Indian Agricultural Statistics Research Institute:
A Profile

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1. Historical Development

IASRI has been and continues to be a premier Institute of the ICAR with glorious tradition of carrying out research, teaching and training in the areas of *Agricultural Statistics* and *Computer Application*. Recognizing the importance of research and education in Agricultural Statistics way back in 1930, the then Imperial Council of Agricultural Research established a small *Statistical Section* to assist the State Departments of Agriculture and Animal Husbandry in planning and designing their experiments, analysing the experimental data, interpreting the results, rendering advice on the formulation of the technical programmes and examining the progress reports of the schemes funded by the Council. The statistical section was headed by a statistician and Late Shri M. Vaidyanathan was the first statistician of the statistical section.

The research activities of the statistical section took a big leap with the appointment of Late Dr. PV Sukhatme as statistician in 1940. Basic research in the theory of statistics was undertaken to bridge the gaps in the available methodologies for solving practical problems in agricultural research. With an expansion in its scope and research activities being undertaken, the statistical section was re-organised as the *Statistical Branch* in 1945 with associated expansion in its strength. The statistical branch was headed by a Statistical Advisor. The advisory work relating to agriculture and animal husbandry was separated into two units, each under the charge of a statistician.

A new dimension was added to the activities of the statistical section towards the end of 1943 when the enquiry committee set up by the Government of India to enquire into the causes of the Bengal famine came to the conclusion that one of the main factors responsible for the famine was the inappropriate statistics of crop production available at that time. As desired by Government of India and the ICAR, the statistical section undertook research in the methods of collection of yield statistics of crops by developing techniques for yield estimation based on the methods of random sampling. In the course of this work the statistical section also undertook research in sampling theory and imparted practical training to the field staff in different States. The work involved in scrutiny, compilation and analysis of the voluminous data collected in the crop cutting surveys was immense and the activities of the statistical branch were ever mounting.

An important development that took place in 1945 was the initiation of two regular certificate courses, one course of six months duration, called Junior Certificate Course (JCC) and the other course of one year duration called Senior Certificate Course (SCC). Besides, there was another course of one year duration that was introduced to train professional statisticians. Subsequently, a Diploma course involving a research project of one year duration, in addition to the Professional Statisticians' Certificate Course (PSCC) consisting of one year course work in advanced statistics, was also introduced. This necessitated the augmentation of the staff and accordingly, the strength of the branch was increased to two Professors of Statistics and other staff. These certificate courses helped in strengthening the linkages of the institute

with the state departments of agriculture and animal husbandry. The certificate courses started in 1945 were discontinued by the Indian Council of Agricultural Research (ICAR) in 1985-86. However, during 1997, the Senior Certificate Course in 'Agricultural Statistics and Computing' was revived. This course is now of six months duration and lays more emphasis on statistical computing using statistical software. The course was divided into two modules viz. (i) Statistical Methods and Official Agricultural Statistics, and (ii) Use of Computers in Agricultural Research, of three months duration each.

The period 1945-49 was one of intensive activities in the statistical branch when under its technical guidance, yield estimation surveys were carried out in almost all the States covering Wheat and Rice crops. By 1949, the results of sample surveys were also being used for official forecasts. Gradually these surveys were extended to other crops such as Jowar, Bajra, Maize and Cotton.

The statistical branch was renamed as *Statistical Wing* in 1949. In 1951, Late Dr. PV Sukhatme moved to FAO as Chief, Statistics Branch, Rome. Late Dr. VG Panse took over as Statistical Advisor of the Council in 1951. The Statistical Wing soon acquired the international recognition as a Centre of Research and Training in the field of Agricultural Statistics. Subsequently, in recognition of the important role as a training and research institution and based on the recommendations of two FAO experts Dr. Frank Yates and Dr. DJ Finney, the Statistical Wing was re-designated as the *Institute of Agricultural Research Statistics* (IARS) on 02 July 1959. In 1966 on retirement of Late Dr. VG Panse, Late Dr. GR Seth took over as statistical advisor. In April 1970, the IARS was given the status of a full fledged institute of the ICAR headed by a Director with Late Dr. GR Seth as the first Director. On 01 January 1978 the name of the institute was changed to Indian Agricultural Statistics Research Institute (IASRI) emphasizing the role of Agricultural Statistics as a full fledged discipline by itself.

