# ABSTRACTS OF PAPERS PRESENTED AT THE 31ST ANNUAL CONFERENCE HELD AT NEW DELHI, 16-18 DECEMBER, 1977

**1. *n*-Symbol Partially Balanced Arrays**

By M.L. Chandak and B.L. Misra
*J.N. Agricultural University, Jabalpur*

A method of construction of $n$-symbol partially balanced arrays of strength $\beta \geqslant 2$ is presented. The paper contains two theorems, generalising the results of Dey, Kulshrestha and Saha (1972, Annals Inst. Stat. Math. 24, 525-528). The second theorem is, in fact, more significant result, in a sense that it is for any strength $\beta \geqslant 2$.

**2. On Balanced Matrices**

By S.C. Gupta and Mrs. S. Gupta
*I.A.R.S, New Delhi-12*

A general class of balanced matrices are defined in this paper. These matrices are generalisations of the balanced orthogonal designs of Rao and generalised balanced matrices of Dey and Midha. In this paper we go further by relaxing the condition imposed on the types of elements a balanced matrix can have. Some methods of construction of these balanced matrices are discussed. Some remarks on the usefulness of these matrices are also made.

**3. A Note on Incomplete Multiresponse Design Problem**

By S.C. Gupta and M. Singh
*I.A.R.S., New Delhi-12*

Roy *et al.* (1971) have considered the theory of incomplete multiresponse designs. While analysing the data obtained from such designs, they have used a set of linear transformations so that the transformed data may fit into the general linear model of Multivariate Analysis of Variance. It seems that their transformation involves some arbitrariness at one place which is likely to give some misleading results. This note aims at the correction of such arbitrariness.

**4. Some Qualitative-Cum-Quantitative Designs**

By Basant Lal and G.V.S.R. Krishna
*I.A.R.S., New Delhi-12*

Experiments in which some of the factors are of qualitative nature while others are of quantitative nature are known as qualitative-cum-quantitative experiments.

In the past some investigations have been made for evolving designs for such experiments considering only one or two factors of qualitative nature connected to one factor of its quantity. In the present paper an attempt has been made to discuss the design and analysis of an experiment with three factors each at three levels of which one of the factors is of qualitative nature connected to the combinations of the rest of the two quantitative factors rather than that of the levels of the individual factor. In this design the 3-factor interactions gets only 2 degrees of freedom. The existing designs available for quantitative factors can be utilized for such type of situations also. It has been shown that one can use any one replication out of the four replications given for three factors each at three level experiment. Other advantage is that one can get information on all the important interactions.

**5. Ties in Fractional Paired Comparisons**

By S.C. Rai
*I.A.R.S. New Delhi-12*

Various models have been developed for analysing the data obtained from paired comparisons. Most of these models do not permit a judge for declaring a tie. Without going into details of merits or demerits of the models, it can be said that procedures which do not allow the possibility of ties, are not making full use of the information contained in the no-preference class. In the present paper, we propose a model when only a fraction of the pairs are considered and ties are permitted. Procedures for estimation of various parameters are discussed. The methods for testing the appropriateness of the model and combination of results for different experiments are given. Some of the procedures developed in the paper have been explained through a numerical example. The model is quite useful when the experimenter wishes to compare a new variety with existing varieties.

**6. Problems of Testing Proportionate Hypotheses**

By S.P. Singh and M. Pratap
*J.V. College, Baraut (Meerut)*

Normally inference is drawn from data collected, using different experimental designs by testing null hypothesis

$$t_1 = t_2 \text{ ——— } = t_v, \quad \text{where } t_1, t_2 \text{ ——— } t_v$$

are the effects of the treatment. But there are situations where other types of hypotheses are more meaningful. For example while discussing the analysis of qualitative-cum-quantitative experiments

Yates (1937) suggested some type of proportionate hypotheses. In the present paper a method of testing the hypothesis

$$\frac{t_1}{z_1} = \frac{t_2}{z_2} = \ldots\ldots\ldots = \frac{t_v}{z_v} = t$$

(a non zero constant which may be known or unknown), where $z_1$, $z_2 \ldots\ldots\ldots z_v$ are known constants and $t_1$, $t_2$ ——— $t_v$ are treatment effects, using data from different experimental design has been obtained. This type of hypothesis has been called proportionate hypothesis and $t$ is called as the constant of proportionality. In this paper we have discussed the three basic designs along with the incomplete block design. It will be shown that the present method has resemblance with analysis of covariance.

