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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 are:

(a) **Ph.D. (Agricultural Statistics)**
Two students were admitted and 4 students completed the Ph.D. (Agricultural Statistics) degree.

(b) **M.Sc. (Agricultural Statistics)**
Five 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 2006-07 is as follows:

Ph.D. (Agricultural Statistics)

(i) Sandipan Bhattacharyya—Some investigations on repeated measurements designs

Repeated measurements designs form an important class of designs that has been advantageously used in dairy feeding trials, long-term experiments, clinical trials, etc. These designs are also known as change over designs and switch over designs. In these designs each experimental unit receives a sequence of treatments over a number of periods with observations recorded in each period. In this study, two new classes of partially balanced repeated measurements designs have been proposed. For the first class only the presence of first order residuals effects of treatments have been assumed whereas for the second class presence of first and second order residual effects have been considered. These designs are based on the circular association scheme. An outline of the method of analysis of these designs has been given along with an illustration. A modification of these designs, called repeated period partially balanced repeated measurements designs, has also been dealt with for the first class. Universal optimality of a class of balanced repeated measurements designs has been established for the estimation of direct, first and second order residual effects. Besides, the double-extra-period balanced repeated measurements designs, obtained by repeating the treatments of the last period in two succeeding periods for this class, are shown to be universally optimal for the estimation of second order residual effects. Moreover, one class of three-period balanced repeated measurements designs considering direct, first and second order residual effects has been proposed. Universal optimality of these three-period designs has been established after making them circular for the estimation of direct, first and second order residual effects. Lastly, efficient two-treatment repeated measurements designs are obtained using efficiency factors when the errors are auto-correlated, considering (i) first order residual effects of treatments, and (ii) first and second order residual effects of treatments.

Guide: Dr. V.K. Sharma

(ii) Subrata Kumar Satpati—Computer aided search of efficient designs for dependent observations

In many field experiments, the observations are mutually correlated through some systematic pattern of environmental variations. For example, plots occurring close together within a field area are well known to be more similar than plots occurring far away from each other. Whenever spatial contiguity is used as criteria for blocking, it is often the case that the experimental units occurring close together within spatial blocks created are correlated or that there may exist significant trends even within small blocks caused by things like fertility gradients within fields. In general three different types of correlation structures may exist among the observations within a block namely, (i) Nearest Neighbors correlation structure in which the same amount of correlation ($\tilde{n}$) exists between the observations in the nearest neighboring units i.e. the plot positions differ by 1 within a block, (ii) AR(1) correlation structure in which the same amount of correlation ($\tilde{n}$) exists between the observations in the nearest neighbors and the correlation decreases at a geometric progression rate among the observations as the difference in their positions increases and (iii) Equi-correlation structures in which the same amount of correlation ($\tilde{n}$) exists between the observations within a block. Further, in each type of correlation structure it is assumed that the observations from different blocks are independent. In the present investigation computer algorithms have been developed by making modifications in the existing algorithms for searching efficient designs for correlated observations for various experimental settings, like block designs, nested block designs and change-over designs.

Using this algorithm, a computer aided search of efficient block designs for making all possible pairwise treatment comparisons is made for v (number of treatments) ≤ 10, b (number of blocks) $\leq$ min(33, int[100/k]), k (block size) $< v$ such that n (total number of observations) = $bk \leq 100$. The bounds on ρ so that the correlation structure Ω is positive definite differs

according to the correlation structure assumed. NN and AR(1) correlation structures are considered for rectangular blocks and NN correlation structure for circular blocks. Efficient designs are obtained for $-0.50 \leq \tilde{n} \leq 0.50$ for NN correlation structure in rectangular blocks; $-0.95 \leq \tilde{n} \leq 0.95$ for AR(1) correlation structure in rectangular blocks and $-0.45 \leq \tilde{n} \leq 0.45$ for NN correlation structure in circular blocks. In practice, the value of the correlation coefficient between correlated observations may not be known exactly. Robust designs have been identified.

Designs efficient for correlated observations are position dependent and lack within block randomization. Therefore, robustness aspects of designs that are efficient for zero correlation structure has been studied by performing randomization 5000 times, and for all these randomized layouts, the lower bounds to A- and D-efficiencies have been obtained for a given correlation coefficient and correlation structure. The ranges of $\tilde{n}$ for different correlation structures when the loss in minimum efficiencies is less than 10% and 1% are obtained and the robust designs are catalogued.

Guide: Dr. V.K. Gupta

(iii) Ananta Sarkar—A study on design and analysis of microarray experiments

In microarray experiments, the four experimental factors are array (A), dye (D), variety (V) and gene (G). These four experimental factors give rise to $2^4-1=15$ possible experimental effects excluding the general mean. Out of these 15 possible experimental effects, seven effects, viz. array (A), dye (D), variety (V), gene (G), array-gene interaction (AG), dye-gene interaction (DG), variety-gene interaction (VG) effects are of main interest to the experimenter. In the present investigation, we have considered experimental situations where the same set of genes is spotted on each array. Therefore, gene/gene specific effects (G, AG, DG, VG) are orthogonal to global effects (A, D, V). Optimality aspects of designs for microarray experiments, can therefore, be studied leaving gene specific effects from the model, i.e., by taking only array, dye and variety effects in the model. Designs that are good under the model containing global effects are also good under the model containing both global and gene specific effects.

