the case of stratified sampling.

5. On some Alternative Ratio and Product type Strategies

BY P.C. GUPTA AND DHIRESH ADHVARYU
South Gujarat University, Surat

Some sampling strategies have been obtained by suitably combining the usual mean per unit estimator with ratio on product estimators. The proposed strategies, to first degree approximation, are as efficient as the conventional linear regression strategy $(S_{rs}; \bar{y}_{er})$ in the optimum case. Further these strategies are superior to the corresponding ratio or product strategies as long as the difference between the weight used and the optimum weight is less than $|1-\rho \frac{C_y}{C_x}|$. Under the same conditions these alternative strategies are found to be superior to the relevant strategies in two-phase set-up also. When the first and second phase samples are drawn independently the proposed strategies, with optimum weights, comes out to be even better than the corresponding linear regression strategy. It is interesting to note all these findings have similarities with the result of Gupta (JISAS, 78).

6. On Bias Reduction of Ratio Estimator

BY G.C. TIKKIWAL AND MANJU SAXENA
University of Jodhpur, Jodhpur.

The utility of Quenouille's technique (1949, 1956) of bias reduction, was examined by Durbin (1959), for the reduction of bias classical ratio estimator, under certain models for $g=2$. Rao (1965), Rao and Webster (1966), further generalised the Durbin's results and proved that bias and mean square error of Quenouille's estimator are decreasing function of g. Therefore, they suggested that the optimum choice of g is n. This paper derives the expression of bias and mean square error of Quenouille's estimator in general. It is shown that bias and mean square error need not be decreasing function of g. Thus, $g=n$ may not be optimum choice in general. These results are illustrated empirically with regard to the data on wastage in education.

7. Sampling Design *Vis-a-Vis* Experimental Design

BY S. MOHANTY
Orissa University of Agriculture & Technology, Bhubaneswar.

Through the present investigation the author has shown the relationship between sampling design with that of experimental design and have given the variance of the estimate if the variance in term of the characterising parameter of the sample space for sever- equal probability and unequal probability sampling schemes.

8. A Bayesian Approach to Optimal Sequential Sampling

BY FAURAN SINGH CHAUDHARY, *HAU, Hissar*
AND
RANDHIR S. KHATRI, *I.A.S.R.I., New Delhi*

Generally it is required to estimate the population parameter mean when relative frequency is known. Suppose we have a sample from some specified population together with some prior information on the parameter mean. A general Bayesian model is considered for a finite population and the overall distribution or the marginal distribution (if nuisance parameters are involved) are obtained. We suggest in this paper for two sample case and the information about the parameter can be modified by change in the prior distribution, *i.e.*, by the availability of more number of observations subject to the restrictions of the sampling structure. By minimizing the risk function of the sampling structure, a sequential sampling scheme has been discussed. Two-sample method has been considered by taking

posterior and conjugate posterior distribution. The sampling rules are framed to decide the sizes of both samples. Ultimately the process terminates by giving optimal sample sizes sequentially.

9. On Generalized Sequential Estimators

BY FAURAN SINGH CHAUDHARY, *HAU, Hissar*
AND
JAI BHAGWAN SINGH, *G.B.P. Univ. of Ag. & Tech., Pantnagar.*

Starting with generalized linear estimators for simple random sampling, an attempt has been made to define generalized sequential estimators for a perametric function. The basic concept of the probability measure has been considered and has been introduced recently by some authors for defining both parameter and estimator in this new line of approach. There are situations where census or complete enumeration is well-nigh impossible and at the same time well-known sampling methods do not suffice the purpose. Then only sequential sampling will help. These sequential estimators can be used in all the designs. Necessary illustrations have been made and practical utility has been established.

10. A Note on Generalized R.P.D. Estimator in Double Sampling

BY SURENDRA K. SRIVASTAVA
Punjabi University, Patiala.

In this note it is shown that the generalized ratio-product-difference estimator in double sampling proposed by Ray and Singh (1979, JISAS, Vol. 31) attains the same asymptotic minimum mean square error as that attained by a much simpler estimator defined by Srivastava (1970, Aust. Jour. Stats. Vol. 12) and hence is unnecessarily complicated. Then an alternative equally simple estimator—a linear combination of the simple mean per unit estimator and ratio estimator in double sampling—which also attains the same asymptotic minimum mean square error, has been shown to have a bias which is twice that of the Srivastava's estimator.

11. A Generalized Two-phase Sampling Estimator

BY SURENDRA K. SRIVASTAVA
Punjabi University, Patiala.

For estimating the mean $\bar{Y}$ of a finite population using an auxiliary variable, a large class of ratio and product type estimators in two-phase sampling is defined. The class of estimators considered is $\bar{y}_{dh}=\bar{y}_{h(u)}$ where $h(u)$ is a function of $u=\bar{x}/\bar{x}'$ such that $h(1)=1$, and it satisfies certain regularity conditions. Here $\bar{x}'$ and $\bar{x}$ denote

the simple random sample means of the auxiliary character based on the first phase sample of size n' and the second phase sample of size n ($<n'$) respectively. A large class of estimators considered in literature are members of this class of estimators. Large sample expression for the variance of the estimator $\bar{y}_{dh}$ has been obtained. It has been shown that the lower bound for the asymptotic variance for this class of estimator is equal to that of the conventional linear regression estimator when second phase sample is a sub-sample of the first phase sample. For the case when the two samples have been drawn independently, an argument is given for the lower value of the minimum variance of the proposed class of estimators than that of the linear regression estimator. The results have been extended to the case when information on more than one auxiliary characters is collected.

12. Sampling from Incomplete Frames

BY RANDHIR SINGH
I.A.S.R.I., New Delhi.

For any sampling enquiry or census the existence of a frame is most important. Unfortunately an appropriate frame to serve the requirements of the survey is hardly present. Since the preparation of an up-to-date frame may well consume lot of time and survey resources, therefore, generally frames prepared for other purposes are used. In such situation the frame may include some of the units which no more exist in the population and may not be containing some units which have entered the population after the preparation of the frame. In the present investigation use of such frames is discussed.

13. A Study of some Ratio-estimators in Multi-stage Sampling Design

BY V.K. DWIVEDI, *I.V.R.I., Izatnagar*
AND
A.K. SRIVASTAVA *I.A.S.R.I., New Delhi*

In sample survey, when information is available from all the units of the population under study on an ancillary character which is highly correlated to the character under study, the precision of the estimator can be increased either at the planning stage or at both these stages. When the ancillary information is available at different stage in a multi-stage sampling design, reliable estimates of the population parameters can be obtained by using the same for estimation as in ratio, product and regression methods after selecting the sample by equal or unequal probability scheme.

This paper deals with the different ratio estimators of total production obtained by using the ancillary information at different stages of sampling units. We have obtained the expressions of variances and biases of these estimators to a first order of approximation. The relative efficiencies of estimators have been estimated on the basis of data collected in an apple survey conducted in Nainital in 1973-74. It is observed that application of ancillary information to form ratio-estimators has been substantially rewarding.

14. On the Estimation of the Correlation Coefficient in Simple Random Sampling with replacement with Incomplete Data

BY J.P. GUPTA AND LALIT KISHORE
Punjab Agricultural University, Ludhiana.

The estimation of the population correlation co-efficient with incomplete data in SRSWR sampling has been discussed in this paper. The information on one variable has been assumed to be complete but its counterpart second variable having some observations missing. It has been shown that the estimator suggested r' using all the available data is more efficient than that when the information on pairs only is used for the same set of data in the neighbourhood of $\rho=0$ and small n and n'.

15. On a Biased Estimator of Mean Utilizing Prior Information

BY S.D. SHARMA
G.B.P.U.A. & T., Pantnagar.

