

Proceedings of the National Seminar

RECENT ADVANCES IN APPLIED STATISTICS AND ITS APPLICATION IN FORESTRY

Three days National Seminar on '**Recent Advances in Applied Statistics and its Application in Forestry**' was inaugurated on April 15, 2013 by Prof. Kedar Nath Singh Yadav, Hon'ble Vice Chancellor, Rani Durgawati Viswavidyalay, Jabalpur at Tropical Forest Research Institute, Jabalpur (TFRI) in the presence of Dr. U. Prakasham, Director, TFRI, Dr. Ram Prakash, Director, SFRI, Jabalpur, senior forest officers, Experts from IASRI, New Delhi, ICFRE, Dehradun, Kerla Forest Research Institute, Lucknow University, Allahabad University, YS Parmar University of Horticulture and Forestry, Solan, Jawahar Lal Krishi Viswa Vidhyalaya, Sikkim Manipal Institute of Medical Sciences, Sikkim, Burdwan University, WB, National Institute of Technology, Patna, APS University, Rewa, Indian Institute of Forest Management, Bhopal, Bidhan Chand Krishi Vishwa Vidyalaya, WB, former scientists of TFRI and officers from NSSO, Jabalpur etc. Dr. Girish Chandra, organizing secretary briefed about the aims and significance of the seminar.

Dr. U. Prakasham in his introductory remarks emphasized about the vision of Indian Council of Forestry Research and Education (ICFRE), Dehradun and its institutes/centers. On this occasion, he paid such tribute to founder of Statistics in India, Prof. P. C. Mahalanobis and his contribution in the fields of statistical development and economic planning, his model of development planning, the large scale sample survey techniques etc. He also emphasized about International year of Statistics-2013 and National Statistics day (June 29 every year) in the context of the present scenario. He was also delighted to thank Hon'ble Director General, ICFRE, Dr. V. K. Bahuguna, for his kind support and guidance to organize this seminar and the support received from Ministry of Statistics and Program Implementation, Government of India, CSIR, MPCST, Bhopal, Union Bank of India, SPSS and Systat, experts from different organizations and all the committee members of the seminar. Dr. Ram Prakash and Dr. C. P. Rai also recorded their views on the relevance of Statistics with forestry research by explaining

its indispensability for design of experiments, sampling techniques, multivariate analysis, time series analysis etc.

Prof. K. N. Yadav delivered his key note address and focused on the importance of applied statistics in facing the problems on development of different streams of science through collection of relevant data and drawing valid and reliable conclusion of specified objective under economically optimized way. In forestry research statistically designed experiments with models are important in field experiments in order to gain a better understanding of trees, stand, and forest responses and minimized the biasness and experimental errors. Recently developed software like SAS, SPSS, Systat, R, Minitab etc. are the new advancement in analyzing the collected data in the most efficient way. He was happy that TFRI is carrying out the pilot studies/field research through projects funded by external agencies and ICFRE and catering the overall research needs of forests of four central Indian states, viz., Chhattisgarh, Madhya Pradesh, Maharashtra and Orissa, in particular, and specific issues of forests and forestry sector confronting India, in general.

There were many invited speakers for special lectures, and contributed papers under the four important themes viz. (a) Role of Applied Statistics in Scientific Research (b) Design of Experiments in Forestry Research (c) Sampling techniques and Time Series in Forest Survey and (d) Applied Mathematics and Forest Biometrics. Besides these a colloquium on “Statistical Modelling and Forecasting” and a half day workshop on “Importance of Statistical software in Survey Data Analysis” were the parts of the seminar. Session wise summary is given below:

Invited Paper Session I (Role of Applied Statistics in Scientific Research)

Chairperson: Dr. S. A. Ansari

In this session, total two papers were presented. In the first paper Dr. M. Sivaram briefed about the non availability of proper statistical system to track the timber market trends in developing countries. The newly developed Timber Market Intelligence System by KFRI, Peechi, computer based decision support system tool to gather, store, search, retrieve and analyze timber price trends, is successful for the same. Selected models for forecasting future timber price trends were integrated in the system. It is useful for monitoring timber prices as was demonstrated through a case study of timber market of Kerala State, India.

