IASRI
Annual Report-2023

Fourth Paradigm: Data Discovery · Agricultural Statistics · Computer Applications · Bioinformatics · Data Science · Sample Survey · Prediction Servers · Virtual-Reality · Design of Experiments · ICAR-Data Centre · ICAR-Disaster Recovery Centre · Statistical Modelling · Krishi-Megh · Statistical Genetics · Web/Mobile Applications · Data Analytics · Machine Learning · Artificial Intelligence · ASHOKA · Computational Tools · Web Resources

ICAR-Indian Agricultural Statistics Research Institute

Library Avenue, Pusa, New Delhi - 110012

https://iasri.icar.gov.in

ISO 9001:2015 Certified Institute

Annual Report
2023

Compiled and Edited:

Ajit, Prabina Kuma Meher, Upendra Kumar Pradhan and Rajender Parsad

Contents

Advisors / Directors

Dr. P.V. Sukhatme	September 1940 – July 1951
Dr. V.G. Panse	August 1951 – March 1966
Dr. G.R. Seth	April 1966 – October 1969
Dr. Daroga Singh	November 1969 – May 1971
Dr. M.N. Das (A)	June 1971 – October 1973
Dr. Daroga Singh	November 1973 – September 1981
Dr. Prem Narain	October 1981 – February 1992
Dr. S.K. Raheja (A)	February 1992 – November 1992
Dr. R.K. Pandey (A)	December 1992 – May 1994
Dr. P.N. Bhat (A)	June 1994 – July 1994
Dr. O.P. Kathuria	August 1994 – May 1995
Dr. R.K. Pandey (A)	June 1995 – January 1996
Dr. Bal B.P.S. Goel	January 1996 – October 1997
Dr. S.D. Sharma	October 1997 – August 2008
Dr. V.K. Bhatia	August 2008 – February 2013
Dr. U.C. Sud	March 2013 – July 2017
Dr. A.K. Choubey (A).....	August 2017 – January 2018
Dr. L.M. Bhar (A)...........	January 2018 – October 2019
Dr. Tauqueer Ahmad (A)	October 2019 – October 2020
Dr. Rajender Parsad.......	October 2020 onwards

Vision

Statistics and Informatics for enriching the quality of Agricultural Research

Mission

To undertake research, education and training in Agricultural Statistics, Computer Application and Bioinformatics for Agricultural Research

Mandate

- To undertake research, education and training in agricultural statistics, computer applications in agriculture and agricultural bioinformatics
- To provide advisory/consultancy services / methodological support / computational solutions to NARES/NASS (National Agricultural Research and Education System/ National Agricultural Statistics System)

Preface

It is a matter of proud privilege, immense pleasure and great satisfaction to present the Annual Report 2023 (January-December) of ICAR-Indian Agricultural Statistics Research Institute (IASRI). The Institute has been using the power of Statistics, as a science, blended with Informatics and their judicious fusion in agricultural sciences for enhancing the quality of agricultural research and policy planning. The Institute has made notable contributions to research, education and training in the fields of Design of Experiments, Sample Surveys, Statistical Genetics, Forecasting Techniques, Statistical Modelling, Statistical Computing, Computer Applications, Artificial Intelligence and Agricultural Bioinformatics. It has made its presence visibly felt in National Agricultural Research and Education System (NARES) and also occupies a place of pride for methodological development in the National Agricultural Statistics System (NASS). The Institute has been playing the leading role in development of robust Agricultural Knowledge Management Systems for NARES and providing web hosting and e-governance services to all ICAR Institutes through ICAR Data Centre and Disaster Recovery Centre.

This publication highlights some of the glimpses of the research achievements made, new methodologies/ information systems/portals developed, significant advisory services provided, dissemination of knowledge acquired and human resource development.

In pursuit of objectives and mandate of the Institute, research was conducted across 84 projects (29 institute funded, 13 in collaboration with other institutes, and 42 outside funded) including two NAHEP projects funded by World Bank. Over the course of this year, 20 projects have been successfully concluded, while 28 new projects have been launched. The Institute also has a Network Project on Agricultural Bioinformatics and Computational Biology with 20 ICAR Institutes as partners.

A total of 210 Research Papers (on an average 3.2+ papers per scientist), 12 R-packages/Python modules/GitHub repository and 14 biological webservers/databases have been published. Sixteen technologies/methodologies developed by the Institute were awarded certificates on 95th ICAR Foundation and Technology Day. The Institute received 18 copyrights and signed 03 MoUs/Work Plan with various institutions viz. NABARD, Project on Climate Resilient Agriculture, Govt. of Maharashtra, Department of Food and Public Distribution, Ministry of Consumer Affairs, Food and Public Distribution, Govt. of India and Food Corporation of India.

The Institute has adapted to the contemporary needs of agricultural research and policy planning. Among its notable research achievements in 2023 include the development of two-part structurally complete and incomplete designs for Integrated Farming System experiments, mixed level response surface designs to address overlap effects from neighbouring experimental units and compilation of Food Loss Index for India, using data from three post-harvest loss surveys and the FAO methodology. An end-to-end solution to conduct Integrated Sample Survey for estimation of production of four major livestock commodities (milk, meat, egg and wool) consists of eLISS web portal and eLISS data collection App that is being used Pan India by Department of Animal Husbandry and Dairying, Govt. of India. Developed advanced machine learning and computational tools such as RBPLight, ASLncR, and ASmiR for identifying RNA-binding proteins, predicting abiotic stress-responsive lncRNAs, and miRNAs, respectively, that will significantly contribute to the development of stress-resistant crop varieties. The Institute has also developed web-enabled prediction tools for root-associated proteins and compound bioactivity against plant and microbial targets. AgriResponse, a real-time agricultural query-response system, leverages a comprehensive knowledge base to provide timely plant-protection advice to farmers. AI-DISC and AI-DISHA, forefront systems in disease identification for crops and livestock respectively, offer crucial extension support in managing agricultural and livestock diseases. The Institute's commitment to education is evident in strengthened E-Learning Portal, and initiation of NARES-Blended Learning Platform. The Institute has played a lead role in setting up Virtual Reality Experience Labs in 75 universities. These initiatives have broadened access to quality education and fostered a digital-first mind-set.
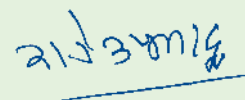
One of the thrust areas of the Institute is human resource development in statistical sciences for meeting the challenges of agricultural research in the newer emerging areas. During the 61st

Convocation of PG School, IARI 29 students received their respective degrees in Agricultural Statistics, Computer Application, and Bioinformatics. The Institute conducted 18 training programmes attended by 3,077 participants, 5 Hindi workshops with 124 participants, and 38 sensitization programs involving 8,205 participants. The Institute also organized an International Conference on the Blended Learning Ecosystem for Higher Education in Agriculture in hybrid mode, partnering with PIU NAHEP. Given the industry's growing demand for data science courses, which combine statistical computing with R, Python and other computing solutions, the Institute initiated training programmes in Data Science. The Institute is blessed with the gracious visit of Dr. Gurdev Singh Khush, World Food Laureate and popularly known as Rice man. Data and information available on KRISHI Portal and KVK Portal have been exchanged through API with Open Government Data Platform, DARPAN, KISAN SUVIDHA App, VISTAAR (Virtually Integrated System To Access Agricultural Resources) and other platforms. KISAN SARATHI an Information Communication and Technology based interface solution received 2.5 lakh calls from the farmers and sent 3.5 crore SMS in the form of agricultural advisories to the registered farmers on this portal.

I am happy to note that some of our colleagues/alumni received academic distinctions from different professional societies and Govt. organisations. The scientists of the Institute have also been contributing as experts in several national level committees.

I wish to extend a heartfelt gratitude to all the senior officers at ICAR Headquarters for their invaluable guidance, encouragement, inspiration, and unwavering support. My sincere appreciation goes out to the Heads of Divisions, scientists, all technical and administrative personnel for their dedication, whole-hearted support, and seamless cooperation in executing the varied functions and activities of the Institute. The significant contributions of colleagues in the PME Cell, notably Dr. Ajit, whose diligent efforts in compiling and ensuring the timely publication of this Annual Report are truly commendable.

I am hopeful that the information contained in this publication would be useful and informative to all stakeholders. We look forward to any suggestions and comments for improvement in presentation of the information.
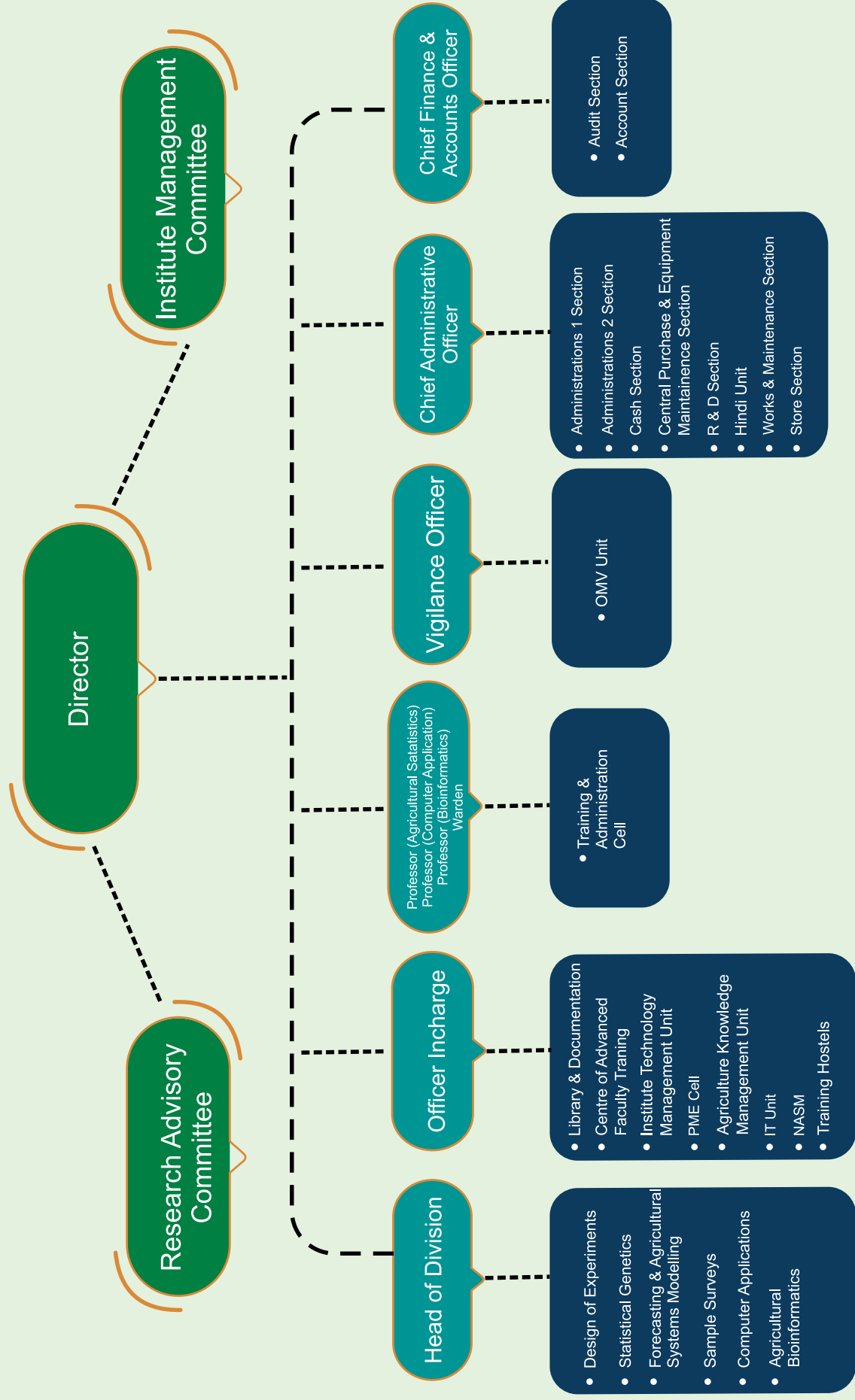
(Rajender Parsad)
Director

Milestones

Year		Milestone
1930	*	Statistical Section created under ICAR (then Imperial Council of Agricultural Research)
1940	*	Activities of the Section strengthened with the appointment of Dr. PV Sukhatme
1943	*	Research in developing techniques for crop yield estimation based on the methods of random sampling initiated
1945	*	Re-organisation of Statistical Section into Statistical Branch headed by a Statistical Advisor as a centre for research and training in the field of Agricultural Statistics and Junior Certificate Course and Senior Certificate Courses started
1949	*	Statistical Branch rechristened as Statistical Wing of ICAR
1952	*	Activities of Statistical Wing further expanded and diversified with the recommendations of FAO experts, Dr. Frank Yates and Dr. DJ Finney
1955	*	Statistical Wing moved to its present campus in own building (presently Sample Survey Block) and Hostel (presently Panse Hostel)
1956	*	Collaboration with AICRP initiated
1959	*	Re-designated as Institute of Agricultural Research Statistics (IARS)
1964	*	Installation of IBM 1620 Model-II Electronic Computer
	*	Panse Hostel for Students
	*	Signing of MOU with IARI, New Delhi to start M.Sc. and Ph.D. degree programmes in Agricultural Statistics
1970	*	Status of a full-fledged Institute in the ICAR system, headed by Director
	*	New Hostel for students (presently Sukhatme Hostel)
1977	*	Three storeyed Computer Centre Building inaugurated
	*	Installation of third generation computer system, Burroughs B-4700
1978	*	Re-named as Indian Agricultural Statistics Research Institute (IASRI)
1983	*	Identified as Centre of Advanced Studies in Agricultural Statistics and Computer Applications under the aegis of the United Nations Development Programme (UNDP)
1985-86	*	M.Sc. (Computer Application in Agriculture) degree programme initiated
1989	*	Commercialization of Statistical Package for Agricultural Research (SPAR 1.0)
1991	*	Burroughs B-4700 system replaced by a Super Mini COSMOS LAN Server
1992	*	Administration-cum-Training Block of the Institute inaugurated
1993-94	*	Nomenclature of M.Sc. (Computer Application in Agriculture) degree changed to M.Sc.(Computer Application)
1995	*	Centre of Advanced Studies in Agricultural Statistics & Computer Application established by Education Division, ICAR
1996	*	Establishment of Remote Sensing & GIS lab
1997	*	Senior Certificate Course in 'Agricultural Statistics and Computing' revived
	*	Establishment of modern computer laboratories
	*	First software in India for generation of design along with its randomised layout SPBD release 1.0
1998	*	Training programmes in Statistics for non-statisticians in National Agricultural Research System initiated
1999	*	Strengthening of LAN & Intranet with Fibre optics & UTP cabling
2001	*	Data Warehousing: INARIS project under NATP initiated
2002	*	Development of PIMSNET (Project Information Management System on Internet) for NATP
2003	*	Development of PERMISnet (A software for Online Information on Personnel Management in ICAR System)
	*	First indigenously developed software on windows platform Statistical Package for Factorial Experiments (SPFE) 1.0 released.
2004	*	National Information System on Agricultural Education (NISAGENET) Project launched
	*	Training Programme for private sector initiated and conducted training programme for E.I. DuPont India Private Limited.
	*	E-Library Services initiated.
2005	*	Statistical Package for Augmented Designs (SPAD) and Statistical Package for Agricultural Research (SPAR) 2.0 released
	*	Design Resources Server with an aim to provide E-advisory in NARES initiated

Year		Milestone
2007	*	Establishment of Agricultural Bioinformatics Laboratory (ABL)
2008	*	Software for Survey Data Analysis (SSDA) 1.0 released
2009	*	Golden Jubilee Celebration Year of the Institute
	*	Strengthening Statistical Computing for NARS initiated
	*	Expert System on Wheat Crop Management launched
	*	International Training Hostel inaugurated
2010	*	Establishment of National Agricultural Bioinformatics Grid (NABG) in ICAR and Centre for Agricultural Bioinformatics [CABin] initiated
2011	*	Indian NARS Statistical Computing Portal initiated
	*	M.Sc. degree in Bioinformatics initiated
2012	*	Software for Survey Data Analysis (SSDA) 2.0 released
	*	Development of Management Information System (MIS) including Financial Management System (FMS) in ICAR initiated
	*	Half-Yearly Progress Monitoring (HYPM) System in ICAR implemented
	*	Sample Survey Resources Server initiated
2013	*	Advanced Supercomputing Hub for OMICS Knowledge in Agriculture (ASHOKA) and National Biocomputing Portal inaugurated
	*	Ph.D. degree in Computer Application initiated
	*	ICAR-ERP system implemented
	*	Ph.D. degree in Bioinformatics initiated
	*	IASRI Campus Wi-Fi enabled
2014	*	FAO Sponsored Study under the Global Strategy for Improvement of Agricultural Statistics initiated (FAO Consultancy in Institutional Mode)
2015	*	KRISHI: Agricultural Knowledge Resources and Information System Hub for Innovations portal launched as ICAR centralized data repository system
	*	Declared as National Level Agency (NLA) under MIDH (Mission for Integrated Development of Horticulture).
	*	ICAR Data Centre, Unified Communication and Web Hosting Services for ICAR established with ISO/IEC 20000 and ISO/IEC 27001 certification
2016	*	KVK-Portal (Krishi Vigyan Kendra Knowledge Network) and Mobile Application (http://kvk.icar. gov.in/) developed and launched.
	*	Developed sampling methodologies for estimation of crop area and yield under mixed and continuous cropping for different situations and field tested in three countries identified by the FAO.
	*	Developed Personnel Management System, for managing the cadre strength and transfer of the scientific staff and implemented in ICAR.
2017	*	Developed guidelines for estimating post-harvest losses of horticultural crops (fruits and vegetables), livestock (meat and milk) and fish (capture and culture fisheries)/fish products
2018	*	Education Portal-ICAR (https://education.icar.gov.in) developed and launched.
2019	*	Webserver and Mobile App, VISTa (Variety Identification System of *Triticum aestivum*) developed
2020	*	Gold Icon Award in Open Data Championship Category from Ministry of Electronics and Information Technology, Govt. of India for ICAR Research Data Management Initiative
		KRISHI-MEGH: The Cloud Hardware Infrastructure and Software Services, as a step forward towards digital agriculture of the 'New India' has been commissioned and launched.
2021	*	KISAAN 2.0 (Krishi Integrated Solution for Agri Apps Navigation) App
	*	Established Virtual Classroom in 18 Agricultural Universities & Agri-Diksha Web Education Channel
	*	Kisan-SARATHI- System of Agri-information Resources Auto-transmission and Technology Hub Interface, initiated in collaboration with Digital India Corporation, MEITY, Govt. of India
		"eLISS Web Portal" and "eLISS Data Collection App" for Integrated Sample Survey Solutions of Major Livestock Products
2022	*	KCC-CHAKSHU (Kisan Call Centre Collated Historically Aggregated Knowledge-based System with Hypertext User-interface) launched
	*	AI-DISC (Artificial Intelligence based Disease Identification System for Crops) App developed
2023	*	E-Learning Portal and Blended Learning Platform (BLP) initiated

ORGANOGRAM

Institute Management Committee

Director

Research Advisory Committee

Chief Finance & Accounts Officer
- Audit Section
- Account Section

Chief Administrative Officer
- Administrations 1 Section
- Administrations 2 Section
- Cash Section
- Central Purchase & Equipment Maintainence Section
- R & D Section
- Hindi Unit
- Works & Maintenance Section
- Store Section

Vigilance Officer
- OMV Unit

Professor (Agricultural Satatistics) Professor (Computer Application) Professor (Bioinformatics) Warden
- Training & Administration Cell

Officer Incharge
- Library & Documentation
- Centre of Advanced Faculty Traning
- Institute Technology Management Unit
- PME Cell
- Agriculture Knowledge Management Unit
- IT Unit
- NASM
- Training Hostels

Head of Division
- Design of Experiments
- Statistical Genetics
- Forecasting & Agricultural Systems Modelling
- Sample Surveys
- Computer Applications
- Agricultural Bioinformatics

1.

Executive Summary

ICAR-Indian Agricultural Statistics Research Institute (ICAR-IASRI) since its inception is mainly responsible for conducting research in Agricultural Statistics to bridge the gaps in the existing knowledge. The Institute has used the power of Statistics, as a science, blended judiciously with Informatics and has contributed significantly to improving the quality of Agricultural Research. The Institute has also been providing education/training in Agricultural Statistics and Informatics to develop trained manpower in the country. The research and education are being used in improving the quality and meeting the challenges of agricultural research in newer emerging areas.

To achieve its goal and mandate, research was carried out under 84 research projects in the Institute {29 Institute funded, 13 in collaboration with other Institutes and 42 outside funded} in various thrust areas. This year 20 projects were completed, and 28 new projects {15 Institute funded, 06 in collaboration with other Institutes and 07 outside funded} have been initiated.

Some other salient research achievements are:

- For the experiments conducted to select the best possible components in Integrated Farming System (IFS), two-part structurally complete and incomplete designs have been obtained through fusion of two incomplete block designs in a systematic manner. For experiments related to IFS involving both crop and livestock components, developed two series of partially balanced t-designs using the triangular association scheme.

- Obtained response surface designs for one factor at 3 levels and other factors at 2 level each for the situations where experimental units experience the overlap effects from immediate left and right neighbouring units.

- Developed a class of resolvable PBIB designs suitable for multi-site varietal trials based on four-associate class association scheme named as Dichotomized Split-Set (DiSS) association scheme.

- For selection of suitable forecasting models and

the determination of appropriate combination of weights, developed a framework using optimization-based ensemble techniques (OptiSembleForecasting) and made available as an R-package.

- Developed a complete ensemble empirical model decomposition with adaptive noise based hybrid machine learning algorithm combined with stochastic models to capture the volatility of weekly potato price in major markets of India.

- Food Loss Index estimates for India has been calculated employing 12 commodities using the FAO methodology and the data generated through three post-harvest losses surveys conducted during 2005-07, 2012-14 and 2020-21 and all the 45 commodities common to all the three surveys. Steps of year wise decrement method has been suggested for imputing the index during intervening years.

- Developed additional modules for (i) updating the sampling frame of villages/urban wards covering all districts and State/UTs of the country; (ii) re-allocation module for allocating village/urban wards to another enumerator in ongoing survey along with the previously collected data and integrated with eLISS data collection App. This is being used Pan India by Department of Animal Husbandry and Dairying, Govt. of India to conduct Integrated Sample Survey for estimation of production of four major livestock commodities (milk, meat, egg and wool).

- Sampling methodology on GWR-based model calibration estimators for the population total of the study variable has been developed within the context of geo-referenced complex survey designs, when complete auxiliary information along with their spatial locations is available at population level.

- Published Agricultural Research Data Book (ARDB) 2023, twenty sixth edition in the series. It is divided into 10 sections for the purpose of convenience of the users and provides information on natural resources, agricultural inputs, animal husbandry, dairying, fisheries, horticulture, production, productivity, agricultural

engineering, export, import, place of India in world agriculture, investment in agricultural research and human resources. Two tables related to installed capacity of electricity generation and item-wise marine export have been included for the first time.

- Developed machine learning based computational tools (i) RBPLight: to identify RNA binding proteins; (ii) ASLncR: for predicting abiotic stress responsive lncRNAs and (iii) ASmiR: for abiotic stress-specific miRNAs prediction in cereals, pulses, oilseeds, vegetables, fruits and commercial crops and will contribute to the development of abiotic stress resistance improved crop varieties.

- Developed (i) a computational method using machine learning approach to identify species-specific DNA-binding proteins (DBPMod); (ii) web-enabled prediction tool SVM-Root for the root-associated proteins to supplement the existing experimental methods and high throughput GWAS and transcriptome studies and (iii) web-application for prediction of compound bioactivity against plant and microbes target proteins interaction (PhytoMicroBioPred).

- Developed shiny based web application Advanced Tool for Differential Expression Analysis in Proteomics for detecting differentially expressed features in proteomics expression data considering heterogeneity, missing values, and accommodating complex experimental design.

- Developed AgriResponse: A Real-Time Agricultural Query-Response Generation System for assisting nationwide farmers using a comprehensive knowledge base from eight years of farmers' helpline call logs and designed to support Indian farmers by providing timely plant-protection advice. Tested on a question bank covering 151 crops, the system's performance is evaluated using metrics like accuracy, crop-weighted performance, and response time.

- Strengthened AI-DISC: Artificial Intelligent based Disease Identification System for Crops by adding models for identification of new diseases and pests in crops. Presently AI-DISC is enabled for identification of 55 diseases of 20 crops and 19 insects for 3 crops using image data.

- Strengthened E-Learning Portal through collaborative approach wherein the faculty of various universities came together to create and curate self-learning modules. This portal hosts 74 PG and 164 UG Courses.

- Strengthened KISAN SARATHI in association with Digital India Corporation, MEITY, Govt. of India. A total of 1.1 crore farmers got registered on this portal.

- Developed AI-DISHA: Artificial Intelligent based Disease Identification for Livestock to identify visible diseases in livestock. Presently AI-DISA can identify the Foot and Mouth Disease, Mastitis and Lumpy Skin Disease in Bovines and Canine Distemper, Canine Parvo Virus, Rickets, Mange and Mamary Tumour in Canines.

- Developed conversational virtual agents 'Chatbots' named SHRIA-Smart Heuristic Response based Intelligent Assistant for improving livestock, pet, poultry health and production in association with ICAR-IVRI, Izatnagar. "Dairy SHRIA" to address various health and production management concerns regarding cattle and buffalo and "Sheep and Goat SHRIA" for sheep and goats.

- KRISHI Portal has been enriched by adding and updating the Krishi Links of several online resources available/developed at different ICAR Institutes under the categories Databases and Portals, Management Information Systems and Dashboard. KRISHI Portal as Central Research Data Repository has been referred as Good Practice by Data Governance Quality Index 2.0 DMEO NITI AAYOG. ICAR Data Inventory URL for data availability is accepted by reputed Journals like other International Data Repositories such as Mendley Data. This portal has also been shared with BIMSTEC Countries.

- Information System for AICRP on Weed Management was launched during XX Annual Review Meeting of AICRP on weed Management held at SKUAST, Jammu.

- Developed NARES-Blended Learning Platform to inculcate a digital first mind amongst learners and faculty and to act as a catalyst for introducing more engaging forms of classroom instruction while also providing flexible learning mechanisms to learners. It has been successfully implemented in 76 Agricultural Universities

- thereby signifying the wide acceptance of platform amongst stakeholders. A total of 59 2D/3D (PG courses: 12, UG courses: 47) digital contents have been developed.

- Virtual Reality (VR) Experience Labs have been operationalized across all 75 universities with the enabling hardware and software infrastructure including VR kits. Creation of VR infrastructure was complimented with 14 training sessions attended by more than 5,300 participants, both faculty and students.

- Strengthened National Image Base for Plant Protection (NIBPP) & National Image Base for Livestock Diseases (NIBLD). At present there are 4.91 lakhs images of 66 crops with 242 diseases and 373 pests in NIBPP and 41,772 images of 31 diseases of 11 livestock in the NIBLD.

- Artificial intelligence based algorithms for detection of Mastitis disease in Murrah buffalo and Tharparkar cow has been developed using their thermal image.

- Developed NAAS-Fellowship Online Scorecard Information System (NFOSIS) to streamline the application process for candidates applying to various fellowships and awards, including both Fellowships (National Fellow, Pravasi Fellow, Foreign Fellow) and Awards (Young Scientist Award, Memorial Award, Recognition Award, Endowment Award) through NAAS Academy.

- Developed Financial Assistance Management System for Conference and Journals (FAMSCJ), an online workflow based system for managing financial grants given by ICAR to scientific societies in collaboration with Technical Coordination Unit of ICAR. The System was launched by Dr. Himanshu Pathak, Honourable Secretary, DARE and Director General, ICAR.

- Data and information available on KVK Portal has been exchanged with API with other Portals such as DARPAN and KISAN SUVIDHA App.

- During the reported period of 2023, 12 R-packages/Python modules/GitHub repository and 14 biological webserver/databases have been developed in different areas of Agricultural Statistics, Computer Applications and Agricultural Bioinformatics.

- The Institute received 18 copyrights during the year. The Institute has published 210 research papers in national and international peer reviewed journals (155 in Journals with NAAS Score > 6.0), 4 Edited Book/Proceedings, 18 book chapters, 10 popular articles along with other publications. On an average each scientist published 3.15 research papers (2.31 research papers per scientist in Journals with NAAS Score > 6.0). Average NAAS score per research paper is 8.09.

- During the reported period of 2023, in all twenty nine (29) students completed their degree programmes (05 and 08 students of M.Sc. and Ph.D. courses in Agricultural Statistics; 05 and 02 students of M.Sc. and Ph.D. courses in Computer Application; 04 and 05 students of M.Sc. and Ph.D. courses in Bioinformatics). Also 23 students of different Universities/Institutes worked in internship programmes as project trainees for their Graduation/Post Graduation dissertation work.

- Various training programmes and workshops were conducted during the year in different area of Agricultural Statistics and Informatics. Over all 18 training programmes (3,077 participants), 5 Hindi workshops (124 participants) and 38 sensitization programmes (8,205 participants) were conducted by the Institute.

- Organized International Conference on Blended Learning Ecosystem for Higher Education in Agriculture in Hybrid Mode as lead Institute and PIU NAHEP as partner. A total of 3,412 participants (2,505 male and 907 female) registered for this conference, attending either in person or through online platforms.

- Organized (i) XXVII Meeting of ICAR Regional Committee-V in hybrid mode; (ii) 4th Workshop on Applied Deep Learning (IWADL) in hybrid mode jointly with BITS, Goa, Indian Institute of Technology, Mandi and ICAR-IASRI, New Delhi on Blended Learning Platform; (iii) online workshop on Statistical Meta-Analysis; (iv) online workshop on Statistical Data Integration; (v) online workshop on Celebrating Statistics in Memory of Professor CR Rao. Two guest seminars were also organized.

- Sixteen technologies/methodologies developed by the Institute were awarded certificates during ICAR Foundation and Technology Day. Two of these technologies AI-DISC and KCC-CHAKSHU were selected among the 5 best technologies of Agricultural Education Division, ICAR.

- The following achievements of the Institute were included in DARE/ICAR significant achievements 2014-2023: Agricultural Education Portal; ICAR Data Centre (DC) having HCI infrastructure & GPU Server; ICAR Disaster Recovery Centre (DRC); Virtual Classrooms in Agricultural Universities; Agri-DIKSHA Web Education Channel; Sampling methodologies for estimation of harvest, post-harvest losses of horticultural crops, livestock, and fisheries; Integrated sampling methodology of crop yield estimation for Crop Insurance; KRISHI Portal; eLISS Web Portal and eLISS Data Collection App; KISAN SARATHI; KCC-CHAKSHU (Kisan Call Centre-Collated Historically Aggregated Knowledge-based System with Hypertext User-interface); Aggregator Mobile App KISAAN 2.0 (Krishi Integrated Solution for Agri Apps Navigation); KVK portal and KVK App.

- Director's Interview on Role of ICAR-IASRI in the Service of the Nation was broadcasted in Kisan Samachar on DD KISAN Channel.

- Institute Annual Day was celebrated in gracious presence of Dr. Himanshu Pathak, Honourable Secretary, DARE and Director General, ICAR as Chief Guest; Dr. R.C. Agrawal, DDG (Agricultural Education), ICAR & ND (NAHEP), Guest of Honour and Dr. Santanu Chaudhury, Director, IIT Jodhpur as distinguished speaker of 33rd Nehru Memorial Lecture.

- Institute also celebrated Republic Day, National Science Day, International Women's Day, Environment Day, 17th National Statistics Day followed by a walkathon, Independence Day, Teachers Day, Swachhata Campaign 3.0, Vigilance Awareness Week, Constitution Day, Sadbhawana Diwas, Swachhata Pakhwada and Kisan Diwas. Hindi Pakhwada was organized during September 14- 30, 2023.

- Our distinguished guests were World Food Laureate Dr. Gurdev Singh Khush; Honourable Minister of Agriculture Sh. Narender Singh Tomar; Smt. Nikhil Raksha Khadse, Member of Parliament, Raver Lok Sabha (Maharashtra); Honourable Secretary DARE and Director General, ICAR Dr. Himanshu Pathak and Dr. Santanu Chaudhury, Director, IIT Jodhpur.

- Tree Saplings of Chandan (*Santalum Album*) was planted by Dr. G.S. Khush, World Food Laureaute. Tree Saplings of Rudrakash were planted by Dr. Himanshu Pathak, Secretary, DARE and DG, ICAR, Dr. Santanu Chaudhury, Director, IIT Jodhpur and Dr. R.C. Agrawal Deputy Director General (Agricultural Education), ICAR. Sapling of Ashok Tree was planted by Dr. Pankaj Mittal, Secretary General, Association of Indian Universities. Initiated a medicinal garden as part of celebrations of Meri Maati, Mera Desh.

- Dr. Anil Rai has been selected as Assistant Director General (ICT), ICAR and Dr. Anil Kumar as ADG (Technical Coordination), ICAR.

- The Institute has signed 03 MoUs (Memorandum of Understanding) and Work Plan with various institutions viz. National Bank for Agriculture and Rural Development, Mumbai; Project on Climate Resilient Agriculture, Govt. of Maharashtra and Department of Food and Public Distribution, Ministry of Consumer Affairs, Food and Public Distribution, Govt. of India and The Food Corporation of India, Head Quarters, New Delhi.

2. Introduction

ICAR-Indian Agricultural Statistics Research Institute (IASRI) started its journey as a Statistical Section in 1930 in the then Imperial Council of Agricultural Research, has grown in size and stature to a premier Institute to conduct research, education and training in the field of Statistical Sciences (Statistics, Computer Applications and Bioinformatics). ICAR-IASRI has been mainly responsible for conducting research in Agricultural Statistics and Informatics to bridge the gaps in the existing knowledge. The Institute also conducts M.Sc. and Ph.D. degree courses in Agricultural Statistics, Computer Applications and Bioinformatics in collaboration with PG School (now Graduate School) IARI, New Delhi. The Institute also conducts customized and sponsored training courses in Agricultural Statistics and Informatics at National and International level so as to be a leading Centre of Excellence in Human Resource Development. The Institute provides advisory and consultancy services for strengthening the National Agricultural Research and Education System (NARES) and undertakes sponsored research and consultancy for National and International organizations. The methodological support is also provided for strengthening National Agricultural Statistics System (NASS). The Institute has been playing the leading role in development of robust Agricultural Knowledge Management Systems for NARES.

The Institute has used the power of Statistics, as a science, blended with Informatics and their judicious fusion in agricultural sciences for enhancing quality agricultural research, to meet the challenges of agricultural research in newer emerging areas and informed policy decision making. The present main thrust of the Institute is to conduct basic, applied, adaptive, strategic and anticipatory research in Agricultural Statistics and Informatics, to develop trained manpower and to disseminate knowledge and information produced so as to meet the methodological challenges of agricultural research in the country.

ICAR-IASRI has also become a leader in innovative data management by establishing Advanced Supercomputing Hub for Omics Knowledge in Agriculture (ASHOKA), ICAR-Data Center, Krishi Megh (National Agricultural Research & Education System-Cloud Infrastructure and Services). Setting up an advanced teaching-learning environment in Agricultural Higher Education through Academic Management System (AMS), Agri-Diksha Web Education Channel, Virtual Classrooms in all AUs, and AR/VR Experience Centers is providing new age educational technologies in NARES. ICAR received Gold Icon Award in open data championship category-2020 from Ministry of Electronics and Information Technology (MEITY), Govt. of India for ICAR Research Data Management (KRISHI Portal).

Food and Agriculture Organization (FAO) of the United Nations has given several research and/or consultancy projects to the Institute. Besides, many research projects of Government and Public Sector agencies like Department of Science and Technology, Directorate of Economics and Statistics, Department of Animal Husbandry and Dairying, Department of Biotechnology, Department of Agriculture and Farmers Welfare, Planning Commission, Network for Scientific Cooperation for Food Safety and Applied Nutrition (NetSCoFAN), Food Safety and Standards Authority of India (FSSAI), Mahalanobis National Crop Forecast Centre (MNCFC), Ministry of Statistics and Programme Implementation (MoSPI), Coconut Development Board, Protection of Plant Varieties and Farmers Right Authority (PPVFRA) : Department of Food and Public Distribution (DFPD) Ministry of Consumer Affairs, Food Corporation of India (FCI) ; Directorate of Economics & Statistics (DES), Govt. of Meghalaya; have been undertaken by the Institute. Some of these projects were taken on request from several Government agencies and others were awarded through competitive bidding. The Institute works in close collaboration with all NARES organizations (All ICAR Institutes, SAUs, AICRPs and KVKs) and many projects are being run in collaboration with All India Co-ordinated Research Projects, ICAR Institutes and SAUs. Further linkages with the CGIAR organizations such as CIMMYT, IRRI, ICARDA, ICRAF and BMGF have been developed. For further strengthening the collaborations, in last four years, the Institute has signed 10 MoUs (Memorandum of Understanding) and LoAs (Letter of Agreement) with various institutions which include University of Agricultural Sciences (UAS), GKVK Campus, Bengaluru and Punjab Agricultural University, Ludhiana for virtual reality modules; Association of Innovation Development for Entrepreneurship in Agriculture, Centre for Agri-Innovation (a-IDEA) ICAR-NAARM, Hyderabad; CSIR- National Botanical Research Institute, Lucknow for genomic data analysis

generated on cotton crop yield; Food and Agriculture Organization of the United Nations (FAO-India) to Review Food Loss Index estimates and Agricultural Scientists Recruitment Board (ASRB), Department of Food and Public Distribution, New Delhi; National Bank for Agriculture and Rural Development (NABARD); Project on Climate Resillient Agriculture (POCRA) Nanaji Deshmuk Krishi Sanjivani Prakalp. Govt. of Maharastra, RLBCAU, Jhansi and BASU, Patna for FMS development; Agricultural Scientists Recruitment Board for development of Online Application & Scorecard Information System.

The Institute organized VIII International Conference on Agricultural Statistics (ICAS) during 18-21 November 2019, in which 500+ delegates from 108 countries participated. The Conference was inaugurated by Mr. Bill Gates.

Significant Research Achievements and Impact

The Institute has made some outstanding and useful contributions to research in Agricultural Statistics (Design of Experiments, Statistical Genetics, Forecasting Techniques, Statistical Modelling, Sample Surveys), Computer Applications, and Agricultural Bioinformatics. The Institute has conducted basic and original research on many topics of interest and has published number of papers in national and international journals of repute. The Institute has been providing and continues to provide support to the NARES by way of analyzing voluminous data using advanced and appropriate analytical techniques. The Institute has also been very actively pursuing advisory services that have enabled the Institutes to enrich the quality of agricultural research in the NARES. Through its advisory, the Institute has made its presence visibly felt in NARES and now experimenters look to ICAR-IASRI for designing experiments and analysis of experimental data. The Registrar Copyrights Authority of India has granted copyrights to 86 publications/softwares/information - systems / web resources / portals/ databases, etc. with the Institute as lead Centre and 40 as collaborator with other organizations as lead. The scientists of the Institute have also been co-developers for 04 wheat germplasms registered by Plant Germplasm Registration Committee, ICAR for drought tolerance with higher antioxidant (1.8 fold) activity; resistant to stripe rust pathotypes 46S119 and 47S103 for resistant to terminal heat tolerance respectively. The Institute is a partner in one Patent filled.

A brief discussion on the research achievements of

the Institute in different areas of Agricultural Statistics and Informatics are outlined below.

Design of Experiments

The Institute has made many notable contributions in both basic research and innovative applications of the theory of statistical designs and analysis of experimental data. Experimental designs have helped in navigating from varietal trials to varieties and package of practices, translating varieties into enhanced crop production, by harnessing and detecting technologies and identifying conditions that optimize the response. Some significant developments are

- Designs for Single Factor Experiments which include variance balanced; efficiency balanced block designs; α-designs; designs for making test treatments-control treatment(s) comparison; designs with nested factors; structurally p-rep designs; incomplete row-column designs; row-column designs in two-rows; semi-latin squares; designs for multi-response experiments; designs for 2-line and 4-line crosses, crossover designs; neighbour balanced designs and optimality and robustness aspects of designs.

- Designs for Factorial Experiments which include confounded designs for symmetrical and asymmetrical factorials; block designs with orthogonal factorial structure and balance useful for crop sequence experiments; designs for incomplete factorial treatment structure and fractional factorial designs for scarce experimental resources; response surface designs; mixture experiments for single and multifactor experiments; orthogonal main effect plans; orthogonal arrays and supersaturated designs.

- Computer aided construction of efficient designs for various experimental settings.

- Designs for biological assays; designs for microarray experiments; designs for agroforestry experiments; designs for multistage trials and designs for integrated farming systems research.