The biased estimators of mean have been proposed by Goodman (1953), Searls (1964), Blight (1971) and in which mean square error is less than the variance of simple mean, $\bar{x}$ of a random sample. Srivastava (1974), Upadhyaya and Srivastava (1976) have considered biased estimators of the type $\bar{x}+K s^2/\bar{x}$ where s^2 is the sample mean square and K, the constant characterizing the class of estimators. Author (1979) has considered more general biased estimator of the type $K_1 \bar{x}+K_2 s^2/\bar{x}$ with constants K_1 and K_2 chosen so as to minimize the mean square error. The determination of these constants requires the knowledge of the coefficient of variation $\sqrt{c}$, Pearson's Coefficient of skewners $\sqrt{\beta_1}$ and the excess of Kurtosis, γ_2. The estimator has been shown to be better than $\bar{x}$ as well as the Searls' estimator in respect of having smaller mean square error. However, this estimator can only be defined for populations which are almost symmetrical and preferably, are not platykurtic. In the present article, another biased estimator of the type $K_1 \bar{x}+K_2 s$ is proposed which is better than $\bar{x}$ and the Searls' estimator and assumes

the same prior information on $\sqrt{c_1}$, $\sqrt{\beta_1}$ and γ_2 available. However, this estimator is applicable for moderately platykurtic populations as well. Finally, the mean square error of this estimator is shown to be a symptotically smaller than that of $K_1 \bar{x}+K_2 s^2/\bar{x}$, for normal populations.

16. Stratification in Multivariate Population—II

BY D.V.S. RAO

I.A.S.R.I. New Delhi

In survey sampling, stratified sampling scheme is adopted to a large extent for the estimation of mean or total of the population characteristic under study with more precision and least cost. The problem of optimum sub-division of strata has been successfully tackled by several authors for univariate case. However, this problem becomes more complicated when several characters are simultaneously under study. Ghosh (1963) and Samanta (1965) have obtained optimum points of stratification for a bivariate population by minimising the generalised variance of sample means under proportional allocation. The utility of these results are handicapped since no explicit solutions could be obtained.

In case the study character are highly correlated, it is known that a stratification based on any one of the character will generally lead to an efficient stratification with respect to other character as well. In the present paper the stratification of a population when the simultaneous estimation of several independent characters are involved, is given. An alternate plan of allocation that provides explicit solutions and reduces the generalised variance of sample means lying inbetween the corresponding values for optimum and proportional plans, is given. It is shown that this plan provides smaller variances than those of corresponding values under proportional allocation, for sample means of individual characters when strata variances vary widely. It is, further, compared favourably with the compromise allocation (Cocharan 1963). Finally, an approximate rule for quick determination of optimum points of stratification in multivariate population which reduce the generalised variance of sample means under the proposed alternate plan of allocation is obtained.

17. Comparison of Methods for Determining Stratum Boundaries in Multivariate Populations

BY P.R. JAT, D.V.S. RAO AND J.P. JAIN
I.A.S.R.I. New Delhi.

The problem of stratification in multivariate populations has been dealt by Ghosh (1963), Samanta (1965), Rao (1976) and Gupta and Seth (1979). Before designing a multivariate survey a knowledge about the relative efficiencies of these methods is necessary. As those methods are based on different schemes of stratification and approaches, a theoretical comparison among them is rather difficult. In the present papar the relative efficiencies of the methods when more than one stratification variables are involved, viz., methods given by Ghosh, Samanta and Rao have been compared empirically using two real bivariate populations. In the first instance generalised variance of sample means for the study characters under the three methods have been compared. Later the relative performance of these methods by comparing individual variances of sample means with their univariate solutions (Dalenius 1950) under proportional allocation is studied.

18. Some Contribution to Two-stage Sampling

BY ANAND PRAKASH AND PADAM SINGH
I.A.S.R.I., New Delhi.

In two-stage sampling design, we choose either the same number of *s.s.u*'s from each selected *p.s.u.* or the number of *s.s.u*'s proportionate to the total number of *s.s.u*'s in the selected *p.s.u*'s while the former method ignores the variability of *s.s.u*'s within *p.s.u*'s resulting in less efficiency, the latter makes the total sample size a random variable which is not desirable from many considerations.

In this paper, a new approach for deciding upon the number of *s.s.u*'s to be selected from each selected *p.s.u*'s is discussed.

19. An Alternative Sampling Scheme Providing Unbiased Regression Estimator

BY H.V.L. BATHLA AND PADAM SINGH
I.A.S.R.I., New Delhi

Regression method of estimation is considered as an efficient technique of utilising auxiliary information for estimating population mean or total. When regression coefficient is estimated from the sample, the estimator is known to be biased. Singh and Srivastava (1979) considered a sampling scheme in which the usual regression

estimator becomes unbiased. In the present paper, an alternative sampling scheme has been proposed. The alternative sampling scheme provides an unbiased regression estimator. On comparing the efficiency of the suggested sampling strategy with some of the existing sampling strategies, it has been observed that the performance of the proposed sampling strategy for small samples is highly satisfactory.

20. On use of Auxiliary Variates in Ratio Method of Estimation

BY S.K. AGARWAL
University of Jodhpur, Jodhpur.

A ratio-type estimator has been suggested which is found to be more practicable than Olkins (1958) estimator, when the auxiliary information is available on two variates for every unit of the population.

21. Sampling Techniques for Estimation of yield of Vegetable Crops using Partial Harvest Data

BY A.C. KAISTHA AND B.B.P.S. GOEL
I.A.S.R.I., New Delhi.

The existing sampling techniques for estimation of yield of vegetable crops, consists in selecting a random sample of fields growing a particular vegetable crop and collecting yield data for all pickings from a randomly located plot of $5m \times 5m$ during the entire harvesting period of the crop. Since the harvesting of vegetable involve a number of pickings spread over a long period it would require deployment of whole time staff for collection of yield data and thus resulting in exorbitant cost of field work.

An attempt has been made in the present paper to examine some alternative sampling approaches which turn out to be much more efficient and collection of data also becomes comparatively easy.

The alternative approaches considered are those of double sampling and component sampling.

22. An IPPS Sampling Method

BY M.N. DESHPANDE
Institute of Science, Aurangabad.

In this paper a new IPPS Sampling method is proposed and its properties are studied. Further a few particular cases have been discussed.

23. On Estimation of Sub-population Means

BY SATISH TEWARI AND O.P. KATHURIA
I.A.S.R.I., New Delhi.

In sample surveys, often the objective is not only to estimate the population parameters such as mean, total or proportion for the character under study but also to obtain estimates for each of a number of classes into which the population may be sub-divided. Such parts of a population constitute the domains of study or sub-populations. Some sampling procedures, which can be used for estimation of sub-population means, have been discussed. The Technique of double-sampling for estimating the sub-population means has been examined and is found to perform satisfactorily.

Similarly for sampling on two occasions, when there is a partial matching of units on both the occasions, estimates of means of each of the domains under study have been obtained on the second occasion by making use of the information available from the previous occasion. The theory thus developed corresponds to the well-known theory of sampling on two occasions. The results of a sample survey conducted by the I.A.S.R.I., New Delhi have been utilized for the purpose of illustration. The results obtained show that with the application of methodology that has been developed, estimates of domain means have been obtained with a high degree of precision.

24. On use of Auxiliary Information in PPS Method of Sample Selection

BY PRANESH KUMAR, S.K. AGARWAL AND V.K. MAHAJAN
I.A.S.R.I., New Delhi.

A PPS method of sample selection, based on the transformed auxiliary information as the measure of size, has been suggested. It has been observed that the PPSWR estimator under the suggested method is always better than the SRSWR and the PPSWR estimators. Further, the proposed PPSWR estimator is seen to be more efficient than the PPSWR estimator suggested by Reddy and Rao (1977) under certain conditions. The efficiency of the proposed estimators with respect to the estimators under reference has also been empirically compared.

25. Within Pair Order Effects in Paired Comparisons

BY G. SADASIVAN
I.A.S.R.I., New Delhi.