In 1955, the statistical wing moved to its present campus. The building provided adequate space for library, reading rooms, lecture halls, auditorium and office for its technical and ministerial staff. A hostel with modern amenities was constructed for the trainees. Collaboration with the All India Co-ordinated Agronomic Experiments Research Projects of the ICAR started in 1956. This project consisted of two components viz., (a) complex experiments conducted at research centres, and (b) simple experiments conducted on cultivators' fields. A mechanical data processing unit was added to the institute in 1957.

The year 1964 witnessed tremendous changes in the activities of the Institute. An MOU was signed with IARI, New Delhi to start new degree courses leading to M.Sc. and Ph.D. in Agricultural Statistics. In 1981, a two years Diploma Course in Advanced Computer Programming was introduced. On the recommendations of UNDP, this course was soon discontinued and in 1985 another new course leading to an M.Sc. degree in Computer Applications in Agriculture was initiated in collaboration with IARI, New Delhi. This course was redesignated as M.Sc. degree in Computer Application during 1993-94. The institute has so far produced 173 Ph.D. and 287 M.Sc. students in Agricultural Statistics and 81 M.Sc. students in Computer Application. The alumni of the Institute are at present occupying high positions in Universities and other academic research institutions of USA, Canada and other countries.

During 1964, yet another mile stone was the installation of an IBM 1620 Model II electronic computer. In 1977, the IBM 1620 computer was replaced with a third generation computer Burroughs B-4700. The Institute has always kept pace with the latest state-of-the-art-technologies. In 1991 the Burroughs B-4700 was replaced by a Super Mini COSMOS LAN SERVER. The LAN and Intranet were further strengthened with Fibre optics and UTP cabling and at present LAN is supporting all the three buildings

of the Institute and almost every scientist has a PC on the work table.

With the advent of LAN Server and PCs, Divisional computing Labs were created. A Remote Sensing and GIS Lab with latest software facilities was established. A statistics Lab has been created very recently in which almost all the software are available on the PCs. Recently, with the broadening of the horizon of research activities in newer emerging areas, an Agricultural Bioinformatics Laboratory (ABL) has also been established at the Institute.

In 1970, a Staff Research Council was constituted at the Institute to carefully examine and finalize the research programmes of the Institute and to monitor the progress of the projects running at the Institute. The name of the Staff Research Council has recently been changed to Institute Research Council.

In October 1975, a Management Committee of the Institute was constituted in pursuance of the decision of the ICAR. The main purpose of setting up of the Management Committee was to ensure that the working of the Institute is smooth and the research programmes are being run without any problem. The administrative and the financial aspects of the institute are also governed by the Management Committee after approval from the ICAR. The research programmes of the Institute are also broadly guided by the Management Committee.

The functioning of the Institute as a Centre of Advanced Studies in Agricultural Statistics and Computer Application during October 1983 to March 1992 under the aegis of United Nations Development Programme was another landmark in the history of the Institute. The purpose of this programme was to develop the Institute as a centre of excellence with adequate infrastructure and facilities to undertake advanced training programmes and to carry out research in various emerging areas of Agricultural Statistics and Computer Application. Under this programme, a number of illustrious statisticians and computer scientists from abroad visited the institute with a view to interacting with the scientists, giving seminars / lectures and suggesting gaps in the research programmes of the institute and helping initiate research to bridge the gaps. Under the programme some scientists of the Institute received training for capacity building from abroad.

