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Education and Training

DEGREE COURSES

The Institute continued to conduct the following degree courses in collaboration with the Post Graduate School of Indian Agricultural Research Institute (IARI) which has the status of a Deemed University:

(i) Ph.D. (Agricultural Statistics)
(ii) M.Sc. (Agricultural Statistics)
(iii) M.Sc. (Computer Application)

Both Ph.D. and M.Sc. students are required to study courses not only in Agricultural Statistics but also in Agricultural Sciences like Genetics, Agronomy, Agricultural Economics, etc. The Courses in Mathematics, Agricultural Statistics and Computer Application, are offered at this Institute while the courses in Agricultural Sciences are offered at the IARI.

The eligibility qualification for admission to Master's degree in Agricultural Statistics is a Bachelor's degree with atleast 60% marks or its equivalent overall grade point average (OGPA) in Agriculture/Horticulture/ Forestry/Agroforestry/Sericulture/Agricultural Marketing/ B.Sc. (10+2+3 System). For admission to Master's degree in Computer Application, the eligibility qualification is a Bachelor's degree with atleast 60% marks or its equivalent overall grade point average (OGPA) in Agriculture/Computer Science/Agricultural Engineering/B.Sc. (Horticulture), Veterinary Science, Home Science, B.Sc. (Forestry)/ B.Sc. with Maths/ Statistics/ Physics/Biology /B.Sc. (10+2+3 System).

Further for admission to Doctor's degree in Agricultural Statistics the eligibility qualification is a Master's degree with atleast 60% marks or its equivalent overall grade point average (OGPA) in Agricultural Statistics/ Statistics/ Mathematical Statistics/ Bio-Statistics of IVRI/Professional Statisticians' Certificate Course (PSCC) from IASRI.

Number of students admitted/completed various courses during 2004-05 is as follows:

(a) **Ph.D. (Agricultural Statistics)**
Five students were admitted and four students completed the Ph.D. (Agril. Statistics) degree.

(b) **M.Sc. (Agricultural Statistics)**
Six students were admitted and five students completed the M.Sc. (Agricultural Statistics) degree.

(c) **M.Sc. (Computer Application)**
Five students were admitted and three students completed the M.Sc. (Computer Application) degree.

Details of students completed various courses during 2004-05 is as follows:

(a) Ph.D. (Agricultural Statistics)

1. Abhishek Rathore – Development of algorithms for computer aided search of optimal or nearly optimal designs

The present investigation is an attempt to develop new algorithms and obtain optimal/nearly optimal designs for various experimental settings. Research work is mainly divided in two parts. First part deals with computer aided search of optimal/nearly optimal block designs for making all possible pairwise treatment comparisons. Second part consists of developing algorithms for test treatments - control treatment(s) comparisons. The second problem is again divided into two parts (i) designs for the situations where one can not afford more than one replication of test treatments and (ii) where replications for the test treatments is possible. Using this algorithm, a search of the efficient designs for making all possible pairwise treatment comparisons was made for $v \leq 35$, $b \leq 50$, $k \leq 34$ such that average replication number of treatments is less than or equal to 20 and $v > k$. A total of 6474 designs with lower bound to the A-efficiency > 0.95 and D-efficiency > 0.968 were obtained. Out of these 6474 designs, 268 designs have efficiency more than 0.999. This excludes the Balanced Incomplete Block (BIB) Designs and 2-concurrence most balanced designs. Algorithm could obtain all the BIB designs for $v \leq 12$. A search was also made for the efficient designs for the parametric combinations for which either a BIB design does not exist or a combinatorial solution is not available for the number of treatments v (≤ 60). The efficiencies of the all the designs obtained are more than 0.9900. The designs generated using the algorithm are compared with existing catalogues of designs available in literature and found to be more efficient for several cases. Designs for the situations where one can not afford more than one replication of test treatments are known as augmented designs. The algorithm for generation of augmented designs has been converted in to computer software "Statistical Package for Augmented Designs" (SPAD). The software is capable of generating the randomized layout of the augmented design for given number of test treatments '*w*', control treatments '*u*' and number of blocks '*b*'. It computes the number of control replications in each block of the design that maximizes the efficiency per observation for the treatments *vs* control(s) comparisons. The flexibility of choosing the number of replication '*r*' of the control in each of the blocks is also provided. The randomized layout of the design is generated once the values of *u*, *w*, *b* are entered and *r* is chosen by the user. SPAD also analyzes the data generated from the experiments using augmented designs. Algorithm for computer aided search of optimal/nearly optimal designs for comparing test treatments with a control treatment has also been developed. Algorithm copes up with the situations where differential precision is required for two sets of contrasts, namely test *vs* test and test *vs* control contrasts. A search was made through algorithm for a set of parametric combinations where $w \leq 20$, $b \leq 50$, $n \leq 300$ and lower bound to A-efficiency ≥ 0.95. A large number of designs with A-efficiency ≥ 0.95 were obtained. Out of these, 66 are A – optimal and 22 have A-efficiency ≥ 0.9999. For the efficient designs obtained through the computer search, a robustness study against different values of ρ, a function of inter and intra block variances and α, a non-negative weight given to treatment *vs* treatment comparisons, for a fixed and mixed effects model was carried out. Computer aided search was also made to obtain block designs for the situations, where the experimenter is interested in comparing several treatments with more than one control with unequal precision. Execution of algorithm gave a large number of efficient designs whose efficiency is ≥ 0.95, for parametric combination $v \leq 17$, $b \leq 28$, $n \leq 300$. Out of these designs 222 designs were A-optimal and 49 designs were having lower bound to A-efficiency ≥ 0.9999.

