

ABSTRACTS OF PAPERS

1. Trends of Crop Productivity under Intensive Cropping System in Long Term Experiment

P. R. Vaishnav and S. K. Dixit
Gujarat Agricultural University, Anand

The yield data from a long term experiment conducted at two different locations of Gujarat Agricultural University were utilised for the period 1979 to 1992. Two crop sequences tried were specific to the respective regions. Curve fitting approach was used to study the trend in crop yield. In all 24 different equations were tried using original treatment means and three years moving averages. Use of moving average values reduced the seasonal/irregular fluctuations in the data effectively and gave better fit as compared to that of original set of data. The best fitted equation for defining the trend in yield due to treatments within a crop differed, except in case of groundnut. In majority of the cases, polynomial equations with varying degree and bases defined the trend of productivity of the crops.

2. Statistical Models for Sorghum Crop

K. C. Chenna Rayudu, G. Nageswara Rao and K. Ramanababu
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Optimum rate of fertiliser were determined through fitting of an equation to crop yield data collected when different levels of fertiliser were applied. Although several models are available in the literature which described crop yield response to fertilisers, it is seldom explained why one equation is preferred over others. In this paper, an attempt has been made to fit different response models for Sorghum crop and compare their adequacy. Three types of models namely (a) Ordinary (b) Exponential and (c) Inverse polynomials were fitted. The data on the twenty experiments were taken and analysed factorially using RBD analysis. R^2 values were compared between the three types of models. Ordinary polynomials were found better fit for response of sorghum to Nitrogen fertiliser in the majority of the experiments. These ordinary polynomials were however over estimating optimum nitrogen levels compared to others. This

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Income & Expenditure Account for the year ending 31st March 1996

| Previous Year | EXPENDITURE | Current Year | | Previous Year | INCOME | Current Year |
|------------------|----------------------------|------------------|--|-----------------|--|------------------|
| 46,755.00 | To Establishment Expenses | 48,457.00 | | 40,000.00 | By Grant in Aid from Govt. of India, Ministry of Agriculture, Deptt. of Agril. & Coop. | 40,000.00 |
| 3,468.63 | To Printing & Stationery | 4,677.50 | | | | |
| 700.00 | To Audit Fee | 1,000.00 | | 17,904.63 | By Deficit for the year C/o to Balance Sheet | 19,119.25 |
| 2,657.00 | To Travelling & Conveyance | 3,552.50 | | | | |
| 103.00 | To Cycle Repair | 467.25 | | | | |
| — | To Typewriter Repair | 260.00 | | | | |
| 3,300.00 | To Legal Expenses | — | | | | |
| 921.00 | To Depreciation of Assets | 705.00 | | | | |
| 57,904.63 | | 59,119.25 | | 57904.63 | | 59,119.25 |

Place : 64, Regal Building,
Connaught Circus,
New Delhi 110001
Dated: 23 Sept., 1994

Subject to our Report of even date

for C.S. Bhatnagar & Co.
Chartered Accountants
Sd/-
(G.S. Bhatnagar)
Partner

investigation indicated that no single model could be recommended for all the locations.

3. Pre-harvest Forecasting of Rice Yield at Pantnagar on the Basis of Biometrical Characters

V. K. Singh and J. B. Singh

G B Pant University of Agriculture & Technology, Pantnagar

A sample survey was conducted at Pantnagar University farm during Kharif 1994 to investigate the effects of biometrical characters on rice yield at different growth stage and to forecast its yield based on biometrical characters.

A two stage stratified sampling with probability proportional to area under rice crop was adopted for collection of data on eight pre-harvest biometrical characters viz., total number of tillers per hill, number of effective tillers per hill, dry matter accumulation per hill, number of green leaves per main tiller, plant height, length and breadth of flag leaf along with the yield.

The observations were recorded on five plants from 40 selected plots of 1×1 m in 14 fields of four different varieties at four different growth stages at fortnightly interval starting from 30 days after transplanting. The estimates of mean values of biometrical characters and yield of all the four varieties independently and pooled over entire farm was obtained at four different growth stages. The correlation between yield and biometrical characters and also among the characters themselves at different growth stages were also computed and their significance was tested. Simple and multiple linear regression equations were fitted at different crop growth stages and pre-harvest forecast models were also tried by selecting the significantly generated variables using stepwise regression technique.

The estimated mean value of plant height and dry matter accumulation shows an increasing trend and number of total and productive tillers per hill and number of green leaves per main tiller have a decreasing trend with the advancement of crop growth. The total number of tillers per hill decreased as the number of hills per plot increases, consequently, the number of productive tillers per hill will also decrease. It was also observed that the broad and long flag leaf contributes more towards dry matter accumulation and plant height will increase by decreasing the number of total tillers per hill. The per cent deviation of the estimated yield rate for the University farm during Kharif 1994

was obtained as 12.81 per cent which indicates overestimation in small size plot.

The highest value of R^2 among all the simple and multiple linear regression equations and maximum correlation of yield among all the variables were observed in case of plant height followed by dry matter accumulation at third crop growth stage which indicates that these two characters may be used in predicting the grain yield.

It was concluded that the rice yield may be predicted at third growth stage i.e. 75 days after transplanting where plant height and dry matter accumulation contributes significantly towards grain yield and shows 52 per cent deviation in grain yield based on biometrical characters.

4. Preharvest Forecasting of Sugarcane Yield at Pantnagar on the Basis of Weather Parameters

Atul Sah and J. B. Singh

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The present study was conducted to investigate the effect of weather variables on sugarcane yield and to develop preharvest forecasting models for sugarcane crop at Pantnagar University farm on the basis of weather data recorded for a period of 18 years (1971-72 to 1988-89) for plant cane and ratoon cane crop and for a period of 21 years (1971-72 to 1991-92) for average yield of sugarcane crop. The probability distribution of maximum temperature, minimum temperature, relative humidity at 7 a.m. and 2 p.m., total rainfall, number of rainy days, wind speed, panevaporation and sunshine hours based on 65 weeks were studied. The effect of one unit increase above average in weather variables on sugarcane yield was also studied.

It was found that Pearsons type IV distribution was fitted in all the seasons for the weather variables relative humidity at 7 a.m. and rainfall. It was also fitted almost in all the seasons for the variables bright sunshine hours, number of rainy days and panevaporation except in few of the seasons. Pearsons type I distribution was fitted for the variables wind speed and relative humidity at 2 p.m. and Pearsons type II distribution was fitted for the variable maximum temperature for most of the seasons. The effect of one unit increase in average values of all weather on sugarcane yield at different growth stages of the sugarcane crop were fluctuating during the entire crop season except in the case of panevaporation and wind speed, where the effect was beneficial almost

throughout the crop season. The forecast models were developed by using correlation coefficients between yield and weather variables as weights. The plant cane yield, ratoon cane yield and average yield of sugarcane crop at Pantnagar can be forecast at the 2nd week of August, 2nd week of July and 1st week of September respectively using the developed model. About 98 % variation in the sugarcane yield was explained by the forecast model. The sugarcane yield were simulated for the years 1993-94 and 1994-95.

5. Construction of Regular Group Divisible Design from a Balanced Incomplete Block Designs

G. C. Bhimani

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In the present investigation the idea is to construct semiregular and regular group divisible designs, following the identical lines of John (1977) and Theorem 8.6.3 of Raghavarao (1971), two series of group divisible designs are obtained. First series of group divisible design is obtained from balanced incomplete block design with $v_1 = 2k_1$, while the second series is obtained from a balanced incomplete block design which satisfy the condition $v_1 = 2k_1 + 1$. The group divisible designs obtained from series I belonging to regular group divisible design with parameters $v = 2t+2$, $b = 8t + 2$, $r = 4t+1$, $k = t+1$, $m = 2$, $n = t+1$, $\lambda_1 = 2t - 1$ and $\lambda_2 = 2t$. The three designs obtained from the series II gives both the semiregular and regular group divisible designs with parameters $v = v_1 + 1$, $b = 2(b_1 - 1)$, $r = b_1 - 1$, $k = k_1 + 1$, $\lambda_1 = r_1 - 1$, $\lambda_2 = r$, $m = 2$ and $n = k_1 + 1$ which can also be obtained by using balanced incomplete designs when $v_1 = 2k_1 + 1$ is satisfied. Some of the regular and semiregular group divisible designs obtained from series II, are having $r > 10$. Hence it can be seen that semiregular and regular group divisible designs, obtained from series I and series II, are having the same condition $v_1 = 2k_1$. The designs obtained in the present investigation with $r \leq 10$ can not be claimed new as these designs are listed in Clatworthy (1973) but the main finding in the present work is that these designs yields new non-isomorphic solution. However the semiregular and regular group divisible designs with $r > 10$ obtained in this investigation can not reflect new or old design because Clatworthy (1973) table is restricted only for group divisible with $r \leq 10$. However if researchers are interested to use group divisible design with $r > 10$ then the design obtained in this investigation can be useful as it is not listed any where.

