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ABSTRACTS OF PAPERS*

1. ON UNBIASED REGRESSION ESTIMATOR

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Micky (1959) and William (1962) had proposed unbiased regression estimator of population mean. Main drawback with their estimator was computational difficulty and lack of comparability with the usual biased regression estimator. An attempt is made to develop an unbiased regression estimator by drawing two independent samples using SRSWOR from the population. The properties of the estimator are studied and it is found that the proposed estimator is little bit less efficient than usual biased regression estimator up to first order of approximation. But, for higher degree of approximation the proposed estimator is more efficient. Moreover, the unbiased estimate of the variance can easily be obtained.

2. ESTIMATOR OF VARYING PARAMETERS OVER TIME IN A LINEAR MODEL

D. K. GROVER and I. S. KAUSHIK
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In praetice, the parameters of some models undergo change due to passage of time e.g. mpc experience change with technological development. An attempt has been made to estimate the parameters at various time periods for the linear model $Y_t = X_t B_t + \epsilon_t$; $t = 1, 2, \ldots T$ where for a particular time t, Y_t is the observational vector, with dimension $n_t \times 1$, X_t is the non-stochastic matrix of explanatory variables

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with dimension $n_t \times K$, β_t is the $K \times 1$ vector of parameters to be estimated and ϵ_t is $n_t \times 1$ vector of disturbances. Under the assumptions: (I) $E(\epsilon_t) = 0$, $E(\epsilon_t \epsilon_t') = \sigma_t^2 I$ (ii) β_t and ϵ_t uncorrelated and (iii) $E(\beta_t) = \beta$ and $E[(\beta_t - \beta)(\beta_{t-s} - \beta)'] = \sigma_s^2 \gamma_s$ the estimator of β is given by

$$\hat{\beta} = \{X'(T)\, \Omega^{-1}(T)\, X(T)\}^{-1} X'(T)\, \Omega^{-1}(T)\, Y(T)$$

with var $(\beta) = \sigma_\varepsilon^2 \{X'(T)\, \Omega^{-1}(T)\, X(T)\}$ when $\Omega(T) = A(T)$ $\Gamma(T)\, A'(T) + I$.

$$A(T) = \begin{bmatrix} X_T & 0 \ldots\ldots 0 \\ 0 & X_{T-1} \ldots\ldots 0 \\ 0 & 0 \ldots\ldots X_1 \end{bmatrix}$$

and

$$\Gamma(T) = \begin{bmatrix} \gamma_0 & \gamma_1 & \gamma_{T-1} \\ \gamma_1' & \gamma_0 & \gamma_{T-2} \\ \gamma_{T-1}' & \gamma_{T-2}' & \gamma_0 \end{bmatrix}$$

The estimator β is BLUE. The unbiased and consistent estimator of σ_t^2 has also been found.

3. ON ESTIMATION IN FRECHET DISTRIBUTION OF *m*-th MAXIMA

B. K. HOODA
Dr. Y. S. Parmar University of Horticulture and Forestry, Solan
N. P. SINGH and UMED SINGH
Haryana Agriculture University, Hisar

Singh (1989, 1982) derived the maximum likelihood estimates of the scale parameter (b) and the shape parameter (k) of the Frechet distribution with the knowledge of different order statistics. In the present study the maximum likelihood estimates of the parameters of Frechet distribution are derived from single censored samples, double censored samples and from samples censored at middle with the knowledge of different order statistics. Asymptotic variance—covariance matrices of the estimates are computed numerically for different uncensored/censored proportions on both extremes. Asymptotic relative efficiencies of the estimates derived under left, right, double and middle censoring are

presented for different censored proportions for a comparative study for different order statistics.

4. THE SEARLS TECHNIQUE IN THE RATIO ESTIMATION

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Searls (1964) has presented a technique to increase efficiency of an estimator when the coefficient of variation is known. This technique is employed in case of the ratio method of estimation. Comparison of biases of different estimators has been made. The relative efficiency of mean square error of the modified ratio estimator compared to the mean square error of the ratio estimator is calculated taking a specific example with different sample sizes and coefficient of variation.

5. MODIFIED RATIO ESTIMATOR USING THE COEFFICIENT OF VARIATION OF AUXILIARY VARIABLE OBTAINED BY SCALAR MULTIPLICATION

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Estimators utilizing population C. V. of y have been proposed by Searle (1964), Khan (1968), Reddy (1974) Sisodia and Dwivedi (1981), Bisht, Almora and Sisodia (1990) and others. These estimators are more efficient than simple mean.

In this paper, the proposed estimator of population mean $\overline{Y}$ is

$t = \lambda \bar{y} \dfrac{(X + C_x)}{(\bar{x} + C_x)}$, where λ is the positive Scalar quantity and C_x the C.V. of auxiliary variable. The properties regarding Bias, MSE and comparison of t are investigated under the first degree of approximation. This estimator under the optimum condition is compared with simple mean and Searle's estimator. The C.V. of an auxiliary variable can easily be obtained and it can be used to increase the efficiency of t.

6. AN ESTIMATOR BASED ON DISTINCT RESPONDENTS IN UNRELATED QUESTION RANDOMIZED RESPONSE MODEL

N. S. MANGAT
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In usual simple random sampling with replacement (SRSWR) direct question surveys, it is well known that the estimator of population mean based on distinct units is always more efficient than the one based on all selections (Murthy, 1967, pp 65-68). Mangat *et al.* (1990) have shown that this observation is not always true in case of Warner's (1965) pioneer randomized response (RR) model where the respondents are sampled by SRSWR method and the information is gathered by using randomization device instead of direct question. The present paper considers an estimator based on distinct respondents for the unrelated question RR model (*U*-model) (due to Horvitz *et al.* 1967) and Greenberg *et al.* (1969). In this model also, the respondents are selected using SRSWR method. Throughout the exposition, π_y, the proportion of population belonging to non-sensitive attribute, is assumed to be known. An unbiased estimator for the variance of the proposed estimator is given. The condition has been obtained under which the proposed estimator based on distinct respondents is expected to be more efficient than the estimator based on all selections in case of *U*-model with known π_y.

7. ESTIMATION OF FINITE POPULATION VARIANCE USING DOUBLE SAMPLING

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In this paper, a general class of estimators for estimating finite population variance in double sampling is considered. The expression for bias and variance of the proposed class of estimators are given. The class of estimators considered for the double sampling is analogue of the class defined by Srivastava and Jhajj (1980) for the single phase sampling.

8. OPPORTUNITIES FOR THE PRODUCTIVE USE OF RAINFALL FOR SUSTAINABLE PRODCUTION IN DRYLANDS OF EASTERN UTTAR PRADESH

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The concept of water harvesting farming and supplemental irrigation can alleviate climatic risk factors in rainfed dryland regions, by increasing choices for soil and crop management, which in turn can stabilize crop water requirements and therefore, yields. The analysis of rainfall and evapotranspiration data show that variability is a constraint to agronomic production, but the potential for system design to control the effect of droughts (dry spells) is within managable limits with systematic conservation of rain water and supplementing the harvested water available during dry periods or drought years. The researches conducted during a period over 15 years in Alluvial soils (sandy loam) of eastern Uttar pradesh have indicated good prospect of increased cropping intensity (with sequential cropping system) with developing scientific techniques of water harvesting and its recycling at water need stage of the crop. Associate parmeters like quantum of jump in yield/unit of applied water, judicious stage(s) of supplementing water to crops (succeeding summer crops) and responsiveness of crops to applied water have been worked out for identifying the system for sustained production over years.

The rainfall patterns (1972-87) in the region have indicated that 10-15 runoff producing storms each season are capable of generating 40-65 per cent/storm towards runoff (based on soil moistures regime, rainfall intensity and drop factor). Thus on an average 25 to 27 cm of water/unit watershed area could be harvested and supplemented towards stored soil water for increased yield. On an average 10 to 16 percent increase in yield/season can be obtained by supplementing the harvested water at judicious/critical stage(s) of crop growth. The most responsive sequence to supplemental irrigation was found to be pearl millet-central linseed (28 per cent increase) followed by upland rice-mustard (28 percent).

9. REGRESSION ANALYSIS FOR LOCATING CRITICAL STAGES IN GROUNDNUT CROP FOR KAIRA DISTRICT

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Pre-harvest forecasting of the yield of groundnut (*Arachis hypogaea* Linn) in the Kaira district of Gujarat has been attempted by selecting rainfall variables through stepwise regression analysis. utilising data for 24 years. The selected variables X_5, X_6, X_9, X_{12}, and X_{20} corresponding to the rainfall during meteorological standard weeks 26 and 27 of July, 30 and 33 of August and 41 of October were found to be the critical stages (germination, vegetative development, full pegging to pod development and maturity) when groundnut crop needs irrigation.