**7. A Multi-Type Branching Process**

By U.G. Nadkarni
*I.A.R.S, New Delhi-12*

A density dependent branching process model given in an earlier paper of the author (JISAS, 1964) is further extended in this paper to N-variates with a further restriction on the growth of each type of object. The growth of each type of object is restricted to such a set of numbers as determined by the dependence of the growth on the total effective number of objects, the ratio of the latter to the number of objects of each type being kept constan. The mean, variance and conditionality probability of extension of the process are obtained.

**8. Discrimination Between Strains of White Leghorn Cocks By Multivariate Analysis of the Dimensonal Characteristics of The Erythrocyte Nuclei and Sperm Heads**

By R.A. Singhal, *I.V.R.I., Izatnagar.*
and D.P. Mukherjee, *Kalyani University, Calcutta*

The multivariate method is applied by using different combinations of five variates, three of the erythrocyte nucleus (length, breadth and area) and two of the spermatozoan head (length and area) of six indigenous strains of White Leghorn cocks namely My, M, T, V, B and IVRI, to discriminate between the strain pairs. It was found that although a combination of all five variates gave optimal $D^2$ (Distance Function) value, its efficacy was not highly significantly different from the efficacy of a combination of four characteristics namely nuclear length, nuclear breadth, spermatozoan, head length and head area to discriminate the strains. Using a

combination of the four dimensional characteristics all strain pairs except M from IVRI and V, and B from My, could be differentiated. The six strains could be grouped into 3 groups. The distance and the inter-relationship between the groups have been studied.

**9. Impact of Irrigational Projects on Cropped Area In The district of Jullunder during the First Four Five Year Plans**

By R.K. Mahajan and S.C. Rai
*I.A.R.S., New Delhi-12*

In the present study an attempt has been made to study the impact of increasing irrigational facilities on the irrigated acreage as well as on the average yield of principal crops, *viz.*, rice, wheat maize, gram, groundnut and sugarcane in Jullunder district of Punjab during the first four Five Year Plans.

The study has revealed that the cultivators are switching on to tubewells rather than wells and canals resulting in increase of irrigated acreage by tubewells. The irrigated area during the period of 12 years from 1960-61 to 1971-72 have increased by 14 folds for tubewells and decreased by 5 folds for wells. The increased irrigational resources have resulted in significant increase in average yield of food crops during the Fourth Plan over the previous Three Plans.

**10. Production of Groundnut in Vidarbha During 1957-75**

By N.S. Gandhi Prasad
*Punjabrao Krishi Vidyapeeth, Akola*

Production of groundnut is showing a downward trend in some of the regions of this country. In this paper an attempt is made to examine the following points :

(*i*) Whether there is any significant change in the production of groundnut during 19 years under review *i.e.* 1957-75.

(*ii*) If so, what is the trend of production and its direction.

(*iii*) What are the factors responsible for bringing about changes in acreage and production.

On the basis of analysis carried out with the help of ANOVA technique and fitting of non-linear regression and multiple linear regression it was concluded that (*a*) the production of groundnut is behaving in a random manner and is showing a downward trend. (*b*) Neither the high prices not the areas under remunerative crops like cotton had any effect on the acreage of groundnut, (*c*) Unless serious efforts are made to stimulate or improve the out-put by

supply of improved seeds and fertilizers at lower costs to the cultivators, there is every possibility of further shrinkage of area under groundnut and slump of production in near future.

**11. Evaluation of Compound Growth Rate and Instability Indices**

By K.C. Gautam and S.D. Bokil
*Indian Society of Agricultural Statistics, New Delhi-12*

For implementing any stock and allocation policy it is necessary to have the knowledge of Instability Index as measured by the standard deviation of production around trend line, initial production and the growth rate of output for any region. These quantities have been worked out for India as a whole as well as for 14 States, for the period 1954-55 to 1974-75. The relationship of the stability of production with percentage Irrigated area and normal rainfall is also discussed in the paper.

**12. An Empirical Study of Fairfield Smith's Variance Law**

By T.A. Ramasubban and Lalit Kishore
*Punjab Agricultural University, Ludhiana*

Using a simple linear transformation on the log variables, the Fairfield Smith's Variance Law can be expressed as

$$\log C_x = \log \alpha + \beta \log x,$$

where $C_x$ is the coefficient of variation (C.V.) of the variable under study among the plots of size $x$ units, and $\alpha$ and $\beta$ are the constants.

For the estimation of $\alpha$ and $\beta$, the following linear regression is usually fitted on log variables :

$$\log C_x = \log \alpha + \beta \log x + u \qquad \ldots(1)$$

where $u$ is the error term which is commonly assumed to be randomly and independently distributed with mean zero and constant variance $\sigma_u^2$.