6. Construction of Balanced Orthogonal Design

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Rao (1960, 1970) introduced the concept of Balanced Orthogonal Design (BOD) and exploited it for the construction of some families of Balanced Orthogonal Design and Group Divisible Design. It is well known that the Balanced Orthogonal Design which is an extension of Hadamard matrix can be considered as an incomplete weighing design admitting orthogonal estimation of all weights. Rao and Das (1969), Rao and Singh (1970) developed two methods for the construction of Balanced Orthogonal Design having parameters $v = b = s^2 + s + 1$, $r = k = s^2$, $\lambda = s^2 - s$, where s is an odd prime power.

Das (1980) discussed two more methods of constructing the Balanced Orthogonal Design and have shown that a class of Balanced Ternary Design (BTD) can be obtained by using these designs.

In the present investigation a method for constructing the Balanced Orthogonal Design has been carried out. Here it is also shown that a weighing design can be obtained by using the Balanced Orthogonal Design.

7. An Application of Bootstrap Technique for Estimation of Genetic Correlation from Parent Offspring Covariances

S. D. Wahli, Lal Chand and V. K. Bhatia
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The bootstrap technique has been tried to understand fully the statistical properties of genetic correlation and to get their precise and accurate estimates. The distribution of genetic correlation was found to be non-normal and skewed in about 95% of cases. The bias in the estimate of genetic correlation traits but at the same time the increase in sample size helped to contain the bias within reasonable limits. The bootstrap estimate of standard error of genetic correlation was always higher as compared to their usual estimate by the approximate formula. This shows the underestimation of standard error of genetic correlation by the usual formula. The length of the percentile confidence interval was considerably lower as compared to standard normal confidence intervals. The results obtained with low and moderate heritability were not

consistent. This is perhaps due to smaller sample size. The role of sample size on the estimates of genetic correlation by parent - offspring covariances for various combination of population parameter needs further investigation.

8. On Construction and Analysis of $p \times q \times r$ Confounded Asymmetrical Fractional Factorial Design

D. P. Handa and P. R. Sreenath
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Method of construction and analysis of $p \times q \times r$ confounded asymmetrical fractional factorial design, based on confounded symmetrical fractional factorial design with factors each at two levels, using many to one correspondence scheme has been described. The defining contrast used for constructing confounded asymmetrical fractional factorial design involve interactions from two or more pseudo factors. Thus by properly choosing the interactions for confounding and interaction used in defining contrasts for fractionation, we try to save the main effects and interactions of interest between the symmetric factor. The scheme of correspondence between the levels of asymmetrical factors and combination of pseudo factors used for construction of this design provide the methods for carrying out the analysis of variance of asymmetrical fractional factorial design. The technique is illustrated through $5 \times 4 \times 3$ asymmetrical fractional factorial design. The technique can easily be extended to construct confounded asymmetrical fractional factorial design involving any type of levels.

9. Statistical Studies on the Behaviour of Rainfall at Hamirpur in Bundelkhand

D. P. Handa
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The data on rainfall from 1955-77 for a period of 22 years were analysed. It was found that most of the rainfall is received during the 4 months, accounting 88.70% of the total rainfall. Of the average annual rainfall of 858.39 mm, the contribution of the month of June, July, August and September were 54.70, 259.67, 299.93 and 147.39 mm respectively with the variability as indicated

by coefficient of variation to be 18.42%. The average number of rainy days is 17.58. Frequency distribution of rainfall indicates that 46.4% of rainfall is below 50 mm and 10.7% rainfall is above 300 mm. The month of July received 81.5% of rainfall which is more than 200 mm while August received 87.5 % of the rainfall. Rainfall received in February, March, April, May, November and December was quite low that is less than 50 mm. It has been observed that rainfall during July, August and September is mostly normal and out of 12 months, October and January have 41.66% drought and 48.8% during February to May. This necessitating arranging of additional resources of water for agriculture. The amount of rainfall that is expected with 50% chances in the month of June, July, August and September is 46.7, 247.3, 282.3 and 135.1 mm respectively.

10. Universally Optimal Nested Row-Column Designs with Unequal Block Sizes

Rajender Parsad and V. K. Gupta
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The Universal optimality aspects of non-proper block designs with nested rows and columns are studied under a usual homoscedastic, fixed effects model. Generalised binary balanced block designs with nested rows and columns (GBBBN-RC design) and Binary balanced block design with nested rows and columns (BBBN-RC design) have been introduced. These designs are variance balanced with respect to all estimable treatment contrasts and a treatment, if appears in a block, occurs equally frequently in all rows of that block and design is generalised binary (GBBBN-RC design)/binary (BBBN-RC design) with nested rows and columns. Further, it is shown that a GBBBN-RC/BBBN-RC design, whenever existent, is universally optimal in a given class of competing designs. Some general methods of construction of GBBBN-RC/BBBN-RC designs are also given and illustrated with the help of examples.

11. Stability of Different Pulses and Cereal Crops in Agroforestry Systems

B.L. Chaudhary and J.K. Kapoor
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Compatibility/stability of Moong, Moth, Cowpea, Guar and Bajra was studied under *Acacia Nilotica*, *Dalbergia Sissoo* and *Acacia Tortilias* by using Eberhart and Russel (1966) technique. It was observed that the pulses crops like Moth, Moong and Cowpea were more stable than the cereal crops (Guar and Bajra) which were compatible/stable in the above average environment.

12. Moisture Sensitivity to Seed Longevity in Different Crop Species

R.L. Sapra and S.K. Jain
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Relative sensitivity of moisture content to seed longevity in 23 crop species representing four major crop groups viz., cereals (8), oil seeds (7), pulses (5), and vegetables (3) were examined. Analysis of variance (ANOVA) with samples of unequal size based on one way classification depicts that these four crop groups differ significantly at 1% level. The intraclass correlation coefficient ($r = 0.40$) among these four crop groups was found to be positive, indicative of close association of different species within a crop group. The mean values of C_w (moisture sensitivity constants) among four crop groups ranged from 4.3152 to 5.3040. The moisture sensitivity constant which is a measure of rate of decline in seed longevity with the rise in seed moisture is comparatively higher for cereals ($C_w = 5.3040$) followed by pulses ($C_w = 5.1836$) and vegetables ($C_w = 4.33$). Oil seeds are least sensitive to moisture content ($C_w = 4.315$). Compared to cereals, oilseeds are less sensitive to moisture, even though are poor storers, as they have low values for species specific intercept constants (K_E).

13. Index for Nutritive Value of Common Indian Foods — Principal Component Approach

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An attempt has been made to develop nutritional indices of some common Indian foods by applying Principal Component Analysis (PCA) to trace the foods rich in proximate principles, minerals, vitamins and also a combination of these nutrients. By using the nutrient composition tables of these food stuffs, four principal components were formed. Using these principal components, Nutritional Indices were developed. Each food stuff was ranked according to the value of Nutritional Indices. It was found that cereals are rich in proximate principles as compared to minerals and vitamins. Among all cereals, maize tender was categorised as low in PV, PM, PV, MV and PMV. Ragi, rice puffed, wheat flour were classified as high in minerals. Pulses were classified as medium except for peas green and redgram tender which were low for all the nutrients. Peas green and redgram tender were found to be high in V and MV. Among leafy vegetables cabbage, coriander, curry leaves and tamarind were categorised as high where as amarnath stem and spinach as low and the remaining were in medium category. Cereals and pulses were rated as high in proximate principles while leafy vegetables were rich in vitamins.

14. Prediction of Milk Yield in Goats for Later Parities Based on the Initial Parity Yield

M.V. Asokan and K.C. George¹
Indian Statistical Institute, Coimbatore

The prediction of milk yield of different parities based on the initial parities were not attempted so far in the case of goats. As this is a very useful result for the goat farmers, a study has been conducted making use of the average weekly milk yield of 20 weeks duration under different parities of four breeds viz. Alpine Malabari, Malabari, F_2A and F_2S , brought up at the AICRP on Goats at Kerala Agricultural University farm. The data obtained showed very high correlation between first, second and average of first and second parity yields with later parity yields. Hence the first, second and average of first and second parity weekly milk yields were used as independent variable to predict the later parity milk yields. Five mathematical models, viz, Linear, Exponential,

Reciprocal, Multiplicative and Quadratic were tried and it was found that the Reciprocal Model (Model III) was the best and consistent one for predicting the later lactation yield based on the first, second and pooled average of first and second parity yield. By using this result, the uneconomical animal/breed could be culled in the initial stage itself.