(Guide: Dr. V.K. Gupta)

2. K.P. Chandran—A study on some aspects of nonlinear statistical models in agriculture

Nonlinear growth models, viz. monomolecular, logistic and Gompertz models are widely employed in

agricultural research. These models generally assume that carrying capacity of the system is constant. However, for describing plant disease dynamics, evidently plant parts (viz. number of leaves or number of panicles) no longer remains same but also grows over time. So, for a more realistic modelling, it is desirable to incorporate this aspect in the above models. Accordingly, generalized nonlinear growth models with upper asymptote following a growth model, are developed. As an illustration, corresponding generalized nonlinear statistical models are applied to data on powdery mildew development of mango varieties, using constrained optimization in Levenberg-Marquardt iterative procedure and characteristics of importance for disease progress dynamics are computed on the basis of fitted models. In many situations, underlying functional form may not be known. So in these cases, using a parametric model with a specific form is not recommended. A very promising approach of nonparametric regression analysis has recently been developed to address this problem. This approach is flexible and robust to deviations in underlying functional form, since there is no assumption on the form of the function. Most popular method of local linear regression smoother is studied in detail. As an illustration, modelling and forecasting of country's annual rainfall data is carried out. However, above methodology is not applicable when data is affected by the presence of outliers or jump points. Accordingly, a robust approach for nonparametric regression to deal the problem of outliers is thoroughly discussed. The methodology is applied to model monthly onion arrival data and has performed better than Seasonal ARIMA approach. Similarly, standard methodology has to be modified to model situations where change points or sudden jumps are present in the data series. Accordingly, nonparametric regression methodology with jump points is studied. Relevant computer programs are developed for estimating location and size of jumps and for computing critical values for testing the significance of jump size. This methodology is successfully applied to statistically examine jump in productivity of oilseeds after setting up of "Technology Mission on Oilseeds". Extension of the standard nonparametric regression methodology for autocorrelated errors is also considered. Further, when more than one explanatory variables are present, for application of nonparametric methods, too many data points are required. This 'curse of dimensionality' can be handled by application of additive approach. Methodology for two explanatory variables, using local linear kernel regression is studied in detail. Here individual effects of each variable can be separated out as demonstrated with data from the field of agriculture. The usual parametric approach for growth rate analysis is to assume multiplicative error in the underlying nonlinear geometric model and then to fit the linearized model by "Method of least squares". As this methodology is having many drawbacks, new approaches (both parametric and nonparametric) are suggested, which are demonstrated by applying to country's food grain production data.

(Guide: Dr. Prajneshu)

3. Sumanta Kumar Das—Application of multiple frame sampling techniques for crop surveys using remote sensing satellite data

Agriculture is the most important sector of Indian economy for collection and compilation of agricultural statistics, at present the agricultural statistics system is mainly based on the data obtained by the primary reporter of every village (commonly known as Patwaries). Acreage estimates are developed after complete enumeration of all fields whereas yield estimates are obtained through General Crop Estimation Surveys (GCES) based on crop cutting experiments. The current system however suffers from a number of drawbacks. With the advent of remote sensing technology efforts are being made to use remote sensing satellite data to estimate crop statistics. Conventional acreage estimation by satellite data is based on crop discrimination using supervised maximum likelihood classification. However this method has a number of limitations. First, necessary ground information to train the classifier is not always available or is difficult to obtain. Next, it does not consider the spatial aspects of crop growth. In this method a pixel is assigned to the class having the highest probability. However many times a pixel may not exclusively lie in one class or composed exclusively of one material as field sizes in our country are small and several crops may be growing in neighboring fields. Most classifiers rely on a Gaussian probability distribution of the spectral signature of the training data, which often exhibit a non-Gaussian distribution.Fuzzy classification based on indicator kriging can eliminate various limitations of

usual supervised hard classification. In the present study fuzzy classification of satellite data for crop acreage estimation has been developed and the relative proportion of different classes in a pixel are determined by blocked indicator kriging. In order to evaluate the fuzzy classifier approach to sub pixel evaluation, the spectral signature of the desired classes are used. To compare the efficiency of fuzzy classification by indicator kriging we have classified the satellite data for different land cover classes using both supervised maximum likelihood and fuzzy classification. It has been seen that fuzzy classification based on indicator kriging gives reasonable accuracy compared to supervised maximum likelihood classification. it has also been shown that remotely sensed satellite data can be used effectively as area frame for conducting crop yield estimation surveys. The effectiveness of the satellite data to be used as area frame depends on their aerial and spatial resolution. Fine resolution data is costly and aerial coverage is less, whereas coarse resolution data has larger aerial coverage but poor spatial resolution. Since spectral reflectance is a manifestation of integrated effects of all inputs like weather, soil and agricultural practices, it is expected to have a very high correlation with crop vigor and hence the crop yield. An attempt has also been made to apply the multiple frame estimation technique for crop yield estimation when the satellite data is multistratified by different spectral vegetation indices. An empirical study to estimate the yield of wheat crop for district Rhotak, and Haryana state for the year 1997-98 using Indian Remote Sensing (IRS-1D), LISS-III & WIFS data has been conducted. It has been found that multiple frame-sampling estimator is considerably more efficient as compared to conventional estimators. The growth rate of a plant is dependent upon the amount of heat it receives and whether a crop, weed or disease, an organism is adapted to grow at its optimum rate within a specific temperature range. Within this range, the growing degree days (GDD as agro-meteorological index) is the heat accumulation above a given base temperature for a specific period, such as a crop's growing season or phenological stages. A methodology to predict GDD for synthetically generated average growing seasons derived from average climatic data over the Haryana state has been given. An application of these techniques has been made using monthly temperature data to characterize optimum growth of wheat. The predicted GDD surface along with the NDVI are used to predict the wheat yield over the entire Haryana state applying both the ordinary linear regression technique and spatial regression technique. It has been found that prediction of daily temperature is possible using monthly temperature generator.

(Guide: Dr. Randhir Singh)

4. Sunil Kumar, G.—Some investigations on statistical modelling in agriculture

Bilinear family of nonlinear time-series models is thoroughly discussed. A heartening feature is that it is able to capture sharp discontinuities or spikes present in the data. As an illustration, India's marine products export data during the period 1961-62 to 1998-99 is considered. Based on Normalized Akaike Information Criterion (NAIC), appropriate bilinear time-series model is fitted by applying Newton-Raphson iterative procedure. Stability test, used for forecasting hold-out data, is performed on fitted model. Out-of-sample forecasting based on optimal nonlinear predictor is derived theoretically and is then applied to given data. Mixture nonlinear time-series models may be employed to describe those data sets that depict sudden bursts, outliers and flat stretches at irregular time epochs. Various models, viz. Gaussian Mixture Transition (GMTD), Mixed Autoregressive (MAR) and MAR-Autoregressive Conditional Heteroscedastic (MAR-ARCH) are thoroughly studied. Weekly wholesale onion price data during April, 1998 to November, 2001 is considered. Estimation of parameters is done using Expectation Maximization (EM) algorithm and the best model is selected on basis of Bayesian Information Criterion (BIC). Out-of-sample forecasting is performed for one-step and two-step ahead prediction by naive approach. It is concluded that, for data under consideration, a three-component MAR and a two-component MAR-ARCH is the best in respective classes. Further, identified MAR-ARCH model is also shown to perform better than three-component MAR model identified earlier in terms of having fewer numbers of parameters and lower BIC value. Threshold Autoregressive (TAR) types of models are of great importance in the field of agriculture, as, quite often, the time series data depicts cyclical fluctuations. These models are studied and applied to country's lac export data during the period 1901-2003, obtained from annual reports of Shellac Export Promotion Council, Kolkata.