10. PREHARVEST FORECASTING OF GROUNDNUT YIELD

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Attempts have been made by different workers to give models for pre harvest forecasting of yield for different crops based on weather parameters and/or biometrical parameters. In the present study soil moisture per cent at different crop physiological stages of groundnut crop have been considered as indirect measures of soil and weather parameters to predict groundnut yield in Junagadh district of Gujarat State. The study was spread in 8 villages for collection of data. A linear multiple regression equation considering three soil moisture variables could account about 70 per cent of total variation in the yield. The model fitted was

$$\hat{Y} = -1218 + 29.36\ M_1 + 41.63\ M_2 + 40.11\ M_4 \ldots (R^2 = 0.70)$$

where :

$\hat{Y}$ = Estimated jyield goroundnut, kg/h

M_1 = Soil moisture at 68 days after sowing (%)

M_2 = Soil moisture at 75 days after sowing (%)

M_4 = Soil moisture at 90 days after sowing (%)

The inclusion of two easily measurable parameters viz. plant stand and number of pods per plant, 15 days prior to harvest and eliminatinon of M_2 and M_4 gave a model which accounted for about 97% of the total variation. The pre-harvest forecasting model suggested was

$$\hat{Y} = -1222 - 10.03\, M_1 + 781.80\, B_1 + 191.10\, B_2 \ldots (R^2 = 0.97)$$

Where :

B_1 = Plant stand before 15 days of harvest

B_2 = Number of pods/plant before 15 days of harvest

11. EVALUATION OF DIFFERENT APPROACHES TO STUDY THE EFFECT OF RAINFALL ON GROUNDNUT IN DRY FARMING AREA OF GUJARAT

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An attempt was made to study the effect of rainfall on groundnut yield in dry farming area of Gujarat involving total rainfall, monthly total, standard weekly total, crop physiological stage-wise total, shorter interval total in critical stages and different categories of rainy days in crop physiological stages as independent variables. The yield data of long term experiment on crop rotations conducted during 1967 to 1979 at the Dry Farming Research Station, Targhadia (Rajkot) were utilized for this purpose.

The association between yield and total rainfall, monthly total and standard weekly total were not significant in the crop rotations (viz. groundnut-cotton, groundnut-bajra and groundnut-groundnut). The total rainfall in pegging stage (35-50 DAS) had significant influence on yield. When the period of important stages (22-80 DAS) was further splitted into smaller period, it was found that a period of 7 days consisting 36-42 and 43-49 days after sowing was found to have significant association with yield. Considering these two periods a model

$$\hat{Y} = 215.2 + 32.1985\, X_1 + 6.6915\, X_2 \ldots \ldots (R^2 = 0.74)$$

was proposed to predict the yield.

12. APPLICATION OF PARTIAL CORRELATION COEFFICIENT TO KNOW THE EFFECT OF SOIL AND FERTILIZER NUTRIENTS ON GROUNDNUT YIELD

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The yield of crop depends on the uptake of the nutrients by the plants. The uptake depends on the nutrients available in the soil and applied through fertilizers. An attempt has been made to assess the relationship between yield and uptake of nutrients by using the partial correlation coefficients. Data obtained through an experiment conducted during 1984-85 on groundnut under the All India Co-ordinated Soil Test Crop Response Project at Rahuri are utilised for the study. When nutrients of soil and fertilizer contributed independently, uptake of nutrients increased the yield of groundnut.

13. PREDICTION OF AREA UNDER CASTOR CROP IN GUJARAT STATE

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The crop statistics for the period 1965-66 to 1986-87 showed increasing trend in the area and production of castor crop in Gujarat. More than 85 per cent of the total castor area in Gujarat is shared by Ahmedabad, Banaskantha, Mehsana, Sabarkantha and Kutch districts. Analysis showed that lag one year area under castor crop had positive significant influence on castor area. The other important variables influencing castor area are lag one year harvest price of castor for Ahmedabad, Mehsana and Sabarkantha districts; relative profitability of castor over cotton for Mehsana district; lag one year productivity and variation in castor price for Ahmedabad district; total rainfall for Kutch district and lag one year Jowar area for Banaskantha district. Considering simplicity and precision, following prediction equations were derived :

District	*Model*	R^2
Ahmedabad	$\widehat{CA}_t = 0.7045\ CA_{t-1} + 0.2896\ CP_{t-1} - 29.9323$	0.96
Banaskantha	$\widehat{CA}_t = 0.9852\ CA_{t-1} - 0.2054\ JA_{t-1} + 241.0655$	0.96

Mehsana $\widehat{CA}_t = 0.7916\ CA_{t-1} + 0.0954\ CY_{t-1} - 3.7725$ 0.95

Sabarkantha $\widehat{CA}_t = 0.6168\ CA_{t-1} + 0.2562\ CP_{t-1} - 16.3425$ 0.93

Kutch $\text{Log}\ \widehat{CA}_t = 0.7370\ \text{Log}\ CA_{t-1} + 0.4890\ \text{Log}\ R_t - 0.6035$ 0.75

where,

$\widehat{CA}_t$ = Predicted castor area in the year 't' ('00 ha)

CA_{t-1} = Actual castor area in the year '$t - 1$' ('00 ha)

CY_{t-1} = Productivity of castor in the year '$t - 1$' (kg/ha)

CP_{t-1} = Harvest price of castor in the year '$t - 1$' (Rs/q)

JA_{t-1} = Jowar area in the year '$t - 1$' ('00 ha)

R_t = Total rainfall in the year 't' (mm)

14. A STUDY ON THE INTER-RELATIONSHIP BETWEEN MILK YIELD AND THE VARIOUS INFLUENCING FACTORS

R. L. SHIYANI[1], R. D. PATEL[2] and D. B. KUCHHADIYA[3]

The Present study was undertaken in Kheda district during 1981-82 to know the inter-relationship between per day milk yield and the influencing factors like green fodder, dry fodder, concentrates, labour charges, miscellaneous expenses and the fixed cost. Using two-stage stratified random sampling, 240 milk producer households were selected from all the ten talukas of the district. The correlation and regression analysis was carried-out. The findings of the study revealed that, (i) The correlation of milk yield (Y) with green fodder (X_1), concentrates (X_3) and fixed cost (X_6) were significant in all the groups of respondents. (ii) The Marginal value productivity of fixed cost was the highest as compared to the marginal value productivity of other inputs, in all the groups of milk producer households.

1 and 3 : GAU, Junagarh.
2 : GAU, Anand.

15. A STUDY ON THE DISTRIBUTION OF WEATHER PARAMETERS AND THEIR INFLUENCE ON FORECASTING THE YIELD OF WHEAT AT PANTNAGAR

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An investigation was carried out to study the distribution of weather variables for a period of 10 years (1980-89), predicting the extreme values of weather variables and forecasting the yield of wheat at Pantnagar farm on the basis of best fitted model. Normal, lognormal and Pearson's type distribution were studied for each year seperately for the weather variables, viz : maximum and minimum temperature, R.H. at 7 A.M. and 2 P.M., rainfall, wind velocity, Pan evaporation and bright sunshine. It was found that normal distribution was fitted only in case of relative humidity at 2 P.M. for year 1982 and 1986, log normal distribution was fitted in pan evaporation and for wind velocity and Pearson's type I distribution may be fitted in all the variable except few years in case of some variables. Gumble's distribution was used for a return period of two years.

Out of four regression models; viz, linear, Cobb-Douglas, square root and reciprocal, the square root model of the from $y = a + b\sqrt{x} + cx$ was finally selected on the basis of maximum R^2 value treating wheat yield at Pantnagar farm as dependent variable and weather variables as independent variables. The wheat yield at Pantnagar farm was predicted on the basis of best fitted model and percentage deviation in the predicted yield was nearer to actual yield of wheat at Pantnagar farm in most of the years.

16. PREDICTION OF LEAF AREA INDEX IN COTTON HYBRID 4

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The estimation of leaf area index (LAI), an important crop growth parameter influencing yield, consumes lot of time and is costlier. It is destructive in nature as leaves are to be plucked for measurements. In the present study, LAI worked out for 30, 45, 60, 75, 90, 120, 150, 180 and 210 days old crop showed significant quadratic trend (The total leaves measured were 35677 in nine stages). The leaf weight accounted

for maximum variability in LAI. The prediction equation for LAI based on number of leaves (NOL) and crop growth stage i.e. days after sowing (D) occounted for 92.2 per cent of the variability is :

$$\widehat{LAI} = 0.5595 + 0.0085\ NOL - 0.0098\ D$$

17. ESTIMATION OF POST HARVEST LOSSES IN *RAJAPURI* MANGO

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The experiment conducted during 1985 at the Horticulture Farm of Gujarat Agricultural University, Anand Campus, Anand to estimate post harvest losses during ripening and work out the optimum sample size for such estimation in case of *Rajapuri* mango (*Mangifera indica*, L.), revealed that estimate of post harvest losses due to rotting of fruits, physiological and total losses did not differ significantly due to methods of harvesting viz., hand picking and *vedi* picking. But grading of fruits after harvesting resulted in significantly lowering the losses (4%) due to rotting, whereas it was found to be ineffective for checking physiological and total losses as compared to ungraded fruits.

The calcium carbide treatment had lower rotting as well as total losses during ripening which were 12 and 24 per cent, respectively whereas losses were 21 and 35 per cent under untreated control fruits, respectively. An avoidable 11 per cent total post harvest losses could be saved only by treating fruits with calcium carbide after harvesting.

Further analysis revealed that optimum sample size was 50 fruits for the estimation of post-harvest losses in *Rajapuri* mango.

18. ESTIMATION OF CROP LOSS DUE TO LEAF CURL DISEASES IN BIDI TOBACCO

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A field survey was carried out during the crop season of 1988-89 for assessing crop loss due to leaf curl disease in bidi tobacco (*Nicotiana tabacum*, L.) at two locations (Anand and Sarsa) in Kheda district of Gujarat State. Maximum crop loss of 41.3% and 26.9% was observed in the varieties GT 5 and A 119 at Anand while at Sarsa (Ta. Anand), the over all crop loss was 9.1 and 4.7 per cent in early and late planted

variety A 119 respectively. The results thus revealed that the variation in crop loss estimation due to leaf curl disease in the bidi tobacco crop depends on location, variety and time of planting. The comparison of different sampling methods for estimation of crop loss indicated that the stratified random sampling with 10 per cent sample size was the most appropriate sampling plan.