In paired comparison of foods or beverages the rankings are affected by the order in which the items of a specified pair are presented to a judge. This effect is usually eliminated by an appropriate design for the experiment. In this article we treat a method of isolation of the order effect for the purpose. There are two sets of observations on each pair (i, j), one presented in order (i, j) and the other in order (j, i). Assume equal number of repetitions n on each pair in each case. Then we have,

$$E(x_i)=S_i+\theta_{ij} \qquad \text{for order } (i, j)$$
$$E(x_j)=S_j-\theta_{ij} \qquad \text{for order } (i, j),$$

where, X_i, X_j are the ratings of the ith and jth stimuli along a linear continum, S_i, S_j the true ratings and θ_{ij} is the effect for order (i, j). Using the same assumptions as under Thurstone-Mosteller Model,

$$E(d_{ij})=S_i-S_j+2\theta_{ij} \qquad \text{for order } (i, j)$$
$$=S_i-S_j-2\theta_{ij} \qquad \text{for order } (j, i),$$

where, $d_{ij}=X_i-X_j$. Then the variance of d_{ij} *viz.* $\sigma_d^2=2\sigma^2+4\sigma_t^2$ *i.e.*, we postulate equal variances σ^2 for X_i and the same variance σ_x^2 for θ_{ij}. Then using the normal hypothesis and proceeding as under Thurstone-Mosteller Model we get he solutions as

$$S_i' - S_j' = \tfrac{1}{2}\left[D_{ij}^{(1)}+D_{ij}^{(2)} \right] \qquad \ldots(1)$$

$$\theta_{ij}' = \tfrac{1}{2}\left[D_{ij}^{(1)}-D_{ij}^{(2)} \right] \qquad \ldots(2)$$

where the D_{ij}'s depend on the normal integral. Obtaining the solution of (1) by least squares the normal equations are obtained as the set,

$$(t-1)\ S_i' - \sum_{j\neq i} S_j' = \sum_{j\neq i} D_{ij}' \quad \ldots(i=1, 2, \ldots t) \qquad \ldots(3)$$

Setting $S_1'=0$, the linearly independent set can be denoted by,

$$(X'X)\ S=D\ldots\ldots, \qquad \ldots(4)$$

where $(X'X)$ is a $(t-1)\times(t-1)$, matrix, $S'=(S_2, S_3 \ldots S_t)$ and

$$D'=\left[\sum_{j\neq 2} D_{2j}' , \sum_{j\neq 3} D_{3j}' , \ldots\ldots \sum_{\neq t} D_{tj}' \right].$$

Thus the estimates are easily obtained.

But the presence of order effects will affect the conditions of Thurstone-Mosteller Model *viz.* stability of variances and covariances of the ratings as well as additivity of scale. It can be shown that stability of variances and covariances can be reached using an angular transformation, to the original preference data. Carrying out the analysis using the transformed scale we get the ratings as well as their errors. An adequacy test is also developed. The methods are illustrated with the help of an example in sensory evaluation. The example demonstrates that the methods are adequate, but we have to choose the method with transformation as the errors of the estimates can also be obtained in this case.

26. Selection Based on Discriminant function with Different Relative Weights in Rice Crop

BY C.S. RAO, S. RAWLO AND M.J.B.K. RAO
Central Rice Research Institute, Cuttack.

Selection indices, based on linear discriminant function of different characters, are used for selecting best genotypes in crop improvement progammes. Different weights are assigned to different characters for the construction of the discriminant function and in general, relative weights based on economic importance of characters are used. In the present investigation, an attempt is made using path coefficients of different characters in thirteen rice varieties as relative weights for the construction of discriminant function. Comparisons were made among the percentages of expected genetic advance over straight selection using (*i*) equal weights (*ii*) reciprocal variances (*iii*) heritabilities (*iv*) phenotypic correlations (*v*) genotypic correlations (*vi*) phenotypic path coefficients (*vii*) genotypic path coefficients and (*viii*) economic weights. The selection indices based on phenotypic correlations and path coefficients respectively provided 3% and 9% superiority in genetic advance over the index based on economic weights.

27. Log-Normal Distribution and the Estimation of Least Squares Mean and Standard Error

BY R.A. SINHGAL
I.V.R.I., Izatnagar.

The formulae to obtain efficient estimates of population effect means and their standard errors from log-normal distribution are given and applied to estimate least squares means of the effects and standard errors in two-way classified non-orthogonal skew distributed variate from animal breeding experiment. Marked differences are

observed in the least squares means for non-transformed and the estimates derived by use of log-transformation.

28. Analysis of Ordered Data in Taste-testing Experiments

BY S.C. RAI

I.A.S.R.I., 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. In case of taste-testing experiments mostly the data do not satisfy the basic assumptions necessary for valid application of analysis of variance technique. This is also true in the case of social, economic and Psychological studies. A method of analysis for such data has been developed by arranging such set of the values of the variate in order to 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 by various judges 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.

29. Practical Application of Analysis of Covariance Technique when the Relationship Between Main Character Under Study and the Concomitant Variable is Linear

BY KIRAN ARORA, *HAU Hissar,*

AND

K.C. GEORGE, *KAU Trichur*

Analysis of variance is considered to be a very powerful technique to analyse the data generated under controlled conditions. Some work is well known in the literature where analysis of variance is replaced by analysis of covariance by including one more variable called concomitant variable. 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. In this work, 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 has been derived. For practical illustration a data on an experiment

conducted on six varieties on Toria (1972-73) was collected from the Department of Plant Breeding, HAU, Hissar. The data consisted of observations on yield, the main character under study and four auxiliary variable namely plant stand, first flowering days, 50% of flowering days and maturity days. It was reasonably concluded that the differences among the varieties were due to the influence of the concomitant variables on the yield and the efficiency of this technique over the corresponding analysis of variance was calculated to be as 2.920.

30. Personal, Social and Economic Characteristics and their Effect on Risk Preference Attitude of Farmers (A Discriminant Functional Approach)

BY N.S. GANDHI PRASAD AND K.W. WAGHDHARE
Punjabrao Krishi Vidyapeeth, Akola (M.S.)

Prices of farm products, rain-fall occurence and intensity of insects/pests deseases are subjected to the wide range of variations and also they are beyond the human control. Under these conditions a farmer whose income/output which invariably depends on such variables has always to face risk in farming.

A farmer will face 'RISK' in the situation of decision making if he has SUFFICIENT information and can establish a probability distribution of expected outcomes that follows alternative courses of action. The possible other situations of decision making are CERTAINTY and UNCERTAINTY. In the former situation cultivator should have SUFFICIENT knowledge about his outcomes of the alternatives being considered, whereas in the latter situation he is uncertain about his outcomes.

While using traditional farm practices the farmer feels secured about the possible results and he can predict them by the virtue of his knowledge. However, past researches on adoption of improved farm practices have found that farmers perceive risk in the use of improved farm practices.

In the society it is believed that different individuals possess differing degrees of risk preference attitude. Most of the recent research work on the adoption of improved or recommended practices which involves risk concluded that personal, social and economic characteristics like age, socio-economic, status education and size of land holding will have either direct or indirect effect on their adoption.

This study concludes that personal, social and economic characteristics have no effect on the risk behaviour of the farmer. Environmental, psychological and cultural variables possibly may have a significant effect on the risk behaviour of the farmer which is not covered by the present investigation.

31. Flood Frequency Analysis

BY M.N. DAS AND R. KOLLI
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Flood Frequency analysis is conducted by using annual peak flow data at given sites collected over a large number of years. The procedure mainly consists of fitting on appropriate probability distribution and then using such distributions the probabilities of peak flows of different specified magnitudes are estimated. The reciprocal of such probabilities are known as return periods of the corresponding peak flow. The estimates evidently depend on the probability distribution used. A number of such distributions are in the use for this purpose. Prominent among these are the Gumbel's extreme value distribution, log-pearson type-III, Normal and the log-Normal distributions. More recently Box and Cox transformation are being used to normalise the distribution of such data and then utilise the properties of the normal distribution for estimating the return periods.

The Gumbel distribution has for the skewness parameter, $\sqrt{\beta_1}$. The value 1.1396 on many occasions the peak flow data do not satisfy this criterion. In such situations the data should not be analysed by fitting Gumbel distribution. One remedy in such situations consists of transforming the data according to the relation $Z=\frac{\lambda-1}{\lambda}$ where y is the peak flow and $\lambda(\neq 0)$ is a constant so chosen by trial and error that the transformed variate z has the skewness value of 1.1396 as required.

An attempt has been made in the present paper to exploit the above technique for estimation of return periods. Evidently, different values of λ have to be tried. For each value of λ the transformed variate z is obtained for each value of y. Next, the value of $\sqrt{\beta_1}$ is obtained from the transformed data. If this value differs from the required value then another value of λ is tried. This procedure is continued till the transformed variate yields the desired value of $\sqrt{\beta_1}$ As the calculations involved are too heavy, computer help is needed for obtaining the appropriate value of λ through trial and error facilities. A computer programme has accordingly been written for the purpose. The technique has been illustrated by analysing real data obtained from several sites.