It is shown that fitted model, based on minimum Akaike Information Criterion (AIC) value, exhibits a threshold behaviour. Finally, attempts are made to forecast out-of-sample data, which is found to be quite satisfactory. Wavelet analysis with thresholding can be viewed as a powerful alternative for traditional nonparametric regression. This methodology is thoroughly discussed. As an illustration, modelling and forecasting of annual rainfall data of East U.P. meteorological subdivision is carried out. Comparison with traditional approaches, like Autoregressive Integrated Moving Average (ARIMA) time-series approach and nonparametric regression, shows superiority of proposed methodology for data set under consideration. Similarly, wavelet methodology is applied to detect jumps or change points present in data on oilseed yield of the country using wavelet coefficients at finest levels. To this end, various thresholding procedures are studied. It is shown that wavelet analysis with hard thresholding provides a statistical evidence of jump in productivity of oilseeds, thereby demonstrating success of "Technology Mission on Oilseeds". Wavele thresholding methodology is applied to describe country's marine fish production data during 1971 to 2002. Residual analysis reveals presence of autocorrelation and so extension of the level independent thresholding to level dependent wavelet thresholding methodology for autocorrelated errors is considered. It is shown that this methodology is superior to well-known ARIMA and nonparametric regression with autocorrelated errors methodologies.

(Guide: Dr. Prajneshu)

(b) M.Sc. (Agricultural Statistics)

1. Dharam Nath Jha — Some analytical techniques for On-farm trials data

On-farm trials in the National Agricultural Research System are conducted under the aegis of All India Co-ordinated Research Project on Cropping Systems, Project Directorate for Cropping Systems Research, Modipuram. Planning, designing and statistical analysis of these trials are undertaken at Indian Agricultural Statistics Research Institute, New Delhi. The main objective of these trials is to test the performance of recommendations that are made on the basis of experiments conducted at research station. The data from these trials are also used for obtaining fertilizer response ratio.

Fertilizer response ratio has been defined as increase in output of crop in kg for per unit use of fertilizer in kg. Earlier attempts were made to obtain the fertilizer response ratios on the basis of yield of crop without considering the availability of nutrients in the soil, before sowing of crop and also that was on macro level i.e. at country level or at state level. In this study fertilizer response ratios have been worked out in terms of kg/kg i.e. response of nutrient for per unit application of fertilizer for each of the on-farm trials conducted on wheat crop during 2000-2001 in the country. The response ratios have been worked out for various groups formed. Groups have been formed by (i) Natural grouping i.e. at administrative unit basis (ii) using classification of soil as Low, Medium and High (iii) Cluster analysis and (iv) Principal component analysis as per the availability of initial N, P and K in the soil of the farmers' field. Among these grouping methods, grouping based on classification of soil as Low, Medium and High for the availability of N, P and K seems to be of importance as various response ratios i.e. response to N, response to P over N, response to K over N etc. are significantly different in many of the groups. This confirms the assertion that the initial soil test value should be taken into consideration for deciding the amount of fertilizer to be applied to the crop and by this one can make recommendation for that field.

For the identification of the best technology for a given development block, the appropriate analytical procedures needs to be developed. The analytical procedure used at present for combined analysis of data over Farming Situations ignores the variability between blocks (FS), Villages (Block FS), treat × block (FS). Although some researchers have taken care of these variability factors, considering all these effects as fixed. Since FS, development blocks and villages are a random sample from a totality of villages, therefore, these effects and effects depending upon these factors are random. In this study a method has been developed to analyse on-farm trials data, which assumes all factors as random except treatment in the model. By using this method, comparison of treatments within blocks and FS could be carried out and one can identify the treatments that are the best in a given development block and for a given farming situation.

(Guide: Dr. P.K. Batra)

2. Mir Asif Iquebal—Estimation of heritability of threshold characters using auxiliary traits

The assessment for improvement of dairy animal is generally evaluated by various characteristics such as production status, resistance to disease and adaptability to the changing environment. This is the aptitude of the animal to stay healthy and productive in the herd. This characteristic is not only important from economic point of view but is also very important for making room for heifer replacements. This characteristic has been defined in various ways and is directly associated with the longevity/survival/retention status of the animal in the herd commonly known as "stayability". It becomes more important if the net effect of production and other related or unrelated characters are eliminated from stayability to get the true picture of stayability along with its estimate of heritability. Different methods of analysis of stayability and its measures are critically reviewed. The effect of single character adjustment (production) is already available in the literature. The present study has been taken into account to observe the effect more than one auxiliary traits on estimates.For estimation of heritability of stayability (herd life), we considered it as a threshold character. The estimates are obtained using mainly beta-binomial approach and Dempster-Lerner method. Individual narrow sense heritability and family mean heritabilities are computed. For judging the closeness to the true heritability and its precision the relative root mean square errors are used. The effect of non-normality is also studied.The estimate of stayability in terms of herd life adjusted for production and other related as well as unrelated characteristics has been discussed with standard error and root mean square error. It is observed that two characters adjustment always plays significant role. The unbalancedness may induce inconsistency in the results. The procedure based on real data (with transforming to binomial character), beta binomial and Dempster-Lerner shows encouraging results where as procedure based on family mean exhibit very unreliable estimates of heritability. Among the methods which are relatively good, besides the method based on real data, the beta binomial is by and large a good procedure of estimation of heritability of stayability for different situation of parametric values of heritability and points of truncation. It is observed that Lognormal distribution (near to Normal distribution) gives encouraging result as compared to Gamma distribution (far away from Normal distribution) in case of related trait whereas Gamma distribution gives stable performance for unrelated trait.

