ABSTRACTS OF PAPERS

1. Testing Dose Responses on Proportions With Jackknife – A Revisit

K.K. Saxena & O.P. Srivastava

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In toxicological experiments, researchers are interested to study the drug effects when different dose levels of a drug are administered on a group of subjects. The data obtained from such experiments are in the form of percentage successes (mortality or survival) obtained at different dose levels. The hypothesis that the response is same for all dose levels against a suitable alternative is equivalent to testing as the regression has zero slope. For testing such hypothesis, the Students' t-test is recommended but its utility is of limited value as the degrees of freedom depend upon the number of doses rather than the number of subjects in the experiment. In this paper, a procedure for developing large sample test has been derived (for any number of dose levels) which depends on the number of subjects in the experiment. It is seen that Salsburg's test becomes a special case of this test if the number of doses are fixed as 3. The salient feature of the test procedure is that it does not involve the computation of a very large number of covariance estimates for finding jackknife estimate (which is required in the Salsburg's test). Moreover a direct and compact expression for the jackknife estimate and its variance has been derived which does not need separate computation of psuedo-values.

2. Extreme Value Analysis of Weather Variable at Pantnagar

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Data for the weather variables viz; maximum temperature, minimum temperature, relative humidity at 7 A.M. and 2 P.M., rainfall, wind velocity, panevaporation and bright sunchine period were recorded for a period of 10

years (1980–89) from the meteorological observatory Pantnagar distt. Nainital (U.P.) and analysed for forcasting the extreme values using Gumble's distribution. The analysis in the present study has been made according to the Gumble's extreme events theory explained by Subramanya (1989). The highest annual predicted values of each weather variables understudy with a return interval of two years is obtained alongwith their confidence limits. A graphical representation on log–log paper, by taking the values of T_p on x-axis and highest annual value of weather variable on y-axis, was used for fitting of Gumble's distribution. The linearity of the plotted curve, which shows that the weather variable has a Gumble's distribution, was tested using F-test. Finally a comparative study of predicted values and actual values was made.

The Gumble's distribution fits for the extreme values of weather variables viz; maximum temperature, minimum temperature, relative humidity at 7 A.M., wind velocity, panevaporation and bright sunshine period. The heighest predicted values for the year 1991 alongwith their 95% confidence limits given in parenthesis of the above mentioned variables are 42.82°C (42.04°C – 43.57°C), 29.44°C (28.98°C – 29.90°C), 99.3% (98.74 – 99.85%), 18.60 km/hour (17.61 km/hour – 19.01 km/hour), 17.64 mm. (15.51 mm – 19.77 mm) and 12.01 hours (11.77 hours – 12.39 hours) respectively. The Gumble's distribution did not fit for rainfall and relative humidity at 2.00 P.M. The percentage deviation of predicted values with actual values of weather variables is not fluctuating much.

3. Estimation of a Finite Population Total in Randomized Response Surveys

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Problems of estimation of a finite population total of a variable of sensitive in nature are studied under randomized response (RR) surreys. Some optimal sampling strategies are presented under different superpopulation models. A few existing RR techniques are modified to obtain optimal sampling strategies. Performances of a few popular sampling strategies are compared under the proposed RR technique.

4. Improved Predictors in Survey Sampling Under a Super Population Model

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This paper considers the estimation of population mean under a super population model and presents a class of improved estimators. Dominance of this class over the conventional unbiased estimator with respect to predictive mean squased error is studied and a simple condition is deduced. Unbiased estimation of the bias and efficiency gain are also discussed.

5. Statistical Inferences for Intraclass Correlation

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Several approaches have been put forward by different research workers since the last decade or two, to draw statistical inferences about the point and interval estimators and for testing of hypotheses about intraclass corelation.

In this paper these methods of estimating intraclass correlation (ρ_x)and testing of hypotheses about it have been presented, discussed and compared, with some recommendations for the concerned research workers. Tests based on Konishi's transformation have also been proposed. It is observed that Swiger's formula is to be used when ρ_x is small, Smith's formula is most suitable and the ML method performs somewhat better for very small values, while constructing confidence limits. Modified Z-test given by Donner *et al* is recommended for testing equality from dependent samples, whereas in case of independent samples, Z-test based on Konishi's transformation may be used. For testing the significance, the normal deviate test based on Konishi's transformation is recommended. Properties of tests based on approximate F-distribution and modified likelihood ratio need investigation.

6. Bayesian Estimation of Scale Parameter and Reliability in Weibull Distribution Using Asymmetric Loss Function.

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In this paper Bayes estimates of the scale parameter and reliability function in the Weibull life testing model have been derived. The loss functions used are asymmetric to reflect that in most of the situations of interest, over estimation and under estimation may not be equally harmful. A number of prior distributions have been taken to express the belief of the experimenter regarding the parameter. The estimates thus obtained have been compared with the corresponding estimates with the squared error loss function (SELF).

7. On Normality of Crop Yield

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Various routine statistical tests are based on the assumption of normal population. It is, therefore, necessary to examine the normality of the character under study, before applying any statistical procedure to it. The yield of a crop is combined effect of many factors. As these factors vary, there is variation in crop yield which affects normality. Not much research has been carried out about the normality of crop yield. Various reasons for and against normality have been put forth by many scientists. In the present paper, with the help of rice crop yield data of nine tehsils of Ratnagiri district of Maharashtra, an attempt has been made to examine normality of crop yield data. The tests used for testing normality are also discussed. The present analysis indicated that the rice crop yield data follow normal probability law in majority of cases.

8. Preharvest Forecasting Model for Scheduling Irrigation to Groundnut

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The farmers of Saurashtra and other regions of Gujarat have started cultivating groundnut (*Arachis hypogaea* Linn.) in Rabi and Summer, in addition to the usual monsoon season. Preharvest forcasting of the yield of groundnut in the Rajkot district of Saurashtra has been attempted by selecting rainfall variables during the crop growth in monsoon using stepwise regression analysis. The selected variables X_4, X_7, X_{10}, X_{14} and X_{18} are the rainfall during the Meteorological standard week 25th of June, 27th of July, 31st of August, 35th and 39th of September. The rainfall during these weeks correspond to the germination, vegetative growth, flowering and pegging and full pegging to pod maturity stages were found to be the critical stages of the crop. These critical stages would therefore serve as guidelines in scheduling irrigation to the groundnut crop raised during Rabi November to March and Summer during February to May.

9. An Econometric Analysis of Growth Trends and Area Response of Commercial Crops in Punjab Agriculture : Some Policy Issues.

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An attempt was made to examine the changes in the composition and growth of commercial crops like cotton, sugarcane, oilseeds and potato in Punjab as well as to analyse the factors responsible for determining the area under these crops. The analysis revealed that the importance of these traditional commercial crops has diminished over time. Because of the introduction of New Agricultural Technology supported by remunerative pricing policy, the farmers have been encouraged to put more and more area under the two cereal crops viz; paddy and wheat. The main factor responsible for replacing area from groundnut was the development of new technology in cereals. In all other

traditional commercial crops relative price, price stability and lagged area are some of the important factors influencing the area under these crops. There is a need of a long run price policy supported by efficient procurement system which can ensure economic advantage for these crops.

10. Integrated Model in Forecasting the Yield of Groundnut

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To develop suitable model for pre-harvest forecast of groundnut, based on available biometrical characters, agricultural inputs and weather variables, a pilot survey was carried out in Rajkot district (Gujarat) during kharif 1984–86. Multistage stratified random sampling technique was used for selection of villages to enter finally in the forecast model the technique of stepwise regression was used. Agricultural inputs and daily rainfall data were also recorded. The relation between the yield and the biometrical characters, agricultural inputs and weather variables was studied. It was observed that forecast based on available yield attributes of groundnut is possible about 4 to 8 weeks before harvest.