32. High Yielding Varieties Programme—Regional Assessment Based on Different Indices

BY S.K. RAHEJA, A.K. BANERJEE AND P.C. MEHROTRA
I.A.S.R.I., New Delhi

For judging the success of high yielding varieties programme and the extent to which it has contributed towards the improvement in the productivity, production and profitability in different regions in the country, different indices of additional yield, area, production and profit were studied with the help of data for rice crop collected under the project entitled "Sample surveys for methodological investigations into high yielding varieties programme" for the year 1975-76. The four indices worked out were the yield index defined by ratio of additional yield of high yielding varieties over the local varieties to the yield of local variety, the area index defined by the ratio of area under high yielding varieties to the total area under the crop, the production index defined by the ratio of the production from high yielding varieties to the total production of rice crop and the profit index defined by the ratio of additional profit obtained with high yielding varieties over that of the local varieties to the additional investment on the cultivation of high yielding varieties. Data were taken for 22 districts spread over 12 States belonging to three regions namely, the north, the east and the south. In the north India, results of six districts from three States of Punjab, Haryana and Uttar Pradesh showed that there was high correlation between yield index and the area index, in eastern India results from 8 districts in the five States namely, Assam, Bihar, Madhya Pradesh, Orissa and West Bengal showed that while the yield index was fairly high, the area index was rather low; while in the south India with 8 districts in the four States of Andhra Pradesh, Karnataka, Kerala and Tamil Nadu, the yield index was rather low but the area index was quite good. The profitability of cultivation of high yielding varieties was quite high in the northern region, low to moderate in the eastern region except Assam where it was quite high and moderate to high in south India. There was thus a need for a greater extension effort in the eastern region for ensuring a greater coverage under the HYVP as well as a proper profit margin for the grower.

33. A Methodological Study of Marketable Surplus of Wheat in the Union Territory of Delhi

BY S.K. RAHEJA, P.C. MEHROTRA AND K.K. TYAGI
I.A.S.R.I., New Delhi

A number of studies have been carried out in the past to investigate the relationship between marketable surplus and the

total production of food grains, the farm and family size, the farm income, etc. During the past two decades there has been a good deal of emphasis on achieving higher food grain production by adoption of improved agricultural technology including high yielding varieties of major cereals and improved seeds of a number of other crops. To examine the type the relationship most suitable for arriving at the marketable surplus under the changed agrarian system and how this relationship varied over different holding size classes, data on marketable surplus and total production of wheat crop collected under the scheme "Pilot sample survey to study the impact of new technology on crop production, its disposal and employment in agriculture in Delhi State" were studied.

A number of models *viz.* linear, quadratic, square root and Cob Douglas were tried for different holding size classes as well as at the aggregate level. The quadratic function was found to be the most suitable model both in different holding size classes as well as at the aggregate level accounting for 84-99 per cent of the variation in the marketable surplus in different holding size groups and 98 per cent for the overall sample. The coefficients of linear and quadratic terms were both positive for almost all cases showing that the marketable surplus was relatively higher in larger holdings. The marketable surplus per hectare also increased with the increase in the holding size. This was mainly because the small holdings retained a greater portion of their production for own consumption compared to the larger holdings.

34. A Study of Price Behaviour of Vegetables in Delhi—Use of Fractile Analysis

BY RAVENDRA SINGH AND PADAM SINGH
I.A.S.R.I., New Delhi

Indian Agricultural Statistics Research Institute undertook a project entitled "A pilot sample survey to evolve suitable sampling methodology for estimation of price spread and losses in the marketing of vegetables in Delhi", to estimate the share of different inter-mediaries operating in the marketing of vegetables in Delhi to the consumers rupee spent and to ascertain the explaination of the intermediaries about the losses. A lot of valuable data have been collected on the wholesale, semi-wholesale and retail prices for the important vegetables for the period Jan.-Dec., 1977 under this project. It is important to study the difference in the behaviour pattern/price behaviour of retail prices with the wholesale prices of evgetables at two different points of time.

The present study aims at testing the behaviour pattern of retail prices with the wholesale prices for the period April-June, 1977 and Oct.-Dec., 1977 for three important vegetables *viz.*, Brinjal, Tomato and Lady's finger.

Fractile graphical analysis and fractile analysis have been used for the present study to test the difference in the behaviour pattern of retail prices with the wholesale prices for the two periods. It has been observed that the behaviour pattern in significantly different for the periods April-June, 1977 and Oct.-Dec., 1977 for all the three vegetables.

35. Use of Orthogonal Transformations in the Study of Designs for Mixture Experiments

BY M.S. RAMACHANDRA MURTHY AND J.S. MURTHY
Osmania University. Hyderabad

Designs for experiments with mixtures were introducted by Scheff'e (1958, 1963) for the study of the response surface in a multicomponent system in which the response depends on the proportions of the components present. The factor space in such n component systems is a regular $(n-1)$ dimensional simplex. Methods of construction of experimental designs for mixture experiments in n components using complete and incomplete factorial designs and rotatable designs in $(n-1)$ factors have been developed making use of orthogonal transformations (Murty 1966, Thompson and Myers 1968). In fitting response surface models for such n component mixture experiments one can easily fit a model in $(n-1)$ independent factors using the symmetrical properties of the factorials and then pass on to a corresponding model in n mixture components. In this paper the relationships between the estimates of parameters of the resulting models when linear and quadratic models are used for estimating the response surface are derived. Aspects of representation of factor space by designs through these transformations are considered. Expressions for the optimality criteria (A optimality, Doptimality) of the designs are also obtained.

36. On Mixture Experiment with Process Variable

BY S.P. SINGH AND M. PRATAP
J.V. College, Baraut

In mixture experiments Scheffe suggested two types of factors, *viz.* one containing the mixture components having direct bearing on the product under investigation and the other a set of factors which may influence the product but does not form any essential ingredient of the product. The latter type of factors is known as

process variables. Scheffe, Murthy and Das (1967) suggested suitable designs and the method of their analysis for mixture experiment with process variable. In the present investigation a method of construction of designs for mixture experiments with process variable has been investigated. This method essentially leads to a fraction of the designs suggested by the above authors and as such proves more economic. Method of analysis of these designs has also been given.

37. Construction of Partially Balanced *n*-Ary Designs Using Difference sets

BY V.S. SOUNDARA PANDIAN
University of Madras, Madras

Construction of incomplete block designs through the method of symmetrically repeated differences is now well recognised as a more powerful tool than other methods. This method is originally due to Bose (1939). Bose and Nair (1938) extended this method to Symmetrical PBIB designs and Sprott (1955) gave a general module theorem to construct all PBIB designs from a set of initial blocks. Following Tocher's (1952) definition of *n*-ary design, Murty and Das Rao (1968), Dey (1970), Nigam (1974), Saha (1975) and Morgan (1977) have constructed *n*-ary designs through various methods. Shaha and Dey (1973) constructed balanced *n*-ary design through a suitable 'generalised' difference set by developing a single initial block.

Utilizing the definition of PBT design given by Mehta *et al.* (1975), to partially balanced *n*-ary design, this present paper generalizes the binary General Module Theorem of Sprott (1975) and extends it to General *n*-Ary Module Theorem for constructing a new series of partially balanced *n*-ary designs from initial block or a set of initial blocks. First we consider the construction of PBT design from a given initial block of a PBIB design. Suitably selecting a set of initial blocks, we then proceed to construct many PBT designs of moderate sizes. Application of this method yields many more series of PBT designs. Construction of PBT designs when the number of treatments is an odd prime is studied in detail. Utilizing these results, some more useful PBT designs are constructed. Finally a single initial block is developed to construct a general class of partially balanced *n*-ary block designs. Further constructions are in progress under this direction.

38. Lay-out of Horticultural Crops for Spacing Experiments

BY S.V. MAHAJAN AND V.R. KARANADIKAR
Mahatma Phule Krishi Vidyapeeth, Rahuri (Mah.)