As the coefficients of variation for different plot sizes have different precision, we have assumed the error variance $\sigma_u^2$ to be dependent on plot size $x$. For this reason, we have examined the following two models : one in which the error variance $\sigma_u^2$ is taken to be proportional to $x$ and in the other, proportional to $x^2$. Accordingly, the regression equation (1) takes the forms :

$$\log C_x = \log \alpha + \beta \log x + \sqrt{x}\varepsilon \qquad \ldots(2)$$

$$\log C_x = \log \alpha + \beta \log x + \sqrt{x\varepsilon} \qquad \ldots(3)$$

where the variance $\sigma_\varepsilon^2$ of the error $\varepsilon$ is constant and independent of $x$.

The three models (1), (2) and (3) have been fitted using the uniformity trial data from two crops one on Onion and other on Radish. It is found that the models (2) and (3) provide a better fit to the data and also improve the efficiencies of the $\beta$ estimates as compared to the model (1). The study thus appears to show that the assumption of independence between the error term and the plot size $x$ is untenable on both logical and empirical grounds.

## 13. Response Curves in Oats Fodder Crop

By S.B. Agarwal and Bhupal Singh
*N.D.R.I., Karnal*

In this paper an attempt has been made to study the response of oats fodder crop to the application of nitrogen fertilizer applied at different levels and to estimate the optimum doze of nitrogen fertilizer for each variety of oat. Further, maximum net profit for each variety was also estimated.

The data for the present study was taken from the experiment conducted at N.D.R.I., Karnal during 1971 to study the effect of nitrogen and method of application on varieties of oats. Three varieties of oat *viz.* Kent, Fulgham and Weston-II were considered for the experiment. The three treatments were the levels of nitrogen application *viz.* 30, 60 and 90 kg/ha.

To study the response of different varieties of oat linear and quadratic regression models were used. It was observed that the methods of application of nitrogen did not differ significantly. The three methods were, therefore, pooled to study the response of oat varieties.

The average yield of green fodder for 'Kent' variety was highest compared to other varieties. The yield of green fodder for the Kent variety increased with the addition of level of nitgogen, whereas for other two varieties it increased upto 60 kg per hectare of nitrogen and declined in the last application *viz.* 90 kg/ha. This shows a quadratic trend of response to nitrogen for the varieties Fulgham and Weston-II. The quadratic response curves explained maximum variation and were therefore, used for further economic analysis.

## 14. Assessment of Production in Aquaculture

By K. Alagaraja
*Central Marine Fisheries Research Institute, Cochin*

Aqua production is three dimensional when compared to two dimensional terra production. The factors involved in aquaculture

are manifold and hence make the study of this aspect more complex. In this paper the factors involved are brought out, their inter relationships highlighted and the method of analysis pointed out.

## 15. Impact of New Technology on Income, Consumption and Investment Pattern In IADP District of Bihar

By B.N. Singh

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

The new technology in recent years has led to an increase in incomes of the farming community. Though the Intensive Agriculture District Programme was initiated in the year 1960-61 in Karaghar block of Bihar (Study area), introduction of high yielding varieties of food grain during the year 1966 heralded, again, a new era in crop production. The new technology was assumed to be netural to scale but in practice it was biased towards big farmers. Moreover, the performance of this strategy has been uneven and sketchy in relatively less developed areas of Bihar and eastern India. Therefore, the specific objective of this study are to examine the adoption of high yielding variety and its impact on income, consumption and investment pattern.

As already mentioned, the study was conducted in the Karaghar block of Shahabad district (Bihar). In all 50 farmers were selected randomly from small, medium and large farm sizegroups. The study was based on the data of two time periods *i.e.*, 1971-72 and 1974-75 from the same sets of the household. This study is concentrated, mainly, on two crops rice and wheat since (1) these crops cover about 80 per cent of the total cropped area and (2) these are the only two crops in which HYV seeds have been introduced.

The study indicated that in first instance HYV as adopted by large farmers while later it was also followed by the small farmers. It affected the consumption and investment in a same direction. Though, the saving of large farmers was very high in both years, it was the small farmers whose dissavings in the initial years changed into savings. The proportion of investment on the agriculture equipments was higher on the large farms which denotes that the larger farmers invest a significant amount in the development of agriculture while a higher percentage of income of small farmers had gone to the consumption purposes.

**16. Generation Matrix Method of Studying Inbreeding Systems—I**

By K.C. George
*H.A.U., Hissar*

The problem of correlation between relatives under inbreeding systems was studied by several authors such as Fisher (1918, 1949) Wright (1921), Haldame (1937, 1955), Kempthorne (1955), Horner (1956), Korde (1960) and others. Fisher, Wright and Haldane gave a general treatment of the subject. Kempthorne and Herner worked with autosomal gene cases under full-sib mating and parent-offspring mating respectively, but Korde delt with sex-linked gene case. Most of these workers used the generation matrix technique to evolve the joint distributions of the relatives under different systems of inbreeding. In this paper a study of correlations by generation matrix method with particular reference to full-sib and parent-offspring mating under autosomal gene case is made.