In 2-colour microarray experiments, only two varieties labelled with two different dyes can be accommodated on one array; therefore, arrays may be considered as blocks of size 2. Further, array effects may be taken as random. To deal with the problem of obtaining efficient designs when array effects are random, the lower bounds to the A- and D-efficiencies of the designs in a given class of designs have been obtained for block designs under mixed effects model. The existing algorithm based on exchange and interchange of treatments has been modified by incorporating the procedure of computing lower bounds to A- and D-efficiencies under mixed effects model. The algorithm developed is general in nature and can be used for generation of efficient block designs for any $2 \leq k < v$, where v is the number of treatments (varieties) and k is block size. Using this algorithm, efficient block designs for microarray experiments have been obtained in the parametric range $3 \leq v \leq 16$, $v \leq b \leq v(v-1)/2$ and $17 \leq v \leq 25$; $b = v$ and $k = 2$, where b is the number of arrays/blocks. A total of 569 designs including all the 14 unreduced balanced incomplete block designs in this parametric range have been obtained. Efficient block designs obtained under fixed effects model have been compared with the best available designs (designs with highest lower bound to A-efficiency) in literature and 2-associate partially balanced incomplete block designs. 30 designs are found to be more efficient than the best available block designs. The robustness aspects of designs obtained and best available block designs have been investigated under mixed effects model. Out of 30 more efficient designs, 7 designs are found to be strongly robust, 18 designs are found to be robust and the remaining 5 designs are non-robust.

Efficient block designs for 2-colour microarray experiments have been obtained under a restricted model involving array and variety effects. The dye effects have been ignored from the model, since in microarray experiments, the two varieties appearing on the array are to be labeled with two different dyes. If the variety at position 1 in a block is labeled with dye 1 and the variety at position 2 is labeled with dye 2, then the block contents should be so arranged that the varieties are most balanced with respect to dyes. Further, if dye effects are included in the model, then the structure of the design becomes that of a row-column design where arrays represent columns, dyes represent rows and varieties represent treatments. Efficient row-column designs have been obtained in the parametric range $3 \leq v \leq 10$, $v \leq b \leq v(v-1)/2$; $11 \leq v \leq 25$, $b \leq v$ and $(v, b) = (11, 13)$, $(12, 14)$, $(13, 14)$ and $(13, 15)$, where b is the number of arrays/columns by modifying the existing exchange and

interchange algorithm of row-column designs. A total of 139 designs have been obtained. Efficient row-column designs obtained under fixed effects model are then compared with the best available designs (block designs with highest A-efficiency under row-column set up after rearranging the block contents in such a fashion that the varieties are most balanced with respect to dyes) and even designs (designs in which replication of each variety is even). 45 designs are found to be more efficient than the best available designs and 90 designs obtained are more efficient than the best even designs. Robustness aspects of designs obtained and best available designs are then investigated under mixed effects model. Out of 45 more efficient designs, 9 designs are found to be strongly robust, 22 designs are found to be robust and the remaining 14 designs are non-robust.

The catalogues of all efficient block designs and row-column designs obtained and the best available designs have been prepared along with their lower bounds to A- and D-efficiencies under fixed/mixed effects models and their robustness status. Strength of the algorithm for obtaining block designs/row-column designs for 3-colour microarray experiments has also been demonstrated with the help of examples.

After the conduct of experiment using an appropriate design, the next step is analysis of data to identify differentially expressed genes from microarray experiments. We have developed analytical procedure based on single-step mixed effects model as well as two-stage linear mixed effects models considering array effects as random to identify differentially expressed genes from microarray experiments. The analytical techniques developed have been illustrated using real life data sets.

Guide: Dr. Rajender Parsad

(iv) Nilesh Kumar Gupta—On spatial prediction modelling

In regression models when parameter of interest is geographical in nature the regression coefficients do not remain fixed over space. When the regression model is applied to geographical data where each sample observations correspond to a geographical location, space plays no role in the modeling process. To overcome this problem geographically weighted regression was used and the regression model centered at each point p_i could be thought of as a weighted ordinary least square regression. If the concept of spatial dependence was introduced into the weight functions using the spatial variogram models approach then the technique obtained was considered as improved technique over the weights obtained by distance of neighbourhoods.

The yield data obtained from crop cutting experiments (CCE) and the corresponding locations of yield data in terms of latitude and longitude was identified. The spatial statistics was employed 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 unsampled 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. With the help of spatial model the yield values will be generated corresponding to each wheat pixel of the image. Now overlay the boundary map of district on the surface of grids the production of district was obtained. To get the production of individual village, the village map was overlayed over the district map and the estimate of production for villages was obtained, so that we get the population of villages. The average yield and its standard deviation was obtained for each village. The statistics generated in this way was attached to the centroid of each village. Large number of samples of different sample sizes of the villages was selected with the help of Simple Random Sampling for the analysis. The neighborhood criterion was decided for the villages and accordingly the spatial weights were assigned to the sampled villages for spatial regression analysis. The weights were based on the approach followed by Brunsdon *et al*. (1998). The weights will also be assigned with the help of best-fitted variogram model to the data. Same samples were used for the analysis following Bayesian approach of prediction. The prior distribution of the parameters was simulated by incorporating the properties of the empirical distribution from the yield data generated in by the above simulation for each village. Similarly, in case of fuzzy prediction analysis the centers and the width of the fuzzy parameters/variables under consideration were obtained with the help of data generated in the simulation process of each village. In all above procedures the accuracy of the prediction was compared on the basis of the expected residual errors/ width size.