11. A Study on Cost of Artificial Insemination in Himachal Pradesh

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The present study was conducted during 1990–92 in Himachal Pradesh, to estimate the cost of Artificial Insemination per conception. The data on various items of Artificial Insemination were collected from three different semen banks located at Ghanatti (Shimla), Bhangrotu (Mandi) and Palampur (Kangra). The cost of (i) maintenance of bulls (ii) semen collection (iii) freezing

and storage of semen (iv) transportation of semen and (v) production of liquid Nitrogen were estimated. The cost of maintenance per bull per day was calculated as Rs. 86.73 at Ghanatti, Rs. 76.85 at Bhangrotu and Rs. 59.22 at Palampur. The cost of semen collection per bull per day was worked out to be Rs. 19.15, Rs. 18.09 and Rs. 17.35 at semen banks located at these centres respectively. The cost of freezing and storage of semen was the highest Rs. 8.81 at Ghanatti followed by Rs. 4.72 at Bhanagrotu and Rs. 3.39 at Palampur. The cost per dose of semen was Rs. 19.65, Rs. 10.13 and Rs. 7.91 and transportation cost was estimated as Rs. 10.87, Rs. 3.03 and Rs. 1.93 at Ghanatti, Bhangrotu and Palampur respectively. The cost of production of 1 litre of liquid nitrogen was the highest Rs. 33.22 at Ghanatti, followed by Rs. 18.60 at Bhangrotu and Rs. 15.03 at Palampur. The cost per Artificial insemination pooled overall the three semen banks was worked out at Rs. 85.50.

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12. On Generalised Ratio-cum-Product Type Estimator

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A general modified ratio cum product type estimator using c.v. (x) is proposed. Its bias and MSE up to the first order of approximation are obtained. It has been shown that the proposed estimator is superior among its members of the class under certain conditions, as well as it is as efficient as linear regression estimator for optimum value of some arbitrary constant.

13. A Generalized Randomized Response Procedure

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A generalized randomized response procedure has been considered. Generalized method requires the use of m random devices. The conditions when

the proposed generalized strategy is efficient as compared to the Warner strategy and to the Mangat and Singh strategy has been obtained for the case when respondents are truthful. Also the conditions when the generalized procedure reduces to Warner and Mangat and Singh procedure have been given.

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14. A Test of Linear Regression of Power of Tests Involving non Central F (F') statistics

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Attempts are made to compare powers of tests using non central F(F') statistics along with the test of linearity between two sets of powers obtained separately. There are many approaches to get the power of different tests using the statistic. Some of them are of using incomplete β function through pattanaik's approximation using the charts of Pearson and Hartley. A discussion is also given to get the powers of tests using F' statistic if the non centrality parameter and corresponding powers are known for the non central x^2 (x'^2) distribution involving in the F' distribution.

15. Effect of Rainfall Distribution on the Yield of Groundnut during its Growth Period

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Groundnut crop is subjected to moisture stress (rainfall) at different stages of its growth. A study to investigate the effect of rainfall distribution during the crop cycle is undertaken in Rajkot district of Gujrat state. For this purpose data was collected on rainfall at different intervals after sowing of the crop alongwith yield of groundnut under the survey, "Pre- harvest forecasting of yield of groundnut" by I.A.S.R.I., New Delhi. The data was utilized for

establishing a relation between rainfall at different stages of crop growth and yield during the years 1984 to 1986. It was observed that depending upon the rainfall and its distribution groundnut yield was as low as 123 kg. and as high as 1278 kg. per hectare in different taluks of Rajkot district during kharif 1984. The partial regression coefficients of rainfall after 1–30 days and 31–50 days of sowing were positive and significant for pooled data whereas in 1984, rainfall after 1–30 days, 51–60 days and 81–90 days of sowing of the crop contributed significantly.

16. Rayleigh Distribution – Some Approximations to M.L. Estimation

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The maximum likelihood equation in Rayleigh distribution to estimate its scale parameter from type-II censored sample is considered. Two modifications to the likelihood equation to get explicit estimators are suggested. The resulting estimators are used to evaluate the reliability function. The proposed estimators are proved to be asymptotically equally efficient. Small sample comparisons are made through simulation.

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17. Use of Log-Linear Models in Census

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The aim of the present study is to infer about the relationship among the nested classified population such as type of worker, sex and the area of belonging for the states under consideration and also for all India. Three factor log-linear model is used under different hypotheses which is tested with help

of Pearson's chi-square test. The study reveals that the sex and the area of belonging play a significant role to select the type of job. However, no association between the sex and area is evidenced for a given type of labour.

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18. Small Area Estimation of Buffalo Milk

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The estimates of milk production at state level in the country are obtained through integrated sample surveys. However in the larger context of rural development planning it has become necessary to develop estimates of acceptable quality for each district which is considered as the unit of planning. Although integrated sample surveys generate adequate data to provide estimates with reasonable precision for large areas but do not do so for small area sue to inadequate sample sizes.

An investigation made at I.A.S.R.I. demonstrated the feasibility of obtaining district wise estimates of cow milk through the adaptation of the available small area techniques utilising latest livestock census and recent survey data. The information on crossbred and nondescript animals was used as auxiliary information for developing synthetic and other estimators. Since the livestock census does not provide breedwise number of milk buffaloes the procedure used for estimating cow milk is not directly applicable for buffaloes. In this paper an attempt has been made to develop district wise estimates of buffalo milk, using an alternative method. The number of milk buffaloes were estimated using a raking ratio method of estimation which is iterative method for adjusting the cell values of a two-way contingency table. The estimates of cell frequencies are iterated using the marginals of census as well as sample. It was seen that 3 to 4 iterations were sufficient to estimate the breedwise number of milking buffaloes in the small area. Utilising the number as estimated the buffalo milk production in small areas (districts) has been obtained.

19. Growth Analysis of Linseed Crop in Chhattisgarh Region

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Growth rate analysis of the linseed crop grown in Chhattisgarh region of Madhya Pradesh, for three periods : Period I (1971–72 to 1980–81), Period II (1981–82 to 1990–91) and the consolidated period, Period III (1971–72 to 1990–91) showed negative trend in area and production in all the districts/regions barring Raigarh and Sarguja districts. While productivity showed increasing trend during Period II, which was reflected in Period III.

20. Economic Study of Pulse Production in Rajasthan

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Pulses are the important source of protein in Indian diet, but due to its low productivity the per capita availability is hardly 48 gms/day as against 85gms/day recommended by nutritional experts.

In Rajasthan Pulses are grown mostly in Kharif season and it constitutes more than 2 million hectares which is about 15% of the total area under foodgrains. The average yield is very low 200 to 300 kg/ha as compared to 500 kg/ha in India. Since there is a large gap between supply and demand, there is an urgent need to review the performance of these crops. Specifically

(i) to examine the growth rates of area, production and productivity of pulses;

(ii) to examine the variability in pattern of production of pulses and

(iii) to study the performance of pulse production through plan periods.

The data from published reports of Rajasthan from 1953–54 to 1988–89, are used for the study. Different econometric models have been fitted to the data for area, production and productivity. The average value of first three years for each variable have been taken as the base value.

The analysis of linear growth rate models for Kharif pulses for the past 30 years reveal that

(i) growth rates per annum in area, production and productivity are 1.81, 1.36 and 0.20 respectively;

(ii) growth rates per annum in area, production and productivity of Tur are 8.85, 13.56 and 2.8 respectively.

21. Human Energy Consumption in Wheat Production – A Case Study of Hill Region of U.P.

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To assess the consumption of human energy in several agricultural operations particularly land preparation, sowing, fertilizer application, and irrigation, village Igyardevi representing the Pithoragarh district has been selected purposively. The residents of the village were divided in two categories based on the size of land holdings; marginal farmers (with land holdings of one hectare) and small farmers (with land holdings of one to two hectares). The farmers were of only these two categories. Z-test was applied to test the significance of mean difference of human energy between these two categories of farmers. These difference were found to be significant for the operations of land preparation, sowing and fertilizer application, whereas it was non-significant for the operation of irrigation.