The horticultural crops are planted with wide spacing which requirs large area for experiments of such crops. It is suggested to have close planting at initial stage throughout the field and super-imposition of different prunning techniques and uprooting the filler plants at the competition stage of plant growth. Due to suggested lay-out, advantages of close planting *e.g.* increase in yield at initial stage, maintainance of suitable microctimate, etc , can be achieved. Moreover, it may be possible to draw conclusions of spacing requirements at different growth stages of widely spreading horticultural crops like chikku, guava etc.

39. On Construction of Balanced Ternary Block Designs

BY B.L. MISRA AND G.R. MAKAN
J.N. Agriculture University, Jabalpur, (M.P.)

Tocher introduced balanced ternary block designs (BTBD) and constructed some of them by trial error method. Methods of constructing BTBD are given by Murty and Das (1967), Das and Rao (1969), Dey (1970). and Saha and Dey (1973). Recently Saha (1975) have constructed some series of BTBD when $2K<V$ and $K<V$ with reasonably smaller number of blocks which are useful as incomplete block designs. We construct here two series of BTBD by method of differences when the number of treatments are product of twin power primes with $K<V$, which are not presented by Saha (1975). Further we construct, three series of BTB designs when the number of treatments are an odd prime power. Here one series of BTBD have $K<V$ and others have $2K<V$. These designs may be useful as incomplete block designs but have larger number of blocks.

40. Relationship Between Minque and ANOVA Estimators of Variance Components for Balanced Data

BY G. RADHAKRISHNAN
University of Madras, Madras.

For mixed and random linear models, estimation of variance components is an important problem for geneticists. The data collected for the estimation are of two kinds, balanced data and unbalanced data. Balanced data refers to the situation in which the submost cells in the design have equal number of observations. Searle (1971) in his review paper describes ANOVA methods of

estimating the variance components for balanced data. In this method, the traditional method of estimating error variance is extended to the estimation of other components of variance. Equating the mean square errors of different factors to their expected values which are linear functions of variance components, equations involving unknown variance components and known mean square errors, are established. Solving these equations variance components are estimated.

However Rao considers that the Anova method is based purely on intution and does not have a theoretical basis. He has suggested an entirely new method of estimating the variance components which is applicable to all experimental situation. It is named as minimum norm quadratic unbiased estimation (Minque). It may be worthwhile to investigate whether both the procedures will lead to the same estimates for variance components or different estimates for balanced data. With this view investigation has been done for specific models and the results are presented.

41. Idempotent Matrics Associated with Partially Balanced Incomplete Block Designs

BY A.S. ARYA, *R.K. College, Shamli* (*Meerut University*)
AND
PREM NARAIN, *I.A.S.R.I.....New Delhi.*

The paper deals with a general method of evaluating the idempotent matrices of NN' where N is the incidence matrix of a 2-plot block PBIB design with any association structure. It is known that for a PBIB design with m-associate classes, the inverted matrix can have at the most $m+1$ distinct elements. The method consists in working out such $m+1$ distinct elements of the above matrices. These matrices have been worked out and listed for : .....Latin Square type designs with i constraints ; Group-Divisible two, three and m associate designs ; Triangular and Extended Triangular designs ; Rectangular designs ; Right Angular and Generalised Right Angular designs, and Simple Rectangular Lattice designs.

42. Pattern of Balanced Incomplete Block Designs Having a Missing Block

BY P.D. PURI
Haryana Agricultural University, Hissar.

Block designs are widely used in many fields of Physical Sciences. A wide range of BIB and PBIB designs are available in Literature. Generally in most of the experiments in Physical Sciences the blocks are natural units and it is quite common in such experiments that entire block is missing (*see* Zelen, 1954). In the present paper an attempt has been made to examine the pattern of BIB

designs when one complete block is missing. It has been established that a BIB designs with one complete missing block is Partially Efficiency-Balanced designs with three efficiency classes. All possible contrasts along with the respective losses have been given. A simplified Analysis of these designs has been given.

43. New Concepts in Systematic Designs for Spacing Experiments of Horticultural Crops

BY M.R. GAIKWAD, A.V. PATIL AND E.D. YADAV
Mahatma Phule Krishi Vidyapeeth, Rahuri-413 722 (Maharashtra).

Due to present high land values production costs and need for early monitary returns, there exists a world-wide trend in horticulture towards higher density plantings. Having this consideration in view inyestigations were undertake on guava, pomegranate and grape at Mahatma Phule Krishi Vidyapeeth, Rahuri (Maharashtra). The different concepts in layout of horticultural crops and systematic designs for spacing experiment are discussed.

44. Study of Plot-Size in Relation to Homogeneity of Error Variances in Groups of Experiments on Paddy Crop

BY P.P. RAO
I.A.S.R.I., New Delhi.

Magnitude of error variances in field experiments in relation to the plot-size has been studied quite extensively by several authors and suggestions for suitable plot sizes were put forwarded for different crops and soil groups. However, the relationship between the plot-size and the consistency of error variances in group of experiments carreid out on the same experimental units in different seasons has not been studied earlier. Due to the interaction if micro-biological factors in the soil with the weather factors like maximum and minimum temperatures, rainfall, etc., the magnitude of the error is affected and this interaction appears to be one of the most important causes of heterogeneity in error variances in group of experiments. In this paper the results of investigations into 'Plotsize-Homogeneity of error variances' relationship are presented by studying the data of about 390 groups of experiments on paddy crop.

45. Fixing the Number of Replications Required in a Simple Analysis of Variance Problem

BY K.R. SATYAMURTHI
Forest Research Institute and Colleges, Dehra Dun.

Fixing the number of replications of each treatment for a simple analysis of variance is studied. In this paper a practical way of solving this problem is given. Useful upper and lower limits for the replications are derived. An example is worked out to varify the results.

46. An Application of Analysis of Covariance Technique in Mating Design

R.C. HASIJA, *HAU, Hissar* AND K.C. GEORGE *KAU, Trichur*

Generally the analysis of the mating designs, especially that of the diallel mating designs, is being carried out without exploiting the relationship of the main characteristic under study with that of the other characters which are independent to the varieties under trial and at the same time contributing considerably to the main character. It is of interest to note that these characters are influencing the main character to a considerable extent. Hence, it is essential to eliminate these types of influences before analysing the main character under study to make a proper test of significance as well as to get a reasonable estimate of the general and specific combining ability. The present investigation was aimed at :

1. To derive a theoretical procedure for the analysis of covariance of the diallel cross data by taking one concomitant variable under method IV model I of Griffing (1956).

2. To derive the estimate of general combining ability and specific combining ability effect by introducing a concomitant variable in the method IV, model 1 of Griffing (1956).

3. To compare the efficiency of analysis of variance and analysis of covariance of diallel cross data under method IV, model I of Griffing (1956).

In the present investigation analysis of covariance model corresponding to the method IV, model I, Griffing (1956) was taken as

$$y_{ijk}=\mu+g_i+g_j+s_{ij}+b(x_{ijk}-\bar{x})+e_{ijk}$$

The parameters of the above model have been estimated by the method of fitting constants. The various sum of squares and the variances of the different comparisons of the estimates of general and specific combining ability effects were derived. It was found that the variances of the estimates of different effects depend upon the concomitant variable and it will not be a fixed value as in the case of analysis without adjustment with the concomitant variable. Hence for comparison purposes, average variance of the estimate of the various comparisons of the effects were calculated. The efficiency of analysis of covariance over the analysis of variance was worked out. The theory has been illustrated by taking a data from the agricultural field.

47. Multi-Triangular Sampling Plans for Partial Diallel Crosses

BY C. SUBBA RAO, *AICIRP, Rajendra Nagar, Hyderabad*
AND
PREM NARAIN, *I.A.S.R.I., New Delhi.*

The partial diallel crossing system was initially dealt by Kempthorne and Curnow (1961), Fyfe and Gilbert (1963). Fyfe and Giblert (1963) constructed such crosses with the help of 'triangular' designs in which the number of lines could be of the form $\frac{p(p-1)}{2}$ where 'p' is an integer. Narain *et al.* (1974) gave the procedures of constructing and analysing partial diallel crosses based on extended triangular design, where the number of parental lines is of the form $p(p-1)(p-2)/6$ with 'p' as an integar greater than 3. In the present investigation, partial diallel crosses based on multi-triangular design (MTD) have been constructed and analysed when the number of parental lines is of the form $p(p-1)(p-2)(p-3)/24$ with 'p' as an integer greater than 4.