Guide: Dr. Anil Rai

M.Sc. (Agricultural Statistics)

(i) Priya Kohli—Study on supersaturated designs

A supersaturated design (SSD) is a fraction of a factorial replication in which the number of factors (q) is greater than the number of experimental runs (N). These designs are very cost-effective and as such are useful when experimentation is expensive and the number of factors is large. Since the number of runs is less than the number of factors, non-orthogonality is introduced in such designs in the sense that the parameters are not estimated independently. Thus, the analysis and construction of efficient SSDs is very challenging. Motivated by the construction of SSDs, we have developed an exchange algorithm to construct two-level SSDs. It works on a selected column and modifies a pair of coordinates in this column. A catalogue of designs generated from the algorithm in the range $N \leq 50$, $N+1 \leq q \leq 75$, has been prepared. We have, however, in this thesis reported the designs in the range $N \leq 16$, $N+1 \leq q \leq 75$. Comparison of the designs obtained from above algorithm with SSDs available from other methods was also made. Further an algorithm for the construction of multi-level SSDs was developed. This algorithm generates multi-level SSDs through saturated orthogonal arrays. A catalogue of multi-level SSDs was also prepared in the range $N \leq 100$, $q \geq N+1$, $2 \leq s \leq 5$.

Guide: Dr. R. Srivastava

(ii) Nurnabi Meherul Alam—Some analytical techniques for long-term fertilizer experiments

Long-term fertilizer experiments are those experiments, which are conducted on same set of experimental units over a sequence of years with a pre-planned sequence of crops and graded level of fertilizer treatments. The fertilizer experiments are often used to establish a suitable functional relationship between the response and applied nutrients. The established relationship may change its form from year to year. Alternately, these long-term experiments are also analysed as per design adopted. Years are often statistically significant and inconsistency of treatment effects over years enters into significant Year x Treatment interaction, which are difficult to interpret. There seems to be need to complement the usual ANOVA analysis for interpretation of Year x Treatment interaction. Keeping this in view, the objectives of this study were:

(i) To establish the year-wise relationship between response and applied nutrient by including the initial soil test values of major nutrients (available N, P, K) and study the homogeneity of these functional relationship over years.

(ii) To evaluate long term fertility experiments by stability analysis and relative stability analysis and to observe possible benefits of these analyses to compliment the conventional analysis of variance procedure.

The response function studied were undertaken on 6 years data of Rice-Rice Cropping System experiments conducted at R.S. Pura centre under AICRP on Cropping System. Including the terms corresponding to soil parameters like available N, available P and available K modified the usual quadratic fertilizer response model. Year-wise models were obtained for *Kharif* Rice and *Rabi* Rice crops. The test of homogeneity of regression coefficient revealed that the given data set can be split into two groups of year (High and Low) on the basis of soil test values for obtaining the fertilizer recommendations. Stability analyses which consist of regression of the yearly treatment mean with the adjusted environment mean (adjusted for time trends) was undertaken on 20 years soybean and wheat data collected under the Ranchi centre of AICRP on LTFE. The analysis was undertaken for soybean, wheat crop individually and also for soybean – wheat cropping system (in term of monetary value) at constant prices.

Stability analysis results revealed that the treatments T_1 (50% NPK), T_3 (150% NPK), T_5 (100% NPK + lime), T_8 (100% NPK + FYM) and T_9 (optimal NPK + sulphur source) were found to stable for soybean and wheat yields in the sense that their performance is in consonance with the environment effect. Treatment T_7 (100% N alone) and T_{10} (no manure) were not found to be stable. Similar results were obtained for the analysis of monetary return of the wheat – soybean Cropping System.

Guide: Dr. P.K. Batra

(iii) Ranjit Kumar Paul—Robust analysis of designed experiments

Outlier(s) in a set of data is (are) defined to be an observation that is inconsistent with the rest of the data. If the data set contains outliers or the observations are non-normal then the conclusion drawn from the experiments may be wrong. Outliers may arise in the experimental setup due to insect of pest attack in some

particular plot or mistakes may occur during recording of the data. Only one observation needs to move towards infinity to make a marked change in the parameter estimates. Therefore, robust method of estimation of parameters is advocated. The most important robust methods are M-estimation and Least Median of Squares (LMS) estimation. In M-estimation a function of errors in minimized whereas in least squared the error sum of squares in minimized. In the least squares estimation all the observations are given equal weight and that is unity. But if any observation is found to be outlier in the data set then it must get some lesser weight than that of the normal observations. This concept is utilized in the M-estimation. Different functions of robust estimation are available in the literature that is extensively used in the linear regression model. These functions are made used in the experimental setup also by slight modification. A new function for its application in the design of experiments is also proposed. It was observed that the newly proposed function performs very well in present of outliers in the sense that it will produce minimum average variance of a set of orthonormal contrasts in most of the cases. Least Median of Squares estimation utilizes a subset of the data. In the design of experiments experience says that only one or two outlying observations are generally present in the data set. Therefore, the LMS method is modified for its application in the design of experiments that utilizes the set of *n*-1 of *n*-2 observations. Of course it is more advantageous to apply M-estimation than that of LMS because it does not delete any observation.

Guide: Dr. L.M. Bhar

(iv) Prasenjit Pal—Model based estimation of finite population mean square using double sampling

The approach of estimation of parameter of interest in the traditional survey sampling theory is popularly called as "design based". Within the design based approach frame work Horvitz and Thompson (1952) drew attention to the existence of many different classes of estimators and that it may not be possible to find an estimator which is best in all the classes of estimators. These developments subsequently led to the result by Godambe (1955) about the non-existence of Uniformly Minimum Variance Unbiased Estimator (UMVUE). An offshoot of this development was that attempts were made to try alternative approaches to the problem of estimation of finite population mean/total etc. The underlying idea was to obtain "best estimators" within finite population frame work. An approach popularly called as model based approach was also tried. The main advantage of the approach is that it is possible to get the best estimators although the concept of best estimators is tried to a particular model. Thus, if the assumed model is different from the previous model than the model based approach may lead to seriously misleading inferences.