Finally it is concluded that heritability of stayability is a very important genetic parameter and has to be estimated with extra care. Whenever prior information on the relationship between stayability, production and other reproductive traits are available, one should go for adjustment of two characters for arriving the true estimate of heritability because a small adjustment in the estimate of heritability plays a significant role in formulating further breeding strategies for genetic improvement. It is also seen that consistent estimates are found in case of Normal distribution, otherwise stable results are not found except the case of two character adjustment.

(Guide: Dr. A.K. Paul)

3. Sarika - A study on the robustness of estimates of genetic correlation

The knowledge of genetic correlation among different economic trait is must for halting the decline in the other traits while allowing improvement in a particular trait. This is also useful in obtaining simultaneous improvement in two or more than two characters at a time by constructing a suitable selection index. Most of the economic characters in agricultural crops and dairy animals are quantitative in nature and are correlated among themselves and the environment in which the genotype is produced or grown. The breeders use this variability and covariability for improvement in the characters through efficient selection strategies. The formulations of sound and efficient selection programs are possible only when we have the complete information about the genetic properties of the population as well as the characters. The present investigation was conducted to study the robustness of estimates of genetic correlation towards the influence of non-normality and the outliers on the estimates of genetic correlation. The genetic correlation estimates were obtained by the variance covariance components under half sib model. The simulation using statistical-biological models given by Ronningen (1974) was done for various combinations of sires (i.e. 10,15 and 20) and number of offsprings per sire (i.e. 10,15,20,25 and 30). Three levels of genetic and environmental correlations as 0.1,0.25 and 0.5 and three levels of heritability viz. 0.1,0.25 and 0.5 were taken in the

present investigation. Data were simulated for all the above combinations following normal distribution, beta I distribution and in the presence of outliers introduced under normal distribution. The results showed that the genetic correlations were underestimated and had negative bias in most of the cases when the genetic correlation was low as compared to the higher genetic correlation irrespective of the distribution of data. The estimates of standard error as well as the mean square error showed the decreasing trend with the increase in sample size and family size for each of the above said three situations. The probability of inadmissible estimates too showed the decreasing trend as the sample size increases under normal distribution, beta I distribution and the presence of outliers. The deviation from the normality assumption increases the magnitude of estimates of standard error and mean square error. The standard error estimate decreases as the environmental correlation and heritability of correlated traits increases in the population under normal distribution, beta I distribution and in the presence of outliers. It was also found that in the presence of outliers, the estimates of standard errors as well as the mean square errors were higher for the given population parameters and sample size as compared to the data under normal distribution and beta I distribution. The estimates of standard error and mean square error get stabilized for sample size 500 for all the above combinations of population parameter. It shows that at least sample size 500 is required for the precise estimate of genetic correlation.

(Guide: Sh. S.D. Wahi)

4. S. Selvaganapathi—A statistical investigation on growth and variability in the production of gram and tur in India

Indian population is predominantly vegetarian; the pulses constitute its major source of protein. The per capita availability of pulses has reduced to almost half from about 60 gram per day in 1950-51 to 26 gram per day in 2001-2002 as against the recommendation of 43 gram per day of the Indian Council of Medical Research. Among pulses, gram and tur constitute the important pulse crops which together occupy more than 50% of the pulses area and account for 60% of the production at all India level (2001-02). Therefore, the study was confined to these two crops and was based on the state level time series data from 1950-51 to 2001-02 on area, production and yield collected from "Estimates of Area, Production and Yield of Principal Crops in India" published by the Directorate of Economics and Statistics, Ministry of Agriculture, Govt. of India. The period 1950 – 2002 was divided into five sub-periods consisting of decades. A decomposition of change in production in each decade into its constituent components, viz., change in area, yield and their interaction was carried out for both the crops. The growth in production of the crops was examined for their sources, namely, area and yield by fitting compound growth models using the non-linear Levenberg-Marquardt algorithm. Besides, magnitude of fluctuations in the production of the crops was measured using, "Measure of relative fluctuations" which allowed its decomposition into variation due to area, yield and their interaction.

The study revealed that the stagnation or low rates of growth and high fluctuations were the two important characteristics of the yields of gram and tur crop at the all India level. Besides, the acreage of both the crops either stagnated or witnessed a negative growth. The negative growth in acreage implied that the crops were loosing their place in the cropping pattern due to low profitability relative to their competing crops. The fluctuations in yields seemed to be the effect of sensitivity of the existing varieties to vagaries of weather and proneness to insects, pests and diseases. Therefore, to step up the growth in production and yield of these pulses the need is to evolve crop production technologies suiting to various agro-climatic regions of the country and also to help the farmers by providing them seeds, plant protection measures and extension services.

(Guide: Dr. V.K. Sharma)

5. Susheel Kumar Sarkar — Some analytical techniques for growth data on pigs

Pigs are a good source of fat and protein. They are accepted not only among the poor people but also in well to do families when they are reared in good hygienic conditions. Pigs play an important role in increasing meat (pork) production because of their high proficiency, faster growth, excellent feed convergence and shorter generation interval. This study, deals with some analytical techniques such as profile analysis, multivariate analysis of variance, of growth (repeated

measures) data and some non-linear growth models of body weight on pigs. The technique of profile analysis, a multivariate technique, gives a detailed analysis of growth data. The data for present study were used of two research locations viz. Jabalpur and Triputi for the period 1986-1990.

From profile analysis it is observed there is no interaction between groups by time points, there is no difference among groups (male and female) but significant difference was observed among the time points for the data on both the research locations. Since there is interaction among groups by time points, so we can say that the growth of male and pigs is similar (parallel) at different time points. Further, the growth trend of pigs is studied by using the non-linear growth models. It is because the behaviour of growth of pigs may be non-linear. Moreover the non-linear growth models give better insight and are more realistic. Thus the fitting of models Exponential, Gompertz, Logistic and Monomolecular have been attempted. For selection of best fitted model, various statistics viz. mean absolute error (MAE), root mean square (RMSE) and absolute percentage error (MAPE) have been used. The best fitted models for Jabalpur and Tirupati research stations for male and female pigs were studied and Gompertz model was found to be best fitted model in six situations and Logistic model in two situations. Moreover the shape of the curve of body weights seems to be follow the Gompertz trend. Thus, in general, we can say that Gompertz model is the best fitted model for the pigs maintained at Jabalpur and Tirupati research stations.

