Abstracts of Papers

1. Growth Pattern of Indian Native Chickens

Shiv Prasad[1], D.P. Singh[2], Rajendra Singh[1] and C.L. Suman[1]

Aseel has plenty delicious flavoured meat due to its biggest body size among the Indian native breeds of chickens accompanied by broader breast. About 13 varieties of Aseel are found in the country out of which Kagar and Peela are being maintained at Central Avian Research Institute, Izatnagar. The average body weight of Aseel Kagar at 0, 8, 20, 30 and 40 weeks of age for male and female chickens were 34.18 ± 0.71 g, 31.17 ± 0.46 g, 429.28 ± 13.98 g, 375.71 ± 7.54 g, 1471 ± 40.41 g, 1316 ± 31.12 g, 2125 ± 71.88 g, 1871 ± 50.32 g, 2475.71 ± 89.83 g and 2195.24 ± 54.51 g respectively. The male birds grew faster than female birds and attained the maximum weight gain at 15th week of age. Seven nonlinear functions were fitted to average weekly body weights of male and female birds. Gompertz function was found to be the best function to describe their growth pattern.

1. Indian Veterinary Research Institute, Izatnagar
2. Central Avian Research Institute, Izatnagar

2. On Use of Regression Diagnostics in Data of Experiments of AICRP on Soil Test Crop Response Correlations

Aloke Lahiri

The problems of recommending optimum fertilizer dose to the farmers for economic use of fertilizer are many. Experiments conducted by the AICRP (ICAR) on "Soil test crop response correlation" recommends the optimal doses of fertilizer to the farmers since 1967. It was observed that by using multiple regression equations, most of the time it is not possible to get the optimal values. The problem may lie in the goodness of fit of the model, which is being used, or there may be problems with outliers. One of the main problems faced by the project, was that the signs of the regression coefficients and their estimates varied widely over the years. An attempt was made with the help of Regression Diagnostics to look into the probable causes of the same and to find the remedial measures, if any. The possible outliers were detected and subjected to critical examination. It was observed that the process of regression diagnostics should be attempted with great caution as an observation that looks innocent may be 'masked' by another. For simple experiments with less observation one can go ahead with regression diagnostics but in experiments of soil test crop response project, which has more than 100 observations for each experiment, one must be very cautious in dealing with data.

Indian Agricultural Statistics Research Institute, New Delhi

3. Optimum Plot Size in Field Experiment with Bajra *(Pennisetum typhoides S & H)* for North Saurashtra

S.M. Upadhyay, H.R. Pandya and D.V. Patel

Uniformity trial was conducted at the Main Dry Farming Research Station, Junagarh Agricultural University, Targhadia during kharif season of 2003 to find out optimum plot size for field experiment on bajra crop CV GHB – 316. The crop was grown at a spacing of 60 cm × 15 cm. The grain yield data were obtained for 900 basic units. The dimension of each basic unit was two rows of 0.90 meter length. The results revealed that coefficient of variation per unit area (C.V.%) decreased with the increase in size of plot. The rate of reduction in C.V.% was more with the increase in width of the plot (i.e. no. of rows) than that with the increase in length of the plot. The maximum curvature method was used for determining optimum plot size which was worked out to be 10 units plot (10 × 1) i.e. 2 rows each of 9 meter length as an optimum plot size for the field experiment on bajra trial for Targhadia.

Junagarh Agricultural University, Junagarh

4. Vague Query Translation for Accessing Information from Relational Databases

Karan Singh[1], S.S. Thakur[2] and K.N. Singh[3]

In order for a database to be useful, data must be compiled into information using tools such as queries. Queries allow a user to specify what data to retrieve from a database, and in what form. This paper presents a new method for vague query translation based on the cuts operations of vague numbers. This proposed method allows the retrieval conditions of SQL queries to be described by vague numbers. It emphasizes friendliness and flexibility for the inexperienced users. It allows the users to construct his vague queries intuitively and to choose different retrieval threshold values for vague query translation to access the information from existing relational database system. Developing a translator using suitable language may do the implementation of this approach.

1. Central Institute of Agricultural Engineering, Bhopal
2. Government Engineering College, Jabalpur
3. Indian Institute of Soil Science, Bhopal

5. Comparison of Some Stability Analysis Models Based on Pearl Millet Genotypes Tested Over Space and Time

G.K. Chaudhari, B.H. Prajapati and
R.M. Chauhan

Three popular stability analysis models proposed by Eberhart and Russell (1966), Perkins and Jinks (1968) and Freeman and Perkins (1971) were compared empirically for their efficiency using yield data of nine pearl millet genotypes tested over five different locations raised in summer season for two years in Gujarat. Considering the ranking pattern of genotypes based on stability parameters, degrees of freedom associated with regression, information used in estimating stability parameters and simplicity in estimation, the Eberhart and Russell's model was recommended for stability analysis of genotypes/varieties tested over space and time.

S.D. Agricultural University, Sardar Krushinagar

6. The Frequentist Approach vis-à-vis Alternative Paradigms in Statistical Inference – A Look at Broad Areas of Agreement and Differences

C.D. Ravindran

Statistical inference is an inductive process from sample to population and in this process, different schools of statistical thoughts have put forth their respective approaches to the problem. The frequentist school has indeed dominated the statistical thinking for most part of the last century and would thus appear to be well established on the strength of its deductive logic based on the axioms of probability. In the meantime, however, the Bayesian school has emerged as a serious contender and has since growth in popularity. Several other approaches to inference have also developed in recent years. Historically, the contrasting view points of the different approaches (not with standing the fact that on some occasions, these have produced similar results!) have been the cause for generating a vital interest among statisticians and leading to a continued series of debate on the issues. The debates have been so lively indeed, that they have not shown any signs of abating! The topic being of much interest to statistician this presentation seeks to highlight some of the principal points at issue – their agreement and differences, and attempts made at reconciliation – with the help of the literature.

Central Institute for Research on Cotton Technology, Mumbai

7. Status of Groundnut in Andhra Pradesh – A Case Study

K. Venkateswar Rao and M. Devender Reddy

Groundnut is an important crop both for oil and food. It is grown in over 100 countries in the world and plays an important role in the economy of several countries. India accounts for 40% of the area and 30% of output of groundnut in the world. Groundnut is cultivated in India both as kharif and rabi crop but the output is higher in kharif. In rabi season, groundnut is cultivated only in the south. In Andhra Pradesh, groundnut is cultivated in all the three regions (Coastal Andhra, Rayalaseema and Telangana).

Growth rates of area, production and productivity were worked out for the period –I (1988-89 to 2002-03) and period – II (1955-56 to 2002-03). To overview with regards to period – I, the study reveals that the compound growth rates of area, production were negatively significant in Coastal Andhra, Telangana and A.P. state as a whole. However, the rate of productivity (yield) is not significant in all the three regions and state. In period – II, the compound growth rate of area is significant only in Rayalaseema, production is significant in all three regions and A.P. state as a whole and productivity is significant in Coastal Andhra and A.P. state as a whole.