Till sometimes back the major emphasis in survey sampling theory was on estimation of linear parameters like population mean or total. Although model based estimation of quadratic parameters like finite population mean square was also tried, this was limited to the case when auxiliary information is assumed to be known for all the units of the population. In this dissertation an attempt was made to develop predictor for the finite population mean square under linear model set up when the auxiliary information was assumed unknown for all the units of the population. Accordingly a double sampling based predictor of finite population mean square ($\hat{T}'_Q$) was developed. It was shown to be design model unbiased. An expression for the variance was developed. The efficiency comparison of the proposed predictor was made vis-à-vis a predictor which utilizes auxiliary information for all the units of the population ($\hat{T}_Q$) assuming that cost is incurred to collect information on the auxiliary character under a suitable cost function. As a matter of fact cheaper the cost of collection of auxiliary variables vis-à-vis the character under study better is the performance.

Guide: Dr. U.C. Sud

(v) Nitiprasad Namdevrao Jambhulkar—Statistical investigations on QTL detection in maize

Quantitative traits are the traits controlled by many genes and each of the genes has a small effect on the trait. The loci controlling quantitative traits are referred to as QTLs (Quantitative Trait Loci) and the procedure of finding and locating the QTLs are called QTL mapping. The available literature on use of molecular markers for detecting loci influencing the performance of maize in drought stress is very scanty in India, so the data considered belongs to maize crop in drought stress, for the present investigation. Mapping population with 236 RILs (Recombinant Inbred Lines), using $Ac7643S_5$ (drought tolerant) and Ac7729 (drought susceptible) as male parent, at CIMMYT and evaluated in India under AMBIONET (Asian Maize Biotechnology

Network), Maize Genetic Unit, IARI was considered for the present investigation. Phenotypic data on different plant characters was utilized for the present study. Genotypic data on RILs obtained through 138 RFLP markers and a linkage map of a total length of 2250 cM with an average density of 17 cM were used for QTL detection. Genotypic data was obtained through molecular marker assay whereas phenotypic data was derived from evaluation of mapping population of the target traits of interest. The analysis was done using software QTLMapper (version 1) and it was found that marker MK28 was main-effect on four traits, marker MK28, MK101 and MK34 had main-effect on two traits. Interaction effect was also found in different marker pairs. The results were obtained considering the main and interaction effect of markers. For the study the data available on two environments Hyderabad and Karimnagar were considered, for examining QTL × environment interaction. The results on QTL detection were obtained considering the main-effect markers and interaction between markers. Further, the data are subjected to QTL × environment interaction and corresponding results were also obtained on QTL × environment interaction. The results were also obtained using Jackknife procedure and Bayesian methodology and from the results, it was seen that the results obtained by Jackknife and Bayesian methods were very much similar.

Guide: Dr. V.K. Bhatia

M.Sc. (Computer Application)

(i) Kaushik Bhagwati—GIS assisted farm management information

GFMIS is a web based user-friendly, integrated solution for the farm management activities, developed in Java Server Pages (JSP) and ArcView software. It is developed as comprehensive farm management software for Indian Agricultural Research Institute (IARI) research farm.

Geographic Information System (GIS) is the powerful tool that provides exact geographic information and visualization of any feature. Thus, GIS assisted Farm Management Information System helps the farm manager in better and precise decision making for scientific management of the farm. GFMIS provides map search facilities in which one can visualize the location of various features such as the distribution of Irrigation, road network, location of residential area and divisions, distribution of soil layers/series etc. Also 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 e-mail.

On-line help is provided for both administrator and user. The feature of providing information to users through frequently asked questions has been included in this software. Information on various activities being undertaken in various divisions of IARI is also available in GFMIS which contain the General map and Plot map.

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, ArcView for generation of Thematic maps and Java Database Connectivity. Database Layer is implemented in Microsoft Access 2000. GFMIS can be implemented as a network-based system with a server at IASRI so that information is available on-line. GFMIS 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.

Guide: Dr. P.K. Malhotra

(ii) Nisha Jha—Information system on post-harvest management of citrus fruit (*Kinnow mandarin*)

Information System on Post-harvest Management of Citrus Fruits (*Kinnow mandarin*) (InPhoCFK) is a Web-based Information System to provide information to farmers, students, research personnels on post-harvest management of citrus fruits. CIS (Computer based Information System) has great importance in horticulture as experts are not always available to answer farmers' query. InPhoCFK has modules to provide information on various aspects to farmers, etc. Information on citrus fruits varies from the general information, state wise statistics, harvesting methods, storage practices, packaging, transportation modes, processed products, and processing industry details etc. A simple query and report generation facility is provided with the software, so that it is easy to get the information even in the printable formats.

The software has one level of authentication i.e. Administrator. Administrator has the privilege to add, modify or delete information from the database. Users are free to get information from the software. They can

also ask questions regarding the software to the concerned experts by sending an e-mail; this facility is included in the software itself. Users can also view some frequently asked questions (FAQs) regarding various queries.

InPhoCFK is developed using ASP.NET. It is a new web-based technology in the scenario. It is an easy and effective tool to develop web-based applications. Database part is developed using SQL Server 2000. It is the database widely used for its simplicity and ease in operation.