22. A Study on Yield of Paddy under different Scenarios of Occurrence of Flood.

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The yield of crop is affected by the absorption of quantity of water in the root zone of the crop, which depends upon the texture of the soil (clay

and loamy) and land topography (plain and slopy) varying from crop to crop. During the occurrence of flood, the texture and topography of the soil play a great role to absorb and drain away excess water quickly showing thereby better results. A study of this effect is undertaken on paddy crop in Tanda tehsil of Uttar Pradesh. The data was collected on texture and topography of the soil, inputs applied and yield of paddy crop in the sample fields where occurrence of flood was recorded under the scheme, "Pilot sample survey to study the impact of flood on agricultural production in a region of Uttar Pradesh", conducted by Indian Agricultural Statistics Research Institute (ICAR) New Delhi during the years 1981–83.

The results show that the yield of paddy per hectare under different scenarios of occurrence of flood was 18.3 quintals (plain clay) 17.1 quintals (plain loamy) 18.00 quintals (slopy clay) and 16.6 quintals (slopy-loamy).

23. Prevalence of Morbidity among Ovines in a Rural Area

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The paper relates to an analysis of data on morbidity of ovines in Tiruchirapalli district of Tamil Nadu. The data were obtained through a large scale sample survey conducted by IASRI. A substantial number of sheep as well as goats were found to be affected by morbidity during the survey period; the incidence being more frequent among females as compared to males in each species.

Enteritis, sheep pox and pneumonia dominated the disease profile. Enteritis accounted for a lion's share of the morbid cases in each species; the percentage of its incidence being 50 in sheep and 56 in goats. Sheep pox was prominent with 13% affictions. Pneumonia accounted for nearly 4% and 2% of the cases in sheep and goats respectively. About 42% of the disease afflictions in the sheep species and 63% in the goat species occurred among lambs and kids respectively.

The duration of morbidity in the ovines under survey was usually a week or less. The cases lasting more than a week amounted to 24% in sheep and 20% in goats. Over 50% of the disease afflictions in each species were found to last up to 3 days only.

24. Estimation of Parametric Function in Repeat Surveys

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Sometimes our interest may lie in obtaining the minimum variance linear unbiased estimator of population parameter, whether for various years or/and seasons of these years, for fluctuations between years, the seasons between years or/and within the same year or for average/total over some or all the years or seasons over years, in the conduct of a repeat survey over seasons of several years for uni-character as well as multi- correlative-character populations. In this paper attempts have been made to obtain the minimum variance linear unbiased estimators of the aforesaid parameters and all the parametric functions in general following projective geometry approach given by Gurney and Daly (1965).

25. Estimation of Production of Mulberry Leaves in Bangalore District

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In growing of mulberry and rearing of silkworms, there is an agricultural base providing whole/part time gainful occupation to a large number of agricultural families in villages and semi- urban areas. Karnataka State occupies a prominent place in the sericultural map of India and is the biggest producer of mulberry raw silk in the country. A pilot sample survey to estimate the acreage under mulberry and production of mulberry leaves and reeling cocoons was conducted by Central Silk Board, Bangalore in collaboration with Indian Agricultural Statistics Research Institute, New Delhi in selected number of villages spread over nine taluks of Bangalore district during 1986–88. In the present paper the estimates of production of mulberry leaves under rainfed and irrigated conditions were obtained from the data collected from sericulturists in this survey.

The total mulberry leaf yield under tall categories in Bangalore district was estimated as 693 thousand metric tones in a year with 9.6 per cent standard

error. Devanahalli taluk recorded the highest estimate at 138 thousand metric tonnes followed by Hoskote, Kanakapura, Ramanagaram, Channapatna and others. The estimates of mulberry production per hectare per annum in the district was 43.6 tonnes with 8.8 per cent standard error. There was a wide fluctuation in estimates of mulberry production per hectare over different taluks. This estimate was highest in Doddaballapur taluk followed by Devanahalli, Hoskote, Bangalore North, Nelamangala taluk and others.

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26. Optimal Reliability System Enjoying the Advantage of the Technological Progress and Exposed to the CCF's

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In this paper, we consider stochastic reliability systems that are exposed to two distinct modes of failure (as distinct from and also practically more relevant and useful than, most reliability models considered in some recent past), namely : (i) stochastic failures of individual items and (ii) the so-called (recently introduced "idea"), Common Cause Failures (CCF's). Further these systems are brought nearer to reality thus bestowing the virtue of larger coverage of operational models by introducing the new parameter into the modelling formulation, namely, these systems enjoy the advantage of latest / current "technological progress(es)". Analytic procedure is developed to identify cost-optimal systems from among the above described (class of) reliability models.

The theoretical results were well supported through empirical work not only for purpose of demonstrating their illustrative use but also to bring out from the results a quality analysis.

27. Statistical Analysis of Long-term Experiments in Rice-Rice System

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Statistical analysis of long-term experiments in rice-rice system was carried out in respect of Chiplima, Bhubaneswar, Karnamana and Maruteru centres. In Chiplima centre, $N_3P_2K_1$ was the best treatment giving average yield of 33.36 q/ha during *Kharif* and 36.01 q/ha in *rabi*. From the yield trend equation $Y = 23.583 + 2.433t - 0.0432t^2$, ($r^2 = 0.64$ q/ha) it was observed that during kharif, yield would decrease after a lapse of 28 years reaching a level of 14.02 q/ha in the 60 year. However during *rabi*, the yield actually started declining after 11th year and the decline would be sharp after 20th year ($Y = 18.773 + 6.375t - 0.28t^2$, $r^2 = 0.91$ q/ha). At Bhubaneswar centre during *kharif* $N_2P_2K_1$ gave the average yield of 43.81 q/ha and the yield increased yearly at the rate of 2.07 q/ha. During rabi, $N_3P_2K_1$ decline in yield was sharp after 10th year as seen from the trend equation ($Y = 21.09 + 10.54t - 0.81t^2$, $r^2 = 0.74$ q/ha). At Karmana centre during *kharif*, $N_3P_2K_1$ gave the average yield of 40.94 q/ha and yield started increasing after 9th year as observed from the trend equation ($Y = 52.746 - 2.837t + 0.129t^2$, $r^2 = 0.57$ q/ha). In *rabi* $N_2P_2K_0$ gave average yield of 27.55 q/ha, and the yearly rate of increase in yield was 0.25 q/ha. At Maruteru centre, $N_1P_1K_1$ gave average yield of 34.22 q/ha during *kharif*, with an yearly rate of increase of 1.6 q/ha and in rabi, $N_3P_2K_1$ gave average yield of 42.14 q/ha. It started increasing after 5th year as observed from the trend equation ($Y = 52.245 - 2.304t + 0.228t^2$, $r^2 = 0.53$ q/ha). Initial soil analysis was done and plant uptake values were obtained to explain the results.

[Suffix 1 used for 40 Kg/ha, 2 for 80 kg/ha and 3 for 120 kg/ha]

28. An Inequality for Variance Balanced Design When v < b.

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Saha and Pal (1986) have shown that the nonzero eigenvalue is always less than the harmonic mean of replication numbers $\bar{r}_H = \sum_{i=1}^{V} \frac{r_i - 1}{V}$ and so $\theta < \bar{r} = \sum_{i=1}^{v} \frac{r_i}{v}$ for VB designs excepting the equireplicate orthogonal block designs. Here the same result for connected EB designs, has been extended.

The main aim of this design problem is to provide an important parametric relation $\bar{k} < \theta$ when $v < b$, otherwise $\bar{k} > \theta$, for any variance balanced (VB) designs, where $\bar{k} = \sum_{j=1}^{b} \frac{k_j}{b}$. Further an attempt has been made to show that (i) $\theta_1 < \bar{r}_H$ and hence $\theta_1 < \bar{r}$ and (ii) $\theta_2 > \bar{r}_H$ for all connected efficiency balanced (EB) design, where θ_1, θ_2 are the non-zero eigenvalues of C matrix of a Connected EB design.

