

LIST OF PUBLICATIONS

Papers Published

1. ANSARI, J.; PRABHAKARAN, VT and RAO, AR (1999). [A bootstrap - variance approach to the choice of best mating design for heritability estimation](#). Indian Journal of Applied Statistics. 5, 29-40
2. BABOO, R.; KUMAR, M.; SINGH, D. and KUMAR, A. (2002). [Response of clusterbean \(*Cyamopsis Tetragonoloba*\) to *Rijabium* inoculation, nitrogen and phosphorus](#). Journal of Farming System Research & Development, 8 (1 & 2): 128-130
3. BABOO, R.; RANA, N.S.; SINGH, D.; KUMAR, M. and KUMAR, A. (2002). [Response of fodder crop of gaur \(*Cyamopsis tetra gonolaba L* \) to nitrogen \(with and without inoculation\) and phosphorus](#). Journal of Farming System Research & Development, 8 (1 & 2): 125-127
4. BHAR, LM and DEY, A. (2003). [Robustness of block designs for diallel crosses against missing data](#). Communication in Statistics-Theory and Methods, 32(1): 193-213
5. DAS, MN and LAHIRI, ALOKE (2002). [A modified definition of random sampling designs and its use to obtain new sampling designs and a convenient method of estimation of variance](#). Statistics and Applications, 4 (2): 119-128
6. DAS, SOUBHRATRA; KUMAR, BASANT and MALHOTRA, PK (2002) [Online Pest Management Information System](#). Journal of Indian Society of Agricultural Statistics, 45 (2), August 2002: 184-188
7. DEVRAJ; CHATURVEDI, KK and SINGH, PRAVEEN KUMAR (2001) ['Multimedia: An emerging Technology for Extension](#). Agriculture Extension Review, Vol.13(5), Sept.-Oct. 2001, pp 3-8
8. GHOSH, H. (2002). [Optimal design for point and interval estimation of ratio of variance components in one way in ANOVA model](#). Journal of Indian Society of Agricultural Statistics, Vol. 55(1): 47-62
9. GUPTA, VK; RAMANA, D.V.V. and PARSAD, RAJENDER (2002). [Weighted A-optimal block designs for comparing test treatment with controls with unequal precision](#). Special issue of Journal of Statistical Planning and Inference in the memory of Professor Sumiyasu Yamamoto, 106 (1-2): 159-175.
10. HANDA, DP; RAKPALI, SK and BIHARI, PRADEEP (1997). [A study of dry wet spell of rainfall at Jhansi](#). Indian Journal of Forestry, 20(3): 242-243.
11. JAGGI, SEEMA; GUPTA, VK and SHARMA, VK (2001). [Design and analysis of agroforestry experiments: An overview](#). Journal Ind. Soc. Of Agroforestry, 3(20): 120-129.
12. JAIN, RAJNI and ARORA ALKA (2001) [An Information Network for Agriculture Application](#) in Journal of the Computer Society of India, 31 (3) September, 2001 : 27.
13. JYOTI, RATAN, MALHOTRA, PK and DEV DEBJANI (2002). [Information System on National Pusa Insect Collection](#). Shashpa, 9(2): 127-132.
14. KANDALA, VM and PRAJNESHU (2002). [Fuzzy regression methodology for crop yield forecasting using remotely sensed data](#). Journal of Indian Society Remote Sensing, 30: 191-95
15. KAR, ABHIJIT; CHANDRA, PITAM and PARSAD, RAJENDER (2001). [Osmotic dehydration of banana \(*Dwarf Cavendish*\) slices](#). Indian Journal Agriculture Engineering. 38(3) : 9-17.
16. KAUL, SUSHILA and PANDEY, RK (2001). [Food Availability and its Implication for Food Security in India](#). Bihar J.of Agri. Mktg., Jan-March: 42-50.
17. LAL, KRISHAN; SINGH, RAJENDRA; PRASAD, SHIV (2003). [Non-linear models for poultry production in India](#). Indian Veterinary Journal, 80(2): 135-137.
18. MOGHA, AK and GUPTA, AK (2002). [A two priority unit warm standby system model with preparation of repair](#). Aligarh Journal of Statistics, 22 : 73-90.
19. NARAIN, PREM; SHARMA SD; RAI SC and BHATIA, VK (2002): [Dimensions of Regional Disparities in Socio Economic Development of Madhya Pradesh](#). Journal of Indian Society of Agricultural Statistics, 55(1): 88-107.
20. PANDA, DK; PARSAD, RAJENDER and SHARMA, VK (2003). [Robustness of complete diallel crossing plans against exchange of one cross](#). Journal of Applied Statistics, 30(1): 21-35.