The following conclusions are drawn from this study. Under full-sib mating system, the joint distribution of full-sib pairs and parent-offspring pairs are directly calculated, which is some what cumbursome. But in the case of parent-offspring mating system, the joint distribution can be easily calculated from the conditional probability matrix which can easily be generated. In both the systems of mating this correlation increases as the number of generation increases. It was observed that under both the systems of inbreeding the correlation between parent and offspring increases in a rapid phase than that of fullsib pairs and also the correlations increases at a rapid rate in the initial generations of inbreeding under both the systems of inbreeding.

**17. On The Estimation on The Magnitude of Optimum Catch That Can Be Derived From A Fish Stock**

By S.K. Dharma Raja
*Central Marine Fisheries Research Institute, Cochin*

The commercial fishery begins to exploit the fish from a certain age namely the minimum age of capture. The period of exploitation depends on how long the fish lives. The necessity of determining the optimum level of exploitation and the extent of the effect of fishing on the stock arises. This depends on the statistics of the fishery and on changes in the biological characteristics of the fish populations. The methods for determining the magnitude of optimum catch that can be derived from a fish stock are described. A review of the work carried out on the stock assessment of commercially important fishes of India is also given.

**18. Estimation of Fish Population in Ponds By Mark and Recapture Method**

By M. Rout and D.S. Murty
*Central Inland Fisheries Research Substation, Cuttack*

Fish population in small bodies of water (0.15 to 0.5 ha) was estimated by marking and subsequent recapture of fish and 95% confidence limits were calculated. Multiple sample experiments were carried out by one to three hauls. Two-sample estimate with $\pm 2$ standard error for lower and upper limits fairly covered the actual population. Rate of recapture was more for surface feeders followed by column and bottom feeders in all the experiments. The $x^2$ was used to test the uniformity of capture probability in different size classes and it was observed that the increase in size among marked and unmarked fishes during recapture did not differ significantly. Independent successive samples also did not show any marked differences. The estimated population deviated from the actual population by 7, 12 and 19% for surface, column and bottom feeders respectively.

Quantitative information suitable for pond management obtained from population estimate was also discussed.

**19. Partially Balanced *n*-Ary Block Designs From Association Schemes**

By Kishore Sinha
*I.A.R.S., New Delhi-12*

A method of constructing partially balanced *n*-ary block designs from association schemes is given. Several series of partially balanced ternary block designs from three associate Binary number association schemes (BNAS), have been obtained. The partially balanced *n*-ary block designs with BNAS may be useful as *n*-ary Balanced factorial experiment.

**20. Some Results Concerning Strategies of Sampling on Two Occasions**

By Arijit Chaudhuri and Raghunath Arnab
*Indian Statistical Institute, Calcutta*

A few simple modifications on A vadhani and Sukhatme's (1970) strategies of sampling of a finite population on two successive occasions have been proposed and situations when they may fare better than the latter have been examined. The results are derived mostly under two customary super population models and occasionally with a few approximations and restrictive assumptions on variate values.

## 21. Two Stage Successive Sampling when Fsu's are of Uniqual Sizes

By C.L. Agarwal
*University of Rajasthan, Jaipur*

The theory of two stage successive sampling was developed by Tikkiwal (1958, 64, 65), Singh (1968) when first stage units (fsu's) are of equal sizes and alone are partially replaced on various occasions after the first by observing the same set of second stage units (ssu's) under certain assumptions. Agarwal and Tikkiwal (1975) relaxed these assumptions. Further, Singh and Kathuria (1969), Abraham *et al.* (1969), Kathuria and Singh (1971, *a*, *b*), Srivastava and Shivtar Singh (1974) and Agarwal (1977) have studied this theory when partial retention is made at both the stages.

However in practice, very often, the fsu's are not of equal sizes. The two-stage successive sampling with unequal fsu's, so far as, is considered in the literature by Purakam and Koop (1966), Kathuria (1973) and Agarwal and Gupta (1975, 77) when fsu's are selected with probability proportional to their sizes with replacement and fsu's with simple random sample without replacement (SRSWOR). Various ratio and regression estimators for the population mean (or total) are discussed. SRSWOR at both the stages for all the occasions is not considered uptodate. Therefore, in this paper, SRSWOR is used in both the stages and the minimum variance linear unbiased estimator (MVLUE) of the population mean, in $T_{21}$—class of linear unbiased estimators, has been obtained for $h$th occasion. Various lemmas have been developed to prove the estimator MVLUE in the given class. It is seen from the study that there is no gain due to partial retention of fsu's when the linear unbiased estimator of population mean (or total) lies in $T_{21}$—class, therefore the partial retention is made among ssu's only.