19. IMPACT OF TRANSFER OF AGRO-TECHNOLOGY ON FERTILIZER CONSUMPTION IN GUJARAT

R. L. SHIYANI, J. K. PATEL, P. R. VAISHNAV and N. M. PATEL
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The yield rates of most of the crops grown in Gujarat have increased considerably during the post green revolution period due to agro-technological changes. The shift in area under major crops did not influence the total agricultural production which has shown increasing trend in Gujarat. Among various agricultural inputs, fertilizer increases the crop yield manifold and hence farmers have realised its significance in crop production. The fertilizer, NPK, requirements estimated for the period from 1969-70 to 1988-89 on the basis of area under crop and recommended fertilizer dose showed significant increase only in P and K, while the requirement of N fertilizer remained almost static. The consumption of N, P, K fertilizers showed significant increasing trend suggesting that the gap between fertilizer requirements and consumption decreased year after year. The gap estimates showed negative significant trend for N and P fertilizers. The over use has been observed for potashic fertilizers. The analysis for districts showed large variation in fertilizer consumption. The farmers of Saurashtra and Kutch regions showed slight negative trend in fertilizer consumption while other regions were in positive direction.

20. PRODUCTION AND CONSUMPTION TREND OF FERTILIZER NUTRIENTS IN INDIA

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The fertilizer has been recognised as one of the most important inputs under the technological advancements in the field of crop production. The present study was intended to work out the period wise coefficients

of variation and trend of fertilizer nutrients, area under irrigation and HYVP, as well as foodgrains production in India for the period starting from 1951 to 1986. The important findings of the study are :

(i) Higher variation in the data of fertilizer nutrients was observed in pre-green revolution period as compared to post-green revolution period.

(ii) The variability existed in the area under irrigation and HYVP, and foodgrains production was relatively higher during the post-green revolution period.

(iii) The annual compound growth rates of fertilizer nutrients were higher during post-green revolution period since the fertilizer industry was in developing stage during that period.

(iv) The consumption trend of P_2O_5 ranked first among all the fertilizer nutrients during the different periods of time.

(v) The annual trend of area under irrigation and HYVP, as well as foodgrains production was higher during post-green revolution period.

21. FORECASTNG OF YIELD OF JOWAR FODDER CROP ON THE BASIS OF BIOMETRICAL CHARACTERS

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The present study was conducted at NDRI farm, Karnal during 1988 kharif season, with the objectives to measure the biometrical characters at various stages of cut and to estimate the yield of jowar fodder crop on the basis of biometrical characters, before harvest.

The average height of the plant was 170.4 cm at first stage of cut and 181.8 cm at second stage but declined to 170.4 cm at third stage of cut. The average length of top most fully opened leaf declined from 81.9 cm to 69.8 cm from first to third stage of cut. Whereas breadth increased from 4.8 cm at first stage to 5.5 cm at second stage but declined to 5.0 cm at third stage of cut. The average number of green leaves per plant increased from 9.0 to 10.1 from first to second stage of cut but declined to 9.5 at third stage. The stem thickness was 1.0 cm at first stage, 1.2 cm at second and 1.0 cm at third stage of cut. In general, it was observed that the biometrical characters increased upto second stage of cut but declined at third stage of cut in accordance with the expectation.

Linear, log-linear, square-root, semi-log, semi-square root and semi-inverse type of functions were fitted for predicting the yield of jowar fodder crop at various stages of cut. A comparison of R^2 values, sign and significance of regression coefficients of biometrical characters

used in the model showed that the linear function could be used for forecasting the yield of jowar fodder crop at various stages of cut without any loss in precison.

22. ESTIMATION OF PROPORTION USING AUXILIARY INFORMATION

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Rao (1977) has considered the problem of estimation of change in proportion of units possessing a characteristic (an attribute) at a given time when the information regarding the proportion of units possessing that characteristic at a previous time is available. For that he has considered difference and ratio estimators and has given the conditions under which these estimators are more efficient than the sample proportion at given time. In this paper an attempt has been made to show that it is also possible to define ratio (product), difference and linear regression estimators for estimating the proportion (number) of units of the population possessing given attribute when the population proportion of units (total number of units of the population) possessing an auxiliary attribute is known. Ratio, product, difference and linear cegression have been defined for estimating the population proportion of units possessing attribute (characteristic) of interest when the population proportion of units possessing an auxiliary attribute (characteristic) is known. The corresponding expressions of bias MSE/variance have been obtained under SRSWOR sampling scheme. Except for some cases such expressions have been obtained to the first order approximation. Unbiased estimators have also been obtained corresponding to such expressions of bias and MSE/variance. Comparisons among these estimators as weil as with the sample proportion have also been made. Using the unbiased estimators corresponding to the expressions of bias of various estimators, almost unbiased or unbiased estimators have also been defined using Hartley Ross technique.

23. ON ESTIMATION OF TOTAL IN TWO STAGE SAMPLING

SUKHJINDER SINGH and SARJINDER SINGH
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The proposed class of estimator in two stage sampling for estimating population total of a character using auxiliary information is more

efficient than the regression type estimator considered by Sahoo (1987). In view of the practical utility a class of estimators with estimated optimum values has been considered. Further it is shown that the proposed class with estimated optimum values attains the same asymptotic mean square error of the class of estimators based on optimum values.

24. CHANGES IN THE LIFE EXPECTANCY OF NONDESCRIPT BOVINES IN DIFFERNT AGRO-CLIMATIC REGIONS

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The Indian Agricultural Statistics Research Institute has conducted a series of large-scale sample surveys for estimating age-specific current fertility and mortality rates in cattle and buffaloes of different breeds and classes at four centres representating different agro-climatic conditions viz. Andhra Pradesh, Punjab, Gujarat and Assam. These estimates of mortality rates were utilised for construction of life tables which are important for projecting population and using them for estimating animal production. In this paper the life expectancy of either sex of nondescript bovines is compared over the four agro-climatic regions in the country.

The life expectancy in each age group of cattle and buffaloes of either sex was in general highest in Gujarat and least in Punjab region. For cows in the age group of 3 to 9 years which is the most productive period, the observed expectation of life ranged between 4 to 8 years in Andhra Pradesh, 2 to 5 in Punjab, 7 to 11 in Gujarat and 6 to 10 years in Assam while for she-buffaloes in the same age group these ranged between 6 to 9 years in Andhra Pradesh, 3 to 5 in Punjab and 7 to 10 years in Gujarat. The higher lifespan of bovines may be attributed to better environment and facilities available in the area.

25. ON ECONOMICS OF PIG REARING IN A TRIBAL AREA

T. B. JAIN
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Pig rearing is one of the important occupations of a sizeable section of the weaker rural community particularly the Scheduled Tribes and Scheduled Caste people who are traditional breeders of pigs. Study of economics of pig rearing will provide guidelines for efficient utilization of available resources and for giving economic return to the farmers. In

the present study the component-wise costs of maintaining pigs upto assigned stages of growth and the effect of flock size on cost under field conditions were estimated from the data collected from selected number of villages in Ranchi area of Bihar during 1984-85.

The average daily cost of maintenance of a creeper (upto 2 months age) was of the order of 11 paise and that of an adult pig (more than 8 months age) was Rs. 1.20. Feed accounted for about 60 percent and unpaid labour about 30 percent of the total cost in the case of all categories of pigs. The average daily cost per pig showed a decreasing trend with the increase in flock size maintained which indicated that maintaining a large number of pigs per household appears to be economical.

26. COMPARATIVE UTILISATION OF CROSS-BRED AND NON-DESCRIPT WORKING ANIMALS UNDER RURAL CONDITIONS

K. B. SINGH
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The work performance capability of cross-bred working animals has often been questioned. For evaluation of the draft power of the cross-bred working animals studies have been conducted at research stations but no results are available on their performance viz-a-viz non-descript animals under farmers' conditions. Number of hours for which the animals are put to work has been taken as criterion for comparing the utilisation of cross-bred versus non-descripts. Data collected in a sample survey conducted by Indian Agricultural Statistics Research Institute in district Kathua of Jammu and Kashmir State are utilisecl for the study. It has been found that the number of cross-bred working animals put to work expressed as proportion of total number of cross-bred working animals was more than the proportion of non-descripts. The average number of hours of work per bullock per day in different months was almost the same for both cross-bred and non-descripts but the percentage of under utilisation of non-descripts was more than that of the cross-bred working animals and the cultivators in the tract preferred cross-bred animals over the non-descripts for work.

27. DOUBLE SAMPLING FOR ESTIMATING RATIO (PRODUCT) OF TWO POPULATION MEANS

D, N. SHAH[1] and N. C. SHAH[2]

Five double sampling estimators utilizing auxiliary information on two characters are suggested for estimating ratio of two finite population means. Their biases, means square errors (MSE) and minimum MSE'S are presented. When the means of auxiliary variates are not available, a double sampling procedure is uesd for the estimators suggested by Singh (1969) and shah (1989). The technique of chain ratio cum product estimation is used in defining the two out of five suggested estimators. The efficiency comparison, including two empirical studies is also presented.