- Diagnostics in designed field experiments led to improvement in statistical designing and data analytical techniques in NARES.

- Planning, designing and analysis of several AICRPs including IFS Research (both on station and on farm trials), Soil Test Crop Response, Long Term Fertilizer Experiments, Vegetable Crops, Sorghum, Small Millets, Maize, Oilseeds, Weed Management and others.

- Rigorous advisory and persuasion efforts have led to the adoption of modern efficient designs for experimentation and sophisticated analytics of the data generated by the researchers in the NARES, which has helped in improving the quality of agricultural experimentation. The bulletin on significance of statistical designs in agricultural research is a pocket diary for agricultural scientists as it defines the designs actually used. Following efficient designs and analytical techniques have been adopted by the researchers in NARES:

  - Resolvable Block Designs {alpha-(α-) designs, Rectangular Lattice designs, Reinforced Lattice designs} for varietal improvement programmes adopted in crop improvement trials and led to reduction in coefficient of variation of the initial varietal trials and enhanced precision on treatment comparisons.

  - Designs for crop sequence experiments (extended group divisible designs, balanced confounded factorial designs) have been helpful in estimation of the residual and direct effects of treatments applied in different seasons with more precision. Fractional factorial plans have also been used in experiments conducted to prepare super absorbent composites.

  - Modified and/or second order rotatable response surface designs with equispaced doses are being used in food processing experiments and for determining optimum combination of input factors. Semi-latin square type response surface design is used by AICRP on STCR for obtaining fertilizer response relationship and obtaining contribution of organic manures in smaller number of experimental units.

  - Balanced incomplete block designs was adopted by then AICRP on Cropping Systems Research in On-Station Research Programmes, IIFSR (earlier Project Directorate of Cropping Systems Research), Modipuram.

  - Linear programming approach developed for estimating/ projecting energy requirements in agricultural sector has been exploited for the analysis of countrywide data by then AICRP on Energy Requirement of Agricultural Sector.

  - Variance component estimation from unbalanced data has encouraged the experimenters in NARES in the usage of incomplete block designs.

  - Statistical analytical techniques of experimental data from experiments in which it is difficult to change the levels of one of the factors has helped in drawing statistically valid conclusions from post-harvest storage studies on fruits, vegetables, flowers, seed technology experiments and experiments with different water regimes.

  - Experiments with mixtures have been used for experiments with fixed quantity of inputs and ready to serve fruit beverage experiments etc.

  - Analytical techniques based on mixed effects models and SREG biplot developed for the analysis of data generated from farmers participatory trials for resource conservation agriculture have been used by rice-wheat consortium for Indo-Gangetic plains for drawing statistically valid conclusions.

Sample Surveys

The subject of sampling techniques helps in providing the methodology for obtaining precise estimates of parameters of interest. The Institute is involved in evolving suitable sample survey techniques for estimation of various parameters of interest relating to crops, livestock, fishery, forestry, horticulture, perishable commodities like flowers, vegetables and allied fields.

- Significant contributions made in theoretical aspects of sample surveys include successive sampling; systematic sampling; cluster sampling; sampling with varying probabilities; controlled selection; balanced sampling plans excluding contiguous units; distance balanced sampling plans; ranked set sampling; inclusion probability inversely proportional to size sampling; nested stratified sampling; non-sampling error; analysis of complex surveys; various methods of estimation such as ratio, regression and product methods of estimation; calibration based methods of estimation, use of combinatorics in sample surveys; innovative approaches for small area estimation in skewed data situations for agricultural, income and expenditure surveys; for spatial non-stationarity under area level model; other socio-economic and food insecurity parameters as well as use of calibration approach in developing improved estimators.

- Following sampling methodology have been developed and widely used for

  - crop yield estimation using crop cutting

experiments (CCE) has been adopted in general crop estimation surveys in India and is also being widely adopted in African and Latin American Countries.

- cost of cultivation studies for major crops is being used in 19 states of the country.
- Integrated sample surveys (ISS) for livestock products estimation is being used throughout the country by Department of Animal Husbandry and Dairying, Govt. of India.
- estimation of harvest and post-harvest losses of major crops and commodities have been successfully adopted in AICRP on Post Harvest Technology, Ministry of Food Processing, Govt. of India in 3 National Level Surveys.
- estimation of post-harvest losses of horticultural crops (fruits and vegetables), livestock (meat and milk) and fish, field tested in Mexico, Zambia, Nepal and Thailand and accepted by FAO and UN member countries.
- estimation of crop area, yield and production under mixed, repeated and continuous cropping, field tested in Indonesia, Rwanda and Jamaica and accepted by FAO.
- Agriculture Census and generating estimates for parameters of interests for Lao, PDR has been implemented.
- Integrated methodology for estimation of multiple crop area of different crops in north-eastern hilly regions using remote sensing data has been used in Meghalaya, Tripura and North-Eastern States
- estimation of cotton production using double sampling approach has been used in nine major cotton growing states.
- Alternative methodology for estimation of area and production of horticultural crops has been used by Haryana.

- The sample survey methodology for imported fertilizer quality assessment, estimation of private food grains stock at farmers level, estimation of fish catches from marine and inland resources, flower production estimation, fruits and vegetable survey, estimation of seed, feed and wastage ratios of major food grains, etc. has been developed and passed on to the user agencies.

- Reappraisal of sampling methodologies, evaluation and impact assessment studies like studies to make an assessment of integrated area development programmes, sampling methodologies for identifying constraints of adoption in high yielding varieties and

evaluating the impact of Green Revolution, dairy improvement programmes, evaluation of cotton production estimation methodology etc. have been undertaken. Most of the methodologies developed are being adopted for estimation of respective commodities by the concerned state departments.

- The Institute is regularly publishing the Agricultural Research Data Book since 1996. It contains information pertaining to agricultural research, education and other related aspects compiled from different sources.

- The methodologies developed have potential applications in (a) AICRP on (i) Residues; (ii) Ergonomics; (iii) Energy in Agriculture and Agro-based industries and (b) integration of technologies and CCEs for providing estimates at GP (Gram-Panchayat) level for PMFBY (Pradhan Mantri Fasal Bima Yojna).

Statistical Genetics and Bioinformatics

The Institute has made very significant contributions in statistical genetics/ bioinformatics/genomics for improved and precise estimation of genetic parameters, classificatory analysis, genetic divergence and computational biology, etc.

- Developed procedures for estimation of genetic parameters from military dairy farm data; construction of selection indices; studying G×E interactions; progeny testing and sire evaluations; detection of QTLs, classification of genotypes using molecular marker data and QTL environments interactions etc. These procedures are being used in crop and animal improvement programmes.

- 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.

- The Institute has initiated research in the newer emerging area of statistical genomics such as rice genome functional elements information system; comparative genomics and whole genome association analysis.

- Supercomputing facility (Advanced supercomputing Hub for OMICS Knowledge in Agriculture) for high performance computing in the field of agricultural bioinformatics and computational biology has been established.

- Developed National Agricultural Biocomputing Portal for a single point of access to High Performance Computing (HPC) resources for all NARES users. It has given a big leap in terms of computational biology and developed 100+ biological databases/ analytical tools, web servers, prediction tools which include 16 microsatellite databases; 27 genomic and proteomic resources; 14 Transcriptome Databases; 45 Software tools and web servers and 09 Algorithms and Methodologies.

- A network project on Agricultural Bioinformatics and Computational Biology with 20 ICAR Institutes as partner is also being implemented for generation of lab data and also validation of results based on in-silico analysis. The Institute has also been established Centre for Bioinformatics and Computational Biology in Agriculture-BIC (Funded by Department of Biotechnology).

Statistical Modelling and Forecasting

Forecasting of crop yields, prices, production and forewarning of pests and diseases is carried out using linear and non-linear models, discriminant function approach, markov chain approach, Bayesian approach, within year growth models, non-parametric regression, structural time series, fuzzy regression, neural network and machine learning approaches. Pre-harvest forecasting models of crop yields have been developed using data on weather parameters, agricultural inputs, plant biometric characters and farmers' appraisal. Following have been widely adopted.

- Weather Indices based models have been used for forecasting agricultural output using space, agrometeorology and land based observations (FASAL) by Indian Meteorological Department and Mahalanobis National Crop Forecast Centre. This model has also been integrated in Weather Indices based Automated Yield Forecasting System (WIAYFS).

- Methodologies for forewarning important pests and diseases of different crops have been developed which can enable the farmers to use plant protection measures judiciously and save cost on unnecessary sprays. Forewarning models for aphid (mustard) have been used by Directorate of Rapeseed and Mustard Research, Bharatpur to provide forewarning to farmers consecutively for three years. Forewarning models for Powdery mildew (Mango crop) have been used by ICAR-CISH, Lucknow.

- Developed models have potential applications in long term projections of food grain production, aphid population, marine fish production etc.

- Technology forecasting methods such as scenario creation, Delphi survey and cross impact analysis, technology road-mapping, analytic hierarchy process (AHP) etc. have been employed in various sub-domains of agriculture.

The Institute has also made significant contributions in understanding the complex economic relationship of the factors like transportation, marketing, storage, processing facilities; constraints in the transfer of new farm technology to the farmers' field under different agroclimatic conditions of the country. Some of the important contributions of the Institute are measurement of indemnity and premium rates under crop revenue insurance, production efficiency and resource use, impact of micro-irrigation, technological dualism/ technological change, return to investment in fisheries research and technical efficiency of fishery farms, the impact of technological interventions, price spread and market integration, price volatility and the dietary pattern of rural households.

Information Communication Technology: Infrastructure and Applications

The Institute has a rich legacy of computing starting from 1964 with IBM-1620 Model-II Electronic Computer in Data Processing System to a third-generation computer Burroughs B4700 Mainframe Computer in 1977. It was upgraded to Burroughs B4700 Mainframe Computer with 14 Terminals in 1983. Personal computers were introduced in 1991 with Pentium in 1997. In 2002, RISC servers were introduced.

The Institute developed a blue print of KRISHI-NET-a nation wide agricultural research and education information system in 1989 (later known as ARIS, AKMU etc).

In 1960s and 1970s, when the computing facilities were not or scarcely available elsewhere, the entire NARES depended on the computing facilities of the Institute and many agricultural researchers used this facility for advancement of new technologies. This has been further enhanced by creating a healthy Strengthening Statistical Computing Environment for NARES in 2010, Web Resources such as Design Resources Server, Sample Survey Resources Server for e-advisory and e-learning and Indian NARS Statistical Computing Portal for providing service-oriented computing.

A National Agricultural Bioinformatics Grid (NABG), the first supercomputing hub for Indian Agriculture i.e. Advanced Supercomputing Hub for OMICS Knowledge in Agriculture (ASHOKA) built in a state-of-art Data-Centre for high performance computing in the field of agricultural bioinformatics and computational biology was established in 2013. Out of nine super-computers of this grid, two super-computers were then ranked at 11 and 24 in the then list of top super-computers of India. At present ASHOKA has: 30 Nodes/1200 cores ~92 TF), 16 Nodes/192 cores as Big Data; 03 GP-GPU Nodes (~34 TF); 144 cores with 3.0 TB RAM as SMP (~10TF); 128 cores with 1.0 TB Ram as SMP; 64 cores with 1.5 TB RAM as SMP and Storage Capacity: 700 TB + 100 TB. GP-GPU and SMP Clusters are being upgraded with enhanced capacity.

ICAR Data-Centre is operational since September 10, 2014 was inaugurated on December 21, 2016. ICAR Data Centre is certified as ISO/IEC 27001:2013 for Information Security Management System and ISO/IEC 20000:2011 for IT Service Management System. The facilities are built in a state-of-art Data Centre, currently equipped with industry standard 3165 Core Computer, 26798 GB RAM, 6872 TB Storage, 351 devices, Software, Application, Tools and other related technologies. Out of this 1362 Core, 7726 GB RAM, 400 TB Storage is for traditional computing; and 1563 Core,17792 GB RAM, 6451 TB storage for hyperconverged infrastructure (HCI) computing. To pace with the emerging technologies and to provide computational solutions to NARES, Artificial Intelligence (AI) resources have been built in ICAR-DC at the institute having 240 Core, 17 Tesla V100 GPU, 84070 CUDA Core, 10880 Tensor Cores, 21 TB SSD, 1280 GB RAM having buddle of latest AI/Deep learning software /tools kits.

ICAR DC has been continuously providing the unified communication (and webhosting service to ICAR and its Institutes. For unified icar.gov. in domain email ID, there are 24,000+ users. The listed DNS, Portals, Websites, Modules, Systems and Applications are being maintained and hosted at ICAR-DC. At present 400+ applications are hosted on DC. ICAR email is being used as 'Single Sign on' using LDAP authentications in various applications like e-Office, e-HRMS, SPARROW, PMS, FVMS, TMIS, KRISHI Portal, ARMS and others hosted on ICAR-DC.

In the continued expansion of ICAR DC, Cloud Computing (KRISHI Megh) at ICAR-IASRI along with Disaster Recovery Centre (DRC) at NAARM, Hyderabad was established in August 2020. For providing transparency in day-to-day work of the ICAR/Institute, ICAR-ERP (Enterprises Resources Planning) system has been implemented with the MIS-FMS (Financial Management, Project Management, Material Management, Human Resource Management and Payroll System modules). The Institute has developed/ implemented/ maintains critical ICT applications of the Council through ICAR DC, Disaster Recovery Centre and ASHOKA which includes e-Office, SPARROW, ICAR-ERP/FMS/MIS, etc. During Covid period, for smooth functioning of academic activities, MS Teams services were provided through Enterprise-wide complementary license.

Notable contributions have been made in introducing computer culture in agricultural research and human resource development in information technology in the ICAR. The Institute has the capability of development of Information Systems, Decision Support Systems, Expert Systems, Portals, Mobile Apps and Artificially-Intelligence-based applications. The Institute has so far developed 65+ web applications including 27 Mobile apps with 15 million+ page views. More than 50+ R Packages have been developed. These systems are helpful in taking the technologies developed to the doorsteps of the farmers. The stakeholders for these applications are students, scientists, government officials, farmers, etc. Some important among these are:

Web-based Knowledge Resources, Statistical Packages and Service Oriented Computing

- For dissemination, e-learning and e-advisory for scientists in NARES, developed Design Resources Server (https://drs.icar.gov.in) and other web solutions for generation of experimental designs and online analysis of experimental data for different experimental settings which are being viewed across the globe and have helped in changing the status of experimentation/survey in NARES.

- Indian NARS Statistical Computing Portal for service-oriented data analysis which is available to NARES researchers through their Campus/ Institute network

- Statistical Packages developed by the Institute include Statistical Package for Balanced Incomplete Block Designs (SPBD); Statistical

Package for Factorial Experiments (SPFE); Statistical Package for Augmented Designs (SPAD); Software for Survey Data Analysis (SSDA); Statistical Package for Animal Breeding (SPAB) and Statistical Package for Agricultural Research (SPAR). Besides the above SAS macros/R Packages have also been developed.

- Other web resources include estimation of compound growth rate, Fuzzy C-means clustering and GRAPES: General R-shiny based Analysis Platform Empowered by Statistics (With KAU, Vellayani); Online Analysis of Block Designs, Web Generation and Analysis of Partial Diallel Crosses, Web Generation of Designs Balanced for Indirect Effects of Treatments. etc.

Knowledge and Data Management Portals

- KRISHI Portal: Agricultural Knowledge Resources and Information System Hub for Innovations Empowering Knowledge Management as Central Research Data Repository for publications, technologies, unit level data, video, audio, mobile apps, IP resources (patents, copyrights, variety registration), varieties developed, image, geo-portal;, MasterVocab, Infogaraphics Dashboard including Institute and Scientist Profile; single window access to ICT initiatives. Received Gold Icon Award in Open Data Champion category from MEITY, Govt. of India. This has also been referred as Good Practice for ICAR/DARE as Central Data Repository in Data Governance Quality Index 2.0 report of Development Monitoring and Evaluation Office (DMEO), NITI AAYOG.

- KCC-CHAKSHU (Kisan Call Centre- Collated Historcally Aggregated Knowledge-based System with Hypertext User-interface): Provides Insights and Alerts: 35 Million+ Queries call logs from KCC data (available through APIs on the open data platform).

- Artificial Intelligence based Disease Identification System for Crops (AI-DISC App): Identifies 50 diseases of 19 crops (Rice, Wheat, Maize, Tomato, Mustard, Cotton, Brinjal, Apple, Peach, Kinnow, Mandarin, Assam Lemon, Chickpea, Green gram, Cluster bean, Moth bean, Chilli, Coriander etc.) once the image in natural background is uploaded.

- KVK Portal and KVK App: provides basic information and facilities of KVK, District Agricultural Contingency Plan, Upcoming, Ongoing and Past Events organized by KVKs, Package of Practices related to Crop, Horticulture and other enterprises, access to Agrometeorological advisory and Agricultural Commodity Market prices to farming community. Information also shared with Kisan Suvidha App.

- KISAN SARATHI: System of Agri-information Resources Auto-transmission and Technology Hub Interface, ICAR Powered by: Interactive Information Dissemination System (IIDS), DIC, MeitY, Govt. of India: (ICT based platform for two-way multi-lingual communication system between Farmers and Agricultural Experts for transmission of agricultural technology/information and advisory in the form of Text, Images, Audios and Videos). As on 31st December 2023 the Kishan Sarthi Portal had 1.90+Crores registered Farmers, 700+ registered Institutions and 2.80+Lakhs villages covered.

- eLISS Web Portal and mobile app for an end-to-end solution for Integrated Sample Survey (ISS) Solutions for Major Livestock Products (Milk, Meat, Egg and Wool) having 3 modules viz., sample selection module, data entry and analysis module and GIS map module. It is being used Pan India by Department of Animal Husbandry and Dairying, Ministry of Fisheries, Animal Husbandry and Dairying, Govt. of India.

- KISAAN 2.0 (Krishi Integrated Solution for Agri Apps Navigation): aggregator mobile app and provides information on 270+ agricultural related apps with interface in 11 language.

- ASRB OASIS (ASRB-Online Application & Scorecard Information System, system for streamlining the recruitment process for agricultural scientists while providing easy access to application submission and scorecard information

- Education Portal is a single window platform for providing vital education information/ announcements/event schedules/e-learning resources from Agricultural Universities across the country to the rural youth in an easy and fast way on their doorsteps.

- Academic Management System is a web enabled system for management of all academic activities of the university. The system caters to the needs of different users: Dean, Registrar, Professor, Head, Guide, Faculty, Teacher, Student, Administrators and Officials. At present implemented in 60+ Agricultural Universities

- E-Krishi Shikha provides access to UG Level interactive & multimedia e-Courseware contents in seven disciplines viz. Agricultural Science; Fisheries Science; Dairy Science; Veterinary and Animal Husbandry; Horticulture; Home Science and Agricultural Engineering. 325+ online courses available on this resource.

- Virtual Classrooms have been established across 74 Agricultural Universities to improve the quality of education and widen the access to education by all students, while up-skilling teaching faculty across the country. Agri-Diksha, Agri Web Education Channel has also been initiated. AR/VR experience labs have been established accross 74 Agricultural Universities (AU's) to enhance learning experience for students.

- Information Systems for 14 AICRPs for single crops, multi-crop and observational studies, have been developed, which resulted in use of efficient design of experiments, saving of manpower time and resources and creating Research Data Repository and standardization of analysis of experimental data.

- Other Information systems and portals are: ICAR DARE Foreign Visit Management System (FVMS); PMS portal (Personnel Management Information System); LRMS (Land Record Management System); E-Learning portal; Student READY Portal; KRITAGYA for Agri-Hackathons; Accreditation Portal for accreditation of Higher Agricultural Educational Institutions (HAEIs), KVC-ALNET (Krishi Vishwavidyalaya Chhatr Alumni Network); AURS (Agricultural University Ranking System); GRMS (ICAR-AU-Grievance Redressal & Monitoring System); Green and clean Campus portal; Plant Trees Portal; AU-PIMS (Agricultural University Project Information Management System); FFP (Farmer First Project) Portal; CBP Portal (Capacity Building Portal); TMIS (Training Management Information System); RLBS (Research Leadership Building System); DBT DARE MIS (Direct Benefit Transfer Management Information System); MIS-PIMI FMS (Web application to automate the financial operations in two Agricultural Universities); BARP (BRICS Agricultural Research Platform); AEIS (Agriculture Experts Information System); ANIS (Agricultural Nutrition Information System); ARMS (Agricultural Research Management System earlier Half Yearly Monitoring System); PMTS (Project Monitoring and Tracking System); E-Platform for Seed Spices, etc.; Expert Systems on Wheat, Maize, Tomato, Mushroom, Tobacco, Seed spices; Phenomics Pipeline- for Analysis of High Throughput Image Analysis; Knowledge Management System for DUS.

- Mobile apps developed include KVK App; ICAR Technologies; KISAAN-2.0 app; AI-DISC; e-LISS data collection app; NIBPP(National Image Base for Plant Protection); NIBLD (National Image Base for Livestock Disease); Phytochemical Management App; FAW Recorder App; FFP Mobile App; IVRI-Veterinary Clinical Care App; IVRI-Pig Farming App; IVRI-Vaccination Guide App; IVRI-Animal Reproduction; IVRI-Pig Ration App; IVRI-Disease Control App; IVRI-Artificial Insemination App; IVRI-Dairy Manager App; IVRI-Online Veterinary Clinic; CARI-Backyard Poultry Farming App; IVRI-Waste Management Guide App ; IVRI-Zoonoses App; IVRI-Biosecurity and Biosafety App; IVRI-Technologies & Services App ; IVRI-Antimicrobial Resistance App; IVRI-Extension Methods Tutorial Quiz ; IVRI - Landlly Pig App; IVRI- Research Methods Tutorial App, etc.

Human Resource Development

One of the major thrust areas of the Institute is to develop trained manpower in the country in Statistical sciences for meeting the challenges of agricultural research in the newer emerging areas. A humble beginning in the area of development of trained manpower was made in 1945 with the initiation of two regular certificate courses, one course of six-month 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 known as Professional Statisticians' Certificate Course (PSCC) that was introduced to train professional statisticians. Subsequently, a Diploma course involving a research project of one year duration, in addition to PSCC consisting of one year course work in agricultural statistics, was also introduced. 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-month duration and lays more emphasis on statistical computing using statistical software. The course is divided into two modules viz. (i) Statistical Methods and Official Agricultural Statistics, and (ii) Use of Computers in

Agricultural Research, of three-month duration each. Since 1997, 100 participants have completed both the modules, 41 have completed module-I only and 24 have completed module-II only.

The year 1964 witnessed tremendous changes in the activities of the Institute when a Memorandum of Understanding (MOU) was signed with the Post Graduate School, Indian Agricultural Research Institute (IARI), New Delhi to start new degree courses leading to M.Sc. and Ph.D. in Agricultural Statistics. In 1981, a two-year 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 M.Sc. degree in Computer Applications in Agriculture was initiated in collaboration with IARI, New Delhi. This course was re-designated as M.Sc. degree in Computer Application during 1993-94. A new degree course M.Sc. in Agricultural Bioinformatics has been initiated from academic year 2011-12. Ph.D. degree course in Computer Application and Bioinformatics were initiated in 2013-14 and 2014-15 respectively.

The Institute has so far produced 228 Ph.D. and 383 M.Sc. students in Agricultural Statistics; 09 Ph.D. and 161 M.Sc. students in Computer Application; 13 Ph.D. and 40 M.Sc. students in Bioinformatics. The alumni are well placed in NARES, academia, Government, Corporate sector and occupying very high positions globally. IASRI provides unique opportunities to the aspiring post graduate students to learn the cutting edge and new technologies by offering them an ambient academic environment, practical exposure, professional learning and analytical skills.

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 interact with the scientists, giving seminars/ lectures and suggesting gaps in the research programmes of the Institute. 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 programme the Institute organized training programmes on various topics of current interest for the benefit of scientists of NARES. These training programmes covered specialized topics of current interest in statistics and agricultural sciences. The Centre of Advanced Studies (CAS) was renamed as Centre of Advanced Faculty Training (CAFT). So far 90 training programmes have been organized under the aegis of CAS/CAFT. In all a total of 1787 participants have been benefited. A total of 30 Summer/Winter Schools/Short courses have been organized which were attended by 705 participants.

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. Such training programmes on various aspects of Statistical and Computation Techniques and ICT Tools impart necessary skills not only to researchers in NARES but also to Indian Statistical Service professionals. FAO, Afro-Asian Rural Development Organization, World bank for Government officials of Afghanistan, Ministry of Statistics and Programme Implementation, Indian Council of Forestry Research and Education, State Department of Agriculture, other national and international developmental agencies look at the Institute as a valuable partner and organize several national/international training programmes to the developing world. The Institute has broadened the horizon of capacity building by opening its doors to agro-based private sector, CGIAR organizations such as ICARDA, Rice-Wheat Consortium for Indo-Gangetic plains etc. Only few Institutes in ICAR have this distinction. A number of research workers from the Institute have served as consultants and advisors in Asian, African and Latin American countries. Also, a number of statisticians and students of the Institute are at present occupying high positions in universities and other academic and research institutions of USA, Canada and other countries.

It is a matter of great pride for the Institute that 05 of its scientist/alumni have received the most prestigious National Award in Statistics in memory of Late Dr. PV Sukhatme, for outstanding life time achievements in Statistics and 02 received National Award in Statistics in Honour of Professor CR Rao from Ministry of Statistics and Programme Implementation, Govt. of India. ICAR Rafi Ahmad

Kidwai Award has been received by 03 of its faculty/alumni. One scientist occupied the prestigious ICAR National Professor Chair, three scientists have been the National Fellow of the ICAR, 02 of faculty/alumni received (Indian National Science Academy (INSA) Fellowship and 13 faculty/alumni elected as National Academy of Agricultural Sciences (NAAS) Fellows. One scientist received the GP Chatterjee Memorial Lecture award from Indian National Science Academy (INSA); one scientist received the Shri Om Prakash Bhasin award for science and technology in the field of agriculture and allied sciences; one alumni received MS Randhawa Award from NAAS, 02 scientists received NAAS Recognition Award and one scientist received Cochran-Hansen Prize 2009 by International Association of Survey Statisticians. Eight scientists have been adjudged as the 'Best Teacher' of the PG School of IARI, New Delhi and 03 received Bharat Ratna Dr. C. Subramaniam Award for Outstanding Teacher from ICAR. Six students received Jawahar Lal Nehru Award on Ph.D. Dissertation. 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. International Association of Survey Statisticians has initiated Hukum Chandra Memorial Prize for mid-career researchers.

Other Infrastructural Development

There are various labs in the Institute for dedicated services like AKMU lab for training, Statistical computing lab, and Centre of Advanced Study lab or student lab. Business Intelligence Server has also been installed for statistical computing for NARES. A laboratory on Remote Sensing (RS) and Geographic Information System (GIS) was created in the Institute. The laboratory are equipped with latest state-of-art technologies like computer hardware and peripherals. Two smart/virtual class rooms have been setup to facilitate for online/blended form of teaching. Videoconferencing lab and committee room have been setup to facilitate videoconferencing. Auditorium of the institute has been renovated with latest infrastructure.

The Library of the Institute is considered as a well-known and specialized library in the whole country in terms of its resources in the form of print and electronic format in the field of agricultural statistics, computer applications, bioinformatics and allied sciences. It is recognized as one of the regional libraries under NARES. During the XI Plan period, the library has undergone changes in terms of its resources. It has strengthened the resource base in terms of core foreign journals. With procurement of online and CD-ROM bibliographical databases, the awareness for the use of databases has increased and users are able to access scientific information in the field of their interest quickly by clicking of a button. Recently, all housekeeping activities of the library have been computerized and barcoded with hybrid-RFID system and all bonafide library users have been issued RFID-electronic membership cards. All M.Sc. and Ph.D. students thesis have been digitized and given access to users through LAN. The Library is equipped with hybrid-RFID Self-Checkout/Check-in System for the ease of users. Library of the Institute is associated with CeRA in terms of electronic document delivery services and Inter-Library Loan services are also available to all users through DELNET. The library reading room has been renovated with air conditioners to provide congenial environment for readers. All library users have been given training to access on-line services available in the library.

There are three well-furnished hostels, viz. Panse Hostel, Sukhatme Hostel and International Training Hostel to cater to the residential requirements of the students and trainees.

Organizational Set-up

The Institute is having six Divisions, two Units and three Cells to undertake research, training, consultancy, documentation and dissemination of scientific output.

Divisions	Design of Experiments
	Sample Surveys
	Forecasting and Agricultural Systems Modeling
	Statistical Genetics
	Computer Applications
	Agricultural Bioinformatics
Units	IT-Unit
	Institute Technology Management Unit (ITMU)
Cells	Prioritization, Monitoring and Evaluation Cell (PME)
	Training Administration Cell (TAC)
	Consultancy Processing Cell (CPC)

Financial Statement 2023-24

The Institute was able to ensure optimal utilization of funds available in the budget. The actual utilization of the budget is furnished as:

Budget Allocation vis-à-vis Utilization (2023–24)

(Rs.in Lakh)

Head	Total R.E. 2023-24	Expenditure up-to 31.3.24	Total Closing Balance
1	2	3	4(2-3)
Total Grants in Aid-General	1810.00	1810.00	0.00
Total Grants in Aid-Capital	215.00	214.78	0.22
Total Grants in Aid-General-(SCSP)	50.00	49.90	0.10
Total Grants in Aid-Capital-(SCSP)	10.00	9.94	0.06
Total Grants in Aid-Salaries	2926.28	2926.28	0.00
Total Grants in Aid-Pension	737.66	737.26	0.40
Grand-Total (General+Capital+Salaries+Pension)	5748.94	5748.16	0.78

Resource Generation 2023-24 (Rupees in Lakhs)	
Target	Achieved
31.44	45.56

Staff Position during 2023

Staff Strength							
S. N.	Cadre	01-01-2023			31-12-2023		
		Sanctioned Posts	In Position	Vacant Posts	Sanctioned Posts	In Position	Vacant Posts
1	Scientist	121	70	51	121	67	54
2	Administration	88	45	43	87	41	46
3	Technical	138	27	111	138	26	112
4	SSS	39	19	20	39	16	23
5	Auxiliary Staff	14	05	9	14	3	11
	Total	400	166	234	399	153	246

*Three personnel are on deputation at other ICAR Instututes and two on deputation outside the ICAR-Institute.

Row 1

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

Certified that

Dr. Alka Arora
(Lead Developer)

Associate Developers

Dr. Sudeep Marwaha, Dr. A.R. Chaubey, Dr. S.N. Islam, Dr. Soumen Pal, Dr. Ajit, Dr. Rajnili Kumar Paul, Dr. Sarshita Naha, Dr. P. Adhiguru

of

ICAR-Indian Agricultural Statistics Research Institute (IASRI), New Delhi

has developed the technology

Krishi Vigyan Kendra Knowledge Network Portal (KVK Portal) & KVK Mobile App. (2022)

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

Certified that

Dr. Prachi Misra Sahoo
(Lead Developer)

Associate Developers

Dr. Tauqueer Ahmad, Dr. Anil Rai
Dr. Ankur Biswas, Mr. Chirag Vasudev

of

ICAR-Indian Agricultural Statistics Research Institute (IASRI), New Delhi

has developed the technology

End-to-End solution: e Livestock Integrated Sample Survey (eLISS) Web Portal & App. (2021)

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

Certified that

Dr. Upendra Kumar Pradhan
(Lead Developer)

Associate Developers

Dr. Prabina Kumar Meher, Dr. Sarshita Naha, Dr. Ajit, Dr. Soumen Pal, Dr. Rajender Parsad

of

ICAR-Indian Agricultural Statistics Research Institute (IASRI), New Delhi

has developed the technology

Prediction server for discovery of DNA and RNA-binding proteins in plant (2022)

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

Certified that

Dr. Md. Samir Farooqi
(Lead Developer)

Associate Developers

Dr. D.C. Mishra, Dr. K.K. Chaturvedi
Dr. Sudhir Srivastava

of

ICAR-Indian Agricultural Statistics Research Institute (IASRI), New Delhi

has developed the technology

Web application for trait specific gene selection (2021)

Row 2

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

Certified that

Dr. Rajender Parsad
(Lead Developer)

Associate Developers

Dr. Apparao Dhandpani, Dr. Mukesh Kumar, Dr. Anshu Bharadwaj

of

ICAR-Indian Agricultural Statistics Research Institute (IASRI), New Delhi

has developed the technology

ICAR-Technology Repository Ver 1.0 and ICAR Technologies Mobile App. (2021)

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

Certified that

Dr. Samarth Godara
(Lead Developer)

Associate Developers

Dr. Madhu, Dr. Sanchita Naha, Dr. I.P.S Dahas, Dr. Rajender Parsad, Dr. Sanjay, Dr. R.S. Bana, Dr. Teja Kumar, Dr. Gopal Singh Jat, Dr. Mamonar Buffalo, Dr. Ekata Bahiya, Dr. Anita Bhatnaraj, Dr. Anopan Singh, Dr. Shiwan Sagara, Dr. Ram Swal

of

ICAR-Indian Agricultural Statistics Research Institute, New Delhi

has developed the technology

KCC-CHAKSHU: Collated Historically Aggregated Knowledge-based System with Hypertext User Interface (https://kcc-chakshu.icar.gov.in/)

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

Certified that

Dr. Prabina Kumar Meher
(Lead Developer)

Associate Developers

Dr. Upendra Kumar Pradhan, Dr. Sarshita Naha, Dr. Atmakuri Ramakrishna Rao, Dr. Ajit, Dr. Soumen Pal

of

ICAR-Indian Agricultural Statistics Research Institute (IASRI), New Delhi

has developed the technology

Prediction server for discovery of abiotic stress-responsive non-coding RNAs (2022)

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

Certified that

Dr. Prabina Kumar Meher
(Lead Developer)

Associate Developer

Dr. Atmakuri Ramakrishna Rao

of

ICAR-Indian Agricultural Statistics Research Institute (IASRI), New Delhi

has developed the technology

Prediction server for multiple localization of coding and non-coding RNAs (2021)

Row 3

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

Certified that

Dr. Anindita Datta
(Lead Developer)

Associate Developers

Dr. Seema Jaggi, Dr. Cini Varghese, Dr. Eldho Varghese, Dr. Arpan Bhowmik, Dr. Mohd Harun

of

ICAR-Indian Agricultural Statistics Research Institute (IASRI), New Delhi

has developed the technology

Web generation of generalized row-column designs (webGRC). (2022)

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

Certified that

Dr. Tauqueer Ahmad
(Lead Developer)

Associate Developers

Dr. Anil Rai, Dr. Prachi Misra Sahoo
Dr. Ankur Biswas

of

ICAR-Indian Agricultural Statistics Research Institute (IASRI), New Delhi

has developed the technology

Sampling methodologies for food loss measurement in horticultural crops, livestock and fish (2020)

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

Certified that

Dr. Sukanta Dash
(Lead Developer)

Associate Developers

Dr. Anupama Singh, Dr. Anil Kumar, Dr. Anirban Dutta, Dr. Saman Munna, Dr. Alaknanda Meential, Dr. Rajesh Kumar, Dr. Adtil Kamba, Dr. Neeraj Fehrejali, Dr. B Roy Kumar, Dr. Sapcotijo Saha, Dr. K A Rajanna, Dr. V. Shanmugam, Dr. Ramesh K Sodan, Dr. Bhrageshil S

of

ICAR-Indian Agricultural Statistics Research Institute (IASRI), New Delhi

has developed the technology

Web enabled phytochemical knowledge-based system for crop protection (2021)

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

Certified that

Dr. Tauqueer Ahmad
(Lead Developer)

Associate Developers

Dr. Prachi Misra Sahoo
Dr. Anil Rai
Dr. Ankur Biswas

of

ICAR-Indian Agricultural Statistics Research Institute (IASRI), New Delhi

has developed the technology

Sampling methodology for agriculture census (2021)

Row 4

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

Certified that

Dr. Prabina Kumar Meher
(Lead Developer)

Associate Developer

Dr. Tanmaya Kumar Sahu

of

ICAR-Indian Agricultural Statistics Research Institute (IASRI), New Delhi

has developed the technology

Software for identification of circadian genes in plants (2021)

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

Certified that

Dr. Tanmaya Kumar Sahu
(Lead Developer)

Associate Developers

Dr. Prabina Kumar Meher
Dr. Atmakuri Ramakrishna Rao

of

ICAR-Indian Agricultural Statistics Research Institute (IASRI), New Delhi

has developed the technology

An information system to support therapeutic management of foot and mouth disease of cattle (2021)

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

Certified that

Mr. Sanjeev Kumar
(Lead Developer)

Associate Developers

Dr. Anil Rai, Dr. K.K Chaturvedi, Dr. S.B Lal, Dr. Md. Samir Farooqi, Dr. D.C. Mishra, Dr. Jyotika Bhati, Dr. Arijit Saha, Dr. Pankaj Kumar Pandey, Dr. Anuj Kumar

of

ICAR-Indian Agricultural Statistics Research Institute (IASRI), New Delhi

has developed the technology

Abiotic stress-responsive genes, gene ontology and metabolic pathways of major cereal crops (2020)

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

Certified that

Dr. Sudeep Marwaha
(Lead Developer)

Associate Developers

Dr. K.K Agarwal, Dr. Agastan Toran, Dr. Bramananum, Dr. R.K Arorami, Dr. Arvindar Pratap, Dr. S.K, Mr. Pranav Ps Charban, Dr. Eid share, Dr. Chandra Bordi, Dr. Bd Arnamla Imesh, Dr. Sarosi Ngona, Dr. Mcumma Sap, Dr. Ashul Isana, Dr. Santosh Pal, Dr. Ispartion, Dr. Aging Martis, Dr. P Lakshmi Segreqan, Dr. Swati Aruon, Approved, Mr. R.K Dogam, Dr. Arpana Lok, Dr. Lokesh Sangul, Dr. Anpal Handawar, Sarti, Dr. Prabmerarmar, Mr. J R K Acharya, Dr. Amarvaf Sarma, Mr. Locha Kara Chawbher, Mr. Pranav Deb Puri, Dr. Shraddea Pinwari, Bublishigad Sarihar, Dr. Ramesh Singh Sura, Dr. Ashoka Kuma, Dr. umesh Kumar Singh

of

ICAR-Indian Agricultural Statistics Research Institute, New Delhi

has developed the technology

AI-DISC (Artificial Intelligence based Disease Identification System for Crops)

The research targets set by the Institute were implemented by six Divisions of the Institute, viz. Design of Experiments, Sample Surveys, Statistical Genetics, Forecasting & Agricultural Systems Modelling, Computer Applications and Agricultural Bioinformatics. The basic, applied, adaptive and strategic research in Statistical Sciences (Agricultural Statistics, Computer Applications and Bioinformatics) is carried out under six broad programmes that cut across the boundaries of the Divisions and encourage interdisciplinary research. The six programmes are as under:

1. Development and analysis of experimental designs for agricultural system research
2. Forecasting and remote sensing techniques and statistical applications of GIS in agricultural systems
3. Development of techniques for planning and execution of surveys and analysis of data including economic problems of current interest
4. Modeling and simulation techniques in biological systems
5. Development of informatics in agricultural research
6. Teaching and training in Agricultural Statistics, Computer Application and Bioinformatics

Programme 1: DEVELOPMENT AND ANALYSIS OF EXPERIMENTAL DESIGNS FOR AGRICULTURAL SYSTEM RESEARCH

Efficient Statistical Designs

- **Two-Part Structurally Incomplete Designs:** Two-part designs are helpful in selecting the best possible components in Integrated Farming System (IFS). They involve two groups of treatment arranged in incomplete blocks with respect to both groups, and the concurrence of treatment pairs within and between groups is constant. The fusion of two in-complete block designs in a systematic manner can yield two-part designs. Further, for situations where certain experimental units are not available, two-part structurally incomplete designs are obtained.

- **Resolvable PBIB Designs for Multi-site Varietal Trials:** Method of construction for a class of resolvable PBIB designs suitable for multi-site varietal trials has been developed and

are based on newly defined four-associate class association scheme named as Dichotomized Split-Set (DiSS) association scheme.

- **Efficient Designs for Double Cross Experiments:** Constructed a new series of block design for double cross experiments for v (= $4t + 1$) lines. The parameters of the developed mating-environmental design for partial double crosses are $v = 4t + 1$, $b = 4t(4t + 1)/2$, $r = 4t$, $k = t$. It has been shown that if there exists a resolvable incomplete block design (IBD) with block size 4, then Mating-Environment (ME) design can be obtained for partial double cross experiments.

- **Rotatable Mixed-level Response Surface Designs:** Under response surface model for mixed level factors of the form $2^n \times 3$, where experimental units experience the overlap effects from immediate left and right neighbouring units conditions have been derived for the orthogonal estimation of the parameters. A method of constructing rotatable mixed-level response surface designs of the form $2^n \times 3$ has been proposed. The method has been extended to the case of mixed-level rotatable designs of the form $2^n \times 3^n$. Further the work has been extended to $s_1^{n_1} \times s_2^{n_2}$.