A.N.G. Ranga Agricultural University, Hyderabad

8.   Optimum Size and Shape of Plots for Field Experiments in Tomato

C.M. Naliyadara, S.M. Upadhyay and C.V. Ramani

The uniformity trial on tomato (variety Gujarat tomato-1) was conducted during the rabi season 2003-04 at the Vegetable Research Station, Junagarh Agricultural University, Junagarh. The fruit yield data of 1296 plots (basic unit 1.20 m × 0.90 m) were recorded and analyzed to work out optimum size and shape of the plots using different approaches. The variability among plots of different sizes and shapes was determined by calculating coefficient of variation (C.V.%). It was observed that the coefficient of variation per unit area decreased with the increase in plot size. The rate of reduction in C.V.% was more with the increase in length of the plot than that with the increase in width of the plot (i.e. number of rows). Long and narrow plots showed lower C.V.% than approximately square plots.

The observed relation between plot sizes and variance was in conformity with Smith's variance law. At larger plot sizes the regression line showed a tendency to come down although negligible. The optimum plot size observed through Smith's method and maximum curvature method was almost same. Thus the optimum net plot size for field experiments should be 12.96 sq. m covering 3 rows (spaced 90 cm apart) each of 4.8 meter length was found to be most advisable for field experiments on tomato for Junagarh region.

Junagarh Agricultural University, Junagarh

9.   Role of e-commerce in Agriculture and its Allied Sectors

N.S. Raju, K.N. Singh, Abhishek Rathore, Karan Singh and R.K. Samanta

The world is in transition from industrial age to information age. Internet access and electronic commerce (e-commerce) revolutionized the landscape of business, including agribusiness. Clearly e-commerce is a beginning to have a major impact on farming and agricultural input distribution. From new portals aimed at farmers buying inputs and selling raw materials through Web-based niche market. This article deals with the impact and prospects of 'new information technology' also known as e-commerce, in the agriculture and its allied sectors. For all the opportunities that e-commerce offers, farmers need to be aware of possible barriers in this sense. An attempt is made to determine e-commerce opportunities, barriers along with infrastructure requirements.

Indian Institute of Soil Science, Bhopal

10.   AMMI Analysis for Fruit Yield Trial of Okra

C.A. Nimbalkar, V.H. Bajaj, V.D. Deshmukh and A.P. Baviskar

To evaluate the performance of improved, high yielding genotypes of okra *(Abelmoschus esculantus (L) Moench)*, over different agro-climatic locations of Western Maharashtra are assessed through University Multilocational Trial conducted during kharif 2001, summer 2002 and kharif 2002, comprising of ten okra genotypes including two checks at five locations. Significant G × E interaction, influenced the relative ranking of genotypes across the locations. It was evident from AMMI analysis that genotypes, environments and interaction effects accounted 13.8, 78.6 and 7.6% of variance, respectively. The first two AMMI components significantly contributed 60.6, and 23.8% to total G × E interaction variance with 61.1% of degrees of freedom for G × E. AMMI means provide reliable estimates and thus satisfying the goals of an efficient statistical model. GK-IV-2-4-13 exhibited maximum squared correlation (49%) between residuals from the main effects model and the location indices followed by the genotypes GK-IV-3-3-3 (47%), Varsha Uphar (41%), GK-IV-1-3-

2 (40%) and GK-IV-3-4-4 (37%). The genotype Varsha Uphar has maximum contribution to interaction (4%) followed by GK-IV-3-4-4 and Arka Anamika. Similarly, the check Arka Anamika exhibited maximum deviation from regression component of interaction followed by the genotype Varsha Uphar, indicating its best performance in the favourable environment. The interaction biplot with locations and genotypes superimposed exhibited that the genotype GK-IV-2-4-13 situated closed to the centre can be regarded as stable, because of their consistent yield performance across locations. The dendrogram of varieties structured by interaction pattern shows some degree of agreement with the biplots. The cluster dendrogram for genotypes appears to be well related with the clustering based on isozymic groups. Cluster dendrogram for environment also appears to be good formation of groups of locations. The overall ranking of the genotype based on the mean and AMMI have great discrepancies and, therefore, the selection based on the mean estimation will not be precise. The present analysis, therefore, indicates that before making the recommendation for the identification of the genotype which is at present done on the basis of mean yield, it is very important to not only analyze the G × E interaction but also patterns it. Therefore, most of the trial data should be subjected to AMMI analysis rather than to simple ANOVA.

National Agricultural Research Project, Ganeshkhind, Pune (MPKV, Rahuri)

11. Predicting Total of Responses in Seemingly Unrelated Linear Regressions

V.K. Sharma and Amitava Dey

In regression models using time series data, the errors are generally correlated and as such the sample residuals contain information about the future observations. Keeping this in view, a linear unbiased predictor of the total of post-sample observations in a single drawing in seemingly unrelated regression models is proposed which has the minimum variance of the prediction error.

Indian Agricultural Statistics Research Institute, New Delhi

12. Comparative Efficiency of Algebraic Models for Lactation Curve in Gir Cow

N.J. Rankja and H.R. Pandya

Weekly milk production records of 352 Gir cows (covering the period 1992 to 2001) of the Cattle Breeding Farm, Junagarh Agricultural University, Junagarh were analyzed with seven different mathematical models for different lactation records for studying the lactation curve. The efficiency of fitted models were judged considering two criteria viz., coefficient of determination (R^2) and deviation from regression sum of squares (DSS). The curve based on the model proposed by Morant and Gnanasakthy was the best choice.

Junagarh Agricultural University, Junagarh

13. Estimation of Optimum Size and Shape of Plot for Field Experiments on Irrigated Castor *(Ricinus Communis Linn.)*

J.K. Patel, G.K. Chaudhary, K.S. Patel and J.M. Loria

An uniformity trial was conducted during kharif season of the year 2003-04 at the Main Castor Research Station, S.D. Agricultural University, Sardar Krushinagar to determine the optimum size and shape of the plot for field experiments on irrigated castor *(Ricinus Communis Linn.)*. Maximum curvature method, Fair-field Smith's variance law and comparable variance methods were used for the purpose. Single plant ($0.54 \text{ m}^2 = 90 \text{ cm} \times 60 \text{ cm}$) was considered as one basic unit. The coefficient of variation (C.V.%) decreased from 54.78 % to 5.63% with an increase in plot size from 1 unit to 200 units for seed yield. 20 units plot i.e. 2 rows each of 10 dibbles ($6.0 \text{ m} \times 1.8 \text{ m}$) was found optimum for conducting field experiments. Minimum 3 replications were considered to be optimum for 20 units plot size at 10 per cent probability level for seed yield with relatively high land use efficiency.