(Guide: Dr. Krishan Lal)

(c) M.Sc. (Computer Application)

1. Nilbrata Goswami — On Line Agricultural Research Farm Management Information System

The present era has seen an exponential growth and diversification in all forms of information, which is sometimes called, as information explosion. It has been made possible due to the impact of computer technology on the modern society. Computerized information systems have influenced nearly all types of organizations, whether small or large, public or private, national or multinational. Information systems exist for almost all the fields may be IPM, Farm Management, Decision Support System, Expert System etc. ARFMIS is a web based user-friendly, integrated solution for the farm management activities, developed in Java Server Pages (JSP). It is developed as comprehensive farm management software for Indian Agricultural Research Institute (IARI) research farm. It has a three-layered architecture. Client Side Interface Layer is implemented in HTML and JavaScript. Server Side Application Layer is implemented in Java Server Pages and Java Database Connectivity. Database Layer is implemented in Microsoft Access 2000. ARFMIS can be implemented as a network-based system with a server at IASRI so that information is available on-line. ARFMIS runs at any node of the Internet through a browser. Security features are provided in such a way that only concerned person can access the database. There is provision to insert and update the information. AFRMIS assists in informing land and its distribution, types of soil, information on soil testing results, the nutrient status of soil, water resources, information on implements used (tractors, other assets etc.), inputs being used, information on land preparation, information on fields/plots, crops and varieties sown, information on sowing (direction, time of sowing etc), information on seeds (seed rate etc.), information on treatments used in the experiment, information on fertilizers being used, other inputs (electricity, water etc.), manpower used, irrigation schedule, incidence of weeds, pests and diseases, information on important pesticides applied, climatic information (temperature, precipitation, rainfall, humidity etc.), information on harvesting and storage. ARFMIS provides search facility for plot, crop, variety, soil type, fertilizer, infestation, water source and year wise information. The software also provides keyword wise searching facility. Users can also view customized reports on various aspects of farm. User can interact with subject specialists through email. On-line help is provided for both administrator and user. The feature of providing information to users through frequently asked questions has also been included. Information on various activities being undertaken in various divisions of IARI is also available in ARFMIS.

(Guide: Dr. P.K. Malhotra)

2. Ram Manohar Patel—Development of Markov chain crop forecast modeling software

Crop yield forecasts are quite useful in formulation of policies regarding stock and distribution of agricultural

produce to different areas of any country. One among the various statistical approaches in vogue includes models based on Markov chains for providing objective forecasts of crop yields well in advance before harvest for taking timely decisions. A situation, which takes the form of a chain of stages with a limited number of possible states (plant condition classes) within each stage, is called a Markov chain if there is a case of simple dependence that any state of a particular stage depends directly on any of the states of the preceding stage. However, for dealing with the key features of Markov chains like estimation of transition probability matrices, predicted yield distributions etc. to get final forecasts, the computational efforts are tedious. One has to either take recourse to writing programs or use statistical packages. Many standard statistical software packages cater to analyze data and obtain forecasts only using the traditionally used regression models. No single software has tailor-made and customized module to get forecast using Markov chain modeling. Hence a user-friendly software (MC-FOMOS) has been developed based on Markov chain model. It can be used in any platform having Java Virtual Machine (JVM), Java being a platform independent language, programming has been done in Core Java (for back end) and Java Swing (for front end). For testing the software, two years data on biometrical characters and yield collected by IASRI, New Delhi under the "Pilot study on pre-harvest forecasting of sugarcane" in Meerut district were utilized. MC-FOMOS builds first order finite Markov chain model. The software allows up to 20 stages (excluding the harvest stage for first year) depending upon the crop, in the Markov chain model, 16 states within each stage and four variables can be considered within each stage. Minimum ten records are required for performing analysis through this software. It has online help at each screen. The software shows output in terms of the expected crop yield (forecast) at various stages.

(Guide: Dr. R.C. Goyal)

3. Sanjeev Kumar - Online data management system for long term fertilizer experiments

Online data management systems exist for almost all the fields may be Farm Management, Industry Management or Satellite Management etc. (ODMSLTFE) is an attempt to develop such a web based user-friendly, integrated solution for the data management activities. It is developed as online data management system for long term fertilizer experiments. It has a three-layered architecture. Client Side Interface Layer implemented in HTML and JavaScript, Server Side Application Layer in Java Server Pages and Java Database Connectivity. Database Layer is implemented in Microsoft Access 2000. ODMSLTFE can be implemented as a network-based system with a server at a central location (IASRI) so that information is available on-line. ODMSLTFE runs at any node of the Internet through a browser. Security features are provided in such a way that only concerned person can access the database. There is provision to insert and update the information. ODMSLTFE provides centre information, experiment information, crop information and attribute information. Centre information includes location of the centre and related information. Experiment information includes title and objectives of experiments, name of statistical designs, number of replications and treatments, mid course bifurcation done in the experiment (if any), number of original treatments bifurcated and number of superimposed treatments within the original treatment. Crop information includes crops category, crops and their varieties name, treatment input doses, sowing and harvesting date, and crop damage with reason (if any). Attribute information includes yield data like grain and straw, primary, secondary and micronutrients uptake data by plants, available soil nutrients and other characters and weekly weather parameters. ODMSLTFE provides search facility for centre information, experiment information, bifurcate information, weather parameters, crop information, fertilizer dose, experimental data, and experimental data with bifurcated treatments. User can interact with concerned people through e-mail. On-line help is provided for Administrator, Nodal administrator and Users. Further, the features of providing information to users through frequently asked questions are also incorporated.

(Guide: Dr. I.C.Sethi)

Revision of Course Curriculum

(a) Discipline of Agricultural Statistics

An intensive exercise was under taken to revise the M.Sc. and Ph.D. courses in the discipline of Agricultural

Statistics with a view to weed out the obsolete topics/ courses and to add new topics/courses keeping in view the current need and the latest developments in the subject. The courses were updated which also included a two credit separate course on Probability Theory (AS-160) and introduction of two new courses namely, AS-171: Bio-informatics-I (3L+1P), and AS-208: Bio-informatics-II (2L+1P).