- **Trend Resistant Balanced Bipartite Block Designs:** Methods of construction for trend resistant Balanced Bipartite Block (BBPB) designs are developed that are useful when the interest of the experimenter is in making comparisons between two disjoint sets of treatments, in the presence of systematic trend within a block.

Statistical Analysis for Neutrosophic Data Derived from Block Designs and Row-column Designs

In real-life situations it may not be always necessary to get a crisp data. Many times, data has some degree of indeterminacy (unclear, vague, partially unknown, contradictory, incomplete, etc.). Ignoring the range or vague values and taking the mid-value is not appropriate always. For example: 2, 3, 3-5, 7-10. In this situation, if one is taking the mid-value then it may lead to wrong interpretation. The procedures for neutrosophic data analysis obtained through (i)

Treatments	Cropping systems	Remarks
T_1 & T_2	Pre-dominant cropping systems of the region	Check
T_3 & T_4	Ecological cropping systems involving pulses/ green manures and other crops for improving soil health	Soil health
T_5 & T_6	Cropping systems involving cereals/ pulses/ oilseeds to meet the household nutritional security	Family nutrition
T_7 & T_8	Cropping systems for round the year green/ dry fodder production	Livestock nutrition
T_9 & T_{10}	Cropping systems involving vegetables and other high value crops for income enhancement	Income enhancement

block designs and (ii) row-column designs with (a) both sides complete and (b) one side incomplete have been derived.

Designing and Analysis of On-Farm and On-Station Research Experiments Planned under AICRP on IFS

Small and marginal farmers in India prefer an Integrated Farming System (IFS) approach, combining crops and livestock to ensure a stable year-round income. The integrated method results in higher per-capita income, improved living standards, and enhanced resilience for the community and natural resources. Comprehensive data on all components are collected from farmers' fields and need to be properly stored and analysed to provide appropriate recommendations. As a voluntary centre of AICRP-IFS, ICAR-IASRI is responsible for data analysis and developing software for online data entry.

Major analysis includes (i) One way ANOVA to compare the performance of various Farming System (FS) within each centre, (ii) Wilcoxon signed-rank test to compare between existing vs. diversified systems, within each FS, as number of households belonging to each FS are less and (iii) paired t-test for overall existing vs. diversified FS comparison within each centre, with respect to production, return, profit, marketable surplus and cost. The centres/farming systems incurring significant cost, but non-significant production or return or profit or marketable surplus have been identified pertaining to 2020-21 data based on On-farm Experiment 2 (Intensification/diversification of the existing cropping system). Similar analysis was carried out for On-farm Experiment 3 (Agronomic management practices for sustainable system) where cost is significant but other parameters are non-significant, farming system-wise or as a centre.

Kerala state, where same cropping system (paddy-paddy) adopted over 11 years, was considered for studying the trend of response of nutrients to treatments over years based on OFR Experiment 1 (Response of nutrients (N, P and K) on farmer's field (kg/kg)), and it showed a decreasing trend first, then for next few years there was an increasing trend and finally showing a decreasing trend.

On-station Experiment 1(a) (Identification of cropping systems module for different farming systems) has been modified with 10 treatments, grouped under five major categories as given in the table.

Tukey's Honest Significant Difference test was performed for pairwise comparisons, both within treatment groups (test vs. test) and between treatment groups and the control (test vs. check), using crop and fodder yield data from Kharif, Rabi, Summer, and overall seasons generated from Experiment 1(a) at the Akola, Bhubaneswar, Chiplima, and Coimbatore centers. Livestock Nutrition was identified as the best main-crop group, while Income Enhancement was identified as the best by-product group.

Planning, Designing and Analysis of Data Relating to Experiments for AICRP on Long Term Fertilizer Experiments

Combined analysis of Ludhiana centre (Rabi season) for wheat crops was performed for the characters with more than 8 years data. It was observed that T8 (100% NPK + FYM) gives highest grain yield (48.04 q/ha) followed by T3 (100% NPK) which gives 47.65 q/ha and also T8 and T3 are statistically significantly different from each other. For N content in grain, again T8 (100% NPK + FYM) gave highest mean (1.35 kg/ha) followed by T3 (100% NPK) with 1.29 kg/ha and these were statistically significantly different. For P content in grain T10 (control) gives the highest mean (23.25 kg/ha). For N uptake by grain, again T8 (100% NPK + FYM) have highest mean (88.15 kg/ha) followed by T3 (100% NPK) with 86.02 kg/ha and these were statistically significantly different. For P uptake by grain again T8 (100% NPK + FYM) have highest mean (16.48 kg/ha) followed by T3 (100% NPK) with 15.74 kg/

ha and these were statistically significantly different. Similarly for K uptake by grain again T8 (100% NPK + FYM) have highest mean (20.04 kg/ha) followed by T3 (100% NPK) with 19.38 kg/ha and these were statistically significantly different. For Ph, T10 (control) have the highest mean (6.54). For OC, T8 (100% NPK + FYM) gave highest mean (0.44%) and T4 (100% NPK+hand weeding) gives mean 0.33% and these were statistically significantly different. For available N, T8 (100% NPK + FYM) gave highest mean (115.07 kg/ha) followed by T3 (100% NPK) with 110.05 kg/ha and these were statistically significantly different. For available P, T8 (100% NPK + FYM) gave highest mean (112.82 kg/ha) followed by T3 (100% NPK) with 102.02 kg/ha and these were statistically significantly different. For available Zn, T5 (100% NPK+Zinc or Lime) gives the highest mean 3.31 ppm(mg/kg). For available Fe, T8 (100% NPK + FYM) gave highest mean (1.90 ppm) followed by T3 (100% NPK) with 1.78 ppm and these were statistically significantly different. Performed trend analysis on LTFE data including grain yield of sorghum, wheat and climatic variables i.e. rainfall, rainy days, Temp (Min, Max), RHI and RHII for Akola centre.

Breeding Management System for Improving the Genetic Gain in Indian Staple Crops

Ten selected ICAR breeding programmes adopted digital breeding techniques for 08 crops in 5 All India Coordinated Research Projects (AICRP). Researchers of these programs have been trained in digitalization of breeding and trial activities along with digital data recording. A BMS instance for ICAR-BMGF project has been created at ICAR data centre for maintaining the authentication of access to data by ICAR users only using the URL https://bms.icar.gov.in/ibpworkbench/controller/auth/login. All coordinating centres were updated on Data Management in BMS, Digital Data Collection, Creation of nursery, making of crosses, making of F1, export nursery book to the BMS, creation of labels, creation of advance F1 nursery, creation of F2 nursery and export F2 nursery book to BMS and creation of advance F2 nursery.

Programme 2: FORECASTING AND REMOTE SENSING TECHNIQUES AND STATISTICAL APPLICATIONS OF GIS IN AGRICULTURAL SYSTEMS

Optimization-based Ensemble Forecasting using MCS Algorithm and PCA-based Error Index

Ensemble forecasts from multiple models have gained enormous popularity as it provides a more efficient forecast as compared to the individual counterpart. The linear weighted combination method is most widely utilized for its simplicity and efficiency. Despite hard efforts by various researchers, two considerable challenges still exist: (1) Systematic and robust techniques for selecting suitable forecasting models and (2) Techniques to find appropriate combination weights. To address these challenges, a novel framework for optimization-based ensemble technique, 'OptiSembleForecasting' has been proposed. The three components of the proposed framework are (a) Principal Component Analysis-based error index, (b) Model Confidence Set algorithm and (c) Optimization techniques. A total of thirteen forecasting models consisting of five deep learning, five machine learning and three stochastic models and twenty optimization techniques have been implemented in the proposed framework. To examine the effectiveness of the proposed technique, wholesale price of three commodities (TOP: Tomato, Onion, and Potato) each with two major markets in India has been considered. The empirical evaluation of the predictive accuracy of different models with that of the proposed techniques has been carried out by means of root mean square error and mean absolute percentage error. The findings of this study demonstrated the superiority of the proposed algorithm. Moreover, an R-package, namely 'OptiSembleForecasting', has been developed to make the implementation of this technique simple and user-friendly.

CEEMDAN-based Hybrid Machine Learning Algorithm

Accurate prediction of time series data is crucial for informed decision-making and economic development. However, predicting noisy time series data is a challenging task due to their irregularity and complex trends. A Complete Ensemble Empirical Mode Decomposition with Adaptive Noise (CEEMDAN) based hybrid machine learning algorithm combined with stochastic models has been developed to capture the volatility of weekly potato price in major markets of India. The smooth decomposed component is predicted using stochastic models, while the coarser components, selected using Multivariate Adaptive Regression Splines (MARS), are fitted into two different machine learning algorithms. The final predictions for the original series are obtained using optimization techniques such as Particle Swarm Optimization (PSO). The performance of the proposed algorithm is measured using various metrics, and it is found

that the optimization-based combination of models outperforms the individual counterparts.

Modelling and Forecasting for Time-to-Event Analysis in Agriculture

Rice is the second largest food grain crop grown in the world both in terms of area and production. Its productivity depends on the availability of quality seed. Seed germination is one of the most important aspects to assess its quality. Response to germination is a complex phenomenon governed by genetic, physio-biochemical factors and environmental factors like temperature, water potential etc. A novel methodology has been developed for efficient estimation of parameters under nonlinear regression model of counts of germination instead of erroneous modelling of cumulative proportions and accounts correlation and heteroscedastic error variance to estimate the parameters in the framework of weighted non-linear regression. Performances of the estimation methods have been studied along with maximum likelihood estimation method based on time to event model framework. The ranges of favorable temperature for rice varieties of various maturity groups germinated under different stress conditions have been recommended.

Forecasting Onion Prices using Deep Learning Techniques

Developed a methodological framework to assess the comparative performance among the statistical model Generalized Autoregressive Conditional Heteroskedasticity (GARCH), machine learning model such as Time-Delay Neural Network (TDNN) and Support Vector Regression (SVR) and deep learning techniques viz., long short-term memory (LSTM), bidirectional-LSTM (Bi-LSTM), deep LSTM, 1D-Convolutional Neural Network (1D-CNN), Temporal Convolutional Network (TCN) and attention mechanism based LSTM for onion price forecasting. The proposed framework was then utilized to compare the out-of-sample forecasting performances of different onion market prices based on their individual model building capabilities. Three distinct multivariate deep learning approaches have been developed by incorporating the external information for the prediction of Indian onion market prices. These include the multivariate LSTM model, a 2DCNN, and a multivariate LSTM model enhanced with an attention mechanism, all tailored for onion price forecasting. The developed approach have the ability to improve the prediction performance for

onion prices as compared to individual statistical, machine and deep learning techniques.

Development of Spatio-Temporal LSTM model for Forecasting Space-Time Data

The predictive performance of the Spatio-Temporal Long Short Term Memory (STLSTM) model was evaluated by analysing weekly potato price data from October 2011 to December 2023 from five districts in Southern West Bengal, India. Comparative evaluations were conducted involving conventional Space-Time Autoregressive Moving Average (STARMA), Long Spatio-Temporal Long Short Term Memory Term Memory (STLSTM), Recurrent Neural Network (RNN), and Gated Recurrent Unit (GRU) models. The results revealed that the proposed STLSTM model exhibits superior efficacy in both modelling and forecasting precision compared to the benchmark models.

Programme 3: DEVELOPMENT OF TECHNIQUES FOR PLANNING AND EXECUTION OF SURVEYS AND ANALYSIS OF DATA INCLUDING ECONOMIC PROBLEMS OF CURRENT INTEREST

Food Loss Index (FLI)

Compiled Food Loss Index (FLI) for India and Food Loss percentage under the project entitled Study on reviewing the Food Loss Index (FLI) estimates for India and preparing assessment report for inclusion of the SDG Indicator 12.3.1 in the National Indicator Framework of India funded by Food and Agriculture Organization of the United Nations (FAO), Rome through FAO-India using the FAO methodology and the data generated through three post-harvest losses surveys conducted during 2005-07, 2012-14 and 2020-21. The statistics has been calculated using 12 commodities as per procedure of FAO and all the 45 commodities common to all the three surveys. Steps of year wise decrement method has been suggested for imputing the index during intervening years. Some suggestions of weighting the imported quantities only for storage losses has been suggested. The FLI report has been accepted by FAO.

eLISS End-to-End Solution for Major Livestock Products in India

eLISS end-to-end Solution for major livestock products in India consists of eLISS web portal and eLISS data collection App. This is being used Pan

India by Department of Animal Husbandry and Dairying, Govt. of India to conduct Integrated Sample Survey for estimation of production of four major livestock commodities (milk, meat, egg and wool). Following two additional modules were developed (i) Module for updating the sampling frame of villages/ urban wards covering all districts and State/UTs of the country; (ii) Re-allocation module for allocating village/urban wards to another enumerator in ongoing survey along with the previously collected data.
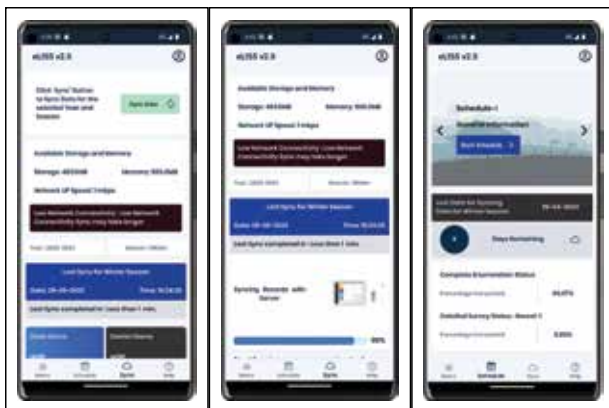
eLISS data collection App has been updated adding many new feature extensions such as showing memory and network status while syncing data, more optimized sync and refresh design and adding many new validation checks for better data quality.

A detailed Standard operating procedure (SOP) was formulated for conducting the ISS survey using the eLISS. In this SOP, all the activities of the survey are mentioned in sequential manner along with the user's role (Enumerator/Supervisor/ DNO/State official) with the timeline. Step wise instruction manuals were developed for newly introduced modules. These instruction manuals include screenshots and details of activities to be performed step by step by the State/UTs officials and DNOs.

The sampling frame for the year 2023-24 was prepared using the updated livestock census data shared by Department of Animal Husbandry and Dairying by processing it to filter out the list of uninhabited and inaccessible villages/urban wards. All States/UTs have selected the first stage units i.e. villages/urban wards for all of their districts using the eLISS web portal.

Presently using eLISS, more than 1.8 crore+ households/enterprises have been surveyed in 1,17,000 villages/urban wards, around 654

slaughter houses have been surveyed throughout the country and data from more than 29,000 commercial poultry farms has been captured. Currently, more than 25,000 enumerators, 8,600 supervisors and 742 DNOs are active on eLISS web portal.

The estimates of number of animals and production pertaining to milk, meat, egg and wool were generated at District/Animal/Group level for all 36 States/UTs for summer and rainy season using the data analysis module of eLISS web portal.

Domain Calibration Estimators under Two Stage Sampling Design

A domain calibration estimator was developed under two stage sampling design when population level domain specific auxiliary information is available at cluster level as well as unit level. It was assumed the domain total of the auxiliary information is available and known. The correlation between the study variable and the auxiliary variable is assumed positive. The case of direct domain estimation when sufficient sample size at domain level is available assumed. The variance and estimator of variance for the proposed estimators were also developed. Through limited simulation study, it was found that the proposed estimators were performing better than the Horvitz Thompson estimator under two stage sampling design from the criterion of % Relative Root Mean Squared Error (%RRMSE).

Geographically Weighted Regression (GWR)-assisted Integrated Estimator of Finite Population Total under Two-phase Sampling: A Model-assisted Approach

In survey sampling, auxiliary information is used to precisely estimate the finite population parameters. There are several approaches available in the literatures that provide a practical method for incorporating auxiliary information during the estimation stage. In order to effectively utilize the auxiliary information, a geographically weighted regression (GWR) model-assisted integrated estimator of finite population total under a two-phase sampling design has been proposed. Spatial simulation studies have been conducted to empirically assess the statistical properties of the proposed estimator. In the presence of spatial non-stationarity, empirical findings reveal that the proposed estimator outperforms all existing estimators such as two-phase Horvitz Thompson,

ratio, and regression estimators, demonstrating the importance of spatial information in survey sampling.

Geographically Weighted Regression-based Model Calibration Estimation of Finite Population Total under Georeferenced Complex Surveys

Sampling methodology on Geographically Weighted Regression (GWR)-based model calibration estimators for the population total of the study variable has been developed within the context of geo-referenced complex survey designs, when complete auxiliary information along with their spatial locations is available at population level. The asymptotic properties of these estimators were evaluated under certain assumptions, including their variances and estimators of variances. A spatial simulation study was conducted to compare the performance of the developed estimators to that of existing estimators. Simulation results revealed that the developed estimators outperformed existing ones in terms of efficiency.

Spatial Approach for the Estimation of Average Yield of Cotton using Reduced Number of Crop Cutting Experiments

In India, cotton yield estimates are obtained using Crop Cutting Experiments (CCEs) conducted under General Crop Estimation Surveys (GCES) scheme. In recent times, for obtaining reliable estimates at levels lower than the district, the number of CCEs has increased which puts an additional financial burden on Government agencies. There is a possibility of reducing the number of CCEs under the GCES methodology and predicting the remaining CCE points using an appropriate spatial prediction model. In this study, a spatial estimator of the average yield of cotton has been developed using the Geographically Weighted Regression (GWR) approach and the predictive performance of different spatial models has been compared. Furthermore, district-level estimate of average yield of cotton has been determined using the developed methodology and the results were compared with those obtained using the traditional GCES methodology. The proposed spatial estimator of the average yield of cotton obtained using the GWR approach is more efficient and the results are comparable with the estimates obtained using the GCES methodology. The developed methodology can be utilized to reduce the number of CCEs and capture the spatial non-stationarity present in the cotton crop yield.

Determination of Minimum Sample Size for Testing Proportion of Non-Bt seeds Under Refuge-in-bag (RIB) for Bt Cotton

The concept of refuge-in bag (RIB) strategy is recommended for Bt cotton which ensures automatic compliance of refuge, since a prescribed range (5–10%) of non-Bt seeds are blended with Bt seeds within each seed packet sold in the market. Since, Bt and non-Bt seeds are mixed and indistinguishable, assessment of Bt trait purity and ascertaining the proportion of refuge within each seed packet becomes critical for the success of RIB. A multi-phased study was conducted to determine the minimum seed sample size to be drawn and tested for RIB compliance in seed lots. Initially, the probable estimate to detect 5% non-Bt in blended seed lot was calculated theoretically which was later analyzed through visual observation of differentially colored seeds on various sample sizes. The minimum seed sample size thus arrived was validated through ELISA testing on a custom-built seed lot in which prescribed level of non-Bt seeds (5%) were blended with the Bt seeds. This was later revalidated using commercial Bt seed packets available in the open market. Based on the results, a minimum sample size of 180 seeds was proposed which shall be tested individually for presence/ absence of transgenes to determine proportion of non-Bt seeds in the Bt cotton seed packets. The proposed sample size may be used for ascertaining RIB compliance in the commercially available Bt cotton seed lots.

Sampling Methodology for Estimation of Private Food Grains Stock at Farm Level Aligned with Input Survey of Agriculture Census in India

In India, Food and Agriculture Organization of the United Nations (FAO) was implementing a project "Strengthening Agriculture Market Information System (AMIS) in India using Innovative Methods and Digital Technology" and supporting the efforts of the Ministry of Agriculture and Farmers Welfare, Govt. of India. A pilot study on private food grains stock estimation at farm level aligned with Input Survey of Agriculture Census in India funded by FAO-India was conducted by ICAR-Indian Agricultural Statistics Research Institute (ICAR-IASRI). A suitable sampling methodology and a suitable questionnaire aligned with existing Input Survey for estimation of private food grain stock at farm level has been developed. Under this study, a pilot survey was conducted in two states namely Haryana and

Madhya Pradesh. The four crops under Agriculture Market Information System (AMIS) study i.e. wheat, paddy, maize and soybean along with pulses were covered under this pilot survey for all the three seasons. The estimates of food grains stock, pre-harvest opening stock, production obtained, quantity sold, quantity stored, quantity disposed and percentage stock at farm level were obtained along with its percentage Coefficient of Variation (% CV) were found to be reasonably good for overall size classes. Therefore, it is expected that for overall holding size classes, the proposed methodology will provide farm level reliable estimates of food grains stock at district level.

Sampling Methodology of Product Type Calibration Estimators under Two Stage Sampling Design

In this study, sampling methodology on product type calibration estimator of the finite population total has been developed for the situations of availability of inversely related auxiliary information at PSU level under two stage sampling design framework. Additionally, in case of non-availability of population-level relatively inexpensive data on auxiliary variable under two stage sampling, product type calibration estimator of the finite population total has been developed using double sampling approach. Statistical properties of proposed product type calibration estimator of population total were studied through a simulation study. The simulation results suggest that the proposed product type calibration estimators were performing better than usual Narain-Horvitz-Thompson, product and linear regression estimators of the population total under two stage sampling design.

Sampling Methodology for Calibration Estimator of Finite Population Ratio under Adaptive Cluster Sampling

Adaptive cluster sampling (ACS) technique is usually used for estimation of the abundance of an exclusive, clustered biological population. In this study, a sampling methodology for calibration estimator of finite population ratio has been developed using auxiliary information under ACS design. The variance and the estimate of variance for these estimators are obtained. The statistical performance of the proposed calibration estimators of population ratio under ACS were evaluated through a simulation study based on real population data with respect to conventional Horvitz Thomson (HT) estimator of population ratio which do not utilize the auxiliary information. The results of the simulation study show that proposed calibration estimators were more efficient than conventional HT estimator of the population mean under ACS design with respect to percentage Relative Root Mean Squared Error (%RRMSE).

Estimation of Ratio in Finite Population using Calibration Approach under Different Calibrated Weights Systems

Estimators for ratios/proportions in finite populations are developed by incorporating known auxiliary information under the calibration approach. The variance and estimate of variance for these estimators are obtained. A simulation study is carried out to evaluate the performance of the proposed estimators, comparing them with a simple estimator of the population ratio that does not incorporate auxiliary information. The estimators generated from this method offer improved precision compared to traditional estimators that do not utilize such information. This means that decision-making processes in various fields such as official statistics, demographic studies, and agriculture can benefit from more reliable data, leading to better-informed policies, resource allocation, and strategic planning.

Development of Robust Estimator by Integrating Data from Different Surveys

A projection estimator has been developed for finite population total by considering Huber's M estimation technique. The M-estimation is a wide class of estimators which among others, includes least squares (LS) estimators and maximum likelihood estimators. Huber M-estimates, use a function $\rho(e)$ that is a compromise between e^2 and $|e|$. The main advantage of these estimates over LS estimates is that they are not sensitive to outliers.

Regression Type Estimator in Dual Frame Surveys under Two Stage Sampling

An estimator for a two-stage sampling design with independent frames was developed when auxiliary information is available at the primary stage unit level. A chi-square type distance function was used between the proposed weight and the sampling design weight to obtain the frame-specific calibrated weights. The variance of the proposed estimator was derived using Taylor series expansion with partial derivatives.

Agricultural Research Data Book 2023

Agricultural Research Data Book (ARDB) 2023 was released at the Annual Day Celebration of the Institute on July 03, 2023. Previously, valuable information on agricultural research, education, and related topics was scattered across various published and unpublished sources, making access difficult. Since 1995, the ARDB has played a crucial role in compiling this dispersed information. The ARDB 2023 has some value additions like predicting the future year production of foodgrains, pictorial/graphical representations of data, depicting state-wise data and thematic maps using Geographical Information System (GIS). Two tables related to installed capacity of electricity generation and item-wise marine export are included in this ARDB. India's first water bodies census report was released by the Ministry of Jal Shakti this year, two tables from this report have also been incorporated in ARDB 2023. This issue has been enriched with latest available information on emerging areas in agriculture sectors. Recognizing its wide user base, a soft copy of the ARDB 2023 is available for download on the ICAR-IASRI website: https://krishi.icar.gov.in/AgResDataBook.jsp. This revised and improved ARDB 2023 serves as a valuable resource for researchers, policymakers, students, and anyone interested in the current state of agriculture in India.

Programme 4: MODELLING AND SIMULATION TECHNIQUES IN BIOLOGICAL SYSTEMS

RBPLight: A Computational Tool for RNA-Binding Protein Prediction in Plant

RNA binding proteins (RBPs) are essential players in post-transcriptional gene regulation in plants. They influence RNA stability, splicing, localization, translation, stress response, development, and epigenetic regulation. Their diverse functions contribute to the precise control of gene expression and the maintenance of plant growth, development, and adaptation to changing environments. Thus, accurate identification of RBPs is important in plants. Majority of the computational techniques suggested for identifying RBPs are mainly applicable to human and mice datasets. Despite substantial improvements in the prediction of RBPs, the development of plant-based models is mostly disregarded. To bridge the gap, a machine learning based computational tools called "RBPLight" has been developed for identification of plant specific RBPs. Despite the fact that certain models have already been trained and assessed on the model organism *Arabidopsis thaliana*, this is the first comprehensive computer model for the discovery of plant-specific RBPs. To develop the generalised plant specific models, RBP sequence dataset from 36 different plant species are considered in the current study. The highest repeated five-fold cross-validation accuracy, 91.24% area under the receiver operating characteristic (AU-ROC) and 91.91% area under Precision-Recall curve (AU-PRC), was achieved by a light gradient boosting machine. The RBPLight achieved high accuracy and outperformed several existing tools for RBP identification in different plant species. The web server RBPLight is publicly accessible at https://iasri-sg.icar.gov.in/rbplight/, for the convenience of researchers to identify RBPs in plants. The RBPLight can be applicable to cereals, pulses, oilseed, vegetables, fruits and commercial crops and will contribute to the development of improved crop varieties and sustainable agricultural practices, thereby addressing global food security and agricultural sustainability challenges.

ASLncR: A Novel Computational Tool for Abiotic Stress Responsive Long Non-coding RNAs Prediction in Plants

Sustainable food production is necessary to meet the demands of the ever-increasing human population. Conversely, crop plants are constantly exposed to adverse environmental perturbations that are predicted to result in a 70% yield loss in important agricultural crops. Abiotic stresses, such as cold, drought, heat, salt, and nutrient deficiencies, have been a major factor in limiting crop yield and productivity. A growing body of evidence indicates that a large number of long non-coding RNAs (lncRNAs) are key to many abiotic stress responses. Thus, identifying abiotic stress-responsive lncRNAs
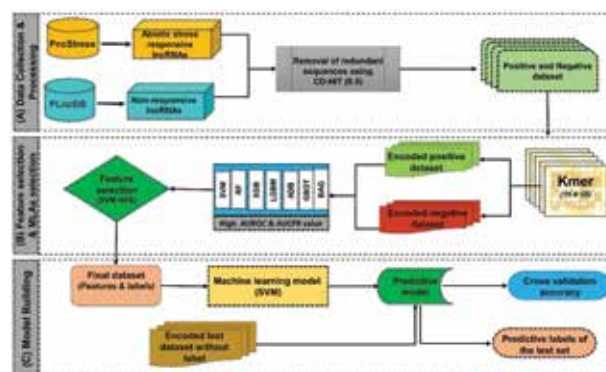
The diagram illustrates the overall workflow of the entire computational strategies followed to develop the abiotic stress responsive lncRNA prediction models.

is essential in crop breeding programmes in order to produce cultivars resistant to abiotic stresses. ICAR-IASRI developed the machine learning-based computational model for predicting abiotic stress responsive lncRNAs. To develop this generalised abiotic stress specific model, the datasets covered 114 different plant species The observed 5-fold cross-validation accuracy, area under the receiver operating characteristic (AU-ROC), and area under Precision-Recall curve (AU-PRC) were found to be 68.84%, 72.78%, and 75.86% respectively. Further, the robustness of the developed model (SVM with selected feature), was evaluated using an independent test dataset, where the overall accuracy, AU-ROC and AU-PRC were found to be 76.23, 87.71 and 88.49 percentage, respectively. For easy accessibility, the developed computational approach "ASLncR" was established as an online prediction tool available at https://iasri-sg.icar.gov.in/aslncr/. "ASLncR" is applicable to cereals, pulses, oilseed, vegetables, fruits and commercial crops and may be contribute to the development of abiotic stress resistance improved crop varieties

DBPMod: A Supervised Learning Model for Computational Recognition of DNA Binding Proteins in Model Organisms

DNA-binding proteins (DBPs) play critical role in many biological processes, including gene expression, DNA replication, recombination, and repair. In recent times, several computational methods have been developed to identify DBPs. However, due to the generic nature of the models, these models are unable to identify species-specific DBPs with a fair accuracy. The computational method "DBPMod" has been developed, which makes use of a machine learning approach to identify species-specific DBPs. Additionally, the evolutionary features outperformed sequence-derived features in terms of accuracy. Five model

Brief outline of the proposed approach DBPMod

organisms, including *C.elegans*, *D. melanogaster*, *E. coli*, *H. sapiens*, and *M. musculus*, were used to assess the performance of DBPMod. Five-fold cross validation and independent test set analyses were used to evaluate the prediction accuracy in terms of the receiver operating characteristic (AU-ROC), and area under Precision-Recall curve (AU-PRC), which was found to be ~89-92% and ~89-95% respectively. The comparative results demonstrate that the DBPMod outperforms 12 existing state-of-the-art computational approaches in identifying the DBPs for all five model organisms. The web server of DBPMod has been established to make it easier for researchers to detect DBPs and is publicly available at https://iasri-sg.icar.gov.in/dbpmod/ as an invaluable tool for discovering DBPs, supplementing the current experimental and computational models.

ASmiR: A Computational Tool for Abiotic Stress-Specific miRNAs Prediction in Plants

Abiotic stresses, such as cold, drought, heat, salt, and nutrient deficiencies, have been a major factor in limiting crop yield and productivity. These abiotic stresses have become a major challenge in recent years due to their pervasive nature and shocking impacts on plant growth, development and quality. MicroRNAs (miRNAs) play a significant role in plant response to different abiotic stresses. Thus, identification of specific abiotic stress-responsive miRNAs holds immense importance in crop breeding programmes to develop cultivars resistant to abiotic stresses. The Institute developed the first machine learning-based computational model "ASmiR" for prediction of miRNAs associated with four specific abiotic stresses, such as cold, drought, heat and salt covering the datasets from 114 different plant species The performance of the ASmiR was validated using both cross-validation approach and independent test set. The highest cross-validated prediction accuracies in terms of area under precision-recall curve (AU-PRC) were found to be 90.15, 90.09, 87.71, and 89.25% for cold, drought, heat, and salt respectively. Overall prediction accuracies for the independent dataset were respectively observed 84.57, 80.62, 80.38, and 82.78%, for the abiotic stresses. For implementation of developed method with ease, online prediction servers ASmiR has also been developed which is freely accessible at https://iasri-sg.icar.gov.in/asmir/."AsmiR" is applicable to cereals, pulses, oilseed, vegetables, fruits and commercial crops and will contribute to the development of abiotic stress resistance improved crop varieties.
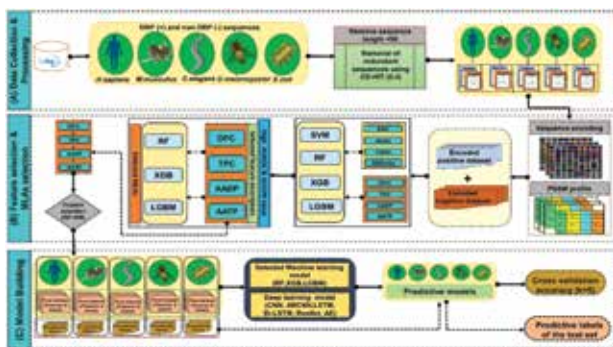
SVM-Root: Computational Identification of Root-Associated Proteins in Plants

Root is a desirable trait for modern plant breeding programs, as the roots play a pivotal role in the growth and development of plants. Therefore, the identification of the genes governing the root traits is an essential research component. With regard to the identification of root-associated genes/proteins, the existing wet-lab experiments are resource intensive and time consuming, whereas the gene expression studies are species-specific. As an alternative, a machine learning-based computational method for the identification of root-associated proteins has been developed. Four different machine learning algorithms such as support vector machine (SVM), extreme gradient boosting, random forest, and adaptive boosting were employed for the classification of proteins of the two classes. Different sequence-derived features such as amino acid composition (AAC), Dipeptide composition (DPC), Composition, Transition, and Distribution (CTD), Pseudo Amino Acid Composition (PAAC), and Autocorrelation Function (ACF) were used as input for the learning algorithms. The SVM achieved higher accuracy with the 250 selected features of AAC+DPC+CTD. Specifically, the SVM with the selected features achieved overall accuracies of 0.74, 0.73, and 0.73 evaluated with single 5-fold cross-validation (5F-CV), repeated 5F-CV, and independent test set, respectively. A web-enabled prediction tool SVM-Root (https://iasri-sg.icar.gov.in/svmroot/) has been developed for the computational prediction of the root-associated proteins. The proposed model is believed to supplement the existing experimental methods and high throughput GWAS and transcriptome studies.
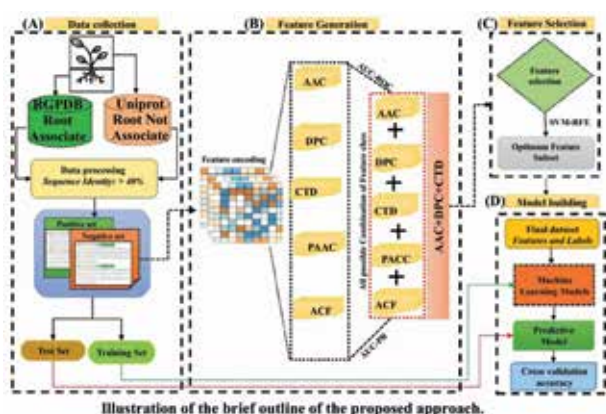

Brief Outline of Proposed Approach of SVM-Root

PhytoMicroBioPred: A Web-Application for Prediction of Compound Bioactivity against Plant and Microbes Target Proteins

With the rise of antibiotic resistance and the continuous threat of plant diseases impacting agriculture, there is a pressing demand for novel antimicrobial and pesticide agents. Traditional methods of drug discovery and development are often time-consuming and resource-intensive, making them less feasible for addressing the growing challenges posed by pathogens and plant pathogens. To predict the bioactivity of the small molecules against plant and microbial target proteins, the study utilized bioactivity data sourced from the ChEMBL database, focusing on compounds interacting with proteins from plants, bacteria, and fungi. Active compounds, with IC50 values below 1000 nM, were distinguished from inactive ones (>10,000 nM), creating balanced datasets for model development. Molecular representations were generated using SMILES notation, with IC50 values transformed into the negative logarithmic scale. Over 800 molecular descriptors were extracted and low-variance features were filtered out. Various machine learning algorithms, including Random Forest (RF), Support Vector Machine (SVM), K-Nearest Neighbors (KNN), linear discriminant analysis, and AdaBoost, were explored. RF emerged as the top-performing model across all datasets, achieving over 90% accuracy for microbial targets and approximately 86% for plants. The optimized RF models for each of the target groups (fungi, bacteria and plants) were then integrated into a web application PhytoMicroBioPred (http://login1.cabgrid.res.in:5260/) for predicting bioactivity in plants and microbes, encompassing bacteria, and fungi.

PlantPathoPPI: Machine Learning-based Tool to Predict Protein-Protein Interaction between Plants and Pathogens

Biological processes are the result of interactions among biomolecules. Protein-ligand interactions, where ligands can vary from small molecules to
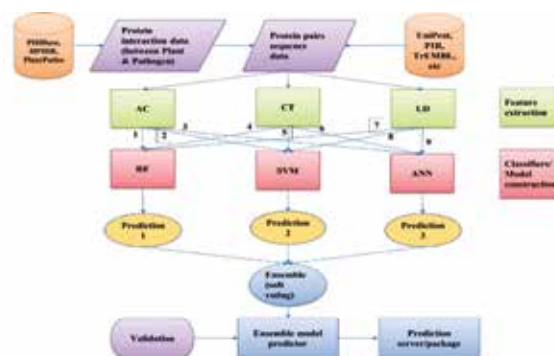
Workflow of the computational pipeline, PlantPathoPPI, for predicting protein-protein interactions between plants and pathogens

proteins, are essential for all processes occurring in living organisms. Protein-protein interactions (PPIs) between plants and pathogens ultimately decide the state of normalcy or disease. Hence, the identification of plant-pathogen PPI is crucial to decipher the complex molecular mechanism of pathogen infection and plant immunity. In this endeavour, a machine learning (ML)-based ensemble model was developed to construct a robust predictor for multi-species plant-pathogen PPIs, utilizing diverse sequence encodings and multiple learning algorithms. It utilized protein sequence data from 161 plant species and 156 phytopathogens. Various amino acid sequence encoding schemes, including auto-covariance (AC), conjoint triad (CT), and local descriptor (LD), were explored and selected based on their performance across various evaluation metrics. These features were amalgamated with learning algorithms such as random forest (RF), support vector machine (SVM), and artificial neural network (ANN). After a comparative analysis, the top-performing models were integrated into a robust ensemble model, PlantPathoPPI, showcasing heightened accuracy (~97%). The ensemble model was rigorously assessed against existing tools in the domain using an independent test dataset, affirming its promising potential. To enhance accessibility for diverse end-users, a user-friendly web-based prediction server available at http://login1.cabgrid.res.in:5090/ and a Python package (https://pypi.org/project/plantpathoppi-ml/) were developed. PlantPathoPPI can serve as a valuable tool for hypothesis-driven research, in plant-pathogen interactions.

DNA Marker Database and Web-Based Breed Prediction System for Indian Equine Breeds

Developed a DNA marker database and web-based breed prediction system for Indian equine breeds using CGI-Perl script, Hyper Text Markup Language (HTML) and Java Scripts. Submit the microsatellite allelic data having numeric values in base pairs. The data can also be uploaded either using .csv or .txt format or direct entry in the submission form. This server can be a valuable tool for conservation and breed improvement programmes. It is available at http://backlin.cabgrid.res.in/horse_ssr/

Genome-wide Identification and Characterization of Tissue-Specific Non-coding RNAs in Black Pepper (*Piper nigrum* L.)

From a panel of 53 RNA-Seq datasets of black pepper from six tissues, *namely*, flower, fruit, leaf, panicle, root, and stem of six black pepper cultivars,

covering eight BioProjects across four countries, we identified and characterized a total of 6,406 lncRNAs. Further downstream analysis inferred that these lncRNAs regulated 781 black pepper genes/gene products *via* miRNA–lncRNA–mRNA network interactions, thus working as competitive endogenous RNAs (ceRNAs). The interactions may be various mechanisms like miRNA-mediated gene silencing or lncRNAs acting as endogenous target mimics (eTMs) of the miRNAs. A total of 35 lncRNAs were also identified to be potential precursors of 94 miRNAs after being acted upon by endonucleases like Drosha and Dicer. Tissue-wise transcriptome analysis revealed 4,621 circRNAs. Further, miRNA–circRNA–mRNA network analysis showed 432 circRNAs combining with 619 miRNAs and competing for the binding sites on 744 mRNAs in different black pepper tissues. These findings can help researchers to get a better insight to the yield regulation and responses to stress in black pepper in endeavour of higher production and improved breeding programs in black pepper varieties.

Development of Wheat Core for Abiotic Stress, Biotic Stress, Morphological and Quality Traits

The phenotyping data of wheat were analysed to develop core collection of various traits, grouped mainly in four categories namely agro-morphological, quality, abiotic and biotic stress. The core was developed for each trait separately and a total of 16 core was developed (3 for agro-morphological, 3 for quality, 7 for biotic and 3 for abiotic stress). The PowerCore software was used for core selection (http://genebank.rda.go.kr/powercore.do). To determine the quality of core collections, four statistical parameters were estimated namely mean difference percentage (MD), variance difference percentage (VD), coincidence rate of range (CR), and variable rate of the coefficient of variation (VR). The size of core is selected as 10% of measured genotypes or default core set reported by PowerCore whichever is maximum.
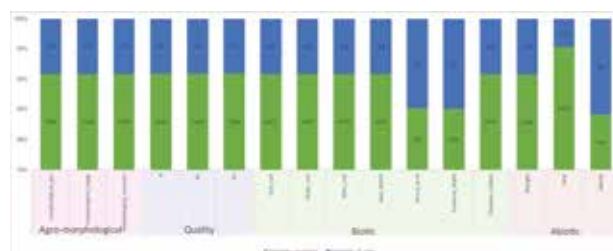
Bar graph for core set developed for wheat. The blue bars are core set out of total genotype examined (number of genotypes are mentioned in the bar for each trait).