S.D. Agricultural University, Sardar Krushinagar

14. WRIS – A Water Resources Information System for Eastern India

H.C. Verma, D.K. Panda, A. Mishra and B.K. James

A Water Resources Information System (WRIS) was developed to provide comprehensive district-wise information on water resources availability and utilization status of eastern India. Menu based user-friendly software comprising of different modules such as data entry and maintenance, backup and retrieval, search/query, charting and descriptive statistical analysis were developed using VB 6.9 as front-end. MS Access 2000 was used as back-end. These software modules were developed in such a way that it automatically takes into account the addition of any new database table or deletion of any existing table and thus makes the software fully scalable. The district-wise data on water resources availability and utilization that can be stored and accessed includes major key indicators, weather data, ground water resources, command areas, water harvesting structures, lift irrigation projects, major and medium irrigation projects, minor irrigation details, drainage networks and crop-wise irrigated area. The database consists 108 database tables for organizing district-wise water resources data. Most of water resources data available from different government department were collected and maintained using the system. The information system thus developed is capable of storing and maintaining the data on database server and provides easy and fast accessibility to the end user by different decision tools such as query and graphical charting. In this paper, an attempt has been made to provide a detailed overview of techniques used and different software modules developed for maintenance and analysis of data.

Water Technology Centre for Eastern Region (ICAR), Bhubaneswar

15. Stochastic Model in Three Graded Structure

V.S. Rao

In many of the corporate sector organizations, it is a common phenomena that the recruitment is made in all grades to maintain efficiency and competitive spirit at every stage. This phenomena is to be incorporated in manpower planning modeling by considering the direct recruitment policy in all grades. Hence, in this paper, a three graded manpower planning model with direct recruitment policy in all grades is developed and analyzed. Here it is assumed that there is a direct recruitment and promotion to all the 3 grades. And the recruitment policy is Poisson. This model is much useful in analyzing the manpower situations arising at places like ICAR, State Universities having implementation of Career Advancement Scheme and direct recruitment to the entire teaching cadre namely Assistant Professor, Associate Professor and Professor. This model is also useful in Defence sector, Research organizations, where efficiency is also an important factor for manpower planning. Using the difference – differential equations, the transient behaviour of the model is analyzed through cummulant generating function. The explicit expansions for means and variances of the three graded sizes are derived. The covariance between grade sizes are also obtained and analyzed in the light of the recruitment rates and promotion rates. The limiting behaviour of this model is also studied by considering the steady state transition equations. The joint probability mass function of the three grades is derived when the system is equilibrium and their corresponding mean and variances are obtained.

Agricultural College, Bapatla

16. Construction of a Class of Group Divisible Designs using Hadamard Matrices

H.L. Sharma

Three new methods of construction of a class of semi-regular (SR) and singular (S) group divisible designs using Hadamard matrices are presented. In particular, a doubly balanced incomplete block design is also presented using the union of SR and singular divisible designs. The illustrative examples have been added in each case when t = 1 and t = 2.

Jawaharlal Nehru Krishi Vishwavidyalaya, Jabalpur

17. Selection of Models to Describe Lactation Trend for Milk Casein in Murrah Buffaloes

C.L. Suman, Shiv Prasad, Y.P. Singh and S.B. Prasanna

The average milk casein was 3.23±0.03% after first month of calving among 92 lactations of Murrah buffaloes maintained at LPR (C&B) farm of the Indian Veterinary Research Institute. Milk casein decreased with advancement of lactation and was lowest (2.89 ± 0.03%) during fourth and fifth month of lactation. Thereafter during the lactation, milk casein started increasing slowly at subsequent months and reached 3.16±0.04% during tenth month of lactation. Therefore, the lactation changes in milk casein of Murrah buffaloes followed a trend opposite to lactation curve of milk production. Five algebraic functions namely quadratic, parabolic exponential, inverse polynomial, gamma type and product of two exponential functions were fitted to monthly least squares means of casein at ten monthly interval points of lactation. The study revealed that fitted gamma type functions: $Y_t = 3.1336$ was the best representative model describing lactation trend of milk casein of Murrah buffaloes followed by quadratic model $Y_t = 3.3393 - 0.1638\,t + 0.0150\,t^2$ during a lactation.

Indian Veterinary Research Institute, Izatnagar

18. Spline Models for Forecasting of Agricultural Production

B.S. Kulkarni and G. Krishna Kanth

The time series data on agricultural production is frequently affected by the technological innovations that are released from time to time. The impact of these innovations is often not of 'continuous' type and can be observed in the form of quantal jumps. Spline models offer an efficient solution for describing such data and hence forecasting. In this paper, the applicability of spline models has been explored in the context of forecasting of state level production of rice and jowar crops in Andhra Pradesh, by using 43 years of data (1956 to 1998). The results indicated that the spline models provide efficient production forecasts (in terms of bias).

A.N.G. Ranga Agricultural University, Hyderabad

19. Use of Soil Fertility Maps for Prescribing Optimum Dose of Nutrients for Targeted Yield in Chhattisgarh by Interlinking Recommendations

K.N. Singh, N.S. Raju, A. Subba Rao, Sanjay Srivastava, Abhishek Rathore and A.K. Maji

An attempt was made here to create spatial fertilizer recommendation maps using available validated fertilizer adjustment equations (STCR's generated) and Geographic Information System (GIS). District wise soil fertility maps have been prepared using index values for nitrogen (N), phosphorus (P) and potassium (K). Corresponding equivalent soil nutrient values in respect of N, P & K were calculated from the index values. Reasonable limits for targeted yields were defined. Using the above information, we obtained soil fertility maps of Chhattisgarh. The recommendations in the form of equations for targeted yields developed by Subba Rao and Srivastava (2001) have been interlinked with the fertility maps. The use of this recommendation system is suggested for varied applications for targeted yields in different districts of Chhattisgarh.

Indian Institute of Soil Science, Bhopal

20. Optimum Plot Size for Field Experiments in Irrigated Chickpea *(Cicer arietinum Linn.)*

B.H. Prajapati, R.M. Chauhan, G.K. Chaudhari and J.M. Loria

Uniformity trial on irrigated chickpea crop was conducted at Main Pulses Research Station, S.D. Agricultural University, Sardar Krushinagar to find out optimum size and shape of plot, number of replications and land use efficiency for the same. Three methods viz. (i) Maximum curvature method (ii) Fair-field Smith's variance law and (iii) Comparable variance method were used for this purpose. A plot of 9.6 m² size having shape of 4 m length (E-W) and 2.4 m cross width (8 rows in N-S) was considered as optimum plot size with 6 minimum replications at 5% S.E. level of accuracy for irrigated chickpea field experiments at Sardar

Krushinagar. Relative land use efficiency for different sizes and shapes of plots also exhibited similar trend to that of C.V.%.