In the second paper Dr. Krishan Lal, discussed about mixture experiment, an experiment in which the response is assumed to depend on the relative proportions of the ingredients present in the mixture and not on the amount of mixture. He suggested a methodology for the

optimization in mixture experiment with process variable with minimum variability when the number of replication is two or more.

Recommendation: Models for timber price trends have been suggested. These models are to be verified by the real data in forest research.

Response surface designs are successfully used in every branch of research. It is hoped that these designs will work well in forest research. Mixture experiments are a particular case of response surface designs. Researchers in forest research may verify its utility in their researches.

Contributory Paper Session I (Role of Applied Statistics in Scientific Research)

Chairperson: Dr. S. A. Ansari

There were 7 papers presented in this session.

Paper 1: The role of women contribution in generating livelihood through forest development activities a cause and effect relationship based on an intensive survey of 20 JFM villages, selected from different forest ranges of Betul, Jhabua, Sheopur and Mandla districts of MP were discussed in this paper.

Paper 2: The aim of this paper was to detect the statistically significant impact of mother's lifestyle characteristics on her neonate weight using statistical (or probabilistic) modeling.

Paper 3: The objective was to find out trends in production, import- export and consumption of particle board and plywood in India using Autoregressive Integrated Moving Average (ARIMA) model.

Paper 4: Rural-Urban sex differentials in the state of Sikkim using chi square test were discussed.

Paper 5: The methodology for tangible and intangible benefits due to plantation was discussed. The usefulness of Contingent Valuation Method for intangible benefits including carbon sequestration, pollution control, improvement in underground water table, soil conservation and remediation, increase in wild life and eco-tourism were discussed

Paper 6: The role of statistics for the development of genetic concepts to accomplish better understanding of genome and its function in different organisms were discussed.

Paper 7: The overviews about statistical methods that are used in phytopathological research and for improving the analysis of data from many types of experiments were discussed.

Recommendation: The role of women contribution in forest development is to be considered in India. Joint modeling of mean and variance may be successfully used in the forest research modeling. In forest research, most data are based on time. Time series data modeling is really important in forest research. Distribution of underground water, soil characteristic study and genetic study are also important in forest research.

Invited Paper Session II (Design of Experiment in forestry research)

Chairperson: Prof. V. K. Choudhary

Total 5 papers were presented in this session. The first paper was presented by Dr. Krishan Lal on Design Resources Server, which is developed to popularize and disseminate research in design of experiments among experimenters in agricultural sciences, forestry, biological sciences, animal sciences, social sciences and industry in planning and designing their experiments for making precise and valid inferences on the problems of their interest, generally treatment contrasts.

Mr. Raman Nautiyal, ICFRE Dehradun presented experiments in field trials of forest tree species, especially for tree improvement by presence of a large number of varieties to be tested. Two classes of experiments were discussed, one pertaining to the field and one to the laboratory.

Dr. Rabin Das presented *invariant* robust first-order *D*-optimal and rotatable designs for correlated lifetime responses having log-normal, exponential, gamma and Weibull distributions. It was shown that robust first-order *D*-optimal designs are always robust rotatable but the converse is *not* true.

Prof. R. B. Singh described multi locational experiments for four categories viz. (a) experimental error homogeneous and the interaction absent (b) experimental errors are homogeneous and the interaction present (c) experimental error are heterogeneous and the interactions absent and (d) experimental error heterogeneous and the interaction present. Prof. H. L. Sharma described the need of confounding problems in design of experiments for agricultural and forestry surveys.

Recommendation: "Design Resources Server" may be used in forest research. For correlated responses with non-normal distributions (like as log-normal, exponential, gamma, Weibull) invariant robust *D*-optimal and rotatable designs may be used in forest research. With heterogeneous and correlated errors, replicated experiments may be used in forest research.

Contributory Paper Session II (Role of Applied Statistics in Scientific Research)

Chairperson: Dr. M. Shivaram

Total 4 papers were presented in this session.

Paper 1: Situational analysis of HIV-positive women on art in Manipur were described.