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15. Use of Principal Component Analysis in Sire's Evaluation

S.C. Agarwal

Project Directorate on Cattle, Modipuram

The paper presents an algorithm for evaluating sires for selection through their progeny performance data under mixed model with multi-traits, required in animal breeding researches. The algorithm comprised of the popular Henderson's BLUP technique and the principal component analysis concept was used to analyse a real data set on life time milk yield, life time days in milk herd life of Haryana cows.

16. Test of Hypotheses Based on Cross Validation for Non-nested Linear Regression Models

G.K. Shukla and Nisha Bawa

IIT, Kanpur

For a given set of data, very often we have more than one alternative models in mind. The question arises which one of them best explains the data. For this some goodness of fit criterion is adopted and the model giving optimum value of the criterion is chosen. At a more formal level the approach of significance testing is employed. In this paper we consider the comparison of fit of two models which are non-nested, i.e., one model cannot be obtained as a special case of the other. The general problem of non-nested models from testing point of view was first considered by Cox (1961, 1962). In the present paper we have considered the approach of cross-validation (data splitting), which is a very commonly used technique for validation of the models, and is of

great relevance for the prediction purposes. Here we have applied Predicting Likelihood test for testing two non-nested linear models for a given set of data. We have also obtained null distribution of the test statistic by bootstrap method and tested the hypotheses about these two models.

17. On Generalised Probability Distribution and Generalised Mixture Distribution

S. K. Agarwal
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A general probability distribution is developed which serves as a general formula for some well known probability distributions such as Weibull, Exponential, Rayleigh, Gamma, Normal, Log-normal, Pareto, Maxwell, Generalised Laplace etc. Besides aforesaid probability distributions, a family of new distributions can also be derived from it. The statistical properties viz. moments and moment generating function have been worked out for generalised probability distribution (GPD). A mixture (or compounded) distribution by mixing gamma distribution with GPD, called generalised probability distribution of mixture (GPDM) has also been obtained. Cauchys, Beta, t, Reversed generalised logistic distributions are shown to be members of GPDM.

18. Genotype \times Environment Interaction in Bidi Tobacco

J. S. Patel and R. Lakshminarayana
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An initial varietal trial on bidi tobacco was conducted under AICRP on Tobacco at Anand (Gujarat) and Nipani (Karnataka) in 1992-93 while it was taken up at Nandyal (Andhra Pradesh) in 1993-94 with a composition of 11 Nipani selections and 6 from Anand with a common check A 119. The genotypes differed significantly for yield at the three locations. In pooled analysis, the differences due to genotypes were nonsignificant while, the genotype \times environment interaction was significant. Stability parameters were worked out following models of Eberhart and Russells (1966) and Perkins and Jinks (1968). Results revealed that the mean squared deviations for all genotypes were non-significant. The test of heterogeneity among the genotypic regressions

was highly significant which indicates the scope for prediction of $g \times e$ for individual genotype. Accordingly genotypes from Nipani centre viz. NPN 62 - 66, and 71 were found suitable for the environments studied while genotypes of Anand viz ABD 26 - 27-29,30-31 and -33 were found suitable to favourable environments of Anand and the check A 119 was for poor environment with low yield.

19. Application of Fuzzy Set Theory in Analysing Animal Behaviour

M. Chandra, V. K. Srivastava and A. K. Shukla
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Fuzzy set theory is being extensively used to reduce complexity in various fields. Problems of decision making, management and prediction arises frequently in agricultural and animal sciences. Due to high degree of uncertainty associated with these problems alongwith information collected in terms of data, scientists face complex situations to analyse. In this paper an attempt has been made to reduce complexity using fuzzy approach to study effect of temperature on semen quality and quantity of Murrah bulls. It was concluded that quality and quantity of semen is good in low temperature season upto certain degree.

20. Testing of Adoptability of Complex Designs in the CSR Experiments

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The production potential experiments of sixteen cropping systems research centres under All India Coordinated Agronomic Research Project (ICAR) were tested for the validity of the complex designs like strip plot. The data of the experiments were subjected to the usual analysis of variance and Bartlett test was applied to all the three error variances obtained in each experiment. It was found that in 73% of the experiments, χ^2 came out to be not significant resulting in the homogeneity of error variances. It showed that the use of complex designs like strip plot may not be suggested. Rather one may conduct experiments in the field straightway with simple design like RBD (Randomised

Block Design). This study also tells that the use of other complex designs like split plot or split split may be thought over on the basis of the prevailing conditions of the experimental environment before suggesting to the experimenter.

21. A Dynamical Model for Aphid Population Growth

Prajneshu

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Aphids are recognised as serious pests of cereals, oilseeds, pulses and vegetable crops in our country. It is highly desirable to investigate optimal control policies for controlling this pest. To this end, as a first step, a dynamical model is developed for describing the dynamics of aphid population growth. The deterministic model, which is expressed in terms of an integro-differential equation, is solved analytically. The corresponding nonlinear statistical model is applied to ten data sets using the Levenberg-Marquardt iterative procedure. Examination of residuals is carried out to study the validity of the underlying assumptions and subsequently the goodness of fit statistics are computed. It is found that the proposed model is quite successful in describing the dynamics of the aphid population growth.

22. Classification of Milk Production Data Under Uncertainty Using Fuzzy Set Theory

Meenu Sharma, V. K. Srivastava, A. K. Shukla and M. C. Joshi
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This paper considers methods for inference based on Fuzzy set theory approach to classify milk production data under uncertainty. This work develops possibility distribution for the amount of milk under different categories of yield such as very-low, low, medium, high, very high. A probabilistic model of the same data is also included. The uncertainty as calculated with possibility distribution is 1.499 bits and that calculated with probabilistic distribution is 1.7355 bits. Thus the comparison of uncertainty in the probabilistic and possibilistic models reveal that uncertainty reduces in possibilistic approach.

23. Soil Crust and Its Relationship with Soil Properties, Temperature of Drying and Time & Amount of Rainfall

Satyendra Kumar and D. K. Das
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Crop establishment problems in sandy areas are usually due to surface crusting or quick drying of seedbeds. Surface crusting is a serious problem in rainy season crops like pearl-millet, sorghum, maize, cotton, soyabean, sunflower etc. grown on the soil having less than 90 per cent sand. The emergence of pearl-millet and cotton seedlings is adversely affected, if the crust is formed on the surface by the occurrence of rainfall within 48 hours of sowing. The thickness of crust depends upon the amount and type of clay and silt present in the soil and increases with the increase in the clay content. The impedance to the emergence of seedlings caused by the soil crusting results in low population and subsequently poor crop yields. Knowledge and use of suitable agro-techniques to reduce soil crusting by the application of FYM @ 30 q/ha or rice husk @ 20 q/ha on seedlings increases the seedling emergences and crop yields of cotton, pearl-millet, sorghum and maize crops in alluvial sandy loam soil. The data collected under the ICAR - All India Coordinated Research Project on *Improvement of Soil Physical Conditions to Increase the Agricultural Production of Problematic Areas* is utilised for the present study.

The study revealed that the textural parameters such as (silt+clay) and clay is a reliable measure for crust strength than other physical or chemical properties of the soil. The thickness of the crust depends upon the amount and type of clay and silt present in the soil and increases with increase in the clay content. The crust strength in cotton and pearl-millet in sandy loam soil decreases with the increase in the amount of rainfall and also increases with number of days after rainfall during kharif season. The crust strength in both the crops is found highly significantly but negatively correlated with the moisture content. The crust strength is found positively correlated with days after sowing. The crust strength decreases with the increase in temperature of drying of the soils.

24. Possibility Distribution of Growth of Insects in Chickpea Plants Using Fuzzy Theory

Sanjay Kumar, V. K. Srivastava, A. K. Shukla and M. C. Joshi
G B Pant University of Agriculture & Technology, Pantnagar

Fuzzy theory has been used to determine the growth of population of *H. armigera* in chickpea plants. An entailment scheme is proposed to predict the possibility of an event in the environment of uncertainty. This paper investigates a technique to take the decision when some uncertainty is there.