S.D. Agricultural University, Sardar Krushinagar

21. Forecast Models for Pests and Diseases in Groundnut

Amrender Kumar[1], Ranjana Agrawal[1],
Lalmohan Bhar[1], A.S. Rao[2], T. Murali Krishna[2],
V. Nandagopal[3], Y.G. Prasad[4] and
Y.S. Ramakrishna[4]

Groundnut is one of the major oilseed crops in India. Major constraints for realizing yield potential in the crop are due to damage caused by pests and diseases. Heavy losses to an extent of Rs. 2380 million per annum (Balasubramanian, 1985) have been reported. In the present study, an attempt has been made to develop models for forecasting pests and diseases status of pest – Tobacco caterpillar (*Spodoptera litura*) for Junagarh (Gujarat), diseases viz. Late leaf spot (kharif and rabi) and Rust for Tirupathi (A.P.). Using historical data on weekly weather parameters such as maximum and minimum temperature, maximum and minimum relative humidity, bright sunshine hours, wind speed and rainfall, weather indices were developed and selected as regressors through stepwise regression technique for their use in the forecast model. Validation of models on data for subsequent years (not included in model development) revealed that the forecasts obtained through the developed models were very close to the observed ones.

1. Indian Agricultural Statistics Research Institute,
    New Delhi.
2. RARS, Tirupati
3. NRCG, Junagarh
4. Central Research Institute for Dryland Agriculture,
    Hyderabad

22. Simulation based Multiple Markov Chain Models for Crop Forecasting

V. Ramasubramanian and Ranjana Agrawal

Crop yield forecasts are extremely useful in formulation of policies regarding stock and distribution of agricultural produce to different areas in the country. Various statistical approaches in vogue such as regression based models and models based on Markov chains aim to provide objective forecasts of crop yields with reasonable precisions well in advance before harvest for taking timely decisions. The Markov chain methodology requires sizable dataset to estimate the transition probability parameters. When the dataset is small, the estimated transition probabilities will not be precise and many zero probabilities may occur because the number of states increases very rapidly with increase in the order of the Markov chain. To this end, the present study deals with development of yield forecast models for sugarcane crop based on simulation based higher order Markov chain. Of the two years data set available, the first year data set has been blown up into a larger from a multivariate normal population with a specified mean vector and variance-covariance matrix of the yield and biometrical characters under consideration preserving Markov chain properties. The estimated parameters of the simulated data set compared well with that of obtained from the available data set. Forecasts were obtained for second year and results revealed that use of simulation based Markov chains advanced the time of forecast. When these models were developed afresh by using transformed data set via principal components and growth indices, instead of using the larger data set as such for combining stages in developing higher order chains, then these models were found to be still better.

Indian Agricultural Statistics Research Institute, New Delhi

23. A Model for Egg Production in Two Strains of White Leghorn-IWN and IWP

Laly John C. and M. Manoharan

Two promising strains of White Leghorn, IWN and IWP undergoing continuous selection for egg production in India from 1979 are analyzed to characterize their egg production process. McNally's, Compartmental, Modified Compartmental and Inverse Polynomial models were fitted for data pertaining to three generations and are compared for goodness of fit based on several criteria. It is seen that all the four models describe well the egg production process of both IWN and IWP strains. Due to simplicity and relatively less computing demands, McNally's model is preferred to the other three. When

the model is intended to serve several purposes, the compartmental models are recommended, by virtue of the biological interpretation of the parameters.

Kerala Agricultural University, Thrissur

24. Bivariate Structural Time-series Modelling and Forecasting all-India Rice Production and Productivity

S. Ravichandran[1], Prajneshu[2] and B.N. Singh[2]

Box-Jenkins ARIMA methodology is widely adopted for modelling and forecasting time-series data. An attempt is made in this paper to study a newer approach, viz., Bivariate Structural Time-series Modelling (BSTM) approach in presence of regular and irregular components. Advantages of this approach are : (i) Both the time-series variables are treated as dependent variables, and (ii) Stationarity of underlying time-series data is not required. Modelling and forecasting of all-India rice production, productivity and rainfall during the period 1960-61 to 2003-04 is carried out using both BSTM and ARIMA approaches. It is noticed that the former performs much better than the latter for data under consideration. Finally, forecasts of rice production and productivity for the year 2004-05 obtained using BSTM methodology are 88.56 million tonnes and 19962 kg ha^{-1} respectively.

1. *Directorate of Rice Research, Hyderabad*
2. *Indian Agricultural Statistics Research Institute, New Delhi*

25. Mixture Modelling and Forecasting Through Nonlinear Time-series Approach

Prajneshu and Himadri Ghosh

Unlike Box-Jenkins ARIMA models, Gaussian Mixture Transition Distribution (GMTD) and Mixture Autoregressive (MAR) nonlinear time-series models are capable of describing those data sets that depict sudden bursts, outliers and flat stretches at irregular time epochs. In this paper, these are studied and applied on weekly onion price data. Estimation of parameters is done using

Expected-Maximization algorithm and the best model is selected on the basis of Bayesian Information Criterion. Out of sample forecasting is performed for one-step and two-step ahead prediction by naïve approach. It is concluded that, for data under consideration, a three-component MAR is the best model.

Indian Agricultural Statistics Research Institute, New Delhi

26. Some Procedures for Measuring Shifts in Agricultural Production

V.V. Narendranath and B.S. Kulkarni

Identification of shifts in crop production/ productivity is an important step in the assessment of technological impact on crops. Shifts are generally measured on the basis of certain pre-defined periods of the data. To overcome this arbitrary selection of time periods, two generalized procedures based on 'Control Charts' and 'Cluster Analysis' approach have been proposed. The application in the context of rice production data of Andhra Pradesh based on 45 years (1956 to 2000) revealed that the performance of both the procedures in identifying the shifts (and hence the time periods) was similar. The procedures identified existence of three different levels of shifts in the production data.

Acharya N.G. Ranga Agricultural University, Hyderabad

27. Trend Analysis of Area, Production and Productivity of Rice in India

K.N. Mathur

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. Rice is the staple food for 65% of total population in India. It constitutes 52% of the total foodgrain production and 55% of total cereal production. Rice environments in India are extremely diverse. Of the 44 million hectares of harvested rice area, about 33% are rainfed low land, 45% irrigated, 15% rainfed upland and 7% flood prone. Since the major portion (55%) of the area under rice in India is rainfed, production is strongly tied to the distribution of rainfall. The production of rice increased from 30 million tones in 1966-67 to about 85 million

tones in 2000-01 registered a growth rate of 2.87%. Area under rice increased at a compound growth rate of 0.67% whereas the productivity increased at the rate of 2.23 per cent. Compound growth rates of area, production and productivity during the high yielding variety ((HYV) period (1966-67 to 2000-01) were computed by the least square technique of fitting the exponential function $Y = a \cdot b^t$. In the regions comprising Uttar Pradesh, Bihar, Assam, West Bengal, Orissa, Madhya Pradesh and Maharashtra, the average yield is low as compared with other regions. Production in general, grew at a much faster rate than area in all the states.