21. PARSAD, RAJENDER and GUPTA, VK (2001). [Balanced bipartite row- column designs](#). *Ars. Combinatoria*, 61, 301-312.
22. PARSAD, RAJENDER, GUPTA, VK and PRASAD, NSG (2003). [Structurally incomplete row-column designs](#). *Communication in Statistics-Theory and Methods*. 32(1): 239-261.
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24. PAUL, AMRIT KUMAR and BHATIA, VK (2002). [Effect of auxiliary traits on estimation of heritability of stayability](#). *Journal of Indian Society of Agricultural Statistics* 55(1):63-69
25. PAUL, AMRIT KUMAR and BHATIA, VK (2002). [Comparison of beta-binomial with other methods for estimation of heritability of stayability](#). *Indian Journal of Animal Sciences*. 72(4): 402-405.
26. PRAJNESHU and RAVICHANDRAN, S. (2003). [Fitting of nonlinear Fox model in fisheries using expected-value parameters](#). *Indian Journal of Animal Sciences*, 73 : 329-31
27. PRAJNESHU; RAVICHANDRAN, S and WADHWA, SAVITA (2002). [Structural time series models for describing cyclical fluctuations](#). *Journal of Indian Society of Agricultural Statistics*, 55: 70- 78
28. RAI, ANIL, SRIVASTAVA, AK and SINGH, M. (2002) [A socio-economic study on agroforestry in Chhachhrauli block of Yamunanagar district of Haryana](#). *Ind. J. Agroforestry*, 3(2): 148-152.
29. RAMASUBRAMANIAN, V. (2002). [Impact of statistical software packages on scientific research and statistical education](#). *Current Science*, 83: 678
30. RAMASUBRAMANIAN, V; SINGH, RANDHIR and RAI, A (2002). [Resampling based variance estimation under two-phase sampling](#). *Journal of Indian Society of Agricultural Statistics*, 55(2): 197-208
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32. RAVICHANDRAN, S and PRAJNESHU (2002). [Dynamical modelling and forecasting of India's food grain production](#). *Proc. Nat. Acta. Sci., India*, B 72: 37-46
33. RAVICHANDRAN, S and PRAJNESHU (2002). [Time-varying state space regression model in fisheries](#). *Indian Journal of Fish.*, 49: 41 – 44
34. SAXENA, BC; ARYA, SRS and BINDAL, VIJAY (2002). [Disease prevalence and productivity losses in bovines](#). *Cherion*, 31 (3, 4): 74-77.
35. SETHI, IC (2002) [Some aspects of restricted multi-trait sire evaluation of dairy cattle](#). *Indian J. of Animal Sciences*, November 2002, 72 (11): 981-987
36. SHARMA, SD (2002): [Role of Information Technology in Agricultural Research and Development](#). *Indian Farming*, Special Issue, 52(.8): 71-76.
37. SHARMA, SD; SINGH RANDHIR and RAI, ANIL (2002): [Integrated National Agricultural Resources Information System \(INARIS\)](#). MAP INDIA 2002. GIS Development. (Web Article) HYPERLINK <http://www.gisdevelopment.net/proceedings/mapindia/2002/ta.htm>
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39. SINGH, RANDHIR; SEMWAL, DP; RAI, ANIL and CHHIKARA, RAJ, S (2002). [Small area estimation of crop yield using remote sensing satellite data](#). *International Journal of Remote Sensing*. (23)1, Jan., 2002 : 49-56.
40. SINHA, P; PRAJNESHU and VARMA, A (2002). [rowth models for mango powdery mildew development](#). *Ann. Pl. Protec. Sci.*, 10: 84-87
41. SUD, UC; SRIVASTAVA, AK and SHARMA, DP (2001). [On estimation of population variance in repeat surveys](#). *Indian Society of Agricultural Statistics*, 54(3), Dec., 2001: 355-369.
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43. VATS, MR; SEHGAL DK and MEHTA, DK (2002). [Extraneous factors affecting cumulative yields in long term fertilizer experiments](#). *Indian Journal of Agril. Research*,. 36 (1): 44-48.

44. VISAKHI, P and SRIVASTAVA, SS (2002). [Agricultural Libraries vis-à-vis Community information service \(CIS\) in Indian Context](#). IASLIC Bulletin, 47(3): 171-177.
45. VISAKHI, P and SRIVASTAVA, SS (2002). [Current trend of research collaboration in the field of statistical science - A case study](#). IASLIC Bulletin, 47(4): 210-215.