(b) Discipline of Computer Application

A comprehensive exercise was carried for the revision of course curriculum. The courses have been renamed from CS to CA, revised, renumbered and rescheduled. Six new courses namely CA-101: Computer Fundamentals and Programming (3L+1P), CA-212: Computer Graphics (2L+1P): CA - 213: Artificial Intelligence (2L+1P): CA-214: Internet Technologies and Applications (2L+1P): CA-221: Data Warehousing and Data Mining (2L+1P) and CA - 222: Multimedia and Applications (1L+1P) have been added in the emerging area in IT. There will be 24 courses consisting of 71 credits (49L+22P) after the revision.

The modified courses and new courses have been included in the new PG School Calendar.

NATIONAL/ INTERNATIONAL TRAINING PROGRAMME

Senior Certificate Course in Agricultural Statistics and Computing

Senior Certificate Course in Agricultural Statistics and Computing was organised for the benefit of research workers engaged in handling statistical data collection, processing, interpretation and employed in research Institutes of the Council, State Agricultural Universities and State Government Departments, etc.and foreign countries including SAARC countries. The main objective of the course was to train the participants in the use of latest statistical techniques as well as use of computers and software packages.

The course was organised during the period 07 July 2004 to 27 December 2004. The course comprised of two independent modules of three months duration each. Eight officials including two international participants from Gambia participated in both the modules. Module –I was organized during 07 July 2004 to 27 September 2004.Two officials participated in Module–I only. Module–II was organised during 06 October 2004 to 27 December 2004. One officer participated in Module–II only. The course covered under both the modules included Statistical Methods and Official Agricultural Statistics, Use of Computers in Agricultural Research, Sampling Techniques, Econometrics and Forecasting Techniques, Design of Experiments and Statistical Genetics.

The valedictory function for the course was held on 27 December 2004 in which Dr. S.D. Sharma, Director,IASRI distributed the certificates to successful participants.

SUMMER/WINTER SCHOOL/SHORT PROGRAMME

A Winter School on “Sample Survey Techniques in Agricultural Research”, was organised at the Institute during 11-31 January 2005. The participants were Assistant/Associate Professors from SAUs and Scientists from ICAR Institutes.

A participant receiving the certificate during Valedictory Function of Winter School of Sample Survey Techniques in Agricultural Research

PROGRAMME UNDER CENTRE OF ADVANCED STUDIES

- A 21 days training programme on Recent Advances in Biometrics under Centre of Advanced Studies in Agricultural Statistics and Computer Application was organised from 24 November to 14 December, 2004 with the objectives: (i) To familiarize the participants with the recent advances in the field of Biometrics and other useful statistical and computational tools applied in the areas like Plant/Animal Breeding, Genomics

Inauguration of a training programme on 'Recent Advances in Biometrics' under CAS

and Bioinformatics (ii) To acquaint the participants with the statistical software packages used in the analysis of data (iii) To help upgrade the research and teaching skills of the participants. The programme was structured in a series of modules such as, some preliminaries on statistical genetics, introduction to computers and use of statistical software packages for data analysis, advanced statistical methods in breeding and genetics, statistical and computational techniques in genomics and bioinformatics and statistical modeling in biological phenomena with 54 class room lectures and practicals on computers, including the demonstration of software packages. One reference manual, giving the details of the lectures, was compiled, edited and distributed to the participants. An electronic reference manual in the form of CD was released by the Director of the Institute and the same was also distributed to the participants. The training was imparted by distinguished faculty comprising of 26 members including 7 guest faculty from outside the Institute. The course was attended by 23 participants from various Institutes of ICAR and SAUs. The training programme was widely appreciated by the participants, particularly for giving special emphasis on the emerging topics like Bioinformatics and Genomics.

- A training programme on Advances in Designing and Analysis of Agricultural Experiments under Centre of Advanced Studies was organized from 03 to 23 February 2005. In all 20 participants from different disciplines (Soil Science, Microbiology, Agricultural Statistics, Agronomy, Floriculture, Economic Botany, Agricultural Economics) and from different ICAR Institutes (12) and State Agricultural Universities (8) attended this training. The training covered various topics on design and analysis of agricultural experiments alongwith use of statistical softwares, viz., SAS, SPSS etc. The participants were also exposed to the information systems and statistical softwares developed in the Institute.

Valedictory function of a training programme on 'Advances in Designing and Analysis of Agricultural Experiments' under CAS

OTHER TRAINING PROGRAMMES

Following training programmes were organised at the Institute:

(i) The Institute organized a training programme on "Sampling Techniques, Sample Surveys and Methodological Aspects relating to Cost of Cultivation Studies", for senior level Officers of Tariff Commission, Ministry of Commerce and Industry, Govt. of India, during 16-21 August 2004. The broader objective of the training programme was to make the participants familiar with sample survey techniques and different aspects relating to cost of cultivation of crops. Nine senior level Officers of Tariff Commission participated in this training programme. A number of lectures on different topics relating to its broader objective were planned. The Resource Persons were from the Institute Faculty as well

Inauguration of Training Programme on 'Sampling Techniques, Sample Surveys and Methodological Aspects relating to Cost of Cultivation Studies' for officers of Tariff Commission, Ministry of Commerce, Government of India

Dr. VK Gupta, Joint Director delivering the lecture to the participants of a Training Programme

as Officers from other Organizations. For this Course Introductory Session was organised at the Institute on 16 August 2004 and Valedictory Function was organised on 21 August 2004.

(ii) A training programme was organized on "Statistical tools for data analysis" during 23-28 August 2004 at IASRI for Scientists/RAs working at Cooperating centres under NATP project " Development of Weather Based Forewarning Systems for Crop Pests & Diseases". The faculty comprised of the scientists (working in this project) and the technical officers of the Institute. The purpose of this programme was to impart in-depth understanding about the techniques/ models developed at the Institute under the project. The schedule comprised of the lectures and demonstration of the techniques on the topics - Overview of Forecasting Techniques in Pests and Diseases, Methodology for Weather Indices Technique & Growing Degree Days, Principal Component and Discriminant Function Analysis, GMDH Technique, Models for Qualitative Data, Deviation Method and Non-linear Models. Apart from these, the analysis of data from the respective centers was also demonstrated. Thus it was an opportunity, not only for the participants but also for the scientists at IASRI associated with the project to have an interaction with the workers at different centres and find solutions of the problems arising in analysis of the data. There were 28 participants in the programme.