Indian Agricultural Research Institute, New Delhi

28. Database Management for the GIS Based Nutrient Recommendation System for Different States of the Country

N.S. Raju, K.N. Singh, A. Subba Rao, R.K. Samanta and Abhishek Rathore

Optimum return and minimum environmental pollution are major issues to be addressed while giving soil test based nutrient recommendations. This GIS based nutrient recommendation system is a database package, which provides an easy mechanism to recommend the major fertilizers N, P, K for different targeted yields of various crops in different seasons based on available nutrients in the soil and targeted yields of crops. An attempt has been made here to design the database suitable for the recommendation of fertilizers for various states with minimal redundancy and functionally independent from the programming. The database was developed with the information of Soil Test Crop Response correlation (STCR) targeted yield equations, soil fertility index data for different states, crops, districts, seasons and suitable targeted yield for different crops. Here we designed a common database, which is required for fertilizer recommendation of different states of the country with independent of programming and for the efficient management of the database. We developed user-friendly interfaces for the database management and efficient data retrieval.

Indian Institute of Soil Science, Bhopal

29. Performance of Coconut : A Global Perspective

M. Lathika[1] and C.E. Ajith Kumar[2]

Coconut, a crop vital to Kerala, by its prevalence in cultivation, its multifarious consumption by the people, means of livelihood to millions and its high-vulnerability to the state economy, is also made to succumb to global trade compulsions, following the recently clamped national policies of structural adjustments, privatization and trade liberalization. An econometric analysis of the performance of the crop world over by using time series data on Area, Production Productivity (APP) and annual export value of the crop for all the major Coconut Producing Countries (CPC) is made in this paper. Three growth models, namely, 'semi-log', 'log-quadratic' and 'log-quadratic (modified)' have been tried and the best-fit model has been identified, following standard protocols of model selection for each characteristic (APP) of each country.

The instability indices like MacBean's index, Murray's index were also computed. The decomposed components (area and yield) of output growth have been estimated. The analysis was conclusive on that India's performance in coconut area expansion and production has been promising, with a growth rate of 2.83 and 4.87 respectively, with no other CPC in the near vicinity. However, it ended with a discontent note that India's output growth of coconut is largely an offshort of area expansion, while many other countries took the productivity route. Coconut economy of India cannot act aloof when the domestic economy is integrated into the new world order economy. It is essentially an incessant interplay of a complex web of variables. With the onset of globalization process, the performance parameters (current status, per cent share of the crop, index value, growth rate) of the crop in a country at different phases – pre and post-liberalization – pertaining to the five crop-characteristics (apart from APP, export value of the crop and the total export value of agricultural crops) have been considered, to identify the competing countries which put up formidable challenge to Indian coconut trade interests. Hierarchical cluster analysis using 'average linkage (between groups)' method with squared euclidean distance measure was resorted to meet the end. Cluster analysis enlisted Indonesia and Philippines also into the Indian contingent, both of which

are indisputably the major players in coconut production scene. The uniform (over the years) growth rate of production and productivity of these two countries is much lower than that of India. However, as the best-fit model for area of the crop for almost all the countries is 'modified log-quadratic', suggesting the growth in a phased manner, kinked exponential model is fitted for these cases and growth rates for both pre and post-liberalization phases of the crop were estimated. This asserted that India, with its already limited per capita land resources, is not able to add to the coconut lands and even lost (growth rate for the post liberalization phase is -0.01) in the game. But Philippines continues to manage to expand its coconut acreage. Only productivity (rather than area) enhancement measures will augur well for the sustained coconut growth in India.

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30. Constraints in Adoption of Crossbreeding Technology in Different Regions of India

S.B. Agarwal, C.B. Singh and S.K. Jha

The present study was undertaken to identify the constraints faced by the adopter of crossbreeding technology in three different regions of India selecting one state from each region viz. Punjab, Karnataka and West Bengal purposively having high, medium and low milk production potential respectively. Multi-stage random sampling technique was used for selecting 225 adopters of crossbreeding technology, 75 from each selected state. The constraints were classified into three major categories viz. (i) Breeding and Feeding (ii) Economic and Social and (iii) Administrative and Organizational. These were further classified as serious, medium and moderate constraints.

Among breeding and feeding constraints, majority of the adopters of crossbreeding technology (CBT) in Punjab reported lack of progeny tested bulls, low fat content in crossbred cow milk, high mortality in crossbred male calves, and repeat breeding as serious constraints. In Karnataka, low fat content in crossbred cow milk was the only serious constraint reported by majority of the adopters of CBT. In West Bengal, all the constraints except for irregular P.D. and lack of progeny tested bulls were reported as serious constraints. Almost all the economic constraints in the three states were

reported as serious except for lack of land for fodder production and lack of availability of dry fodder in Punjab and lack of milk marketing facilities and lack of availability of dry fodder in Karnataka. Among social constraints, inability to take animals to centres for artificial insemination (A.I.) was the only serious constraint in Punjab and West Bengal. However, in Karnataka most of the social constraints were reported as serious except for hostile attitude of affluent farmers towards weaker section and inability to take animals to centres for A.I.

Among administrative and organizational constraints majority of the adopters of CBT in Punjab reported non-castration of scrub bulls, non availability of HYV seeds of different fodders, lack of basic amenities and allowances to field workers, absence of timely procurement and supply of critical inputs and absence of incentives as serious constraints. However, in Karnataka and West Bengal, none of the administrative and organizational constraints were found as serious, except for non-availability of HYV seeds of fodder in West Bengal. In view of the above, it leads to conclude that concerted efforts are required to be made by the concerned Animal Husbandry Departments to overcome these constraints encountered by the adopters of CBT, so as to achieve the desired objectives of crossbreeding programme.

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31. Precise and Cost Effective Integrating Surveys

Jagbir Singh

So far emphasis has been laid down in integration of surveys in order to decrease the totality of the costs incurrable independently on individual surveys under integration by maximizing the number of common and adjacent units while retailing the required probabilities of selection for the surveys clubbing as integration of surveys (Keyfitz (1951)). A reduction/increase in cost precision (precision/cost) is apparent due to the exploitation of correlation between sample units common over the periods by revising a sample (selected in an earlier period with probability proportial to size measure) on the basis of more recent information on the same size measure so as to keep/retain as many of the old sample units as possible in the new/revised sample. A further

reduction/increase in cost precision (precision/cost) is possible provided all the characteristics under study in integration of surveys are related to one single size measure. By executing the above aspects in this paper, the Minimum Variance Linear Unbiased Estimators (MVLUEs) for the characteristics under study for the periods and change/average therein/thereof over the periods have been developed by making use of projective geometry approach.