Research Papers accepted for publication

1. AHMAD, T and RAI, ANIL (2002). [An approach to GIS based spatial sampling procedures for environmental studies in Agriculture](#). American Journal of Mathematical & Management Sciences.
2. ALAM, WASI; WAHI, SD and KUMAR, ANIL. [A comparative estimation approach for time series forecasting of oil seeds in India](#). Farming Systems Research and Development Association
3. BAJPAI, PK and PRABHAKARAN, VT (2003). [Simultaneous testing of Genotype x environment interaction and stability for more than one trait](#). Indian J. Genet.
4. BHAR, L.M. and DEY, A. [Robustness of nested balanced incomplete block designs against missing data](#). Journal of Indian Society of Agricultural Statistics.
5. BHARDWAJ, SP and SIVARAMANE, N. [Study of Spatial integration of Gur/Gaggery Markets India](#). Bihar Jr. of Agril. Marketing.
6. BHARDWAJ, SP; PANWAR, SANJEEV, KUMAR, ANIL and SIVARAMMANE, N.(2003). [Economic study of growth and development of poultry sector in India-A Regional Approach](#). Journal of Farming Systems Research and Development.
7. GHOSH, H. and PAUL, AMRIT KUMAR (2002). [Estimation of variance components in diallel cross design](#). Edited book on 'Recent Advances in Mating Designs'.
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9. KANDALA, VM and PRAJNESHU. [Fuzzy Von Bertalanffy growth model for determining age-length relationship](#). Indian Journal of Fish.
10. KAPOOR, JK and KUMAR, RAJENDRA (2003). [Study of main effects and their interactions for cultural-cum-manurial experiments with similar treatments at the same place over a number of years](#). Ann. agric. Res.
11. KAR, ABHIJIT; CHANDRA, PITAM; PARSAD, RAJENDER; SAMUEL, D.V.K. and KHURDIYA, D.S. [Comparison of different methods of drying for banana \(Dwarf Cavendish\) slices](#). Journal of Food Science and Technology.
12. KAUL, SUSHILA, (2002). [Marketing and price structure of livestock products](#). Bihar Journal.of Agri. Mktg.
13. KAUR, RAJINDER and BHATIA, A.K. (2003). [Performance of mustard crop in multiple crop sequences. Brassica. \(an international Journal of Rapeseed-mustard Research and Development\)](#).
14. KOLLURU, RAMESH; RANA, PS and PAUL, AMRIT KUMAR. [On modelling for growth pattern in crossbreed cattle](#). Indian Journal of Animal Science
15. MOGHA, AK; GUPTA, R and GUPTA, AK. [A two unit parallel system with correlated life times and repair machine](#). Journal of 'Indian Association for Productivity, Quality and Reliability (IAPQR), Kolkata'.
16. PANDA, DK; PARSAD, RAJENDER and SHARMA, V.K. (2002). [Robustness of block designs for complete diallel crosses against interchange of a pair of crosses](#). Recent Advances in Mating Designs. Eds L.S.Kaushik and R.C.Hasija, Dhanpat Rai and Company (P) Ltd., New Delhi.
17. PARSAD, RAJENDER and GUPTA, V.K. (2002). [Optimal designs for diallel cross experiments: an overview](#). Recent Advances in Mating Designs. Edited by L.S. Kaushik and R.C. Hasija, Dhanpat Rai and Company (P) Ltd., N.D.
18. PRAJNESHU and KANDALA, VM. [Fitting of nonlinear Schaefer model](#). Ind. J. Fish.
19. RAVICHANDRAN, S and PRAJNESHU. [Structural time-series modelling for describing trend in sunflower yield](#). Indian Journal of Agricultural Sciences
20. SARDA, C and PRAJNESHU. [Modelling and forecasting country's pesticide consumption using ARIMA time-series approach](#). Ann. Agric. Res.

21. SARKER, S., GUPTA, VK and PARSAD, RAJENDER. Robust block designs for making test treatments - control treatment comparisons against the presence of an outlier. Journal of Indian Society of Agricultural Statistics.
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23. SHARMA, VK and KAUR, RAJINDER (2002). An analysis of a long-term fertilizer experiment on fixed plots. Journal of Indian Society of Agril. Stat.
24. SHARMA, VK and KAUR, RAJINDER (2002). Analysis of a long term experiment on rice based cropping systems. Journal of Agril. Sciences.
25. SHARMA, VK; JAGGI, SEEMA and VARGHESE, CINI (2002). Minimal balanced repeated measurements designs. Journal of Applied Statistics.
26. SHARMA, VK; KAUR, RAJINDER and SHARMA, A. (2002). A statistical investigation on a long term experiment on rice-wheat cropping sequence. Journal of Farming Systems Res. & Dev.
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28. SINGH, DR and SINGH, RP (2002). Groundwater markets and the issues of equity and reliability to water access: A case of western Uttar Pradesh. Indian J. of Agri. Economics.
29. SINGH, HARBIR; SINGH, G and SINGH, DR (2002). Dynamics of Mixed Farming under Irrigated Agriculture. Agricultural Situation in India
30. SINGH, N. OKENDRO and WAHI, SD (2003). Effect of sample size and structure on the bootstrap estimate of variance of heritability. The Indian Journal of Animal Science
31. SUDEEP; GOYAL, RC and MALHOTRA, PK.(2002). Intranet solutions for research organisations. Journal of Indian Society of Agricultural Statistics.