28. INTERVIEW TECHNIQUES AND PROBLEMS IN SAMPLE SURVEYS

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Empirical researches are indespensible in social and behavioural sciences. They provide a sound basis for understanding the real world phenomenon. For such empirical researches collection of primary information through interview is an art of effective communication. In practical situations, an investigator usually encounters many problems while interviewing the respondents. Locating the respondents, adverse whether conditions, determining head of household, discrepancies in the respondents, questioning on sensitive topics, correct interpretation of answers and biases in the responses etc. are some of the situations where a rational decision is far more necessary to get the correct responses. Suggestions have been given to overcome these problems and make the communication between interviewer and interviewee effective for fruitful results of any survey.

29. CONSTRUCTION OF QQTSORD USING BIB DESIGNS

RAJENDRANATH PANDA
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The quality-quantity type response surface designs have been introduc-

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ed recently. Quality-quantity type second order rotatable designs (QQTSORD) have already been constructed from factorial designs. In this paper method of construction of QQTSORD using BIB designs has been considered.

30. ADMISSIBILITY OF A MIXED MODEL ANOVA TEST PROCEDURE FOR THREE LEVEL NESTED CLASSIFICATION WITH UNEQUAL SUBCLASS NUMBERS

KRIPA SHANKER
J. N. Krishi Vishwa-Vidyalaya, Jabalpur (M.P.)

A test procedure based on two preliminary tests of significance is developed for a mixed model analysis of variance of three level nested classification with unequal subclass numbers. A necessary and sufficient condition for admissibility of the test procedure is derived.

31. PLOT TECHINIQUE IN LUCERN

RAMANI, C. V. and N. M. PATEL
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Uniformity trial on lucern (Cv. Anand 2) was conducted for two crop seasons for generating information on plot technique. The experimental crop was grown on loamy sand soil in about 0.2 ha in first season and 0.06 ha in second season. Cutting-wise green fodder yield of 1200 and 400 units (each of 1 m × 1 m area) were recorded and analysed. The results revealed that coefficient of variation per unit area (C.V. %) decreased with the increase in size of plot. The C. V. % showed decreasing trend upto fourth cut and thenafter it increased during both the years. The rate of reduction in C.V. % was more with the increase in width of the plot (i.e. number of rows) than that with the increase in length of the plot. 10 unit plot (1 m × 10 m) was found optimum for field experiment. The estimates of soil heterogeneity index, b were 0.263 and 0.369. Lattice design was found efficient than Randomized Block design.

32. NEED OF BORDER ROWS IN COTTON EXPERIMENTS

M. R. VAISHNAV, P. R. VAISHNAV, L. P. PUROHIT and P. G. PATEL
B. A. College of Agriculture, GAU, Anand

Inter-plot competiton in agricultural experiments are taken care by providing border area (ring lines) which increases size of plot and there-

by the cost of conduct of experiment. To verify whether such borders are necessary for Agronomic experiments on cotton involving the factors like fertilizers, spacing and plant population where the differences are expected to be significant, data of such four experiments conducted for two years at the Cotton Research Station, Surat were collected for (i) border area (ii) net area and (iii) gross area for each treatment.

It was observed that in agronomic experiments on cotton involving levels of fertilizers and plant density per unit area as treatments, do not need border rows. The elimination of borders in such experiment could help in reducing requirement of experimental area by 40 to 60 per cent and thereby reducing cost of conduct of the experiment without affecting precision of the treatment estimates.

33. OPTIMUM PLOT SIZE FOR SUMMER PADDY IN THE NAVSARI ZONE OF GUJARAT

S. M. UPADHYAY, B. H. PRAJAPATI and K. R. V. RAJA
College of Agriculture, GAU, Sardar Krushinagar

Optimum size and shape of plot has been worked out from uniformity trial on summer paddy crop, conducted at the Agronomy farm, N. M. College of Agriculture, GAU, Navsari. Maximum Curvature method, Fair-field Smith's Variance law and the comparable variance method were used for the purpose. A plot size of 12 units i.e. 10 rows each of 6.3 m. length (i.e. 2m. × 6.3m.) was found optimum for paddy variety I.R. 8 grown at Navsari zone of Gujarat state.

34. CHARACTER ASSOCIATION IN DURUM WHEAT UNDER IRRIGATED CONDITIONS IN DIFFERENT SOWING PERIODS

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College of Agriculture, GAU, Junagadh

The performance of one hundred fortyfour genotypes of durum wheat were evaluated under three sowing periods in simple lattice design at Junagadh. The results of ten characters revealed highly significant genotypic variances in all the three sowing periods indicating the presence of large genetic variability in the material. Correlation studies revealed that number of spikes per plant, weight of grains per spike, number of grains per spike and 100 grain weight were the important yield contributing characters in durum wheat. Number of effective tilleres per plant

and weight of grains per spike were found to have maximum direct effect on grain yield in all the three sowing periods suggesting the significance of these traits in improving yield potential of durum wheat.

35. GENOTYPE—ENVIRONMENTAL INTERACTION IN *CHAPADIU* TOBACCO (*Nicotiana tabacum*, L.)

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B. A. College of Agriculture, GAU, Anand

The two crosses viz., GT 6 × Line 18-12-13 (*Kala* Chopadiu type) and Anand 145 × Line 18-12-13 (*Lal* Chopadiu type), their parents, F_1, F_2 and back crosses studied for two seasons revealed significant genetic variability in leaf yield, days to flower, number of leaves per plant, plant height, leaf length and leaf width. The dominance and epistacy had predominant contribution in the expression of attributes. The estimates of gene effects were influenced by seasonal variation. The cyclic method of breeding could help in improving gene pool.

36. STATISTICAL ASSESSMENT OF METEORO-PHYSIOLOGICAL PARAMETERS AFFECTING SUMMER GROUNDNUT PRODUCTION

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B. A. College of Agriculture, GAU, Anand

The causes of high yield potential of groundnut genotype Robut 33-1 in comparison to *GG* 2 (the released variety) during summer season were assessed under experimentally created varying environments using meteorological parameters. Photosynthetically active radiation (PAR) has direct influence on growth parameters of any crop. In the present study PAR was studied in terms of their conversion use efficiency at different growth stages. The genotype Robut 33-1 had higher PAR conversion use efficiency than *GG* 2 at all the growth stages studied. The relation between PAR absorption co-efficient (Y) and days after sowing (D) were of the form

$$Y = -0.647 + 0.018D - 5.7\ (10^{-5})\ D^2 \ldots \text{for Robut 33-1}$$

and

$$Y = -1.016 + 0.029683D - 1.25\ (10^{-4})\ D^2 \ldots \text{for } GG\ 2$$

with $R^2 > 0.86$. The rate of dry matter production demonstrated linearity over the intercepted PAR ($R^2 > 0.88$). The conversion use efficiency (Dry matter produced per unit of intercepted PAR) of 1.542 *g* MJ^{-1} and 1.067 *g* MJ^{-1} were obtained for Robut 33-1 and *GG* 2 by linear regression technique. The results revealed that the parameters like PAR and conversion use efficiency could be utilised in selection programme for high yield potential.

37. PREDICTION OF BRINIAL (*Solanum Melongena* L.) YIELD FROM PARTIAL HARVEST

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B. A. College of Agriculture, GAU, Anand

The analysis of picking-wise fruit weight (yield) data of 1200 brinjal plants (Cv. Doli-5) collected separately from uniformity trial revealed that a plot of 20 plants (2 rows each of 10 plants) spaced 0.75 m × 0.75m is of optimum size for field experimentation. The data were further utilized to predict total production of crop well in advance from first few pickings. The yield data of 1200 basic units were grouped into 60 experimental plots (samples) each of 20 plants. The following linear models were derived to predict total brinjal yield ($\hat{Y}$) on the basis of partial harvest upto 3rd picking.

$$\hat{Y} = (2.746 + 0.0026\ X_{23}) \times 888.89 \quad \ldots\ \ldots\ (R^2 = 0.83)$$

$$\hat{Y} = (4.108 + 0.0016\ X_{123}) \times 888.89 \quad \ldots\ \ldots\ (R^2 = 0.86)$$

where:

$\hat{Y}$ = Predicted yield in brinjal (kg/ha)

X_{23} = Sum of the yield of 2nd and 3rd picking

X_{123} = Sum of the yield of 1st, 2nd and 3rd picking.

38. STABILITY OF PIGEONPEA-PEARLMILLET CROPPING SYSTEMS IN DRY FARMING

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Stability of different cropping systems involving pearlmillet and pige-

onpea in dry farming regions has been analysed. The grain yield of both the crops were converted to the equivalent yields considering price factor. Sole crops of pearlmillet and pigeonpea were found unstable with minimum yield advantage. Intercropping of these crops in 1:1 proportion was found to be stable under favourable environments followed by 2:1 proportion, 0.5:0.5 proportion was the most stable under varying environmental situations. The results indicated that the method of converting yields of intercrops to equivalent yield is simple and could be used in place of LER or such other methods for comparing intercropping experiments.

39. DYNAMIC MILK PRODUCTION FUNCTIONS AND TECHNOLOGICAL CHANGE IN MILK PRODUCTION

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The present study was conducted at N.D.R.I. Farm, Karnal during 1986-87, with the objectives to estimate direct and carry over effects of feed nutrients on milk production and to estimate contributions of breed and feed in total change in milk production. The year was divided into three conventional seasons viz. summer, rainy and winter seasons.

The average daily milk yield of sahiwal cows was estimated at 7.2 kg and that of crossbred cows 12.7 kg. It was the highest (13.9 kg) in winter and lowest (11.2 kg) in rainy season for crossbred cows. In sahiwal cows it was the highest (7.6 kg) in summer and the lowest (6.8 kg) in rainy season. Average daily intake of DCP on dry matter basis was estimated at 0.94 kg per sahiwal cow and 1.60 kg per crossbred cow, In order to estimate direct, carry over and cumulative effects of feed on milk production distributed lagged model was used and to estimate the contributions of improvement in breed and feed inputs in total change in milk production decomposition analysis (Bisaliah, 1977) was used.