Indian Agricultural Statistics Research Institute, New Delhi

32. Study of Lac Marketing in India

S.P. Bhardwaj

India virtually holds monopolistic position in lac production and trade in the world till 1950's and accounts for nearly 90 per cent on both the fronts. But of late the situation has changed as the domestic production has declined from 45000 metric tones in 1950's to about 12000 metric tones in the year 2000. At the same time, Thailand has emerged out to be main competitor in the overseas trade and has captured nearly half of the market. Lac cultivation in India is spread over major forest areas of Jharkhand, Chhattisgarh, Madhya Pradesh, Maharashtra, West Bengal, parts of Uttar Pradesh and N.E.H. region. It is being a cash crop in nature, thus enhances the cash flow of large number of persons involved in its cultivation, processing and trade. The price of stick lac is currently around Rs. 60/ kg. Ministry of Commerce and Shellac Export Promotion Council largely promote the foreign trade of lac. Since it was founded in June 1957. The shellac trade believes in competition through (a) stabilization in prices (b) stabilization of supply and it desires to be strong in competition for proposed quality. Export trade of lac in India, which was once supposed to be pioneer in the world, has been adversely affected over the successive years. The market analysis showed that market in the developing countries of Asia and Africa now consume, about 45 per cent of India's total lac trade. The traditional and industrialized countries like Federation Republic of Germany, USA and UK and now Russia accounted for nearly 36 per cent of Indian lac exports. It may be noted that four decades back the above four developed countries accounted for 76% of Indian total exports. The emergence of developing countries as important buyers of Indian lac is a significant development while pollution

consciousness and urge for natural resin should help us to regain the markets of industrialized countries too. The study of direction of exports further revealed that in the recent year of 2000-01 the Indonesia remained major importing country accounted for 25% of total Indian export followed by Germany (19%), Malaysia (9%) and USA (7%) etc. Thailand has emerged out as a main competitor of India in the export trade of lac. India will have to concentrate on the manufacture and export of Dewaxed, decolorized shellac, bleached lac, lac dye and such other lac based productions as India is already exporting Dewaxed lac. The information system for this product should go a long way in promoting the production and distribution of the important product. Development of information system, a data base will be essential for organized marketing of the product in domestic as well as foreign markets. It would increase the income and welfare of lac producers who are basically landless and marginal poor cultivators.

Indian Agricultural Statistics Research Institute, New Delhi

33. Fishery Sector of India – An Overview

Sushila Kaul

India has witnessed significant increase in food grain production (green revolution), oilseeds (yellow revolution), milk (white revolution), fruits and vegetables (golden revolution) and fish (blue revolution). Blue revolution has been attained by enhancing fish production, which was merely 0.75 lakh tone in 1951. Fish production has increased from 24.42 lakh tones in 1980-81 to 53 lakh tones in 1997 and about 56.56 lakh tones during the year 2000-2001, comprising 28.11 lakh tones of marine fish and 28.45 lakh tones of inland fish. During 2001-2002, the fish production was about 58.00 lakh tones and reached a level of 0.6 million tones in 2002-2003. The fishery sector occupies a very important place in the socio-economic development of India. This sector has emerged as an important source of employment generation as it stimulates growth of a number of subsidiary industries and is a source of cheap and nutritious food, besides being a foreign exchange earner. India is the third largest producer of fish in the world and second in inland fish production. It has been recognized as a powerful income and employment generator. Most importantly, it is the source of livelihood for a large section of economically backward population

of the country. It is estimated that about 6 million people are employed in the fishery sector. In the present study, the trend in the production of marine and fresh water fish as well as the percentage annual growth rate has been studied. There has been a constant increase in the production of inland fish in India, eversince the eighties. However, the production of marine fish has not been so uniform. India's substantial fishery resources are seriously under-utilized and it is widely recognized that there is substantial potential to increase the output of this sector.

Indian Agricultural Statistics Research Institute, New Delhi

34. Trend-free Block Designs for Diallel Cross Experiments

Krishan Lal, Rajender Parsad and V.K. Gupta

Optimal mating designs for experiments with diallel crosses have recently gained importance in the literature. Like other experimental situations, there may be a trend effect due to space or time in experiments for diallel crosses. In such situations, the trend-free block designs for diallel cross experiments should be used. Such designs make the line effects orthogonal to trend effect. A necessary and sufficient condition for a block design for diallel crosses to be trend-free block design, when there is a common trend in experimental units within blocks, is derived. Using this condition some families of optimal diallel cross block designs have been identified that can be converted into trend-free block designs.

Indian Agricultural Statistics Research Institute, New Delhi

35. On Interval Estimation of Heritability Based on Sib-analysis

V.T. Prabhakaran

The existing methods for interval estimation of heritability based on sib analysis will be reviewed. The paper will also provide a simple derivation of the $1-2\alpha$ confidence interval for the sire-dam component (combined) heritability, obtainable from full-sib analysis. The probability of the confidence limits taking inadmissible values will be discussed. A procedure for robust estimation of mean-squares leading to improvement in the confidence interval will be outlined.

Indian Agricultural Statistics Research Institute, New Delhi

36. On Preliminary Test Estimator Using Double Sampling in Stratified Sampling

B.N. Mandal and R. Singh

One estimator was developed for estimating population mean in case of stratified sampling under the assumption that the population mean of the auxiliary variable is not known and we have two estimates. One from double sampling and another from partial information based on earlier experience, guess, prior knowledge etc. It was assumed that variance – covariance matrix of the variables in each stratum is known. The preliminary test was used to decide which of the two estimates should be used to develop the estimator and then separate regression estimator subsequent to preliminary test was developed. Its bias and mean square error were derived and their properties and behaviour were studied under different conditions. The efficiency of this estimator with the usual separate regression estimator in case of stratified sampling was also studied. It was found that the efficiency is maximum when estimate of population mean of auxiliary variable based on partial information is exactly equal to the population mean of auxiliary variable. The relative efficiency increases as correlation between auxiliary variable and variable under study increases.

The estimates obtained by adopting convenient sampling provide some information where baseline data is not available. However, practical problems and certain inherent limitations are also there in obtaining reliable and precise estimates. Such problems and limitations with field situations under varied geographical locations are discussed in the present paper to enable the statistician to evolve suitable sampling technique specifying a code of conduct for sampling. The experience of authors in drawing samples from small and medium size reservoirs to huge manmade lakes have also been incorporated in the paper.

Indian Veterinary Research Institute, Izatnagar

37. Spatial Integration of Price Series using Vector Error Correction Mechanism – A Case of Coconut Oil Markets in India

N. Sivaramane, D.R. Singh and Prawin Arya

The Coconut palm is grown in more than 80 countries of the world. India is the third largest coconut producing country having a share of 21% with an area of about 1.91 million hectares under the crop. The major coconut growing states in India are Kerala, Karnataka and Tamil Nadu. Kerala is the largest producer accounting about 45% of total production in the country. It is observed that there exists wide gap in the prices of coconut oil at different markets which affects the farming community at large as there exists strong linkage between coconut oil prices at wholesale markets and the price of nuts received by farmers. The wholesale prices of coconut oil show wide fluctuations over the time. Also there exists significant difference between the mean price of different markets which show that the markets differ by various parameters such as quantity of handling, quality of the good, location, etc.