Another singular development in the growth of the Institute was the Centre of Advanced Studies programme in Agricultural Statistics and Computer Application established during the VIII five year plan in 1995. Under this program the institute organizes training programmes on various topics of current interest for the benefit of scientists of National Agricultural Research System (NARS). These training programmes cover specialized topics of current interest in statistics and agricultural sciences. There is yet another form of training courses, which are tailor made courses and are demand driven. The coverage in these courses is need based and the courses are organized for specific organizations from where the demand is received. The Institute has conducted such programmes for Indian Council of Forestry Research, Indian Statistical Services probationers and Senior officers of Central Statistical Organization, and many other organizations. The Institute has also conducted several international training programmes on request from FAO, particularly for African, Asian and Latin American countries. The Institute has broadened the horizon of capacity building by opening its doors to the agro-based private sector. One such training programme was organized for research personnel of E.I. DuPont Pvt. Ltd. The Institute has also conducted training programmes for the scientists / research personnel of CGIAR organizations such as ICARDA and Rice-Wheat Consortium for Indo-Gangetic plains.

On the basis of a resolution passed in 65th meeting of the ICAR Society, a Research Advisory Committee was constituted by the council on July 14, 1994 to perform the following functions:

1. To suggest research programmes based on national and global context of research in the thrust areas.
2. To review the research achievements of the Institute to see that these are consistent with the mandate of the institute.
3. Any other function that may be specifically assigned by the Director General, ICAR.

In any research and teaching institute, library is its biggest and most powerful resource, which provides support to its research and teaching programmes. The library of the Institute has witnessed many developments over the years. Presently, the Institute library enjoys the status of a regional library. It plays a vital role in meeting the information needs of the in-house users as well as users from the NARS. Library Information System is fully automated and bar-coded. Now an E-search and retrieval facility is available through LAN.

2. Mandate

Having made a humble beginning as a statistical section of the then Imperial Council of Agricultural Research in 1930, the Indian Agricultural Statistics Research Institute has come a big way and established itself as a pioneer in research and education in Agricultural Statistics and Computer Applications in the country. The vision of the institute is to use the power of Statistics as a science blended judiciously with Information Communication Technology to enhance the quality of agricultural research. To convert this vision into a reality, the institute has set for itself a mission to undertake research, teaching and training in Agricultural Statistics and Computer Applications so that these efforts culminate into improved quality of agricultural research and also meet the challenges of agricultural research in newer emerging areas. The functions and activities of the institute have been re-defined from time to time in the past. The present mandate of the Institute is

a. to undertake basic, applied, adaptive, strategic and anticipatory research in Agricultural Statistics and related fields and use these researches in meeting challenges and improving quality of agricultural research

b. to conduct post graduate teaching and in service, customized and sponsored training courses in Agricultural Statistics and Computer Application at National and International level so as to be a leading centre of excellence in Human Resource Development

c. to provide methodological support in strengthening National Agricultural Statistics System by establishing linkages with State Departments of Agriculture and allied fields, other research institutions, industry, etc.

d. to lead in development of Agricultural Knowledge Management Systems for NARS

e. to provide advisory and consultancy services for strengthening the NARS and undertaking sponsored research and consultancy for National and International organizations.

The research, teaching and training activities are carried out under the following six broad programmes cutting across the six Divisions:

1. Development and analysis of experimental designs for agricultural systems research

2. Forecasting and remote sensing techniques and statistical applications of GIS in agricultural systems

3. Development of techniques for planning and analysis of survey data including economic problems of current interest

4. Modelling and simulation techniques in biological systems

5. Development of information technology in agricultural research

6. Teaching and training in agricultural statistics and computer application.

3. Organizational Set Up

Consequent upon becoming a full fledged Institute of the ICAR in April 1970, the research, teaching and training activities of the Institute were organized in a number of Divisions with the main objective of formulation and implementation of research projects in specific fields. During April 1970, the following seven Divisions were created:

1. Statistical Research (Crop Sciences)
2. Statistical Research (Animal Sciences)
3. Sample Survey Methodology
4. Crop Forecasting Methodology
5. Econometric Analysis
6. Computer Science and Numerical Analysis
7. Training and Basic Research