29. Improving Efficiency of Index Selection by 'Rounding' in Poultry

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In the present investigation, 'rounding' procedure of Tai (1989), originally applied to plants for improving the efficiency of index selection, has been utilised in poultry. Data on 340 pullets of 34 sires over an year 1989–90 were collected from ICAR project, 'Development of specialized sire and dam lines for production of commercial broilers' running in the Department of Animal Breeding, CCS Haryana Agricultural University, Hisar. The different traits considered were egg weight at 32 weeks of age (X_1), egg production upto 280 days (X_2) and age at first egg (X_3) with relative economic weights, 6.83, 10.20 and –2.12, respectively. The goal of selection was to increase the egg weight

and production and to reduce the age of first egg. Phenotypic and genotypic variance-covariance matrices were estimated by half sib analysis and the heritability estimates were 0.63, 0.42 and 0.33 for X_1, X_2 and X_3 respectively. The eigen values and associated eigen vectors of the product $(\hat{\mathbf{P}}^{-1}\hat{\mathbf{G}})$ were obtained by solving the equation $\left|\hat{\mathbf{P}}^{-1}\hat{\mathbf{G}} - \Phi\,\mathbf{I}\right| = 0$. The three eigen values were 0.7649, 0.3647 and –0.0686. Chi-square test indicated highly significant results for the first and second but not for the third. The eigen values are also the heritability estimates of the three transformed variables. The third variable has negative and non-significant estimate of heritability. The selection index (I) obtained by estimating its coefficients as $\hat{\mathbf{b}} = \hat{\mathbf{P}}^{-1}\hat{\mathbf{G}}\,\mathbf{a}$ was

$$I = 10.7185\ X_1 + 4.2284\ X_2 - 2.5269\ X_3$$

where X_1, X_2 and X_3 are the observed values.

The new selection index (J) formed by transforming the original traits into a new set of variables and also after rounding off the third variable associated with non-significant eigen value was :

$$J = 16.0216\ Y_1 - 2.7369\ Y_2$$

where, $Y_1 = \mathbf{c}_1'\mathbf{X}$, $Y_2 = \mathbf{c}_2'\mathbf{X}$ and $\mathbf{X}' = (X_1, X_2, X_3)\,\mathbf{c}$, corresponding eigen vectors.

The expected response to selection based on (I) $R_I = 22.7579$ and that based on J is $R_J = 22.7550$ assuming intensity of selection, $i = 1.4$. Thus it is obvious that R_I is almost equal to R_J. Since the estimate of R_j is based on fewer number of variable with higher heritabilities, R_J is expected to be more precise. Therefore, it can be concluded that selection based on index j would be more reliable than based on I.

30. Construction of Second Order Slope Rotatable Designs using Symmetrical Unequal Block Arrangements

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Hader and Park (1978) introduced slope rotatable central composite designs (SRCCDs). Victorbabu and Narasimham (1991) studied in detail the conditions

to be satisfied by general second order slope rotatable design (SOSRD) and constructed SOSRD using balanced incomplete block designs. In this paper, a new method of constructing SOSRD using a symmetrical unequal block arrangements with two unequal block sizes is suggested. Some illustrative examples are given.

31. Experimental Factors Influencing Variability in Research Data of Pulse Crops

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The results of 1841 experiments conducted during 1980-1990 on seven pulse crops at 15 locations in Gujarat State were scrutinized. The experimental variability (C.V.%) was influenced by locations, crops, plot size, field layout and number of treatments as well as replications. The C.V.% followed positive skewed distribution. F test coupled with C.V.% for data indicated that the experiments having 32 or more C.V.% are less reliable.

32. D^2—Analysis In Grain Sorghum

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The experimental material of 110 diverse genotypes, was evaluated for their variability and genetic divergence using Mahalanobis'D^2 - Statistics, during 1982 -83 at the Main Sorghum Research Station, Gujarat Agricultural University, Navsari. A wide genetics diversity was revealed by the D^2- analysis and by applying clustering technique, 110 genotypes were grouped into ten clusters. The pattern of D^2- clusters clearly indicated that the geographical distribution in sorghum was not fully related to genetic diversity. Some clusters were highly divergent from other clusters. The genotypes SPV 404, SPV 96,M 50, M 35, M 68, M38, M 34, M 52, GJ 108, and B.P. 53 may serve as potential

parents for hybridization programme because they possessed high yield performance, high cluster means and genetic divergence for many desirable traits, which will be most useful to plant breeder for developing varieties/hybrids which possess not only high yield but early maturing and dwarf stature, suitable for most of the sorghum growing areas in the state of Gujarat.

33. Variation in Leaf Attributes of Cotton

V.B. Darji

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A study was under taken to predict quantity of insecticide solution to be sprayed at various growth stages of cotton Hybrid 4. Leaf area, leaf area index (LAI), leaf number and weight increased upto 120 days of crop age and thereafter these variables showed declining trend. Quadratic trend due to age of crop was observed for all attributes. Leaf weight accounted for maximum variability of LAI. Prediction equations were worked out for each variable.

34. Genetic Parameters in Green Gram

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Thirteen pure breeding lines of green grain and their F_2 and F_3 derived from a dialle set without reciprocals were analysed. The GCV, heritability and genetic advance were estimated for nine characters viz plant height, shoot length, root length, nodules/plant, pods/plant, pod length, seeds/pod, 100 seed weight and seed yieid/plant. In general all the characters in F3 exhibited higher estimates of all the parameters than in the F2. Pods/Plant exhibited high heritability with high genetic advance suggesting that it may be improved through phenotypic selection.

35. Selection Index Study In Chickpea

B.H. Prajapati, V.M. Bathar, K.R. Thaker And V.B. Darji

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The Interrelationship between grain yield and its attributes in chickpea (Cicer arietinum, L.) was studied using experimental data of 20 treatment combinations comprising of four levels of N and five levels of P. The field experiment was conducted at the Agriculture College farm. Gujarat Agricultural University. Sardar Krushinagar during rabi season of 1988. The straw yield, number of pods per plant, 1000-grain weight and number of branches per plant accounted for 98 per cent of the total variation in the grain yield.

36. A Comparison of certain Clustering methods

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A.P. Agricultural University, Hyderabad.

The performance of the four clustering methods viz, the Average Linkage, the Complete Linkage, the Divisive and Canonical method has been examined. Out of these four methods, the first three belong to the commonly referred hierarchical approach, while the other belongs to the ordination category. These methods were applied for clustering the districts of Andhra Pradesh on the basis of rainfall of 4 different seasons covering a period of 30 years (1961–62 to 1990–91). It was found that within a season all the four methods behaved in a similar way. In particular, within a season, the average and complete linkage methods resulted in almost similar clusterings, while the divisive method had a tendency to form small sized clusters. The canonical method, which is subjective with regard to the cluster formation, has the advantage of identifying the single object clusters (*i.e.*, the objects which are far apart) more efficient than the closer ones. The clusterings of the districts under a method, were found to vary with the season and a majority of the clusters consisted of a representation of districts from all the three administrative zones.

37. On Sequential Estimation of Genetic Parameters and Their Functions

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The concept of sequential estimation of gene, genotype or phenotype proportions of a population has been introduced under two situations viz. (i) Using the Hardy Weinberg law and (ii) when the law does not hold good.

The sequential procedure of estimation under these two cases has been discussed after highlighting the sequential sampling plan and efficient estimation of proportions and secondly the genotype and phenotype distribution of a population.

38. Two factor Change-over design based on Williams squares

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A method is given for constructing symmetrical type of change-over design based on Williams' squares having arrangement of combination of levels of two non-interacting factors. Two factors L and M with even and odd number of levels of each factor are taken. In the method of construction, a set of k or 2k sequences according to even or odd levels of sub-factor M are made by making use of Williams' squares for both the factors. The ith sequence of factor M is associated with each level in the ith sequence of factor L. The procedure developed has been illustrated for $k = 4$ and $k = 5$ respectively. The proposed design is suited to situations where residual effects are important and less number of units are required.

39. Two-Period Cross-over for Animal Clinical Trials

G.C. Chawla

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Two-period change-over design has been investigated taking into account three treatments by assuming subject effect as a random variable. Two-period and three treatment methodology is developed and its use is made to eliminate between subject variability in animal clinical trials. This design is compared with a design in which the subjects (animals) are assigned randomly to a single treatment. The comparison shows that we are less dependent on residual effect which is one of the important points always discussed, specially, in clinical trials. A numerical example is also presented.