Conventionally, the relationship of prices was studied using correlation matrix and regression. But, in case of non-stationary series, the relationship was found to be spurious and statistics such as Student's t test and Adjusted R square does not hold good. Hence, an alternative approach called Cointegration is used in this study. Cointegrating relationship can be studied either using bivariate or multivariate models. However, the multivariate model was found to be superior to bivariate model as it solves the problems of simultaneity, omitted variables, non-constant elasticities and serial correlation. For the present investigation, monthly wholesale prices for the period 1991-2000 of six major coconut oil markets viz., Rajmundry, Kozhikode, Chennai, Kanpur, Kolkata and Delhi were used.

The stationarity of data were examined using Autocorrelation Function (ACF) and Augmented Dickey Fuller (ADF) Test and the results showed that selected price series were non-stationary at levels {I(0)} and stationary at first-differenced level {I(1)}. The Akaike's Information Criterion (AIC) showed that the order of the estimating function was three. Vector Autoregressive (VAR) model using order of three and allowing for linear deterministic trend and intercept estimated the long run elasticities of the price series. The rank of the cointegration matrix was found to be two using Maximum Eigen Value Test. This shows that there exists cointegrating relationship among the selected markets defined by two cointegrating equations (vectors). The normalized Vector Error Correction Model (VECM) showed that the adjustment towards equilibrium is rather slow and it varies from 0.025 to 3.13% every period (month). The VECM also gives the shortrun elasticities of the price relationships.

Indian Agricultural Statistics Research Institute, New Delhi

38. An Application of Box-Jenkins Approach for Forecasting Copra Wholesale Price Series

Prawin Arya, D.R. Singh and N. Sivaramane

Coconut production is mainly concentrated along the coastal regions in the wet tropical areas of Asia in Philippines, Indonesia, India, Sri Lanka and Malaysia. India is the third largest producer with an area of about 1.91 million hectares under the crop. Annual production was about 12141 million nuts with an average of 6345 nuts per hectare during 2002-03. Copra has an oil content varying from 65 to 72%. There are two types of copra namely milling (high quality) and edible made in India. Milling copra is used to extract oil while edible grade of copra is consumed as a dry fruit and used for religious purposes. For framing proper policies for sustained growth of this industry, forecasting the prices of copra will be imminent. Even though the storability of copra is higher compared to other agricultural crops, it also shows wide fluctuation over the time and thus makes forecasting process difficult. This study attempted to fit ARIMA model for forecasting the wholesale copra prices of four markets in India (Alapuzha, Kochi, Kozhikode and Mangalore). The tentative model was identified using Correlogram and Augmented Dickey Fuller (ADF) test. The best model estimated was selected based on the Akaike's Information Criterion (AIC) and the forecastability of the model was compared using Mean Square Error (MSE) and Mean Absolute Percent Error (MAPE). The results show that all the four price series have different functional forms. The price series of Alapuzha was best fitted through ARIMA (1,0,0) (0,0,1)^2 whereas the AIC was the least (-2.369). The best ARIMA models were (2,1,2), (0,1,0) (1,0,0)^2 and (1,1,2) for

Kochi, Kozhikode and Mangalore price series respectively.

Indian Agricultural Statistics Research Institute, New Delhi

39. Determinants of Access to Groundwater Irrigation : An Application of Logit Model

D.R. Singh and N. Sivaramane

Groundwater is considered to be most reliable and flexible source of irrigation for modern agriculture. The present investigation was undertaken to study the ownership of and access to tubewells and to identify the factors responsible for farmer's decision to install tubewell and buying groundwater. The primary data were collected from 180 randomly selected farmers from Meerut district of Western Uttar Pradesh. The determinants of farmers' access to groundwater irrigation were assessed using a logit model and by recording the farmer's perceptions. The electric operated tubewells were dominant in the study area. With respect to diesel plus electric operated tubewells, farmers' access was higher than that of their ownership. The estimated logit model established that farm size, farm fragmentation and joint ownership were the major factors contributing to the installation of electric operated tubewells. Farmers' perception availability of canal water and adoptions of new technology were found to be other important factors responsible for installation of electric operated tubewells. Fragmented holdings and non-availability of canal water along with multiple use of diesel engine/tractor and erratic supply of electricity were important factors affecting the installation of diesel operated tubewells. The model established that the small farmers with fragmented holdings, low education and less possibility of joint ownership of tubewell would opt for the buying of groundwater. For enhancing equity and sustainability of groundwater use, the findings of the study will provide some insight for policy prescriptions such as improvement in the quality and reliability of power supply, provision of surface water to command area of canal and tubewell, consolidation of holding and joint ownership of tubewells.

Indian Agricultural Statistics Research Institute, New Delhi

40. Statistical Modelling and Optimization of Fertilizer Nutrients for Rainfed Crops based on Soil and Weather Parameters under Dryland Conditions

G.R. Maruthi Sankar, K.P.R. Vittal and Y.S. Ramakrishna

The data generated from Long Term Fertilizer Experiments (LTFE) conducted for a period of 12 seasons or more in the same experimental site for rainfed crops at different locations of All India Coordinated Research Project for Dryland Agriculture are examined in this paper. The treatments comprised of (i) control; (ii) 100% recommended inorganic fertilizer; (iii) 50% recommended inorganic fertilizer; (iv) 50% organic +50% inorganic fertilizer; and (v) farmers practice for 9 different crops viz., rice, sorghum, pearl millet, finger millet, maize, pigeonpea, green gram, cotton and groundnut. The locations varied in, climate and were grouped into arid (rainfall < 500 mm), semi-arid (rainfall between 500 to 1000 mm), and moist sub-humid climate (rainfall>1000 mm). Four different soil orders existed at the locations viz., alfisols, vertisols, oxisols and inceptisols. Using the time series data of rainfall and crop yield parameters, statistical models have been explored for assessing the influence of rainfall and land degradation (due to conduct of trials in the same site) on crop yield, the variability and sustainability of organic and inorganic fertilizer application over a period of time. Rainfall had a high coefficient of variation in terms of quantity and distribution (number of rainy days) and has significantly influenced the productivity of rainfed crops. It had a negative relation with the yield of sorghum, finger millet and maize, while a positive relation for remaining crops. Based on the regression models calibrated for predicting yield through rainfall and land degradation. It was found that sorghum yield had a higher coefficient of determination or predictability (R^2), followed by groundnut, finger millet and green gram. The predictability was higher when linear and quadratic terms of rainfall, land degradation and interaction of rainfall and land degradation variables were included in the regression model. The regression coefficients of rainfall were found to be significant for predicting yield of pearl millet at Agra, finger millet at Bangalore, sorghum at Solapur, pigeonpea at Arjia, green gram and cotton at Akola. Using the estimate of error (σ) based