Over time, the organizational structure also underwent changes as a result of the recommendations of the Quinquennial Review Teams (QRT). In 1985, the QRT suggested dismantling the Division of Training and Basic Research and adding a new division of Bio-statistics and Statistical Genetics. It also suggested restructuring the seven existing divisions into the following six divisions:

1. Sample Survey Methodology and Analysis of Survey Data
2. Design of Experiments and Analysis of Experimental Data
3. Bio-statistics and Statistical Genetics
4. Statistical Economics
5. Forecasting Techniques for Crops, Diseases and Pests
6. Computing Sciences

In 1998-99 once again on the recommendations of the QRT, the names of some of the Divisions were changed although the constitution remained the same. The new names were:

1. Sample Surveys
2. Design of Experiments
3. Biometrics
4. Statistical Economics
5. Forecasting Techniques for Crops, Diseases and Pests
6. Computer Applications

During 1999-2000 the ICAR suggested changing the names of some Divisions without affecting the mandate of the Divisions. The structure of the Divisions is the following:

1. Sample Surveys
2. Design of Experiments
3. Biometrics
4. Econometrics
5. Forecasting Techniques
6. Computer Applications

4. Achievements

The success stories of the Institute have been many and fairly wide spread. The contributions towards research, teaching and training have been monumental. It is a matter of great pride for the Institute that two of its scientists have received the most prestigious National Award in Statistics in memory of Late Dr. PV Sukhatme, for outstanding life time achievements in Statistics. One scientist is presently occupying the prestigious ICAR National Professor Chair, two scientists have been the National Fellow of the ICAR, one scientist received the GP Chatterjee Memorial Lecture award from Indian National Science Academy (INSA) and one scientist received the Shri Om Prakash Bhasin award for science and technology in the field of agriculture and allied sciences. Six scientists have been adjudged as the 'Best Teacher' of the PG School of IARI, New Delhi. Several of its scientists have received 'Young Scientist Award' from National Academy of Agricultural Sciences, Indian Council of Agricultural Research and many other scientific societies / associations. Several scientists have been the elected members and one scientist had been the Council member of the International Statistical Institute. Scientists are also Editors, Associate Editors and Members of the Editorial Board of many National and International Journals. The scientists of the institute have published eight text books, four handbooks and many monographs. Agricultural Research Data Book consisting of collation of information on various aspects of agriculture is also brought out. In the sequel, an attempt has been made to provide a glimpse of the achievements of the institute over the past 50 years.

4.1 Research achievements

The Institute has made some outstanding and useful contributions to the research in Agricultural Statistics in the fields like Design of Experiments, Statistical Genetics, Forecasting techniques, Statistical Modelling, Sample Surveys, Econometrics, Computer Applications in Agriculture, Software development, etc. IASRI has conducted basic and original research on many topics in design of experiments, sample surveys, biometrics, etc. By way of its publications in International Journals, the Institute has come to be known globally. IASRI has been providing and continues to provide support to the NARS by way of analyzing voluminous data using advanced and appropriate analytical techniques and providing efficient designs for experimentation. IASRI has also been very actively pursuing advisory service that has enabled the institute to enrich the quality of agricultural research in the NARS. Through its advisory, IASRI has made its presence visibly felt in NARS and now experimenters look to IASRI for designing experiments and analysis of experimental data. The efficient designs like balanced incomplete block designs, group divisible and extended group divisible designs, reinforced extended group divisible designs, square and rectangular lattice designs, alpha designs, reinforced alpha designs, augmented designs, designs for fitting

response surfaces, etc. and advanced analytical techniques including, contrast analysis, linear models with nested structures, experiments with mixtures methodology, mixed effects models, biplot, etc. have been adopted by the experimenters. The analytical techniques for estimating/projecting the Energy Requirement in the Agricultural Sector has been exploited for the analysis of countrywide data. The analytical techniques for the analysis of data from the experiments conducted to study the post harvest storage behaviour of the perishable commodities like fruits and vegetables are being widely used in NARS. The Institute works in close collaboration with NARS organizations and has many projects being run at the institute in collaboration with All India Co-ordinated Research Projects and ICAR Institutes. Institute has developed linkages with the CGIAR organizations such as CIMMYT, IRRI and ICARDA. The status of experimentation is now changing and with the support provided in terms of suggesting efficient designs and analyzing the data using modern complicated statistical tools, the research publications of the agricultural scientists are finding a place in high impact factor international journals.