(iii) Thirteen participants of International Statistical Education Centre (ISEC) sponsored by Ministry of Statistics and Programme Implementation, New Delhi visited on 27 October 2004 and one day training was arranged for them.

(iv) Three training programs were organized on 'Working with INARIS data warehouse' for participants from ICAR Institutes during 13-15 September 2004, 01-03 November 2004 and 08-10 November 2004.

(v) Five two-day training programs were organized on 'Exposure and usage of Personnel Management Information System' during 19-20 July 2004, 23-24 July 2004, 17-18 August 2004, 1-2 September 2004 and 8-9 September 2004. 185 Nodal Officers from all ICAR Institutes, NRC's, PD's & Bureau attended these programmes.

Director releasing the User Manual for PIMSNET

(vi) Eleven probationers of Indian Statistical Service sponsored by Ministry of Statistics and Programme Implementation, New Delhi visited on 25 November 2004 for one day training programme.

(vii) A training programme for the personnel of E.I. Du Pont India Private Limited was organized during 25-26 November 2004. Twelve participants attended the training programme. A total of 12 lectures were organized during the training programme.

Inauguration of Training programme for the personnel of E.I.Du Pont India Pvt. Ltd.

Discussion with the participants during a training programme

(viii) Twenty four participants attended the course on Large Sample Survey on 28.01.2005 and were sponsored by Ministry of Statistics and Programme Implementation, New Delhi.

Research Fellowships

During 2004–05, 14 Ph.D and 20 M.Sc. students received research fellowship. 13 Ph.D. students received IARI Scholarship at the rate of Rs.4400/- p.m. in addition to Rs.10,000/- per annum as the contingent grant. One Ph.D student received CSIR fellowship at the rate of Rs.8000/-p.m besides Rs.20000/- per annum as the contingent grant. Eleven M.Sc. students received ICAR Junior Research Fellowship at the rate of Rs. 3600/- p.m. besides Rs.6000/- per annum as the contingent grant and nine M.Sc. students received IARI Scholarship at the rate of Rs.3200/- p.m. besides Rs.6000/- per annum as the contingent grant.

Joint Director addressing the students of M.Sc. and Ph.D. during the orientation programme

Faculty members/scientists during orientation programme

Faculty members of P.G. School, IARI, in Agricultural Statistics

S. No.	Name	Year of induction
1.	Dr. V.K.Gupta, Joint Director	1984
2.	Dr. V.K.Sharma, Professor (Agricultural Statistics)	1984
3.	Dr. Randhir Singh, Principal Scientist	1974
4.	Dr. Prajneshu, Principal Scientist	1984
5.	Dr. V.T.Prabhakaran, Principal Scientist	1987
6.	Dr. V.K.Bhatia, Principal Scientist	1987

S. No.	Name	Year of induction
7.	Sh. S.D.Wahi, Principal Scientist	1987
8.	Dr. Ranjana Agarwal, Principal Scientist	1988
9.	Dr. H.V.L.Bathla, Principal Scientist	1991
10.	Dr. R.Srivastava, Principal Scientist	1993
11.	Dr. U.C.Sud, Principal Scientist	1995
12.	Dr. K.K.Tyagi, Principal Scientist	1995
13.	Dr. Chandrahas, Principal Scientist	1996
14.	Dr. P.K.Batra, Principal Scientist	1996
15.	Mrs. Asha Saxena, Principal Scientist	1998
16.	Dr. Amit Kumar Vasisht, Principal Scientist (at IARI)	1998
17.	Dr. Rajender Parsad, National Fellow	1995
18.	Dr. Anil Rai, Senior Scientist	1995
19.	Dr. Seema Jaggi, Senior Scientist	1995
20.	Dr. Jagbir Singh, Senior Scientist	1996
21.	Dr. M.S.Narang, Senior Scientist	1998
22.	Dr. Aloke Lahiri, Senior Scientist	1998
23.	Dr. Lal Mohan Bhar, Scientist (Sr.Scale)	1998
24.	Dr. Amrit Kumar Paul, Scientist(Sr.Scale)	1998
25.	Dr. Tauqueer Ahmed, Scientist(Sr.Scale)	1998
26.	Dr. A.R.Rao, Scientist(Sr.Scale)	1998
27.	Dr. Ramasubramanian, V. Scientist(Sr.Scale)	1999
28.	Dr.Girish Kumar Jha, Scientist(Sr.Scale)	1999
29.	Dr. Cini Varghese, Scientist (Sr.Scale)	2000
30.	Dr. R.L.Sapra, Principal Scientist (at IARI)	2002
31.	Dr. Prachi Misra Sahoo, Scientist	2002
32.	Dr. Krishan Lal, Senior Scientist	2003
33.	Sh. Hukum Chandra, Scientist	2003
34.	Sh. Amrender Kumar, Scientist	2003
35.	Md. Wasi Alam, Scientist	2003
36.	Dr. Prawin Arya, Scientist (Sr.Scale)	2003
37.	Dr. Himadri Ghosh, Scientist	2004

FACULTY MEMBERS OF P.G. SCHOOL, IARI IN COMPUTER APPLICATION

1.	Dr. S.D.Sharma, Director	1996
2.	Dr. P.K.Malhotra, Professor (Computer Application)	1991
3.	Dr. R.C.Goyal, Principal Scientist	1995
4.	Dr. I.C.Sethi, Principal Scientist	1995
5.	Dr. V.K.Mahajan, Principal Scientist	1996
6.	Sh. Harnam Singh Sikarwar, Scientist (S.G.)	1997
7.	Dr. D.K.Agarwal, Principal Scientist	1999
8.	Md. Samir Farooqui, Scientist	2001
9.	Ms. Alka Arora, Scientist	2001
10.	Ms. Shashi Dahiya, Scientist	2001
11.	Ms. Sangeeta Ahuja, Scientist (Study Leave)	2002
12.	Sh. Sudeep, Scientist (Study Leave)	2002
13.	Sh. Vipin Kumar Dubey, Scientist	2002
14.	Sh. K.K.Chaturvedi, Scientist	2002
15.	Sh. S.N.Islam,Scientist	2004
16.	Sh. S.B.Lal, Scientist	2004
17.	Ms. Anshu Dixit, Scientist (Study Leave)	2004
18.	Ms. Anu Sharma, Scientist	2004