SesameGWR: Sesame Genomic Resource

Sesame (*Sesamum indicum* L.) is a globally cultivated oilseed crop with notable nutritional and medicinal attributes, sesame has demonstrated promising effects in combating malnutrition and other diseases like cancer, diabetes, and cardiac issues. Despite its importance, sesame production faces significant challenges from environmental threats (biotic and abiotic stresses), resulting in economic losses for farmers. To address this gap, a user-friendly sesame genomic resource (SesameGWR) has been developed accessible at http://backlin. cabgrid.res.in/sesameGWR/. This platform provides key insights into differentially expressed genes (DEGs), transcription factors (TFs), miRNAs (microRNAs), Simple Sequence Repeats (SSRs), Single Nucleotide Polymorphisms (SNPs), and InDels (Insertions and Deletions) associated with both biotic and abiotic stresses.

Microsatellites Database of Whole-genome Sequences of *Mycogone perniciosa* Strain MgR1

The Database (http://backlin.cabgrid.res.in/ mushroom/) comprises SSR markers mined from whole genome data of *Mycogone perniciosa* strain MgR1. *Mycogone perniciosa*, the causal agent of Wet Bubble Disease (WBD), is an important pathogen especially in button mushroom. We have generated data on microsatellite (Simple Sequence Repeat (SSR)) in Mycogone perniciosa strain MgR1. This pathogen is of great interest to us in mushroom cultivation because sometime it causes complete crop failure. The data we present were generated at ICAR- Directorate of Mushroom Research, Chambaghat, Solan, HP. SSRs were detected using MIcroSAtellite Identification Tool (MISA v1.0) from assembled scaffolds. The generated information in this study will be useful in understanding the pathogen biology and provides basis for studies on disease development and host-pathogen interaction.

## Novel Feature Extraction from Metagenomics Data for Binning

Metagenomics plays a pivotal role in examining the entirety of microbial communities in a complex environment and enables the identification of unknown bacteria through computational methods using next-generation sequencing technologies. A metagenomics experiment typically involves two essential steps: sequence assembly and sequence binning. Binning is most prominent technique in metagenomics analysis and there are two approaches such as reference based and reference-free. However, existing binning tools do not account for mutations, insertions, or deletions, thereby neglecting the evolutionary relationships within metagenomics binning. This study aims to address this gap by proposing a novel and efficient pipeline for metagenomics binning, leveraging an innovative feature selection method applied to metagenomics datasets. The proposed approach offers several advantages for metagenomics binning firstly, it incorporates the concept of indels, distinguishing it from other methods. Secondly, unlike other approaches, it can detect mutations. Thirdly, it effectively clusters all contigs within the dataset. Lastly, it reduces dimensionality, mitigating potential space or memory allocation issues.The proposed approach offers several advantages for metagenomics binning and performed better than MaxBin and MetaBat.

ATDEAP : Advanced Tool for Differential Expression Analysis in Proteomics

Developed a user-friendly web application Advanced Tool for Differential Expression Analysis in Proteomics (ATDEAP) for detecting differentially expressed features in proteomics expression data considering heterogeneity and missing values, and accommodating complex experimental design. We have integrated different approaches of normalization and imputation to detect differentially expressed/ abundant features (peptides/ proteins) in proteomics data. Further, we have incorporated our developed hybrid approaches of normalization and imputation for differential expression analysis. Furthermore, several statistical tests such as t-test, moderated t-test, linear fixed and mixed effect models with adjustment of effect of extra covariates have been provided. The tool can be accessed freely by the users from http://omics.icar.gov.in/ATDEAP/.

Artificial Intelligence based Framework for Prediction of Protein 3D Structure

In structural molecular biology, protein 3D structure prediction is prime most research since five decades. The development of a true ab initio methodology that can accurately predict protein structures holds the key to success in the field of generic 3D structure prediction and drug design. We work toward this goal by presenting segmentation of sequence and structure motifs and then applied deep leaning based Long Short Term Memory (LSTM) network. This is a novel method extracting features from existing 3D structures by segmentation of sequence and structure, then building mapping among them sequence segments to structure segments. These mapped data have been used as training data to train the model using LSTM approach. Basic topology of the structure will be generated with only back bone atoms, after basic topology model, side chain packing has been done using FASPR (Fast and Accurate Side-chain Packing and Refinement) tool. Finally, side chain and over all energy minimization has been done using ModRefiner to get final predicted structure. The web based prediction server has been developed on python flask frame work. The algorithms have been evaluated rigorously in community-wide tool Ramachandran Plot and RMSD on superposition of the original and predicted protein structure.
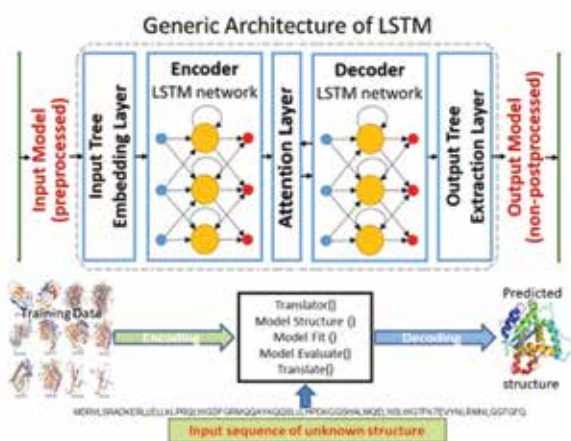
Implementation of LSTM model for protein 3D structure prediction

Networks of LncRNAs, miRNAs and mRNAs in Response to Heat Stress in Wheat

Climate change has become a major source of concern, particularly in agriculture, because it has a significant impact on the production of economically important crops such as wheat, rice, and maize. In the present study, an attempt has been made to identify differentially expressed heat stress-responsive long non-coding RNAs (lncRNAs) in the wheat genome using publicly available wheat transcriptome data (24 SRAs) representing two conditions, namely, control and heat-stressed. A total of 10,965 lncRNAs have been identified and, among them, 153, 143, and 211 differentially expressed transcripts have been found under 0 DAT, 1 DAT, and 4 DAT heat-stress conditions, respectively. Target prediction analysis revealed that 4,098 lncRNAs were targeted by 119 different miRNA responses to a plethora of environmental stresses, including heat stress. A total of 171 hub genes had 204 SSRs (simple sequence repeats), and a set of target sequences had SNP potential as well. The current study reveals many elements of gene expression regulation in wheat under heat stress, paving the way for the development of improved climate-resilient wheat cultivars.

Programme 5: DEVELOPMENT OF INFORMATICS IN AGRICULTURAL RESEARCH

AgriResponse: A Real-time Agricultural Query-response Generation System for Assisting Nationwide Farmers

AgriResponse is a real-time agricultural query-response system designed to support Indian farmers by providing timely plant-protection advice. It constructs a comprehensive knowledge base from eight years of farmers' helpline call logs. The system uses three response-retrieval models that incorporate approximate matching and spatial searching to address diverse farmer queries effectively. Tested on a question bank covering 151 crops, the system's performance is evaluated using metrics like accuracy, crop-weighted performance, and response time.

AI-DISC : Artificial Intelligent based Disease Identification System for Crops

AI-DISC an AI-enabled mobile application that can identify a broad range of diseases and pests in the field condition through images. The initiative has significantly improved processes and services in agriculture by introducing a mobile application that swiftly identifies plant diseases without expert intervention. This real-time identification capability facilitates prompt delivery of remedies, enhancing efficiency and reducing manual labour costs associated with disease diagnosis. The rollout strategy is to collaborate with agricultural institutes
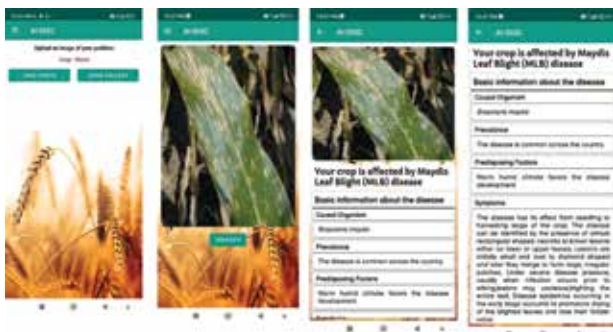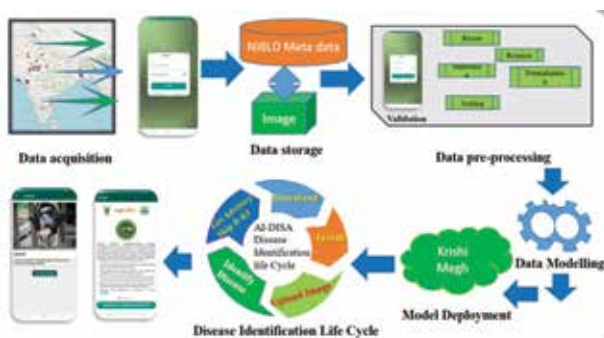
Identification module of AI-DISC mobile application

and Krishi Vigyan Kendras (KVKs), ensures widespread adoption and benefits for farmers across the country.

Technologically, AI-DISC utilizes a robust stack including TensorFlow, Keras, and other Python packages for deep learning purposes, alongside Java, Android SDK, and MS SQL Server for app development. Model training and deployment are carried out on NVIDIA DGX GPU Clusters, ensuring computational efficiency and scalability. The user-friendly Android-based UI enhances accessibility for farmers. Moreover, AI-DISC sustainability lies in its incremental growth, ongoing model refinement, and potential integration with other applications, ensuring its long-term viability. Presently AI-DISC is enabled with sophisticated deep learning models for identification of 55 diseases of 20 crops (50 diseases of 19 crops reported earlier) and 19 insects for 3 crops.

AI-DISHA: Artificial Intelligent based Disease Identification for Livestock

AI-DISA (Artificial Intelligent based Disease Identification for Livestock) is an artificial intelligence based mobile application capable of identifying visible diseases in livestock. Presently AI-DISA can identify diseases in Bovine and Canine. For Bovine, AI-DISA can identify the Foot and Mouth Disease, Mastitis and Lumpy Skin Disease and for canine it

Life cycle of AI-DISA Mobile Application

can identify Canine Distemper, Canine Parvo Virus, Rickets, Mange and Mamary Tumor.

ICAR Research Data Repository for Knowledge Management

- **Strengthening and Maintenance of KRISHI Portal:** KRISHI Portal has been enriched by adding and updating the Krishi Links of several online resources available/developed at different ICAR institutes under the categories Databases and Portals, Management Information Systems and Dashboard.

- **Video and Audio Gallery:** Links of 4,352 videos (3,771 reported earlier) available on gallery. The video files for 4,320 videos (3,640 reported earlier) were also uploaded for archiving. Added feature of total view of Video Gallery using KRISHI Portal is 16,770+ since January, 2023.

- **Technology Repository:** At present 2,042 (1,980 reported earlier) technologies from 82 Institutes are available in public domain. ICAR Technology Mobile App has 10,000+ downloads. JSON URL of Technology Repository prepared and shared with ARMS.

- **Mobile App Gallery:** Mobile App Gallery has links of 409 Mobile Apps (ICAR: 283; SAU/CAU: 67; KVK: 28 and Other Govt. Agencies: 31). The 353 Mobile App files were also uploaded for archiving. Total view of Mobile App using KRISHI Portal is 5,080+ and downloads through KRISHI Portal is 240+ since January, 2023. At present 132 of mobile apps have 1,000+ downloads with a total of 5.62 lakh downloads. Out of these 13,103 app have 50,000+downloads, 23 have 10,000+ downloads, 19 have 5,000+ downloads and 87 have 1,000+ downloads.

- **Interportal Harvester:** In order to bring agricultural research publications collected by various organizations within and as well as outside of ICAR Meta Data has been harvested from Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH) protocol enabled web applications. Unified search is ready for 37 repositories for 7,96,797 (6,46,370 reported earlier) records at https://krishi.icar.gov.in/iph/.

- **Publication and Data Inventory Repository:** Enriched through populating data by Nodal Officers and other researchers. 76,120 (70,720+ reported earlier) publications and 1,066 datasets (1,038 reported

earlier) have been submitted from 111 Institutes. Since May 2017, there are more than 50,94,568 (32,20,105 reported earlier) downloads from this repository inclusive of those fetched through computer programmes by other sites.

- **ICAR IPR Repository:** The repository has been enriched by adding and updating collection of reports of ICAR- IPDB Application for Copyrights by filter data ranges with start date like (yyyy-mm-dd) to current date along with advanced search has been embedded. The repository is enriched with having (i) Patents 654 applications (ii) Copyright – 163 (143 earlier); (iii) Variety Registration -1323; (iv) Trademark -124 and (v) IPR Designs – 58. Also Added dated range filter in four modules of IPR repository (i) Variety Registration; (ii) Patent; (iii) Copyright and (iv) Trademark.

- **Observational Data Repository:** Updated the python script to fetch the weather data for (i) ICAR-IARI, New Delhi; (ii) ICAR- IISWC, Dehradun; (iii) ICAR-CRIJAF, Barrackpore; (iv) ICAR-NIASM; (v) ICAR-CCARI; (vi) ICAR-CSSRI and (vii) ICAR-CSWRI. Updated the 2022 agro-meteorological data provided by ICAR-CRIDA, Hyderabad for the 07 centres: Prabhani, Anand, Banglore, Bhubaneswar, Depoli, Kovilpatti and Palampur and by ICAR-IARI for the period 2020-2022.

- **ICAR Image Gallery:** Enriched through populating data by Nodal Officers. 379 images (217 images reported earlier) have been submitted from 15 Institutes.

- **ICAR Geo-Portal:** Partner Centre ICAR-NBSS&LUP reported that (i) Integration of thematic raster layers on the Interoperable Geoportal Platform has been successfully implemented and integrated 10 raster layers (NDVI/VCI/kharif and rabi Maize suitability) between ICAR-KRISHI and BHOOMI Geoportal;

(ii) Query builder has been designed and developed on the Interoperable Geoportal Platform to query the class-wise information on vector layers across the Geoportals; (iii) Query builder has been designed and developed on the Interoperable Geoportal Platform to query the administrative unit-wise (State/district) information on vector layers across the Geoportals; (iv) Processed and developed APIs for grapes suitability maps for Maharashtra and Madhya Pradesh states and uploaded them on Interoperable Platform GeoServer. Uploaded the same thematic services through APIs on KRISHI Geoportal; (v) APIs were developed to upload the revised vector layers of mountainous, red, black and alluvial soils of India on ICAR-KRISHI Geoporal; (vi) APIs were developed to upload the revised vector layers of soil depth, texture, and slope and erosion status of India on ICAR-KRISHI Geoportal and (vii) APIs were developed to upload the soil physiography of India on ICAR-KRISHI Geoportal.

- **Experimental Data Repository:** Information System for AICRP on Weed Management Launched during XXX Annual Review Meeting of AICRP on Weed Management held at SKUAST-Jammu during May 26-27, 2023 by Dr. JS Misra, Director, ICAR-DWR, Jabalpur. Strengthened the Information System on AICRP on Vegetable crops with analysis module.

Kisan Sarathi: System of Agri-information Resources Auto-transmission and Technology Hub Interface and Implementation in ICAR

To support this emerging need of multi ways and multilingual communication among various agricultural stakeholders, "Kisan Sarathi" an Information Communication and Technology (ICT) based interface solution has been launched on July 16, 2021. The ultimate goal of this project is to implement an intelligent online platform for supporting agriculture at local niche with national perspective. Project intended to provide a seamless, multimedia, multi-ways connectivity to the farmers with the latest agricultural technologies, knowledge base and the pool of large number of subject matter experts. The services of Kisan Sarathi for the farmers is available through an IVR based calling system via toll free numbers 1800-123-2175 and a short number 14426. Once a registered farmer calls to any of these numbers, his call is directly gets connected to one of the agricultural scientist of associated

Kisan Sarathi (F) App
(Beta Version)

Status	Reporting Period
Registered Farmer	11,599,598
Number of Villages Covered	2.59 lacs
Total Call	2.5 Lacs
Total SMS sent	35,564,285

KVK of his locality. Where they can mutually talk in their respective local language to resolve any issue related to agriculture or farming. All calls made into the system are recorded in the MIS of Kisan Sarathi and are available for future reference.

Almost all the KVKs across India and DATTC centres of Andhra Pradesh and Telangana are enrolled with the system. During reporting period around 1.1+ Crore farmers were got registered with Kisan Sarathi. Apart from receiving more than 2.5 lakh calls from the farmers, more than 3.5 crore SMS in the form of agricultural advisories has also been sent to the registered farmers by Scientists of KVK using Kisan Sarathi Platform. Further, to enhance the services of Kisan Sarathi, a new Interactive Voice Response System (IVRS), in 13 languages (11 major regional languages along with English and Hindi), has been implemented during the reporting period. Again, to support both ways multimedia exchange a Kisan Sarthi Mobile App for Farmers (KS-App/F- Beta version) has been made available to the farming Community. KS-App/F in 13 (11+2) languages is available with UMANG platform of MeitY, Government of India at Google play store and supports following activities viz.: Registration of Farmers; Advisory notification; Ask and track Query; Call from App etc. (https://play.google.com/store/apps/details?id=in.gov.umang.negd.g2c&pli=1).

Management and Impact Assessment of Farmer FIRST Project

Graphical dashboard has been developed for Principal Investigator Level. During the 2023, 213 interventions, 162 events, 368 images, 21 videos and 42 publications related to FFP have been uploaded. The details of 1,620 interventions, 1,348 events, 3,820 images, 145 videos and 517 publications related to FFP are available on the portal. The portal has been visited by 1,04,593 users since February 2018; in the year 2023, 17,602 visitors have been visited.

Intelligent Decision Support System for Precision Agriculture under ICAR Network Program on Precision Agriculture (ICAR-NePPA)

- **Artificial Intelligence based Mastitis Disease Detection in Murrah Buffaloes**: In this study, an attempt has been made to detect mastitis through a Convolutional Neural Networks (CNN)-based deep learning model using 7,615 udder thermograms of 40 Murrah buffaloes. The thermograms were grouped separately as healthy, sub-clinical (SCM), and clinical mastitis CM) affected udder quarters based on California Mastitis Test (CMT) scores, Somatic Cell Count (SCC) values and thermal image analysis. The sequential (Normal vs Clinical and Normal vs Sub-clinical) models had training accuracy and validation accuracy of 0.999 and 0.988, 0.991 and 0.978, respectively. The results for Normal vs Clinical and Normal vs Sub-clinical models reflected a loss of 0.009 and 0.029, precision of 0.947 and 0.980, and recall of 0.996 and 0.904, respectively. Consequently, the sequential (Normal vs Clinical and Normal vs Sub-clinical) models achieved a testing accuracy of 0.970 and 0.943, respectively.

- **Artificial Intelligence based Mastitis Disease Detection in Tharparkar Breed of Cow:** This study aimed to assess intramammary infection seasonally and to diagnostically ascertain mastitis through deep learning models using 7,223 udder thermograms of 22 Tharparkar lactating cows. The udder health was ascertained using thermograms, captured using a DarviDTL007 camera and further assessed using the California Mastitis Test (CMT) and Somatic Cell Count (SCC) values. In this study, we used Convolutional Neural Network (CNN), Residual Network with 50 layers (ResNet-50) and Visual Geometry Group (VGG) 16 models. The performance of sequential CNN on the original and the augmented dataset, ResNet-50 and VGG 16 were compared for both Normal vs. Subclinical and Normal vs. Clinical mastitis cases. The CNN (Normal vs. Clinical and Normal vs. Sub-clinical) models outperformed other models and showed the highest training and validation accuracy of 0.98 and 0.93, 0.98 and 0.90, respectively. The results for Normal vs. Clinical and Normal vs. Sub-clinical models reflected a loss of 0.03 and 0.29, precision

of 0.91 and 0.92, and recall of 0.95 and 0.87, respectively. Consequently, the sequential (Normal vs. Clinical and Normal vs. Sub-clinical) models achieved a testing accuracy of 0.93 and 0.90, respectively.

- **Web Application for Capturing Images at Different Stages from Field/Plot along with Meta Data (stage, time, location, etc.) for Wheat:** Developed a web application for capturing the images related to assessment of nitrogen (N) contents and accordingly determine the required doses of N for obtaining the optimum yield. Suitable Specifications or Standard Operating Procedures (SOPs) has been developed for capturing the images from the field. The developed application has been handed over to the institute for testing and implementation. The required data is being entered into the system. The ICAR-IIWBR has already entered first year of their experimental data by using this system. The system is accessible at http://neppa.icar.gov.in:8080/neppa_webapp.

Cereal Systems Initiative for South Asia (CSISA) Integration with KVK Portal

To find the common village list for the randomization of the villages, census data and list of villages of selected block of the districts (provided in the table below) were imported into SQL Server database and mapping was done on the basis of village code(s) between the census data and the LGD data.

District	State
Mirzapur, Shahjahanpur	Uttar Pradesh
Dumka, Ranchi, Gumla, Sahibganj	Jharkhand
Samastipur, Bhojpur, Nalanda, Muzaffarpur	Bihar
Hisar, Bhiwani, Mahendragarh, Sirsa, Fatehabad, Kurukshetra	Haryana
Sagar, Chattarpur, Tikamgarh, Shivpuri	Madhya Pradesh
Bargarh, Cuttack, Dhenkanal, Mayurbhanj, Puri	Odisha

A total of 16,011 data points for n Landscape Diagnostic Survey (LDS) on rice and 13,592 data points for LDS on wheat have been added into CSISA database. All the data have been used in the LDS dashboard (https://kvk.icar.gov.in/CSISAv1.aspx), the report and the map view have been customized accordingly.

Knowledge Management System for Agriculture Extension Services in Indian NARES (KVK Portal)

e-Governance of Activities and Data Exchange with API with other Portals: KVK Portal is being used for e-governance and data exchange with other Government organizations like Jal Sakti Abhiyan, Krishi Kalyan Abhiyan (KKA)-I, II, III, Darpan Dashboard, Kisan Suvidha and Open Data Platform. Portal is used for e-governance of activities in three different ways.

1) Event category is added in the portal. the\\\ The information related to programs organized is entered by KVK's and a separate dashboard is created by the system showcashing event details along with Image Gallery. For example, Crop Residue Management activity is depicted in KVK Portal with dashboard.

2) For some of the schemes like Garib Kalyan Rojgar Abhiyaan (GKRA), KKA-I, II; data was entered by KVK's in the portal and dashboard was developed for monitoring the data by various ministries and stakeholders involved in the process. MIS report was developed to view the data at different levels. For example, Data was uploaded on weekly basis to GKRA official Portal (http://gkra.nic.in).

3) On the other hand, for some of the schemes data was entered in KVK Portal and using API's it is exchanged with other Government. Portals.

KVK portal is linked to ICAR DARPAN Dashboard (https://icar.dashboard.nic.in/) through Web API, to display the KVK KPIs data like Mobile agro advisories provided to farmers, Farmers training and Agriculture extension activities. Functionality has been developed in the KVK portal, to reflect KVK KPIs


Displaying the KVK KPIs data for farmer training provided to farmer by KVK's on DARPAN Dashboard

Data in DARPAN Dashboard by pushing the KPIs data into the DARPAN Dashboard by consuming the WEB API provided by National Informatic Center (NIC) team.

Data from KVK Portal has been integrated with Kisan Suvidha Portal/APP developed by NIC (https://kisansuvidha.gov.in/). Different API's have been developed to share district level data. API's have been developed to share the data for Open Government Data (OGD) platform.

- Packages & Practices Agro Advisory Web API, to provides the path of the agro advisory for a particular state in english or local language in the json format by passing the 'state code' and 'language type' parameters.

- KVK details API, to provide the KVK's details. Facilities details API, to provide the facilities available in the KVK's under the particular district. KVK KPIs Web API, to provides the state and district wise cumulative data of KVK's, KPIs. (No. of farmer and No. of farmer's training, No. of mobile agro advisories issued to farmers, No. of extension activities organized by KVK)
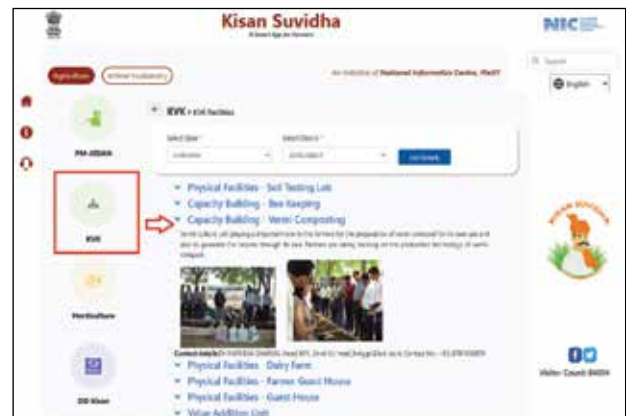
Displaying the KVK facilties details on Kisan Suvidha Portal

An Intelligent System for Determining Pig Live Weight

A regression-based Convolutional Neural Network (CNN) model was developed using over 3,000 digital images of live pigs along with their corresponding weight values. These images were captured under various imaging conditions on a custom-built platform. The dataset was pre-processed and split into training and testing sets. The CNN model, implemented using Keras backed by TensorFlow, achieved promising results with R^2 values ranging from 0.791 to 0.821. The study demonstrates the potential of CNN and deep learning for accurate and high-throughput weight estimation of live pigs

from digital images. Future applications may include deployment in mobile apps for on-field use by farmers.

The herd management Module offers a comprehensive suite of features for efficient pig farming. With individual pig wise record entry and the ability to access previously updated or uploaded information, farmers can maintain accurate and up-to-date data on each pig in their herd. The module provides detailed pig wise weight progression reports over time, enabling farmers to track the growth and development of each animal. Additionally, herd wise weight progression functionality allows for a broader view of the herd's overall health and performance. Temporal images of the pigs further enhance monitoring capabilities, providing visual insights into their physical condition and allowing for timely intervention when needed. Combined, these features empower farmers with the tools they need to optimize herd management practices and ensure the well-being and productivity of their pigs.The live weight estimation feature simplifies the process for farmers by allowing them to upload or capture images of their pigs effortlessly. Once the image is uploaded or captured, they can simply click on the "Predict weight" button to obtain an estimated weight for the live pig. This streamlined process enables farmers to quickly and accurately assess the weight of each pig in their herd.
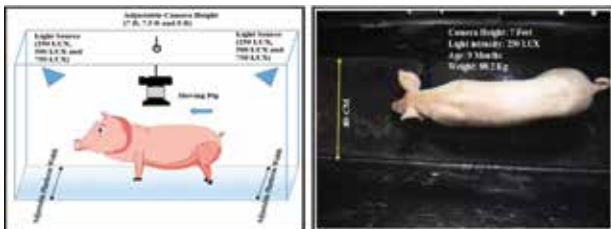

In-house Imaging platform developed at ICAR-IVRI, with adjustable camera height, platform width and light intensity; (B) Digital image of 9 months old pig with 88.2 Kg body weight where the camera height was 7 feet and 250 LUX.

Conversational Virtual Agents 'Chatbots' for Improving Livestock, Pet and Poultry Health & Production

- **Dairy SHRIA (Smart Heuristic Response based Intelligent Assistant):** Designed and developed a conversational virtual agent, 'Chatbot', to address various health and production management concerns regarding cattle and buffalo. In collaboration with ICAR-Indian Veterinary Research Institute (ICAR-IVRI), a dataset comprising 40,000 and 42,000 question-answer pairs, respectively, for buffalo and cattle has been curated. These pairs were collected from diverse sources, such as incoming query calls to IVRI veterinary polyclinic and Kisan Call Center. Leveraging artificial intelligence-based pretrained Large Language Models (LLMs) like Bidirectional Encoder Representations from Transformers (BERT), Robustly Optimized BERT Approach (RoBERTa), Distilled BERT (DistilBERT), and generalized autoregressive pretraining method (XLNet) have been fine-tuned on the dairy dataset to generate query embedding matrices. When users input queries, these matrices are used to identify the most similar Q&A entry, and the corresponding answer is provided as the chatbot response. We evaluated the performance of these models using metrics such as exact matches (EMs) and BLEU scores and ultimately deployed the best-performing model, BERT, for chatbot development. The bot is hosted on the central server of the ICAR-Data Center and is publicly accessible at https://dairyshria.icar.gov. in/chatbot/api. Additionally, an Android-based mobile application has been developed to offer a user-friendly interface for the chatbot. This application is available on the Google Play Store in 10 different languages. The application can be downloaded from https://play.google.com/ store/apps/details?id=com.ivriapp.ivri_chatbot. ivri_chatbot&hl=en-IN.

- **Sheep and Goat SHRIA (Smart Heuristic Response based Intelligent Assistant):** Developed a new chatbot tailored specifically for sheep and goats, employing a methodology like the one utilized in the development of dairy SHRIA. The training dataset, comprising 90,000 Q&A pairs evenly split between sheep and goats, forms the backbone of this methodology. Recognizing the unique health and production management challenges faced by sheep and goats, this chatbot is crafted to address these specific concerns. To facilitate accessibility, an Android-based mobile application has been developed, which is accessible via https://play. google.com/store/apps/details?id=com.ivriapp. ivri_chatbot.ivri_chatbot&hl=en_IN&gl=US. This application boasts support for 10 different languages. Thus far, it has successfully resolved over 6,500 queries pertaining to sheep and goats.

Precision Engineering Technologies for Agricultural Input Production Management and Value Addition to Ensure Profitability, Sustainability and Environmental Safety

An innovative AI-based 3D points cloud processing pipeline designed for precise estimation of various parameters related to tree canopies. The pipeline addresses the limitations of existing semi-automatic methods by offering a fully automatic solution, making it efficient and suitable for autonomous robotic systems. Leveraging remote sensing techniques, the proposed pipeline processes raw 3D points cloud data, delivering results in shorter time frames compared to conventional methods. A key aspect of the pipeline is its utilization of unsupervised learning-based segmentation stages, tailored to operate effectively in computationally resource-restricted environments. The efficacy of the pipeline was validated through a series of experiments with different scanning times, resulting in minimum Mean Absolute Error (MAE) and Root Mean Square Error (RMSE) values. These findings demonstrate the precision and reliability of the pipeline's outputs, highlighting its potential applications in precision agriculture and forest/orchard tree management activities.

Digital Initiatives for Agricultural Education

- **Blended Learning Platform:** National Agricultural Research and Education System - Blended Learning Platform" viz. NARES-BLP, has been developed to inculcate a digital first mind amongst learners and faculty and to act as a catalyst for introducing more engaging forms of classroom instruction while also providing flexible learning mechanisms to learners. The BLP follows a tenant-based mechanisms, thus providing each agricultural university a distinct identity of their room customisation in future.

NARES BLP has been successfully implemented in 76 Agricultural Universities, thereby signifying the wide acceptance of platform amongst stakeholders. The launch of the platform was well supported with sensitization workshops and capacity building sessions offered both online and offline across all Agricultural Universities with aggregate attendance of more than 12,000 participants. Overall, the success of the initiative also stems from the encouraging response it has received, since its launch with over 93,000 users have already been onboarded on to the platform.

- **AR/VR Experience Labs and Content:** Virtual Reality (VR) Experience Labs have been operationalized across all 75 universities (earlier 10) with the enabling hardware and software infrastructure including AR/VR kits. Additionally, five new AR/VR curriculum aligned modules have also been introduced for varied disciplines within the agricultural education ecosystem taking the total AR/VR learning modules count to 19. Creation of AR/VR infrastructure was complimented with 14 training sessions attended by more than 5,300 participants (both faculty and students). These sessions included sensitising users about various aspects to drive adoption steps like unboxing of kits, usage of equipment, access content and also mechanisms for inhouse creation of AV/VR modules by faculty.

- **Digital Content:** The project also saw successful development of multi-media rich content. A total of 59 2D/3D (PG courses- 12, UG courses- 47) content were developed under the pilot program. Over 800+ learning hours of digital content was created to facilitate the enrichment of the agricultural educational landscape and

S.No	Course Name	S.No	Course Name
1	Communication of Livestock Development	33	Information Technology in Dairy Industry
2	Fish Canning Technology	34	Advanced Food Sciences
3	Shellfish and Hatchery Management	35	Tropical and Sub Tropical Vegetables
4	Plastic Applications in Agriculture	36	Comparative Sphlanchology
5	Aquatic Ecology and Disaster Management	37	Fish Population Dynamics and Stock Assessments
6	Principles of Seed Production	38	Oceanography
7	Veterinary Protozoology	39	Cattle and Buffalo Production Management
8	Thermodynamics	40	Tropical and Sub Tropical Fruits
9	Agricultural Marketing Trade and Prices	41	Fish By Products and Waste Utilisation
10	Growth and Development of Horticultural Crops	42	Engineering Physics
11	Water Management including Micro-irrigation	43	Seed Production of Vegetable, Tuber and Spice Crops
12	Problematic Soils and Their Management	44	Medicinal and Aromatic Crops
13	Management of Canal Irrigation	45	Crop Process Engineering
14	Engineering Properties of Food Materials	46	Drain Engineering
15	Waste and By-Production Utilisation	47	Watershed Hydrology
16	Farm Power and Machinery	48	Breeding of Vegetables, Spice and Tubers
17	Fish Food Organisms	49	Design of Structures
18	Fishery Extension Education	50	Disaster Management in Fisheries
19	Fisheries Business Management and Entrepreneurship Development	51	Biomass Management for Fodder and Energy
20	Horti-Business Management	52	Soil Mineralogy, Genesis, Classification and Survey
21	Global Extension Systems	53	Agribusiness Management and Trade
22	Ruminant Clinical Medicine 1	54	Groundwater, Wells and Pumps
23	General Pathology	55	Condensed and dried Milk
24	Chemistry of Milk	56	Fluid Mechanics
25	Insects Pests of Vegetables, Ornamental and Spice Crops	57	Veterinary Neuropharmacology
26	Principles Of Dairy Machine Design	58	Animal Welfare, Ethics and Jurisprudence
27	Diagnostic Laboratory Section	59	Avian Pathology
28	Fisheries Administration and Legislation		
29	Dairy Biotechnology		
30	Surveying and leveling		
31	Weed Management in Horticulture Crops		
32	Pet Animal Breeding, Management, Nutrition and Health Care		

equipping students and faculty with the learning resources.

- **e-Learning Portal:** The e-Learning platform was also strengthened through collaborative approach wherein the faculty of various universities came together to create and curate self-learning modules. The e-learning portal proudly hosts over 250 e-learning courses comprising of reference materials and self-assessment tools.

- **Virtual Classroom and Agri DIKSHA:** The Agri-DIKSHA Web Education Channel and Virtual Classroom system have made a substantial impact in teaching/training by benefiting numerous students and faculty members across 50 contributing universities.

Agri-DIKSHA channel proudly hosts a repository of 3,430+ e-content, over 1.3 lac views, and 3.2 lacs minutes of curated content. Various modifications were done to enhance the user experience and user interface of the portal such as incorporated a video viewing feature similar to YouTube into the Agri-DIKSHA portal, developed features for filtering videos and searching videos by university, launched a YouTube-like video viewing feature on the Agri-DIKSHA portal, developed functionality for liking and rating videos, enhanced the video experience UI, including suggestions for similar videos, added a dashboard to the Home page for a better user experience. The platform's reach extends to 50 countries, hosting live interactions and question-and-answer sessions, showcasing its widespread adoption and positive impact on the global education community.

- **Strengthening Krishi Megh**: Krishi Mmegh, the data center, has undergone a significant upgrade to cater to the escalating demands of AI and HPC. This strategic enhancement is marked by the integration of cutting-edge hardware, ensuring robust and efficient data processing capabilities. At the heart of the upgrade are dual AMD ROME processors in each node, boasting a total of 128 CPU cores with speeds up to 3.4 GHz max boost. These are complemented by eight Nvidia A100 GPU accelerators per node, each with 40GB of RAM and NV Link 3.0 for superior GPU-GPU communication. This powerful combination delivers an impressive 5 PetaFLOPS of AI performance and 10 PetaOPS INT8, showcasing the system's formidable processing strength. Memory capacity has been expanded to a minimum of 1TB DDR4 RAM per node, operating at 3,200 MHz, facilitating swift data access and efficient multitasking. The GPUs contribute an additional 320GB of memory system-wide, supporting large datasets with a high-speed memory bandwidth of 1.5TB/sec. Network enhancements include Mellanox ConnectX-6 VPI adapters, offering high-speed data transfers at 200Gb/s, essential for clustered environment efficiency. Storage solutions have also been upgraded, with a minimum of 15TB of internal NVME storage per node, accommodating large data volumes with ease. The implementation of a scale-out NAS, in line with ICAR-DC replication policy, ensures data protection and supports the Krishimegh Applications, including object Storage, and

computing and storage requirements for various platforms and databases.

Data protection and disaster recovery are bolstered by the distributed nature of the data across the added nodes, which also brings improved flexibility to the infrastructure. It can now scale both vertically and horizontally, adapting to changing business needs with ease. The infrastructure's resilience is heightened, with the ability to shift processes to other nodes in the event of a failure, ensuring uninterrupted operation. The enhanced network capacity facilitates faster and smoother data transmission, while the latest efficiencies in compute, storage, and networking technologies drive overall system performance improvements. The centralized management software of HCI simplifies the addition and management of new nodes. At the Disaster Recovery Center (DRC), the strengthened HCI compute nodes have not only improved system performance by providing additional compute capacity but have also bolstered system resilience. Similarly, the enhanced HCI storage nodes have expanded storage space, ensuring high availability of data and improved performance. The DRC is now better equipped to rapidly recover from failures, prevent data loss, and scale efficiently in response to business demands. The storage nodes now offer advanced data protection features, such as snapshots and replication, while handling larger volumes of data with increased speed and efficiency

- **Academic Management System:** Academic Management System (AMS) is a comprehensive e-Governance System for university functions, including Student Life Cycle, Administrative, and Operations activities. It has been designed, developed, and implemented by the Division of Computer Applications, IASRI. The implementation of the AMS under the project NAHEP Component II marked a significant achievement with the successful deployment in 60+ AUs. Moreover, the project Resilient Agricultural Education System (RAES) has witnessed the successful implementation of AMS in 14 AUs. The implementation of AMS in the AUs symbolizes a broader transition, bringing efficiency and modernization to the academic processes within these specific universities. The implementation of AMS across AUs under the RAES initiative reflects a collective

	64 Universities		677 Institutes / Colleges		652 Non-Teaching Staff
	75671 Students on Roll		6844 Students Pass-Out		1473 Student Dropped/ Left Out
	12680 Faculty		1 Faculty Transferred		97861 Total Registered Users

effort to enhance the overall resilience and effectiveness of agricultural education systems. Approx. 40 Trainings have been conducted to build the capacity of stakeholders to enhance stakeholders' ability to utilize AMS in AUs.

- **Strengthened National Image Base for Plant Protection (NIBPP) & National Image base for Livestock Diseases (NIBLD):** Using the two mobile applications namely NIBPP and NIBLD image base have been strengthened. Around 4.91 lakhs images (3,77 lakh reported earlier) of 66 crops (61 reported earlier) with 242 diseases and 373 pests (277 reported earlier) have been collected from several ICAR institutes and State Agricultural Universities in the NIBPP. There are 41,772 images (37,818 reported earlier) of 31 diseases (27 reported earlier)of 11 livestock that have been collected in the NIBLD application in collaboration with ICAR-IVRI, Izatnagar and other State Veterinary Universities.

- **Other Initiatives:** Along with the key initiatives under NAHEP Component 2 over past one year, it is noteworthy to mention that there have been several brownfield developments which have also been undertaken to strengthen existing applications. These include introduction of new modules, improvement in UI-UX of existing portals and improvement in workflows and user experience of several portals including the Project Information Management System, KVC ALNET portal, Expert Information Management System.

Online portal for Research Pre-proposal Management & Information System for National Agricultural Science Fund (ORPIMS-NASF)

The Online portal for Research Pre-proposal Management & Information System for National Agricultural Science Fund (ORPIMS-NASF) has successfully designed, developed and tested. The system was live to take research pre-proposal for NASF call (https://nasf.icar.gov.in/). After completion of the call several reports has been generated for the smooth completion of the initial evaluation of the submitted project.

IIVR - Sabji Gyan Mobile App for ICAR-Indian Institute of Vegetable Research

Sabji Gyan mobile app has been designed and developed in collaboration with ICAR-Indian Institute of Vegetable Research for android users. The app is available in Google Play Store (https://play. google.com/store/apps/details?id=net.iasri.iivr.sabji. gyan&hl=en&gl=US) in hindi and english languages. This application serves as a comprehensive guide, offering detailed insights into the cultivation and effective management of a wide array of vegetable crops. Users can access step-by-step guidance on optimal planting practices, soil preparation, irrigation methods, pest control strategies, and harvesting techniques. The app aims to empower both novice and experienced growers by providing in-depth knowledge, backed by scientific principles, to enhance the overall success and productivity of vegetable cultivation.