40. SIRE EVALUATION ON BASIS OF PROGENY PERFORMANCE IN MULTIPLE HERDS

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N.D.R.I., Karnal

The project on progeny testing of Sahiwal bulls on the basis of daughters performance in six herds spread over the states of Panjab, Har-

yana, U.P. and M.P. was started in 1980. The performance of first set of six bulls with number of daughters varying from 14 to 19 indicated that the sire index by least squares method ranged from—10.2% to 9.5% above the weighted breed average of 1534 kg. The comparison of least-squares method with contemporary comparison method on the basis of error variance, showed that least-squares method was superior. The rank correlation between breeding value of sires on the basis of first lactation yields predicted from part lactation yield with the actual first lactation yields was very low. This suggested that under our conditions where the number of sires and the number of daughters per sire is limited, the accuracy of sire evaluation on the basis of part lactation records would be low. Further in sire evaluation the herd differences are very large and their adjustment by least squares method is more satisfactory as compared to contemporary comparison method.

41. SIRE EVALUATION USING MULTIPLE RECORDS UNDER SELECTION

V. S. KULKARNI and M. GURNANI
N. D. R. I., Karnal

The data on 742 Sahiwal female calves born to 23 sires of Sahiwal breed at this farm were taken. It was found that 72.5% of the female calves born survived upto their age at first calving and survivability upto commencement of first, second and third lactation respectively was 61.5%, 48.8% and 34.8%. The differences in survivability of daughters in various sire groups were significant. In order to remove the selection effects the missing second and third lactation yields were estimated by use of appropriate prediction equations using earlier available production performance. The adjustment for selection effects resulted in reduction in average lactation yield of second and third lactation and there was decrease in heritability estimate of second lactation yield and increase in heritability estimate of third lactation yield. The average lactation milk yield increased from first to second and from second to third lactation for every sire group. The rank correlations between sire-wise milk yields for various pairs of lactations were high. The rank correlation of sire's daughters average lactation milk yield adjusted and unadjusted for selection effects for second lactation as well as that for third lactation were high (0.973 ann 0.886, respectively) suggesting that the adjustments for selection effects may slightly alter the rank of sire. The best sire index was based on average Expected producing ability of daughters whose

multiple records were adjusted for selection effects (within sire variance being 99×10^3 kg^2). However, the accuracy of index based on simple average of first lactation was 98.1% as compared to the above best index.

42. FORECASTING YIELD OF PEARL MILLET IN JODHPUR DISTRICT

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CAZRI, Jodhpur

The present study is aimed to find out the crop weather relationship for making the preharvest forecasting of Bajra-Pearl millet yield for Jodhpur district. Yield of bajra can be predicted at about 19 weeks after sowing through step down regression analysis using eye estimates, crop season rainfall, maximum temperature, bright sunshine hours and weighted rainfall. The predicted equation explained 87.8 percent of variation.

43. FOOD DEMAND ANALYSIS IN INDIA—AN APPLICATION OF ALMOST IDEAL DEMAND SYSTEM

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N.D.R.I., Karnal

The study estimates Demand System for food in India using Almost Ideal Demand System (AIDS) model. Pooled time series and cross-section data on consumer expenditure for different states both for rural and urban sectors obtained from NSS 25th, 32nd and 38th round reports pertaining to the periods 1970-71, 1977-78 and 1983 respectively formed the database. The price indices for various items of consumption in the rural sector were obtained from Labour Bureau, Simla while that for urban sector from Central Statistical Organisation, New Delhi. The expenditure data of various states were aggregated into different regions viz., North, South, East, West, Central and North-East by computing weighted average for each of the expenditure class observed using proportion of population as weight in each state. The price Indices for each region were obtained as

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$$P = \sum_i Wsi \text{ Log } (psi)$$

where W_{si} is the share of ith commodity in the Sth state of region R and p_{si} is the corresponding price index. The following AIDS model with dummy effects for regions and time period was estimated for six comodity groups viz., Cereals and pulses; milk and milk products; edible oils; meat, fish and eggs; sugar, and all other food items for rural and urban sectors separately.

$$W_i = a_i + \sum_j b_{ij} \text{ Log } (p_j) + C_i \text{ Log } (E/p^*)$$

where $$\text{Log } P^* = \sum_i W_i \text{ Log } (p_i)$$

W_i = share of expenditure on ith item of consumption to total food expenditure,

p_j = Price indices of all the items, and

E = Total Food expenditure.

The variables were weighted according to the proportion of population in each expenditure group. Usual homogeneity, symmetry and adding up restrictions were imposed. An iteratively seemingly unrelated procedure was used for estimation of Simultaneous Linear Equation demand system.

The food expenditure elasticity was less than unity for cereals and pulses while greater than unity for remaining commodity groups in both the sectors. Own price elasticities for milk and milk products and meat, fish and eggs were greater than unity in the rural sector while in the urban sector it was so for meat, fish and eggs only. Own price effects viz., own price elasticities were larger than the cross price effects viz., cross price elasticities for majority of the commodity groups. Cereals and pulses were net substitutes to all other Commodity groups in both the sectors which is consistent with the priori expectation that these are consumed first for minimum subsistence utility level. Milk and Milk products were substitutes to all the food commodity groups except sugar in the rural sector while it was substitute to only edible oils in the urban sector. Meat, fish and eggs were substitutes to all the food commodity groups except cereals and pulses in the rural sector while these were substitutes to only cereals and pulses and other food items in the urban sector. Sugar was observed to be substitute to cereals and pulses and

meat, fish and eggs in the rural sector and to cereals and pulses and other food items in the urban sector. Conclusively AIDS model provided better estimates of both expenditure and price elasticities.

44. STATISTICAL EVALUATION OF ANIMAL NUTRITION EXPERIMENTS

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The present paper deals with the statistical evaluation of the animal nutrition experiments. Methodology used was similar to that developed by Bajpai and Nigam (1980). Taking into consideration the peculiarities of animal nutrition experimentation, design weight W_1 and precision weight W_2 have been defined for animal nutrition experiments. Applying the methodology to 623 statistically designed animal nutrition experiments in the past 3 decades at 18 important research stations of India, the overall research index has been found to be of the order of 71 per cent which is a satisfactory index.

45. HEALTH AND SATISFACTION OF AGRICULTURAL SCIENTISTS WITH WORK ENVIRONMENT

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It is well known that psychosocial factors in the work setting bear a significant relationship with psychological health and productive functioning. Based on this premise, a research investigation has been started with a view to assessing the quality of work environment of agricultural scientists and its impact on their health and behaviour. This ongoing study is being conducted in 15 ICAR Institutes. A Work Environment Questionnaire (WEQ) has been used to assess the scientists' perception of work environment along with General Health Questionnaire (GHQ) to assess the health aspects. Some items of the WEQ provide a direct measure of scientists' satisfaction with their work environment. These

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have been scored to yield Work Environment Satisfaction Index in each respondent. The GHQ threshold score has been used to identify cases who are at risk of poor health. Those above the threshold score have been compared with others in the institutional cohort on the various aspects of work environment and their satisfaction in the 3 broad areas of satisfaction. The Statistical Test for Extreme Reactions has been used for comparing those who score low with others who score high. This test focuses on spread and span of control cases and is based on the principle of testing the null hypothesis.

The results bring out significant differences between the health risk cases vis-a-vis others. The statistical method used for such comparisons appears to have applicability in comparison of control and experimental groups in a work setting.

46. COMPUTATIONS IN LOGISTIC MODELS ANALYSES AND THEIR EQUIVALENCE FOR MULTICLASSIFIED BINARY DATA WITH UNEQUAL SUB-CLASS NUMBERS

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Modern statistical computations for analysing binary response data with unequal subclass numbers, following the recommendation of Agresti's (1983) survey of methods, are presently through two linear logistic models (LLM), namely (1) Σ-restricted LLM, and cell probability LLM. We describe here these computations and show their equivalence through a worked example on mortality data. Based on the findings, the paper suggests to use cell probability LLM over the Σ — restricted LLM for analysing binary data with multicassifications and unequal subclass numbers.

47. COMPUTATIONAL ASPECTS OF BEST LINEAR UNBIASED PREDICTION FOR GENETIC EVALUATION OF SIRES

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The best linear unbiased prediction (BLUP) procedure has been accepted worldwide for genetic evaluation of sires. Because of its useful properties, this method is superior to other methods used in the past, e.g. sire indexes, herdmate comparison, contemporary comparison, least

squares means (LSM), simplified regressed least squares (SRLS) etc. Some animal breeding research workers in our country have been still recommending the methods like LSM and SRLS stating these methods were found equally efficient as BLUP and are computationally easy and need less computer time than the BLUP. Infact it is not true for a specified model. The BLUP and LSM require exactly the same computer memory and time, and have little difference in setting up the equations for sires.

This paper describes the computational aspects of the BLUP for evaluation of sires from a large data set and using models with two or more effects and where an effect, for example the herd-year-season, may have numerous levels. Some models that may be applicable to progeny testing data in various progeny testing schemes in our country have also been discussed.