Research Project Reports

(a) Published

1. Pilot Sample Survey for estimating the area and yield rates of ginger and potato in hilly areas by SS Gupta, MS Narang and RC Gola.
2. Development of early warning and yield assessment models for rainfed crops based on agrometeorological indices by Asha Saxena, RC Jain and RL Yadav.
3. Forecasting fish production from ponds by Lalmohan Bhar, SS Walia and AK Roy
4. Study on growth pattern and Heritability of fitness traits in Indian breeds of goats (2002) by Lal Chand, S.D. Wahli and V.K.Bhatia.
5. Improvement in Migratory Sheep Production Programme for tribal farmers in North-West by RK Pandey, Sushila Kaul and DR Singh.
6. Annual Report (2001-02) Socio-economic Conditions and Food security Status of the Target Population in Tribal, Backward and Hilly Areas of India by Mruthyunjaya, R.K.Pandey, D.K.Manthia, B.C.Bhaumik, Ajay Verma, P.K.Katiha, R.S.Singh, Sushila Kaul, D.R.Singh. A.K.Gauraha, Sant Kumar, Anil K. Dixit, Pradeep Verma.
7. Annual Report (2001-02) On Synthesis Benchmark Status of the Technology Intervention and Crop Diversification in Tribal, Backward and Hilly Areas. by Mruthyunjaya, R.K.Pandey, D.K.Manthia, B.C.Bhaumik, Ajay Verma, P.K.Katiha, R.S.Singh, Sushila Kaul, D.R.Singh. A.K.Gauraha, Sant Kumar, Anil K. Dixit, Pradeep Verma.
8. Planning, designing and analysis of experiments planned on stations under the Project Director for Cropping Systems Research (1996-2001) by Rajinder Kaur, Ajit Kaur and Anil Kumar.
9. Planning, designing and analysis of experiments planned on stations under the Project Directorate for Cropping System Research (1999-2000) by Rajender Kaur and Ajit Kaur (Status Report).

(b) Finalised

1. Forecasting the loss in yield due to weeds by Madan Mohan, Ranbir Sharma (IARI) , T Rai and Ranjana Agrawal.
2. Forecasting sugarcane yields using Multiple Markov Chains by Ramasubramanian, V.; Ranjana Agrawal and LM Bhar.

(c) Submitted

1. A pilot study on cost of production of coconut in Kerala. (Funded by Coconut Development Board, Kochi, Kerala) by UC Sud, HVL Bathla, Jagbir Singh, DC Mathur, KK Kher, GK Jha and K Murlidharan.
2. Statistical investigation on the fertilizer use efficiency in relation to cultural practice by Rajendra Kumar and JK Kapoor.
3. Planning, designing and analysis of experiments conducted under AICRP on STCR by MR Vats, DK Sehgal and DK Mehta
4. Design and analysis of agroforestry experiments by DP Handa, Seema Jaggi, VK Sharma and AS Gill

Book Published

- Agricultural Research Data Book, 2002 (2002): HVL Bathla, KK Tyagi, RS Khatri, Jagbir Singh, JP Goyal, SC Agarwal, RM Sood and BN Chakraborty.

DISSERTATIONS APPROVED

(a) Ph.D. (Agricultural Statistics)

1. B.M. Krishna Raju - On some statistical aspects of assessing sensitivity of crop varieties

In sensitivity studies, multi-environment testing of varieties often leads to incomplete structure for genotype by environment data. Treating environment effect as random has a desirable consequence of correcting the bias creeping in due to selection of environments. While evaluating the Factorial Regression for unbalanced data, the estimates of sensitivity corresponding to a single covariate obtained from "Substituted" method suggested by Eeuwijk (1995), as an approximate method where random interaction effect for a missing cell is imputed by zero, are shown to be biased towards zero as compared to the usual Ignored method where interaction effects of missing cells are "ignored". Joint Regression with Fitcon estimates and Digby's Modified Joint Regression were found to be similar when the varieties did not differ in their sensitivities to environmental index. Ofversten (1998) methodology was found to be very inferior to the proposed Substituted BLUP and Ignored BLUP methodologies with respect to its ability to assess the sensitivity rank order obtained from the balanced data set. The sensitivity estimates obtained from Substituted BLUP method were found to be biased towards unity as compared to the ones obtained from Ignored BLUP method.