40. Linear and non linear regression of Age at first Calving on Genetic Groups in Friesian *x* Sahiwal Crossbreds

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Data were collected from four military dairy farms viz Ambala, Jhansi, Lucknow and Meerut of various crossbred cows belonging to six genetic groups of Friesian (Fr) x Sahiwal (Sw) *i.e.*, 1/4 Fr, 3/8 Fr, 1/2 Fr, 5/8 Fr, 3/4 Fr & 7/8 Fr x Sw for age at first calving in days. Linear, quadratic and cubic regressions of Age at first calving on genetic groups were fitted and their corresponding R^2 values were observed to be 10.0%, 94.4% and 94.7% respectively. The differences in R^2 values of quadratic and cubic equations were not statistically significant. The least squares average age at first calving was found to be highest (994 days) for 1/4 Friesian x 3/4 Sahiwal crossbreds which gradually declined to minimum of 930 days for 5/8 Frisian x 3/8 Sahiwal and then gradually increased to 970 days for 7/8 Friesian x 1/8 Sahiwal.

41. A Classification of the Districts of Andhra Pradesh on the basis of the relative potential of paddy crop through the cluster analysis approach

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The approach of cluster analysis particularly the Single Linkage method was applied for identifying the clusters of the districts of Andhra Pradesh having similar affinities for paddy crop. It is assumed that agro-climatic as well as socio-economic factors are equally responsible for the crop preference and these were duely considered in the classification. The study which covers a period of 24 years (1966–67 to 1989–90) since the introduction of new technology, revealed a differential response of the two technological sub periods *i.e.*, the 'new technology' and the 'post technology' with regard to the clusterings. The clusterings obtained, under a sub period corresponding to kharif and rabi seasons of paddy were also entirely different. During the post technology sub period, there existed only 5 clusters in kharif season as against 8 during the rabi season. The districts which exhibited an independent behaviour during a season were grouped alongwith the other districts in the other season. Several clusters consisted of representations of districts from all the three regions of Coastal Andhra, Rayalseema and Telangana. The differentialities that existed between the clusterings of both the seasons suggest the need for studying not only cropwise but seasonwise affinties of the crop for planning suitable crop improvement measures in these clusters of the districts.

42. Balanced p-ary and Partially Balanced p-ary Designs Through Triangular Designs

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The present investigation discusses the construction of balanced p-ary and partially balanced p-ary designs, obtained by associating incomplete block design, with a BIB design of series v, b = v (v–1), r = v– 1, k = 2 and λ = 1, provided the blocks of the given BIB design is considered as a number of

treatments, of triangular PBIBD. It is noted that the balanced p-ary designs, obtained required smaller number of replications.

43. Interplot Interference and Its Effect on Treatment Contrasts in a Tomato Field Trial

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Interplot interference arising from application of nonvarietal treatments in nearby plots was studied in a tomato field trial conducted at Pantnagar in an RCBD with 4 blocks and 8 treatments including one control. The aim of the trail was to compare yields of nutritional treatment i (i=1, ... , 7) and control treatment i = 8. The usual RCBD model $y_{ij} = \mu + \tau_i + \beta_j + \varepsilon_{ij}$ $(i = 1, \ldots, 8;\ j = 1, \ldots, 4)$, following Mendenhall (1968), was reformulated as $y_m = \theta_o + \sum_{i=1}^{7} \theta_i X_{im} + \sum_{j=1}^{3} \Phi_j Z_{jm} + \varepsilon_m$, or, equivalently, as $Y_{n\times 1} = \underset{n\times 1}{1} : \underset{n\times 7}{X} : \underset{n\times 3}{Z} \left(\begin{matrix} \theta_0 \\ 7\times 1 \end{matrix} : \begin{matrix} \theta \\ 3\times 1 \end{matrix} : \Phi \right)' + \underset{n-1}{\varepsilon}$ where m = 1, . . ., n; n is total number of plots; $\theta_0 = \mu + \tau_8 + \beta_4$; $\theta_i = \tau_i - \tau_8$, i=1, . . ., 7; $\Phi_j = \beta_j - \beta_4$, j = 1, 2, 3 ; X_{im} is 1 if observation on plot m belongs to treatment i and 0 othrwise; Z_{jm} is 1 if observation on plot m belongs to block j and 0 otherwise; X and Z are treatment and block design matrices; $\theta = (\theta_1, \ldots, \theta_7)'$ is treatment contrast vector; $\Phi = (\Phi_1, \Phi_2, \Phi_3)'$ is block contrast vector; and $\varepsilon \sim N(0, \sigma_\varepsilon^2 I_n)$. When fitted, this model, not accounting for interference, yielded nonsignificant $\hat{\theta}$; residual SS = 24, 540; CV = 26% and R^2 = 23%. Following Draper and Guttman (1980), the model was extended to $Y = (G1 : GX : Z)(\theta_o : \theta : \Phi)' + \varepsilon$ to bring interference into focus through nxn symmetric matrix G with its elements as g_{kk}=1, and $g_{kp} = |\alpha| < 1$ $(k \neq p)$ if plots k and p were immediate neighbours and 0 otherwise; k, p = 1, . . ., n. The extended model, when fitted, delivered $\hat{\alpha} = -0.24$ significant at $p < 0.01$, indicating presence of interplot interference; estimates θ_i $(i = 1, ..., 5)$ turned out to be significant; residual SS decreased to 15,278; CV decreased to 21% and R^2 increased to 52%. It thus appeared that taking cognizance of interplot interference in trials in which its presence is anticipated could lead to increased precision and reduce the danger of arriving at erroneous conclusions.

44. Least Squares Parameter Estimates of Macro-Equation Obtained by Aggregating a Micro-Equation.

D.K. Grover and L.S. Kaushik
HAU, Hisar.

Least squares estimate of macro-equation parameters β has been found by making use of micro-equation parameters β_i $(i = 1, 2, \ldots, n)$ under the assumption of simple aggregation. The economic relationship for the i^{th} unit has been considered as

$$Y_i = X_i \beta_i + \varepsilon_i \; ; \; i = 1, 2, \ldots, n \qquad \ldots (1)$$

while macro variable and are obtained by simply adding over the units. The model thus, considered is

$$\underline{Y} = \underline{X}\beta + \underline{\varepsilon} \qquad \ldots (2)$$

Expectation of any one element of β of (2) will be weighted average of all β_i's of (1). In practice the coefficients do not remain fixed, the assumption is relaxed and β_i's are assumed random with mean as β. Unbiasedness of $\hat{\beta}$ the estimate of β has been established under the relaxed assumption.

45. A Study on Marketed Surplus of Important Food Grain and Pluses of Farm Households in Haryana

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The present study was undertaken to estimate the marketed surplus of wheat, barley, bajra and gram of farm households of Sirsa district, Haryana. In all 98 farmers comprising 60 small, 23 medium and 15 large were selected randomly by employing multi- stage sampling procedure for the selection of district, block and village. The data were collected through personal interview on production, consumption, stock position and other disposals for the estimator of marketable and marketed surplus of various crops under consideration for the crop year 1991–92. Marketed surplus for wheat have been estimated to the tune of 10.85, 53.05 and 168.35 quintals for small, medium and large farmers

while 5.19, 7.35 and 13.40 quentals in case of barley; 2.33, 4.81 and 7.28 quintals for bajra and 4.36, 15.30 and 36.34 quintals for gram respectively. In percentage terms marketed surplus w.r.t. average stock; wheat and bajra has increased while in case of barley and gram it has decreased as the size of holding has increased.

46. Modelling the Effect of Rainfall and its Distribution on Cotton Yields

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The proposed model, based on relating cotton yields deviations either with seasonal or stage specific rainfall deviations, was found more suitable than relating their absolute values and predicting cotton yields. The rainfall occurrence during flowering and green boll periods showed positive direct and negative indirect effects on cotton yields. On the basis of this proposed model with the help of rainfall, the cotton yields can be safely forecasted.