48. SERIES OF VARIANCE BALANCED TERNARY DESIGNS THROUGH BIB AND GD DESIGNS

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John (1964) and Hedayat and Federer (1974) developed mathods of construction of variance balanced designs with unequal block sizes and unequal number of replications using balanced incomplete block designs. Furthermore Kageyama (1987), Khatri (1982), Ghosh and Divecha (1989) gave several methods of constructing variance balanced designs. Ghosh and Joshi (1990) have obtained some methods of construction of variance balanced design using group divisible designs. Agarwal and Kumar (1986) have developed few methods to construct variance balanced ternary design with unequal block sizes using group divisible designs. In the present investigation some systematic methods have been developed for the construction of variance balanced designs and variance balanced ternary designs with more than $(v+2)$ treatments using balanced incomplete block designs and group divisible designs with v treatments.

49. CONTRIBUTION OF FISHERIES LIVESTOCK AND AGRICULTURE IN NATIONAL ECONOMY

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IVRI, Izatnagar

The output values from 1980-81 to 1985-86 on 1980-81 prices for Agriculture, Livestock and Fisheries were analysed. The growth rate of these values from Agriculture increased by only 13.44% with trend of stagnation throughout the period of reference but the same recorded high order increase of 29.97% and 31.75% with steady trend of growth in Livestock and Fisheries respectively. Contribution of Livestock and Fisheries to GNP increased from 7.84 to 7.86% and 0.73 to 0.74% but decreased in Agriculture from 33.47 to 29.27%. The combined share of these three sectors in GNP reduced from 42.04 to 37.87%, only because of Agriculture. Fisheries and Livestock showed more potential for investment than Agriculture.

50. DESSIGNS ADOPTED IN ANIMAL NUTRITION EXPERIMENT—A REVIEW AND SUGGESTIONS

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An attempt has been made to examine critically the designs adopted in the past for animal nutrition experimentation in India and to suggest for future improved designs in appropriate situations. Only statistically designed experiments are critically examined by way of classifying into two broad categories viz. Qualitative and Quantitative. Various slopes and curvature studies are made and change-over, factorial, second order rotatable designs etc. are recommended.

51. FOOD GRAIN PRODUCTION IN INDIA : PERSPECTIVES AND FUTURE PLANNING

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An attempt was made to estimate the trends in area, production and productivity of food grains and population. The study revealed that the growth rate of area declined from 1.23 per cent per annum in the pre-green revolution period to 0.36 per cent in the later period indicating

that there is less scope to increase the area under food crops. The growth rate of production remains more or less the same for all the three periods. However, the growth rate of productivity increased from 1.67 per-cent in pre green revolution period to 2.45 per cent after launching the Green Revolution. The increase in production was not sufficient to bridge the gap between demand and supply because of the alarming growth rate of population (14.11 per cent) resulting in deficit supply of 32 kg per capita per annum. The higher coefficient of variation of productivity and production during the post green revolution period is disappointing. The change in the production prior to Green Revolution was of both area and productivity, while in the later stage the effect of area on change in production declined drastically from 36.20 per cent to 9.42 per cent but its ill effects have been compensated by the increased effect of productivity from 53.31 per cent to 85.20 per cent.

52. ESTIMATES OF OPTIMUM PLOT SIZE FROM THE UNIFORMITY DATA OF MUSTARD FOR NORTH GUJARAT

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College of Agriculture, GAU, Sardar Krushinagar

Uniformity trial was conducted at the Regional Research Station, Gujarat Agricultural University, Sardar Krushinagar during rabi season of 1986-87 to find out optimum plot size and number of replications for field experiment on mustard crop cv. Varuna T-15. The crop was raised at a spacing of 30 cm. × 10 cm. The grain yield data were obtained for 1600 basic units; the dimension of each basic unit was single row of 1 metre length. The coefficient of variation and soil heterogeneity index were used for determining optimum plot size, which was worked out to be of 16 units, i.e. 8 rows each of 2 metre length (2.4 m × 2.0 m). For normal field experiments 5 replications were adequate.

53. IDENTIFICATION OF IMPORTANT INTERACTIONS (PACKGES OF PRACTICES) FOR HIGHER PRODUCTIVITY IN RICE-RICE SEQUENCE

G. L. KHURANA, and K. C. BHATNAGAR
IASRI, New Delhi

By utiising the data of production potential experiments under resource constraints conducted under AICARP (CAR) for rice-rice

sequence for a 3 year period (1983-86) at 3 locations viz., Maruteru (Andhra Pradesh), Thanjavur (Tamil Nadu) and Bhubaneshwar (Orissa), a study was conducted to identify the important interactions between agronomic factors (inputs). The four factors were date of sowing (D), fertilizer (F), plant population (P) and Weed Control (W) during kharlf rice and date of sowing (D), fertilizer (F), irrigation (I) and Weed Control (W) during rabi rice. Each factor was at two levels—one recommended and the other reduced. The amount of information in the form of rss (residual sum of squares) from each fitted regression model was obtained. Consecutive models were compared by examining the differences in their rss. Their importance was determined by comparing partial regression coefficient of each interaction variable with its corresponding standard error. The important interactions identified were $D \times P$, $D \times P \times W$ for kharif and $D \times I$, $D \times I \times W$ for rabi for Maruteru. $F \times P \times W$ for kharif and $I \times P$, $F \times I$ for rabi were found important at Thanjavur. $D \times F$ and $F \times P \times W$ were found important for kharif and rabi respectively at Bhubaneshwar. Thus for higher productivity date of sowing with plant population or with plant population and weed control during kharif and date of sowing with irrigation or with irrigation and weed control during rabi is preferable at Maruteru. At Thanjavur, fertilizer with plant population and weed control during kharif and irrigation with plant population or with fertilizer for rabi is suitable. Date of sowing with fertilizer for kharif and fertilizer with plant population and weed control are useful at Bhubaneshwar.

54. PACKAGES OF AGRONOMIC FACTORS AND ENVIRONMENT INTERACTIONS IN JOWAR-WHEAT SEQUENCE AND THEIR TESTING PROCEDURES

G. L. KHURANA and K. C. BHATNAGAR
I.A.S.R.I., New Delhi

A study was conducted to suggest testing procedures for packages of practices obtained from 4 agronomic factors (inputs) viz., date of sowing (D), fertilizer (F), plant population (P), Weed Control (W) during kharif and date of sowing (D), fertilizer, (F) irrigation (I) and Weed Control (W) during rabi in production potential experiments conducted under AICARP (ICAR) on Jowar-wheat sequence. These experiments were conducted at Akola (Maharashtra) and Sehore (Madhya Pradesh) for a three year period. Each agronomic factor was at two levels—one recommended and other reduced.

The packages obtained from *D-F* factors during kharif jowar and from *D-I* factors during rabi wheat provided significant interactions with environment (*YXL*) rather than with year (*Y*) or location (*L*) alone. This revealed that there was an important differential response to specific environmental condition which was not accounted for either year alone or location alone. An estimate of the number of replications, years and locations that might be most efficient in package testing was obtained. During kharif season an increase in the number of replications is suggested rather than repeating the experiments at more locations or years. During rabi, an increase in the number of locations is advisable.

55. COMPARATIVE STUDY OF RETURNS IN CROP CULTIVATION

R. L. RUSTAGI and SHIVTAR SINGH

Information of economic aspects of crop cultivation is useful for formulation of farm policies and programmes. In this study an attempt has been made to compare the costs and returns in cultivation of Paddy, Jute and Groundnut crops utilizing data collected in a survey undertaken by IASRI in Cuttack district of Orissa during 1985-86. Paddy and Jute are the main crops of Orissa State. The study revealed that cultivation of Paddy not only meets the home requirements, but its cultivation is quite profitable.

The net income from Paddy crop was Rs. 2144/- per hectare. The percentage of return over cost A, cost B and cost C was 184, 69 and 57 respectively. The net income in Groundnut cultivation was Rs. 1717/- per hectare and the percentage return over cost A, cost B and cost C were 183, 77 and 74 respectively. Net income from Jute per hectare was negative. Jute is labour intensive and this makes its cultivation less remunerative than Paddy cultivation.

56. ON THE PRELIMINARY TEST ESTIMATOR FREE FROM THE SIZE OF THE TEST IN RANDOMISED RESPONSE MODEL

RAJENDRA SINGH
I.V.R.I., Izatnagar (U.P.)

The preliminary test estimator of the population mean of sensitive variable was so developed that its efficiency is free from the size of the test. The bias and mean square error were also derived. It was concluded that in the absence of appropriate knowledge about the population mean

of non-sensitive variable, its estimate should be selected in such a way that the bias should be positive with prescribed limits. Allocation of total sample size in two samples have been obtained under various conditions and the optimum value and the range of weight (w) have bean derived to make the preliminary estimator efficient than usual estimator.

57. EMPIRICAL EVALUATION OF SAMPLING DESIGNS FOR ESTIMATION OF FREQUENCY DISTRIBUTION

RAJENDRA SINGH, SHIV PRASAD, DINESH KUMAR and KRISHAN LAL
I.V.R.I., Izatnagar

Data on six characters viz. households by size of land holding, immunization practices, breeding practices and sources of drinking water for animals and animals by size of land holding and species from 2 villages comprising 500 households and 1433 animals were collected from Bareilly district and were used for empirical evaluation of some selected sampling designs for estimating frequency distributions. The efficiency of a sampling design in estimating a frequency distribution was measured either the measure $E(\alpha_1)$ or $E(\alpha_2)$. The average variance formula was also used to compare the suitability of some selected sampling with an aim to replace measure $E(\alpha_1)$ or $E(\alpha_2)$ by the estimator of average variance when population frequencies of different classes are not known.

