ABSTRACT OF PAPERS

1. Study the Effect of Coefficient of Variation on the Heterogeneity of Error Variance in Agricultural Field Experiments

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Experimental data with factorial structure of treatments of 160 agricultural field experiments conducted during the period 1972-1985 at various research stations of Maharashtra State on oilseeds, cereals, pulses and cash crops were further analysed for the study of presence of heteroscedasticity of error variance. To identify the causes of presence of heteroscedasticity of error variance, the coefficient of variation of these experiments were also calculated. It was observed that experiments exhibiting heteroscedasticity had the high value of coefficient of variation. Some treatments like date of sowing, spacing, varieties and fertilizer levels were also found responsible for presence of heteroscedasticity of error variance in agricultural field experiments, since the plant population and growth cycle of the crop gets greatly affected by these treatments. The present study indicated the existence of heteroscedasticity (Unequal Variances) in 19% of the experiments and 70% of them had high value of coefficient of variation more than 10%. This shows that coefficient of variation plays very important role in exhibiting heteroscedasticity of error variance in agricultural field experiments.

2. Study of Heritability of Stayability : A Threshold Character

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Stayability being an threshold character in dairy cattle breeding needs through genetic analysis. Herdlife a measure of stayability depends on many characters of interest. In order to arrive at a true measure of stayability this

measure has been adjusted for various production and reproductive traits. For estimation of heritability of stayability the adjusted herdlife for production is converted to binary trait using threshold probability. The procedure of beta-binomial was modified to incorporate the adjustment of herdlife. Dempster-Lerner method was also used to estimate the heritability of stayability and compared it empirically with the beta-binomial method. It is seen that even small adjustment on account of production has a great effect on estimates of heritability of stayability. Further, relative root mean square were also obtained and found that precision and accuracy of estimates were affected by adjustment of production. From this study, it is concluded that beta-binomial method gives improved estimates than other methods.

3. Stability Analysis in Pearl Millet (Pennisetum americanum L.)

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The phenotypic stability of 9 genotypes of pearl millet grown under four different weed management treatments (created environments) were studied for three years at G.A.U., Anand. Significant G × E interaction was observed for grain yield and its attributes in year wise as well as in pooled analysis. Genotypes GHB 181, GHB 229 and MH 179 gave high grain yield and high stability, hence were considered as stable genotypes. Based on environmentwise analysis, genotype GHB 229 was noticed high yielding and stable in "no weeding" and "hand weeding" environments while MH 179 appeared high yielding and stable under "herbicide application."

4. Pooled Analysis and Response Functions of Agricultural Experiments

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Pooled analysis and response surface functions were worked out for the data obtained from experiments conducted with lay out of 3 × 2 partial

confounding by All India Co-ordinated Agronomic Research Project (AICARP) for several years at Rudruru Centre of Andhra Pradesh. The response surface equations were fitted using multiple linear regression procedure and pooled analysis was carried out for all the experiments as per the procedure given by Nigam and Gupta (1979).

From the fitted 2nd order response surface functions for Kharif (rice), it was found that linear coefficients of N and P (b_1 and b_2) were positive and substantial in 5 out of 6 experiments indicating increased yields were obtained with the increased levels of N and P. There was no quadratic trend of N and P as indicated by very small coefficient values (b_{11} and b_{22}). Negligible interaction effect was noticed in all the 6 experiments. In Rabi (wheat), the linear coefficients of N and P were positive and higher in 3 out of 4 experiments. Here also negligible quadratic effects (b_{11} and b_{22}) were noticed besides no interaction effect of N with P.

Pooled analysis indicated WGL 22245 rice variety responded well for N, P, K and their interactions compared to other varieties in Kharif (rice) and HDM 1553 wheat variety yielded well for N, P, K and also for their interactions in Rabi (wheat) compared to Sonalika variety.