The methodology for General Crop Estimation Surveys (GCES), cost of cultivation studies, Integrated Sample Surveys (ISS) for livestock product estimation, fruits and vegetable survey, which are being adopted throughout the country are research efforts of IASRI. Methodology based on small area estimation technique for National Agricultural Insurance Scheme suggested by IASRI has been pilot tested in the country. A status paper on chronological development and present status of information support system for management of agriculture was prepared as a part of State of Indian Farmer: A Millennium Study of Ministry of Agriculture. The sample survey methodology for imported fertilizer quality assessment, fish resources estimation, flower production estimation, horticultural crops estimations, etc. have been developed and passed on to the user agencies. Integrated methodology for estimation of multiple crop area of different crops in North Eastern Hilly Regions using Remote Sensing data has been developed.

The Institute has also made very significant contributions in developing the analytical techniques for the estimation of genetic parameters, models for pre-harvest forecasting of crop yields, models for forewarning of incidence of pests and diseases and econometrics and statistical modeling of biological phenomena using structural time series and machine learning approaches. The methodology developed for forecasting based on weather variables and agricultural inputs was used by Space Application Centre, Ahmedabad, to obtain forecast of Wheat yield at national level. Models developed for forewarning of aphids in mustard crop were used by National Research Centre for Rapeseed and Mustard to provide forewarning to farmers, which enabled them to optimize plant protection measures and save resources on unnecessary sprays consecutively for three years. The modification in the procedure of estimation of genetic parameters has been suggested for incorporating the effect of unbalancedness, presence of outliers, aberrant observations and non-normality of data sets. Procedures for studying genotype $\times$ environment interactions have been developed and used for the analysis of data generated from Crop Improvement Programmes.

4.2 Achievements in information communication technology

Today information is accessible to anyone and anywhere. It is increasingly becoming a basic economic resource and a structuring factor in society. The Institute has the capability of development of Information Systems, Decision Support Systems and Expert Systems. Realizing the need of integration of databases to prepare a comprehensive knowledge warehouse that can provide desired information in time to the planners, decision-makers and developmental agencies, Integrated National Agricultural Resources

Information System (INARIS) with the active support of 13 sister institutes as partners has been developed. The data warehouse comprises of 59 databases on agricultural technologies of different sectors of agriculture and related agricultural statistics at districts/state/national levels, population census including village level population data as well as tehshil level household assets and livestock census. Subject-wise data marts have been designed, multi-dimensional data cubes developed and published in the form of on-line decision support system. The Institute has also developed information systems for agricultural field experiments, animal experiments and long term fertilizer experiments conducted in NARS. Besides, a comprehensive Personnel Information Management Information System network has been implemented for the ICAR for man power planning, administrative decision making, and monitoring. For National Agricultural Technology Project, a Project Information and Management System Network (PIMSNET) was developed and implemented for concurrent monitoring and evaluation of 845 projects. A National Information System on Agricultural Education Network in India (NISAGENET) has been designed, developed and implemented on the recommendations of the National Statistical Commission (NSC-2001) so as to maintain and update the data regularly on parameters related to agricultural education in India. An Expert System on Wheat crop Management has also been developed and implemented.

A milestone in the research programmes of the Institute was created when it started developing indigenous statistical software packages mainly for analysis of agricultural research and animal breeding data and then generation of experimental designs for various experimental situations, both unstructured and factorial structure of treatments, catalogues of designs, randomized layout of design and analysis of data generated. Statistical package for analysis of survey data is perhaps one of its kinds of indigenous packages.