58. ON THE PRELIMINARY TEST ESTIMATOR OF INTER GROUP VARIANCE COMPONENT IN UNBALANCED RANDOM MODEL

C. B. TIWARI and B. SINGH
I. V. R. I. Izatnagar (U.P.)

Expressions for moments and the probability of negative values of preliminary test estimators of the group variance component are derived under unbalanced one way random model. These results are used to investigate the effect of unbalancedness on the preliminary test estimators and their comparison under balanced situations, numerically, for certain *a priori* parametric values. These computed results reveal that unbalancedness increases the bias, variance, mean square error and probability of negative value of the estimators, however, their comparison under balanced situations remains unaffected.

59. ON THE ANALYSIS OF VARIANCE FOR NOMINAL DATA

B. SINGH
I. V. R. I., Izatnagar (U.P.)

The asymptotic distributions of catanova and chi-square statistics are derived to compare the power of two tests, numerically, for *a priori* probability structures in one-way multinomial model. The computed results reveal that the power of catanova and chi-square tests are almost same. This implies that one can use the catanova method without any power loss for analysis of nominal data. The main advantages of catanova method are : (i) its analogy with ANOVA method for quantitative data and (ii) easy generalization to multiclassified nominal data.

60. THE DISTRIBUTION OF NUMBER OF BIRTHS

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In recent years the study of variation in number of births to a couple has attracted considerable attention. Besides empirical investigations, probability models are being attempted for understanding the nature of this variation. Brass (1958), Dandekar (1955), Henry (1956), Sheps and Perrin (1966), Singh (1963, 1968), Pathak (1966) and others have used mathematical models for explaining the observed distribution of births under different sets of assumptions about human reproduction. These models provide estimates of fertility parameters and are useful for prediction. Singh, Bhattacharya and Yadav (1975) derived a probability model of the number of births to a female, during a given marital duration of t years. They have taken the risk of conception, m as constant. In this paper m is assumed as a random variable having the gamma distribution. The application of the model is discussed, and, as a illustration, it is fitted to the observed data.

61. ON ESTIMATION OF EXPONENTIAL LINEAR MODEL

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and
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A theory is developed for the estimation of linear functions of unknown parameters β and θ in a Gauss-Markoff linear model

$$\underline{Y} = X\underline{\beta} + \underline{e},$$

where

each independent e_i $(i = 1, 2, \ldots, n)$ is assumed to follow exponential distribution. The maximum likelihood estimator and least square estimator of the parametric function $\Delta = \underline{c}'\underline{\beta} + \delta\theta$ are obtained and they are compared in the sense of mean square error. The linear unbiased estimator of the parametric function Δ is also compared with the unbiased estimator based on the maximum likelihood estimator. A unified theory has been developed for the estimation of Δ.

62. A PRODUCT-TYPE CLASS UNDER SUPER POPULATION PROBABILITY MODEL

D. SHUKLA
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This paper presents the study of a product-type class of estimator under super-population probability model. The comparison of efficiencies and optimum selection of weights have been taken into account. Few numerical illustrations have also been given.

63. ESTIMATION OF MEAN OF A CHARACTER WHEN THE AUXILIARY INFORMATION IS ON AN ATTRIBUTE

V. D. NAIK and P. C. GUPTA
South Gujarat University, Surat

Ratio, product, difference and regression estimators all well known for estimation of population mean or total of a character when the population mean or total of an auxiliary character is known. In this paper, when a character and an attribute are point biserially correlated, feasibility of using the advance knowledge regarding proportion of units in the population or number of units in the population, which possess an auxiliary attribute, has been investigated for estimating the population mean of the character of interest. Ratio, product, difference and linear regressions estimators have been defined for this case and the expressions, mostly of first order approximation, have been obtained for their bias and MSE/variance. The unbiased estimators corresponding to these expressions have been obtained. Efficiency comparison among these estimators as well as with the sample mean have been made. Using

the unbiased estimators of expressions of biases of various estimators corresponding almost unbiased or unbiased estimators have also been defined using Hartley-Ross (1954) technique.

64. FITTING OF THEORETICAL PROBABILITY DISTRIBUTIONS TO ANNUAL MAXIMUM MONTHLY TOTAL RAINFALL DATA FOR DISTRICT SOLAN, HIMACHAL PRADESH

PAWAN KUMAR and O. P. SAMBHAR
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In this paper the annual maximum monthly total rainfall data of 30 years for district Solan, Himachal Pradesh have been collected from the Directorate of Land Record, Shimla. Two different theoretical probability distributions, viz, lognormal distribution and Gumbel distribution have been fitted to the data and compared the theoretical and observed rainfall by Theil's method. The theoretical probability distributions are in close agreement with the observed rainfall data except at the highest rainfall for the two distributions. Also, the computed values of Theil U-Statistic for lognormal distribution and Gumbel distribution i.e. $U_{\text{lognormal}} = 0.0013$ and $U_{\text{Gumbel}} = 0.00011$ respectively, shows that these fittings are best with reasonable accuracy. Since the value of U for Gumbel is less than the value of U for lognormal distribution, the fitting of Gumbel distribution is better as compared to the fitting of lognormal distribution. From practical point of view, any of the two distributions may be used for the prediction or forecasting of annual maximum monthly total rainfall for district Solan with a reasonable accuracy.

65. A NOTE ON PRIOR INFORMATION IN REGRESSION

D. N. SHAH
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Theil and Goldberger (1981) have derived a mixed estimator wherein the sample information could be combined with the prior information. The prior information could either be in the form of exact linear restrictions or in the form of stochastic linear restrictions. If the value on the prior stochastic information is diminished, then the mixed estimator tends to the least square estimator. The converse question as to what happens when the value on the prior increases is examined for a very special case by Brook and Wallace (1973). A general case, in which the

value on the prior is allowed to increase and thereby shown that the mixed estimator tends to that implied by exact linear restrictions is presented in this note.

66. GROWTH PATTERN OF IRRIGATED HECTAREAGE : A CASE STUDY OF SOME SELECTED CROPS IN DIFFERENT DISTRICTS OF EASTERN UTTAR PRADESH

M. N. SINGH[1] and ASHOK KUMAR[2]

The paper attempts (i) to work out average per annum growth rates of irrigated hectareage (area under assured means of irrigation) and (ii) to test the statistical significance of these growth-rates for major food grain (wheat, rice, gram, barley) and non-food-grain (sugarcane, potato) crops, in the each of the fifteen districts (presently 17) and the whole of eastern Uttar Pradesh, by running linear regressions over time, making use of respective time series (1966-67 to 1981-82) data through simple indices triennium (average ending 1969-70 as the base value). The main findings of the paper reveal that (i) while the irrigated hactareage in the whole of east Uttar Pradesh and also in majority of its districts for wheat, rice and potato has increased significantly; it has for gram and barley decreased significantly; and in case of sugarcane it has increased but not significantly; (ii) wheat, as compared to other crops, has recorded highest and significant positive growth rate; (iii) for east U.P. the respective average per annum growth rates of irrigated hectareage for wheat, rice, gram, barley, sugarcane and potato have been 14.74 per cent, 4.55 per cent, —1.08 per cent,—5.98 percent, 0.26 percent, and 2.95 percent.

67. SOME RULES FOR DETERMINING AOSB BASED ON AUXILIARY VARIABLE

A. G. PATEL[3] and P. C. GUPTA[4]

In the present paper it is proposed to evaluate the performance of various known rules, when Stratification is done on an auxiliary variable correlated with character under study using some live data. It is also proposed similar rules to determine AOSB when stratification is carried

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out on an auxiliary variable, viz.

(i) $W_h \mu_{hs}$ = constant, for all h
(ii) Cum $\sqrt{f(x)}$ = constant, for all h
(iii) Cum $\sqrt[3]{f(x)}$ = constant, for all h

The rule (ii) is expected to provide a good approximation to OSB under Neyman's optimum allocation while (iii) provides a good approximation to OSB under proportional allocation. Rule (i) is expected to perform well for high values of the correlation between the character under study and the auxiliary variable. An empirical study of on three sets of live data taken from the project entitled "Comprehensive scheme to study cost of cultivation in Gujarat state", has been conducted to find AOSB for the above proposed three rules.

Mahalanobis equiproportion rule gives good results. Efficiency comparisons for the proposed rule with Mahalanobis equiproportion rule has been done. It was observed that when stratification is done on the auxiliary variable the Cum $\sqrt{f}$ and Cum $\sqrt[3]{f}$ rules, do not perform very well. However, it needs further investigation in order to reach any meaningful conclusion.

68. PARTIAL DIALLEL CROSS PLANS FROM SINGULAR GD DESIGNS

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Partial diallel cross (PDC) plans are useful in breeding experiment involving large number of inbred lines, because it is not possible to accommodate all possible crosses of complete diallel cross (CDC) plans in a block of usual randomised block design or incomplete block designs. Several authors (Curnow, 1963; Gilbert, 1958; Fyfe and Gilbert, 1963; Hinkelmann and Kempthorne, 1963; Das and Sivaram, 1968) have shown correspondence between PDC plans and partially balanced incomplete block (PBIB) designs of two-associates, three-associates or m-associate classes with blocks of size two. However, these designs are not grouped into blocks. In the present investigation PDC plans are considered that are grouped into blocks derived from a singular GD design and developed a method of construction of these plans. The method of estimation have come out in very simple manner.