Paper 2: This paper was an attempt to effectively employ the quantitative parameters to study the plant diversity and helping in ecological monitoring of the study region.

Paper 3: The research of this paper were carried out in the state of Sikkim for estimating the Maternal Mortality Rates that occurred during 2000 to 2011, assessing the rural- urban differences in maternal mortality and for identifying the specific age groups associated with maternal mortality.

Paper 4: The paper discusses uses of quantal-response statistics, particularly Probit Analysis in toxicological determinations, viz., Effective Concentrations/ Lethal Concentrations/ Lethal Time for 50% or 90% mortality in forest insect pests.

Recommendation: Toxicological determinations are very important in forest research. Data on such experiments may be modeled by second-degree polynomials, and mean, variance to be modeled simultaneously. Model selection should be done based on the data.

Invited Paper Session III (Statistical Modeling and Forecasting)

Chairperson: Prof. Anoop Chaturvedi

Two papers were presented in this session. In the first paper Dr. Amrender Kumar showed that the pests and diseases adversely effects many aspects of forest such as tree growth, survival, yield, quality of wood and non wood products. He successfully showed that complex polynomials through Group Method of Data Handling (GMDH) technique, Ordinal Logistic Model, Fuzzy approach and Artificial Neural Network are reliable forewarnings models. Some case studies have also been explained.

The second paper was presented by Dr. V. Ramasubramanian on Technology Forecasting for prediction of the future characteristics of useful machines, procedures or techniques. Using this technique he demonstrated the case studies in the field of Indian agriculture. He further highlighted Questionnaire approach, Analytical Hierarchy Process, Cross Impact Analysis, Substitution Modelling and Scientometrics.

Recommendation: Pests and disease effects study is very important in forest research. This may be done by dose-response experiments. Experimental designs (response surface) may be

used for generating data in dose-response study. These data to be modeled based on the data nature, but not the respective design used.

Invited Paper Session IV (Sampling Technique and Time Series in Forest Survey)

Chairperson: Mr. Raman Nautiyal

Two papers were presented in this session. First paper was presented by Prof. S. K. Pandey on controlled sampling. The need of controlled sampling along with stratified random sampling were discussed and different important research papers on forestry sampling were also explained.

In the second paper Prof. Anoop Chaturvedi presented the ecological and forestry studies with time series data. He introduced different time series models, which can be used for modeling forestry and ecological data. The spectral analysis of time series models and its role to investigate cyclic behavior of time series data generated in forestry were also discussed.

Recommendation: Both sampling techniques (controlled and stratified) and time series analysis is always important in forest research. No fundamental rule may be suggested for all cases of study. Based on the situation and time series data, appropriate sampling and time series data analysis may be suggested in forest research.

Contributory Paper Session III (Sampling Technique and Time Series in Forest Survey)

Chairperson: Dr. Krishan Lal

Four papers were presented in this session.

Paper 1: The estimation of domain total in the presence of nonresponse when the domain size is assumed unknown and the sampling design is two-stage is discussed.

Paper 2: The problems of estimation of finite population mean in systematic sampling were discussed. Ratio-cum-product estimators of finite population mean have been suggested using known parameters of auxiliary variates.

Paper 3: The statistical analysis of wood based panels in India which relates to forestry was presented. The wood based panel's viz. veneers, plywood, fiber boards and other similar boards, particle boards and other similar boards have also been examined for their trends.

Paper 4: The usefulness of statistical software Systat was demonstrated.

Recommendation: Based on the situation and time series data, appropriate sampling and time series data analysis may be suggested in forest research.

Invited Paper Session V (Applied Mathematics and Forest Biometrics)

Chairperson: Dr. Hukum Chandra

Two papers were presented in this session. In the first paper brief view on the application of multivariate analysis techniques viz. Cluster Analysis, Principal Component Analysis and Factor Analysis in important forest species namely – Wild Marigold (*Tagetes minuta* L.) were discussed.

In the second paper Dr. S. K. Singh successfully used Newton's forward and backward interpolation formula for reading the data inside and outside of given domain.