on a regression model, the sustainability (η) of treatments over a period of time has been measured based on the procedure discussed by Vittal *et al.* (2002). The results indicated that an application of 50% through organic + 50% through inorganic source is optimum and has a relatively higher sustainability for pearl millet at Agra (dry sub-humid inceptisols) in Uttar Pradesh, finger millet at Bangalore (semi-arid alfisols) in Karnataka, maize at Arjia (semi-arid vertisols) in Rajasthan and cotton at Akola (semi-arid vertisols) in Maharashtra. Application of 100% recommended fertilizer was relatively superior and nearer to optimum for sorghum at Solapur (semi-arid vertisols) in Maharashtra, and was at par with 50% organic + 50% inorganic application for pearl millet at Agra (dry sub-humid inceptisols) in Uttar Pradesh. Application of 50% recommended fertilizer dose through inorganic source was found to be superior for groundnut at Anantapur (arid alfisols) in Andhra Pradesh, while the farmers practice was superior for rice at Ranchi (moist sub-humid oxisols) in Jharkhand. The study has also indicated that application of 50% fertilizer through inorganic source had a relatively lower coefficient of variation for finger millet at Bangalore, maize and pigeonpea at Arjia and green gram at Akola. Farmers practice had a lower variation for rice at Ranchi, cotton at Akola and groundnut at Anantapur, while the control had the lowest variation for sorghum at Solapur and pearl millet at Agra in the study conducted for different rainfed crops under dryland conditions.

Central Research Institute for Dryland Agriculture, Hyderabad

41. Use of Geographical Information System for the Study of Spatial Distribution of Cattle Diseases in the Peri-urban Regions of Pondicherry

R. Ganesan, S. Ramkumar and S.V.N. Rao

In this paper, an attempt has been made to study the spatial distribution of cattle diseases in the peri-urban regions of Pondicherry using GIS. The study also helps in pointing out regional variations. The methods of prevention, control and treatment of the diseases/conditions could be effectively planned in a comprehensive manner by studying the digitized maps developed.

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42. Multivariate Analysis of Variance of Data from Long-term Fertilizer Experiments

Ananta Sarkar, Rajender Parsad and M.R. Vats

In Long-term fertilizer experiments, the treatments are applied to the same set of experimental units over a sequence of years. These experiments are generally conducted using a randomized complete block (RCB) design. Same design layout (including randomization) is followed over years. In other words, randomization of treatments to plots is done only once during the first crop season and layout in all the subsequent cropping seasons exactly follows the initial layout. In the present investigation, we have restricted to long-term fertilizer experiments on a fixed crop sequence that are being conducted at 17 locations under the aegis of All India Co-ordinated Research Project (AICRP) on Long Term Fertilizer Experiments (LTFE) of Indian Council of Agricultural Research using a randomized complete block design. Treatments in these experiments are graded levels of fertilizers. The data for each year is separately examined using univariate analysis of variance (ANOVA). Combined analysis of data over years using the procedure of groups of experiments or split plot analysis (taking years as sub plots) is not valid because the observations from the same plot may be correlated. Therefore, the use of multivariate analysis of variance (MANOVA) is suggested. The comparison of treatments after MANOVA is a problem. For comparison of treatments, ANOVA based on score of first principal component explaining more than 75% of variation is generally attempted. In some situations, first principal component may not explain more than 75% of variation and even if it explains, still about 25% of variation remains unexplained. The inference made on the basis of a partial variation of the population may be misleading. To tackle this problem, we have developed a multivariate treatment contrast analysis procedure based on Wilk's Lambda criterion. All these analytical techniques have been illustrated with the help of data from Ranchi Centres' of AICRP on LTFE. Several pairwise treatment

comparisons that are non-significant through univariate analysis are found to be significant through multivariate contrast analysis. It is, therefore, recommended that the data pertaining to these experiments should be analyzed through MANOVA. If the number of years for which the experiment is conducted are more than the error degree of freedom, then MANOVA may be performed using a suitable number of principal components.

Indian Agricultural Statistics Research Institute, New Delhi

43. Non-linear Growth (Body Weight) Models for Pigs

Susheel Kumar Sarkar, Krishan Lal and G.K. Jha

Suitable non-linear models, viz., Exponential, Gompertz and Logistic have been fitted to describe the growth (body weight) of 50% breed (cross of Largwhite Yorkshire × Desi) of pigs, maintained at Jabalpur and Tirupati research stations during 1986-1990. The underlying assumptions of independence and normality of errors have been tested by using run test and Shapiro-Wilk test, respectively. It is found that Gompertz model is the best fitted model in most of the cases. So in general, we can say that Gompertz model is the best-fitted model for the pigs.

Indian Agricultural Statistics Research Institute, New Delhi

44. Sheep Productivity Estimation – Data Paucity and Loss Issues and Their Possible Redemption using Plug-in

J.P. Goyal[1], J. Jayasankar[2], V. Geethalakshmi[3] and R.S. Khatri[1]

Traditionally livestock surveys have been severely plagued by lack or loss of valid information. An attempt has been made to offset such lacunae in sheep and wool production survey by way of data plug-in. Data collected from a three stage stratified random sampling design conducted in Kolar district of Karnataka has been used towards this end. Two streams of production and productivity information from the selected households were used to plug-in the lock or loss of information on the productivity of sheep as per the existing final stage sampling strategies. Of all information gathered from 336 households spread across 48 villages from four strata carved out of congruent tehsils of Kolar district was subjected to detailed analysis both as per the traditional methodology as well as by adopting the newly suggested data plug-in approach based on physical, non-simulated data collected from two different sources viz., research farms/big sheep farms located in the strata as well as the secondary information collected pm the overall flock productivity performance gathered from the selected households. The precision, measured as SE, showed overall improvement in general with a minimum of 0.5 to 3% on categories of data abundance, viz. Non-descript Adult Female, Non-descript Adult Lambs etc. The categories where there was real data paucity like the crossbred categories showed dramatic enhancement in precision levels for the obvious reason of increase in the ultimate sample size. Finally an attempt has been made to statistically ascertain the over all consistency of the season-stratum-wise production and productivity figures.

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45. Outliers in Block Designs for Diallel Crosses

S. Sarker, Rajender Parsad and V.K. Gupta

The purpose of this article is to formulate a test statistic for detection of a single outlier in block designs for diallel crosses. A correspondence between two existing criteria of robustness i.e. minimization of average Cook-statistic and minimization of variance of discrepancy or bias in estimation of error variance is established. It has been shown that a proper binary balanced block design for diallel crosses is robust against the presence of a single outlier. Block designs for diallel crosses in which every line appears at an equal number of times in each block are also found to be robust against the presence of a single outlier.

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