25. Comparative Study of Nonequilibrium vis-a-vis Equilibrium Schaefer Model

R. Venugopalan and Prajneshu
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Schaefer model is extensively used for efficient fishery management. Generally, due to mathematical convenience, the assumption is made that the fish population is in equilibrium. In this paper, the procedure for fitting a nonequilibrium Schaefer model is described. Comparative performance of the equilibrium vis-a-vis nonequilibrium version is carried out on some catch and effort data. As the results obtained by the two approaches are found to differ markedly, it is concluded that nonequilibrium approach should invariably be adopted in order to capture reality.

26. A Study of Behaviour of Wheat Response to Long Term Fertiliser Application

Asha Saksena, Ajit Kaur Bhatia and Hamam Singh Sikarwar
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Responses of wheat (*Triticum aestivum L.*) to eighteen fertiliser treatments applied over a period of thirteen years from 1979-80 to 1991-92 were analysed to study the extent of variation due to changes in weather and soil fertility. Six-weather variables at four crop growth stages were used to classify years into six clusters of homogeneous weather years for wheat. Mean yields of these

clusters were significantly different from each other for all treatments and control. Regression of responses (additional yield over control) over clusters were found to be quadratic in nature. Clusters accounted for 8 to 54 per cent variation in responses of treatments containing no P_2O_5 . However, variation accounted in responses of other treatments was between 87 and 95 per cent. Difference in responses of various treatments in unfavourable years was smaller than in favourable years. $80 \text{ kg} \cdot \text{ha}^{-1}$ was optimum dose of nitrogen. P_2O_5 was found to be essential nutrient. No steady deterioration in responses of any treatment was observed. However, some slow changes seemed to be taking place in responses of six treatments without P_2O_5 . These slow changes accounted for 12 to 32 per cent variation in responses. Performance of treatment N P K $\text{kg} \cdot \text{ha}^{-1}$ was best in favourable as well as unfavourable years.

27. Forecasting of Crop Yields Using Second Order Markov Chains

R. C. Jain and Ramasubramanian
IASRI, New Delhi - 110 012

A second order Markov chain model has been developed for forecasting of sugarcane yield through which, it was possible to use two stages data simultaneously. This model has been found better than the models in use i.e. first order Markov chain model and the regression model.

28. A-optimal Block Designs with Unequal Block Sizes for Comparing Two Disjoint Sets of Treatments

Seema Jaggi and V. K. Gupta
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This study considers an experimental setting in which it is desired to compare v_1 test treatments with v_2 control treatments and the experimental units are arranged in b blocks, where each of the b_h blocks contains k_h experimental units, $h = 1, \dots, p$. Majumdar (1986) obtained sufficient conditions for a proper design to be A-optimal for estimating differences of two treatments, one from each set, for the experimental situations with blocks of small size. Extending this under the present setting, a general algorithm has been developed to generate

A-optimal block designs for making such comparisons, when the block sizes are small and also the sizes do not vary widely. Moreover the number of distinct block sizes are few. As a particular case the algorithm has been obtained when there are two types of block sizes i.e. $k_1 = 2$ and $k_2 = 3$. A computer program using this algorithm have been developed which generates a number of A-optimal designs. For large block sizes, a sufficient condition has been obtained to establish the A-optimality of non-proper designs for such comparisons.

29. On Experiments Involving Split Application of a Fertiliser

P. K. Batra, Rajender Parsad and O. P. Khanduri
IASRI, New Delhi - 110 012

In order to determine the effect of split application of Nitrogenous fertiliser to Paddy crop, large number of experiments have been conducted at different Research Stations of the country (*source* : Agricultural Field Experiments Information System; IASRI). These experiments have been conducted through Randomised Complete Block Designs (RCBD) with 2 to 5 replications, 4-15 treatments and a fixed dose of fertiliser is split into 3 or more stages of crop growth. These experiments, however, have similarity with those of experiments with mixtures. Here various crop growth stages corresponds to the components of mixture and the proportion of fertiliser applied at, say i^{th} stage as the contribution of the component to the mixture.

We have analysed these experiments using the method of analysis of mixture experiments. The results are illustrated with an example of experiment involving three splits. The design adopted for experimentation are found to be inefficient as per average variance and generalised variance criterion. Efficient designs for these experimental situations have been suggested.

30. Yield Forecast Model for Wheat Crop

T. Rai, Onkar Swarup and Chandrahas
IASRI, New Delhi - 110 012

The experimental data collected under the project on All India Coordinated Research Project on Cropping System Research at Gujarat Agricultural

University, Junagarh are utilised to develop wheat forecast model. The data on wheat yield and plant biometric characters such as number of tillers, height of plants and the length of earheads were collected over a period of five years 1990-95. Two types of functions i.e. linear and quadratic are fitted. It is found that these bio characters as explanatory variables explain the variation in yield upto 66% if they are considered to be linearly related with yield. The variability can be explained to the extent of 68% when quadratic terms of these bio characters are added in the linear model. The linear type of model is found to be more valid than that of quadratic. The linear forecast model developed can successfully be used for obtaining advance estimate of wheat yield for a period of four years, combined data may be preferred because of the forecast being very close to the observed yield.

31. Non-Linear Statistical Models for Pre-Harvest Forecasting of Inland Fish Production from Ponds

S. S. Walia and R. C. Jain
IASRI, New Delhi - 110 012

Three species of inland fish, viz. Rohu, Mrigal and Commoncarp were included in the present study. Non-linear statistical models were fitted to forecast fish weight at the time of harvest i.e. 12 months after stocking of fish. Results revealed that forecast of fish weight can be made three months before harvest for Rohu and Mrigal using logistic growth model. In case of exotic species, namely common-carp also the forecast of fish weight can be provided three months before harvest using Gompertz model.

32. A Statistical Analysis of Adoption of HYVs in India — The Case of Wheat and Paddy

V. K. Sharma
IASRI, New Delhi - 110 012

HYVs played a major role in heralding green revolution in the country, an attempt has been made here to study the pattern of adoption of HYVs for two important cereal crops viz., wheat and paddy in the major growing states and also to identify the factors that are responsible for wide variation in the

adoption behaviour using secondary data from 1966-67 to 1992-93. The analysis revealed that in most of the states demonstration effect played an important role in the adoption of HYVs. Besides, adoption of the existing HYVs has reached its saturation limit in most of the states for both the cereal crops. This implies that future growth in output of these crops will be slow, unless there is further technological breakthrough. However, there may be still some scope for improving the production through balanced use of chemical fertilisers and manures and better management practices. For both the crops, irrigated area under the crops came out to be a significant factor for determining the ceiling level of adoption in different states. At present, there is a need for development of new location specific HYVs suiting to various agro-climatic conditions of various states. Moreover, adequate infrastructural support in terms of irrigation, credit, market, road, delivery services, etc. would be essential for spreading any technology to different areas.

33. Identifying Influential Subsets of Data in Regression Models

V. K. Dwivedi and C. B. Tiwari
IVRI, Izatnagar - 243 122

For investigating and modelling the relationship between variables, the most widely used technique is regression analysis. Characteristics observations which cause them to be influential in least square analysis are investigated and related as residual variance, residual correlations, and the convex hull of the observed values of independent variables. The results are investigated on physiological experimental data.

34. Structure Resistant Factorial Designs

R. Srivastava, Rajender Parsad and V. K. Gupta
IASRI, New Delhi - 110 012

Factorial experiments occupy a significant place in experimentation since 1935 when they were first introduced by Fisher. To ensure the between - interaction and within - interaction orthogonality, the designs with orthogonal factorial structure (OFS) have been advocated. However, if one plans his

experiment using a design with OFS and later on finds that the treatment combinations belonging to one of the levels of any factor cannot be put to experimentation, as the material for that source may not be available, or the level may be lethal to the experiment. In such situations, it is important to study the properties of the residual design and obtain the designs which remain unaffected structurally by such disturbances.

In this investigation, the structurally resistant factorial designs with OFS have been defined. The characterisation properties of these designs have been studied. Some methods of construction of such designs have also been proposed.

35. Cross Over Designs for Making Test Treatments – Control (s) Comparisons

G. C. Chawla and Rajender Parsad
IASRI, New Delhi - 110 012

The problem of comparing several test treatments with the control has been studied by Pigeon and Raghavarao (1987) and Yadav (1990). However, there do arise experimental situations where we have to compare a set of test treatments with the set of control treatments. In the present investigation, we have studied a combinatorial aspect of changeover designs for comparing a set of test treatments with a set of control treatments.

36. Strategies for Composite Forecast

S. C. Mehta, Ranjana Agrawal and V. P. N. Singh
IASRI, New Delhi - 110 012

An attempt has been made to develop a composite forecast by combining the forecasts obtained from the models based on two different types of parameters which account for the variations in the crop yield. Various strategies of assigning appropriate weights viz. equal weights, weights proportional to variances and weights based on variances and co-variances are studied.