National Information System on Agricultural Education Network in India (NISAGENET-IV)

New System / Functionality / Module Developed

- **Netaji Subhas - ICAR International Fellowship**
    - Fellowship Application form has been redesigned as per requirements from Education Division.
    - Admin Module has been added. Role-wise dashboard has been provided for monitoring of applications and reports for status of applications
    - Mailing system has been integrated for sending Email notifications

e-NAM – e-National Agriculture Market
KCC – Kisan Credit Card
PDMC – Public Debt management Cell
SMAM - Sub-Mission on Agricultural Mechanization

SHC – Soil Health Card
MIDH – Mission for Integrated Development of Horticulture
PMFBY – Pradhan Mantri Fasal Bima yojana
NFSM – National Food Security Mission

- **VIKAS-Venture for Interaction of Kisan & Agri-Students** Mobile Application is under development for Integration of Framework of RAWE in Student READY portal.

  - Students in 19th week of training, are required to collect information from farmers and there feedback regarding various Government schemes.
  - Mobile App has been developed by integrating Student Ready Module and forms have been developed for Government schemes like soil health card, FPOs, Natural farming, Extension Activities for reporting feedback of these activities.
  - Login access to students enrolled under RAWE programme.
  - API's have been developed for fetching login credentials and other related information from Education portal required on VIKAS mobile app

- **Student READY** (RAWE/IPT/Internship/ Experiential Learning) module has been redesigned as per the requirement from Education division.

  - Modification in various reports has been done as per requirement received from Education division.
  - Education Portal has been redesigned to comply with the GIGW guidelines. Related New web pages like website policies, Terms & Condition, Sitemap and about us have been added.
  - Security Audit of the applications was carried

out and changes done as suggested for security audit. Security Audit certification received.

  - Education portal homepage UI design has been updated
  - Issues faced in filling university details like Courses Offered, Sports Facilities, Laboratory Facilities has been resolved.
  - Support has been provided to nodal officer to complete their pending tasks and filling information in different systems (DBTdare/IT Helpdesk/Grievance Redressal & Monitoring System/eLearning /Accreditation etc.)

Research Leadership Building System (RLBS)

RLBS (https://rlbs.icar.gov.in) has been designed and developed for inviting online proposals, for ICAR-National Fellow (NF)/National Professor (NP)/ Emeritus Scientist (ES)/Emeritus Professor (EP) schemes, assessment of applications and sanction. MIS reports have been developed to monitor the different functionalities in the system. RLBS portal was open for inviting applications for Emeritus Scientist and National Professor in online mode for the year 2023-24 and a total of 73 applications for Emeritus Scientist & 5 applications for National Professor were received.

ASRB- Online Application & Scorecard Information System (ASRB - OASIS)

ASRB-OASIS introduced by ASRB revolutionizes the application process for aspiring agricultural

scientists. By moving the entire process to a digital platform, ASRB has streamlined the submission of applications, making it more convenient for candidates. This online approach eliminates geographical constraints, allowing candidates to apply from the comfort of their homes or any location with internet access. The system is designed to be user-friendly, simplifying the application procedure and reducing the burden of paperwork. Process re-engineering for digital transformation involves streamlining workflows through automated processes and ensuring seamless data integration. User-centric design and mobile accessibility enhance user experiences, while robust cyber security measures safeguard digital assets. Additionally, the portal offers online administrative and technical screening, as well as dynamic committee selection features. This system is beneficial in managing the entire recruitment process efficiently. In 2023, total 05 advertisements for 423 posts were published for various RMP and Non RMP posts. A total of 5,885 applications received.

NAAS-Fellowship Online Scorecard Information System (NFOSIS)

The National Academy of Agricultural Sciences (NAAS) has embraced the digital era by implementing an Online Application & Scorecard Information System, marking a significant shift in the way candidates interact with the fellowship process. This technological leap brings numerous advantages, enhancing efficiency, transparency, and accessibility. The NFOSIS portal designed to streamline the application process for candidates applying to various fellowships and awards, including both Fellowships (National Fellow, Pravasi Fellow, Foreign Fellow) and Awards (Young Scientist Award, Memorial Award, Recognition Award, Endowment Award) through NAAS Academy. User-centric design and mobile accessibility enhance user experiences, while robust cyber security measures safeguard digital assets. Additionally, the portal offers online administrative and technical screening. This system is beneficial in managing the entire fellowships and awards distribution process efficiently. In 2023, nominatyions/applications for various fellowships (National Fellow, Pravasi Fellow, and Foreign Fellow) and awards (Young Scientist Award) are invited through NFOSIS portal.

Financial Assistance Management System for Conference and Journals

Financial Assistance Management System for

Conferences & Journals (FAMSCJ) is an online workflow based system for managing for financial grants given by ICAR to scientific societies for: (a) organizing National / International Conferences/ Seminars /Symposia; (b) publication of Scientific Journals. Online application, approval process and tracking of application's status by ICAR officials. The FAMSCJ will make the financial assistance approval process more efficient and transparent. The Key-Features of FAMSCJ are: (i) online financial assistance application (proposal) process, (ii) online application assessment process; (iii) online tracking of application's current status; (iv) automatic sanction letter generation process; (v) downloading of sanction letter by concerned Society and (vi) online submission of report by concerned Society. FAMSCJ has been developed in collaboration with Technical Coordination Unit of ICAR. The System was launched by Dr. Himanshu Pathak, Honorable Secretary DARE and Director General ICAR on January 01, 2023 at ICAR- IARI sports ground.

ICAR Institute Ranking System (IRS 1.0)

The Institute Ranking System framework outlines the indicators and methodology for ranking the relative performance of ICAR institutes. These indicators are broadly categorized into three groups i.e. (i) Institute Performance (ii) Recognitions of the Institute and (iii) Research Output and Outcome of the Institute. Each of these three groups have been assigned differential weightages based on their importance i.e. 30%, 10% and 60% respectively for computing over all institute score. Further, this score is divided by the number of scientists in the institute in determining the relative ranking of the institute. Indicators for ranking of the institutes were finalised based on the discussion in various meetings at different levels in the Council. A web based system has been developed for taking

the applications from various ICAR institutes. The system is accessible to any user based on LDAP authentication by using their respective icar.gov.in email credentials. Any institute representative nominated by the director of the institute, generally Incharge PME cell is designated as nodal officer who will fill all the required information in the system along with proof duly certified by the director of the institute. After submitting the information by the nodal officer, the director of the respective institute will forward the application to respective Deputy Director General of their institute who will then forward the application to ADG (Technical Coordination) for further evaluation of these applications for scoring and ranking. A separate dashboard and reporting window has been developed for all the levels. This system is accessible from https://irs.icar.gov.in

ICAR eSupport System

A unified ICAR-Data Center is providing support for email services, hosting of web applications/websites, e-Office, ICAR-ERP, Agricultural Research Management System, Foreign Visit Management System, Personnel Management System, eHRMS, SPARROW, supercomputing facility, etc. This is a centralized help desk in the form of web application which address the issues and concerns related to use of ICAR-web application services. Any user can raise their ticket regarding the issues being faced by the user in accessing any of the listed application by providing brief about the problem along with the screenshots and his mobile number for the resolution of the problem. Once the problem is submitted by the user, a support executive will see an alert and then he will address the issue and if require any information, they can communicate with each other

Create a ticket regarding the issue faced by the user

to clarify the doubts in resolving the issues. Once the issue will be resolved, it should be closed by the respective user or support executive. User can track the progress of the ticket using ticket number. The system is accessible from https://esupport.icar.gov.in.

Advanced supercomputing Hub for OMICS Knowledge in Agriculture (ASHOKA)

A National Agricultural Bioinformatics Grid (NABG), the first supercomputing hub for Indian Agriculture i.e. Advanced Supercomputing Hub for OMICS Knowledge in Agriculture (ASHOKA) stablished in a state-of-art Data-Centre for high performance computing in the field of agricultural bioinformatics and computational biology in 2013. The facility is being accessible either through web portal https://ashoka.cabgrid.res.in or through command line access for the intranet users. There are 215+ open source tools/pipelines and various libraries/modules of python and R are installed and configured for the end users. In this year, there were 33 new users accounts created and 11,269 jobs were submitted by the users into various clusters under ASHOKA. Out of these submitted jobs, 7,539 jobs were successful and rest were unsuccessful. The reasons for unsuccessful jobs might be syntax errors, error in data formats, errors in parameters etc. In addition to this, the facility also hosts 185+ web applications/databases/prediction server related to omics domain. The facility also provides the hosting of R Shiny based web application developed for various types of omics data analysis.

ICAR-Data Centre (ICAR-DC)

ICAR Data-Centre is operational since September 10, 2014 and was inaugurated on December 21, 2016. ICAR Data Centre is certified as ISO/IEC 27001:2013 for Information Security Management System and ISO/IEC 20000:2011 for IT Service Management System. The Data Centre is equipped with industry standard 1,818 Cores Compute, 11,814 GB RAM, 10,81,858.16 GB Storage, Precision Cooling, Building Management System, State of art firewalls and security components, Software, Applications, tools and other technologies. Presently, around 26,053 Active Directory, 24,670 e-mail boxes and 405 websites hosted in the facility so far. There are large number of emails are being hit on email servers and significant number of emails are being filtered/blocked.

R-packages/Python modules Developed: 12

1. **ABSurvTDC**: Survival Analysis using Time Dependent Covariate available at https://cran.r-project.org/web/packages/ABSurvTDC/index.html.

2. **PBtDesigns**: Partially Balanced t-Designs (PBtDesigns) available at https://cran.r-project.org/package=PBtDesigns.

3. **MixedLevelRSDs**: MixedLevelRSDs developed for generating Mixed Level Response Surface Designs (RSDs) and is available at https://CRAN.R-project.org/package=MixedLevelRSDs.

4. **pRepDesigns**: To generate Partially Replicated (p-Rep) Designs is available at https://CRAN.R-project. org/package=pRepDesigns

5. **EpiSemble**:A novel ensemble model for the prediction of epigenetic sites of genomes in plants available at https://cran.r-proj- ect.org/web/packages/EpiSemble/index.html.

6. **TSSVM**: Time Series Forecasting using SVM Model available at https://cran.r-project.org/web/packages/TSSVM/index.html

7. **ECTSVR:** The co-integration based support vector regression model is a combination of error correction model and support vector regression is available at https://cran.r-project.org/package=ECTSVR

8. **EMDANNhybrid:** Application of Empirical Mode Decomposition based Artificial Neural Network for univariate time series forecasting available at https://cran.r-project.org/package=EMDANNhybrid

9. **DEXA**: A Python-based Tool for the Advanced Deciphering of Differential Gene Expression Patterns available at https://github.com/ICAR-BIOINFORMATICS/DEXA

10. **SSRmine**: Python-based Command-line Tool for Precise Genomic SSR Markers' Extraction available at https://github.com/ICAR-BIOINFORMATICS/SSRmine

11. **plantpathoppi-ml:** A python package to predict protein-protein interaction between plants and pathogens based on ensemble-based machine learning model is available at https://pypi.org/project/plantpathoppi-ml/

12. **Tri.Hierarchical.IBDs:** (Tri- Hierarchical Incomplete Block Designs). It generates tri-hierarchical designs with six component designs under certain parameter restrictions is available at https://CRAN.R-project.org/package=Tri.Hierarchical.IBDs).

Webservers/ Databases Developed: 14

1. **RBPLight**: A machine learning based online prediction server for discovery of RNA binding proteins in plants and is available at https://iasri-sg.icar.gov.in/rbplight

2. **ASmiR**: A machine learning-based web server for predicting the abiotic stress specific miRNAs in plants and is available at https://iasri-sg.icar.gov.in/asmir

3. **ASLncR**: A machine learning-based web server for predicting the abiotic stress responsive LncRNAs in plants and is available at https://iasri-sg.icar.gov.in/aslncr

4. **SVM-Root**:Computational Identification of Root-associated Proteins and is publicly accessible at https://iasri-sg.icar.gov.in/svmroot/

5. **DBPMod**: A computational tool to recognition of DNA binding proteins in model organisms and is available at https://iasri-sg.icar.gov.in/dbpmod/

6. **RBP-RNA-Interact-DB**: A database of RBP-RNA-Interaction study, several RBPs and their networks responsible for miRNA biogenesis and is available at http://14.139.59.221/RbpRnaDB/

7. **Microsatellite based Horse Breed Prediction**: Webserver for breed identification using microsatellite DNA markers accessible at http://backlin.cabgrid.res.in/horse/

8. **Equine CNVs database (EqCNVdb)**: Web genomic resource created to provide data on identified CNVs in six equine breeds. Accessible at http://backlin.cabgrid.res.in/eqcnvdb/

9. **Bp2SSRdb:** Black pepper polymorphic SSR database accessible at http://backlin.cabgrid.res.in/bp2ssrdb/index.php

10. **BpVarDB:** Database for polymorphic variants (SNP/InDels) of black pepper extracted among 39 genotypes of black pepper found across India accessible at http://backlin.cabgrid.res.in/bpvardb/index.php

11. **AVR-AgDb:** A web resources for Antiviral Agricultural crop produce for post COVID-19 world accessible at http://backlin.cabgrid.res.in/avragdb/.

12. **NutTraitDataBase:** This database contains information about genes and gene families that directly or indirectly govern nutritional traits in field crops and flowering plants is available at http://backlin.cabgrid.res.in/nutritrait/

13. **CB-DE-lncRNAdb:** CB-DE-lncRNAdb has been designed and populated with the information on predicted DE-lncRNAs from three tissues: shoot,

leaf, flower of cluster bean accessible at http://backlin.cabgrid.res.in/Cb-DElncRNA/.

14. CCncRNAdb: Common Carp Non-coding RNA Database serves as a repository for non-coding RNAs (ncRNAs) in Common carp that are unique to various tissues. It is available at http://backlin.cabgrid.res.in/ccncrnadb/

Certified Technologies/Methodologies: 16

Following 16 Technologies received Certificate during ICAR Foundation and Technology Day during July16-18, 2023

1 Krishi Vigyan Kendra Knowledge Network Portal (KVK Portal) & KVK Mobile App.
2 AI-DISC (Artificial Intelligence based Disease Identification Systems for Crops)
3 End-to-End solution: e Livestock Integrated Sample Survey (eLISS) Web Portal & App.
4 Prediction server for discovery of DNA and RNA-binding proteins in plant
5 ICAR-Technology Repository Ver 1.0 and ICAR Technologies Mobile App

6 KCC-CHAKSHU: Collated Historically Aggregated Knowledge-based system with Hypertext User-interface
7 Prediction server for discovery of abiotic stress-responsive non-coding RNAs
8 Prediction server for multiple localization of coding and non-coding RNAs
9 Web generation of generalized row-column designs (webGRC)
10 Sampling methodology for agriculture census
11 Sampling methodologies for food loss measurement in horticultural crops, livestock and fish
12 Web enabled phytochemical knowledge-based system for crop protection
13 Software for identification of circadian genes in plants
14 An information system to support therapeutic management of foot and mouth disease of cattle
15 Abiotic stress-responsive genes, gene ontology and metabolic pathways of major cereal crops
16 Web application for trait specific gene selection

4.
Education and Training

The Institute conducts post graduate teaching and in-service courses in Agricultural Statistics, Computer Application and Bioinformatics for human resource development. Institute is conducting M.Sc. and Ph.D. programmes in Agricultural Statistics since 1964, M.Sc. in Computer Application since 1985-86, Ph.D. in Computer Application since 2013-14, M.Sc. in Bioinformatics since 2011-12 and Ph.D. in Bioinformatics since 2014-15. The Institute continued to conduct the above mentioned degree courses in collaboration with the Post Graduate School (now Graduate School) of Indian Agricultural Research Institute (IARI), New Delhi that has the status of a Deemed University. 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, Computer Application and Bioinformatics, are offered at this Institute while the courses in Agricultural Sciences are offered at ICAR-IARI.

Number of students admitted / completed various courses during the period under report are:

S. No.	Course	No. of Students	
		Admitted*	Passed Out**
1	Ph.D. (Agricultural Statistics)	12	08
2	M.Sc. (Agricultural Statistics)	04	05
3	Ph.D. (Computer Application)	08	02
4	M.Sc. (Computer Application)	03	05
5	Ph.D. (Bioinformatics)	09	05
6	M.Sc. (Bioinformatics)	02	04

*students admitted as on 31.12.2023; **students who received degrees in 2023 convocation

FACULTY MEMBERS OF GRADUATE SCHOOL, IARI in

(i) Discipline of AGRICULTURAL STATISTICS

S. No.	Name of Faculty	Year of Induction
1	Dr. Rajender Parsad, Director	1995
2	Dr. Cini Varghese, Professor (Agricultural Statistics)	2000
3	Dr. Tauqueer Ahmad, Head (Sample Surveys)	1998
4	Dr. Amrit Kumar Paul, Principal Scientist	1998
5	Dr. Girish Kumar Jha, Head (Agricultural Bioinformatics)	1999
6	Dr. Prachi Misra Sahoo, Principal Scientist	2002
7	Dr. Prawin Arya, Principal Scientist	2003
8	Md. Wasi Alam, Principal Scientist	2003
9	Dr. Amrender Kumar, Principal Scientist (at ICAR-IARI)	2003
10	Dr. Himadri Ghosh, Principal Scientist	2004
11	Dr. K.N. Singh, Head (F&ASM)	2011
12	Dr. Ranjit Kumar Paul, Senior Scientist	2011
13	Dr. Mir Asif Iqubal, Principal Scientist	2011
14	Dr. Susheel Kumar Sarkar, Senior Scientist	2011
15	Dr. Kaustav Aditya, Senior Scientist	2012
16	Dr. Sukanta Dash, Senior Scientist	2013
17	Dr. Ajit, Principal Scientist	2015
18	Dr. Ankur Biswas, Senior Scientist	2015
19	Dr. Anindita Datta, Scientist	2016
20	Dr. Sarika, Principal Scientist	2018
21	Mr. Deepak Singh, Scientist	2018
22	Dr. Achal Lama, Scientist	2018
23	Dr. Mrinmoy Ray, Scientist	2018
24	Dr. Raju Kumar, Scientist	2019
25	Dr. Kanchan Sinha, Scientist	2019
26	Dr. Prabina Kumar Meher, Senior Scientist	2022
27	Dr. Md. Harun, Scientist	2022
28	Dr. Md. Yeasin, Scientist	2023
29	Dr. Rajeev Ranjan Kumar, Scientist	2023

30	Dr. (Ms.) Bharti, Scientist	2023
31	Dr. Pankaj Das, Scientist	2023
32	Dr. Med Ram Verma, Head (Design of Experiments)	2023
33	Dr. Prakash Kumar, Scientist	2018 and reinducted in 2024

(ii) Discipline of COMPUTER APPLICATION

S. No.	Name of Faculty	Year of Induction
1	Dr. Alka Arora, Professor (Computer Application)	2001
2	Dr. Sudeep Marwaha, Head (Computer Application)	2002
3	Dr. Shashi Dahiya, Principal Scientist	2001
4	Dr. Md. Samir Farooqi, Principal Scientist	2001
5	Dr. K. K. Chaturvedi, Principal Scientist	2002
6	Dr. Sangeeta Ahuja, Scientist	2002
7	Dr. Anu Sharma, Principal Scientist	2004
8	Dr. S.B. Lal, Principal Scientist	2004
9	Dr. Anshu Bhardwaj, Principal Scientist	2004
10	Dr. Rajni Jain, Principal Scientist (at ICAR-NIAP)	2007
11	Dr. Mukesh Kumar, Principal Scientist	2014
12	Dr. A.K. Mishra, Principal Scientist (at ICAR-IARI)	2014
13	Ms. Shaloo, Senior Scientist (at WTC, ICAR-IARI)	2016
14	Dr. S.N. Islam, Scientist	2018
15	Dr. Souman Pal, Senior Scientist	2020
16	Dr. Chandan Kumar Deb, Scientist	2021
17	Dr. Md. Ashraful Haque, Scientist	2023
18	Dr. Sapna Nigam, Scientist	2023

(iii) Discipline of BIOINFORMATICS

S. No.	Name of Faculty	Year of Induction
1	Dr. Rajender Parsad, Director	2010
2	Dr. S.S. Marla, Principal Scientist (at ICAR-NBPGR)	2010
3	Dr. Sudeep Marwaha, Head (Computer Application)	2010

4	Dr. Kishore Gaikwad, Principal Scientist (at ICAR-NIPB)	2010
5	Dr. P.K. Singh, Senior Scientist (at ICAR-IARI)	2010
6	Dr. A.K. Mishra, Principal Scientist (at ICAR-IARI)	2010
7	Dr. S.B. Lal, Principal Scientist	2010
8	Dr. Md. Samir Farooqui, Principal Scientist	2010
9	Dr. Anu Sharma, Principal Scientist	2010
10	Dr. Sunil Archak, Principal Scientist (at ICAR-NBPGR)	2010
11	Dr. D.C. Mishra, Senior Scientist	2010
12	Dr. Sarika, Principal Scientist	2010
13	Sh. Sanjeev Kumar, Scientist	2010
14	Dr. Mir Asif Iquebal, Principal Scientist	2013
15	Dr. Monendra Grover, Principal Scientist	2013
16	Dr. U.B. Angadi, Principal Scientist	2014
17	Dr. K.K. Chaturvedi, Principal Scientist	2015
18	Dr. M.G. Mallikarjuna, Scientist (at ICAR-IARI)	2017
19	Dr. Yasin Jeshma K, Scientist (at ICAR-NBPGR)	2018
20	Dr. Sudhir Shrivastava, Senior Scientist	2019
21	Dr. Sunil Kumar, Principal Scientist	2021
22	Dr. Neeraj Budhlakoti, Scientist	2022
23	Dr. Ratna Prabha, Scientist (at ICAR-IARI since 09.03.2023)	2022
24	Dr. Sarika Sahu, Scientist	2023
25	Dr. Sneha Murmu, Scientist	2023

*Dr. Girish Kumar Jha is Professor (Bioinformatics) since October 05, 2023

DISSERTATIONS APPROVED

Ph.D. (Agricultural Statistics)

Name of Student: Rahul Banerjee
Roll No: 10583
Guide: Dr. Seema Jaggi

Statistical Designs for Mixture Experiments in Agricultural Research: An Algorithmic Approach

Mixture designs are one of the most widely used designs in biological and engineering sciences.

Most of the designs available in literature are based on polynomial and canonical models, which are linear in nature. However, there are instances, where a nonlinear model would be much more apt in explaining the relationship in a mixture phenomenon. The difficulty in using nonlinear model generally stems from the point of design construction for the models algebraically. The Fedorov algorithm has been modified to obtain locally D-optimal saturated designs for mixture experiments with and without restriction on the factor space. A two-stage algorithm is proposed where the basic intuition is to generate a candidate set by an initial parameter guess and an increment size. The algorithm exchanges each row of the design with points in the candidate set in all iterations, optimizing the objective function satisfying all the constraints imposed on the mixing proportions. The algorithm iterates and terminates at a point when no further gain on the objective function is achieved. At this stage, the design obtained is locally D-optimal and saturated. The same methodology has been extended to obtain designs for mixture experiments employing nonlinear models with an intrinsically linear mean response, particularly the exponential model. The algorithm has also been used to obtain designs for mixture process experiments with and without restrictions on the factor space. The issue of hard to change levels in process variables when complete randomization is not possible is tackled by developing designs in process variables with minimally changed run sequences. Further, the algorithm has been extended to obtain designs for mixture experiments involving a qualitative response, which is often not normally distributed. The advantage is that it provides a greater flexibility in terms of the models to be fitted and the number of runs required for the design. The optimality of the constructed designs has been validated using the General Equivalence Theorem.

Name of Student: Nobin Chandra Paul
Roll No: 10767
Guide: Dr. Anil Rai

Integration of Data from Two Surveys with Spatial Sampling Units

Several spatially integrated estimators of finite population total have been developed by integrating data from two independent surveys using spatial as well as auxiliary information. The approximate variance of the proposed estimator was also derived. Furthermore, a Spatial Proportionate Bootstrap (SPB) method has been proposed for approximately unbiased variance estimation of the developed

Spatially Integrated (SI) estimators. The performance of the proposed estimators has been compared with few existing estimators through a spatial simulation study considering three different situations. Simulation results show that the developed spatially integrated estimators are more efficient than all the existing estimators under consideration. Further, developed a geographically weighted regression (GWR)-assisted integrated estimator of finite population total under two-phase sampling design using spatial information. A Proportional Spatial Bootstrap (PSB) method for variance estimation of the proposed SI estimator in presence of missing values has been proposed. A case study has also been conducted on real crop cutting experiments (CCE) survey data of cotton crop to demonstrate the predictive ability of the GWR model in reducing the number of CCEs under the General Crop Estimation Surveys (GCES) scheme. It has been concluded that integrating data from multiple surveys brings significant improvement in the estimator.

Name of Student: Ronit Jaiswal
Roll No: 10976
Guide: Dr. G.K. Jha

A Study on Recurrent Neural Networks for Agricultural Price Forecasting

A set of recurrent neural networks (RNNs) variants has been developed for accurate and reliable agricultural price forecasting. Firstly, a variant of RNNs named nonlinear autoregressive with exogenous input (NARX) model was developed for real monthly price series of potato and soybean in which the information of correlated exogenous series has been utilized. The performance of NARX model was compared with ARIMA, TDNN, and ARIMAX models and it was found that the neural network models for the agriculture price series have shown improvement over their counterparts by utilizing the closely linked price series as exogenous series. Secondly, a deep long short-term memory (DLSTM) model was developed by stacking hidden layers of LSTM units using the monthly international price series of maize and palm oil. Thirdly, the seasonal trend decomposition based on loess (STL) technique was utilized for de-seasonalization and a novel STL-LSTM hybrid model is developed using the monthly wholesale price of potato possessing seasonality. The STL decompose the price series into trend, seasonality, and remainder components each of which is then modelled through LSTM and thus ultimately improves the modelling accuracy. The empirical results show that the proposed

DLSTM and STLLSTM models outperform the respective competing models in terms of various evaluation criteria viz. root mean square error, mean absolute deviation, mean absolute percentage error and directional statistics. Lastly, a popular deep learning technique, convolutional neural network (CNN), is utilized for feature extraction and a novel CNN-LSTM hybrid model is proposed. The tuning of the hyperparameters of the CNN-LSTM model is done through genetic algorithm (GA) which discards the unfit configurations and carries forward only the fittest ones in successive generations. The empirical assessment of CNN-LSTM on price series of palm oil, soybean oil, soybean, and maize demonstrates that the developed model outperforms the competing models including LSTM for nonlinear relationships in terms of various evaluation criteria.

Name of Student: Samir Barman
Roll No: 10977
Guide: Dr. V. Ramasubramanian

Bootstrap Resampling Based Prediction Intervals for Time Series Forecasting

Construction of Prediction Intervals (PIs) of future values for time series (TS) models are cumbersome by conventional methods due to the requirements of tedious derivations and stringent assumptions. To overcome these limitations, two new Sieve Bootstrap methods viz., Predictive residual based Sieve Bootstrap (PSB) and Predictive residual based Rescaled Sieve Bootstrap (PRSB) have been proposed for linear TS models. The proposed methods are not only an improvement over the existing predictive residual based Bootstrap methods in AR(p) set up but also have been extended to be applicable in ARMA(p, q) situations as well. For non-linear TS models with conditional heteroscedastic errors, two new robust Sieve Bootstrap methods based on weighted least squares estimation viz., Robust Unconditional Sieve Bootstrap (RUSB) and Robust Sieve Bootstrap (RSB) have been proposed to deal with the presence of outliers in TS data while developing PIs for both returns and volatilities for the ARCH model setup. Two variants of neural network model in combination with Bootstrap methods viz., Neural Network Predictive Root Bootstrap (NN-PRB) and its rescaled version (NN-PRRB) for the construction of PIs have also been proposed. The performance of these proposed methods for constructing PIs have been compared using both simulated as well as real TS data sets and found to be better when compared with their corresponding existing counterparts.

Name of Student: Kapil Choudhary
Roll No: 11207
Guide: Dr. G.K. Jha

Decomposition Based Deep Learning Models for Agricultural Price Forecasting

Hybrid models have been developed by combining different decomposition techniques such as empirical mode decomposition (EMD), ensemble empirical mode decomposition (EEMD), complementary ensemble empirical mode decomposition with adaptive noise (CEEMDAN), and variational mode decomposition (VMD) with different forecasting models such as time-delay neural network (TDNN), long short-term memory (LSTM), and convolutional neural network (CNN) to improve the accuracy of agricultural price forecasting. Specifically, each decomposition tool disintegrates a price series into a set of intrinsic mode functions (IMFs), and the obtained IMFs are modelled and forecasted using a suitable model (TDNN, LSTM, and CNN) individually. Finally, the forecasts of all the IMFs were combined to provide an ensemble output for the actual price series. Among decomposition tools, VMD overcomes the limitations of the mode mixing and end effect problems of the Empirical Mode Decomposition (EMD) based variants, and thus produces superior decomposition results with minimum decomposition loss. Further, the knack of the two deep learning forecasting tools, namely LSTM and CNN, have been utilized to capture hidden nonlinear patterns more accurately. In addition, the hyperparameters of the VMD and the LSTM were optimized through an evolutionary approach known as genetic algorithm (GA). The prediction ability of the different hybrid models was compared with individual models like TDNN, LSTM, and CNN using international monthly price series of maize, palm oil, and soybean in terms of different evaluation criteria. In addition, to better understand the proper order, TOPSIS was utilized, to ranks all models by combining their performances of both level and directional metrics. The empirical results show that the hybrid models outperform the individual models, and among the hybrid models, VMD-based hybrid models (VMD-TDNN, VMD-LSTM, and VMD-CNN) outperform the EMD and its variants-based hybrid models in terms of different forecasting evaluation criteria like MAPE, RMSE and D_{stat}. Among VMD based hybrid models, VMD-CNN outperforms the other two hybrid models, and thus VMD-CNN is superior to all the models studied. Further, the DM test result shows that the hybrid models significantly improve forecasting accuracy over other models.

Name of Student: Sayantani Karmakar
Roll No: 11221
Guide: Dr. Cini Varghese

Multi-Balanced Experimental Designs for Agricultural Research

Some new series of partially balanced t-designs (a generalized class of Incomplete Block Designs (IBDs)) have been developed. These generalized IBDs are of particular interest when there is a requirement of selecting t-components out of v ($v > t$). The characterization properties of the designs have been studied and the association of the proposed designs with t-packing designs has been demonstrated. Amalgamating various compatible IBDs in a systematic manner led to the development of some new series of Incomplete Row-Column (IRC) designs. General expressions of the information matrices have been derived to study the properties of these designs. An algorithmic method of construction and an R package "iRoCoDe" for easy generation of IRC designs have been developed. Further, for situations where certain experimental units are not available for the application of treatments, structurally incomplete (SI) designs viz., 2-part SI row-column designs and 2-part SI block designs have been developed through appropriate fusion of IBDs. The canonical efficiency factors of all the proposed designs are also computed.

Name of Student: Debopam Rakshit
Roll No: 11437
Guide: Dr. Ranjit Kumar Paul

Long Memory and Asymmetric Volatility Models for Forecasting Commodity Prices

The degree of unexpected variation of a time series over time is known as volatility. Asymmetric volatility is the situation when positive and negative shocks of the same magnitude affect the underlying time series to a different degree. Asymmetric GARCH-type models, like EGARCH, APARCH, and GJR-GARCH models, can capture asymmetric volatility. The weekly modal price of onion for Delhi, Lasalgaon and Bengaluru markets and the weekly modal price of potatoes for Agra, Ahmedabad, Bengaluru, Delhi, Kolkata and Mumbai markets are modeled with the help of these asymmetric variance models. For all of the chosen onion markets, the APARCH model fared better than the competitive models, and it is regarded as the best-fit model. For the potato markets, the EGARCH model was found to be the best fitted model for Agra, Ahmedabad and

Bengaluru markets. For the Delhi market, the GJR-GARCH model was found to be the best. For the Kolkata and Mumbai markets, the price volatility exhibits symmetric volatility and the GARCH model has been found to be the best-fitted one. Finally, news impact curves are used to illustrate the degrees of asymmetry caused by positive and negative shocks for each of these market places. To capture the long memory in volatility, fractionally integrated nonlinear time series models like FIGARCH and FIEGARCH model have been used. Daily modal price of onion for Delhi, Lasalgaon and Bengaluru markets and the S&P 500 index are modeled with the help of these fractionally integrated models. The FIEGARCH model was obtained the best-fitted model for all the selected time series. The out-of-sample forecast formulae along with the forecast error variances for the AR-FIGARCH and AR-FIEGARCH models have been obtained by recursive use of conditional expectations and conditional variances.

Name of Student: Vinay Kumar LN
Roll No: 11440
Guide: Dr. Cini Varghese

p-rep Statistical Designs for Breeding Trials

In early generation breeding trials (EGBTs), a large number of breeding lines are tested in multiple environments with at least two replications in each environment. However, due to resource crunch, breeders often prefer un-replicated trials, which may lead to higher selection possibilities but less statistically reliable results. For such multi-environmental trials (METs), partially replicated (p-rep) designs would work as an intermediate solution of an un-replicated and replicated conventional design. In this study, few series of higher associate resolvable Partially Balanced Incomplete Block (PBIB) designs have been proposed, which in turn are used to obtain equi-replicated, partially balanced p-rep designs with equal/unequal block sizes. Modified p-rep designs are also helpful in comparing test versus control lines in EGBTs. The developed designs were found to have quite high efficiency factors, with fewer replications and possess high application potential in METs. To enhance the accessibility and usability of these designs, R-packages named "ResPBIBD" and "pRepDesigns" have been developed for generation of these designs. Moreover, usually a sample of inbred lines from a possible large hypothetical population is considered for breeding trials. Hence, the problem of Best Linear Unbiased Prediction (BLUP) under a random effects model set up for p-rep block designs has also been considered.

M.Sc. (Agricultural Statistics)

Name of Student: Bappa Saha
Roll No: 21416
Guide: Dr. Ankur Biswas

Geographically Weighted Regression-based Model Calibration Approach under Complex Sampling Design

In many surveys, the relationship between the study and auxiliary variables vary across the locations and the observations tend to be similar for the nearby units than those located further apart. This phenomenon is known as spatial non-stationarity. Several Geographically Weighted Regression (GWR) based model calibration estimators of the population total have been developed in the context of uni-stage Simple Random Sampling Without Replacement (SRSWOR) and two-stage sampling design when the population level complete auxiliary information is available. The proposed GWR based model calibration estimators were proved to be asymptotically design unbiased and approximately model unbiasedness under a set of regularity assumptions. Under the same set of assumptions, the approximate variances and estimators of the variances of the developed estimators were derived. The performance of the developed estimators was compared with the Horvitz Thompson estimator, ratio and regression estimators through a spatial simulation study considering wide range of situations. Simulation results show that the proposed GWR based model calibration estimators of the population total under SRSWOR and two-stage sampling were asymptotically design unbiased on the basis of percentage of relative bias. The proposed estimators were found to be more efficient than the Horvitz Thompson estimator, ratio and regression estimators based on %RMSE.

Name of Student: Ankit Kumar Singh
Roll No: 21417
Guide: Dr. Sukanta Dash

Designs for Factorial Experiments for Main Effects and Consecutive Two-factor Interactions

In consecutive cropping sequence experiments, more than one treatment has been applied in two or more consecutive seasons. In these cases, it is required to estimate main effect of treatments in each season as well as residual effect of treatments and their interaction with treatments of next season. Also, in several situations it is found that not all interactions are of primary importance. It is not always the choice of experimenters to estimate all two-factor interactions because experimenter may be interested in estimation of all main effects and consecutive two factor interactions as often required in cropping sequence experiments. The experimental situations where the number of factors become large it may not possible to maintain homogeneity within a block where fractional factorial experiments have been suggested over factorial experiments. In addition, a little work based on fractional factorial experiments are available in literature and those designs are based on computer specific algorithm. Hence, there is a need to develop methods of construction/procedure for $\frac{1}{2^k} 2^n$ *i.e.*, factorial with fractional replicates that provides estimation of all main effects and two factor interactions between consecutive factors. General methods of construction have been developed for two special situations *i.e.*, (i) consecutive two factor interactions estimated with full efficiency (ii) all the main effects and two factor interactions having equal efficiency. Designs obtained from these methods of construction and efficiencies of required factorial effects are catalogued for 2^n factorial experiments for any value of *n*<10, where *n* is the number of factors to serve as a ready reckoner for the experimenters. Sometimes, it is desirable to consider a fraction of the complete factorial set up when number of factors are large. Considering this problem, general methods of construction/procedure were developed for $\frac{1}{2^k} 2^n$ *i.e.,* factorial with fractional replicates that provides estimation of all main effects and two factor interactions between consecutive factors. Designs obtained from these methods of construction were also catalogued for $\frac{1}{2^k} 2^n$ factorial experiments with $\frac{1}{2^k}$ replicates for *k* =1,2…,4 and *n*<10, where *n* is the number of factors and *k* denotes the fraction to serve as a ready reckoner for the experimenters.

Name of Student: Rabsanjani Pramanik
Roll No: 21420
Guide: Dr. Wasi Alam

Developing Hybrid Time Series Model using Bayesian Model Averaging Approach

Time series model GARCH, machine learning techniques like time-delay neural network (TDNN), support vector machine (SVM) and deep learning models like long-short term memory (LSTM), Stacked LSTM and Bi-LSTM have been applied to measure the performance on volatile weekly price series of onion for two different markets in India. The models were trained with the training dataset

to forecast the values for next twelve horizons and eventually the forecasted values have been compared with the testing dataset. Deep learning models outperformed the machine learning techniques and time series models in dealing with the two datasets. An attempt has also been made to enhance the forecast accuracy by using Bayesian model averaging (BMA) approach, which has the advantage of combining more than two models that might be linear or non-linear. The model weights were based on their posterior probabilities and the final forecasted value is a weighted average of the forecasts of all the three deep learning models. The results of the study revealed that the hybrid time series model developed by BMA has enhanced accuracy measures compared to time series and machine learning models used.

Name of Student: Anita Sarkar
Roll No: 21421
Guide: Dr. Prachi Misra Sahoo

An Alternative Survey-based Approach for Generating Estimates of Milk Production

An improved methodology has been developed for the estimation of milk production with variance and standard error of estimators for estimating the number of in milk animals at district and state level by using the calibration approach. Four different types of estimators namely separate type single constraint calibration estimator; combined type single constraint calibration estimator; separate type double constraints calibration estimator and combined type double constraints calibration estimator for the population total have been developed for stratified cluster sampling design. Approximate variance and estimates of the variance of the developed estimators has also been obtained. An empirical evaluation of the proposed calibration estimators using real survey data for the states of Uttarakhand and Kerala for estimation of milk production has been carried out. Using the developed methodology, the number of in milk animals of all seven groups – Cattle (Indigenous, Crossbred, Non-Descript and Exotic); Buffalo (Indigenous and Non-Descript) and Goat have been estimated along with percent standard error (%SE) at the district level and the state level which is not provided under the Integrated Sample Survey (ISS) scheme. The proposed calibration estimators have been compared with the existing estimators namely Horvitz-Thompson and Ratio estimator based on percent relative bias and percent standard error.

Name of Student: Pathi Devendra Kumar
Roll No: 21240
Guide: Dr. Kaustav Aditya

Multivariate Calibration Estimator of the Population Total under Two Stage Sampling Design When the Auxiliary Variables are Highly Correlated

The calibration approach is commonly employed in survey estimation to modify the sampling design weights using auxiliary information to produce efficient estimator for the finite population parameters. In real life surveys, while collecting data on study variable sometimes information on more than one auxiliary variable were available and that extra information can be used to improve the precision of the estimator. One such technique is multivariate calibration estimation. Under multivariate calibration framework, one may encounter the problem of multi-collinearity among the auxiliary variables. To tackle this type of problem a multivariate calibration estimator using a nonlinear constraint function under a stratified sampling design is available in literature that is restricted to uni-stage sampling designs while large-scale real-life surveys are based on multistage complex sampling designs. Therefore, a multivariate calibration estimator of the population total under two-stage sampling design has been developed in the presence of two auxiliary variables that were highly correlated. The performance of the proposed estimators is evaluated through simulation studies. The empirical result shows that the developed estimators perform better than the existing estimators under two stage sampling design.