Guide: Dr. R.C. Goyal

(iii) Anesh Raj Y.—Information system on cropping sequence experiments

The information technology is changing at a very rapid rate and the information needs are growing day by day. The recent advances in computer and communication technology have made computer more affordable, user friendly and have resulted in faster processing of the information. The information technology also plays an important role in the field of agriculture. Agricultural Research in India is undertaken at various Agricultural Research Institutes of ICAR, State Agricultural Universities etc. Large number of agricultural field experiments is conducted in the country for the development of new agro-technologies. The results of experiments are of immense practical value and play crucial role in increasing the productivity of various crops. For increasing the cropping intensities the research is directed to crop sequence and intercropping experiments.

Cropping Sequence refers to an arrangement of crops in temporal and spatial dimension on a given piece of land and their interactions with farm resources and available technologies. Sequence cropping comprises the planting of two or more crops in the same plot one after other. Cropping Sequence Experiments Information System (CSEIS) site provides information related to cropping sequence experiments, conducted at various agricultural research stations in the country, their data and results. The information has been hyper-linked so that users can view the information in an easy manner. It aims to act as reference material for scientists, research workers and those who are working in the field of agricultural sciences. As improved systems on component technologies will become available, they will replace or be linked to the system.

It has a three-layered architecture. Client Side Interface Layer is implemented using HTML and JavaScript, Server Side Application Layer using Java Server Pages (JSP) and Java Database Connectivity. Database Layer is implemented using Microsoft Access 2000. CSEIS can be implemented as a network-based system with a server at a central location (IASRI) so that information is available on-line. Security features are provided in such a way that only authorised person can access the database. The authentication has two levels, viz. end user and administrator. End users can access the information system only whereas Administrators can access, update, insert and delete information in the database. The features of the information system include online addition, modification and deletion of the information, search facility, report generation, on-line help scheme etc.

This information system will provide information's regarding following aspects of the cropping sequence experiments: location details, experimental site history, cultural and other practices followed, objectives of the experiments conducted, details about treatments, details about design used, general crop conditions, summary results and/or plot wise observations for each of the crops in the sequence and over all results obtained.

Guide: Dr. V.K. Mahajan

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 03 July 2006 to 23 December 2006. The course comprised of two independent modules of three months duration each. Six officials including one Departmental candidate participated in both the modules. Module-I was organized during 03 July 2006 to 30 September 2006. One official participated in Module-I only.

Module-II was organised during 09 Oct 2006 to

A participant receiving the certificate after completing "Senior Certificate Course in Agricultural Statistics and Computing"

23 December 2006. Two officials 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 23 December 2006 in which Dr. SD Sharma, Director, IASRI distributed the certificates to successful participants.

Programme under Centre of Advanced Studies

- A 21 days training programme on "Statistical Methods for Agricultural Research with Use of Software" was organized during 01 to 21 November 2006 under aegis of Centre of Advanced Studies in Agricultural Statistics and Computer Applications. The training programme was attended by 20 participants from various ICAR Institutes and State Agricultural Universities. Dr. Seema Jaggi was the Course Director for the training programme. The training programme was aimed at providing the participants opportunity to study and learn some sophisticated techniques of data analysis using softwares which may help them in analysis and interpretation of their results more meaningfully, with better sense of reliability and confidence. In particular, this course was designed to acquaint researchers with the techniques of data collection, statistical analysis, interpretation and presentation of results. The course was oriented towards application and a combination of lectures, exercises, and hands-on exercises on SPSS/SAS/MS-EXCEL. A web page was designed regarding the details of the training and was attached in our Institute's website. This course was intended primarily for scientists undertaking agricultural research. In all 20 participants from various disciplines of Agriculture representing different ICAR Institutes (9) and State Agricultural Universities (11) attended this training.

  The topics were covered under following four modules (i) Statistical Softwares and Information Systems in Agricultural Research, (ii) Statistical Methods in Agricultural Research, (iii) Planning of Agricultural Experiments/Surveys and (iv) Modern Approaches to the Analysis of Agricultural Data. Concepts were explained largely without using much of mathematics using computer software and the course emphasized on understanding that which analysis is appropriate to use and correct interpretation of the results. 22 faculty members from the institute and 7 guest speakers (Prof. B.K. Sinha, Prof. T. Krishnan, Prof. R.L. Karandikar, Prof. Navneet Goyal, Dr. B.M. Prasanna, Dr. Rabi Narayan Sahoo and Dr. Girish Kumar Jha) delivered lectures during this training. Course material in the form of Reference Manual and Electronic Manual was provided to all the participants.

Inauguration of a training programme on "Statistical Methods for Agricultural Research with Use of Software"

- A 21 days training programme on "Design & Development of Web based Application using .NET Technology" was organized during 22 November to 12 December 2006 under aegis of Centre of Advanced Studies in Agricultural Statistics and Computer Applications. The training programme was attended by 20 participants from various ICAR Institutes and State Agricultural Universities. Mrs. Alka Arora was the Course Director for the training programme.

This training programme offered sufficient practical knowledge to develop and host a web application using Microsoft .NET technology on IIS Web Server. In brief the practicals were divided into four modules—Hypertext Mark-Up Language (HTML), Internet Information Server, SQL Server and ASP.NET. Major areas covered were Web Portals, An Overview, Role of Information

A participant receiving the certificate during Valedictory Function of CAS training programme on "Design & Development of Web based Application using .NET Technology"

Communication Technology in taking Scientific Knowledge/Technologies to the End Users, Data Warehouse and its Applications in Agriculture, On-line Library Information System, Web Application Architecture, Introduction to .NET Framework, Working with HTML (Structure, Formatting, Tables and Images), Demo of Training Site for HTML Controls, VB.NET Language Concepts, OOPS Concepts using VB.NET, Introduction to Web Server (IIS), Configuration & Development of Web Application, Concepts of RDBMS, Structured Query Language, Overview of SQL Server, Creation of Tables, Views using SQL Server Enterprise Manager, Introduction to Visual Studio.NET, Introduction to ASP.NET, ASP.NET Web Application, Web Controls, Accessing Database with ADO.NET, Manipulating data with ADO.NET, securing ASP.NET Web Application etc. Guest Lectures on Consuming and Creating Web Services, Report Generation, XML, State Management and Mobile Controls & Advances in Microsoft Technologies were also arranged.