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47. Study of Changes in Land Holdings and Resource Endowments

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For evolving agricultural development strategy, a knowledge of the detailed structure and characteristics of agricultural holdings is imperative for effective and efficient planning. The present study has been undertaken to make temporal analysis of the structural changes which have occurred in the number of operational holdings, the area operated by them, irrigation resource endowment, land use efficiency and allocation of area to different crops during the period

1970–71 to 1985–86 at the national level. Relevant data for the study have been culled out from the available Reports of Agricultural Census of Ministry of Agriculture, Govt. of India.

One of the most significant aspects of structure of land holdings is the extent of concentration over the period. This has been measured by Lorenz ratio and Gini Coefficient of concentration. Non-parametric tests such as Slippage Test, Kruskal Wallis Test for Categorical data have been used to study the changes over time and categories of holdings.

Analysis of data of number of operational holdings over the 15–year period revealed significant positive growth at the rate of 2.48 percent per annum where as area operated had shown marginal increase from 162.14 million hectare in 1970–71 to 163.91 million hectare in 1985–86. The growth rate of operated area (0.06%) was not found to be statistically significant. The significant increase in the number of holdings but only marginal increase in the operated area during this period had resulted in statistically significant decline in the average holding size at the rate of 1.73 percent per annum. The computed values of Gini Coefficient of concentration indicated that the extent of inequity in the distribution of land among operated holdings of different sizes had been reduced in 1985–86 over 1970–71.

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48. On Construction of Second Order Slope Rotatable Design Over all Directions

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Park S.H. (1987) introduced Second Order Slope Rotatable Design over all directions (SOSRD OAD) and gave some methods of construction through Geometrical Configuration, Central Composite Designs, 3^n–factorial etc. Draper N.R. (1960) Herzberg A.M. (1967) Huda S. (1981) gave Embedding Techniques in Second Order Rotatable Designs (SORD). In this paper an attempt is made to construct V-factor SOSRD OAD from (v-1) factor and (v-l) factor SOSRD OAD using Embedding Techniques. Some illustrations are given to demonstrate the methods of construction.

49. Construction of Three Level Second Order Slope Rotatable Designs Using a Pair of Balanced Incomplete Block Designs

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Hader and Park (1978) introduced slope rotatable central composite designs (SRCCDs). Victorbabu and Narasimham (1990, 91a, 91b) derived a set of sufficient conditions for general second order slope Rotatable designs (SOSRDs) and gave several methods of their constructions using incomplete block designs. Victorbabu and Narasimham (1993) constructed in particular three level SOSRDs using BIB designs.

In this paper, a new method of construction of three level SOSRDs using a pair of balanced incomplete block designs is suggested. It is shown that the results of Victorbabu and Narasimham (1993) are subsumed in this method. Some illustrative examples are also included.

50. Fertilizer Management for Gram (Cv. ICCC–4) Under North Gujarat Condition

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A field experiment was conducted with four nitrogen levels (0, 20, 40 and 60 kg/ha) and five phosphorus levels (0, 20, 40, 60, and 80 kg/ha) on well drained loamy sand soil at the Agriculture College Farm, Gujarat Agricultural University, Sardar Krushinagar to ascertain the response on gram (Cv. ICCC–4) during rabi season of 1988. All the yield attributing and yield characters were significantly influenced with different levels of nitrogen and phosphorus showing increasing trend. Grain protein content also significantly increased with successive increases in Nitrogen and Phosphorus. From economic point of view, maximum net realization was recorded when crop was fertilized with 40 kg/ha application each of N and P. However, maximum net return was obtained by fertilizing gram with 40 kg N + 60 Kg P_2O_5 /ha under North Gujarat condition. The cost benefit ratios were above 6.5 for all the treatment combinations but N levels were more beneficial as compared to levels of P.

51. Full–Sib Correlation under Full–Sib Mating System (Two loci case)

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Many authors such as Fisher (1918, 1965), Wright (1921), Haldane (1955), Korde (1960), Herner (1956), George and Narain (1975), George (1975) have attempted generation matrix method of generating joint distribution (Correlation tables) of various pairs under different systems of mating. But all these authors have considered, single locus with two alleles cases only. In the present investigation an attempt was made to study the genetic correlations by using generation matrix method with particular reference to full–sib mating system in the case of two loci with two allels at each locus.

As the case of two loci with two allels were taken into consideration, the problem of linkage comes automatically. The gametic proportions of p (1–p)/2, p/2, p(1–p)/4 in the coupling phase and p/2, p(1–p)/2, p(1–p)/4, p/2 in the repulsion phase were considered. The ten classes of phenotypic mating and the various genotypic mating under each class were considered for this study. On the whole there were 45 genotypic matings. In the mating type mentioned above, the reciprocal crosses as well as reciprocal full-sib pairs were not separately considered.

Denoting the vector of frequencies for the nth generations as $u^{(n)}$, the recurrence relation for the vector of frequencies is given by $\underline{u}^{(n)} = \mathbf{A}\,\underline{u}^{n-1}$, where **A** is the generation matrix under full-sib mating system. Based on $\underline{u}^{(n)}$, the joint distribution (Correlation table) of full-sib pairs for the first three generations we derived and the correlation worked out. This procedure has been extended to 10 generations of full-sib mating. The correlation, in general case, under complete linkage and no linkage cases were calculated and graphs plotted. It was inferred that the correlations in both the cases increase as the generation advances. Under complete linkage case the correlation is consistently greater than that in the case of no-linkage case. Both these correlations will be turning to unity as number of generations increases.

52. Management System for Computing the ANOVA

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In almost all fields of studies in agriculture, biology, engineering, social science etc. generally the main purpose of conducting an experiment is to make comparisons among various treatments. For example, in case of agricultural research one conducts an experiment to compare grain yields of say three rice varieties under three management practices and five nitrogen doses. For this purpose a split-split-plot design can be used with nitrogen as main plot factor, management practice as sub-plot factor and variety as sub-sub-plot factor. Consider another example from food processing engineering to study preservation of *khoa* under three preservatives, two temperature and two storage time. Thus, here the treatment includes three levels of a preservative, two temperatures and two storage time. So we have a three-factor experiment in completely randomized design.

To analyze the data arising from the experiments of the type described above the algebraic analysis of variance (ANOVA) technique as given by Fisher is used in which hypotheses about the various components are tested. Various software packages like SPSS, BMD, etc. deal with narrow domain and can be used only for the commonly used designs. If a user is confronted with a new design he is helpless and has to write a new program as the above packages are not flexible.

In the present paper a state-of-the-art technology has been developed for computation of ANOVA table based on the design as per user's specification *i.e.*, by management of various sums of squares. The salient features of this package are :

(i) Executable version requires 14k in MSDOS,

(ii) Has portability at different hardware plateforms,

(iii) Runs without overlays and OS overheads.

Data based on 'n' number of factors the combinations of sums of squares are 2^n–1. The ANOVA Table of the design under consideration is computed by management from the sums of squares of these 2^n–1 combinations. The management taking effect by mapping based on empirical relation.

53. Designs for Asymmerical Slope Ratio Assays

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CCS, H.A.U., Hisar.

Incomplete block designs have been used quite effectively in Bio- assays. Designs for parallel line assays have been given by many workers. Design, given by Das and Kulkarni (1966), Kulsherstha (1969), Kyi Win and Dey (1980), Nigam and Boopathy (1985) and Puri and Gupta (1986, 1988, 1989, 1992), estimates the important bio-assay contrasts L_p, L_1, and L_1' free from block effects.

In slope ratio assays the contrasts of interest are Blank contrast (L_B), Intersection contrast (L_I), the regression contrasts and the slopes of the two preparations β_t and β_s. Das and Kulkarni (1966), Kulsherstha (1972) proposed some incomplete block designs for symmetrical slope ratio assays, which provides the estimation of L_I free from block effect but the Blank contrast (L_B) is confound with block effects.

In this paper some systematic procedures of construction of incomplete block designs are given for symmetrical/asymmetrical slope ratio assays which estimate important contrast of interest L_I and L_B free from the block effects. These designs have been identified as PEB designs with at most three efficiency classes.