5. Construction of Plans for $q \times 2^n$ and $q \times 3^n$ Type of Asymmetrical Factorial Experiments

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One of the methods of construction of asymmetrical factorial experiments of $q \times 2^n$, $q \times 3^n$ with smaller number of experimental units, involve obtaining first a suitable confounded design for symmetrical factorial experiment (2^n or 3^n) containing a group of pseudo factors for each factor separately. Each pseudo factor is at two (three) levels. Next a many to one (one or two) correspondence between the levels of factors of symmetry and the combination of pseudo factors corresponding to that factor has been set up. Since we have a several choices for many to one correspondence, one would like to look for one choice which is best in some sense. For finding the best association scheme the criteria of minimum trace of C matrix, similar to A optimality was considered. The other criteria based on eigen value and correlation's between the estimated contrast were also considered. The schemes only provide the answer to the association

of how many to how many. This does not however, answer the question of which of the combinations of the levels of pseudo factors are to be used to denote which level of the factor of asymmetry. This aspect is likely to be significant depending on the interaction component confounded in the symmetrical factorial before using the merger of combinations of certain factors (called pseudo factors) to get the levels of factor of asymmetry. This seems to help in getting better plans in the sense that they provide estimation of more components of higher order interaction. This aspect has been discussed with the help of connectedness of the treatment combinations in the construction of various plans viz. 5×2^2, 6×2^2 ... etc.

6. Nonlinear Statistical Models for Describing Yield-Water Relationship of Wheat

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Quantitative relationship between crop yield and applied water plays an important role for devising optimal water programs in irrigation projects. For establishing this relationship different measures of water viz. total water supply, evapotranspiration, relative evapotranspiration, ratio of irrigation water to cumulative pan evaporation etc. have been reported in the literature. An array of models viz. simple linear regression, polynomial and linearised nonlinear models have been reported for describing the functional relationship between yield and water. In this study, nonlinear statistical model has been proposed for describing yield-water relationship. Appropriate procedures for estimating parameters of such model has also been emphasised. Logistic model has been found appropriate for describing yield-water relationship of wheat.

7. Construction of q $\times$ s^2 Design

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The method proposed allows estimation of main effects as well as two factor interactions orthogonal to blocks by suitably choosing the block sizes.

Let $(k-1)$ $s < q \leq ks$. We choose the block size as ks^2. The method of construction involves obtaining first s^3 design in s^2 plot/block by confounding the three factor interactions. The first factor being the pseudo factor, second and third factor of symmetry is the required design. By repeating some of the q levels, we bring their number of ks. Then these ks levels, some of which are replicated are grouped into s groups of k level each. In the above s^3 design in s^2 plot/block, we replace the level of pseudo factor by the ith group of level formed above. In the design, it can be seen that the factor levels as also the combination of the factors taken pairwise are orthogonal to block.

8. Clustering Genotypes Based on Genotype–Environment Interaction

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A distance function between any two genotypes based on their interaction with environments, when error variances in the different environments are homogeneous, suggested by Lin (1982) was used for two methods of clustering genotypes. One is an iterative relocation algorithm (IRA) which produces an optimal non overlapping cluster configuration that has minimum over all with in cluster Genotype-Environment Interaction (GEI) mean square. The optimum number of clusters was determined by the method of maximum curvature. The other procedure known as statistical clustering results in formation of maximum sub sets of genotypes such that the GEI is absent within any set, while any addition to the set brings in GEI. These clusters may be overlapping. The procedures are illustrated by experimental data.

9. A-Optimal Balanced Augmented Designs for Diallel Cross

Somy Kuriakose, Rajender Parsad and R.C. Jain
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The present article deals with mating designs for diallel crosses for the experimental situations where the experimenter is interested in comparing the

general combining ability (gca) effects of p-secondary lines with one primary line. Balanced Augmented designs for Diallel Crosses (BADC designs) have been introduced. A-optimality aspects of incomplete block designs for comparing gca effects of secondary lines with that of one primarily line investigated. Two general methods of construction of BADC designs have also been given using the concept of Balanced Treatment Incomplete Block (BTIB) designs and Nested Balanced Incomplete Block (NBIB) designs. The designs obtained from this method are checked for their optimality. A catalogue of BADC designs along with their A-efficiencies is also presented.