Ph.D (Computer Application)

Name of Student: Arpan Kumar Maji
Roll No: 11010
Guide: Dr. Sudeep

Drought Assessment and Prediction of Yield using Deep Learning and Image Analysis

A novel methodology, called SlypNet has been developed, using advanced deep learning networks i.e., Mask R-CNN and U-Net, which can extract various plant morphological features like spike and spikelet from the visual image of the wheat plant and provide a high throughput yield estimate with great precision. Mask RCNN outperformed previous networks in spike detection by its precise detection performance with a mean average precision (mAP) of 97.57%, F1 score of 0.67, and MCC of 0.91 by overcoming several natural field constraints like overlapping and background interference,

variable resolution, and high bushiness of plants. The spikelet detection module's accuracy and consistency were tested with about 99% validation accuracy of the model and the least error, i.e., mean square error of 1.3 from a set of typical and complex views of wheat spikes. In addition, a stress assessment methodology has been proposed that can provide high precision and automation in stress prediction using a low-cost imaging technique. A newly proposed image dissection approach explores in-depth plant visible information and produces a noteworthy quantification of plant greenness. It also quantifies several other drought traits derived using visible and hyperspectral images. It classifies them into seven classes and four subclasses using robust image processing techniques and machine learning. Their significant correlation with plant stress provides high accuracy (about 96%) in stress classification. A standing crop monitoring platform has been designed that integrates these two plant phenotyping approaches, and has been published as a web tool

Name of Student: Madhu Bala Priyadarshi
Roll No: 11013
Guide: Dr. Anu Sharma

Machine Learning for Modelling Physicochemical Properties of Chickpea using NIR Data

Spectral data analysis is frequently used to calculate a range of analyses in food and agricultural products. First, it is important to determine which wavelength regions offered the most valuable qualitative and quantitative information for predicting the amount of physicochemical components in chickpea (*Cicer arietinum* L.) flour. A spectral interval that is particularly instructive with respect to each physicochemical component is chosen using Interval Partial Least Squares (*i*PLS). In order to create models for predicting the physicochemical components of starch, sugar, oil, phosphorus, moisture, phenol, flavonol, and protein in chickpea, used five fundamental machine learning techniques: Linear Regression (LR), Artificial Neural Network (ANN), Partial Least Squares Regression (PLSR), Random Forest (RF), Support Vector Regression (SVR), and Decision Tree Regression (DTR). The created models were validated using the performance metrics Root Mean Square Error (RMSE), Residual Standard Error (RSE), Coefficient of Determination (R^2), Adjusted R^2, and Residual Prediction Deviation (RPD). All the ML techniques worked excellently, but SVR and LR have been found to have better accuracy than all the other models.

M.Sc (Computer Application)

Name of Student: Vanaja V.
Roll No: 21441
Guide: Dr. Mukesh Kumar

Development of Decision Support System for Malnutrition Marker Assessment through Energy Balance Techniques

The goal of this research is to develop an Android-based mobile application that helps assess human nutritional status using a variety of anthropometric measurements and energy balance techniques that are useful for giving them a basic picture of their health status and directing them. The already-existing application "NutriGuide" was integrated with a mobile-based decision support system called "NutriEnergy," which helps users assess their level of physical fitness, energy expenditure, and nutritional status as well as providea quick summary of the benefits of various food types for various age groups. This Android-based mobile application was developed using the Android Studio development environment, the Java programming language, eXtensible Markup Language for application user-end development, and a MySQL server as a backend database to store the personal information of humans and the various index values of all the humans. Additionally, it provides an option to save the data as an excel file for additional analysis and delivers personalized reports. The developed DSS offers a few brief details with recommendations for the recommended dietary allowance, recommended dietary intake, and food requirements for nutritional sufficiency.

Name of Student: Pawana B.
Roll No: 21442
Guide: Md. S.N. Islam

Development of Machine Learning based Decision Support System for Variety Selection in Millets

A three-tier architecture has been used to develop the machine learning based decision support system (DSS). The DSS layer contains Decision model (Machine Learning algorithms), Web API and Presentation layer (Mobile app). The secondary data of millet varieties (Sorghum, Finger millet, Pearl millet, Kodo millet) is collected from ICAR-IIMilletR, Hyderabad. One hot encoding is used for categorical data. Classification algorithm such as Logistic regression, Decision tree, K- Nearest Neighbors (k-NN) and Artificial Neural Networks (ANN) have been used to develop the decision model. Logistic

Regression performed well on testing dataset and resulted in 95% accuracy on Sorghum dataset, 99% accuracy on Finger Millet dataset, 98% accuracy on Pearl Millet dataset and 100% accuracy on Kodo Millet. Decision Tree and KNN give 100% accuracy on all testing dataset. ANN performed well on testing dataset and resulted in 100% accuracy on all dataset except Pearl Millet dataset whose accuracy is 97% accuracy. MilletDSS is the app developed as Mobile User Interface for Machine Learning based DSS.

Name of Student: Vivek Dinkar Jadho
Roll No: 21443
Guide: Dr. S.B. Lal

Mobile App for Nutraceuticals in the Fruits for Human Health

Farmers are country's greatest resource because they provide food to the entire population. The majority of common people are engaged in a wide range of activities that strengthen a country's power. However, if they fall ill or become undernourished, this could impede the development of a country. Therefore, it is essential to give them the best service possible in order to maintain their nutritional health and a tool as a guidance. Numerous mobile apps focused on nutrition and agriculture have already been developed to give this industry a digital boost, and more are on the way. An android-based mobile app named 'BioLife' is developed for this purpose, and it would provide important information of the nutraceuticals of major fruits, their classification and potential benefits related to human health. In addition, it gives quick note on important fruits, its scientific names, local names, varieties and nutraceuticals content. It provides fruit intake advisory, RDA (Recommended Dietary Allowances) and safety aspect and regulations for nutraceuticals. This android-based mobile app was developed using a variety of software tools, including the Android Studio development environment, Java programming language, and eXtensible Markup Language (XML) for application user-end development, and SQLite DB browser as a backend database to store the user data. The developed mobile app 'BioLife would assist in preventing and controlling health-related issues by recommending sources of fruits and RDA.

Name of Student: Tanvi Kumari
Roll No: 21560
Guide: Dr. Sangeeta Ahuja

Development of Mobile Application-based DSS on Physico-chemical Test for Fruits

Researchers often struggle to find the proper procedure of physicochemical test (e.g. fruit diameter, peel thickness, TSS, Total phenol content, Total anthocyanin etc.) for the analysis while grading fruits and to test the nutritional value, physico-morphological traits, and biochemical of fruits. After surfing on the websites and consuming many study articles, it is difficult to to locate the right approach. To overcome these difficulties, a mobile application named "Fruit Quality Analytics" also called "FQA" has been developed. This mobile application assists students, researchers, fruit preservation facilities, or training centers in examining different physico-chemical tests under predetermined circumstances with the aim to provide standard protocols and an easily understandable flow chart with in-house developed videos for physico-chemical tests of fruits. Following the completion of a certain test's analysis, all of the findings of a parameter are displayed on the screen in order to draw a more valid conclusion. The Java programming language and Android Studio are used to create the app. The database constructed using MS SQL Server database, contains the data produced by various analyses. The XML, and IDE were also used to create the "Fruit Quality Analytics" mobile app. In this app, python language is used to create API. The database is in MS SQL Server, created at local host.

Name of Student: Akash
Roll No: 21559
Guide: Dr. Shashi Dahiya

Decision Support System for Assessment of Agricultural Activities using Physiological and Postural Ergonomics Techniques

Several decision support systems are available in literature for assessment of agricultural activity related risks and providing suggestions for correcting the postures using some scientifically proven assessment tools like Rapid Upper Limb Assessment (RULA), Rapid Entire Body Assessment (REBA) and Human Physical Drudgery Index (HPDI). However, there is no decision support system (DSS) available for physiological and postural analysis using Work Ergonomic Risk Assessment (WERA). Therefore, a WERA based DSS has been developed for postural analysis. An integrated mobile based DSS "ErgoQuant" has been designed which provides physiological assessment tools such as BMI, PFI, VO2 (max), TCCW and PCW, and based on fitness an option to choose ergonomic technique from RULA, REBA, HPDI and WERA for postural assessment. In this software, farmers are evaluated based on various physiological and postural measures and conclusions about their effectiveness and constraints are drawn and suggestions for correct postures are

provided accordingly. In this regard, the mobile application "ErgoQuant" would serve as a decision support system to eliminate the drudgery associated with the agricultural activities. After a farmer has undergone a thorough study, the findings of every parameter are displayed on the screen to allow the user or extension worker to reach at a more informed decision. It determines whether there is a need to change or improve the working conditions based on the findings of the physiological and ergonomic analyses conducted using "ErgoQuant".

Ph.D. (Bioinformatics)

Name of Student: Md. Asif Khan
Roll No: 10595
Guide: Dr. Anil Rai

Development of Integrated Index for Genomic Selection

Genomic selection (GS) is a cutting-edge breeding method where the training population i.e. phenotypic and marker information is used to build the statistical model to estimate the marker effects. Further, the developed model is utilized to obtain genomic estimated breeding values (GEBVs) of the individual in the breeding population, for which only marker data is available. Selection based on GEBV can result in enhanced genetic gain per unit time for complex traits. Combining complex multi-trait in an efficient selection index structure, on the other hand, is often a complex and challenging task. The Selection Index (SI) is a linear combination of optimally weighted multiple traits to obtain greater overall genetic gains. Breeders and biometricians have advocated the use of both phenotypic and genomic selection indices. The phenotypic selection index (PSI) is an optimally weighted linear combination of various observable phenotypic trait values, whereas the genomic selection index (GSI) represents a linear combination of GEBVs used to evaluate an individual's net genetic merit and accordingly select superior individuals from the breeding population. Estimation of marker effects to obtain GEBVs by a simple linear regression statistical model encounter the problem of over-parameterization and multicollinearity in whole genome regression. To overcome this problem, penalized and Bayesian regression models such as rrBLUP, Bayesian LASSO, Bayes A, Bayes B, and Bayes C were used to estimate the marker effect. It is desirable to take advantage of both the phenotypic and genomic information by combining, and constructing a robust integrated index for multi-trait data, to select individuals as parents for the

next generation under the breeding programme. Further, evaluated the performance of the developed Integrated Index, by applying suitable evaluation measures such as correlations of indices with the net genetic merit, selection response, and expected genetic gain per trait.

Name of Student: Arfa Anjum
Roll No: 10596
Guide: Dr. Seema Jaggi

Study on Genomic Sequence Segmentation using Statistical and Computational Approach

Genome segmentation methods are powerful tools for obtaining cell-type or tissue-specific genome-wide annotations and are used to discover regulatory elements. A change-point in a genomic data marks the boundary of two segments and hence identification of change-points is important for segmentation such that the segments differ from each other with respect to statistical and biological properties. Multivariate statistical techniques have been studied here and the agglomerative sequential clustering greedy approach was found to be most suited to obtain segments. Computational steps for multivariate segmentation were implemented on multivariate data of chromosomes of Rice genome. Segmentation based on univariate approach was performed using Kolmogrov-Smirnov two sample test. The multivariate segmentation results in reduced number of segments, which is more useful for practical purpose and is based on more information. Studying the fluctuations over different segments also revealed the heterogeneity between consecutive segments. Influential positions or anomaly detection procedure has been described and the same has been investigated in cow genome data. Further, the anomalies detected have been validated to know whether they are actual change-points or not. An R package '*mvgSegmentR*' for multivariate segmentation of genome data has been developed and uploaded on GitHub.

Name of Student: Nalinikanta Choudhary
Roll No: 10779
Guide: Dr. A.R. Rao

Identification of Deep Learning Models to Study Microbial Diversity in North Indian River Systems

The present investigation was carried out to study deep learning model based procedures to analyze microbial communities of major north Indian River

system, and to compare the performance of deep learning model based procedures with the existing procedures meant for metagenome data analysis. The river sediment samples collected from three sites, each at Kanpur & Farakka and Delhi for the Ganga and the Yamuna rivers respectively, by ICAR-CIFRI, Barrackpore were used. The raw metagenome data generated from the collected samples was pre-processed for quality checks and subsequently metagenome assembly was carried out to obtain contigs and scaffolds. The BLAST was initially applied on the scaffolds to identify the number of known microbial classes. It was found that there were broadly five classes present in the metagenome data. The entire metagenomic data with the extracted features was subjected to iterative K-means clustering to classify the microbes into five categories. The identified group/class labels along with the extracted feature data were used to train and test the machine learning (SVM, RF, GBDT, XGBoost, AdaBoost) and deep learning (BiLSTM) models. A 10-fold cross-validation technique was employed to assess the performance of learning classifiers in terms of metrics such as sensitivity, specificity, accuracy, etc. It was found from the comparison of performances of classifiers that the RF performed with high accuracy (89%) over other classifiers. In addition, the results revealed that Acetobacter, Achromobacter, Bacteroidetes, Fadolivirus, Indivirus, Gaeumannomyces, Phoenix, Strongyloides, Halobacterium, Haloferax, Halogeometricum, and Halosimplex microbes are most abundantly present in the metagenome data. Further, 66% of unknown microbes have also been classified into the identified known five categories. The deep learning models have shown 87-89% for the analysis of metagenomic data.

Name of Student: Ankita Negi
Roll No: 11225
Guide: Dr. Sarika

Computational Approach for Prediction of AMP and Molecular Markers in Black Pepper Germplasm

Antimicrobial peptides (AMPs) produced by most living organisms as an innate immune response against microbes, have gained popularity due to rising multidrug resistance of microorganisms, new microbial infections, and a great dearth of novel antibiotics in recent years. This study provides a species-specific (Black pepper) AMP candidate prediction server *BPepAMPred* (http://login1.

cabgrid.res.in:5040/) based on 10 fold cross-validated bidirectional- gated recurrent unit based deep neural network architecture with 99.34% accuracy, 98.68% sensitivity, 98.67% specificity. This server also linked with *BPepAMPdb* (http://backlin.cabgrid.res.in/blackpepper_amp_db/) which catalogs predicted 43759 AMP candidates across black pepper proteome along with 10935 functionally associated unique genes, chromosome number, genomic location, associated gene ids and functional properties. Also developed a web-genomic resource, *BlackP2MSATdb* (http://webtom.cabgrid.res.in/blackp2msatdb/), which is the largest and first reported web resource for black pepper's genomic and polymorphic SSRs. A total of 276230 genomic SSRs were discovered from most recent black pepper genome assembly, with an average distance of 2.76 Kb between each SSR and a relative density of 362.88 SSRs per Mb over 26 chromosomes. 3176 polymorphic SSRs were yielded in the GBS data of 29 black pepper genotypes using this assembly, out of which 2015 were hypervariable. This study also reports 2029 putative conserved miRNAs from black pepper whole genome available in public domain and 4207 miRNA targets were found on black pepper coding sequences which were functionally characterized to determine the possible post-transcriptional regulatory processes.

Name of Student: Aamir Khan
Roll No: 11226
Guide: Dr. Mir Asif Iquebal

Study on Computational-based Approach for Genome-Wide Prediction of AMP and Molecular Markers in Buffalo

Buffaloes are found to express many antimicrobial peptides (AMPs) such as defensins, cathelicidins, and hepcidin, which play an important role in neutralizing the invading pathogens. This study provides a faster, improved and species-specific (buffalo) AMP/non-AMP candidate prediction server, BufAMPpred (*http://login1.cabgrid.res.in:5030/*) based on an ensemble of CNN+LSTM deep learning neural network architecture with improved prediction accuracy (98.72% accuracy, 99.79% sensitively and 98.68% specificity) in comparison to existing tools/servers till date. This server also facilitates analyses up to 500 sequences at a time and linked with *BufAMPdb* (*http://backlin.cabgrid.res.in/buffampdb/*) which is the collection of all candidate AMPs (61711) and non-AMPs (2529971) predicted for buffalo along with their corresponding gene information. The

first comprehensive, holistic and user-friendly web genomic resource of buffalo (*BuffGR*) developed and made accessible at *http://backlin.cabgrid.res. in/buffgr/,* which catalogues 6028881 SNPs and 613403 InDels extracted from the set of 31 buffalo tissues. We found 3727122 SNPs and 634124 InDels distributed in the four breeds of buffalo (Murrah, Bangladesh, Jaffarabadi and Egyptian) with reference to Mediterranean breed. It also houses 4504691 SSR markers from all the breeds along with 1458 unique circRNAs, 37712 lncRNAs and 938 miRNAs.

M.Sc. (Bioinformatics)

Name of Student: Chandini B.C.
Roll No: 21255
Guide: Sh. Sanjeev Kumar

CRISPR/Cas9 off Targets Prediction in Plants using Deep Learning

CRISPR-Cas9 is among the most significant genome editing systems in recent times. Potential to alter the specific target genes and regions of the genome, complementary to the chosen guide RNA (sgRNA), makes it important in biological research. Different sgRNA were created for precisely modifying the desired genomic locations according to the target sequence. However, it allows DNA fragment manipulation leading to off-target impact, which is still a problem with CRISPR-Cas9. Many significant progresses are made in the area of off-target prediction, but the available tools are based on the Human genome data. So here, two deep learning models viz. Convolutional Neural Network (CNN) and Feedforward Neural Network (FNN) have been developed for estimating the CRISPR-Cas9 cleavage sites, exclusively for plant genomes. The developed deep learning models are based on plant dataset collected and compiled from various available published literatures, which includes sequence data of on-targets and off-targets. Under CNN and FNN paradigms of deep learning, altogether seven models have been developed. Using 5-fold cross validation methods CNN and FNN were found best within their group but FNN marginally outperformed CNN. All comparison were made using the ROC curve as well as other evaluation parameters like accuracy, precision, recall, specificity, FPR and TPR. The present study demonstrated the improved applicability of deep learning methodology for off-target prediction in CRISPR-CAS9 system of gene editing, exclusively for plant genomes.

Name of Student: Soutrik Mukherjee
Roll No: 21438
Guide: Dr. Anu Sharma

Identification of Bacteriophage from Metagenomic Data of Ganga and Yamuna Rivers

Identification of bacteriophage from various regions of Ganga and Yamuna rivers is important to know the abundance of different species of bacteriophages. Very few works have been done on the annotation of bacteriophages identified from the Ganga and Yamuna rivers. Sediment samples were collected from 9 sites of Ganga and Yamuna rivers by ICAR-Central Inland Fisheries Research Institute. Two approaches were followed for the identification of bacteriophages, one is identification of bacteriophages by binning of the metagenomic contigs data with Metabat2 tool and then distinguishing bacteriophage sequences by a machine learning based tool MARVEL. The other approach was alignment-based approach by BLASTN with the query as the contigs of the metagenomics samples and database made from the bacteriophage sequences downloaded from NCBI. With MARVEL tool from the 9 datasets, two bins of Balkeshwar-Ganga contigs data shows the result of having bacteriophage sequence. Using the bioinformatics software program Blast2GO, unique sequence data was functionally annotated (genes, proteins). Aeribacillus phage AP45, complete genome phage was the most abundant phage in all 9 sites of Ganga and Yamuna rivers.

Name of Student: Madhusudan
Roll No: 21556
Guide: Dr. Ulavappa Angadi

Development of Web-based Tool to Detect Polymorphic Microsatellite Markers for RAD SEQ Data

Microsatellite markers are tandem repeats of 1-6 nucleotides, which are distributed randomly throughout the genome of an organisms. These markers are said polymorphic when the mutation rate exceeds 1%. Polymorphisms can be applied in functional study of genes for physical mapping based on positional markers and, linkage analysis. The in vitro method of detection of polymorphic markers are costlier and time consuming. Through in silico approach one can get the markers in affordable cost and in less time. Polymorphism can be detected by using whole genome sequence or reduced representation sequence. RAD-seq (Restriction site associated DNA) is one of the reduced representation methods which uses restriction

enzymes to reduce the genome complexity and made it easier to handle compare to whole genome sequence data. The earlier tools developed to detect polymorphism takes whole genome sequence data as input although RAD-seq is the future technology for mining markers. *PolyMiRA* is webserver developed by using Perl programming language, which identifies polymorphic microsatellite markers from RAD-seq data. Webserver takes assembled sample file in FASTA format. The main advantage of the webserver is that it does not require reference genome for mining polymorphic markers, so this webserver is applicable for non-model species/ samples for which whole genome sequence is not available. PolyMiRA identified 1032 polymorphic microsatellite markers from 20 varieties of black pepper.

Name of Student: Kabilan S
Roll No: 21557
Guide: Dr. S.B. Lal

Quality Control of Label-Free Proteomics Expression Data Considering Missing Values and Heterogeneity

The liquid chromatography-mass spectrometry (LC-MS) is an indispensable tool for protein identification and quantification analysis because of its improved coverage, sensitivity, and high throughput. The most popular approach for LC-MS based protein analysis is the label-free bottom-up approach, where the unlabeled proteins are proteolytically digested into peptides by specific proteases and are then analyzed. The label-free LC-MS proteomics dataset often suffers from the problems of data heterogeneity and missing values. Various normalization and imputation methods are widely used for removing these biases, but there is no standard condition available for selecting the suitable combination of normalization and imputation methods for the proteomics expression dataset. This study aims to develop an approach for finding the suitable combination of normalization and imputation methods for the label-free proteomics expression data based on various quality control measures such as Percent Coefficient of Variation (PCV), Percent Explained Variance (PEV), and Percent Median Absolute Deviation (PMAD). The standard benchmark dataset based on a highly complex yeast lysate sample spiked with different levels of a Universal Proteomics Standard 1 (UPS1) protein was taken. The three popular normalization methods namely, Variance Stabilizing Normalization (VSN), Locally Estimated Scatterplot Smoothing (LOESS), and Robust Linear Regression

(RLR) and three efficient imputation methods named k-Nearest Neighbors (k-NN), Local Least Squares (LLS), and Singular Value Decomposition (SVD) methods were considered for this study. They were paired with each other and nine combinations of these methods considered. The combination of LLS imputation and LOESS normalization was given as the suitable combination in the developed approach. This combination identified a greater number of significant proteins in differential expression analysis, than other combinations in most cases. The performance of the developed approach was consistent even after generating the missing values artificially by three different ways in the dataset and based on the Normalized Root Mean Square Error (NRMSE) scores.

Board of Studies for Academic Year 2022-23

Agricultural Statistics

1.	Dr. Cini Varghese, Professor (Agricultural Statistics)	Chairperson
2.	Dr. Rajender Parsad, Director	Member (Ex-officio)
3.	Dr. Prachi Misra Sahoo, Principal Scientist	Member
4.	Dr. Kaustav Aditya, Senior Scientist	Member
5.	Dr. Achal Lama, Scientist	Member Secretary
6.	Ms. Moumita Baishya, Student	Students' Representative

Computer Application

1.	Dr. Alka Arora, Professor (CA)	Chairman
2.	Dr. Rajender Parsad, Director	Member (Ex-officio)
3.	Dr. Anshu Bharadwaj, Principal Scientist	Member
4.	Dr. Soumen Pal, Senior Scientist	Member
5.	Dr. Chandan Kumar Deb, Scientist	Member Secretary
6.	Ms. Monika Singh	Students' Representative

Bioinformatics

1.	Dr. Alka Arora, Professor (Bioinformatics)	Chairman
2.	Dr. Rajender Parsad, Director	Member (Ex-officio)
3.	Dr. K.K. Chaturvedi, Principal Scientist	Member
4.	Dr. Mir Asif Iquebal, Principal Scientist	Member
5.	Dr. Neeraj Budhlakoti, Scientist	Member Secretary
6.	Mr. Sharana Basappa	Students' Representative

Central Examination Committee for Academic Year 2022-23

Agricultural Statistics

1.	Dr. Rajender Parsad, Director
2.	Dr. Cini Varghese, Professor (Agricultural Statistics)
3.	Dr. K.N. Singh, Head (Forecasting & Agricultural Systems Modelling)
4.	Dr. Tauqueer Ahmad, Head (Sample Survey)
5.	Dr. A.K. Paul, Pricipal Scientist

Computer Application

1.	Dr. Rajender Parsad, Director
2.	Dr. Alka Arora, Professor (CA)
3.	Dr. Sudeep Marwaha, Head (CA)
4.	Dr. K.K. Chaturvedi, Principal Scientist
5.	Dr. Shashi Dahiya, Principal Scientist
6.	Dr. Anu Sharma, Principal Scientist

Bioinformatics

1.	Dr. Rajender Parsad, Director
2.	Dr. Alka Arora, Professor (Bioinformatics)
3.	Dr. U.B. Angadi, Principal Scientist
4.	Dr. S.B. Lal, Principal Scientist
5.	Dr. Sarika, Principal Scientist

RESEARCH FELLOWSHIPS

During 2023, 64 Ph.D. and 41 M.Sc. students received research fellowship. 41 Ph.D. students received IASRI fellowship @ Rs.31,000/-(First and Second Year), 35,000/- (Third Year) per month in addition to Rs.10,000/- per annum as the contingency grant. 04 Ph.D. students received UGC fellowship @ 31,000/- per month and Contingency Rs.10,000/-.18 students received ICAR-SRF fellowship @ Rs.31,000/- (First and Second Year), 35,000/- (Third Year) per month in addition to Rs.12,500/- per annum as the contingency grant. 01 student received ST fellowship from Ministry of Tribal Affairs @ Rs. 28,000/- per month and contingency @ Rs. 20,500/- per annum. 12 M.Sc. students received ICAR Junior Research Fellowship @ Rs.12,640/- per month in addition to Rs.7,500/- per annum as contingency grant and 29 M.Sc. students received IASRI fellowship @ Rs.7,560/- per month and Rs.6,000/- per annum as contingency grant.

NATIONAL / INTERNATIONAL TRAINING PROGRAMME

Senior Certificate Course in Agricultural Statistics and Computing

Senior Certificate Course in Agricultural Statistics and Computing was organized for the benefit of research workers engaged in handling statistical data collection, processing, interpretation and employed in research Institute of the Council, State Agricultural Universities, State Government Departments 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 organized during the period November 01, 2023 to April 14, 2024. The course comprises of two independent modules of three months duration each. Module – I was organized during November 01, 2023 to January 25, 2024 and Module-II was organized during January 27, 2024 to April 14, 2024. Two officers participated in Module – I and and two officers participated in Module - II. 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. Dr Sudeep Marwaha was the course coordinator of the course.

Training Programmes Organized

S. No.	Title and Coordinators	Period	Number of Participants
1	Advanced Statistical Techniques for Efficient Agricultural Experiments (Funded by Education Division of ICAR under CAFT) (Coordinators: Anindita Dutta and Mohd. Harun)	January 11-31, 2023	25
2	Short Course on Python for Artificial Intelligence in Agriculture (Funded by Education Division of ICAR) (Coordinators: Sudeep, Sanchita Naha and Md Ashraful Haque)	February 02-11, 2023	23
3	On E-Governance Applications in ICAR for Administrative Personnel (Coordinators: S. B. Lal and Mukesh Kumar)	February 06-10, 2023	24
4	Artificial Intelligence and Machine Learning in Agriculture using Python (under NAHEP –CAAST) (Coordinators: Sudeep, Soumen Pal, Sanjeev Kumar and Anindita Dutta)	February 13-17, 2023	25
5	Computational Biology and its Applications in Agriculture (Coordinators: Sudhir Srivastava, Sneha Murmu and Soumya Sharma)	February 21-March 02, 2023	21
6	E-Governance Applications in ICAR for Technical Personnel (Online) (Coordinators: K. K. Chaturvedi, S.B. Lal and Sanjeev Kumar)	February 22-March 28, 2023	45
7	Statistical Analysis and Interpretation of Agricultural Data (Online) (Coordinators: Anil Kumar, Susheel Kumar Sarkar and Sukanta Dash)	March 01-10, 2023	20
8	Operationalization and Usage of Agri-DIKSHA Web Education Channel (online) (Coordinators: Sudeep, Anshu Bharadwaj and Sanchita Naha)	May 29-31, 2023	253
9	Analysis of Agricultural Data using Statistical and Data Mining Techniques through Blended Learning Platform (Online) (Coordinators: Sudeep, Shashi Dahiya and Mrinmoy Ray from ICAR-IASRI and S.S Tomar, V.B. Singh, Shashi Yadav and Ankita Yadav from RVSKVV)	July 11-20, 2023	226
10	Data Analysis and Interpretation for 45th batch of Indian Statistical Service (ISS) Probationers (Coordinators: Ajit, Ankur Biswas and Prabina Kumar Meher) *Sponsored by NSSTA, MoSPI, Government of India*	July 24 - August 04, 2023	27
11	Data Science in Agriculture (Online on Blended Learning Platform) (Coordinators: Rajender Parsad, Alka Arora, Chandan Deb, Sapna Nigam, Mrinmay Ray and Upendra Kumar Pradhan)	September 09-15, 2023	90
12	Omics Data Analysis: Genome to Proteome (Online) (Coordinators: Girish Kumar Jha, Sudhir Srivastava and Sneha Murmu)	October 09-18, 2023	50
13	Blended Learning Techniques for Quality Higher Education (Coordinators: S.N. Islam, Sapna Nigam and Madhu)	December 19-26, 2023	21
14	Introduction to Virtual Reality Modules (Coordinators: Sudeep and Anshu Bharadwaj)	July 05-07, 2023	1537
15	E-Learning Content Creators and Reviewers for E-Learning Portal & RAES E-Learning Content (Coordinators: Sudeep, Shashi Dahiya and Madhu)	June 07-09, 2023	109
16	Metagenomics Data Analysis (Online) (Coordinators: G.K. Jha, Anu Sharma, Samir Farooqi and Sneha Murmu)	December 11-13, 2023	36
17	Onboarding Meet for Nominated SPoCs of Blended Learning Platform (Coordinator: Soumen Pal)	August 02-04, 2023	122

हिन्दी कार्यशाला			
1	परीक्षण अभिकल्पना के अनुप्रयोग समन्वयकः अनिल कुमार सह–समन्वयकः सुशील कुमार सरकार एवं सुकान्त दास	मार्च 28-29, 2023	14
2	सरकारी काम काज को हिन्दी में करने के लिए ई–टूल्स की जानकारी संयोजकः अभिषेक श्रीवास्तव एवं मनोज कुमार	मई 30, 2023	28
3	कृषि में सांख्यिकीय और मशीन लर्निंग तकनीक का परिचय संयोजकः प्रकाश कुमार, हिमांद्री शेखर राय एवं अजित	जून 06-12, 2023	25
4	कृषि एवं प्रतिदर्श आँकड़ों का विश्लेषण हेतु सांख्यिकीय सॉफ्टवेयर का अनुप्रयोग समन्वयकः पंकज दास सह–समन्वयकः राहुल बनर्जी एवं भारती	सितम्बर 06-13, 2023	42
5	सांख्यिकीय एवं मशीन लर्निंग तकनीक के माध्यम से समय श्रृंखला का पूर्वानुमान समन्वयकः कंचन सिन्हा, सह–समन्वयकः मृन्मय राय एवं राजीव रंजन कुमार	दिसम्बर 07-13, 2023	15

Other Sensitization Programme Organized

- eLISS Web Portal and eLISS Data Collection App under the project Integrated Sample Survey Solution for Major Livestock Products (Prachi Misra Sahoo): 850 participants

  - Tirupati during February 02-03, 2023
  - Bhopal during February 08-10, 2023
  - Jaipur during February 16-17, 2023
  - Ranchi during February 23-24, 2023
  - Dehradun during February 28-March 01, 2023
  - Guwahati during April 27-28, 2023

- Online training for eLISS Web Portal and eLISS Data Collection App under the project Integrated Sample Survey Solution for Major Livestock Products for 02 UTs namely Puducherry and Lakshadweep on 21 September, 2023 (Prachi Misra Sahoo): 50 participants

- Online training on AR /VR Installation, Configuration and Usage for SAUs on 16.02.2023 (Sudeep): 423 participants

- Online Sensitization workshop on NARES – Blended Learning Platform (Sudeep Marwaha)

  - For the Vice Chancellors of Agricultural Universities on May 23, 2023: 80 participants
  - For Dean and Directors of 75 Agricultural Universities on June 09, 2023: 250 participants
  - Demonstration Session on NARES-Blended Learning Platform at TANUVAS on May 26, 2023: 130 participants

- Online capacity building session on Features and Functionalities of Agri-DIKSHAWeb Education Channel on April 28, 2023 (Sudeep Marwaha and Anshu Bharadwaj): 70 participants

- Online training program on Operationalization and Usage of Agri-DIKSHAWeb Education Channel on May 29-31, 2023 (Sudeep Marwaha, Anshu Bharadwaj and Sanchita Naha): 250 participants

- Training on Features and Functionalities of Agri-DIKSHA at IARI on June 23, 2023 (Sudeep Marwaha): 12 participants

- Introduction to Virtual Reality Modules

  - July 05 –07, 2023 (Sudeep Marwaha and Anshu Bharadwaj): 1537 participants
  - For students of Agricultural Universities from August 23-25, 2023 (Sudeep Marwaha): 1282 participants

- Blended Learning Programmes

  - Dau Shri Vasudev Chandrakar Kamdhenu Vishwavidyalaya, Durg during July 24-25, 2023: 22 participants (Sudeep Marwaha)
  - IGKV, Raipur during July 27-28, 2023: 43 participants (Sudeep Marwaha)
  - ICAR-IARI, New Delhi on August 08, 2023: 94 Participants (Sudeep Marwaha)
  - ICAR-NDRI, Karnal on August 23, 2023: 388 participants; (Sudeep Marwaha and Shashi)
  - GADVASU, Ludhiana on August 25, 2023: 51 participants (Sudeep Marwaha)
  - RVSKVV, Gwalior on August 28, 2023: 53 participants (Sudeep Marwaha);
  - Rani Lakshmi Bai Central Agricultural University, Jhansi on September 06, 2023:

74 participants (Alka Arora and Soumen Pal)

- PJTSAU on September 11, 2023: 138 participants (Ramasubramaniam V.)
- PV Narsimha Rao Telangana Veterinary University, Telangana on September 12, 2023 : 57 participants (Ramasubramaniam V.)
- Shri Konda Laxman Telangana State Horticultural University, Telangana on September 13, 2023: 208 participants (Ramasubramaniam V.)
- Acharya N.G. Ranga Agricultural University on September 15, 2023: 126 participants (Ashraful Haque)
- ICAR-IVRI, Izatnagar on September 15, 2023: 331 participants
- Uttar Banga Krishi Viswavidyalaya, West Bengal on September 15, 2023: 44 participants
- Bihar Agricultural University, Bihar on September 19, 2023: 139 participants (SN Islam)
- SVVU, Andhra Pradesh: 170 participants (Ashraful Haque);
- UAS, Bengaluru on September 20, 2023 : 98 participants (Alka Arora)
- BASU, Bihar on September 20, 2023: 117 participants (SN Islam)
- SKUAST, Jammu on September 21, 2023: 92 participants (Sudeep Marwaha);
- NAU, Navsari on September 22, 2023: 81 participants (Anshu Bharadwaj);
- SVPA&T, Meerut on September 26, 2023: 46 participants (Sudeep Marwaha)

● Review Workshop on Agri-DIKSHA Web Education Channel

- July 27, 2023: 203 participants (Sudeep Marwah and Anshu Bharadwaj)
- September 27, 2023: 314 participants (Anshu Bharadwaj)

● Demonstration training session on AMS

- Vishwa Bharti, West Bengal on July 06, 2023 : 11 participants (Sudeep Marwaha)
- MPKV, Rahuri on July 24-26, 2023; 98 Participants (Alka Arora)
- Dr. YSR Horticultural University on July 27, 2023: 68 participants (Sudeep Marwaha)
- ICA-IARI, New Delhi, August 11, 2023: 113 participants (Sudeep Marwaha)
- SKUAST, Jammu: September 21, 2023: 92 participants (Sudeep Marwaha)

Internship Programme

During the year 2023, following students of different Universities/Institutes worked at ICAR-IASRI as project trainee for their Graduation/Post Graduation dissertation work.

S. No	Name of Student and Organisation	Title of the Study	Name of the Mentor	Duration
1	Ms. Maira Sajawal Sharma, Sher-E-Kashmir University of Agriculture Science and Technology, Jammu	Designing Web Tool for Differential Expression Analysis of RNA-Seq Data Considering Heterogeneity and Complex Experimental Design	Sudhir Srivasatava	February 13-May 15, 2023
2	Ms. Aanchal Gupta, Sher-E-Kashmir University of Agriculture Science and Technology, Jammu	Identification of Differentially Expressed Genes for Sclerotinia Stem Rot in *Brassica napus*	Neeraj Budhlakoti	February 13-May 15, 2023
3	Ms. Tejasman Kaur Sharma, Sher-E-Kashmir University of Agriculture Science and Technology, Jammu	Understanding the Molecular Interactions Between PGIP and PG in Cotton-Pathogen System	Sunil Kumar	February 03-May 15, 2023
4	Ms. Shivangi Sharma, Sher-E-Kashmir University of Agriculture Science and Technology, Jammu	Potential Herbal Ligands from Medicinal Plants for Treating Psoriasis using Computational Approach	M.A. Iquebal	February 03-May 15, 2023
5	Ms. Yashi, Sher-E-Kashmir University of Agriculture Science and Technology, Jammu	Identification of Microbial Communities and Nitrogen Cycling Genes involved in Biogeochemical Cycle from Soil	Anu Sharma	February 01-June 30, 2023
6	Ms. Aarushi Agarwal, Amity University, Noida, U.P.	A Study on Species Specific DNA Binding Protein Prediction based on Machine Learning Algorithm	U.K. Pradhan	January 25-May 07, 2023

S. No	Name of Student and Organisation	Title of the Study	Name of the Mentor	Duration
7	Ms. Paakhi Singh, College of Biotechnology, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut U.P.	Identication of Circular RNA from Agriculturally Important Crop Species	Sarika Sahu	January 25-June 04, 2023
8	Utkarsh Tiwary, Manipal University, Jaipur	Web App Development	K.K. Chaturvedi	February 20-June 19, 2023
9	Ms. Rashi Rathore, College of Biotechnology, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, U.P.	RNA Sequencing Analysis and A Review on Genomic Selection with the Effect of Environment.	Prakash Kumar	March 05- August 05, 2023
10	Padmalochan Sethi, Odisha University of Agriculture and Technology, Bhubaneswar, Odisha	A Study on Computational Recognition of Plant Photosynthetic Proteins	P.K. Meher	June 15 - October 14, 2023
11	Prasanjit Behra, Odisha University of Agriculture and Technology, Bhubaneswar, Odisha	A Computational Study on Abiotic Stress-Responsive Circular RNAs Prediction in Plants	P.K. Meher	June 15 - October 14, 2023
12	Ms. Anuradha Mahapatra, Odisha University of Agriculture and Technology, Bhubaneswar, Odisha	Abiotic Stress Responsive Transcription Factor Prediction based on Machine Learning Algorithim	U.K. Pradhan	June 15 - October 14, 2023
13	Ms. Varnika Choudhary, Gokhale Institute of Politics and Economics, Pune	Time Series Analysis using Python	A.K. Paul	June 01-July 31, 2023
14	Ms. Aleema Ahmad Sameer, Delhi University, Delhi	Harnessing Livestock Statistics using the Power of Web GIS	Prachi Misra Sahoo	June 08-August 11, 2023
15	Chiranjit Paul, IIT, Kalyani, West Bengal	AI in Agriculture	Sudeep Marwaha	2 months
16	Ms. Aqsa, Sher-E-Kashmir University of Agriculture Science and Technology, Jammu	Circular RNA Target Gene Prediction	Soumya Sharma	October 16-December 15, 2023
17	Ms. Anshita Virdhi, Sher-E-Kashmir University of Agriculture Science and Technology, Jammu	Development of Database for Annotation from InterproScan	Anu Sharma	October 16-December 15, 2023
18	Ms. Sunidhi Malgotra, Sher-E-Kashmir University of Agriculture Science and Technology, Jammu	Prediction of Antibacterial Compound using Machine Learning	Sneha Murmu	October 16-December 15, 2023
19	Hardik Gupta, Sher-E-Kashmir University of Agriculture Science and Technology, Jammu	Bioinformatics in R	Neeraj Budhlakoti	October 16-December 15, 2023
20	Ms. Harshita Gupta, Sher-E-Kashmir University of Agriculture Science and Technology, Jammu	Protein-Structure Prediction and Protein-Ligand Interaction	Sunil Kumar	October 16-December 15, 2023
21	Ms. Novika, Sher-E-Kashmir University of Agriculture Science and Technology, Jammu	Development of Plant Circular RNA Database	Sarika Sahu	October 16-December 15, 2023
22	Ms. Alina Tabassum Suharwardy, Sher-E-Kashmir University of Agriculture Science and Technology, Jammu	Protein Structure Prediction through Homology Modelling and Liagand Binding through Docking	Sarika	October 20-December 20, 2023
23	Md. Rahil Butt, Sher-E-Kashmir University of Agriculture Science and Technology, Jammu	Basic of R, RStudio and Shiny App for Biological Data Analysis	Md. Sameer Farooqi	October 23-December 22, 2023

Training Programmes Attended

- Airborne Hyperspectral Remote Sensing for Agriculture organized by ICAR-IARI under NAHEP-CAAST, New Delhi during January 16-25, 2023. (Pankaj Das)

- Computational Biology and Its Applications in Agriculture organized by CAR-IASRI, New Delhi during February 21- March 02, 2023. (Prakash Kumar, Sukanta Dash and Raju Kumar)

- Intensive GS & Modern Experimental Design organized by International Rice Research Institute, Philippines during February 13-24. (Susheel Sarkar)

- Big Data Analytics in Agriculture (Online) organized by ICAR-NAARM, Hyderabad during March 09-10, 2023. (Sneha Murmu)

- Multivariate Data Analysis (Online) organized by ICAR-NAARM, Hyderabad during March 20-27, 2023. (Soumya Sharma)

- Theoretical and Practical Aspects of Genomic Approaches for Utilization of Crop Genetic Resources jointly organized by CIMMYT-BISA, Ludhiana and ICAR-NBPGR, New Delhi during March 28-31, 2023 at CIMMYT-BISA, Ludhiana. (Neeraj Budhlakoti)

- Statistical and Machine Learning Techniques for Time Series Forecasting organized by ICAR-IASRI, New Delhi during December 07-13, 2023. (Raju Kumar, Deepak Singh and Rahul Banerjee)

ICBLE 2023

DID YOU KNOW?