## 22. Use of Auxiliary Information in Estimating the Finite Population Variance

By Ajit Kumar Das and T.P. Tripathi
*Indian Statistical Institute, Calcutta*

We consider the problem of estimating the finite population variance

$$\sigma_y^2 = (1 \mid N) \sum_{i=1}^{N} (y_i - \bar{Y})^2$$

of a character $y$ in the situations where population mean $\bar{X}$ or variance $\sigma_x^2$ or coefficient of variation $(\sigma_x/\bar{X})$ of an auxiliary character $x$ is known. We present the classes of ratio-type and product-type estimators in case of simple random samples, obtain optimum estimators in the classes and identify the situations in which our proposed estimators are better than the usual unbiased estimator

$$s_y^2 = \sum_{i=1}^{n}(y_i-\bar{y})^2 \mid (n-1) \text{ of } \sigma_y^2 \text{ in}$$

simple random sampling with replacement.

## 23. Component-Wise Ratio and Regression Estimation

By A.S. Sethi, *H. P. University, Palampur*
and A.K. Srivastava, *I.A.R.S., New Delhi-12*

In many situations the character under study and the auxiliary character are made up of various components. Sometimes the two characters are more highly correlated for individual components rather than for the aggregate characters as such. The use of component-wise ratio type estimators was studied by Robson and Vithayasai (1961). In this paper the application of a biased component-wise ratio estimator and an unbiased component-wise regression estimator has been investigated. The efficiency of the suggested estimators have been illustrated with the help of three examples and it was observed that under some realistic situations these estimators lead to substantial gains in efficiency over the usual ratio and regression estimators.

## 24. On Estimation of The Finite Population Correlation Coefficient In Systematic Sampling

By J.P. Gupta
*Punjab Agricultural University, Ludhiana*

The usually estimator $r$ of the correlation coefficient $\rho$ for finite populations in case of systematic sampling has been studied in this paper. The bias, upper limit of bias, variance and estimate of the variance of the estimator $r$ have also been obtained.

**25. Double and Successive Sampling Model For Estimation of Non-Response in Mail Surveys**

By G. Sadasivan and Z. Schariah
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In sample surveys where the public is under no obligation to cooperate, it may happen that the data are not obtainable from all the units. This is particularly so with Mail Surveys where some portion of the population will not care to respond. Hence the problem arises as to what conclusions are authorised from such surveys or what measures could be taken to gain some insight into the part of the population left uncovered. This is the problem of non-response. Hansen and Hurvitz (1946) developed the first model for this. El Badry (1956) extended the model to $m$ stages. Srinath (1971) gives rules for selecting a sub-sample of non-respondents when the population consists of one or more strata. Sadasivan and Barah (1974) extended the Hansen and Hortwitz model to one more stage and have obtained the optimum sub-sampling fraction at the third stage as well as optimum size of initial sample using an appropriate cost function.

In the present paper a double sampling model for non-response has been developed with three estimates of the mean of a continuous character along with the errors of the estimates. Further, a regression estimate along with its errors and bias using samples on both the occasions is also worked out. Two studies of optimum sample sizes under different constraints are also made using the double sampling model. The scheme has been extended to $p$ stages and the general expressions derived. This is a generalisation of El Badry's Model.

**26. On Unbiased Ratio Estimation**

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

In this paper two sampling strategies are considered. The first one consists of Midzuno's scheme and usual ratio estimation. The second cosists of a new sampling scheme an unbiased ratio type estimation. At the end the two strategies are compared.

**27. On a Ratio and Product of Biased Estimators**

By P.C. Gupta
*South Gujarat University, Surat*

So far in the literature the ratio and product of unbiased estimators has been considered [Murthy (64, 67)]. In this paper the

general expression for the bias and variance of the ratio and product of biased estimators for population characteristics have been considered. The use of these estimators have been illustrated with the biased estimators developed by Yogi (1976). Further, the stratified estimators have been developped using the results of the author (1967).

**28. An Alternative Estimator in Sampling with Pps with Replacement**

By Randir Singh and Padam Singh
*I.A.R.S., New Delhi-12*

In case of Simple random sampling, it has been shown by Des Raj and Khamis (1958) and Pathak (1962) that the mean based on distinct units is more efficient than the sample mean based on all the units. In the present investigation an estimate based on only distinct units in the case of ppswr has been proposed and its efficiency has been compared with the usual *pps* estimate and the Aorvitz-Thomson estimate.