10. On the Construction of Orthogonal Arrays of Strength Two Using GF ($3^s, s \geq 2$)

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The concept of orthogonal arrays was introduced by Rao (1947). Bose and Bush (1952) constructed orthogonal arrays of strength two using method of differences. Zeiden (1954) considered the construction of orthogonal arrays of strength two using the method of differences. Zeiden and Zemach (1956) have studied in detail algebric and structural properties of orthogonal arrays. Shrikande (1964) pointed out some connections between generalised Hadamard matrices and various tactical configurations and orthogonal arrays of strength two. A systematic study of some combinatorial problems of arrays and applications to design of experiments has been thoroughly examined by Rao (1973), Lie (1977), Jiang (1979), Xu (1979) and Xiang (1983) have studied the existence of orthogonal arrays of strength two using difference set for prime and prime powers. It is well known that the minimum function which generates the elements of GF (p^s) is in general not unique. With the request of Prof. C.R. Rao, Alanen and Knuth (1964) studied in detail the finite field theory and obtained the exact number of minimum functions for every prime power ($p^s, s \geq 2$). In this investigation, the authors have attempted to evolve new methods of construction of orthogonal arrays of strength two for GF ($3^s, s \geq 2$).

11. On the Construction of Orthogonal Arrays of Strength Two Using GF (2^s , s $\geq$ 2)

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Rao (1947) for the first time introduced the concept of orthogonal arrays. Bose and Bush (1952) used the method of differences for the construction of orthogonal array of strength two. Masuyama (1957 and 1969), Liu (1977), Jiang (1979), Xu (1979) and Xiang (1983) have shown that the difference set D (2p, 2p, p, 2) exists when p is a prime or prime power. Recently Liu and Fujii (1995) have studied in detail orthogonal array of strength two. It is well known that the minimum function which generates the elements of GF (P^s) is in general not unique. Alanen and Knuth (1964) have made an extensive study of the determination of minimum function for prime powers. They have presented a list of minimum function for every prime power (p^s , s $\geq$ 2). In this investigation an attempt has been made to suggest alternative methods of construction of orthogonal arrays of strength two. Orthogonal arrays of strength two for GF (2^s , s $\geq$ 2) are reported in this paper.

12. Analytical Appraisal of Rural Socio-Economic Studies: Contribution to Fish Sector

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A cluster of agricultural research covering rural socio-economic studies over period of ten years considered. Selected cluster contains research projects taken in said area by PG students of Allahabad Agricultural Institute, Allahabad, who were awarded degree for education session during 1988-1997. A number of thesis studied in detail and finally 59 projects are screened for the purpose. According to main emphasis given to particular sector/systems, all projects are classified into agricultural, allied sectors and putting remaining in 'others' category. Category 'others' is further classified into development of women, and children, Bhartiya Agro-Industrial Foundation Programme, community TV viewing impact, family welfare/planning, non-traditional energy use, training of rural youth and Jawahar Rojgar Yojna for self employment. On the basis

of general classification, proportions contribution to each sector, combined Agriculture + Animal Husbandry dominates. It is followed by Agriculture, Animal Husbandry, Fish culture and Forestry as single components of farming systems. Similarly within 'others' group, sector dominating was identified as training of rural youth and Jawahar Rojgar Yojna for self employment. It is followed by development of women and children, Bhartiya Agro-Industrial Foundation Programme and community T.V. viewing impact, literacy, family welfare, nontraditional energy use, training of carpet weavers and environmental awareness of students. Proportion contribution to fish sector was found 0.05084.

13. Stein-Rule Restricted Regression Estimator in a Linear Regression Model

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This paper considers a linear regression model with a set of exact linear restrictions upon vector of coefficients. A family of restricted Stein-rule estimators are proposed. Proposed estimators are compared with restricted least square estimators under quadratic loss function and conditions of dominance are obtained.

14. Designs with Two Systems of Blocking

Asim Kumar Chakraborty and P.R. Sreenath[1]
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After making an overall assessment on the existing variability of the experimental material, a statistician recommends to adopt a design which provides for such elimination of heterogeneity for maximum number of ways. To carry out the experiment pursuing a typical type of blocking throughout the design may force an experimenter to discard some of the available units and there is a compulsion to look for another set of units that can be accommodated in the type of design. Further, the use of higher ways of elimination of heterogeneity imposes restricted randomisation, which may impugn the unbiasedness in estimation and validity of the experiment. Given

a set of experimental material, it may happen that few of the total units, having homogeneity among themselves, can be arranged into simple blocks needing one-way elimination of heterogeneity only. Whereas, the rest of the units, which are more heterogeneous, are to be arranged in blocks with nested rows and columns and needing three-way elimination of heterogeneity. Thereby an agreement on the available experimental units and judicious control of heterogeneity is attainable. In this paper, analysis and construction of such designs holding the property of variance balance is presented.