All four designs developed on the basis of the multi-triangular sampling plans involved in four different variances and were efficient than those delt by Kempthorne and Curnow (1961).

48. Generation Matric Method of Studying Inbreeding Systems—III

BY K. C. GEORGE
Kerala Agricultural University, Trichur.

The problem of correlation between relatives in the case of sex-linked gene has been studied by several authors like Fisher (1943), Haldane (1955), Li (1955), Karde (1960), George and Narain (1975) and George (1978). Expecting Korde, George and Narain, none else made use of the generation matrix to calculate correlation between relatives. But the problem of studying various full-sib and parent-offspring pairs under continuous system of parent-offspring mating in the sex-linked gene case has not been completely explored by these authors. In the present investigation a study of the joint distribution, as well as the correlation between sister-sister pairs, sister-brother pairs and brother-brother pairs were studied. Also a study of the joint distribution and correlation between the parent-off spring pairs, such as mother-daughter pairs, mother-son pairs, father-daughter pairs and father son-pairs were made. Finally a comparative study of the correlation of the various pairs under this system was also made. It was found that, among the full-sib pairs sister-sister

correlation was found to be the highest for all generations of parent-offspring mating even though all the correlations tends to unity, when the number of generations increases indefinitly large. Similarly in the case of parent-offspring pairs father-daughter correlation was found to be the highest.

49. Effect of Selection on Repeatability Estimates of Lactation Milk Production of Indian Dairy Cattle

BY M. GURNANI, G.K. SACHDEVA AND D.S. BHATNAGAR
National Dairy Research Institute, Karnal (Haryana)

Animal breeders use the estimate of repeatability of milk production to evaluate the Expected Producing Ability of animals. Estimates of repeatability are expected to be affected by selection and breeding management among other factors. In order to estimate the effect of selection of cows on milk production, intra cow correlations among repeated records were calculated separately for the groups (m) of cows retained for two, three, and so on upto six lactations. This was done separately for the Tharparkar and Sahiwal cattle maintained at National Dairy Research Institute, Karnal. As the number of records of the cows, on which the repeatability is based, affects the estimate of repeatability so to avoid it, repeatability was calculated separately taking minimum (k) of 2, 3 and so on upto eight records for each of the above groups. For the Tharparkar herd, it was found that the repeatability estimate of milk production did not change significantly among different data sets (k) within groups whereas for the Sahiwal herd it was found that repeatability estimate tended to decrease with the increase in intensity of selection.

50. Power of Analysis of Variance Test in Animal Experimentation

BY S.N. BAJPAI, A.K. NIGAM AND A. DEY
I.A.S.R.I., New Delhi

In the present paper results of 1200 experiments pertaining to animal nutrition were examined. Distribution of coefficient of variation for various categories of experiments pertaining to growth, milk yield, wool production, digestibilities of nutrients, balance study etc.. was formulated with respect to species, breed and category of animal. Dimensional studies like magnitude of growth at various stages, milk production at stages and at number of lactations were made. Further for various expected alternative hypotheses based on dimensional studies, power of analysis of variance test for different number of animals and treatments available for experimentation have been presented for C.R.D., Randomised block and latin square designs.

51. Association between blood group antigenic factors and biometrical traits on the basis of phenotypic relationship regression approach.

BY H. P. SINGH
I.A.S.R.I., New Delhi

An alternate approach of regression technique was developed for studying the association between blood group antigens and the biometrical traits on the basis of phenotypic relationship. The data on blood grouping and biometrical traits pertaining to four important indigenous breeds of cattle, namely, Hariana, Tharparkar, Sahiwal and Red Sindhi and three breeds of buffaloes, namely, Murrah, Nili and Surti was analysed. The multiple regression coefficient and the point biserial correlation between the phenotypic expression of the two traits showed that the amount of variation explained by the blood group factors is of very low order in all the breeds. The forecasting efficiency of the immunogenetic traits as regards the determination of the biometrical traits was found about 2 per cent in both the cattle and buffaloes.

52. Fan Design :—Use and Limitation

BY N. M. PATEL AND R. M. PATEL
Gujarat Agricultural University, Anand Campus, Anand

The present investigation was undertaken to examine relative utility of the fan design (Nelder, 1962) in relation to the randomised block design and the split plot design for spacing experiments and also to assess the influence of border effect and the existence of bias, if any, using cotton variety IAN 579-188. The fan design which permits single row plots, can be used for spacing trial on a crop with monopodial growth habit in place of systematic or random arrangements with equal or unequal row plots. However, it yields biased estimates of the treatment means.

53. Discriminatory Analysis in Wheat and *Triticale* with the help of Diallel Cross Data

BY M. S. BATRA & PREM NARAIN
I.A.S.R.I., New Delhi

The data on 7×7 diallel cross in wheat and 8×8 diallel cross in *triticale* used by Subharao (1972) were further analysed to demonstrate the use of discriminant function which represents a plant type for discriminating between the two crops. Five characters *viz* ; number of days to flower, number of spikelts per ear, plant height,

1,000 grain weight and yield per plant which were common to wheat and *triticale* crops were chosen for the study. A linear discriminant function involving these characters was obtained by maximising the difference between wheat and *triticale* representing the two different populations. Using this function, discriminant scores were obtained for each of the observation in the complete diallel crosses for the crops. Diallel tables, so obtained were analysed. Heritability eatimates of dircriminant score were worked out alongwith their standard errors.

It was found that the discriminant score, representing the plant type, was largerly determined by the plant height and the number of spickelets per ear. The contribution of these two characters to the D^2—statistics, together amounted to about 95 per cent. It was concluded that, so far as wheat crop was concerned, the lowest discriminant score could be judged the best on the scale of disirability. General combining ability effects of lives as well specific combining ability effects of pairs of lines were, in general found to be highly significant in almost all the cases. Heritability estimates of the discriminant score both for wheat and *triticale* were found to be quite appreciable, being 0.48 and 0.501 respectively.

54. Forecasting of Cashew Yield

BY M. V. GEORGE AND K. VIJAYKUMAR
C.P.C.R.I., Kasaragod

Multiple regression model of the form $y=b_0+\Sigma' bi\ xi$ were fitted for forecasting the total yield ($\dot{y}$) of a cashow tree based on biometrical characters, *viz.* number of shoots (x_1) number of panicles (x_2), and number of nuts in all stages of maturity (x_3), from an area of $\frac{1}{2}m \times \frac{1}{2}m$ each from four directions, N, E, S and W in the periphery of the canopy, total counts of nuts in the whole tree (x_4), average weight per nut (x_5), and canopy area (x_6). Two formulae were suggested. Taking single spot observations on the above biometrical characters at the first peanut stage the forecast can be made by the equation $y=-1.402+0.022\ x_1-0.029\ x_3+0.006\ x_4+195x_5+0.004\ x_6$ with an $R^2=0.523$, where y is astimated in kgs. By this, the yield forecast can be made one to two months in advance of the first harvest which extends to 3-4 months. Another is by taking 3 observations at monthly intervals starting from the first peanut stage, the yield forecast can be made using the equation $y=-0.716+0.003\ x_1+0.019\ x_2-0.048\ x_3+0.014\ x_4+0.081\ x_5+0.001\ x_6$ ($R=0.810$) where x_1, x_2, x_3 and x_4 are the average values of the above characters recorded at the first peanut stage, one month and two months after.

Out of these characters count of total number of nuts (x_4) alone was found to contribute substantially to the yield. Taking the everage of three monthly observations of the total number of nuts starting from the first peanut stage, the total yield is estimated with the equation $y=0.1739+0.0117x$.