**29. A Note on Exact Ratio Estimator**

By T.K. Das Gupta and T.K. Gupta
*B.C. Krishi Viswa Vidyalaya, Kalyani (West Bengal)*

Ratio estimators are used for estimating the population mean $\bar{y}$ of the character $y$ under study, utilizing an auxiliary variate $x$ which is positively correlated with $y$. It is well known that ratio estimators are in general biased and the bias may be negligible in large sample. But little is known about the exact expressions of bias and mean square error of ratio estimators. In this paper, we have obtained exact expressions of bias and mean square error of the well known ratio estimators *viz.* mean of the ratios and ratio of the means using SRSWOR under the super population model :

$$y=\alpha+\beta x+u \text{ with } E(u/x)=0,$$
$$E(uu'/xx')=0' \; V(u/x)=\delta$$

and $x$ has a gamma distribution. The exact variance of the ratio of means using SRSWOR is compared with the exact variance of the ratio of means using Midzuno's sampling scheme under the same model (Darbin, 1959; Rao and Webster, 1966; Chakrabory, 1974). Results are exact for any sample size.

**30. Use of Multi-Auxiliary Information for Increasing the Efficiency of Cluster Sampling in Conjunction with Ratio and Regression Methods of Estimation**

By S.K. Agarwal
*University of Jodhpur, Jodhpur*
and B.B.P.S. Goel
*I.A.R.S., New Delhi-12*

Zarckovich and Krane (1965), have shown that the correlation between the cluster means of two characteristics increases as the cluster size increases. Mislro and Sukhatme (1972), utilized these findings and gave the conditions under which cluster sampling in conjunction with ratio and regression methods of estimation is more efficient than simple random sampling in conjunction with the corresponding methods of estimation even if intra-class correlation coefficient is positive. In this paper, it is shown that the efficiency of cluster sampling can further be increased by making use of more than one auxiliary characters in the ratio/regression estimators.

**31. On the Sampling Design for Estimation of Price spread**

By Padam Singh and M.R. Zurmati
*I.A.R.S., New Delhi-12*

The study of price spread and marketing margin could be a very valuable indicator provided reliable and precise data are available. The studies of Nath (1963) on the estimation of price spread of vegetables, the report of marketing of fruits and vegetables (1966) and the report of sub-group committee on grading of marketing (1975), provide the estimates of price spread without bothering about the standard errors of the estimates. It is well known that standard errors of the estimates as the indicator of reliability are as important as the estimate themselves. In this paper the role of sampling has been investigated in the estimation of price spread. For this four sampling schemes have been considered. The expression for the bias and the mean-square errors of the estimates of price spread for these sampling schemes have been worked out. The relative efficiencies of these sampling schemes have been examined.

The usefulness of the different sampling schemes has been illustrated by the data on four vegetables namely, Tomato, Brinjal, Cauli-flower and Peas for the month of January, Feburary and March, 1977 collected by the Institute of Agricultural Research Statistics. It has been observed that the share of the grower to the consumer's rupee spent is very small and that of the retailer in

particular is very large. On comparing the efficiency it is observed that the performance of sampling scheme-II is the best followed by sampling schemes-IV and sampling schemes-III.

**32. Indices and Growth Rates of Irrigated a Creage under Principal Crops in Punjab**

By R.K. Mahajan and D.K. Agarwal
*I.A.R.S., New Delhi-12*

In Punjab, the irrigated acreage under all principal crops has been growing since the beginning of first Five Year Plan. The present study of growth rates crop-wise has shown that the food crops like ice, wheat and maize have been benefited in a much more conpi-ious degree than other food and cash crops discussed in this paper.

**33. Estimation of Fruit Drop in Apple—Uttar Pradesh**

By Jagmohan Singh
*I.A.R.S., New Delhi-12*

Apple is the principal fruit crop in hilly area of Uttar Pradesh. This paper works out approximate estimates of apple drop from a sample of apple orchards selected for a cost of cultivation survey on apple. On the basis of the estimates, it is shown that there is a possibility of significant addition to the income of the apple growers by utilization of dropped fruit for production of Jams, Jellies etc. Estimates obtained are of practical interests and as discussed in the paper it will be possible to utilize apple fruit, which is wasted now, by organising processing as a cottage industry with the co-operation of the agro-fruit processing factory at Ramgarh, District Nainital.

**34. Study of District Imbalance in Milch Livestock in Aurangabad Division (Marathwada) of Maharashtra State**

By B.W. Shirurkar, B.L. Kulkarni, and N.K. Palinkar
*Marathwada Agricultural University, Prabhani*

An attempt has been made in this study to see the trend of milch animals (Cows and Buffaloes) and availability of per day per capita milk in Aurangabad division (Marathwada) of Maharashtra State during the livestock census 1961, 1966, 1972. Inter district differences have been computed by using analysis of variance technique and growth rates have been computed to study the variations over a period of time. Considering the growth rates, future availability of per day per capita milk is computed

The study shows that there is a good scope for the development of milch animals in Marathwada. The present livestock can be improved in respect of milk yield by launching intensive cross breeding programme, providing nutritional food and better management.