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15. Now-Iterative Least Squares Estimation of Missing Values in Repeated Latin Square Designs

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In this paper an attempt has been made to estimate several missing values in repeated latin square designs. Consequently, we have developed a systematic procedure to obtain the estimating equations of several missing values. Further, we have also presented explicit expressions for the non-iterative least squares estimators for particular patterns of missing values. This procedure is also illustrated with the help of a numerical example.

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16. Non-Negative Estimators for Variance Components

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In the present study non-negative estimators are obtained for variance components in mixed linear models, which consists of a combination of quadratic forms and linear functions of observations. The proposed method is also illustrated with numerical example for balanced one way random model.

17. An Algorithm to Search for Optimal Designs

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Advances in computer technology have facilitated not only fast and easier searches for optimal designs but have also led to an expansion of the theory of optimal design - theory of optimum experimental design. Traditional theoretical methods for the search of optimal designs imposed severe constraints. The human quest for knowledge and the difficulties in search of optimal design paved the way for the development of the concept of algorithms. In this paper, I have proposed an algorithm which holds good for more than one optimality criteria, i.e., for A-, D- and E- optimality. An algorithm has been developed for obtaining an optimal block design within a given class of designs. The concept of simulation technique has been utilized in designing the proposed algorithm using probability mechanism. The range of constant (α) has also been obtained to control the number of Exchange and Interchange procedures. The algorithm has been executed and the results are obtained with the help of numerical example.

18. Structurally Incomplete Row Column Designs

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Structurally incomplete row column (SIRC) designs have practical appeal in the situations where the blocking criteria are implemented in stages and empty cells do not represent waste or under utilisation of experimental units. Hedayat and Raghavarao (1975) and Ray (1986) provide various examples of structurally incomplete row column designs. Stewart and Bradley (1991) introduced the concept of structural balance with respect to column effects and gave various methods of construction of universally optimal row column designs with empty nodes. This study was restricted to the designs having equal row and column sizes. This concept of structural balance has been extended to cover those situations requiring unequal rows or unequal column sizes i.e. number of non-empty nodes in row/column are unequal. A general method of construction of universally optimal SIRC designs with unequal rows/columns sizes is also proposed.

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19. On the Application of PBIBD(2) for the Construction of Partial Triallel Crosses

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Given three distinct lines (varieties or strains) say A, B and C, we can form three distinct three-way crosses (AB)C, (AC)B and (BC)A. The set of all possible three-way crosses $V_T = \dfrac{v(v-1)(v-2)}{2}$ among the given set of v lines is termed as Triallel Crosses or Triallel Mating Design. As the number of lines v increases, the triallel crosses become too many to be accommodated within the resources of the breeder. One way to overcome this situation is to take a sample of three-way crosses, called Partial Triallel Crosses (PTC). Hinkelmann (1965) and Ponnuswamy (1971) have made substantial contributions to the theory of Partial Triallel Crosses. Subbarayan (1988) has used PBIBD (2) of simple type and has considered the construction of PTC only when the number of lines involved is a prime or prime power and for a few composite numbers only.

In this investigation an attempt has been made to use PBIBD (2)'s with $\lambda_1 > 0$ and $\lambda_2 > 0$. The number of lines considered for constructing PTC includes prime, prime power and composite numbers.

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20. Use of Basic Inferential Statistical Tools in Animal Experimentation - A Review

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This article relates to an overview of the basic statistical concepts and principles to be applied in experimental designs being used for planning, execution and general inference of animal experiments. The real purpose is to acquaint and make cautious the beginner who is planning to conduct an experiment on animals having a little knowledge on the subject matter. This article has been prepared after examining critically the experimental data collected and published compendia volumes on various animal experiments under the project "National Index of Animal Experiments."