AMMI model was shown to be more realistic to capture the non-linear interactions when linear regression techniques fail. Effective number of replications confirmed the Stein effect making the AMMI model more predictively accurate. The success of biplots to draw reliable stability conclusions is subject to the significance of proportion of interaction explained by the first or first two PCA axes. The proposed stability measure $W_{i(AMMI)}$ was shown to be equivalent to Wricke's ecovalence. It was shown that the reliability of stability conclusions improves with increase in the number of PCA axes accommodated by the measure of stability. It is concluded that the stability information that can be derived from the AMMI model can never be better than Wricke's ecovalence. The ranking ability of $W_{i(AMMI)}$ was found to be superior to F_{p_i} , B_i , F_{Ai} when there are missing cells in the data; showing some kind of robustness to the missing data. The ranking abilities of different stability measures were found to be better in the proposed EM-AMMI with random environments as compared to EM-AMMI (Gauch and Zobel, 1990) and Modified EM-AMMI (Bajpai, 1998) revealing its superiority over the other two methodologies. It is concluded that stability measure $W_{i(AMMI)}$ using EM-AMMI with random environments methodology may be employed to derive stability conclusions from AMMI model when some cells in two-way table are missing. However Piepho's (1994a) stability variance approach for incomplete data was found to be slightly superior to EM-AMMI with random environments, which may be attributed to the poor predictive success of indirect data. The proposed EM-AMMI enriched techniques for Factorial Regression and Joint Regression were found to be inferior to Substituted and Ignored methods revealing the failure of EM-AMMI to impute the true (balanced) interactions as compared to zero substituted interactions for the data set considered. Hence EM-AMMI methods may be used with considerable care to impute missing cells. To identify the robust and reliable measures of stability when the interaction effects not normal, various non-normal and contaminated normal distributions were generated using Monte-Carlo simulation. Thirteen measures of stability were considered in total for the study. Defined values of σ_{12} were assigned to each genotype so that the true stability rank order is known a priori. The measures of stability taken for study were compared with respect to their ability

to assess the true rank order, which was quantified by Spearman's rank correlation averaged over 1000 runs. The results suggest that, given a normal distribution of interaction effects, it is best to estimate stability by the MINQUE of σ_{12} (or equivalently by $W_i / W_{i(AMMI)}$). The situation does not change dramatically under mild departures from normality. However with extreme and longer tailed distributions, significantly departing from normality for the interaction effects, it may be worth while to use one of the more robust measures like L_i , $p_i^{(2)}$ and $p_i^{(3)}$.

(Guide: Dr.V.K.Bhatia)

2. Subhra Sarker - Study on outlier in designed experiments

An outlier in a set of data is an observation that appears to be inconsistent with the remainder of the observations in that data set and whose value is not in the pattern of the values produced by the data. Presence of outlier(s) may disturb the experimental set up and analysis of data may become more complicated. In the literature, the problem of outlier(s) has been extensively studied in the general linear model setup to a great extent. But most of these studies relate to regression models in which the design matrix has the full column rank. Although the general set up of an experimental design is that of a linear model, yet detection and testing of outlier(s) in experimental designs have some problems viz.(i) The design matrix does not have full column rank and (ii) the interest is in a subset of parameters rather than whole vector of parameters.

In the present investigation, Cook-statistic has been derived for testing the presence of more than one outlier in a balanced binary block (BBB) design when the outlying observations pertain to a block. The robustness criterion of minimization of discrepancy or bias in measurement of error variance has been extended for the identification of robust designs against the presence of two and three outliers. It has also been shown that in a proper block design set up, the two criteria of robustness viz. minimization of discrepancy or bias in measurement of error variance and minimization of average Cook-statistic are equivalent for a single outlier situation. Nested balanced incomplete block (NBIB) designs and nested partial balanced incomplete block (NPBIB) designs have also been shown to be robust in the presence of a single outlier. Cook-statistic has been derived for detection of outlier in the data from block designs for diallel cross experiments. All universally optimal binary balanced block designs for diallel cross experiments have been shown to be robust in the presence of a single outlier. Cook-statistic for detection of a outlier has also been obtained for the block designs for making test treatments control treatment comparisons. All balanced test treatment incomplete block (BTIB) designs that are binary with respect to test treatment are shown to be robust against the presence of a single outlier.