55. Disparities in Growth Rates of Area, Production and Productivity for some Major Crops in Maharashtra State and Marathwada Division

BY P. R. WAGHMARE, G. M. POTEKAR, D. D. SHINDE
MAU, Parbhani

There is convincing evidence that due to improved agricultural production technology and irrigation facilities the productivity of important crops have been increased. Hence to measure the changes in area,/production and productivity time series data from 1960-61 to 1975-76 for Maharashtra State and Marathwada Division (Aurangabad, Purbhani, Nanded, Bhir and Osmanabad) for some important crops, like, rice, kharif jowar, rabi jowar, wheat, total jowar, sugarcane, cotton, gram, tur, groundnut and sessamum were analysed for its growth by fitting linear and compound growth curves, the risk in area, production and productivity were estimated for the study period. The results revealed that the productivity of State was higher than that of the division except rabi jowar. The productivity of all the crops declined in the state and division except rice, bajra, wheat in the state and wheat and sugarcane in the division.

The area under cotton and groundnut and rabi jowar significantly declined in the state and division. The production of sugarcane significantly increased for the State and Division whereas the increase in wheat production was significant for the state and non-significant for the division.

High risk for production and productivity were observed for the division as compared to the State.

56. Changes in Cropping Pattern of Nanded District (Maharashtra State)

BY P.R. WAGHMARE, D.D. SHINDE AND G.M. POTEKAR
MAU, Parbhani

Cropping pattern of the region is the most important factor in deciding the economic status of the region, which is influenced by number of factors.

Cropping pattern largely depends upon the irrigation level, quantity of rainfall and improved technology.

Taking into view these facts, an attempt has been made to study the shift and deviation in cropping pattern of Nanded district. The data of area for twenty two crops grown in Nanded district from the year 1960-61 to 1974-75 was analysed by using non-parametric statistics—such as Spearman's rank correlation coefficient and Kendall's coefficient of concordance. The deviation is area were worked out by using linear and compound growth curves.

The results of the study revealed no shift in cropping pattern of the district for each pair of years from 1960-61 to 1974-75 seperately as well as for the overall period of 1960-61 to 1974-75. Secondly, the major crops, like, kharif jowar, rabi jowar and cotton occupies nearly 70 per cent of the average gross cropped area and virtually there was no change in the ranking of these crops throughout the period of study. Therefore, the cropping pottern of the district was studied excluding these major crops. It was also observed that the cropping pattern did not show any shift for each pair of years as well as for the overall period of study. In general eventhough there was no change in cropping pattern it was observed that the area under rabi jowar significantly declined with significant increase in area under turmeric, banana and sugarcane (cash crop), tur, mung and udid (pulses) and groundnut, safflower, sesamum (oilseeds).

57. Studies on alternate cropping for weather abberations in *kharif* season

BY N.Y. PALIMKAR, P.G. WAGHMARE AND S.V. RAIKHELKAR
MAU, Parbhani

A field experiment was conducted at Dry Farming Research Station, Marathwada Agricultural University, Parbhani during 1977-78 and 1978-79 to study the possibility of taking an alternate crop under the different weather abberations for Marathwada region. The pooled analysis of two years data was carried out and the results indicated that sorghum equivalent grain yield due to the treatment combination of 30th June sowing with Red gram type-21 gave significantly highest sorghum equivalent yield over other treatment combinations followed by sorghum equivalent yield of sunflower EC-68414 and Sorghum CSH-6. 15th July sowing with suflower and sorghum gave significant highest sorghum equivalent yield.

For the 30th July sowing, crops, like, Redgram and Finger Millets gave sorghum equivalent grain yied at par.

If the monsoons are delayed beyond 30th July it was not economical to show any kharif crop for this region.

58. Analysis of data Relating to Experiments on crops having Multiple Pickings.

BY H.V.L. BATHLA AND K.S. KRISHNAN
I.A.S.R.I., New Delhi

The data partaining to individual pickings yield are recorded at research stations. However, it has been observed that the statistical analysis of the data are performed, generally, on total yields only. For deeper investigations of treatment effects including coefficients of variation of different pickings as also of total yield and relative contribution of each picking to total yield, data collected on experiments (cultural and manurial) on cotton crop at Gujarat Agricultural University, were utilized.

On examination of coefficients of variation for different pickings and total yield it was observed that in all the years for both the experiments the minimum coefficient of variation was obtained in case of total yield. In cultural experiment the major portion of yield was obtained in the first picking whereas, in the manurial experiment, more yield was obtained after first picking. This difference may be due to different varietal characters. The difference in yield between years for both the experiments were significant. The stability of the performance of different treatments with changing environment has also been measured by Eberhert and Russell (1966) method.

59. Response of Sorghum Fodder Crop to the Application of Nitrogen.

BY BHUPAL SINGH, S.B. AGGARWAL AND V.D. MUDGAL
National Dairy Research Institute, Karnal

The paper deals with the study of response of sorghum fodder crop to the application of Nitrogen fertilizer applied at different levels. The three varieties of sorghum and three methods of application of nitrogen were JS-260, Ujjain-8 and Vidisa 60-1 ; and soil, soil+spray and spray respectively. It was observed that the green yield of sorghum was highest for Vidisa 60-1 compared to other varieties. The analysis of variance test showed that the methods were significantly different. The linear, Cobb-Douglas, quadratic and Mitcharlitch-type of response curves were fitted for each variety and different methods.

60. Agricultural Production Trend and Its Components In Marathawada Region of Maharashtra State.

BY D.T. BHARAMBE.

Operational Research Project, Wardha (Maharashtra).

An attempt has been made to study the trends in Agricultural output (of 11 major crops: 8 foodcrops and 3 nonfood crops) in Marathawada for the period 1957-58 to 1974-75, Pre HYV period (1957-58 to 1964-65) and Post-HYV period (1965-66 to 1974-75) and contribution of three important components to growth of agricultural production *viz.* area, yield per hectare and cropping pattern, with a view to finding out the extent to which HYVs and Fertilizer application made their impact on agricultural output of the region and the components responsible for it.

A comparative study, on compound growth rate has been made and it is observed that aggregate the output of all crops decreased, increased and decreased at the rate of 2.30, 1.60 and 7.10 percent per annum during the period of 1957-58 to 1974-75, Pre HYV period and Post-HYV period respectively. More or less similar pattern is observed with respect to foodgrain and non-foodgrain production. It is also observed that the major component responsible for decrease in Agril. Production of all crops (2.30) during 1957-58 to 1974-75 was yield per hectare. While in Pre HYV period the increase in production was mainly due to increase in yield per hectare (68.75%) and favourable cropping pattern (25.00 per cent). In Post-HYV period the decrease in production was mainly attributed to decrease in yield per hectare (83.10%) and decrease in area (14.08%). This was due to occurrence of drought in the years 1970-71, 1971-72 and 1972-73.

61. Impact of High yielding varieties and other improved practices in Jaipur District.

BY LAJPAT RAI, *HAU, Hissar*

AND

S.K. RAHEJA, *I.A.S.R.I, New Delhi*

The impact of high yielding varieties of the cereals and the use of the scientific agricultural production Technology has been studied in Jaipur district during 1970-71. The simple ratio estimate was used for estimating the area under high yielding varieties of wheat end Bajra and it was found that standard error and bias of the estimates was fairly small.

The proportion of area under high yielding varieties was relatively large for small farmers and decreased with the increase in holding

size. The varieties commonly grown by the cultivators were HB-1 for bajra and S-308 for wheat. Bajra was grown unirrigated more by the large farmers while cultivators with small holding applied irrigations and in some cases fertilizer too. However, the wheat crop was generally irrigated and fertilizers application was at the recommended rate in most of the cases. The use of improved practices was more marked in wheat than bajra due to the fact that rabi crop is usually less exposed to the vagaries of weather.

The average amount of loan taken from non-Government sources was much higher than that taken from the Government agencies, which shows that the conventional system of borowing money from money lender, etc., is still fairly common particularly among cultivators who required large amount of money for which he is usually unable to satisfy the gurantee conditions laid by the Government, Bank, etc.

62. Functional Relationship of Nitrogenous Fertilizer Doses and Sugarcane Yields in the Punjab State

BY JASWANT SINGH CHAMAK AND P.L. MEHRA
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The results of the present study refer to the data of varietal-cum-manurial trials taken on sugarcane crop during 1970 and 1971 in Gurdaspur district of Punjab. The cane-growers as well as extension agencies are supposed to know optimal economic doses of fertilizer to get maximum returns from this commercial crop.