21. Some Resampling Procedures Under Two-Phase Sampling

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The resampling procedures such as the Jackknife and the Balanced Repeated Replication have been suggested in the literature for estimation of variance under two-phase sampling. The resampling procedure known as the Bootstrap gained popularity over time due to its simplicity. It is well known that the direct extensions of the standard resampling procedures to non-IID problems (read here samples obtained by applying two-phase sampling designs) may often lead to misleading inferences. Considering the special structure and wide applications of the two-phase sampling design, in this article, two new Bootstrap variance estimation techniques developed under two-phase sampling viz. the Two-phase Post-stratified Bootstrap and the Two-phase Proportionate Bootstrap are discussed. The estimation of the variance of the two-phase ratio estimator is considered. Comparison of the developed methods with the existing Jakknife method have also been done theoretically. Moreover, their practical applications have been validated by conducting a simulation study. In addition to the conventional design-based approach of drawing inferences, a conditional design-based approach has also been considered for the study which allows to restrict the set of samples to a 'relevant subset' for inference purposes. Overall, the study revealed that the proposed Bootstrap methods perform at par with the Jackknife. The developed methods are computer-intensive, reliable and easy to adopt in practice. Moreover, the proposed Bootstrap methods have broader applications over the existing methods viz. the Jackknife and the Balanced Repeated Replication which have limitations.

22. Acreage Response Functions for Rice Crop in Uttar Pradesh

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Rice is an important food crop in the country. The crop is grown quite extensively in the state of Uttar Pradesh. The welfare of the farmers depends on the production of this crop. The state contributes about 13 per cent of the total rice production of the country. The main aim of the paper is to examine

the status of area, production and productivity of this crop in the state. The acreage response functions for the crop are also estimated.

Uttar Pradesh is one of the main producer of rice in India which contributes about one-eighth of the total rice production of the country. The production of rice in U.P. was 19.19 lakh tonnes in 1950-51, with an area coverage of 38.52 lakh hectares and productivity of 5.19 qtls. per hectare. But by introducing modern production technologies and continuous emphasis on increasing the rice production the output of rice has reached a level of 117.59 lakh tonnes with an area coverage of 55.45 lakh hectares and productivity of 21.21 qtls. per hectare in 1996-97. While the present national average productivity of rich is about 19.50 qtls. per hectare. Thus, the average rice productivity of the state of U.P. can be said to be satisfactory but the yield levels of neighbouring states like Punjab (35.07 qtl/ha) and Haryana (27.32 qtl/ha) are much higher.

The growth rates of area, productivity and production of rice has been examined for the period of 1966-67 to 1995-96.

The growth of rice production had been positive and statistically significant during this period. The same was true for the crop yield. The growth in area is less than one per cent.

The acreage response function for rice crop are estimated using Nerlovian lag adjustment models. The dependent variable in the equation is the crop area in thousand hectares. The explanatory variables are crop area lagged by one year in thousand hectares, farm harvest prices in rupees lagged by one year, irrigated area under the crop in thousand hectares and crop yield in kg/hectare. The analysis is based on the published data. The period covered in the analysis is 1968-69 to 1993-94. The analysis was done for the eastern, central, western hill and Bundelkhand zones and for the state as a whole.

The analysis indicated that the farm harvest prices and area under irrigation might be helpful in raising rice production. Thus, adequate and timely supply of farm inputs and appropriate price policy will be instrumental in improving productivity and production of rice crop in the state.

23. Economic Study of Human Resource Development - A Case Study

S.P. Bhardwaj and V.K. Mahajan
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The involvement of economist in the matters related to health is of quite recent origin. The rapidly growing population especially in developing countries,

encountered with the increasing health hazards. The growing incidence of diseases affect adversely the timely completion of economic activity and the pace of economic development. The demand for and supply of health care facilities largely depends upon supply of safe drinking water, sanitation, awareness towards health, level of education, food habits, size of family, consumption of high calorific food and the expenditure on health care facilities. The present study has been undertaken to examine the status of human resource development at the national level and at the micro level, using village level data.