Recommendation: Multivariate analysis technique may be used very little in forest research. Researchers may have some knowledge on Multivariate analysis. In forecasting data inside and outside of given domain, it is better to use probabilistic models based on the data. Newton's forward and backward interpolation formula may not work well. Hope that researchers (in forest research) may identify which model will work well.

Contributory Paper Session IV (Applied Mathematics and Forest Biometrics)

Chairperson: Prof. R. B. Singh

Total three papers were presented in this session.

Paper 1: Inventory of volume and biomass tree allometric equations for South Asia were discussed.

Paper 2: Growth tables for coppice origin plants of important species of RDF areas in different forest types of Madhya Pradesh have been presented.

Paper 3: Ninety one randomly selected trees were sampled for recording the data by visiting felling site in Yamunanagar district of Haryana. Four equations were fitted using linear and non linear regression techniques to predict the volumes.

Recommendation: The researchers may identify suitable models based on the data available.

Invited Paper Session VI (Importance of Statistical software in survey data analysis)

Chairperson: Dr. V. Ramasubramanian

In this session, Dr. Hukum Chandra explained about various software used in survey data analysis and their significance in the case of simple and complex sample survey designs. He discussed the impact these design complexities on the sampling variance and summarize survey function in software R to carry out analysis on sample survey data.

Recommendation: Forest researchers may use R- programming. It is free. But the researchers may have adequate knowledge on statistics. Scientists should justify the out-comes obtained by using the programming. Without proper justification, any out-come from any software may not be accepted.

Practical on SPSS Software

Chairperson: Dr. Rabin N Das

The usefulness of SPSS software were discussed in this session and demonstrated with the help of many examples.

Recommendation: Forest researchers may use SPSS. It is costly. But the researchers may have adequate knowledge on statistics. Scientists should justify the out-comes obtained by using the programming. Without proper justification, any out-come from any software may not be accepted.

Plenary Session

Chairperson: Dr. U. Prakasham

In this session the recommendations of all the chirpersons were presented by Dr. N. Roychoudhary. Theme wise recommendations are as follows:

Role of Applied Statistics in Scientific Research

- (i) The systems like Timber Market Intelligence System developed by KFRI, Peechi are required for monitoring timber prices.
- (ii) In forestry experiments, mixture experiments are important to optimize the area when mixture of two or more species are grown in fixed plot area for having the maximum gain
- (iii) The statistical tools should be effectively utilized for toxicological studies in control/ management of pests and development of genetic concept and understanding of genomic function in forestry sector.
- (iv) Screening of the plant species should foremost criterion for sequestration of atmospheric carbon.

Sampling Techniques and Time Series Analysis in Forest Survey

- (i) The role of sampling techniques including controlled sampling should be properly used in forestry research for better results and precision.

- (ii) Time series models like purely random process, random walk, moving average, autoregressive average and mixed autoregressive moving average are helpful for forecasting and cointegration analysis purposes.

Design of Experiments in Forest Survey

- (i) Different designs discussed in this session like split plot design, row-column design, alpha design, balanced incomplete and other incomplete designs, multi-locational experiment can be applied in forestry experiments.
- (ii) The Design Resources Server, developed by IASRI is very helpful to researchers engaging in forestry research.

Applied Mathematics and Forest Biometrics

- (i) More use of multivariate analysis technique is to be required in forestry research. Interpolation and extrapolation techniques are also helpful to predict the data inside or outside the given domain.

Statistical Modeling and Forecasting

- (i) Forewarning models for pests and diseases needs to be developed based on weather conditions of different agro-climatic conditions of specific pests and diseases.
- (ii) Technology forecasting methods including Pearl/ Fisher-Pry/Logistic and Gompertz models can be used in forestry research.

Importance of Statistical software in survey data analysis

- (i) Different softwares like SPSS, Systat, Stata, SAS, SUDAAN etc. may be used as per the requirement for analysing the survey data.
- (ii) The analysis of survey data using standard statistical software yields biased estimates of parameters and its standard errors. In such cases one may use appropriate and free software R for analysing data collected using complex survey sampling designs rather than using general software which just assumes that the data has been generated using simple random sampling only.