Courses taught during the Academic Year 2003 – 04
Trimester – III

Code	Title	Course Instructors
Agricultural Statistics		
AS-103	Elementary Sampling and Non- Parametric Methods (2+1)	Asha Saxena, Jagibir Singh and Prachi Misra
AS-163	Statistical Inference (4+1)	Rajender Parsad and L.M.Bhar
AS-164	Design of Experiments – I (3+1)	Seema Jaggi and V.K.Gupta
AS-166	Statistical Genetics – I (3+1)	V.T. Prabharkran and A.R. Rao
AS-299	Seminar (1+0)	V.Ramasubramanian
AS-302	Advanced Design of Experiments-II (2+1)	R.Srivastava and P.K.Batra
AS-304	Advanced Sample Survey-II (2+1)	U.C. Sud and Prachi Misra
AS-307	Forecasting Techniques (1+1)	Chandrahas and V.Ramasubramanian
AS-370	Recent Advances in the Field of Specialisation (1+0)	U.C.Sud
Computer Application		
CS-115	Introduction to Computer Use and Use of PC (1+1)	Balbir Singh
CS-132	Data Structures and Structured Programming (2+1)	Shashi Dahiya and K.K.Chaturvedi
CS-133	Numerical Algorithms Analysis and Software (2+1)	H.S.Sikarwar and Pal Singh
CS-134	Modeling and Simulation (2+1)	P.K. Mathotra and Anshu Dixit
CS-135	Computer Communication Networks (2+0)	Alka Arora and S.N.Islam
CS-299	Seminar (1+0)	V.Ramasubramanian

Code	Title	Course Instructors
	Courses taught during the Academic Year 2004–05	
Agricultural Statistics		
	Trimester – I	
AS-101	Elementary Statistical Method (2+1)	V.T.Prabhakaran and S.D. Wahi
AS-150	Mathematical Methods in Statistics-1 (4+0)	Cini Varghese and Himadri Ghosh
AS-161	Statistical Methods-1 (3+1)	V.T. Prabhakaran and G. K. Jha
AS-167	Applied Multivariate Analysis (2+1)	Ranjana Agrawal and A.R.Rao
As-168	Econometrics(2+1)	V.K.Sharma and Sivaramane N.
AS-169	Planning of Surveys/Experiments (2+1)	M.S.Narang, R.S.Khatri and M.R.Vats
AS-200	Design of Experiments-II (1+1)	Rajendra Parsad and Cini Varghese
AS-201	Sampling Techniques – II (1+1)	K.K. Tyagi and G.K.Jha
AS-202	Statistical Genetics – II (1+1)	V. K. Bhatia and A.K. Paul
AS-203	Regression Analysis (1+1)	L.M. Bhar and V.Ramasubramanian
AS-204	Linear Models (2+0)	V.K.Sharma and R.Srivastava
AS-206	Optimization Techniques (1+1)	U.C.Sud and Amrendra Kumar
AS-370	Recent Advances in the Field of Specialisation	Prajneshu
AS-299	Seminar (1+0)	V.Ramasubramanian
	Trimester – II	
AS-102	Elementary Design of Experiments (2+1)	Aloke Lahiri and Krishan Lal
AS-151	Mathematical Methods in Statistics – II (4+0)	P.K.Batra and N.K. Sharma
AS-162	Statistical Methods – II (3+1)	Seema Jaggi and G.K. Jha
AS-165	Sampling Techniques – I (3+1)	Tauqueer Ahmed and Anil Rai
AS-170	Statistical Modeling (2+1)	Prajneshu and Wasi Alam
AS-205	Advanced Statistical Inference (1+1)	Krishan Lal and U.C.Sud
AS-207	Stochastic Processes (3+0)	Himadri Ghosh
AS-301	Advanced Design of Experiments-I (2+1)	R.Srivastava and V.K.Gupta
AS–303	Advanced Sample Survey – 1 (2+1)	H.V.L.Bathla and Jagbir Singh
AS-370	Recent Advances in the Field of Specialisation	V.K.Gupta
AS-299	Seminar (1+0)	V.Ramasubramanian
Computer Application		
	Trimester – I	
CS-111	Introduction to Computer Organization and Architecture (3+0)	Shashi Dahiya and S.B.Lal
CS-113	Data Analysis in Agriculture (1+2)	V.K. Mahajan and M.S. Farooqi
CS-114	Discrete Mathematics (2+0)	P.K. Batra and H.S.Sikarwar
CS-115	Introduction to Computer Use and Use of PC (1+1)	V. H.Gupta and Pal Singh
CS-211	Compiler Construction (2+1)	V. K. Dubey and S.B.Lal
CS-212	Operating System (2+1)	I.C. Sethi and H.O. Agarwal
CS-215	Software Engineering (2+0)	K.K. Chaturvedi and Anu Sharma
CS-216	Object Oriented Analysis and Design (2+1)	Sudeep and Anu Sharma
CS-299	Seminar (1+0)	V. Ramasubramanian
	Trimester-II	
CS-115	Introduction to Computer Use and Use of PC (1+1)	V.H. Gupta
CS-123	Fundamental of Computer Programming and Its Applications (2+1)	K.K.Chaturvedi and Pal Singh
CS-125	System Analysis and Design (2+1)	I.C. Sethi and M.S. Farooqi
CS-131	System Administration and Management(2+1)	Alka Arora andS.N.Islam
CS-227	Data Base Management System (2+2)	R.C.Goyal and Sudeep
CS-228	GIS and Remote Sensing Techniques (2+1)	Anil Rai and Prachi Mishra

Note: Figures in the parentheses indicate the number of credits (Lectures + Practicals)


शीतकालीन स्कूल
"कृषि अनुसंधान में प्रतिदर्श सर्वेक्षण तकनीक
(दिनांक 11 - 31 जनवरी, 2005)
प्रतिदर्श सर्वे प्रभाग
कृषि सांख्यिकी अनुभाग नई दिल्ली