Methodology used in the study includes construction of development indices based on various parameters such as life expectancy at birth, per capita expenditure on health, literacy rate both for male and female and population density. Weighted Human Development Index (WHDI) and Mean Human Development Index (MHDI) were constructed. At micro-level the parameters of health care were estimated through demand and supply equations using a simultaneous model.

24. A Linear Regression Model for Estimating the Available Water Storage Capacity of Fine Textured Soils

Satyendra Kumar, D.K. Das and Satya Pal[1]
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In the present study, an attempt has been made to correlate the available water storage capacity of the soil with the some easily measurable soil physical properties like clay, silt, sand, organic matter and bulk density, soil water balance as well as crop yield and climatic parameters. The study revealed that the available water storage capacity (Y) is best predicted by the following multiple regression equation

$$Y = 26.769 + 0.096 \text{ Cl} + 0.046 \text{ Si} - 11.476 \text{ BD} \quad (r = 0.78^{**})$$

These parameters contributed only 29% to the variation in available water storage capacity. The inclusion of organic matter and sand in the multiple regression equation did not improve the correlation coefficient.

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25. Estimation of Change in Domain Parameters

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In a cross-sectional survey, the estimation of a population mean is naturally followed by the estimation of the mean Y within separate domains of the population defined by the categories of a discrete 'explanatory' variable X. Estimates of domain totals, means, proportions etc. in case of simple random sampling, double sampling and ratio method of estimation are available in the literature when the domain size is both known and unknown. In this paper, emphasis has been laid on developing Minimum Variance Linear Unbiased Estimators of the level parameters, change therein, average and total there of over time for each of the domains of study in sampling on two successive occasions by Projective Geometry Approach.

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26. Yield Gap Analysis Using Regression Technique

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The bovine population in India is about one fifth of the total bovine population of the world but the performance of milch animals is just about 8 per cent. This reflects the low productivity of our milch animals. This is mainly due to poor plan of nutrition as well as low genetic potential for milk production besides poor management and health care. It has been seen through nutritional studies that the milk production can be increased by 20 to 30 per cent by improved feeding of the animals. But the bulk of Indian farmers largely feed their animals on crop residues and natural herbage, suggesting an inadequate nutrient, supply to these animals, especially with respect to productive purposes. The milk producers' units make use of three or four of the most critical inputs to obtain potential yield. The difference between potential yield and the yield farmers actually get under their normal conditions of feeding and management is termed as yield gap. The increase in milk yield is due to selected physical factors (inputs) that could be added to the producers' practices resulting in higher levels. Hence the question arises why farmers are not using the inputs at the prescribed level and in the way that result in the

potential yield to be achieved. The purpose of yield gap analysis is to give a brief resume of statistical technique for undertaking yield gap analysis under farmers' management condition.

27. Forecasting Rainfall for Agricultural Application

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Methods for agrometerological forecast are mainly based on crop-weather relationship and statistical models. Models developed from historical data make it possible to obtain the expected values fairly in advance so that appropriate action may be taken to avail of beneficial aspect of weather and minimise or avoid detriment effect. Validity of these models under different conditions is imperative as the climatic conditions of general field may be quite different from those of experimental one. Using the rainfall data for the years (1976-1997) pertaining to Chidambaram taluk of Cuddalore district, this paper discusses the prediction of rainfall through fitting of Gamma distribution and Exponential smoothing time series model.

28. Conditional Inference under Two-Phase Sampling

Girish Kumar Jha, A.K. Srivastava and Anil Rai
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The most common criticism of inferences based on randomization is that it does not take enough account of the available partial knowledge regarding the sample while drawing the inferences about the parameter of interest. In this paper, some aspects of this criticism has been addressed and an attempt has been made to show how to use approximations to counter it in the particular case of double sampling for ratio estimation in sample survey. Here, a conditional bias adjusted ratio type estimator has been proposed under two-phase sampling. A conditionally adjusted variance estimator has also been conjectured for the proposed conditional estimator, which has been supported through simulation results.

Further, a simulation study of two populations, one where the model on which ratio estimator is based holds and one where it does not has been undertaken to show the improvements in the performance of proposed estimator as compared to existing estimator under conditional framework.