- A 21 days training programme on "Advances in Data Analytical Techniques" was organized during 08–28 February 2007 under aegis of Centre of Advanced Studies in Agricultural Statistics and Computer Applications. Dr. Rajender Parsad, National Fellow was the Course Director for the training programme.

The training programme was aimed at familiarizing the participants with the advances in statistical data analysis for making inferences from agricultural research data and to acquaint the participants with the use of statistical software packages SAS/SPSS/MINITAB/SYSTAT. This course was intended for the scientific research personnel working in the National Agricultural Research System. The training programme was attended by 19 participants from various disciplines of Agricultural Sciences representing different ICAR institutes (13) and State Agricultural Universities (6). The entire course for this programme was structured in a series of six modules namely (i) Computer Usage and Statistical Software Packages, (ii) Basic Statistical

Inauguration of a CAS training programme on "Advances in Data Analytical Techniques"

Techniques consisting of Statistical Methods and Inference, Design of Experiments and Sample Surveys, (iii) Diagnostics and Remedial Measures, (iv) Applications of Multivariate Techniques, (v) Modelling and Forecasting Techniques in Agriculture and (vi) Other Useful Techniques such as Bio-informatics, Geoinformatics, Microarrays, Nanotechnology in agriculture, DNA fingerprinting, Biplots, etc.

The course material was distributed to the participants at the beginning of the programme in the form of Reference Manual in two volumes that consisted of 834 pages. The course contents were completed in 64 lectures. 8 practical exercise/ participants presentation sessions were also given. 21 faculty members from the Institute and 10 guest

speakers (Professor Bikas Sinha, Member, National Statistical Commission; Dr. Aloke Dey, Professor, ISI, Delhi Centre; Dr. T. Krishnan, Crane Softwares, Bangalore; Dr. A.K. Singh, Project Director, WTC, IARI; Dr. Navneet Goel , BITS, Pilani; Dr. B.M. Prasanna, Division of Genetics, IARI; Dr. T.R. Sharma, NRC on Plant Bio-Technology, IARI; Dr. R.N. Sahoo, Division of Agricultural Physics, IARI; Dr. Girish Kumar Jha, Division of Agricultural Economics, IARI and Dr. K.V. Bhat, NBPGR) delivered the lectures. Among the 31 faculty members 8 were IARI Best Teacher Awardees.

- One International training programme for a trainee from NARC, Nepal on "Biometrics in Agricultural Research" was organised during 04 October to 29 November 2006.

Inaugural session of International training programme on "Biometrics in Agricultural Research"

OTHER TRAINING PROGRAMMES

- Training programme on "Design and Analysis of Experiments for Rapeseed-Mustard Varietal Trials" for the plant breeders and statisticians of All India Co-ordinated Research Project on Rapeseed-Mustard, National Research Centre on Rapseed-Mustard, Bharatpur was organized during 10–11 May 2006.

  13 participants attended the training programme, 8 participants were from State Agricultural Universities and 5 from ICAR Institutes. Dr. Rajender Parsad was the Course Director. The topics covered in this training programme included Fundamentals of Design of Experiments, MS-Excel: Analysis of Experimental Data, SPSS: An Overview, Combined Analysis of Data and Stability Analysis. Participants have analyzed some of the data sets on their own. The preparation of data and important characters such as seed yield, oil content and plant stand were finalized on which replicated data should be collected. It was also decided that the randomized layout should also be provided along with data to the co-ordinating unit.

Inaugural session of training programme on "Design and Analysis of Experiments for Rapeseed-Mustard Varietal Trials"

- A Summer School on "Sample Survey Techniques in Agricultural Research" was organised at the Institute during 05–25 September 2006 for Assistant/Associate Professors from State Agricultural Universities (SAUs) and Scientists from ICAR Institutes. Dr. K.K. Tyagi was the Course Director. The broader objective of the Summer School was to provide exposure to the participants to the different sample survey techniques in agricultural research as well as to help to upgrade their capabilities in research, teaching and training. 23 participants participated in the Summer School. The main topics covered were overview of survey sampling in relation to agricultural research, various concepts in sample survey, different procedures of sample selection, simple random sampling, stratified sampling, cluster sampling, sampling on successive occasions, multi-stage sampling, multi-phase sampling, systematic sampling, use of auxiliary information in sample surveys, small area estimation techniques in relation to national agricultural insurance scheme, use of remotely sensed data and GIS in survey sampling, simulation techniques, survey data analysis packages, planning & organisational aspects

A session of a summer school on "Sample Survey Techniques in Agricultural Research"

related to conduct of sample surveys, some recent agricultural surveys related to crops, livestock, farm mechanization etc.

Training Programme for Visitors

Following one day training programme was organised.