54. Statistical Aspects of Farming System Research in the Homesteads of Kerala

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Farming system research (FSR) has become the major research theme in the tropical agriculture. The small size of holdings with a multitude of crop species and the increasing pressure on land makes FSR all the more appropriate in the context of homesteads of Kerala. The important research activities incorporated under FSR include, FSBDA (farming systems baseline data

analysis), FSAR (farming systems adaptive research), FSA (farming system analysis) and FSCR (farming system component research). As, many of these activities operate under certain amount of uncertainties, statistical analysis become mandatory and related aspects are discussed here. Classification and analysis of major farm systems based on agro- climatic conditions and pattern of agricultural production are aimed at FSBDA. As historical data at sub-zone levels are seldom available, feasibility of using small domain estimates in this connection has to be investigated. Forming target groups of homogenous farm systems, on-farm experimentation and monitoring and evaluation are the important activities under FSAR. Planning and implementation of experiments in the homesteads are critical ; systematic documentation of response over a wide range of circumstances would not only provide essential information for deciding the relevant factors but an alternative research tool. The diversity among components in outputs (yield/functions) is the central problem of evaluation ; and for that the basic attributes like productivity, sustainability and adoptability are to be considered. FSA aims at the basic research on farm system and the interaction among components are to utmost concern ; statistical procedures are to be developed to study interactions at different levels. FSCR is focused at the station-based applied and adaptive research on farm subsystems or components and statistical tools for this purpose have been considered in the past.

55. On Use of Bootstrapping for Estimation of Confidence Intervals of Heritability

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Genetic parameters like heritability are important in the theory of quantitative genetics. Although a number of estimators have been proposed in literature for heritability based upon various procedures such as information on relatives, selection experiments etc., there has been a distinct lack of availability of estimators of their precision. The available estimators of precision are generally based upon normal approximations of the sampling distribution. More so is the case of confidence interval estimation which is also suffering from these approximations heavily. This work is aimed at the confidence interval estimation of heritability using the non-parametric resampling Bootstrap

procedure. Attempts are made to follow the trend of confidence intervals for a range of heritability values with due comparison with the existing estimators at each stage using simulated data.

56. Performance of new wheat varieties and optimum fertilizer requirement in relation to dates of sowing

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The introduction, development and release of high yielding varieties, to a great extent have been instrumental in breaking the yield barriers and in helping to raise the ceiling of current yield levels. The dates of sowing not only effect the yield of present crop but also the subsequent crop. The fertilizer doses for the present crop need to be suitably adjusted for the dates of sowing. The study will be helpful to planners and other users in selection of varieties with their fertilizer requirement under normal and delayed sowing conditions. The results indicate that at most of the centres 15 to 21% fertilizer can be saved where the sowing is delayed.

57. Chisel Technology and its Economics for Improvement of Soils having Layers of High Mechanical Impedance at Shallow Depth

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Productivity of the soils having high mechanical impedance layers (Hardpans) at shallow depth is poor due to its adverse effect on the plant growth and root penetration of fertile sub-soil region. 'Chisel Technology' developed under the ICAR – All India Coordinated Research Project on 'Improvement of Soil Physical conditions to Increase Agricultural Production of Problematic Areas' provides favourable environment for root growth by reducing the

sub-surface resistance of the soil and data collected under the experiments conducted for this technology at various centres of the project is used for the present study.

The Chiseling of sandy loam, silty loam, silty clay loam and clay soils having high mechanical impedance layers encourages deep root growth, increases infiltration of rain and irrigation water and hence increases the yields of both rainfed and irrigated crops.

The economics of 'Chisel Technology' showed that in terms of monetary benefits, the total returns increased by Rs. 1716 to Rs. 3372/- q/ha assuming the sale price of sorghum/maize grain @ Rs. 170/q and sorghum and maize straw @ 50/q and Rs. 25/q, respectively.

58. On Structure of Sheep Population in Tonk District of Rajasthan

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Rearing of sheep is an important occupation of the rural people in arid and semi-arid regions, and particularly in hilly regions. It is a major source of income to weaker sections of people. In the present study the structure of sheep population of either sex was studied by utilising the data collected from selected villages in Tonk district of Rajasthan during 1991–92.

The strength of sheep in the area varied widely over all the rearers. It ranged from 3 to 234 in Malpura tehsil and 5 to 337 in Tonk tehsil. The average number of sheep reared per village in Malpura and Tonk tehsils were 1206 and 681 respectively. From the distribution of sheep rearers according to flock size, it was found that in Malpura tehsil 46.8 per cent of sheep rearers had flock size of 51 to 100 sheep while in Tonk tehsil 61.4 per cent rearer had flock size of 11 to 50 sheep. About 3 per cent rearers in Malpura and 1 per cent in Tonk tehsil were having a flock size of 200 or more sheep. The average flock size per rearer was 66.2 in Malpura and 48.0 in Tonk tehsil. The average male and female numbers in age groups of 6 months and below were respectively 7.6 and 8.9 in Malpura and 5.0 and 7.3 in Tonk tehsil, whereas in the age group of above 6 months these were 2.2 and 48.5 in Malpura and

1.2 and 35.3 in Tonk tehsil. Sheep rearers in the area were found rearing different breeds separately and in combination. The principal breeds of sheep observed were Kheri (including black face), Malpura and Cross-bred.

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59. Growth and Instability in Cereals Production of Orissa

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OUAT, Bhubaneswar

This paper presents the study on variability in total cereals production between the pre-and post-technology periods in the state of Orissa and it was observed that not only the main factors like average yield of the crop were responsible for variation in cereals production but there were also some other attributing interaction effects like change in area-yield covariance, interaction between change in mean area and yield and changes in area-yield covariance, etc., On the basis of the results obtained, some technological modification are suggested to bring the stabilisation at production level.

60. Construction of Variance Balanced Designs Through Latin Square Type PBIB Designs

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Several authors have discussed the construction of binary variance-balanced (VB) designs and ternary VB designs by using either from balanced incomplete block (BIB) designs or from balanced incomplete block (BIB) designs or from group divisible (GD) designs or Triangular PBIB designs. In the present investigation other systematic methods have been developed for the construction of VB designs using from (I) Latin Square type PBIB designs and its second associate treatments and (II) two Latin Square type PBIB designs. The construction of VB designs in further supported by examples.

61. Empirical Comparison of Different Selection Strategies for Genetic Improvement

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Simultaneous selection based on multiple traits is very useful technique of bringing improvement in the net merit of the individual both in plant and animal breeding experiments. There are several methods to achieve this objective and depending upon different situations, the efficiency of different selection procedures vary. In most of the procedures, their theoretical comparisons are made and necessary conditions have been identified under the principle of efficiency of one procedure over the other. There are, however, procedures available in the literature whose theoretical comparisons are not available and also not possible to compare theoretically because of non-availability of explicit solutions. Under these situations one is then left with the method of empirical comparison. In this case, all conclusions are drawn from the results obtained in analysing the real life situations. With this in mind, the present investigation has been undertaken to examine empirically the performance of three different selection strategies viz. Selection Index, Phenotypic Index and Transformed Culling method.

62. Seed, Feed and Wastage Rates of Bajra and Gram Crops in Rajasthan

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The present study aims at knowing the proportion of seed, feed and wastage of bajra and gram crops in Rajasthan. The percentage of seed, feed and wastage out of total production are 0.75%, 0.006% and 6.00% and availability of crop for human consumption is 93.244% of bajra crop. For gram these percentages are seed 6.81%, feed .003% and wastage 9.5% and availability for human consumption is 83.687 percent.

63. Study to Compare the Efficiency of Different Sources of Nitrogen

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In this paper, the nitrogen efficiency of different slow release nitrogenous fertilizers and modified urea compounds such as prilled urea (PU) Gympsum coated urea (GCU), Neem cake coated urea (NCCU), Rock phosphate coated urea (RPCU), Lac coated urea (LCU), Large granular urea (LGU), Tarcoated urea (TCU) has been studied by means of additional responses. The efficiency of nitrogen at 40 kg/ha is minimum in (NCCU) viz 881.42 kg/ha and maximum in RPCU viz 1308.32 kg/ha. However the efficiency of N at 112 kg/ha, is maximum in case of LGU viz. 2552.02 kg/ha. when N is 40 kg/ha usage of RPCU is recommended in comparison with LGU and TCU provided the cost permits. At moderate level of N *i.e.*, 60 kg/ha the efficiency of LGU is 1355.30 kg/ha.