29. A Bootstrap Technique for Imputed Survey Data

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Bootstrap is a time honoured distribution free approach for estimating standard error of any statistic of interest but has not received much attention for survey data with missing values. In this article, a new bootstrap technique of variance estimation known as "Proportional Bootstrap Without Replacement" for dealing with missing observations has been developed which parallels the original sampling scheme. The proposed technique for estimation of variance of non-linear statistics such as ratio, correlation coefficient and regression coefficient etc. for imputed survey data is justified by showing that in the linear case bootstrap variance estimator reduces to the usual variance estimator. Further, an optimum choice of bootstrap sample size in case of missing observations has also been obtained.

30. Nonparametric Regression With Correlated Errors

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Linear smoothing is a popular technique for estimating the mean function in a nonparametric regression model $y = m(x) + \varepsilon$, where $m(x)$ is a smooth function and ε is an i.i.d. error with mean zero. In this article, the linear smoothing technique is extended to accommodate a correlated error process. The cross-validation criterion for choosing the optimum bandwidth, performs very badly when the errors are correlated. A method is proposed to estimate the error covariance function based on the residuals from a linear regression smoother. Using the estimated covariance function, the regression model is transformed to produce uncorrelated transformed errors. The nonparametric

regression function estimate is obtained by using the linear smoothing technique on the transformed model. The method is illustrated through simulation studies.

31. A General Method for Estimation of Variance for Any Sampling Scheme Including PPS Sampling With and Without Replacement

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The method consists of first taking two general quadratic functions of the observations in the sample one being a quadratic function involving only the squares of the observations in the sample and the other is again a quadratic function involving products like $y_i y_j$ ($i \neq j$) for all possible i and j. As variance of mean is a quadratic function of the observations in the population so also the estimate of this variance is also a quadratic function of the observation in the sample. Accordingly by finding the expected value of each of the above two functions and joining them suitably, variance of estimate of mean has been obtained. Such general quadratic functions can be written in two ways. An estimate of variance has been obtained for each such manner of writing general quadratic functions. The method is simple and straightforward and the final estimate arrived at comes to be the same as obtainable using usual probabilistic considerations.

32. Modelling and Forecasting Cashew Production in Kerala

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This paper makes an effort to formulate statistical models for discrete time series and the use of these models in forecasting the production of cashew in Kerala. Three different stochastic models viz. Box-Jenkins model, Log-normal diffusion model and Markov chain model are evaluated on the basis of their efficiency with a view to modelling and providing accurate forecasts for the cashew production. Appropriate models are selected with the help of sound

statistical techniques. Forecasting of cashew production is done with the help of selected models.

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33. Use of Rank Stability Statistics for the Comparison of Arecanut Cultivars

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The reproductive phase of arecanut is exposed to various weather parameters and their interactions during the long period of development. The evaluation of arecanut breeding trials thus involves test for cultivar × year interaction and comparison of cultivars for stable yield. When the data over different years are used for assessing the stability of cultivars, the assumption that observations are independent will not hold good. The parametric stability statistics may be more vulnerable to violations of assumptions of this kind than the non-parametric ones. Hence it is suggested to use non-parametric (or rank) stability statistics to measure the yield stability over years. The procedure is illustrated with the yield data from a varietal trial on arecanut conducted at CPCRI (RS), Vittal Krishnapuram.

34. Identification of Structural Breaks in Time Series-Piecewise Linear Regression Approach

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During late sixties, Indian agriculture experienced technological change. The dissemination of technology is not uniform across crops or region due to variation in physical and institutional set up. For periods marked by sudden and concentrated technological change, it is common for researchers to check the data for break in trends and to fit trend equations by sub periods. In the Indian context researchers have used the years 1965-66 as cut-off point and

have adopted regression analysis using dummy variables to study the growth characteristics during pre and post green year for all crops and all regions. Hence there is need to use other techniques by which the structural breaks can be obtained in more scientific manner. Piecewise Linear Regression (PLR) approach was adopted to identify structural breaks in productivity of major crops of Karanataka viz. rice, ragi, jowar, tur, bengalgram, groundnut, cotton and sugarcane using time series data over the period of 35 years viz. 1959-60 to 1993-94.