(Guide: Dr. V.K. Gupta)

(b) M.Sc. (Agricultural Statistics)

1. Ajeet Kumar - Analytical techniques for plot sampling data in designed field experiments

The plot-sampled data from designed field experiments is generally analyzed as per analytical procedure of the design adopted on the plot means. Another procedure of analysis of plot sampled data that is available in literature is based on individual observations. The latter procedure provides the estimate of the sampling error that can be used to determine the optimum sample size. Through empirical investigations it has been established that the estimate of sampling error is same as that of pooled variance of plot sampled observations and inference on treatment effects is generally same from the ANOVA based on plot means and individual observations. Therefore, this method does not add much to the information that is available from the analysis based on plot means. The plot variances, however, are different from plot to plot and may violate the assumptions of constancy of variances and normality of observations. Therefore, there is a need to evolve variance-stabilizing transformations so as to satisfy the assumptions of analysis of variance. Keeping this in view, several existing variance stabilizing transformation viz. Aitken's transformation, Box-Cox transformation, transformation based on the slope of regression equation of variances of each plot and log of mean of corresponding plot have been used. Box-Cox transformation has been used in three different ways viz. minimization of experimental error, sampling error and total error. A new transformation of data based on minimum value of x_2 is also suggested. Each of these transformations has been illustrated with the help of examples based on the data from a completely randomized design, randomized complete block design, an incomplete block design and row-column design. A SAS code using PROC IML has been developed for performing all the computation of the transformations of data at one go.

The plot sampled data is in the form of sample observations that can be used for constructing intervals for the response variable for each of the plots. Analyzing such experimental data on the averages may cause a loss of information. Hence, a procedure that can handle the data in the interval form rather than averages may be helpful. In view of this, fuzzy regression theory is modified in order to apply it for analyzing data obtained from experiments conducted using completely randomized designs or binary block designs. The modification is in terms of some extra constraints in the linear programming function that is used for fuzzy regression theory. Three different intervals for the response variable for each of the plots were formed by two methods that are based on (i) the range of the observations (ii) confidence intervals (95% and 99%). The fuzzy regression theory provides the interval estimates of parameters and not that of treatment contrasts. These estimated parameters have been used to develop the interval for elementary treatment contrasts using fuzzy set theory. A SAS code has been developed for the analysis of plot

sampled data from field experiments using modified fuzzy regression theory. The procedure is illustrated with the help of examples.

(Guide : Dr. Rajender Parsad)

2. Dinesh Kumar Pateria - On some analytical techniques for agro-forestry experiments

Agro-forestry is a land use system where woody perennials are deliberately used on the same land management units along with crops. Agroforestry field experiments are considerably more complex than research confined to annual crops. The evaluation is also therefore a complex task. The data structures from these experiments consist of different forms of yield information available from different components of the system. There is not a single form of statistical analysis which is appropriate to all forms of agro-forestry data.

The present study deals with some analytical techniques as applied to agro-forestry experiment. The data used for this study is from an agri-horticultural experiment on "Establishment and growth of fruit trees and their effect on crop growth and production" conducted at NRCAF (National Research Centre for Agroforestry), Jhansi from 1989-90 to 1998-99. The experiment consists of four fruit tree species viz. Guava (*Psidium guajava*), Ber (*Ziziphus mauritiana*), Anar (*Punica granatum*) and Kinnow (*Citrus reticulata*) and four crop rotations (Sorghum-Wheat, Sorghum-Gram, Groundnut-Wheat and Groundnut-Gram). The design used for laying out the experiment was a split-split plot design.

The pattern of wheat yield has been studied over years separately under different tree species by fitting different models to get the best fit model. A comparison has been made of yields between different trees to study the effect of tree species on wheat productivity. Under all the tree species, a declining trend of wheat yield has been observed. However, the wheat productivity is higher under Guava as compared to other trees. In order to evaluate the performance of the system as a whole, the wheat yield and the fruit yield are added in terms of the money value and the behavior of the system has been studied over years and accordingly trend equation has been estimated. It is found that the Guava-wheat system has performed the best over years as compared to other systems.

Step-wise regression analysis has been performed on guava fruit yield with height, canopy and collar diameter as the independent variables. The variables contributing significantly to fruit yield are canopy and collar diameter of the tree. Principal component regression has been performed between fruit yield and first principal component score. Bivariate analysis has been performed by considering the wheat yield and first principal component score as the two variates with factors tree and year in the model. Both the factors are found to be significant and a negative correlation is observed between wheat yield and first principal component score.