- Training programme on "Sensitization of Database" for the ISS officers of CSO, Govt. of India on 06 July 2006.
- Twenty participants of the course on Large Sample Survey sponsored by Ministry of Statistics & Programme Implementation, New Delhi visited on 12 December 2006.
- Thirty participants of the B.Sc. Course sponsored by CSK, Himachal Pradesh Krishi Vishvavidyalaya, Palampur visited on 20 January 2007.
- A training course on "Small Area Estimation Techniques" was organized for the 8 senior and middle level ISS officers of CSO, Ministry of Statistics and Programme Implementation, New Delhi during 10–15 July 2006.

A view of Inaugural session of a training course on "Small Area Estimation Techniques"

A view of presentation for three member delegation from Department of Statistics, Malaysia

- A study visit for three member delegation from Department of Statistics, Malaysia was organized during 01–05 August 2006. They were taken to different offices such as DES & Agricultural Census at Krishi Bhavan, Registrar General Office, CSO, so as to apprise them about their functions and activities. They were also taken to Agra under the study excursion tour. They also visited National Science Museum, NASC Complex, New Delhi.

Research Fellowship

During 2006–07, 13 Ph.D. and 26 M.Sc. students received research fellowship. 11 Ph.D. students received IARI Scholarship at the rate of Rs. 7,000 p.m. in addition to Rs.10,000 per annum as the contingent grant. 2 Ph.D. students received CSIR Scholarship at the rate of Rs. 8,000 p.m. in addition to Rs.15,000 per annum as the contingent grant.14 M.Sc. students received ICAR Junior Research Fellowship at the rate of Rs. 5,760 p.m. besides Rs. 6,000 per annum as the contingent grant and 14 M.Sc. students received IARI Scholarship at the rate of Rs. 5,040 p.m. besides Rs. 6,000 per annum as the contingent grant.

FACULTY MEMBERS OF P.G. SCHOOL, IARI IN AGRICULTURAL STATISTICS

S. No.	Name	Year of induction
1.	Dr. VK Gupta, National Professor	1984
2.	Dr. VK Sharma, Professor (Agricultural Statistics)	1984
3.	Dr. Prajneshu, Principal Scientist	1984
4.	Dr. VK Bhatia, Principal Scientist	1987
5.	Dr. VT Prabhakaran, Principal Scientist	1987
6.	Sh. SD Wahi, Principal Scientist	1987
7.	Dr. Ranjana Agrawal, Principal Scientist	1988

S. No.	Name	Year of induction
8.	Dr. HVL Bathla, Principal Scientist	1991
9.	Dr. R Srivastava, Principal Scientist	1993
10.	Dr. UC Sud, Principal Scientist	1995
11.	Dr. KK Tyagi, Principal Scientist	1995
12.	Dr. Rajender Parsad, National Fellow	1995
13.	Dr. Anil Rai, Senior Scientist	1995
14.	Dr. Seema Jaggi, Senior Scientist	1995
15.	Dr. Chandrahas, Principal Scientist	1996
16.	Dr. PK Batra, Principal Scientist	1996
17.	Dr. Jagbir Singh, Principal Scientist	1996
18.	Mrs. Asha Saksena, Principal Scientist	1998
19.	Dr. MS Narang, Senior Scientist	1998
20.	Dr. Aloke Lahiri, Senior Scientist	1998
21.	Dr. Amit Kumar Vasisht, Principal Scientist	1998
22.	Dr. Lal Mohan Bhar, Scientist (Sr. Scale)	1998
23.	Dr. Amrit Kumar Paul, Scientist (Sr. Scale)	1998
24.	Dr. Tauqueer Ahmad, Scientist (Sr. Scale)	1998
25.	Dr. AR Rao, Scientist (Sr. Scale)	1998
26.	Dr. Ramasubramanian V, Scientist (Sr. Scale)	1999
27.	Dr. Girish Kumar Jha, Scientist (Sr. Scale)	1999
28.	Dr. Cini Varghese, Scientist (Sr. Scale)	2000
29.	Dr. Prachi Misra Sahoo, Scientist	2002
30.	Dr. RL Sapra, Principal Scientist	2002
31.	Dr. Krishan Lal, Senior Scientist	2003
32.	Sh. Hukum Chandra, Scientist	2003
33.	Sh. Amrender Kumar, Scientist	2003
34.	Md. Wasi Alam, Scientist	2003
35.	Dr. Prawin Arya, Scientist (Sr. Scale)	2003
36.	Dr. Himadri Ghosh, Scientist	2004

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

S. No.	Name	Year of induction
1.	Dr. SD Sharma, Director	1996
2.	Dr. PK Malhotra, Professor (Computer Application)	1991
3.	Dr. RC Goyal, Principal Scientist	1995
4.	Dr. IC Sethi, Principal Scientist	1995
5.	Dr. VK Mahajan, Principal Scientist	1996
6.	Dr. DK Agarwal, Principal Scientist	1999
7.	Sh. Harnam Singh Sikarwar, Scientist (SG)	1997
8.	Md. Samir Farooqi, 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. KK Chaturvedi, Scientist	2002
14.	Sh. Vipin Kumar Dubey, Scientist	2002
15.	Sh. SN Islam, Scientist	2004
16.	Sh. SB Lal, Scientist	2004
17.	Ms. Anshu Dixit, Scientist (Study Leave)	2004
18.	Ms. Anu Sharma, Scientist	2004
19.	Ms. Rajni Jain, Sr. Scientist (at NCAP)	2007