PLR is essentially a combination of hierarchical cluster analysis and regression theory and in this method the 't' index is used to control the clustering. The results indicates that the PLR method could identify regimes indicating growth, decline as well as the stagnation periods more conspicuously than Dummy Variable Approach where in most of the crops, it could only identify break during the period where Karnataka experienced stagnation in agricultural production.

35. Quadratic Discriminated Weather Score - A Regressor for Forecast of Rice Yield

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The study deals with the development of the forecast models based on the time series data from 1970 - 71 to 1994-95 for Rajpur district of Madhya Pradesh. A stepwise regression model using quadratic discriminant weather score, input variables, fertilizer nutrients (N, P and K) and the trend effect is obtained at each phase of the crop growth for the forecast of rice yield. All the models are found to be statistically significant i.e., the models are adequate. The values of coefficient of determination is found to be in the increasing order upto active vegetative phase of the crop growth. At the most 87.4 per cent of the variation in yield can be explained by regressors at this phase of the crop growth. The quadradic weather scores at pre-sowing phase, active vegetative phase and also at lag vegetative phase show significant contribution in the models developed at various phases of the crop growth. However, the forecast model developed at active vegetative phase indicate the significant contribution of input variables (N, P and K) along with the quadratic discriminated weather score of this phase. The forecast value obtained on the basis of various crop growth phases of rice yield during the year 1995-96

indicate that the forecast value (1514 kg/ha) at active vegetative phase of crop growth resemble very much to the observed value of 1524 kg/ha.

36. Sampling Over Two Occasions - Least Square Method and Missing Observations

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In sampling on two occasions, on the first occasion a simple random sample of n units is taken. A random sub sample of m units (matched) is retained for use on the second occasion and another independent sample of n - m units is selected (unmatched) with the first occasion. The matched and unmatched portions constitute the second occasion sample. If M_1 and M_2 are the population means on the first and second occasions respectively then for estimating the mean in the second occasion i.e. M_2, two independent estimators one based on the unmatched part and second based on the matched part are made. A minimum variance unbiased estimator for the second occasion mean is obtained by combining two estimators. In the present paper the mean of the population on the second occasion has been obtained by an alternative approach using least square technique. This estimator and its variance are the same as given in survey sampling literature. The estimators of the population mean for the second occasion is also obtained when there are randomly missing observations on the matched portion of the second occasion sampling.

37. On Some Aspects of Estimation of Heritability

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Heritability is one of the most important genetic parameter widely used in plant and animal breeding genetic improvement studies. The prime objective of these studies is to predict response due to selection. In literature several methodologies are available for estimation of heritability for different experimental situations. Unfortunately none of these provide always a valid estimate of heritability and the estimate is so inadmissible that no conclusions

can be drawn for the inheritance of the trait under consideration. Thus the present study deals with the empirical comparison of different procedures particularly computer oriented methods for exploring the methodologies which are not only resistant to aberrant values but also robust to underlying statistical assumptions for the admissible estimates of heritability.

In order to achieve this, samples from different populations are simulated for the situations of balanced, unbalanced, contaminated and presence of outliers. The exercise is carried out for various population parametric values of heritability. The methods of ANOVA, REML and ML have been utilised. From the results so obtained it is seen that ANOVA and REML behaved almost in a similar way for all the parametric values of heritability. The ML estimates are always found to be underestimated which clearly indicates some biasedness in the estimates. The behaviour is also seen for the case of unbalanced situation. The only difference between the two is the closeness to the population parametric values. In the case of unbalanced case REML estimates are very close to the population parameter as compared to the other methods. For the case of the contaminated populations, it is once again observed that REML estimates are better estimates as compared to other two methods. Finally the influence of aberrant values has also been examined. For this aberrant value is created deliberately by changing the normal value by varying degree of aberrant value and subsequently its effect on the estimate has been examined. It is being seen that even one observation in the data set, affects significantly to the estimate of heritability. In the presence of aberrant value, none of the method gives the reliable and correct estimate. However when the aberrant value is not far of from the rest of the data set then one can depend to a certain extent on the procedure of REML. In the case of extreme observations even REML also fails to yield estimates close to the parametric values. Finally, it is thus concluded that in most of the practical situations REML estimates are more accurate and reliable as they yield unbiased estimates of the variance components.