Formerly known as Imperial Council of Agricultural Research, Indian Council of Agricultural Research (ICAR) was established on 16 July 1929.

It is an autonomous body responsible for co-ordinating agricultural education and research in India.

#BeeCurious

5.
Awards and Recognitions

Awards

Ankur Biswas

- **CWSS Young Scientist Award (2023)** by Crop and Weed Science Society (CWSS) in the 6th CWSS International Conference on Agricultural Innovations for Sustainable Development Goals with Special Focus on Natural Farming (AISDGONF-2023) organized during September 30-October 02, 2023 at Farmers' Academy & Convention Centre (FACC), BCKV, Kalyani, Nadia, West Bengal, India.

Rahul Banerjee

- **Institute of Scholars (INSC) Young Researcher Award-2023** for the paper: Rahul Banerjee, Seema Jaggi, Arpan Bhowmik, Eldho Varghese, Cini Varghese and Anindita Datta (2022). Cost friendly experimental designs for product mixtures in agricultural research. *Journal of Community Mobilization and Sustainable Development*, **17(1)**, 120-133.

Best Paper Award (Published, Oral/ Poster Presentation)

Sudeep Marwaha

- **Best Oral Presentation Award** in the DST-SERB sponsored National Symposium on Crop Health Management: Safeguarding Crop through Diagnostics and Innovations organized by ICAR-VPKAS, Almora during September 29-30, 2023 for presenting the paper: {Sudeep Marwaha*, R.C. Agrawal, Rajender Parsad, Ramasubramanian V., Alka Arora, Anshu Bharadwaj, Ajit, Shashi Dahiya, S.N. Islam, Chandan Kumar Deb, Md. Ashraful Haque, Sapna Nigam, Mrinmoy Ray, Achal Lama, Soumen Pal, Rajni Jain, Sujay Rakshit, P. Lakshmi Soujanya, Sumit Kumar Aggarwal, K.S. Hooda, Brejesh Lall, Lokesh Gupta, Kalpit Dipak Kumar Shah, Prasannakumar M.K., V.S. Acharya, Abhishek Shukla, Ladhu Ram Choudhary, Palash Deb Nath, Shubha Trivedi, Mehraj Ul Din Shah, Ravinder Singh Rana, Subrata Dutta and Vaibhav Kumar Singh . AI-DISC (Artificial Intelligence-based Disease Identification System for Crops) Mobile Application: A step towards Intelligent crop health management}.

Cini Varghese and Sukanta Dash

- **Best Research Paper Award** on the occasion of 34th Foundation day of the ICAR- Indian Institute of Farming Systems Research, Modipuram, celebrated on April 01, 2023 for the published paper: {Natesan Ravisankar, Meraj A. Ansari, Mohammad Shamim, Ashisa K. Prusty, Raghuveer Singh, Azad S. Panwar, Debashis Dutta, Suryanarayana Bhaskar, Jayasree S. Bindhu, Mothkur T. Sanjay, Jashonjot Kaur, Cini Varghese, Sukanta Dash, Arpan Bhowmik and Santanu K. Bal. (2022) Sustainable livelihood security of small farmers improved through resilient farming systems in the Semi-Arid Region of India. *Land Degradation and Development*, **33(15)**, 2830-2842.}

K.K. Chaturvedi

- **3rd Prize in Oral Presentation** during National Conference on Futuristic Approach to Viable Animal Production vis-a-vis Climate and Calamity Challenges held at College of Veterinary Science & Animal Husbandry, OUAT, Bhubaneshwar, Odisha during January 18-20, 2023 for the paper: {S.L. Gayathri*, M. Bhakat, T.K. Mohanty, K.K. Chaturvedi, R.R. Kumar and S. Kumar. Precise detection of mastitis by improved deep learning convolutional neural networks: a comprehensive assessment method using udder thermograms of Sahiwal cows}.

Anu Sharma

- **Best Poster Award** in the 5th IGM on Climate-Proofing Cereal Agriculture: Strategies for Resilience and Sustainability organized at ICAR-IIWBR, Karnal, Haryana during March 27-29, 2024 for the paper: {Monika Singh*, Anu Sharma, Krishna Kumar Chaturvedi, Alka Arora, Dwijesh Chandra Mishra, Sanjeev Kumar, Rakesh Bhardwaj, Mamatha Y.S. A Comparative study on applying machine learning techniques for seed classification}.

R.K. Paul

- **Dr. R.T. Doshi Foundation Award** from Agricultural Economics Research Association in

2022 for the best published paper: {R.K. Paul and P. Birthal (2021). The prices of perishable food commodities in India: the impact of the lockdown. *Agricultural Economics Research Review*, **34**}.

D.C. Mishra and Neeraj Budhlakoti

- **Best Oral Presentation Award** in 13th NABS National Conference on Current Perspectives for Sustainable Development in Life Science, Environment and Agriculture held at Periyar University, Salem, Tamilnadu during January 23-25, 2023 for the paper: {V.K. Vikas*, Anjan Kumar Pradhan, Neeraj Budhlakoti, Dwijesh Chandra Mishra, Tilak Chandra, S.C. Bhardwaj, Subodh Kumar, M. Sivasamy, P. Jayaprakash, R. Nisha, P. Shajitha, John Peter, M. Geetha, Reyazul Rouf Mir, Kuldeep Singh and Sundeep Kumar. Multi-locus genome-wide association studies (ML-GWAS) for the identification of novel genomic regions associated with seedling and adult plant stage leaf rust resistance in bread wheat (*Triticum aestivum* L.)}.

Chandan Kumar Deb

- **3rd Prize in Oral Presentation in** International Conference on Systems and Technologies for Smart Agriculture (ICSTA 2023) organised by Centre for Development of Advanced Computing (C-DAC) Kolkata, in association with the University of Calcutta at *Kolkata* during December 19- 20, 2023 for presenting the paper: {Chandan Kumar Deb, Sudeep Marwaha, Md. Ashraful Haque, Chiranjit Pal, Abhishek Shukla, Amit Trivedi, Subrata Dutta, Kalpit Shah, Mehraj Ul Din Shah, Prasanna Kumar M.K. Leveraging auto encoders for accurate plant disease diagnosis in the face of unbalanced data. *Transactions on Computer Systems and Networks*}.

Sarika Sahu

- **2nd Prize in Oral Presentation** in International conference on Strategies and Challenges in Agricultural and Life Science for Food Security and Sustainable Environment (SCALFE-2023) organised at Himachal Pradesh University, Summer Hill, Shimla, HP during April 28-30, 2023 for the paper: {Sarika Sahu*, Swati Saxena, Palak Gupta, Priya Sharma, Kishor Gaikwad and A.R. Rao. Identification of differentially expressed long non-coding RNAs in cluster bean (*Cyamopsis tetragonoloba*) for regulating growth and development in various tissues}.

Samarth Godara

- **Best Oral Presentation Award** in National Symposium on Crop Health Management: Safeguarding Crop through Diagnostics and Innovations organized by ICAR-Vivekananda Parvatiya Krishi Anusandhan Sansthan, Almora, Uttarakhand on September 30, 2023 for presenting the paper: {Samarth Godara*, Rajender Parsad, Shruti Godara, Sudeep Marwaha. Revitalizing Punjab Agriculture: A decade of farmer query calls analysis for sustainable crop health management}.

Sneha Murmu

- **2nd Prize in Oral Presentation** in National Conference on Spices, Aromatic and Medicinal Plants for Economic Prosperity and Ecological Sustainability-2023 organised at ICAR-Central Island Agricultural Research Institute, Port Blair, Andaman Nicobar Islands organized during October 05-06, 2023 for presenting the paper: {Sneha Murmu*. Identification of potent phytochemicals against *Magnaporthe oryzae* through vitual screening and molecular dynamics simulation approach}.

Soumya Sharma

- **Best Oral Presentation Award** at National Conference on Generative AI in Practice for Empowering Agricultural Research Productivity organized at ICAR-NRC Grapes, Pune during September 11-12, 2023 in Online/Virtual mode for presenting the paper: {Soumya Sharma. Artificial Intelligence-powered manuscript editing: improving clarity and readability}.

Ritwika Das

- **Best Oral Presentation Award** in 6th CWSS International Conference on Agricultural Innovations for Sustainable Development Goals with Special Focus on Natural Farming (AISDGONF-2023) organized at BCKV, Kalyani, West Bengal during September 30-October 02, 2023 for presenting the paper: {Ritwika Das*, A. Rai and D.C. Mishra (2023). CNN_ FunBAR: deep learning technique for fungi taxonomic classification based on DNA barcode sequences}.

Congratulations to Alumni/Former Faculty

Anil Rai

- Selected as Assistant Director General (ICT), ICAR on 23.02.2023

Anil Kumar

- Selected as Assistant Director General (Technical Coordination) on 14.01.2023

Recognitions

- Two of the Institute technologies viz. AI-DISC (Artificial Intelligence-based Disease Identification Systems for Crops) and KCC-CHAKSHU: Collated Historically Aggregated Knowledge-based system with Hypertext User-interface have been identified among the five best technologies and Certificates were given by Honourable Minister of Fisheries, Animal Husbandry and Dairying, Govt. of India on ICAR Foundation and Technology Day July 16, 2023.

Rajender Parsad

- **Chairman,** Committee constituted to review Standard operating Procedure (SoP) for monitoring quality of food grains stocks procured under Decentralized Procurement (DCP) Scheme by Ministry of Consumer Affairs, Food and Public Distribution.

- **Chairman**, Sub-Group constituted consisting of officials from AS, ES(E), NSO(FOD) to recommend the methodology and sample size for conduct of CCE by third party and other technical aspects pertaining to its implementation.

- **Member, 4th Research Advisory Committee,** for setting up institute specific annual work-plan and targets for Agro-Economic Research Centres/Units (AERCs/Us) under the AER Scheme under the aegis of DAC&FW.

- **Member, Expert Committee** Revisiting survey design, constituted by Ministry of Statistics and Programme Implementation, Government of India.

- **Member**, **Technical Committee** constituted for third party evaluation of crop cutting experiments, Agricultural Statistics Division, Department of Agriculture and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, Government of India.

- **Chief Information Officer, DARE/ICAR** nominated by Honourable Secretary DARE and Director General, ICAR on December 18, 2023

- **Member**, sub-committee constituted for developing technical framework for Fisheries Censes of India, 2023-24 by Department of Fisheries, Ministry of Fisheries, Animal Husbandry and Dairying, Government of India.

- **Member**, Technical Committee on 21 Quinquennial Livestock Census 2024.

- **Chaired**, 17th Meeting of Technical Monitoring Committee on Fisheries Statistics, Department of Fisheries, Ministry of Fisheries, Dairying and Animal Husbandry, Government of India held online on October 27, 2023.

- **Letter of appreciation** from CEO, PMFBY & Joint Secretary (Credit), Ministry of Agriculture & Farmers Welfare, Government of India for outstanding contribution in the compilation of the YES-TECH Manual 2023 for the implementation of Yield Estimation System (YES) based on technology under PMFBY.

- **Chairman**, Invited Talk Session and **Panelist** during National Conference on Recent Trends on Applied Statistics and Data Science in the Memory of 100th Birthday of Late Professor MN Das organized by P.C. Mahalanobis Department of Statistics, Saurashtra University, Rajkot during January 28-29, 2023.

- **Convener** (i) Dr. M.N. Das Memorial Lecture and (ii) Dr. V.K. Gupta Endowment Award for achievements in statistical thinking and practice session, and **Chairman** in an **Invited Paper Session** organized during the International Conference on Significance of Statistical Sciences in Emerging Scenario (25th Conference of Society of Statistics and Computer Applications (SSCA)) held at Department of Statistics, University of Jammu, Jammu during February 15-17, 2023.

- **Technical Lead** from ICAR/DARE for implementation of AI-ENGAGE (Advancing Innovations for Empowering NextGen AGriculturE) for QUAD countries programme

- **Member,** Organizing Committee for Annual Conference of Vice-Chancellors of Agricultural Universities organized during March 04-05, 2023.

- **Member** of Overall Program Coordination Committee and **Guest of Honour** in inaugural session of National Conference on Policy Development and Implementation of Strategies for Academia Industry Government Linkages in Agricultural Higher Education in India organized under NAHEP Component-2 at ICAR-NAARM Hyderabad during March 12-13, 2023.

- (i) **Co-Chair**, Organizing Committee, (ii) **Member** Advisory Committee, (iii) **Chairman**, Local Coordination Committee, (iv) **Co-Chair** in the Plenary Session on Blended Learning Ecosystems and Community Outreach and (v) **Panelist** in panel discussion on Digital Transformation in Education Sector during International Conference on Blended Learning Ecosystems for Higher Education in Agriculture hosted jointly by ICAR and the World Bank under NAHEP and organized by ICAR-IASRI, New Delhi at NASC Complex during March 21-23, 2023.

National Conference on Academia-Industry-Government Linkages for Agricultural Higher Education in India held at ICAR-NAARM

- **Chairman**, Technical Session during XXX Annual Review Meeting of AICRP on Weed Management held at SKUAST-Jammu during May 26-27, 2023.

- **Panelist** in panel discussion on Roadmap for Agricultural Research, Education and Extension for Amrit Kaal-2047 organized by National Academy of Agricultural Sciences held on June 04, 2023 and provided views on Digital Agriculture Roadmap.

- **Panelist** in ICAR-Industry Interface organized by Agricultural Education Division ICAR on July 18, 2023

- **Panelist** during Interaction Meet of Directors with the 113th FOCARS Batch of ARS Scientists at ICAR-NAARM, Hyderabad on August 05, 2023.

- **Convener,** Technical sessions on (i) Digital Agriculture and (ii) Artificial-based Systems on theme Next Generation Technologies: Digital Agriculture, Precision Farming and AI Based Systems during the XVI Agricultural Science Congress and ASC Expo organized at ICAR-CMFRI, Kochi during October 10-13, 2023.

Girish Kumar Jha

- **Chairman,** Technical Session on Agriculture Market Intelligence and Innovative Price Forecast Methods on December 11, 2023 in International Conference on Drive Agriculture Forward: Recent Trends and Innovation in Agricultural Market Intelligence in Anand Agriculture University, Anand.

- **Member**, Scientific Panel on GMO & Food (SP04) in Food Safety & Standards Authority of India (FSSAI), Ministry of Health and Family Welfare, Govt of India for three years (2022-2025).

Tauqueer Ahmad

- **Member**, Standing Committee on Statistics (SCoS) by Ministry of Statistics & Programme Implementation (MoSPI), Government of India for the next two years w.e.f. July 13, 2023.

Sudeep Marwaha

- **Member**, Second Meeting of National Steering Committee (NSC) on National programme on Electronics and ICT Applications in Agriculture and Environment (AgriEnIcs) being implemented by C-DAC, Kolkata (Nodal Centre).

- **Judge**, AgriEnIcs Grand challenge on Electronics and ICT Applications in Agriculture with Ministry of Electronics and Information Technology, Government of India (MietY).

- **Organizing Secretary,** International Conference on Blended Learning Ecosystem for Higher Education in Agriculture (ICBLE-2023) and **Keynote Speaker** on NAHEP- Blended Learning Platform and associated IT initiatives organized by ICAR and World Bank under RAES project (NAHEP Component-2) at National Agricultural

Science Complex, New Delhi during March 21-23, 2023.

- **Member,** Overall Program Coordination Committee and **Co-chairman**, Technical session-4 on Strategies for Implementation of the AIG in the National Conference on Policy Development and Implementation Strategies for Academia Industry-Government Linkages for Agricultural Higher Education in India during March 12-13, 2023 at ICAR-National Academy of Agricultural Research Management, Hyderabad.

- **Advisory Committee member**, International Conference on Systems and Technologies for Smart Agriculture (ICSTA 2023) organized by Centre for Development of Advanced Computing (C-DAC) Kolkata, in association with the University of Calcutta.

Alka Arora

- **Session Convener**, Panel Discussion on Accelerating Digital Development through Effective Capacity Building and Change Management in International Conference on Blended Learning Ecosystem for Higher Education in Agriculture (ICBLE-2023) organized by ICAR and World Bank under RAES project (NAHEP Component-2) at National Agricultural Science Complex, New Delhi during March 21-23, 2023.

- **Session Coordinator**, Technical Session on Digital Agriculture under the theme Next Generation Technologies: Digital Agriculture, Precision Farming and AI-based Systems in the XVI Agricultural Science Congress and ASC Expo organized at ICAR-CMFRI, Kochi during October 10-13, 2023.

- **Member, Judging Committee** for the posters under the theme Next Generation Technologies: Digital Agriculture, Precision Farming and AI-based Systems in the XVI Agricultural Science Congress and ASC Expo organized at ICAR-CMFRI, Kochi during October 10-13, 2023.

Prachi Misra Sahoo

- Winner of USDA scholarship, for presenting paper titled "Neoteric and Innovative end-to-end solution for generating livestock statistics in India: eLISS Portal and eLISS Data Collection App" in the International Conference on Agricultural Statistics (ICAS) held at World Bank in Washington, DC, USA during May 17-19, 2023.

Anshu Bharadwaj

- **Panelist**, Panel discussion on Bridging the Digital Gender Divide on the occasion of International Women's Day in the Annual Summit of BRICS Chamber of Commerce & Industry on the theme Women Shaping the Techade.

- **Session Convener**, Panel discussion on Digital Transformation in Education Sector, in ICBLE 2023 organized by ICAR and World Bank under RAES project (NAHEP Component-2) at National Agricultural Science Complex, New Delhi during March 21-23, 2023.

Shashi Dahiya

- **Session Convener,** Plenary Session on Sustainable Digital Transformation in Education System in ICBLE 2023 organized by ICAR and World Bank under RAES project (NAHEP Component-2) at National Agricultural Science Complex, New Delhi during March 21-23, 2023.

Sarika and M. A. Iquebal

- **Fellow** of the National Environmental Science Academy, New Delhi in the year 2023.

Sarika

- **Member** of the Sectorial Expert Committee on Space Biomanufacturing for 3 years (2023-2026) by the Secretary, Department of Biotechnology, Govt of India.

6.

Linkages and Collaborations including Outside Funded Projects

SN	Title	Collaborative / Funding agency	Date of Start	Date of completion
1.	Designing and Analysis of On-farm and On-station research experiments planned under AICRP on IFS	AICRP on IFS, ICAR-IIFSR, Modipuram	15.03.2023	31.03.2026
2.	Planning, designing and analysis of data relating to experiments for AICRP on Long Term Fertilizer Experiments	AICRP on LTFE, ICAR- IISS, Bhopal	01.04.2017	31.03.2026
3.	ICAR research data repository for knowledge management as KRISHI: Agricultural Knowledge Resources and Information System Hub for Innovations (ICAR Headquarters component ICT including Data Centre & Research Data Repository)	ICAR-NAARM, Hyderabad; ICAR-NBSSLUP, Nagpur; ICAR-IARI, New Delhi; ICAR-CRIDA, Hyderabad; ICAR- CMFRI, Kochi; ICAR- DKMA, New Delhi as partners and all other ICAR Institutes as Nodal Centers	24.07.2015	31.03.2026
4.	Efficient designs for double cross experiments under fixed/mixed effects model	ICAR-DPR, Hyderabad; ICAR- IARI, New Delhi	11.11.2021	10.11.2024
5.	Application of next-generation breeding, genotyping, and digitalization approaches for improving the genetic gain in Indian staple crops.	ICAR-IIMilletsR, Hyderabad; ICAR-IIPR, Kanpur; ICAR-CPRI, Shimla; ICAR-NRRI, Cuttack; ICAR-IIRR, Hyderabad; ICAR-IIWBR, Karnal; ICAR-Project Coordinating Unit (Pearlmillet), ICRISAT(upto November, 2021), Excellences in Breeding, CIMMYT (since November 2021)	22.01.2019	31.03.2024
6.	Biomass and carbon mapping across altitudinal gradient of major Darjeeling and Sikkim Himalayan land uses: implications for carbon sink management and mitigation (DST funded)	UBKV, Cooch Behar	10.02.2021	09.05.2024
7.	Sustainable biochar production and use through Rice-Cotton based agro-forestry system in Odisha: A climate resilient soil management approach	World Agroforestry Centre, International Center for Research in Agroforestry (ICRAF); ICAR-IISS, Bhopal	25.08.2021	31.05.2023
8.	Diversified farming through livestock and agriculture. (ICAR-CIRB Farmer First)	ICAR-CIRB, Hisar; ICAR-IARI, New Delhi	25.11.2021	31.03.2024
9.	Doubling farmers' income in India by 2021-22: Estimating farm income and facilitating the implementation of strategic framework.	ICAR-NIAP, New Delhi	31.03.2017	31.03.2023

SN	Title	Collaborative / Funding agency	Date of Start	Date of completion
10.	Modelling insect pests and diseases under climate change and development of digital tools for pest management (NICRA Funded: CRIDA)	ICAR-NCIPM, New Delhi	20.06.2017	31.03.2023
11.	Knowledge management system for agriculture extension services in Indian NARES (ICAR-Extramural Research Project)	ICAR, New Delhi	04.03.2016	31.03.2026
12.	Market information system	ICAR-NIAP, New Delhi	22.01.2022	31.03.2026
13.	Management and impact assessment of Farmer FIRST Project	ICAR-NIAP, New Delhi; ICAR-NAARM, Hyderabad; ICAR-DKMA, New Delhi	14.02.2017	31.03.2026
14.	Molecular markers for improving reproduction of cattle and buffaloes - Funded by Bill and Melinda Gates Foundation (BMGF)	ICAR-NDRI, Karnal; ICAR-CIRB, Hisar	19.09.2018	30.09.2023
15.	Genomics assisted crop improvement and management - Centre for Advanced Agricultural Science and Technology (CAAST) project funded by National Agricultural Higher Education Project (NAHEP Funded)	ICAR-IARI, New Delhi; ICAR-NBPGR, New Delhi and ICAR-NIPB, New Delhi	26.09.2018	31.03.2023
16.	Mainstreaming rice landraces diversity in varietal development through genome wide association studies: A model for large-scale utilization of gene bank collections of rice (DBT Funded)	ICAR-IARI, New Delhi	01.05.2020	30.04.2025
17.	Germplasm characterization and trait discovery in Wheat using genomics approaches and its integration for Improving climate resilience, productivity and nutritional quality. (DBT Funded)	ICAR-NBPGR, New Delhi	01.04.2020	31.03.2025
18.	Minor oilseeds of Indian origin: Mainstreaming sesame germplasm for productivity enhancement and sustainability through genomics assisted core development and trait discovery (DBT Funded)	ICAR-NBPGR, New Delhi	29.02.2020	28.02.2025
19.	Identification and functional characterization of the key resistance/susceptible determinants for Sclerotinia stem rot disease in oilseed Brassica (DST Funded).	ICAR-NIPB, New Delhi	30.12.2020	31.12.2023
20.	Forecasting Agricultural output using Space Agrometeorology and Land based observations (FASAL)	Indian Meteorological Department (IMD)	13.04.2016	04.10.2023
21.	Characterization, evaluation, genetic enhancement and generation of genomic resources for accelerated utilization and improvement of minor pulses (DBT Funded).	Institute of Life Sciences, Bhubaneshwar, ICAR-NBPGR, New Delhi, UAS, Bangalore, PAU, Ludhiana, VNMKV, Parbhani, ICAR-CAZRI, Jodhpur, World Vegetable Centre, South Asia, Hyderabad	24.10.2018	23.04.2023

SN	Title	Collaborative / Funding agency	Date of Start	Date of completion
22.	Improving seed health and storage system.	ICAR- Indian Institute of Seed Science (IISeedS), Mau	25.01.2022	31.03.2026
23.	Assessing genetic variability in duck of Eastern states.	ICAR-RCER, Patna	08.02.2021	09.03.2023
24.	Potential irrigated area mapping through remotely sensed high resolution data.	ICAR-IIWM, Bhubaneswar; ICAR-NBSSLUP, Nagpur; Office of Climate Research and Services, IMD, Pune	05.09.2021	04.09.2024
25.	Network Program on Precision Agriculture (NePPA) at ICAR-IARI New Delhi	ICAR- IARI, New Delhi; ICAR-IIWBR, Karnal; ICAR-NRRI, Cuttack; ICAR-IIWM, Bhuabaneswar; ICAR-IIVR, Varanasi; ICAR-IISS, Bhopal; ICAR-CIAE, Bhopal; ICAR-NRCB, Tiruchirappalli; ICAR-CICR, Nagpur; ICAR-NBSSLUP, Nagpur; ICAR-NDRI, Karnal; ICAR-CIPHET, Ludhiana; ICAR-CIFE, Mumbai; ICAR-CIFA, Bhubaneswar; ICAR-CIFRI), Barrackpore	04.09.2021	31.03.2026
26.	Investments in Indian Council of Agricultural Research leadership on agricultural higher education under the National Agricultural Higher Education Project (NAHEP Funded)	ICAR-NAARM, Hyderabad; ICAR-NIAP, New Delhi	28.02.2019	31.08.2024
27.	Development of artificial intelligence integrated big-data based system for automatic query-response generation and analysis of Indian farmers' queries	ICAR-IARI, New Delhi	09.12.2021	08.12.2024
28.	AI and machine learning for supply forecasts	ICAR-NIAP, New Delhi	03.03.2022	31.03.2026
29.	Mining agricultural microbiome datasets for Antibiotic Resistance Genes (ARG) diversity and prediction of microbial resistome.	ICAR-NBAIM, Mau	03.10.2022	02.04.2025
30.	Development of an intelligent system for determining pig live weight	ICAR-IVRI, Izatnagar	31.03.2022	17.09.2023
31.	Development and assessment of conversational virtual agents 'Chatbots' for improving livestock, pet and poultry health and production	ICAR-IVRI, Izatnagar	10.10.2022	31.08.2025
32.	Computational and analytical solutions for high-throughput biological data (CRP Genomics)	ICAR-NBFGR, Lucknow	04.09.2015	30.03.2026
33.	Study on reviewing the food loss index estimates for India and preparing assessment report for inclusion of the SDG indicator12.3.1 in the National Indicator Framework. Consultancy from FAO, India	FAO, India	11.11.2022	10.05.2023

SN	Title	Collaborative / Funding agency	Date of Start	Date of completion
34.	Energy audit survey of AICRP on EAAI: sampling design and analysis	ICAR-CIAE, Bhopal, Madhya Pradesh	01.06.2018	31.05.2026
35.	Planning of survey and analysis of AICRP data on Honey bees and Pollinators	ICAR-IARI, New Delhi	30.03.2021	31.03.2023
36.	Agri-drone in ICAR: ICAR-IASRI component.	ICAR-ATARI, Jodhpur	21.07.2022	31.03.2023
37.	Planning and data analysis of FSSAI and NeTSCoFAN surveys	ICAR- IIHR, Karnataka; ICAR- CARI, Uttar Pradesh; ICAR- CIFT, Kerala ; ICAR-NRCM, Telangana; ICAR-NRCG, Maharashtra	22.07.2022	20.10.2024
38.	Statistical approaches for analysis of zero-inflated and over-dispersed counts data and their in single cell studies	ICAR-DFMD, Bhubaneswar	25.11.2021	24.05.2024
39.	Forest cover trend and above ground biomass estimation using advanced statistical technique based on remote sensing data	IIRS, ISRO, Dehradun	22.10.2022	21.10.2025
40.	Genome wide association studies in giant freshwater prawn, M rosenbergii: Linkage mapping and QTL identification	ICAR- CIFA, Odisha	01.09.2022	31.08.2025
41.	KISAN SARATHI (Powered by IIDS): System of agri-information resources auto-transmission and technology hub interface (Funded by ICT and ICAR Data Repository, ICAR Hq)	DIC, MeitY, New Delhi	09.08.2021	31.03.2026
42.	Modelling and forecasting for time-to-event analysis in agriculture	ICAR- NBPGR, New Delhi	22.06.2020	21.06.2023
43.	Consortium of Research Project-Biofortification	ICAR-IARI, New Delhi	15.03.2023	14.03.2026
44.	Global Challenges Research Fund (GCRF) South Asian Nitrogen Hub	ICAR-IARI, New Delhi	03.08.2023	28.02.2024
45.	Genomic selection accuracy for key quality traits in potato (*Solanum Tuberosum L.*)	ICAR-CPRI, Uttar Pradesh	17.07.2023	16.07.2026
46.	Development of precision engineering technologies for agricultural input production management and value addition to ensure profitability, sustainability and environmental safety	ICAR-IARI, New Delhi	20.01.2023	31.03.2026
47.	Development of artificial intelligence based model and tools for genomic studies	ICAR-NIPB, New Delhi	11.09.2023	10.09.2026
48.	Landscape Diagnostic Survey of cotton production practices and crop performance in Maharashtra. Funded by Rajiv Gandhi Science and Technology Commission, Govt. of Maharashtra	ICAR-CICR, Maharashtra	10.10.2023	31.05.2024
49.	Development of advanced information and communication technologies (ICT)-based communication and education tools for millets promotion	ICAR-IIMR, New Delhi	30.11.2023	31.03.2026

SN	Title	Collaborative / Funding agency	Date of Start	Date of completion
50.	AI-DISC (integration) in POCRA app for providing advisory and receiving new images from POCRA	Nanaji Deshmukh Krushi Sanjivani Prakalp (NDKSP), Department of Agriculture, Govt. of Maharashtra presently located in Mumbai through it's Project Director (POCRA: Project on Climate Resilient Agriculture)	04.10.2023	03.07.2026
51.	Sampling procedure for selection of representative sample for food grain quality check for DCP and Non-DCP system	Department of Food and Public Distribution (DFPD), Ministry of Consumer Affairs, Food and Public Distribution, (MCAF&PD), Govt. of India. The Food Corporation of India	31.10.2023	30.10.2025
52.	Integration KVK APIs, KCC-CHAKSHU and AI-DISC. Undertaking programmes in research, capacity building, extension, consultancy in various area of agriculture sciences	National Bank for Agriculture and Rural Development (NABARD) Mumbai (Work Plan under ICAR Umbrella MOU)		
53.	Co-operating for accessing the laboratory and infrastructure facilities and mentoring under the incubation proramme of a-IDEA, NAARM. It aims to promote entrepreneurship in agriculture and allied sectors.	Association of Innovation Development for Entrepreneurship in Agriculture Centre for Agri-Innovation ICAR-NAARM, Hyderabad-500030	08.07.2022	07.07.2025
54.	ASRB-Online Application & Scorecard Information System	ASRB (Agricultural Scientists Recruitment Board)	28.11.2022	31.03.2026
55.	Study on reviewing the food loss index estimates for India and preparing assessment report for inclusion of the SDG indicator12.3.1 in the national indicator framework	FAO of the United Nations, Rome through FAO-India	11.11.2022	10.05.2023
56.	Efficient designs for double cross experiments under fixed/mixed effects model	ICAR-IARI, Jharkhand	11.11.2021	10.11.2024
57.	Development of methodology for CCE on squash and methodological improvement for CCE on Cashewnut, Pineapple and Arecanut etc. in Meghalaya	DES, Govt. of Meghalaya	26.07.2023	25.01.2025
58.	Network project on agricultural bioinformatics and computational biology	ICAR- NBAIR, ICAR- NBAIM, ICAR- NBPGR, ICAR- IARI, ICAR- IIWBR, ICAR- NIPB, ICAR- DRMR, ICAR- CPRI, ICAR- IISR, ICAR- IIHR, ICAR- IIVR, ICAR- NBPGR, ICAR- CIBA, ICAR- CIFA, ICAR- CIFRI, ICAR- NBAGR, ICAR- IVRI, ICAR- CIRG, ICAR- CIRB, ICAR- NRCE	12.07.2020	31.03.2024
59.	Recruitment management system for Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya (RMS-RVSKVV). (Contract research)	Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya (RVSKVV), Gwalior	25.09.2023	24.08.2024
60.	Development of software to conduct IDA election through e-voting for the 15 positions for Indian Dairy Association (IDA) (Contract research)	Indian Dairy Association	21.02.2022	20.02.2023

7.

Publications

Research Papers

1. Adak S, Bandyopadhyay K, Sahoo RN, Krishnan P, Sehgal VK, Kumar SN, Datta SP, Sarangi A, Bana RS, Mandal N, Bhattacharya P and Yeasin M (2023). Interactive effect of tillage, residue, nitrogen, and irrigation management on yield, radiation productivity and water productivity of winter wheat in semi-arid climate. *Journal of Agrometeorology*, **25(3)**, 383-391.

2. Aditya K, Kumar R, Bharti and Sanyal S (2023). Environmental impact of greenhouse gas emissions from the tea industries of Northeastern states of India. *Frontiers in Sustainable Food Systems*, **7**, 1220775.

3. Agrawal R, Singh KN, Lama A, Gurung B, Haque MA, Singh KK and Singh P (2023). Weather based models for pre-harvest crop yield forecasting. *Journal of Indian Society of Agricultural Statistics*, **77(1)**, 59–69.

4. Ahlawat S, Arora R, Sharma R, Chhabra P, Kumar A, Kaur M, Lal SB, Mishra DC, Farooqi MS and Srivastava S (2023). Revelation of genes associated with energy generating metabolic pathways in the fighter type Aseel chicken of India through skeletal muscle transcriptome sequencing. *Animal Biotechnology*, **34(9)**, 4989-5000.

5. Ahmad SF, Singh A, Deb CK, Panda S, Gaur GK, Dutt T, Mishra BP and Kumar A (2023). Evaluation of imputation possibility from low-density SNP panel in composite Vrindavani cattle. *Animal Genetics*, **54(5)**, 647-648.

6. Ahmad T, Biswas A, Sud UC, Sahoo PM and Singh M (2023). Sampling methodology for estimation of private food grains stock at farm level aligned with input survey of agriculture census in India. *Journal of Indian Society of Agricultural Statistics*, **77(1)**, 95-104. https://krishi.icar.gov.in/jspui/handle/123456789/79675

7. Aiswarya S, Padaria RN, Burman RR, Sarkar S, Kumar P and Lama A (2023). Analysing the climate change adaptations among the communities of Agasthyamalai biosphere reserves. *Current Science*, **125(12)**, 1354-1359.

8. Ajay A, Chauhan A, Vaishnav S, Rani C, Kumar B, De UK, Verma MR, Singh M and Gaur GK (2023). Impact of body condition on sow and litter performance, postpartum physiological, hematological, and biochemical parameters in Landlly crossbred pigs. *Tropical Animal Health and Production*, **55(6)**, 393.

9. Arora R, Sharma R, Ahlawat S, Chhabra P, Kumar A, Kaur M, Vij RK, Lal SB, Mishra DC, Farooqi MS and Srivastava S (2023). Transcriptomics reveals key genes responsible for functional diversity in pectoralis major muscles of native black Kadaknath and broiler chicken. *3 Biotech*, **13**, 253.

10. Bana RS, Bamboriya SD, Kumar V, Godara S, Gaydon DS, Laing AM, Dhakar R, Shivay YS, Meena VS and Singh D (2023). Identifying optimum residue levels for stable crop and water productivity and carbon sequestration under a conservation agriculture based rice-wheat system. *Soil and Tillage Research*, **232**, 105745.

11. Bana RS, Choudhary AK, Nirmal RC, Kuri BR, Sangwan S, Godara S, Bansal R, Singh D and Rana DS (2024). High-value crops embedded groundnut-based production systems vis-àvis system-mode integrated nutrient management: long-term impacts on system productivity, system profitability, and soil bio fertility indicators in semi-arid climate. *Frontiers in Plant Science,* **14**, 1298946. https://krishi.icar.gov.in/jspui/handle/123456789/81811

12. Bana RS, Grover M, Singh D, Bamboriya SD, Godara S, Kumar M, Kumar A, Sharma S, Shekhawat PS, Lomte D, Bhuva HM, Babar SR, Suryawanshi RT, Vasuki V, Singh N, Khandelwal V, Kumar A, Singh S and Satyavathi CT (2023). Enhanced pearl millet yield stability, water use efficiency and soil microbial activity using superabsorbent polymers and crop residue recycling across diverse ecologies. *European Journal of Agronomy*, **148**, 126876.

13. Banerjee R, Bharti, Begum S, Das P and Ahmad T (2023). Issues and challenges of imputation

techniques in genome wide association studies (GWAS): A review. *Bhartiya Krishi Anusandhan Patrika*, **38(3)**, 193-202. https://krishi.icar.gov.in/jspui/handle/123456789/81535

14. Basak P, Ray M, Sinha K and Anuja AR (2023). Prediction of urban unemployment rate in India using Grey model. *Journal of Indian Society of Agricultural Statistics*, **77(3)**, 243–248.

15. Bhardwaj A, Tando G, Pal Y, Sharma NK, Nayan V, Soni S, Iquebal MA, Jaiswal S, Legha RA, Talluri TR, Bhattacharya TK, Kumar D, Rai A and Tripathi BN (2023). Genome-wide SNP based genomic diversity and runs of homozygosity for selection signatures in equine breeds. *Genes*, **14(8)**, 1623.

16. Bharti, Aditya K and Devi S (2023). Marketing analysis of apple crop in high hills of Himachal Pradesh. *Current Science*, **125(5)**, 530-535.

17. Bharti, Das P, Banerjee R, Ahmad T, Devi S and Verma G (2023). Machine-learning based apple yield prediction using morphological characters. *Horticulturae*, **9(4)**, 436.

18. Birteeb PT, Varghese C, Jaggi S, Varghese E and Harun M (2022). An efficient class of tree network balanced designs for agroforestry experimentation. *Communications in Statistics - Simulation and Computation*. **51(12),** 7169-7179.

19. Biswakarma N, Pooniya V, Zhiipao RR, Kumar D, Shivay YS, Das TK, Roy D, Das B, Choudhary AK, Swarnalakshmi K, Govindasamy P, Lakhena KK, Das K, Lama A, Jat RD, Babu S, Khan SA and Behara B (2023). Identification of a resource-efficient integrated crop management practice for the rice-wheat rotations in south Asian Indo-Gangetic plains. *Agriculture, Ecosystems & Environment*, **357**, 108675.

20. Biswas A, Aditya K and Sud UC (2023). Product type calibration estimator with inversely related PSU level auxiliary variable under two stage sampling. *Journal of the Indian Society of Agricultural Statistics*, **77(2)**, 171–176. https://krishi.icar.gov.in/jspui/handle/123456789/80862

21. Biswas A, Aditya K, Sud UC and Basak P (2023). Calibration estimator in two stage sampling using double sampling approach when study variable is inversely related to the auxiliary variable. *Statistics and Application*, **21(1)**, 11-22. https://krishi.icar.gov.in/jspui/handle/123456789/79674

22. Biswas A, Kumar R, Singh D and Basak P (2023). Calibration estimation approach for population ratio under adaptive cluster sampling. *Journal of Indian Society of Agricultural Statistics*, **77(2)**, 177–183.https://krishi.icar.gov.in/jspui/handle/123456789/80863

23. Borgohain A, Sarmah M, Gogoi BB, Konwar K, Handique JG, Paul RK, Yeasin M, Pandey V, Yadav R, Malakar H, Saikia J, Deka D, Rahman FH, Panja S, Khare P and Karak T (2023). Can tea pruning litter biochar be a friend or foe for tea (*Camellia sinensis* L.) plants growth and growth regulators?: Feasible or fumes of fancy. *Industrial Crops and Products*, **195**, 116394.

24. Brar JS, Das P, Adhikary T and Khehra S (2023). Energy assessing and optimizing energy efficiency of pear orchards in North-Western India. *Scientist*, **3(3),** 374-352.