The creation of Design Resources Server, an e-learning and e-advisory resource for the experimenters, has been another revolution in the growth of the institute. The server provides a platform to popularize and disseminate research and also to further strengthen research in newer emerging areas in design of experiments among peers over the globe in general and among the agricultural scientists in particular so as to meet the emerging challenges of agricultural research. This is hosted at www.iasri.res.in/design.

5. Future Agenda

In an effort to maintain the past glory, the Institute plans to maintain a judicious balance of basic research and innovative applied research and also to expand the horizon of the teaching and training programmes so as to remain the leader in human resource development. The Institute would delve on developing roadmaps on combating the major problems of depleting natural resources, climate change, uncertainties of economy and marketing by addressing the statistical issues involved in it. The fusion of Statistics and Informatics would help addressing this alarming problem. The Institute would undertake research in newer emerging areas with fresh vigor and zeal. Block designs having orthogonal factorial structure with balance have many applications in crop sequence experiments and in cDNA micro array experiments. Generation of designs with full efficiency on main effects and controlled efficiency on interactions is one area of research. Fractional factorial designs, permitting estimation of main effects and some selected, important two factor interactions, with large number of factors and with scarce resources is another important area of research with many applications. A special class of fractional factorials with number of design runs smaller than the total degrees of freedom for all the main effects and the intercept

term, called as supersaturated designs, is also an important area of research that would need attention. Generation of orthogonal arrays with varying symbols, particularly resolvable or nested arrays assumes significance in view of their applications in many fields. A special class of orthogonal arrays of strength one is very useful in computer experiments. Integrated farming systems research is becoming the order of the day. Data designing for such systems will be of considerable importance and the institute would take lead in this area. Small area estimation is another important area of research that would be addressed to and its applications in policy planning at block and village levels, in crop yield estimation, demographic studies and health sciences, poverty and malnutrition, etc. will be made. Bayesian analysis of survey data and experimental data would be another area of active research. The institute needs to take a deep plunge into the internationally adapted areas of research in statistical genomics, proteomics, bio-informatics and nanotechnology. The creation of a bioinformatics Lab is the first step in this direction. The institute would also like to initiate action on starting an M.Sc. degree course in Bio-informatics jointly with IARI. Remote sensing, GIS, ANN and other machine learning algorithms would be used in developing models for biological and economic phenomena. These techniques would also be used for developing models for forecasting crop yields, forewarning and early warning systems for incidence of pest and disease. Data mining activities would be taken up rigorously to add value to the various information systems and the data ware house available at IASRI.

The important activity of developing indigenous statistical software packages would be rejuvenated with more vigor and zeal. A blend of statistics and computer applications would help in developing agricultural knowledge information system and decision support systems. Such systems would be beneficial in building a bridge between the farm scientists and the farming community so as to bring prosperity to the farmers.

The institute has also been playing a leadership role in developing methodologies for the National Agricultural Statistics System (NASS). Several methodologies developed have been passed on to the state departments for replicating them in the states. This activity needs to be further reinvigorated with new zeal and vigour to provide support to the NASS to help in proper implementation of policy planning and developmental programmes. The small area estimation techniques, the categorical data analysis of survey data, regression analysis of survey data, etc. would be judiciously and innovatively used for developing methodologies.

IASRI has also been very actively pursuing advisory service that has enabled the institute to enrich the quality of agricultural research in the NARS. This activity has made a strong impact in providing help to improve the quality of agricultural research. This activity needs to be further strengthened to become more effective in helping make agricultural research globally competitive.

The developmental activity is a continuing process. It is hoped that the institute would keep growing with an accelerated pace. It is also wished that the institute would continue providing leadership in the disciplines of agricultural statistics and computer applications. The institute would also revisit its role in agricultural research and would keep helping improve the quality of agricultural research by undertaking research in other newer emerging areas.