COURSES TAUGHT DURING ACADEMIC YEAR 2005–06

Code	Title	Course Instructors
	Trimester – III	
	Agricultural Statistics	
AS-103	Elementary Sampling & Non-parametric Methods (2+1)	Jagibir Singh & Prachi Misra
AS-163	Statistical Inference (4+1)	Rajender Parsad & L.M. Bhar
AS-164	Design of Experiments-I (3+1)	Seema Jaggi & V.K. Gupta
AS-166	Statistical Genetics-I (3+1)	V.T. Prabharkran & A.K. Paul
AS-208	Bioinformatics-II (2+1)	V.K. Bhatia, Rajender Parsad, & K.V. Bhatt (NBPGR)
AS-302	Advanced Design of Experiments-II (2+1)	R. Srivastava & P.K. Batra
AS-306	Advanced Statistical Genetics-II (2+1)	A.K. Paul
AS-307	Forecasting Techniques (1+1)	Chandrahas & Ramasubramanian V.
AS-299	Seminar (1+0)	Seema Jaggi
	Computer Application	
CA-131	Data Base Management System (2+2)	Vipin Dubey & Anu Sharma
CS-132/ CA-132	Data Structures and Structured Programming/ Data Structures and Algorithms (2+1)	Shashi Dahiya & S.B. Lal
CA-134	Modeling and Simulation (2+1)	P.K. Malhotra & Samir Farooqi
CS-135/ CA-135	Computer Communication Networks (2+0)/ Computer Networks (2+1)	Alka Arora & S.N. Islam
CA-299	Seminar (1+0)	S.N. Islam

COURSES TAUGHT DURING THE YEAR ACADEMIC YEAR 2006–07

Code	Title	Course Instructors
	Agricultural Statistics	
	Trimester – I	
AS-101	Elementary Statistical Method (2+1)	V.T.Prabhakaran & S.D. Wahi
AS-150	Mathematical Methods (4+0)	Cini Varghese & Himadri Ghosh
AS-160	Probability Theory (2+0)	L.M. Bhar
AS-161	Statistical Methods-I (2+1)	V.T. Prabhakaran & Seema Jaggi
AS-167	Applied Multivariate Analysis (2+1)	Ranjana Agrawal & Amrender Kumar
As-168	Econometrics (2+1)	V.K. Sharma & Prawin Arya
AS-169	Planning of Surveys/Experiments (2+1)	M.S. Narang, R.S. Khatri & M.R. Vats
AS-200	Design of Experiments-II (1+1)	Rajender Parsad & Cini Varghese
AS-201	Sampling Techniques-II (1+1)	K.K. Tyagi & Prachi Mishra
AS-202	Statistical Genetics-II (1+1)	A.K. Paul
AS-203	Regression Analysis (1+1)	L.M. Bhar & Ramasubramanian V.
AS-204	Linear Models (2+0)	V.K. Sharma & R. Srivastava
AS-206	Optimization Techniques (1+1)	U.C. Sud & Amrendra Kumar
AS-370	Recent Advances in the Field of Specialisation (1+0)	V.K. Bhatia
AS-299	Seminar (1+0)	Seema Jaggi
	Trimester – II	
AS-102	Elementary Design of Experiments (2+1)	Krishan Lal & P.K. Batra
AS-151	Mathematical Methods in Statistics-II (4+0)	N.K. Sharma & Cini Varghese
AS-162	Statistical Methods-II (2+1)	L.M. Bhar & Ramasubramanian V.
AS-165	Sampling Techniques-I (3+1)	Tauqueer Ahmed & Anil Rai
AS-170	Statistical Modeling (2+1)	Prajneshu & Amrender Kumar
AS-171	Bioinformatics-I (3+1)	V.K. Bhatia, Rajender Parsad & K.V. Bhatt (NBPGR)
AS-205	Advanced Statistical Inference (1+1)	Krishan Lal & U.C. Sud
AS-207	Stochastic Processes (3+0)	Himadri Ghosh
AS-301	Advanced Design of Experiments-I (2+1)	R. Srivastava & V.K. Gupta
AS-370	Recent Advances in the Field of Specialisation (1+0)	Anil Rai
AS-299	Seminar (1+0)	Seema Jaggi
	Computer Application	
	Trimester – I	
CA-100	Introduction to Computer Application (1+1)	V.H. Gupta
CA-111	Computer Organization and Architecture (3+0)	V.K. Dubey
CA-112	Fundamentals of Computer Programming in C (2+1)	K.K. Chaturvedi
CA-114	Mathematical Foundations in Computer Application (4+0)	P.K. Batra & N.K. Sharma
CA-211	Compiler Construction (2+1)	S.B. Lal
CA-212	Computer Graphics (2+1)	Pal Singh
CA-213	Artificial Intelligence (2+1)	S.N. Islam & Rajni Jain
CA-214	Internet Technologies & Applications (2+1)	Alka Arora & Shashi Dahiya
CA-215	Software Engineering (1+0)	Anu Sharma
CA-299	Seminar (1+0)	S.N. Islam
	Trimester – II	
CA-101	Computer Fundamentals & Programming (3+1)	Alka Arora & Anu Sharma
CA-121	Object Oriented Programming & Design (2+1)	V.K. Dubey & S.B. Lal
CA-122	Operating System (2+1)	H.O. Agarwal
CA-123	Numerical Analysis (2+1)	H.S. Sikarwar & Pal Singh
CA-124	System Analysis & Design (2+1)	I.C. Sethi & M.S. Farooqi
CA-221	Data Warehousing and Data Mining (2+1)	Anil Rai & K.K. Chaturvedi
CA-222	Multimedia and Applications (1+1)	Shashi Dahiya
CA-224	GIS and Remote Sensing Techniques (1+0)	Prachi Mishra & M.S. Farooqi
CA-225	Data Analysis in Agriculture (1+2)	V.K. Mahajan & Wasi Alam

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