## 35. Methodology for Estimating the Yield of Cotton Based on Cotton Partial Harvest Data

By B.B.P.S. Goel, S.K. Raheja,
P.C. Mehrotra and V.S. Rustogi
*I.A.R.S., New Delhi-12*

The estimates of average yield of cotton are at present obtained on the basis of crop cutting surveys conducted on a sample of fields. Harvesting of cotton is spread over a period of 2-3 months and involves a number of pickings and thus entails quite heavy work load on the field staff entrusted with the work of conducting crop cutting experiments. Since it may be difficult to collect data on all the pickings doubts are sometimes expressed about the realiability of estimates of yield obtained through crop cutting surveys. Thus, there is a need to study the feasibility of alternative techniques by utilising the data of the pickings in the selected fields. Such techniques should be simple and conveniently fit into the programme of work of the field staff thereby improving the reliability of estimates. These aspect has been studied in this paper utilizing the data collected in the pilot sample survey for estimating the yield for cotton conducted in Hissar district of Haryana State during khariff 1976-77. Use of double sampling and component sampling has been suggested for this purpose. An approximate estimate which is quick and simple has also been considered.

## 36. Some Experimental Results on sampling Methods Studying from Family Planning Case Sheets

By P. Krishan
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From a finite population of 201 family planning case sheets, various types of probability samples have been drawn to estimate the mean of the female age at enrolment and compare the suitability of the various designs toward this end. For 4.5 per cent degree of precision and 95 per cent degree of confidence, the sample size is worked out as 66. The sequential procedure developed by Lalu and Krishnan (1977) assures that the same means for samples of this size are normally distributed. Stratification of the universe has been done on the basis of income and occupation of the spouses. The

income strtification employed here coincides with the Delenius-Hodges income strata when the same number of strate is required. Income stratification is found to be superior to occupation based startification. Form a convenience point of view, systemetic sampling fares better than both simple random and stratified sampling.

**37. Study of Markefed Surplus of Wheat in Union Territory of Delhi**

By B.N. Singh & R.K. Pandey
*I.A.R.S., New Delhi-12*

The study aims at studying the mature of relationship existing between the marketed surplus of wheat and factor affecting it in, the Union Territory of Delhi.

The term, 'marked surplus', in this study denotes the actual quantities sold by farmers for cash or on barter basis.

The study was carried out in the 12 villages of Nazafgarh block. All the holdings in the selected villages were grouped in an ascending order and were stratified into three size-groups, *viz.*, (*i*) upto 2 hecters, (*ii*) 2 to 4 hecters, and (*iii*) above 4 hectares,

243 holdings in all were selected to carry out detailed enquiry at the farm level. Each selected household was approached individually and information was collected by personal interview method with the aid of a set of schedules. The time of reference of the enquiry was July 1976 to June 1977.

This study compares the relationship between production and marketed surplus on the basis of per farm and per hectare in different categories of households. It was observed that percentage of marketed surplus of wheat to its production on per farm basis was 33.86, 46.31 and 55.08 for the first, second and third size group respectively. The percentage share of marketed surplus of wheat production on per hectare basis was similar to per farm. The marketed surplus had positive relation with the size of form and production.

**38. "Use of Some Ancillary Plant Traits in Peridiction of Grain of Yield and in Breeding Superior High Yielding Varieties in Rice**

By K.M. Palaniswamy
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Correlations among grain yield/plant, plant height, panicle length, grain number, paniclegrain weight/panicle, per cent unfilled

grain/panicle, number of earbearing tillers and density were studied in IR 22 rice variety grown with 0,60 and 120 kg/ha N applied plots at International Rice Research Institute, Philippines, Strong positive correlation between grain yield and other related variables namely plant height, panicle length, grain number per panicle and grain weight/panicle were found and regession analysis indicated possibility of prediction of grain yield through the above ancillary traits. The estimated error in prediction in different methods was found to be within about 2% error. Selection of tillers in the plant was found to be an important factor in the prediction. Data collected from the tallest two tillers of the plant were recommended for prediction purpose. Correlation studies as well as path analysis indicated that number of productive tillers/plant played a more important role in the expression of grain yield than other characters. Consistency in results in three N rates showed the suitability of the various prediction methods in rice grown with varying nitrogen levels. About 92% to 96% of the variability in the grain yield had been explained by the variables included in the study.