37. Selection of Biometrical Characters for Wheat Yield Forecast

Chandrabhas, T. Rai and Onkar Swarup
IASRI, New Delhi - 110 012

The present study is an attempt to examine the direct and indirect effect of the various causal factors such as number of tillers, plant height and length of earhead on wheat yield. The correlation coefficients among these variables are found to be positive. The direct effects of number of tillers and plant height are found to be positive whereas the direct effect of length of earhead is negative. All these causal factors explain about 67% of the variation in yield.

38. On Method of Rejection Procedure for Crop Performance Data

N. S. Gandhi Prasad and B. G. Sapate
Dr. Punjabrao Deshmukh Krishi Vidyapeeth, Akola - 444 104

Repetition of experimentation is a common feature in research to test the consistency of the results of experimentation over a period of time or a set of environments or both. At times some of the data obtained through designed field experiments (trials) poses a problem to the research worker about its inclusion and for pooling it with other sets of data which probably might have been recorded more precision. Bowman and Rawlings (1995) established a rejection criterion for the data which is based on historical information on level of precision (EMSS) and grand mean (M) of each similar type of experiment conducted some time back.

In the present study, an attempt is made to revise the B-R model and to develop a criterion for rejection based on studentised residuals if the R^2 of the fitted model is significant or from the values of EMSS observed otherwise. The methods proposed have been illustrated with the help of data compiled from reports on varietal trials under irrigated, rain fed and late sown conditions conducted by wheat research unit, Central Research Station, Dr. Punjabrao Deshmukh Krishi Vidyapeeth, Akola during 1983-95.

39. On the Specification of Error Structure in the Linear Regression Model

Kuldeep Kumar

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Regression models are widely used in agricultural sciences. However the assumptions regarding the independence of error in the linear regression model may not be valid quite often. For example the yield data from nearby blocks may be autocorrelated. In this paper we have discussed a new method based on the theory of Pade approximation for the specification of the error structure which may follow a general ARMA (p, q) model. We have also discussed the consequences of the error and reviewed the existing methods for the specification of the error. Using simulation studies we have shown that this method works well for the specification of error structure.

40. Statistical Analysis of Production and Distribution of Broilers

S. P. Bhardwaj, R. K. Pandey and K. P. S. Nirman

IASRI, New Delhi - 110 012

The broiler consumption in India has tremendous scope as the current per capita availability of 746 grams against 15 kg. in the developed countries. The production of broilers in India is gaining popularity in the village poultry as well as commercial poultry. The major benefits of village poultry is that it can provide additional income and employment in the villages. The present study has been undertaken to analyse the production and distribution of broilers in the rural areas of Haryana State. The study showed that mortality rates were higher (3 per cent) in the early age groups and it gradually falls in succeeding age groups. The study further reveals that small farms have higher mortality as compared to large farms. The depletion rates of broilers decreases as the size of poultry farms increases i.e. lowest depletion was observed in the large poultry farms. The supply of broilers was reported to be maximum in winter season mainly due to increase in consumption demand.

The distribution and marketing of broiler indicated that the price of broilers were low in whole sale market and the conditions in the market were rigid. Farmers have to pay commission and other cost in the market.

The study suggested that market practices were influenced by the size of farms and seasons. The local sales were reported to be very remunerative to the farmers. The study therefore concluded that local markets may be developed for the proper growth of broilers farms in the villages. Also the provision of remunerative farm prices would go a long way in developing this industry.

41. Improved Estimators of Variance in the Presence of Response Errors & Non-Response Errors

K.N. Singh and Randhir Singh¹
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It has been seen that when data contains response errors as well as non-response errors (in case of imputation) the estimator of variance becomes biased. In this paper improved estimators of variance have been suggested. The suggested variance estimators are in general quadratic functions of observed values. Two sets A & B have been formed and each of $n(n-1)$ pairs (n is sample size) of sample units falls in one of the two sets A & B. It has been shown that if n , n_1 & n_2 (where n_1 & n_2 are number of pairs in A & B) are fixed then this estimator becomes unbiased for the variance.

¹ IASRI, New Delhi - 110 012.

42. A Comparison Between Sustainability and Coefficient of Variation in Area, Production and Productivity of Major Crops in Northern Telangana Zone of Andhra Pradesh - A Case Study

K. Venkateswar Rao and K.C. Chenna Rayudu
APAU, Hyderabad

In Northern Telangana Zone of Andhra Pradesh comprising Adilabad, Karimnagar, Warangal and Nizamabad districts major crops grown are rice, redgram and greengram etc. A comparative study of sustainability index and coefficient of variation of the area, production and productivity in the four districts are compared with reference to the each crop. It is found that the

sustainability index is negatively correlated with coefficient of variation (with respect to area, production and productivity) and found to be significant.

43. A Sampling Scheme Using Varying Probabilities of Selection

D.N. Shah and Pravender
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A simple and elegant scheme of selecting a sample of size n using varying probabilities of selection from the finite population of size N has been proposed in this paper. Six special cases of scheme have also been obtained by defining very simple relationship between the vectors involved in the scheme. It is interesting to note that in some cases inclusion probabilities for individual and pairwise units are same as obtained under Midzuno-Sen (1952) scheme. Schemes of Narain (1951) and Deshpande (1996) can be obtained as particular cases of our scheme. An application of the scheme is also discussed.

44. Growth and Instability in Groundnut - A Study in Agro-climatic Zone-10

Nikita Gopal, I. Narender and P.B. Parthasarathy
APAU, Hyderabad

Oilseeds occupy 15 per cent of the gross cropped area in Agro-climatic Zone 10, the Southern Plateau and Hills Region. The most important oilseed crop is groundnut occupying almost 90 per cent of area among oilseed crops.

This paper attempts to study the growth and instability in groundnut in this zone.

Zone 10 consists of 35 districts falling in the states of Andhra Pradesh, Karnataka and Tamil Nadu. Time-series data for area, production and yield of groundnut for the period 1971-72 to 1991-92 was used for the study. Linear growth rates were calculated for the parameters. Trend lines were fitted for observed values higher and lower than the trend for overall observations to arrive at convergence/divergence, which was used as a measure of instability.

Production was decomposed to find out the components of change in average and variance of production.

Growth rate of area under groundnut had decreased in period I (1972-73 to 1981-82) accompanied with low instability in most sub-regions of the Zone. In period II (1982-83 to 1991-92) area growth rate had increased which resulted in increase in the production growth rates too. This was accompanied with increasing year-to-year fluctuations in both these parameters. The effect of period II was reflected in the overall period also. Yield growth rates had recorded significant increase in period II in sub-region 5.

Change in area was the main contributor to change in average production in sub-regions 2, 3 and 4 and change in yield contributed in sub-regions 1, 5 and 6.

Covariance of yield and area was the main contributor to changes in variance of production in groundnut.

Increase in area due to introduction of new technology results in certain amount of instability because there is a sudden change in area under the crop. This phenomenon is observed in groundnut in this Zone.

45. A Study on the Trends in Yield of Sunflower in Andhra Pradesh, Karnataka and Maharashtra

K. Chugh and Satya Pal
IASRI, New Delhi

Sunflower has emerged as an important oilseed crop in the country due to its great commercial and economical importance. The seeds of the crop are known to have 40% oil contents of high nutritive value almost twice the oil contents of groundnut.

An attempt has been made to study the trends in yield of the crop in Andhra Pradesh, Karnataka and Maharashtra. Data on area and production of the crop in these states from 1979-80 to 1993-94 (15 years) has been used for the study. The total time has been divided into three quinquennial periods. These periods are (I) 1979-80 to 1983-84 (II) 1984-85 to 1988-89 and (III) 1989-90 to 1993-94. Trends in yield have been studied by comparing the quinquennial averages of yield rather than annual yields as these are likely to average out, to a great extent the differential effect of weather and other uncontrolled factors. There has been phenomenal increase in area under

sunflower in the three states during the period under study. Karnataka alone accounted for more than half of the area under sunflower in the country during the triennial ending 1993-94. The three named states accounted for 90% of the area reported under the crop.

The decrease in yield was of the order of 4% per year in case of Maharashtra and 5% in Karnataka. Increasing trend was observed during the third period over the 2nd period. In case of Andhra Pradesh the percentage increase was of the order of 13.1% which was statistically highly significant.

46. Ratio Method of Estimation in the Presence of Measurement Errors

Shalabh
University of Jammu, Jammu

In the present article, the effect of measurement errors on the ratio estimation technique of the population mean is examined.