Since agroforestry experiments are conducted for a number of years, combined analysis has been performed over years of the crop data (wheat and gram) that have been classified according to the different tree species and the distance of the rows from the tree base on which the crop is grown. The effect of trees and distances are found to be significant over years. Contrast analysis has also been performed for the significant factors. Further the combined analysis of data from split-split plot design is also performed by taking the four crop rotations in terms of money value.

(Guide: Dr.Seema Jaggi)

3. Memita Devi-Estimation of finite population regression co-efficients using double sampling

Multiple regression techniques are commonly used in statistical analysis of data mostly through complex software using ordinary least square (OLS) technique. The regression co-efficients are computed under the assumption that observations are independent. This assumption of independence of observations does not hold good in the sample survey context as survey data are generally obtained through multi-stage sampling designs involving clustering and stratification leading to correlation between observations in same stratum or cluster. Nathan and Holt (1980) has shown that the OLS estimator is biased in case the data are obtained with the help of Complex survey design and also claimed that the maximum likelihood estimator (MLE) developed by Demets and Halperin (1977) performs better than the usual OLS estimator. Demets and Halperin (1977) developed this MLE using a design variable in the survey stage. A limitation of this MLE is that it assumes that the information on the design variable is available for all the population units. At times this information is not available for all the population units. In such situations an alternative MLE developed through double sampling approach is proposed. The proposed estimator is found to be better performed than the OLS estimator. The relative efficiency of the proposed estimator over the OLS estimator is computed under a suitable cost function and it is found that the relative efficiency is greater than 1 thereby showing that the proposed estimator is an improvement over the OLS estimator. And the study also reveals that as the cost of collecting the information on the design variable becomes cheaper the relative efficiency of the proposed estimator increases.

(Guide: Dr. H V. L. Bathla)

4. Nilesh Kumar Gupta- Application of spatial models in estimation of wheat production in Rohtak district of Haryana.

The estimation of production of wheat in Rohtak district as well as its tehsil's were obtained with the help of crop cutting experiments (CCE) data of the district using spatial models. The yield data from (CCE) and the corresponding locations of yield data in terms of latitude and longitude was identified. The spatial statistics was applied to the data of yields and locations to determine the spatial model of best fit along with its parameters. With the help of best fitted spatial model ordinary kriging method was used for spatial prediction at un-sampled locations. Ordinary kriging gives both a prediction and standard error of prediction at sampled as well as unsampled locations. Also, production surface was obtained using ordinary kriging method in the form of grids of desired size. By overlaying the administrative boundary map of district on the surface of grids, the production of district was obtained. To get the production of individual tehsil, the tehsil administrative map was overlayed over the district map and the estimate of production for tehsil's was obtained. The estimates of production were improved, with the help of normalized difference vegetation index (NDVI) from remotely sensed satellite data for the study area. A simple linear regression model was fitted for the purpose for estimation of coefficient. The residual error of the model has been tested for normality and further observations were generated with the help of NDVI and simulated error component of the model. The additional points were taken at random from the classified image of district. Again production was estimated by using these additional points along with actual observations. The production surface is also obtained on the basis of yield data obtained from CCE and the simulated yield data using auxiliary character NDVI. This process is repeated till convergence. It has been found that accuracy of prediction of the production depends on grid size and number of sample points. The accuracy increases with increase the sample points and decrease in the grid size.

(Guide: Dr. Anil Rai)

5. Praveen Krishana - A study on some aspects of ranked set sampling

The applications of auxiliary variables in case of random sampling for improving the efficiency of sampling for improving the efficiency of sampling strategies are quite popular in case of survey sampling. This may result in misleading inferences of the target population. There may be situations where the exact measurement auxiliary variable of a selected unit is either difficult or expensive in terms of time, money or labour, but where the ranking of small sets of selected units according to the characteristic of interest can be done with reasonable success on the basis of visual inspection or other rough measurement of such kind. For such situations McIntyre proposed the method of Ranked Set Sampling (RSS) to get better precision than SRS. Most of the earlier work related to RSS has been done for the case of infinite population. In this thesis RSS procedure has been proposed for finite population. In this procedure the inclusion probabilities have been shown to be equal for every unit of the population. An estimator for estimating population mean has been proposed. It has been proved to be unbiased and an expression of its variance has been derived in terms of variability of individual ranks. The statistical properties of this estimator have been studied using simulation. It was found that the proposed RSS estimator is always better than SRS estimator. Further, a ratio estimator based on auxiliary character has been proposed. Sample is drawn by RSS procedure in four different situations. The expressions for Bias and Mean Square Error as well as estimate of Bias and Mean Square Error have been derived for all four ratio estimators developed. The simulation study carried out to study the performance of these estimations showed that RSS ratio estimator is superior to SRS ratio estimator.