## 39. Study on Trends in Yield of Rice and Wheat Crops in Punjab During the First Four Five Year Plans

By R.K. Mahajan and D.K. Aggarwal

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An attempt has been made to study the trends in yields rates of rice and wheat crops in Punjab state for the first four five year plans and pre-plan with a view to finding out the extent to which these plans have made their impact on the yield of these crops in the state.

The results of statistical analysis showed that at the state level, the yield per hectare of rice in second, third and fourth plans were raised by 63.9 and 63 per cent respectively. No state showed a significant increase in yield during all the four plan periods. Patiala showed significant increase in yield rates during second and fourth plan periods. In contrast to these, Jullundur and Ferozepur showed decrease in yield in first and third plans respectively though these decreases were found to be statistically not significant in both the divisions.

Unlike, rice, plans efforts seems to have very little impact on the yield per hectare of wheat during the first three plan periods. However, the increase in yield in fourth plan as compared to third plan was 81 per cent. At the state level, the increase in yield rates of wheat in the First, Third and Fourth Plan periods were 114, 112 and

688 kg/ha. respectively when compared against their corresponding control quinquenum. Jullundur Division showed significant increase in yield rates of wheat in all the plans except Fourth Plan where a decrease in yield of wheat was observed though decrease was statistically not significant. The apparent increase in yield rates of wheat in the first plan in all divisions appeared to be the result of recovering from the rust opidemic of 1946-47, the effect of which could not be during the-next-two-years.

**40. On Double Sampling For Product Estimators**

By K.C. Goyal and O.P. Srivastava
*H.A.U., Hissar*

The ratio estimator proposed by Cochran (1940) provides a more efficient estimator of population mean $\bar{Y}$ than the simple mean for any probability sampling design if both the correlation coefficient and the population ratio $R$ between the auxiliary variable and the character of interest are positive. When this correlation is negative, Murthy (1964) and Singh (1965) proposed a product estimator to improve upon the sample mean as an estimator of the population mean. Thus the product estimator is complementary to ratio estimator in the sense that the former is efficient when $\rho$ is negative while the latter is efficient when the $\rho$ is positive. Though the estimator was proposed and its properties were studied as early as 1965 but the study has not been extended when the information on auxiliary variable is drawn through a double sampling procedure. In this paper we derive expressions for bias and mean square error of the product estimator for any probability double sampling design in which the sample is drawn as a sub-sample of the pilot sample.

Bias and *MSE* of the estimator $t_p=(t_{1m}t_{2m})/t_{1n}$ where $t_{2m}$ and $t_{1m}$ are the linear unbiased estimators of the population means for the character of interest and auxiliary variable based on the sub-sample and $t_{1n}$ is the linear unbiased estimator of the population mean of the auxiliary variable based on the pilot sample are :

$$B(t_p)=1/\bar{X}\,[E_1\,C_2\,(t_{1m}\,t_{2m})]$$

$$MSE(t_p)=V(t_{2n})+[E_1V_2\,(t_{2m})+2\,RE_1\,C_2\,(t_{1m}\,t_{2m}) + R^2E_1V_2\,(t_{1m})]$$

For simple Random sampling

$$B(\bar{y}_p)=1/\bar{X}\,[(1/m-1/n)\,\rho\,S_x\,S_y]$$

$$MSE(\bar{y}_p)=(1/m-1/N)\,(S_y^2+2\rho R\,S_xS_y+S_x^2) + (1/n-1/N)\,(2\rho RS_xS_y+R^2S_x^2)$$

## 41. Designs for Two-way Elimination of Heterogeneity

By P.N. Bhargava, A.K. Nigam, and J.K. Kapoor
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A procedure for constructing designs for two-way elimination of heterogeneity in a treatments has been suggested. The designs are of the type $T : TT$ and $O : SS$ (Hoblyn *et al.* 1954). This method provides designs for all values of $s$ excepting $s=6$.

The method of construction consists in selecting a pair of orthogonal latin square $(A_1, A_2)$ of order '$s$'. Such a pair exists for all values of '$s$' other than $s=6$. By superimposing $A_1$ over $A_2$ and deleting all letter of $A_1$ corresponding to a given letter of $A_2$, a combinational in $(s^2-s)$ cells is obtained. The arrangement has $s$ rows, $s$ columns, with empty cells. This arrangement is of the type T: TT. If another treatment is added in the '$s$' empty cells then the arrangement in $(s+1)$ treatments is of the type $O : SS$. Two way elimination of heterogeneity designs obtained by Agrawal (1966) and Raghavarao (1970) for even values of '$s$' are particular cases of proposed series of designs. Some more two-way elimination designs are also suggested. The simplified method of analysis on the lines similar to one proposed by Calinski (1971) for two-way classified designs is given for these designs.