47. Statistical Techniques to Access the Intake of Feed Nutrients on the Performance of Milk Yield

Satya Pal, R.M. Sood and T. Rai
IASRI, New Delhi - 110 012

The present investigation is an attempt to know the contribution of explanatory variables towards milk yield. Three statistical procedures path-coefficient, multiple regression and principal component techniques are employed. It is observed that the effect of DCP (Digestible Crude Protein) amounts to .7232, where as the direct effect of TDN (Total Digestible Nutrient) is found to be -0.3185. All the input variables (quantitative and qualitative) together explain about 43% of the total variability in milk yield. DCP is the only variable whose effect on the yield is found to be significant.

48. Study on Paddy Crop - Soil Relationship

Jagmohan Singh, Ranjana Agrawal and B.H. Singh
IASRI, New Delhi - 110 012

The quantity of water required in the root-zone for proper growth of crop depends on soil texture and its topography. In India, there is a great contrast in the climate from place to place resulting in large scale variation in rainfall in different parts of the country. Excess rainfall may cause flood situation anywhere reeling large tracks of cropped area under flood water. It is, therefore, essential to assess the effect of flood water on crops cultivated in the fields of different texture and topography. With this view, a study is carried out for investigating the effect of flood on yield of paddy in soil of various textures and topography in Tehsil Tanda of Faizabad district of Uttar Pradesh with the data consisting of yield, inputs, number of times flood occurred, depth and duration of each flood.

Flood indices of depth and duration of flood water at different points of time were developed and used as regressor in the regression model for studying the flood effect on yield of Paddy. Loss in yield (kg/ac.) of Paddy for each centimeter of depth of water ranged between 9.83 in clay undulated soil and 1.5 in loamy plain soil respectively whereas for duration of flood water, it was 25.92 kg/ac. and 5.78 kg/ac. in loamy plain and clay plain soils respectively.

49. Estimation of Regression Coefficient from Survey Data Based on Test of Significance

Anil Rai and A.K. Srivastava
IASRI, New Delhi - 110 012

The ordinary least square (OLS) estimator of regression coefficient is implicitly based on IID assumptions, which is rarely satisfied by survey data. Many approaches are proposed in the literature which can be classified in two broad categories as model based and design consistent. Du Mouchel and Duncan (1983) proposed a test statistic which helps in testing the ignorability of sampling weights. In this article a preliminary test estimator is proposed, based on which, is found to be a better compromise between model based and randomization based inferential frame work.

50. Fitting of Regression Model and Assessing the Loss in Yield of Rice due to Different Categories of Weeds

Madan Mohan and B.H. Singh
IASRI, New Delhi - 110 012

The paper deals with the development of statistical model for assessing the loss in rice crop due to different categories of weeds namely : 1. Grassy 2. Leaved 3. Sedges. The study reveals that out of total variation (R^2) in yield due to weeds is 70%. The grassy, leaved and sedges type of weeds explained 49, 68 and 18% variations respectively and then the percentage loss due to these categories of weeds was worked out to be 4.4, 12.4 and 9.0% respectively.

51. Study Impact of Command Area Irrigation Project on Rice in Periyar District of Tamil Nadu

R.M. Sood and Madan Mohan
IASRI, New Delhi - 110 012

Irrigation is a crucial input particularly in the context of adoption of new agricultural technology involving use of high yielding varieties, fertilisers, chemicals etc. Accordingly the Command Area Development Programme (CADP) was initiated. CADP covers the area between Bhavani river and lower Bhavani canal. The study reveals that the overall yields of 4785, 5534 and 6154 kg/ha for the Command Area in 1988-89, 1989-90 and 1990-91 were statistically significantly higher compared to the average yield of 3352, 4330 and 4771 kg/ha for the above respective years in the Non-command Area, as revealed by t-test.

52. Estimation of Absolute Change in Rice Yield due to Technological Advance - A Spline Function Approach

Ashok Kumar and R.K. Pandey
IASRI, New Delhi - 110 012

India's achievements in food production are mainly due to technological advance in agriculture. However, given the site-specific variation in local

ecologies and topography may strongly affect the benefits from technological advances. In the Indian context the variation in land quality across states is well known resulting wide variation in local ecologies and difference in the yield of rice among the states. This paper is aimed at to study the historical change in the yield of rice due to technological advance across different rice growing states using spline function approach. The study covers major rice producing states and data for the period 1951-91 has been utilised.

53. Flow in Dynamic Population

Jagbir Singh
IASRI, New Delhi - 110 012

The population of agricultural operational holdings and human labour has been undergoing a change in its composition due to various factors for the past several decades. Now a days there is a growing demand in planning to estimate the flow in various classes in the population for assessing social and economic development of the population engaged in agriculture, industry etc. instead of estimating population point parameters. In this paper, after adopting the usual successive sampling plan, an attempt has been made to develop the estimators for the structural changes occurring in terms of number of units in dynamic population due to cross movements of units in two classes over the two occasions under general developmental phenomenon.

54. Comparative Study of Regression Estimators from Survey Data for Small Sample Sizes

Y.K. Sharma, Randhir Singh¹, Anil Rai¹ and S.S. Verma
Defence Institute of Physiology & Allied Sciences, Delhi - 110 054

The technique of regression analysis gives misleading inferences when applied to complex survey data. In recent past number of attempts have been made to find out suitable statistical procedure for regression analysis of survey data under different inferential frame-work. In this article an attempt is made to study the performance of different regression estimators of survey data for small sample sizes. The performance of p-weighted estimators were found to

be satisfactory for small sample sizes as they are robust against the failure of model assumptions.

1 IASRI, New Delhi

55. Effect of Date of Sowing on Yield of Paddy

S.C. Sethi, D.C. Mathur, D.K. Bhatia and Jagmohan Singh
IASRI, New Delhi - 110 012

Paddy crop is generally sown from first week of June to second week of August during the Kharif season. As this crop needs lot of water for its cultivation so it is generally sown on the onset of rainy season, where irrigation facilities are available, there its process of sowing is started in the month of June or even earlier. It is important to study the effect of sowing period on the yield of paddy along with the other inputs applied as usual. To investigate the effect of sowing dates on yields of paddy, data collected under the supervision of Haryana Government by conducting crop cutting experiments on major food and cereal crops, is utilised. This study is confined to paddy crop in district Hisar during the year 1988. Two groups of cultivators sowing paddy crop in different period of times are considered. In both the groups, inputs used are urea, other fertilisers and four groups of irrigation in different span of time during the cultivation of crop. The number of irrigation in each group are clubbed.

The study reveals that the yield of paddy per acre in case of farmers (i.e. sowing paddy crop in June and earlier) is 382 kg/acre (%S.E. = 13.58) whereas in case of II group of farmers (sowing paddy crop after June) it comes out to be 488 kg/acre (%S.E. = 6.9).

56. An Alternative Approach for Estimation of Crop Yield

R.C. Gola, S.S. Gupta and P.C. Mehrotra
IASRI, New Delhi - 110 012

Under the present system of preparation of estimates of production of crops, crop cutting experiments are planned and conducted which is quite expensive and time consuming. Currently it is being opined that an alternative

to this approach could be to collect data on crop production by enquiry. The soundness of this approach from efficiency and many other angles needs deeper investigations. The present paper is an attempt in that direction with an empirical illustration from past live data collected both through crop cutting experiments and enquiry.

57. Post-stratified Estimator in Two-Stage Design Using Auxiliary Information

M.S. Narang, P.C. Mehrotra and A.K. Bhatia
IASRI, New Delhi - 110 012

Post stratification in two stage sampling utilising auxiliary information at the second stage has been attempted. Units at both the stages are selected with simple random sampling without replacement. It is empirically demonstrated that the suggested procedure not only provides estimate of the character under study with higher precision according to the stratification variable but also improves the precisions of the estimates pooled over the strata vis-a-vis the common post stratified two-stage sampling procedure not utilising auxiliary information.

58. On Different Estimators of Finite Population Regression Coefficients When the Variables are Subject to Measurement Errors

U.C. Sud, I.C. Sethi and Anil Rai
IASRI, New Delhi - 110 012

This paper is concerned with examining relative performances of three estimators of finite population regression coefficients namely : Kish and Frankels estimator, weighted version of maximum likelihood estimator (when response variance in the explanatory variable (x) is known) and the weighted version of maximum likelihood estimator when the response variance in the explanatory variable is estimated by re-interview technique. The efficiency of B_{p2} is compared with B_{p1} when information on response variance for each unit of x is collected. Optimum values of sample sizes are obtained. A simulation study is carried out to examine the situations under which B_{p2} scores over B_{p1} .