Production functions indicating input-output relationship for each variety of sugarcane under examination were worked out to study the response of cane-output to the use of nitrogenous fertilizer at various levels of application. An attempt was also made to determine the optimum and yield maximizing levels of input as well as the rates of marginal productivity for each of the varieties. Linear and quadratic forms of production functions were derived.

The results of production functions showed that the maximum expected yields for Co. 975, Co. L. 29 and Co. 1158 turned out to 295 qtls., 219 qtls. and 333 qtls., on an average, in response to the use of 217 lbs., 192 lbs. and 253 lbs. of nitrogenous fertilizer, beyond which every added unit of this input would result in an increase in the net loss. The maximum expected yields of the three varieties at the estimated yield maximising doses of nitrogenous fertilizer declined during 1971 over 1970. The decrease in cane-output at the profitable

optimum doses of the input factor was more in respect of Co. L. 29 compared to Co. 975 and Co. 1158. The main cause of this decline was attributable to the non-availability of water for a couple of weeks due to some mechanical breakdown of the farm tubewell.

The average profitable optimum doses of nitrogenous fertilizers were 210 lbs., 185 lbs. and 247 lbs. for Co. 975, Co. L. 29 Co. 1158 varieties of sugarcane respectively, insofar as the transformation rate, $\frac{dy}{dN}$, was reduced to the nitrogen-sugarcane price ratio in each case. Beyond these levels, the cane-growers would, though, get more returns upto the yield maximising levels, yet each additional unit of fertilizer would add more to their total expenditure than to their total returns.

Co. L. 29 variety of sugarcane started negative response of nitrogen use earlier than the Co. 975 and Co. 1158 varieties, which indicated that the latter varieties exhibited greater capacity in absorbing fertilizer nutrients resulting in higher returns. The reason of low yield in case of Co. L. 29 might be attributed to its early maturing character as well as its thin canes.

Among the three varieties, the maximum returns were obtained from Co. 1158 and also this variety experienced the lowest decline in the yield during 1971 over 1970. To sum up, it was economical to grow Co. 975 and Co. 1158 midseason varieties which were good germinators with non-lodging habit, fairly tolerant to frost and short dry spell as well as moderately resistant to red rot, smut and insect pests.

63. A Study on Fluctuation of areas of Jute & Mesta in Eleven Districts of West Bengal (from 1957-58 to 1977-78)

BY B.K. SAMANTA

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The eleven districts of West Bengal have been considered because these districts are main contributor in production of jute and mesta in this State. Twenty-one years (*i.e.*, 1957-58 to 1977-78) data have been consereed for this study. The correlation coefficient between the area of jute and mesta and that of Aus paddy is negative in each district. Four districts (24-Parganas, Nadia, Hooghly & Howrah) show significant negative correlation coefficient at 1% level of significance and three districts (Midnapore, Jalpaiguri and Coochbihar) show significance negative correlation coefficient at 5% level of significance and remaining four districts (Murshidabad, Burdwan,

Malda and West Dinajpur) show negative correlation coefficient but not significant. The highest variability (48.80%) in area of Jute and Mesta can be explained by the variability in area of Aus paddy in Howrah district and the lowest variability, (*i.e.*, 4.82%) in area of jute and mesta can be explained by the variability in area of Aus paddy in Burdwan district. The cultivators may shift to Aus paddy cultivation for sudden fall in price of jute and mesta in last year, or increase in paddy price or sudden demage of Aman paddy in previous year.

The remaining unexplained variation in area of jute and mesta may be due to wether condition and some other causes. The variability in area of jute and mesta due to weather condition will be a separate study.

64. Studies on Performance Characteristics in Cattle Maintained Under Village Conditions

BY R.P. SINGH AND K.C. RAUT
I.A.S.R.I., New Delhi

Data obtained from a large scale sample survey conducted by I.A.S.R.I. in I.C.D. area, Bikaner (Rajasthan) during 1975-77 were analysed for Non-descript and Rathi cows, to explore the possibility of obtaining the performance characteristics of cattle maintained under village conditions. The average age at first calving worked out to 58.6 ± 0.97 months for N.D. cows and 60.5 ± 1.12 months for Rathi cows. The overall calving interval and lactation length worked out to 556 ± 10 days and 371 ± 7 days respectively for N.D. cows and the corresponding values for Rathi cows were 617 ± 13 days and 431 ± 10 days. The averages of the dry period were 226 ± 9 days and 198 ± 12 days for N.D. and Rathi cows respectively. Analysis of lactation yield records did not reveal any marked influence of order of lactation and season of calving on milk yield. Rathi cows were significantly superior to that of N.D. cows in respect of milk yield. Age at first calving also did not show any significant difference on first lactation yield. Mortality rate was 2.7% for Non-descript calves and 6.2% for Rathi. The mortality rates among milch stock was of the order of 5.8%.

65. Estimation of Loss in Milk Yield of Animals due to Mortality

BY K.C. RAUT AND SHIVTAR SINGH
I.A.S.R.I., New Delhi

Much animals die in various age groups and it different order and stages of locations. Such untimely death results in loss in milk production and thereby an economic loss to the producers. Attempts

have been made to work out the extent of loss in production due to mortality utilisingdata collected by the I.A.S.R.I. through methodological investigations on livestock in different areas (Hissar district of Haryana, Krishna delta area of Andhra Pradesh, Dhulia region of Maharashtra, I.C.D. areas in Bikaner of Rajasthan, and in Bhopal of Madhya Pradesh). The study has shown that the rate of mortality was 4.6 to 5.9 per cent for cows and 3.0 to 6.5 per cent for buffaloes in the area studied. The average age at death varied from 115 months to 143 months for cows and 113 to 140 months for buffaloes. The percentage of loss in milk production was worked out to be of the order of 1.9 to 3.2 per cent for cow milk and 1.7 to 3.4 per cent for buffalo milk.

66. Accelerated Agricultural Development through extension

BY BHAGAT SINGH

I.A.S.R.I., New Delhi

Agricultural extension under "Benorplan" and television under Satellite Instructional Television Experiment (SITE) have been the recent additions to communication system with a view to give a fillip to agricultural development. Both the systems served chambal command area of Kota district and adjoining areas of Bundi district of Rajasthan either in combination with or independent of each other. The SITE is now closed and the interest lies in the study of its effectivity in conjunction with agricultural extension under the three systems *viz.*, (*i*) Agricultural extension (*ii*) Television Non-command area and (*iii*) Agricultural extension plus television.

The study is based on data collected by the planning commission during June, 1976 (when SITE was in operation) from a sample of 144 farmers spread over 12 selected villages—4 villages served by each system.

Yield rates of wheat for different areas during the year, increase in yield rate over preceding year and Economics of the programme have been studied.

It emerges from the study that the benefits augment with the use of more developed system of communication whether it be through agricultural extension or through television. It sharpened when agricultural extension and television were intertwined.

67. A Methodological Study on Estimation of Straw to Grain Ratio in Wheat Crop

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One of the main sources of cattle feed in India is straw obtained mostly as a by-product of foodgrains. While reasonably accurate information on grain production of different crops is available, similar information on straw production is generally lacking. Also, as is well known, the straw to grain ratio varies not only from crop but also from one variety to the other for the same crop. This ratio may be influenced by a number of other factors like soil type, level of fertilizers used, irrigation, etc. For estimating the production of straw, therefore, the effect of these various factors would have to be taken into account. There is, thus, a need to develop a suitable method of estimation of straw to grain ratio for a district or a region which could be utilised for estimating the straw production with the help of the estimate of grain production which is generally available fairly accurately.

In this paper, an attempt has been made to develop suitable methodology for building up a reliable estimate of straw to grain ratio. For this purpose, different ratio estimators, namely, the conventional ratio estimator, the Hartley-Ross estimator and the geometric mean of ratios were investigated. The relative efficiencies of these estimators were studied with the help of data available from the crop estimation surveys conducted under the project "Sample surveys for methodological investigations into high yielding varieties programme" in Jalgon district of Maharashtra State during the years 1976-77 and 1977-78. It was found that Hartley-Ross estimator was more efficient than the other two. It was also observed that the straw to grain ratio was significantly higher for the local varieties than that for the high yielding varieties. The study also revealed that the ratio was higher under normal rainfall conditions compared to that under high or low rainfall for both high yielding and local varieties of wheat.