69. SIMULTANEOUS CONFIDENCE INTERVALS FOR VARIANCE COMPONENTS IN TWO-WAY BALANCED CROSSED CLASSIFICATION RANDOM EFFECTS MODEL

ARUNA JAWKHEDKAR
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The simultaneous confidence intervals for variance components of two-way balanced random effects model with interaction have been derived under the usual assumptions of normality and independence of random effects. The Intervals are conservative in the sense that the true confidence coefficient is as large as pre-assigned value.

70. AN APPRAISAL OF REGIONAL IMBALANCES IN BREEDABLE AND IN-MILK BOVINE IN INDIA

C. B. TIWARI, V. K. DWIVEDI and KRISHAN LAL
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There is vast variation in agro-climatic conditions and socio-economic dimensions of different regions of the country. To know whether these variations also effect the population dynamics of breedable and in-milk bovines in a region, livestock censuses (1961-1982) data were statistically analysed which showed significant difference ($P < 0.01$) among the regions. The human population, breedable and in-milk bovines and gross sown area were maximum in North West plane (NWP) region of the country while least in North Eastern Hill (NEH) region during the period 1961-1982. There was a remarkable change in composition of milking bovines in NWP region where in-milk buffaloes surpassed the milking cows in 1982. However, among all the regions, the NEH region was found to have maximum growth rate of breedable and in-milk bovines during the same period while in general, Eastern plane region showed the minimum progress in this regard.

71. REASONS FOR MORTALITY AND DISPOSAL OF BUFFALOES IN THE VICCINITY OF ANAND

S. N. ARYA, D. K. BHATIA and B. GOERGE
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Reasons for mortality and disposal of buffaloes in an ICD area and an adjoining non-ICD area are analysed. Association between reason for

death-disposal and factors such as area and sex of animals is studied with the help of Chi-square technique. The differential effect of various reasons on area is highlighted thus indicating the impact of the ICD programme.

72. YIELD STABILITY OF CHEWING TOBACCO VARIETIES UNDER VARYING LEVELS OF IRRIGATION IN TAMIL NADU

N. S. MURTHY, R. V. S. RAO and M. MOHAN
C. T. R. I., Rajahmundry

The chewing tobacco production in India is about 77 million kg of which 17% is produced in Tamil Nadu. Frequent irrigations are vital to produce good yield and quality chewing tobacco. Generally farmers give 20 or more irrigations to obtain good yield of the crop. Irrigation being a limited resource, it must be used judiciously. An experiment with eleven popular chewing tobacco varieties was conducted with five levels of irrigations (0, 5, 10, 15 and 20 irrigations). The stability in the performance of whole leaf yield under different levels of irrigation was studied using Eberhart and Russel (1966) model. The yield potential interm of percentage of maximum yield for different irrigation levels was obtained for each variety. It was observed that varieties Vairam, Bhngyalakshmi, Pv-7 and VR-2 performed better under limited number of irrigation while HV81-3, HV80-4 and Thangam yielded better under favourable environment.

73. ON SOME METHODS OF CONSTRUCTION OF PARTIAL TETRA-ALLEL CROSSES

K. N. PONNUSWAMY[1] J. SUBRAMANI[2] and S. NATARAJAN[3]

The present paper describes some methods of construction of Partial Tetra-Allel Crosses (PTAC) using (i) BIBD (ii) PBIBD (iii) SOLS and (iv) Steiner quadruple systems (SQS). It may be worth mentioning the resulting PTAC constructed from some special type of (i) and (iv) provide unbiased estimators for six genetic components and at the same time results in considerable savings in resources as compared to double cross mating design.

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74. APPLICATIONS OF CALCULUS FOR FACTORIAL ARRANGEMENTS : HYPERCUBIC DESIGNS

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The calculus for factorial arrangements of hypercubic designs is presented by using the matrices NN' and C. In the present investigation we establish that hypercubic (HC) design is a property (A), n-aray partially balanced, generalized balanced and balanced factorial rectangular experiment (BFRE). Here we extend the idea of structure (K) given by Mukerjee (1979) to row-column C-matrix, that is, structure (K_1) and (K_2) $\Rightarrow$ structure (K_1K_2) $\Rightarrow$ structure (K). The results are motivated through examples.

75. ON THE METHOD OF DIFFERENCES USED TO CONSTRUCT MOLS

C. C. GUJARATHI
Sardar Patel University, Vallabh Vidyanagar

Bose, Shrikhande and Parkar (1960) used the method of differences in the construction of Mutually Orthogonal Latin Squares (MOLS). The method is modified for a class of Latin Squares of order $S = 3m + 1$, m being odd. The method is illustrated for $S = 10$ and $S = 22$.

76. ESTIMATION OF MILK PRODUCING EFFICIENCY OF TWO AND THREE BREED GIR CROSSES

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Mahatma, Phule Agricultural University, Rahuri

Milk production records of first lactational traits for 242 PG (1/2 Friesian + 1/2 Gir), 107 JG (1/2 Jersey + 1/2 Gir), 279 FJG (1/2 Friesian + 1/4 Jersey + 1/4 Gir), 165 JFG (1/2 Jersey + 1/4 Friesian + 1/4 Gir) and 155 BFG (1/2 Brown Swiss + 1/4 Friesian + 1/4 Gir) maintained at AICRP on cattle, MPAU, Rahuri were used to assess influence of genetic group, period and season of calving and groups of age at first calving from 1973 to 1987. The milk producing efficiency per kg of body weight at first calving (MPEK) was 8.36, 6.93, 8.73, 8.23 and 8.31 kg for FG, JG, FJG, JFG and BFG, respectively. The corresponding figures for the milk producing efficiency per day of first lactation

length for per kg body weight at first calving (MPEK)/day) was 32.21, 20.61, 31.04, 29.41 and 35.11 grams, respectively. Both the traits were significant for genetic group and period of calving. Milk producing efficiency at any blood level of Friesian and Brown Swiss inheritance was higher than 50 per cent blood of Jersey.

77. CLASSIFICATION OF GIR CROSSES WITH EXOTIC DAIRY BREEDS

D. Z. JAGTAP[1], C. A. NIMBALKAR[2] and M. S. KARKELI[3]

Comparative evaluation of 1/2 Friesian × 1/2 Gir (FG), 1/2 Jersey × 1/2 Gir (JG), 1/2 Friesian × 1/4 Jersey × 1/4 Gir (FJG), 1/2 Jersey + 1/4 Friesian × 1/4 Gir (JFG), 1/2 Brown Swiss + 1/4 Friesian + 1/4 Gir (BFG) and Gir was done on the basis of body weight at birth, 6, 12 months, first lactational fat corrected milk yield, first lactational length and first calving interval using Mahalanobis D^2-statistic. Five genetic groups of crossbred cattle and Gir purebreed were utilized for genetic divergence studies using Mahalanobis D^2-statistic by combining 6 traits (Body weight at birth, 6 and 12 months, first lactational fat corrected milk yield, first lactational length and first calving interval of economic importance). All inter-genetic D^2 values differed significantly from each other. Four clusters were formed having higher inter cluster distance than intra-cluster distance. JG, BFG and Gir formed individual cluster whereas remaining three genotypes formed one cluster.

78. PREDICTION OF FIRST LACTATIONAL MILK YIELD BY FIRST MISSING MONTHLY AND CUMULATIVE MILK YIELD OF RED SINGHI COWS

D. Z. JAGTAP[1], R. S. BANSOD[2] and MAHESHKUMAR[3]

The data on 114 Red Sindhi cows spread over 37 years (1952 to 1988) corrected for significant effect of lactational milk yield (LMY), monthly milk yield (MMY) and cumulative monthly milk yield (CMMY) was utilised for multiple regression ananlysis. The partial regression coeffi-

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cient of 10th MMY and CMMY on LMY was highly significant. Similarly, partial regression coefficient of 9th CMMY on LMY was also significant. The maximum R^2 value was observed in inclusion of all MMY and CMMY (88.11 and 88.90%) for predicting LMY.

79. SIMULTANEOUS CONFIDENCE INTERVAL FOR VARIANCE COMPONENTS IN TWO-WAY UNBALANCED NESTED RANDOM MODEL

RINA AGRAWAL
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The problem of simultaneous confidence intervals of variance components for two-way unbalanced nested random model has not been reported so far.

The model under consideration is

$$y_{ijk} = \mu + a_i + b_{ij} + e_{ijk}$$

$$i = 1, 2 \ldots p, j = 1, 2 \ldots q_i, k = 1, 2 \ldots r, N = r \sum_{i=1}^{p} q_i.$$

Here $a_i \sim N(0, \sigma_a^2)$, $b_{ij} \sim N(0, \sigma_b^2)$, $e_{ijk} \sim N(0, \sigma_e^2)$ and all of them are independently distributed. The usual Anova sum of squares are S_a^2, S_b^2 and S_e^2. Further $S_a^2/E[S_a^2/(p-1)]$ is not distributed as $\chi^2(p-1)$ because of unbalanced data. But $S_b^2/E[S_b^2/\Sigma(q_i - p)]$ and $S_e^2/E[S_e^2/(N - \Sigma q_i)]$ are distributed as χ^2 with $(\Sigma q_i - p)$ and $(N - \Sigma q_i)$ degrees of freedom respectively.

Using matrix method a new statistic $\bar{rq}\, s_{\bar{y}}^2$ has been developed which is approximately distributed as chi-square. . . . when $q_1 = q_2 \ldots = q_p = q$ then $\bar{rq}\, s_{\bar{y}}^2 = S_b^2/p(q-1)$. The simultaneous confidence intervals for (σ_a^2, σ_b^2) for given value of σ_e^2 has been constructed. The interval is conservative in the sense that the true confidence coefficient is as large as the pre-assigned value.