59. Sampling Methodology for Estimation of Fish Catch from a Lake

H.V.L. Bathla, O.P. Kathuria and K.K. Kher
IASRI, New Delhi - 110 012

This study is based on the secondary data on fish catch pertaining to Chilka lake. This semi-enclosed coastal body of water has a right degree of salinity so as to support and sustain the brackishwater culture. Department of Fisheries, Orissa regularly collect the fish catch data from all the eleven landing centres of Chilka lake as per a sampling design. On the observed day, the fish catch from the three randomly selected boats and total number of boats arriving at a landing centre are recorded. An attempt has been made in this study to use part of data for estimating fish catch from the lake with a reasonable degree of precision. It was observed that when the partial data as regards to landing centres was taken, an encouraging trend was noticed. If an appropriate methodology using part of data can be standardised, it will reduce a lot of data collection work.

60. Plot Sampling Technique for Yield Estimation in Lucerne (*Medicago sativa*)

Ashok Kumar and D.P. Handa¹
IGFRI, Jhansi

Variability amongst the plot yields of lucerne in Jhansi, has been studied by Handa *et al.* (1995), and the relationship between variability with the size and shape of plots as well as efficiency of different designs was also discussed. However, the optimum size of sample for productivity estimation of this crop grown under uniform conditions has not been studied so far. Hence, an attempt has been made to find out the optimum size of sample to be harvested for productivity estimation of lucerne using simple random sampling without replacement technique. For this purpose the yield data of lucerne recorded from one of the experiment conducted on uniformity trial at C R farm of Indian Grassland & Fodder Research Institute, Jhansi, were utilised.

The result indicate that, an area of size 10.60%, 7.73% and 9.28% (of the total area) consisting different plots of sizes 2m² (1m x 2m or 2m x 1m) each selected with simple random sampling without replacement technique, will

be sufficient to be harvested for yield estimation of lucerne, respectively during 1st, 2nd and 3rd cut at 10% sampling error. The well known quadratic response equation of the form given below gave a very good fit to the underlying relation between the per cent sampled area (Y) to be harvested and size & shape length (X_1) and breadth (X_2) of the sample unit (plot).

$Y = a + b_1 x_1 + b_2 x_1^2 + b_3 x_2 + b_4 x_2^2 + b_5 x_1 x_2$ with ($R^2 = 0.94, 0.78$ and 0.89 respectively for 1st, 2nd and 3rd cut).

1 IASRI, New Delhi - 110 012.

61. Disease Profile of Sheep and Goats in a Rural Environment

S.N. Arya, D.C. Mathur and D.K. Bhatia
IASRI, New Delhi - 110 012

The disease profile of sheep and goats in Tiruchirapalli district of Tamil Nadu is highlighted from sample survey data. The sample was drawn by stratified two-stage simple random sampling without replacement. Two parameters, viz. disease prevalence rate (DPR) and case fatality rate (CFR) were used as measures of the intensity of disease infliction among the ruminants. Further, relative frequencies of various diseases were obtained separately for each category of the animals. The proportions of cases treated, recovered, died and disposed were also worked out.

The DPR was found to be of the order of 6% in sheep and 8% in goats; lambs and kids having rates of 8% and 12% respectively. The CFR was over 60% in the case of sheep and around 40% in the case of goats. Prominent among the various ailments were enteritis, sheep/goat pox and pneumonia. Enteritis was conspicuous for the lions share in the disease inflictions. While a good proportion of the animals had received treatment and recovered, very high proportionate mortality was noticed among the untreated cases.

62. A Study on Yield of Pepper in Maharashtra and Karnataka

P.M. Ramesan, V.K. Jain and S.S. Shastri
IASRI, New Delhi - 110 012

A pilot study was conducted in Karnataka and Maharashtra to estimate the annual yield of pepper during the period of three years from 1991-92 to 1993-94. Successive sampling technique was used for estimating the average yield per standard and the production of green berries. An attempt has been made to improve estimates using one year for estimating another year's data. Four different estimates were generated for every year. The paper discusses the relative merits of these estimates.

63. On Relationship Between Different Traits of Sahiwal - Jersey Crossbred Cows - A Case Study of Tarai Region of Uttar Pradesh

V.K. Bharti, V.P. Ojha¹ and A.K. Shukla
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For the present study the data regarding first and second calving characteristics of 90 S×J crossbred cows were obtained from the Livestock Research Centre of G.B. Pant University of Agriculture & Technology, Pantnagar. It was of 11 years i.e. from 1971 to 1981. Six characters of first two calvings namely gestation period, age at calving, weight of calf, milk yield, lactation period and average milk yield per day has been taken into account. Correlation coefficient of 35 combinations were obtained and if found significant their simple regression equations were ascertained. Effect of more than one trait (multiple regression equation) on first lactation milk yield, second lactation milk yield, first lactation average per day milk yield and second lactation average per day milk yield were also obtained.

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64. On Unequal Probability Sampling Techniques

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In unequal probability sampling where units are not replaced after each draw, we need a probability vector for selecting first unit and different sets of conditional probabilities for subsequent draws. In this paper we present a sampling scheme for drawing two units. Here a general type of conditional probabilities are suggested and a few special cases are considered.

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65. Student's t-Statistics : A Bibliography

R.A. Singhal and P.S. Pandey
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The work pioneered by W.S. Gosset (1908) in small samples for testing the hypotheses and for the estimation of confidence intervals particularly for population means has become very extensive. For this purpose one or two random samples are drawn from populations admitting classical assumptions namely (i) normality, (ii) equality of variances for two samples and (iii) independence. The article consists of a compilation of 600 and odd references on student's t and related topics. A large number of work can be found for samples from Edeworth, Laguerre, Cauchy, Poisson, Bessel, Symmetrical, Logistic, Rectangular, Exponential, etc. populations. Besides plethora of references can be seen on Behrens - Fisher problem whereas a few references are found dealing with the problem of dependence. Non-central t, fractiles and power of the test coupled with approximation have been dealt with by a large number of researchers. The researchers have also compared the Student's t with non-parametric counterparts and have found them near robust under moderate departure from assumptions. Some work on multivariate t can also be seen in the bibliography.

66. Effects of Nonnormality on Confidence Intervals for Between Group Variance Component in a One-way Random Model

R. A. Singhal and P. S. Pandey
IIPR, Kanpur - 208 024

The effects of nonnormality on confidence intervals for the between group variance component, where samples for both the random effects are taken from an Edgeworth population, are investigated using approximate methods based on classical chi-square and F distributions. It is found that the intervals are much more affected by the kurtosis of the group effects than of the error effects. Moreover, the intervals based on F approximation are shorter than those based on chi-square approximation.

67. Overlapping Clusters Using Auxiliary Variable

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Cluster sampling is adopted in practice due to its operational convenience even if list of all units in the population is available. Many a times overlapping clusters are formed. Amdekar (1985) has given an unbiased estimator of population mean for such a situation. In this note we study use of auxiliary variable in the formation of overlapping clusters.

68. Improvement of Yardsticks of Additional Production of Castor from the Use of Fertilisers with Irrigation

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Castor is a crop that can be grown in any part of the country. It is tolerant to drought. It is grown as a sole crop and as a mixed crop. The oil extracted from seed is used for medicinal, lighting, lubricating and industrial purposes.

Castor is generally grown as a kharif crop under dryland/rainfed conditions. Even irrigated, it is irrigated lightly.

In this paper, an attempt has been made to demonstrate that yardsticks of castor from the use of fertilisers can be improved further with irrigation. The improvement is up to 3.65 kg.

69. Yardsticks of Additional Production of Soyabean to the Application of Fertilisers

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Soyabean is a crop getting recognition and encouragement due to its multifaced uses. The grain contains proteins upto 40% and oil upto 20%. The oil extracted from seed is used as edible oil and is said to be free from cholesterol. Soyabean cakes made of waste after oil extraction is used as a cattle feed. Soya milk made from seed is used in dairy and baby food and is highly nutritive. The fodder contains good amount of proteins and used as a cattle feed. In this paper, yardsticks of additional production are worked out and their behaviour is discussed.

70. On the Use of Ratio-Type and Regression Methods of Estimation at Different Stages of Sampling

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Under stratified two-stage random sampling design, different types of estimators, making use of auxiliary information, for estimating the energy utilisation in various crops at strata (tehsil) level as well as at district level have been investigated. Various estimators, making use of ratio-type and regression methods of estimation at different stages of sampling were taken into consideration. With energy utilisation in a crop being characteristic under study, area under the crop has been taken as the auxiliary characteristic. It was observed that first stage component of the estimate of variance contributed highly significantly as compared to the second stage component. Simple

two-stage sampling estimator was also taken into consideration in case where no auxiliary information was used.