64. Comparative Study of Additional Response of Rice to Different Sources of Phosphorous in Rice-Wheat Sequence

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In this paper additional response of rice in rice-wheat sequence due to application of phosphorous through different sources of phosphorous such as single super phosphate (SSP), Mussoorie rock phosphate (MRP), Rock phosphate (RP), (SSP + RP), Ammonium poly phosphate (APP), Di-ammonium phosphate (DAP), Rock Phosphate + Pyrite (RP + Pyrite), (SSP + MRP), phosphal, (Rock Phosphate + Phosphorous bacteria), Nitrophosphate (N.P.) partially acidulated rock phosphate (PARP) have been studied. At 30kg P_2O_5 per ha the response was only 149.87 in RP + P bacteria. It was highest in SP + MRP *i.e.*, 915.23 followed by phosphate 906.38 kg/ha. At 60 kg/ha P_2O_5 also it was least in RP + P bacteria (243.95) where as it was as high as 1824.52 in case of SSP + MRP followed by phosphal 1668.52. At 90 kg/ha of P_2O_5 the trend was third, second place being taken by RP + Pyrite. It may be

concluded that phosphorous can be utilized better by application through SSP + MRP, phosphal and RP + Pyrite.

65. Comparison of Growth – A multivariate approach

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In biological investigation, the growth of an organism or part of organism is often subject of study. To compare growth among different groups of organism, the procedure under univariate case is extended to multivariate case.

If there are K populations from which samples for p correlated variables are available we obtain the analysis of dispersion of p correlated variables. The A – Criterion is obtained. The tests based on distribution of A suggested by Wilks (1932) and Nair (1939) are used. The method is illustrated, using the 12 week body weights of Japanese quails.

66. Predictions for A Composite Target in Linear Regression Model

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The problem of prediction in linear regression models is considered and a target function is presented which allows prediction of actual and the average values both of the study variable simultaneously. In order to appreciate the merit of the proposed target function, predictors based on least squares and the Stein procedures are exposed to it and their performance properties are studied for two specific cases, viz., when predictions are to be made within the sample and when they are to be made outside the sample such as for forecasting purposes. Unbiased estimators for the bias vectors and the mean squared error matrices of the proposed predictors are also given which may be helpful in evaluating the performance of predictors in any given application.

67. The Class of Unbiased Dual to Ratio Estimators

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A class of dual to ratio estimators of the population mean is proposed in the case of interpenetrating subsamples design which includes Srivenkataramana (1980) estimator. The case of simple random sampling without replacement is also studied where a similar class of unbiased dual to ratio estimators is developed which includes Srivenkataramana's estimator as a special case. Exact expression for the variance formula of the proposed estimator in SRSWOR is derived. The results are illustrated by means of a numerical example.

68. Estimation of Heritability Under Finite Population Assumptions

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New estimators of heritability obtainable from full-sib and half-sib analysis have been derived by assuming a balance hierarchical model of random effects, coming from finite populations of such effects. While the usual infinite population estimators can assume values outside the permissible limits of zero and unity the new approach is shown to give admissible estimates under wide range of situations. A procedure of determining the sizes of the populations of effects is also outlined.

69. Group Divisible Designs for Partial Diallel Crosses

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Several authors have discussed the construction of complete diallel crosses plan by using BIBD and PBIB designs. In the present investigation some

methods of construction of partial diallel cross have been developed using Group Divisible designs. While taking the crosses between the treatments within a block, it is found that the incidence matrix of crosses which are considered as lines yields Partially Balanced n-ary designs. Due to this reason we have discussed simultaneously the method of construction of Partially Balanced n-ary design and the analysis of Partial diallel crosses as well as Partially Balanced n-ary design separately. It is noted that the variances of the treatment contrast of Group Divisible designs are related with the variances of two lines. This helps in the analysis of Group Divisible designs. The analysis of Partially Balanced n-ary design and Partial diallel crosses are obtained, using the analysis of Group Divisible designs. This result is true for all Group Divisible designs.

70. Some Extensions to Two Level Cross Experiments

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In view of environmental hazards and economy based considerations, today's plant breeder is too much concerned about Forestation and Tree Improvement programmes. One of several effective means of plant improvement has been to raise hybrids through a variety of diallel crossing experiments. These experiments, however, evaluate the performance of clones or inbred lines on an intra-population basis. However, as population species and racial hybridization becomes more important it seems imperative to evaluate the performance of parents on inter-population or inter-species basis. Such populations may represent species, races, clones, subpopulations or genetically meaningful collections of individuals. For example inter species crosses among five different species of *Pinus Strobus* produced very successful results (T.W. Wright, 1959) Forest Sci., 5: 210–222). Hinkelmann (1974, Silnae Genetica 23, 18–23) presented two-level diallel cross experiments considering only inter-population crosses. Such experiments evaluate the GCA and SCA effects of the populations as well of parents within populations simultaneously and hence the name 'Two-level cross experiments'.

In the present paper it is proposed to extend the above work to include the parental lines and both the sets of single crosses in each of the populations. Inclusion of parents is desirable because it provides a means of estimating hybrid vigour directly from the specific combining effects. Similarly the sets of F_1s

will sort out the best combiners on intra-population basis, an information non-obtainable from designs of Hinkelmann. In addition, information on reciprocal crosses will help to differentiate suitable plants to be used as males or females.

71. Estimation of Long Range Effects of Continuous Cropping and Fertilizer Application on Productivity in Sorghum-Wheat Sequence in Vidarbha Region

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For sorghum-wheat crop sequence in general there was a reduction in yield. The reduction in grain yield of sorghum was 19.26 per cent after 2 years over the average of first three years whereas the reduction was 15.24 per cent in case of wheat. The rate of decline is minimum in case of N_{120} P_{80} K_{40} for Kharif sorghum and for rabi wheat, the rate of decline is minimum in case of N_{120} P_{80} K_{40} and N_{120} P_{80} K_0.

72. Yield Response of Rice Crop to Different Levels of Package of Practices Under Field Conditions in the Konkan Region of Maharashtra

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The optimum quantities of physical inputs like seed, fertilizers, pesticides, etc. are decided by experimentation. On the basis of this, recommendations are made to the farmers. However, when farmers use many inputs simultaneously on their fields the response may be different due to varying soil fertility, micro-climate, management practices and interaction effects. In the present paper the response to different combinations of factors under field condition is studied for rice crop in the Konkan region, using the data collected

under the cost of cultivation scheme of Govt. of Maharashtra. The different combinations of the levels of selected factors i.e. variety, seed rates and fertilizers were defined as the adoption levels of new innovations. The significance between different combinations were tested by student's 't' test. The study revealed that the cultivators using the combination of High yielding varieties (HYV) seeds, seed rate above 75 kg./ha. and nitrogen dose between 50 to 100 kg. nitrogen (N) per hectare has shown significant increase in yields over different groups with positive net returns.

73. An Outline of Statistical Ideas Relevant to Inter-cropping Research

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Intercropping can be defined as the growing of two or more crops simultaneously on the same piece of land. It has been recognised for a long time that intercropping was important in the developing tropics but in the past it seemed to have been assumed that it would give way to monocropping as a consequence of agricultural development. Experimental evidence confirmed that, even if pests, disease or poor weather destroys or inhibit the growth of the component crops, the second crop provides a yield which, in solo cropping would not have been achieved. It is now clear that intercropping can give substantial yield advantage compared with monocropping to produce the same yield of the component crops but there can be problems in assessing the degree of yield conversions when two species are interplanted. Also interpretation of experimental data present statistical difficulties because the yield of the crops will not in general be independent. The paper gives brief account of the statistical methods on agricultural research into intercropping.