(Guide: Dr. Anil Rai)

(c) M.Sc. (Computer Application)

1. Ashish N. Patil - Decision Support System for Nutrient Management in Wheat, Mustard and Bajra

Decision support systems and expert systems can be of tremendous help to guide the people engaged in modern agriculture. These systems usually provide decision support either for extension workers who have to decide what advice to offer to clients, or for the farmers who have to decide on a course of action to be taken in a given situation. Deficiency of nutrient is widespread in soils and plants and it goes unnoticed because of lack of support for decision-making. Keeping in view the importance and widespread deficiency of nutrients the problem of developing a computer-aided system was undertaken. Information and knowledge gathered for this system is from various books and journals. This forms the core of the database, which supports the decision-making effort. The system is complete one for wheat mustard and bajra and is web based. Further, this system can be implemented as net work - based system with a server. The system is menu driven and user-friendly. Hopefully, the use of this system will provide intellectual support to farmers and extension workers in knowing nutrient availability in their soils and fertilizers type for nutrient application.

(Chairman: Dr. I.C. Sethi)

2. Harish - Online System for Information and Marketing of ICAR Publications

The Indian Council of Agricultural Research (ICAR) disseminates information on recent technological developments through various publications, i.e. books, bulletins, popular publications and

reports so as to cater the needs of scientists, extension workers, progressive farmers, students and general public. The development of an Information System for ICAR Publications (AgriPub's) will help progressive farmers, industrialists, researchers, students and extension workers in rapid dissemination and online ordering of knowledge for the benefit of human kind. The present investigation was carried out with the idea of developing Online System for Information and Marketing of ICAR Publications. AgriPub's provides information on various aspects of publications viz. books, Hindi journals, English journals, discounted books, bibliographies & proceedings and miscellaneous publications. The information is provided in the form of text as well as pictures. AgriPub's is very user friendly for disseminating information on publications. AgriPub's can be implemented as a network-based system with a server at central location so that information is available on-line. AgriPub's can run at any node of the Internet through a browser. Security features are provided in such a way that only administrator can access the database. There is a provision to insert, delete and modify the information. It has facility to browse, search and online ordering the publications. It has on-line help to facilitate smooth navigation. Facility has been provided for interaction with the System Administrator of AgriPub's through AgriPub's ContactUs Form. Links are also provided for publications information that is currently available on the Internet.

(Chairman: Dr. V.K. Mahajan)

3. Sridhar Gajavelli - Web Based Information System for Maize Crop

Maize is a very important crop and an information system on Maize is expected to serve useful purpose to provide the required information to the users. The present investigation was carried out with the idea of developing web based Information System for Maize Crop (ISM). ISM provides information on various aspects of varieties, cultural practices, insects, diseases, weeds and also post harvest technologies. The information is provided in the form of text as well as pictures. ISM can be implemented as a network-based system with a server at central location so that information is available on-line. Security features are provided in such a way that only administrator can access the database. There is a provision to insert, delete and modify the information. It has facility to browse and search the crop's critical stages and their remedies also. It is possible to get enlarged view of the image of varieties, insects, diseases and weeds. It has on-line help to facilitate smooth navigation.

(Chairman: Dr. V.K. Mahajan)

4. V.N. B.S. Madhavanand - Interface Development for the GIS Assisted Ground Water Potential Assessment

Ground water is the most important natural resource required for drinking, irrigation and industrialization. The resource can be optimally used and sustained only when quantity and quality of ground water is assessed. The Ground water potential assessment models are limited in that they do not explicitly allow for the inclusion of spatial data and attribute data as model inputs. Data must be processed into a form that the model can use. Processing these data, even with the use of a Geographic Information System (GIS), is tedious and time consuming due to the large number of model parameters required executing ground water assessment models. The parameters involved in the development of the model and subsequent validation needs a large data set. In this context, data analysis and interpretation through GIS coupled with modeling capabilities will assist to take alternative decisions within a defined system. So an interface to the GIS, GWAS, has been developed using Microsoft Visual Basic 6.0 and Arc Macro Language (AML) so that the data required by the ground water potential assessment models will be assessed from the GIS info tables and access database and the output from the executed model can be displayed with the help of menus, which can eliminate many sources of error and reduce run preparations significantly. With the help of this software, a novice modeller who is familiar with the basic windows applications also can do tedious GIS related tasks. GWAS gives a tremendous time saving so that modeler can spend considerable time on modelling, planning and in decision-making.

(Chairman: Dr. P.K. Malhotra)