71. Stratified PPS Sampling and Allocation of Sample Size

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In this paper we shall consider the problem of Neyman optimum allocation of sample size to strata when sampling is done by using a probability proportional to size with replacement (PPSWR) sampling technique within each stratum. Observing that this allocation depends on population parameters, we shall obtain near optimum allocations based on auxiliary information available and compare them. Finally, we illustrate these results by numerical examples from live data.

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72. Establishment of Core Collection in Sesame

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Data for 25 descriptors on 3500 accessions were utilised for developing the statistical methodology for delineation of core set in sesame, *Sesamum indicum*. Initially, data on 75 accessions belonging to different geographical regions were subjected to the following clustering techniques :

1. Simple linkage
2. Complete linkage
3. Weighted average linkage
4. Average linkage
5. Wards sum of squares

Wards minimum sum of squares technique was the most efficient as it could classify accessions into 8 well characterised groups belonging to different ecogeographical regions. The remaining accessions were then allocated to these

groups. For varying sample sizes viz. 5%, 10%, 15%, 20% and 25% the following methods of allocation using SRSWOR were compared for maximising diversity.

1. Equal sample size from each of the groups
2. Proportional to the size of the group
3. Proportional to logarithmic size of the group
4. Proportional to Shannon Diversity Index (SDI) in each group

A sample size of 15% using allocation proportional to SDI was the most efficient one. A core set of 350 accessions was established.

73. Analysis of Directional Data in Agricultural Research Using DDSTAP

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Data on orientations, displacements, angular measurements, directions, periodic phenomena, measuremental errors, etc. are often cast in the arena of circular or directional data. Usual statistics for linear data are often not even meaningful for such data. Statistical analyses of such data call for new techniques which are often computer intensive for implementation. With the advent of computers, attempts can now be made to tackle many important real-life problems in agricultural research. This is illustrated through a "data" from a real life experiment on the onslaught of aphids laying waste huge areas of agricultural fields. Inferences on the expected arrival time, the direction of the flight, differences on the preferred directions of flights for two or more different species, adaptive modelling of flight directions and flight times after preliminary exploratory data analyses, etc. together with determining the predictive density are only just a few practical problems that beg applications of analysis of directional data. The interplay of time, temperature, humidity, agricultural products, fertility gradients, aphid-density etc. call for circular-linear regression using probability models which are enhanced through the principle of maximum entropy. Another important problem is that of objectively and statistically detecting the change-point in such preferred directions or times. A comparison of real-time onsets of effects of deterring mechanisms or pesticides translates to the statistically challenging problem of testing for the significant difference in the change-points of competing deterrents. The analyses

demands extensive computer work. However, many of these problems may be solved through DDSTAP, a statistical software package for analysis of directional data, being currently developed by this researcher at ISI-Calcutta, as is hoped to be demonstrated during the presentation.

74. The Horvitz-Thompson Strategy (HTS) in Teaching the Concepts and Methods of Sampling Theory

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Stuart (1964) observed : *Sample survey theory seems, more than most branches of statistics, to suffer the lack of a unifying thread on which to string the various topics of which it is composed.* Courses in sampling often lack a coherent structure because many related sampling designs, estimators, variances and variance estimators are presented as separate cases. Sampling texts often introduce the Horvitz-Thompson (1952) Estimator in the narrow context of varying (or unequal) probability sampling of primary sampling units (clusters), according to a measure of size of the clusters (Cochran 1977; Kish 1965; Desraj 1968). However, the HT strategy has much greater theoretical importance and practical utility than demonstrated in most of the sampling texts. It provides a unifying generalisation for a large part of the design-based sampling.

The HT strategy is able : to derive estimators and variances for many commonly used designs and also for the specialised sampling strategies; to establish the intuitively appealing solution that unequal inclusion probabilities are accounted for simply by using the appropriate weights, the inverses of the inclusion probabilities, in the estimator; to derive several important cases simply by defining y_i in the HT strategy to give the appropriate parameter (i) if $y_i = 1$, then $e_{HT} = N$, the number of objects in the finite universe, (ii) if $y_i = 1$ for $i \in A$, otherwise 0, then $e_{HT} = N_a$, the number of objects in subpopulation A and (iii) if $y_i = y_i$ for $i \in A$, otherwise 0, then $e_{HT} = Y_a$, the total of y for subpopulation A.

The HT strategy is based on the strategy of deriving consistent estimators and establishes itself as the basis for a generalised strategy for consistent estimation : any continuous function of linear parameters is estimated consistently by the same function of HT estimators of those linear parameters.

A correspondence between a model-based estimator and HT estimator is useful. For an IPPS design, HT estimator $e_{HT} = \sum_{i \in s} y_i / \pi_i = (X/n) \sum_{i \in s} (y_i / x_i) = Xr$. This may be considered as the mean-of-ratios estimator, where r is the BLUE of the model parameter β , under a specific model for the error structure. Specification of other models lead to alternative estimators.

Focusing on properties of inclusion probabilities enhances the understanding of basic definitions and concepts. For instance, by examining the π_i 's for various designs, it becomes apparent that SRS is not the only equal probability sampling design. Completely enumerating the sample space and calculating the inclusion probabilities for a small population and small sample size for some of the basic sampling design demonstrates that inclusion probabilities are a characteristic of the design, not of a sample. The inclusion probabilities are fixed at the time of sample selection. In practice, the HT strategy requires inclusion probabilities to be known only for the sample. Inclusion probabilities associated with nonsampled units need only be knowable. Thus a useful working definition is that a probability sample is one that admits HT estimation. The utility of such a definition is that it is sometimes impractical to know π_i 's for all $i \in U$. If π_i 's can not be calculated the design is not a probability design and the researchers must be willing to base inferences on an alternate methodology.

The term size-biased sampling is appropriate only relative to samples for which actual π_i 's can not be determined. By definition, such samples are not probability samples and thus, other estimation procedures are required. An example of size-biased data occurs in line transect sampling of animal populations in which it may be virtually impossible to ascertain the probability of including a particular animal in the sample. Using the HT strategy, it is easy to establish the validity of inferences based on variable probability samples as long as the π_i 's are appropriately taken into account in the estimator.

75. Two-dimensional Branching Process with Emigration —A Dispersal Model

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Karlson and Taylor (1992) studied the dimorphic dispersal of stream population of freshwater bryozoans through a one-dimensional branching

process. However the above phenomenon produces a mixture of non-dispersed and dispersed offspring (called as Sessoblasts and Floatoblasts) and thus can be studied more realistically through a two-dimensional branching process. Since both of these species (called as type-I and type-II offspring) undergo mortality at a substantial rate, the process, therefore, becomes a two-dimensional branching process with emigration. The p.g.f. of the offspring distribution has been obtained as follows:

$$F(1)(s_1, s_2) = [1 - \beta(1 - s_1)]^{m_{11}} [1 - \alpha(1 - s_2)]^{m_{12}}$$

The extinction probabilities of both types of offsprings have been computed separately.

76.

Relative Variance— A Guide for Judging the Stability of Estimate of Variance

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A modified approach considered as "Two-Unit Reduced BRR" which is an extension of two-unit per stratum stratified design for variance estimation to a general n_h - unit per stratum stratified design. Here n_h denotes the number of selected units in h-th stratum. By this approach, first the arbitrary size of each stratum is reduced to size two by grouping the units randomly and then the usual Balanced Repeated Replications (BBR) technique is followed. We shall use the statistic Relative Variance [$CV^2(T)$] - square of coefficient of variance of estimate (T), a guide to judge stability of the estimator of variance obtained by this approach. For illustration, the results on relative width of confidence intervals used in Health Examination Survey (McCarthy, 1966) have been cited. It is seen for L (number of strata) higher than 15, some 20 to 40 independent replications (k) would be required.

77. Growth Rates of Area, Production and Productivity of Rice in India

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India has the largest area under rice among the rice growing countries of the world and in respect of production it occupies the second position. The production of rice increased from 30 million tonnes in 1966-67 to 73 million tonnes in 1992-93 registering a growth rate of 2.94 percent. Area under rice increased at a compound growth rate of 0.67 percent whereas the productivity increased at the rate of 2.29 percent. Compound growth rates of area, production and productivity during the high yielding variety period (1966-67 to 1992-93) were computed by the least square technique of fitting the exponential function $Y = ab^t$. The growth rates were computed for states as well as All India.