25. Chandra T, Jaiswal S, Iquebal MA, Singh R, Gautam RK, Rai A and Kumar D (2023). Revitalizing miRNAs mediated beneficial agronomic traits improvement in rice. *Plant Physiology and Biochemistry Journal*, **202**, 107933.

26. Chaturvedi KK, Kumar U, Sane A, Singh P, Kumar P and Tripathi PC (2023). Exploring the genetic diversity of *Aegle marmelos* (L.) Correa populations in India. *Plant Genetic Resources: Characterization and Utilization*, **21(2)**, 107-114. https://krishi.icar.gov.in/jspui/handle/123456789/82101

27. Chaudhary K, Jha GK, Jaiswal R, Venkatesh P and Parsad R (2023). Agricultural price forecasting based on variational mode decomposition and time-delay neural network. *Statistics and Applications*, **21(2)**, 237-259. http://krishi.icar.gov.in/jspui/handle/123456789/80951

28. Chhetri S, Alam M, Hasan MA and Lama A (2022). The efficacy of varying length of cladode cutting and IBA concentration on root and shoot growth in dragon fruit (*Hylocereus costaricensis* [F.A.C. Weber] Britton and Rose.) cv. Royal Moroccan Red. *Journal of Crop and Weed*, **18(3)**,190-194.

29. Chiru TDG, Sharma N, Padaria RN, Ahmad N, Punitha P and Ramasubramanian V (2022). Farmers' preferences for animal husbandry

advisory services of public and private extension service organizations in Meghalaya. *International Journal of Extension Education*, **18**, 90-95.

30. Choudhary P, Waseem M, Kumar S, Subbarao N, Srivastava S and Chakdar H (2023). Y12F mutation in *Pseudomonas plecoglossicida* S7 lipase enhances its thermal and pH stability for industrial applications: a combination of *in silico* and *in vitro* study. *World Journal of Microbiology Biotechnology,* **39(3),** 75.

31. Das A, Ahmed N, Purakayastha TJ, Biswas S, Ray P, Singh B, Das TK, Kumar R and Lama A (2023). Impact of conservation agriculture on humic acid quality and clay humus complexation under maize (*Zea mays*)-wheat (*Triticum aestivum*) and pigeon pea (*Cajanus cajan*)-wheat cropping systems. *Indian Journal of Agricultural Sciences*, **93(9)**, 1013-1018.

32. Das A, Munshi AD, Raju D, Kumar S, Singh D, Talukdar A, Hongal D, Iquebal MA, Bhattacharya RC, Ghannoum O, Behera TK and Dey SS (2023). Key physiological traits for drought tolerance identified through phenotyping a large set of slicing cucumber (*Cucumis sativus* L.) genotypes under field and water-stress conditions. *Genetic Resources and Crop Evolution*, **71**, 1855–1868.

33. Das J, Kumar B, Saha B, Jaiswal S, Iquebal MA, Angadi UB and Kumar D (2023). Genome-wide identification and characterization of tissue specific long non-coding RNAs and circular RNAs in common carp (*Cyprinus carpio* L.). *Frontiers in Genetics*. **14**, 1239434.

34. Das J, Kumar S, Mihra DC, Chaturvedi KK, Paul RK and Kairi A (2023). Machine learning in the estimation of CRISPR-Cas9 cleavage sites for plant system. *Frontiers in Genetics*, **13**, 1085332.

35. Das P, Chandra T, Negi A, Jaiswal S, Iquebal MA, Rai A and Kumar D(2023). A comprehensive review on genomic resources in medicinally and industrially important major spices for future breeding programs: status, utility and challenges. *Current Research in Food Science*, **7**, 100579.

36. Das P, Grover M, Chauhan D, Mishra DC, Kumar S, Chaturvedi KK, Bhardwaj SC, Singh AK and Rai A (2023). Comparative transcriptome analysis of wheat isogenic lines provides insights into genes and pathways associated with stripe rust resistance. *Indian Journal of Genetics and Plant Breeding*, **83(01)**, 52-58.

37. Das P, Grover M, Mishra DC, Guha MS, Kumar S, Chaturvedi KK, Bhardwaj SC, Singh AK and Rai A (2023). Genome-wide identification and characterization of *Puccinia striiformis*-responsive lncRNAs in *Triticum aestivum*. *Frontiers in Plant Science*, **14**, 1120898.

38. Das P, Jha GK and Lama A (2023). Empirical mode decomposition based ensemble hybrid machine learning models for agricultural commodity price forecasting. *Statistics and Applications*, **21(1),** 99-112. http://krishi.icar.gov.in/jspui/handle/123456789/77772

39. Das P, Jha GK, Lama A and Parsad R (2023). Crop yield prediction using hybrid machine learning approach: A case study of lentil (*Lens culinaris* Medik). *Agriculture*, **13(3)**, 596.

40. Das P, Lama A, and Jha GK (2022).Variational mode decomposition based machine learning models optimized with genetic algorithm for price forecasting. *Journal of Indian Society of Agricultural Statistics*, **76(3)**, 141-150.

41. Das R, Rai A and Mishra DC (2023). CNN_FunBar: Advanced learning technique for fungi ITS region classification. *Genes,* **14(3)**, 634.

42. Das S, Pal S, Rautaray SS, Mohapatra JK, Subramaniam S, Rout M, Rai SN and Singh RP (2023). Estimation of foot-and-mouth disease virus sero-prevalence rates using novel computational approach for the susceptible bovine population in India during the period 2008–2021. *Scientific Report,* **13**, 22583.

43. Datta A, Jaggi S, Varghese C, Varghese E, Harun M and Bhowmik A (2022). Efficient row-column designs with multiple units per cell balanced for special effects. *Journal of Indian Society of Agricultural Statistics*, **76(3)**, 131–140.

44. Dey S, Purakayastha TJ, Sarkar B, Rinklebe J, Kumar S, Chakraborty R, Datta A, Lal K and Shivay YS (2023). Enhancing cation and anion exchange capacity of rice straw biochar by chemical modification for increased plant nutrient retention. *Science of the Total Environment,* **886**, 163681.

45. Gaddikeri V, Sarangi A, Singh DK, Bandyopadhyay KK, Chakrabarti B and

Sarkar SK (2023). Comparative evaluation of reference evapotranspiration estimation models in new Bhupania minor command, Jhajjar, Haryana, India. *Current Science*, **124(01),** 73-78.

46. Ganiga N, Bhatia R, Dubey K, Arora R, Singh KP, Panwar S, Bollinedi H and Sarika (2023). Protocol for in vitro regeneration and rapid mass multiplication of apetalous male sterile lines of marigold. *Indian Journal of Horticulture*, **80(1),** 110-116.

47. Garai S, Paul RK, Rakshit D, Yeasin M, Paul AK, Roy HS, Barman S and Manjunatha B (2023). An MRA based MLR model for forecasting Indian annual rainfall using large scale climate indices. *International Journal of Environment and Climate Change*, **13(5)**, 137-150.

48. Garhwal R, Bhardwaj A, Sangwan K, Mehra R, Pal Y, Nayan V, Iquebal MA, Jaiswal S and Kumar H (2022). Milk from Halari donkey breed: nutritional analysis, vitamins, minerals, and amino acids profiling. *Foods*, **12(4)**, 853.

49. Garhwal R, Sangwan K, Mehra R, Pal Y, Nayan V, Tiwari M, Chauhan MS, Iquebal MA, Jaiswal S, Kumar H and Bhardwaj A (2022). Comparative metabolomics analysis of Halari donkey colostrum and mature milk throughout lactation stages using 1H-Nuclear Magnetic Resonance. *LWT- Food Science and Technology*, **182**, 114805.

50. Gautama PV, Kushwaha HL, Kumar A, Khura TK and Sarkar SK (2023). Microcontroller-based low-cost seed metering module retrofit on cultivator. *Indian Journal of Engineering and Materials Sciences,* **30**, 180-188.

51. Geetha ML, Venkatesh P, Jha GK, Singh DR and Sangeetha V (2023). A study on consumer awareness, perception and willingness to pay for biofortified products in Delhi, India. *Current Science*, **125(7)**, 728-736.

52. Gole P, Bedi P, Marwaha S, Haque MA and Deb CK (2023). TrIncNet: a lightweight vision transformer network for identification of plant diseases. *Frontiers in Plant Science*, **14**,1221557. https://krishi.icar.gov.in/jspui/handle/123456789/82018

53. Gowdra MM, Tomar R, Chandappa LH, Sahu S, Mishra DC, Rao AR and Chinnusamy V (2023). Genome-wide identification of potassium channels in maize showed evolutionary patterns and variable functional responses to abiotic stresses. *Plant Physiology and Biochemistry*, **206**, 108235.

54. Gurung B, Dutta S, Singh KN, Lama A, Vennila S and Gurung B (2023). The development of a statistical model for forewarning *Helicoverpa armigera* infestation using beta regression. *Journal of Crop and Weed*, **19(1)**, 210-215.

55. Gurung B, Lama A, Sinha K, Bhardwaj SP, Singh KN and Gurung B (2023). Econometric study of supply side interventions based on marketing reforms. *Agri-India Today*, **3(1)**, 1-5.

56. Gurung B, Pal S, Reza Md. W, Gurung B and Lama A (2023). A machine learning model for studying the seasonality of aphids in wheat based cropping systems of terai zone of Darjeeling, West Bengal. *Current Science*, **125(11)**, 1244-1249.

57. Haqmal M, Dass A, Nasrat NA, Choudhary AK, San AA, Gautam MK, Rajannaand GA and Sarkar SK (2023). Effect of land configurations and phosphorus on root-shoot growth, yield attributes, harvest index and net B:C of soybean in Kandahar, Afghanistan. *Annals of Agricultural Research*, **44 (1)**, 1-4.

58. Harisha R, Singh SK, Ahlawat AK, Narwal S, Jaiswal JP, Singh JB, Kumar RR, Singhal S, Balakrishnan AP, Shukla P and Bhavya B (2023). Elucidating the effects on polyphenol oxidase activity and allelic variation of polyphenol oxidase genes on dough and whole wheat-derived product color parameters. *International Journal of Food Properties*, **26(2)**, 2716–2731. https://doi.org/10.2174/15748936186662303 16151648

59. Irshad M, Kumar M, Ray M, Sattar A, Paswan S and Minnatullah (2023). Effect of meteorological elements on sugarcane wilt in Bihar. *International Journal of Statistics and Applied Mathematics*, **8(4)**, 128-133.

60. Jaggi S, Sarkar KA, Bhowmik A, Varghese E, Varghese C and Datta A (2023). Trend resistant balanced bipartite block designs. *Statistical Methods & Applications*, **32(1)**, 211-235. http://krishi.icar.gov.in/jspui/handle/123456789/79406

61. Jaggi S, Varghese C and Dalal A (2023). Polygonal association scheme and PBIB(3) designs in two replicates. *Journal of the Indian*

Society of Agricultural Statistics, **77(3)**, 257-264.

62. Jaiswal R, Jha GK, Kumar RR and Lama A (2023). Agricultural price forecasting using NARX model: A case study of soybean oil. *Current Science*, **125(1)**, 79-84.

63. Janani R, Sharma BB, Dhar S, Arora A, Choudhary H, Yadav RK, Singh D, Singh D, Solanke AU and Kumar P (2023). Physiological and biochemical responses of garden pea genotypes under reproductive stage heat stress. *Genetic Resources and Crop Evolution,* **71(3)**, 1177-1200. https://krishi.icar.gov.in/jspui/handle/123456789/82685

64. Jangir CK, Sangwan PS, Panghaal D, Kumar S, Meena RS, Bharti, Jat RD and Singh N (2023). Release behaviour of iron and zinc in different textured soil and its distribution in rice plant (*Oryza sativa* L.) in North West of India. *Acta fytotechn zootechn*, **26(1),** 67-77.

65. Jangir CK, Sangwan PS, Panghaal D, Kumar S, Meena RS, Bharti, Jat RD, Singh N (2023). Spatial variability and statistical analysis of soil properties in the rice wheat-based systems of North-West India. *Communications in Soil Science and Plant Analysis*, **55(8)**, 1205-1223.

66. Jat RA, Jain NK, Yadav RS, Reddy KK, Choudhary RR, Zala PV, Meena HN, Sarkar S, Rathore SS and Sharma GK (2023). System-based integrated nutrient management improves productivity, profitability, energy use efficiency and soil quality in peanut-wheat cropping sequence in light black soils. *Sustainability*, **15**, 1361. http://krishi.icar.gov.in/jspui/handle/123456789/75549

67. Johnson DC, Chander M, Sagar MP, Verma MR and Patil AP (2023). Organic poultry farming knowledge test for tribal farmers: design, development and evaluation. *Indian Journal of Extension Education*, **59(4)**, 141-144.

68. Joshi B, Singh S, Tiwari GJ, Kumar H, Boopathi NM, Jaiswal S, Adhikari D, Kumar D, Sawant SV, Iquebal MA and Jena SN (2023). Genome-wide association study (GWAS) of yield-related traits uncovers the novel genomic regions and candidate genes in Indian upland cotton (*Gossypium hirsutm* L.). *Frontiers in Plant Science,* **14**, 1252746.

69. Kanupriya C, Chaturvedi K, Karunakaran G, Singh P, Venugolalan R, Samant D and Kumar P (2024). Phenotypic diversity in *Tamarindus indica* L. sourced from different provenances of India. *Agroforestry Systems,* **98,**477-490. https://doi.org/10.1007/s10457-023-00925-0

70. Kanrar B, Kundu S, Sengupta S, Yeasin M, Paul RK and Karak T (2023). Assessment and health risk of fluoride from Northeast Indian tea (*Camellia sinensis* L.): Fixing up the maximum residue level of fluoride in tea. *Journal of Food Composition and Analysis*, **127**, 105928.

71. Karigar GP, Singh S, Mangal M, Saroha S, Saini N, Ray M and Behera TK (2023). Dietary micronutrient content, heterosis and combining ability for breeding mineral-rich hybrids in early- and mid-maturity groups of Indian cauliflower. *Scientia Horticulturae*, **312**, 111848.

72. Karmakar S, Varghese C, Harun M, Vinaykumar LN and Varghese E (2023). Experimental designs for the selection of integrated farming system components. *Current Science*, **124(9),** 1053-1057. http://krishi.icar.gov.in/jspui/handle/123456789/77598

73. Karmakar S, Varghese C, Jaggi S and Harun M (2023). Partially balanced t-designs. *Communications in Statistics - Simulation and Computation*, **52(12)**, 6141-6148. https://krishi.icar.gov.in/jspui/handle/123456789/76619

74. Karmakar S, Varghese C, Jaggi S and Harun M (2023). t-designs involving treatment combinations for animal experimentation. *Indian Journal of Animal Sciences*, **93(3)**, 314-317. http://krishi.icar.gov.in/jspui/handle/123456789/76879

75. Karmakar S, Varghese C, Jaggi S and Harun M (2022). Partially balanced t-designs with unequal sizes. *Journal of Community Mobilization and Sustainable Development*, **3**, 952-957. http://krishi.icar.gov.in/jspui/handle/123456789/76650

76. Kashyap A, Kumari S, Garg P, Kushwaha R, Tripathi S, Sharma J, Gupta NC, Kumar RR, Yadav R, Vishwakarma H, Rana JC, Bhattacharya R and Rao M (2023). Indexing resilience to heat and drought stress in the wild relatives of rapeseed-mustard. *Life*, **13(3)**, 738.

77. Kashyap A, Kumari S, Garg P, Kushwaha R, Tripathi S, Sharma J, Gupta NC, Kumar RR, Vishwakarma H, Bhattacharya R, Yadav R, Rana JC and Rao M (2023). Morpho-biochemical responses of brassica coenospecies to glyphosate exposure at pre- and post-emergence stages. *Agronomy*, **13**, 1831.

78. Kaur M, Thakur S, Choudhary OR, Kaur R, Kaila V and Sharma JP (2023). Effect of salt stress on morpho-physiological and anatomical attributes of Salix clones. *Israel Journal of Plant Sciences*, **70(3-4)**, 253-267.

79. Khan MA, Rai A, Mishra DC, Budhlakoti N, Satpathy S and Majumdar SG (2023). Comparative study of multi-trait genomic and phenotypic selection indexes for selection of superior genotypes. *Indian Journal of Genetics and Plant Breeding*, **83(01)**, 88-94.

80. Khan S, Pawde AM, Banu SA, Manjusha KM, Kalaiselvan E, Kumar R, Kinjavdekar P, Singh KP, Verma MR, Chandra V and Mukherjee R (2023). Impact of platelet-rich plasma and adipose-derived stromal cascular fraction on atrophic non-union fracture healing in a rabbit model. *Regenerative Engineering and Translational Medicine*, 1-13. https://doi.org/10.1007/s40883-023-00325-x

81. Kuhn JH, Abe J, Adkins Scott, ..., Chaturvedi KK,*et al*. (2023). Annual (2023) taxonomic update of RNA-directed RNA polymerase-encoding negative-sense RNA viruses (realm Riboviria: kingdom Orthornavirae: phylum Negarnaviricota). *Journal of General Virology*, **104(8)**,001864. https://doi.org/10.1099/jgv.0.001864

82. Kumar A, Sarangi A, Singh DK, Dash S and Mishra IM (2023). Evaluation of ultrasonic sensor for flow measurement in open channel. *Journal of Scientific & Industrial Research*, **82(10),** 1091-1099. https://krishi.icar.gov.in/jspui/handle/123456789/80591

83. Kumar AK, Kumar A, Ramasubramanian V, Kushwaha HL, Chakraborty D and Tomar BS (2023). Demographic and socio-economic of the tobacco farmworkers in Andhra Pradesh, India. *The Pharma Innovation Journal*, **12(5)**, 1090-1092.

84. Kumar B, Saha B, Jaiswal S, Angadi UB, Rai A and Iquebal MA (2023). Genome wide identification and characterization of tissue specific non-coding RNAs in black pepper (*Piper Nigrum L.*). *Frontiers in Plant Science,* **14,** 1079221.

85. Kumar D, Ramkumar MK, Dutta B, Kumar A, Pandey R, Jain PK, Gaikwad K, Mishra DC, Chaturvedi KK, Rai A, Solanke AU and Sevanthi AM (2023). Integration of miRNA dynamics and drought tolerant QTLs in rice reveals the role of miR2919 in drought stress response. *BMC Genomics*, **24,** 526.

86. Kumar K, Parihar CM, Nayak HS, Godara S, Avinash G, Patra K, Sena DR, Reddy KS, Das TK, Jat SL, Ghatala MK, Singh U and Sharawat YS (2023). Enhancing maize yield in a conservation agriculture-based maize (*Zea mays*)- wheat (*Triticum aestivum*) system through efficient nitrogen management. *The Indian Journal of Agricultural Sciences*, **93(4)**, 420-424.

87. Kumar KR, Dashora K, Kumar S, Dharmaraja S, Sanyal S, Aditya K, Kumar R (2023). A review of drying technology in tea sector of industrial, non-conventional and renewable energy based drying systems, *Applied Thermal Engineering*, https://doi.org/10.1016/j.applthermaleng.2023.120118

88. Kumar M, Ansari WA, Zeyad MT, Singh A, Chakdar H, Kumar A, Farooqi MS, Sharma A, Srivastava S and Srivastava AK (2023). Core microbiota of wheat rhizosphere under upper Indo-Gangetic plains and their response to soil physicochemical properties. *Frontiers in Plant Science*, **14**, 1186162.

89. Kumar P, Gupta RK, Chandel A, Verma G and Kaur S (2023). Genetic variability and divergence studies in quantitative traits of wild pomegranate (*Punica granatum L*). *International Journal of Plant & Soil Science*, **35(21)**, 455-461.

90. Kumar P, Jha GK, Kumar RR and Lama A (2023). Forecasting agricultural commodity prices using singular spectrum analysis. *International Journal of Statistics and Applied Mathematics*, **8(4)**, 586-591.

91. Kumar P, Kumbhare NV, Nain MS, Bishnoi S, Biswas A, Kumar P and Prashad S (2023). Factors for value realization of tomato, onion, and potato (TOP) under operation greens using DEMATEL method. *Indian Journal of Extension Education*, **59(4)**, 72-76.

92. Kumar PD, Aditya K, Ahmad T, Biswas A and Tripathi SP (2023). A new two auxiliary calibration estimator of the population total in two stage sampling design using nonlinear constraints. *Journal of the Indian Society of Agricultural Statistics*, **77(3)**, 265–274.

93. Kumar R, Biswas A and Singh D (2023). Estimation of ratio in finite population using calibration approach under different calibrated weights systems. *Journal of the Indian Society of Agricultural Statistics*, **77(2)**, 225–232.

94. Kumar RR, Dubey K, Goswami S, Rai GK, Rai PK, Salgotra RK, Bakshi S, Mishra DC, Mishra GP and Chinnusamy V (2023). Transcriptional regulation of small heat shock protein 17 (sHSP-17) by *Triticum aestivum* HSFA2h transcription factor confers tolerance in arabidopsis under heat stress. Plants, **12**(20), 3598; https://doi.org/10.3390/plants12203598.

95. Kumar RR, Jha GK, Jaiswal R and Choudhary K (2022). A novel hybrid approach for forecasting mustard price having long- memory property. *Current Science*, **124(5),** 632-635**.**

96. Kumar S, Behera SK, Gururaj K, Chaurasia A, Murmu S, Prabha R, Angadi UB, Pawaiya RS and Rai A (2023). In silico mutation of aromatic with aliphatic amino acid residues in Clostridium perfringens epsilon toxin (ETX) reduces its binding efficiency to Caprine Myelin and lymphocyte (MAL) protein receptors. *Journal of Biomolecular Structure and Dynamics*, **2**, 1-13. https://krishi.icar.gov.in/jspui/handle/123456789/80415

97. Limbalkar OM, Vasisth P, Singh G, Jain P, Singh R, Sharma M, Dhanasekaran G, Kumar M, Meena ML, Iquebal MA, Jaiswal S, Rao M, Watts A, Bhattachraya R, Singh KH, Kumar D and Singh N (2023). Dissection of QTLs conferring drought tolerance in *B. Carinata* derived *B. Juncea* introgression lines. *BMC Plant Biology.* **23**, 664.

98. Majumdar SG, Rai A and Mishra DC (2023). Estimation of error variance in genomic selection for ultrahigh dimensional data. *Agriculture*, **13(4),** 826.

99. Mallikarjuna KN, Tomar BS, Mangal M, Singh N, Singh D, Kumar S, Tomar A, Singh B and Jat GS (2023). Genetic diversity, population structure and gene flow analyses in bitter gourd (*Momordica charantia* L.) based on agro-morphological and microsatellite markers. Plants, **12**(19), 3512.

100. Meena BP, Shirale AO, Yadav DK, Jha P, Yadav D, Gurav PP, Yeasin M and Biswas AK (2023). Millets for sustainable food and nutrition security. *Indian Journal of Fertilizers*, **19 (5),** 412-432.

101. Meena SN, Sharma SK, Singh P, Ram A, Meena BP, Jain D, Singh D, Debnath S, Yadav S, Dhakad U, Verma P, Meena JK and Nandan S (2023). Tillage-based nutrient management practices for sustaining productivity and soil health in the soybean wheat cropping system in viertisols of the Indian semi-arid tropics. *Frontiers in Sustainable Food Systems,* **7**, 1234344. https://krishi.icar.gov.in/jspui/handle/123456789/81884

102. Meenakshi RN, Bharti N, Chauhan A and Sankhyan N (2023). Exploring intraspecific provenance variation in seed morphological traits of *Albizia Procera* in mid-Himalayan region of India. *Journal of Tropical Forest Science,* **35(2)**, 168–178.

103. Meher PK, Gupta A, Rustgi S, Mir RR, Kumar A, Kumar J, Balyan HS and Gupta PK (2023). Evaluation of eight Bayesian genomic prediction models for three micronutrient traits in bread wheat (*Triticum aestivum* L.). *The Plant Genome*, e20332.

104. Meher PK, Hati S, Sahu TK, Pradhan UK, Gupta A and Rath SN (2024). SVM-Root: Identification of root-associated proteins in plants by employing the support vector machine with sequence-derived features. *Current Bioinformatics*, **19(1),** 91-102**.** https://krishi.icar.gov.in/jspui/handle/123456789/81078

105. Mehta S, Dhawi F, Garg P, Rao M, Bhattacharya R, Akthar J, Yadav R, Singh M, Singh K, Nallathambi P, Maheswari CU, Meena PD, Meena HS, Rai PK, Pant U, Harun M, Choudhary R, Matic S and Gupta AK (2023). Potential source of resistance in introgressed, mutant and synthetic *Brassica juncea L.* lines against diverse isolates of white rust pathogen, *Albugo candida*. Agronomy, **13(5),** 1214. http://krishi.icar.gov.in/jspui/handle/123456789/77264

106. Mir ZA, Chandra T, Saharan A, Budhlakoti N, Mishra DC, Saharan MS, Mir RR, Singh AK, Sharma S, Vikas VK and Kumar S (2023).

Recent advances on genome-wide association studies (GWAS) and genomic selection (GS); prospects for Fusarium head blight research in durum wheat. *Molecular Biology Reports*, **50**, 3885-3901.

107. Mir ZA, Chauhan D, Pradhan AK, Srivastava V, Sharma D, Budhlakoti N, Mishra DC, Jadon V, Sahu TK, Grover M, Gangwar OP, Kumar S, Bhardwaj SC, Padaria JC, Singh AK, Rai A, Singh GP and Kumar S (2023). Comparative transcriptome profiling of near isogenic lines PBW343 and FLW29 to unravel defense related genes and pathways contributing to stripe rust resistance in wheat. *Functional and Integrative Genomics*, **23(2),** 1-19.

108. Mishra DC, Bhati J, Yadav S, Awasthi H, Sikka P, Jerome A, Balhara AK, Rai A and Chaturvedi KK (2023). Comparative expression analysis of water buffalo (*Bubalus bubalis*) to identify genes associated with economically important traits. *Frontiers in Veterinary Sciences*, **10**, 1160486.

109. Mishra DC, Majumdar SG, Kumar A, Bhati J, Chaturvedi KK, Kumar RR, Goswami S, Rai A and Budhlakoti N (2023). Regulatory networks of lncRNAs, miRNAs, and mRNAs in response to heat stress in wheat (*Triticum aestivum* L.): An integrated analysis. International journal of Genomics. https://doi.org/10.1155/2023/1774764

110. Mishra P, Alakkari KM, Lama A, Ray S, Singh M, Shoko C, Abotaleb M, Al AMG and Karakaya K (2023). Modeling and forecasting of sugarcane production in South Asian countries. *Current Applied Science and Technology*, **23(1)**, 1-15.

111. Moharana PC, Dharumarajan S, Yadav B, Jena RK, Pradhan UK, Sahoo S, Meena RS, Nogiya M, Meena RL, Singh RS, Singh SK and Dwivedi BS (2023). Prediction of soil inorganic carbon at multiple depths using quantile regression forest and digital soil mapping technique in the Thar desert regions of India. *Communications in Soil Science and Plant Analysis*, **54(21)**, 2977-2994. https://krishi.icar.gov.in/jspui/handle/123456789/82099

112. Mondal S, Chakraborty D, Paul RK, Mondal A and Ladha JK (2023). No-till is more of sustaining the soil than a climate change mitigation option. *Agriculture, Ecosystems and Environment*, **352**, 108498.

113. Murmu S and Archak S (2023). In-silico study of protein-protein interactions in wheat blast using docking and molecular dynamics simulation approach. *Journal of Biomolecular Structure and Dynamics,* 1-11. https://doi.org/10.1080/07391102.2023.2228907

114. Nagrale DT, Chaurasia A, Kumar S, Gawande SP, Hiremani NS, Shankar R, Gokte-Narkhedkar N, Renu and Prasad YG (2023). PGPR: the treasure of multifarious beneficial microorganisms for nutrient mobilization, pest biocontrol and plant growth promotion in field crops. *World Journal of Microbiology Biotechnology*, **39(4)**, 100.

115. Nagre K, Singh N, Ghoshal C, Tandon G, Iquebal MA, Nain T, Bana RS and Meena A (2023). Probing the potential of bioactive compounds of millets as an inhibitor for lifestyle diseases: molecular docking and simulation-based approach. *Frontiers in Nutrition*, **10**, 1228172.

116. Nigam MS, Kumar S, Marwaha S and Chandra MS (2023). Paddy leaf disease classification using ResNet-50 integrated with canny edge detection mechanism. *AMA Agricultural Mechanization in Asia, Africa and Latin America*, **54(12),** 16627-16641. https://krishi.icar.gov.in/jspui/handle/123456789/81097

117. Nigam S, Jain R, Marwaha S, Arora A, Haque MA, Dheeraj A and Singh VK (2023). Deep transfer learning model for disease identification in wheat crop. *Ecological Informatics*, **75**, 102068. http://krishi.icar.gov.in/jspui/handle/123456789/76881

118. Padmanabha K, Choudhary H, Mishra GP, Mandal B, Solanke AU, Mishra DC and Yadav RK (2024). Identifying new sources of resistance to tomato leaf curl New Delhi virus from Indian melon germplasm by designing an improved method of field screening. *Genetic Resources and Crop Evolution,* **71***,* 1911-1933*.* https://doi.org/10.1007/s10722-023-01744-z

119. Parihar AK, Singh D, Lamichaney A, Singh AK and Dixit GP (2022). Assessment of extra early field pea (*Pisum sativum* L.) genotypes performance using GGE biplot. *Indian Journal of Genetics and Plant Breeding*, **82(4)**, 440-447. https://doi.org/10.31742/ISGPB.82.4.7

120. Paul NC, Rai A, Ahmad T, Biswas A and Sahoo PM (2023). GWR-assisted integrated

estimator of finite population total under two-phase sampling: a model-assisted approach. *Journal of Applied Statistics*. http://krishi.icar.gov.in/jspui/handle/123456789/80916

121. Paul NC, Rai A, Ahmad T, Biswas A and Sahoo PM (2023). Spatial approach for the estimation of average yield of cotton using reduced number of crop cutting experiments. *Current Science*, **125(5),** 518-529. https://krishi.icar.gov.in/jspui/handle/123456789/80864

122. Paul NC, Rai A, Ahmad T, Biswas A and Sahoo PM (2024). Spatially integrated estimator of finite population total by integrating data from two independent surveys using spatial information. *Journal of the Korean Statistical Society*, **53**, 222-247. https://krishi.icar.gov.in/jspui/handle/123456789/81274

123. Paul RK, Das T and Yeasin M (2023). Ensemble of time series and machine learning model for forecasting volatility in agricultural prices. *National Academy Science Letter,* 46(3), 185-188.

124. Paul RK, Yeasin M, Kumar P, Paul AK and Roy HS (2023). Deep learning technique for forecasting the price of cauliflower. *Current Science*, **124(9)**, 1065-1073.

125. Prabhakaran P, Hebbani AV, Menon SV, Paital B, Murmu S, Kumar S, Singh MK, Sahoo DK and Desai PPD (2023). In silico generation of novel ligands for the inhibition of SARS-CoV-2 main protease (3CLpro) using deep learning. *Frontiers in Microbiology*, **14,** 1194794.

126. Pradhan AK, Budhlakoti N, Mishra DC, Prasad P, Bhardwaj SC, Sareen S, Sivasamy M, Jayaprakash P, Geetha M, Nisha R, Shajitha P, Peter J, Kaur A, Kaur S, Vikas VK, Singh K and Kumar S (2023). Identification of novel QTLs/ defense genes in spring wheat germplasm panel for seedling and adult plant resistance to stem rust and their validation through KASP marker assays. *Plant Disease*, **107(6),** 1847-1860.

127. Pradhan UK, Meher PK, Naha S, Pal S, Ajit and Parsad R (2023). PlDBPred: A novel computational model for discovery of DNA binding proteins in plants. *Briefings in Bioinformatics*, **24 (1)**, bbac483. http://krishi.icar.gov.in/jspui/handle/123456789/75819

128. Pradhan UK, Meher PK, Naha S, Pal S, Gupta S, Gupta A and Parsad R (2023). RBPLight: a computational tool for discovery of plant-specific RNA-binding proteins using light gradient boosting machine and ensemble of evolutionary features. *Briefings in Functional Genomics*, elad016. https://doi.org/10.1093/bfgp/elad016

129. Pradhan UK, Meher PK, Naha S, Rao AR and Gupta A (2023). ASLncR: a novel computational tool for prediction of abiotic stress-responsive long non-coding RNAs in plants. *Functional & Integrative Genomics*, **23(2)**, 113. https://doi.org/10.1007/s10142-023-01040-0

130. Pradhan UK, Meher PK, Sanchita N, Sharma NK, Agarwal A, Gupta A and Parsad R (2023). DBPMod: a supervised learning model for computational recognition of DNA-binding proteins in model organisms. *Briefing in Functional Genomics*, elad039. https://krishi.icar.gov.in/jspui/handle/123456789/81076

131. Pramanik R and Alam MW (2023). Evaluating forecast performance of GARCH model on weekly price of onion. *Journal of Crop and Weed*, **19(1)**, 01-07.

132. Pramanik R, Alam MW, Singh KN, Ray M, Naya H, Kuma RR and Chaturvedi KK (2023). A comparative study of advance forecasting models on volatile time series price data. *Journal of the Indian Society of Agricultural Statistics*, **77(2),** 1–16.

133. Prema P, Bangar YC, Sharma VB, Kumar S, Kumar D and Verma MR (2023). Estimating heterogeneity and pooled prevalence of classical swine fever in pigs in India: A meta-analysis. *Indian Journal of Animal Research*, **57(9)**, 1221-1226.

134. Priyadarshi MB, Sharma A, Chaturvedi KK, Bhardwaj R, Lal SB, Farooqi MS, Kumar S and Mishra DC (2022). Comparing various machine learning algorithms for sugar prediction in chickpea using near-infrared spectroscopy. *Legume Research*, **46(2)**, 451-456.

135. Priyadarshini S, Arora A, Jain R, Marwaha S, Bharadwaj A, Rao AR and Pal S (2022). Application of STUCCO algorithm for finding contrast sets for agricultural datasets. *Journal of the Indian Society of Agricultural Statistics*, **76(2)**, 85–92.

136. Priyanka PS, Sangeetha V, Venkatesh P, Lenin V, Muralikrishnan L and Jha GK (2023). Assessing farmers' knowledge towards agri-

nutrition (A2N) in Uttar Pradesh and Telangana: A psychometric test development and impact analysis. *Agricultural Mechanization in Asia*, **54(10)**, 15927.

137. Puneeth PV, Yadav RK, Lata S, Iquebal MA, Tomar BS, Choudhary H, Tomar A, Sharma PK and Jaiswal S (2023). Development and validation of novel SSR markers using transcriptome data in okra (*Abelmoschus esculentus* L.)- A genetically orphan crop. *Indian Journal of Genetics and Plant Breeding*, **83(1)**, 95-102.

138. Raghavendra KJ, Kumar S, Kar A, Kumar P, Singh R, Arya P and Kumar TK (2023). Awareness and determinants of farmers' participation in e-marketing of agricultural commodities in India. *Indian Journal of Extension Education*, **59(4)**, 161-164.

139. Rani SU, Kumar P, Singh NP, Srivastava SK, Paul RK, Padaria RN, Kishore MR, Naik BN and Tadigiri S (2023). Impact of Krishi Bhagya Yojana (KBY) farm pond technology on semi-arid farmers in north eastern transition zone of Karnataka state in India. *International Journal of Environment and Climate Change*, **13(11)**, 2697-2706. https://krishi.icar.gov.in/jspui/handle/123456789/82095

140. Rani SU, Kumar P, Singh NP, Srivastava SK, Paul RK, Padaria RN, Tadigiri S, Naik BN, Rani N and Kishore MR (2023). Farmers' perception and efficacy of adaptation strategies to climate change in North Eastern transition zone of Karnataka state in India. *International Journal of Environment and Climate Change*, **13(12)**, 545-558. https://krishi.icar.gov.in/jspui/handle/123456789/82096

141. Rasal KD, Dixit S, Swain PP, Siriyappagouder P, Kumar R, Iquebal MA, Vasam M, Debbarma J, Jaiswal S, Angadi UB, Rai A, Kumar D and Sundaray JK (2023). Identification of host-specific skin-mucus and gut microbiota in snakehead murrel (*Channastriata*) (Bloch, 1793) using metagenomics approach. *Journal of Applied Biology & Biotechnology,* **11(5)**, 70-80.

142. Ravisankar N, Ansari MA, Shamim M, Prusty AK, Singh R, Panwar AS, Dutta D, Bhaskar S, Bindu JS, Mothkur TS, Kaur J, Varghese C, Dash S, Bhowmik A and Bal SK (2022). Sustainable livelihood security of small farmers improved through resilient farming systems in the semi-arid region of India. *Land Degradation and Development*, **33(15)**, 2830-2842. http://krishi.icar.gov.in/jspui/handle/123456789/72413

143. Ray A, Gadratagi BG, Budhlakoti N, Rana DK, Adak T, Govindharaj GP, Patil NB, Mahendiran A and Rath PC (2023). Functional response of an egg parasitoid, *Trichogramma chilonis* Ishii to sublethal imidacloprid exposure. *Pest Management Science*, **79(10)**, 3656-3665.

144. Ray M, Singh KN, Pal S, Saha A, Sinha K and Kumar RR (2023). Rainfall prediction using time-delay wavelet neural network (TDWNN) model for assessing agro-meteorological risk. *Journal of Agrometeorology*, **25(1)**. https://doi.org/10.54386/jam.v25i1.1895

145. Ray S, Lama A, Mishra P, Biswas T, Das SS and Gurung B (2023). An ARIMA-LSTM model for predicting volatile agricultural price series with random forest technique. *Applied Soft Computing*, **149**, 110939. https://doi.org/10.1016/j.asoc.2023.110939

146. Renjini VR, Jha, GK and Kathayat B (2023). Pushing for self-sufficiency in edible oils in India in the aftermath of recent global events. *National Academy Science Letter*, **46(6)**, 483-86.

147. Roy A, Marwaha S, Mishra DC and Chinnusamy V (2023). Development of a Genome-phenome Browser for Rice Cultivars. *International Journal of Plant & Soil Science*, **35(14)**, 269-277.

148. Sachan H, Islam SN, Misra S, Marwaha S, Haque A, Kumar M and Pal S (2023). Identification of weeds in wheat crop using artificial intelligence techniques. *International Journal of Environment and Climate Change*, **13(11)**, 4077-4083.

149. Saha A, Singh KN, Gurung B, Lama A, Rathod S and Shekhawat R (2023). Robust estimation of single exponential smoothing through Kalman filter: an application to agricultural and allied commodities. *Journal of Indian Society of Agricultural Statistics*, **77(2)**, 201-207.

150. Saha B, Biswas A, Ahmad T and Paul NC (2023). Geographically weighted regression-based model calibration estimation of finite population total under geo-referenced complex

surveys. *Journal of Agricultural, Biological, and Environmental Statistics*. https://doi.org/10.1007/s13253-023-00576-9

151. Saha S, Sharma N, Burman RR, Sinha PK, Joshi P and Ramasubramanian V (2023). Analysing attitude of the farmers towards IARI Pusa extension approaches. *Journal of Extension Education*, **23(1)**, 23-29.

152. Saini S, Burman RR, Padaria RN, Mahra GS, Bishnoi S, Aditya K, Nithyashree ML, Mallick S, Mukherjee S and Padhan SR (2023). Mapping the research trends of migration behaviour in agricultural households: a bibliometric analysis. *Frontiers in Sustainable Food Systems*, **7**, 1241716.

153. Samal I, Bhoi TK, Majhi PK, Murmu S, Pradhan AK, Kumar D, Saini V, Paschapur AU, Raj MN, Ankur, Manik S, Behera PP, Mahanta DK, Komal J, Alam P and Balawi TA (2023). Combatting insects mediated biotic stress through plant associated endophyticentomopathogenic fungi in horticultural crops. *Frontiers Plant Science*, **13**. https://doi.org/10.3389/fpls.2022.1098673

154. Samal I, Bhoi TK, Raj MN, Majhi PK, Murmu S, Pradhan AK, Kumar D, Paschapur AU, Joshi DC and Guru PN (2023). Underutilized legumes: nutrient status and advanced breeding approaches for qualitative and quantitative enhancement. *Frontiers in Nutrition*, **10**.

155. Santhy V, Balasubramani G, Biswas A, Santosh HB, Puttawar M, Raut P, Waghmare VN and Prasad YG (2023). Determination of minimum sample size for testing proportion of non-Bt seeds under refuge-in-bag (RIB) for Bt cotton. *Environment, Development and Sustainability*. https://doi.org/10.1007/s10668-023-04188-8

156. Sareen S, Budhlakoti N, Mishra KK, Bharad S, Potdukhe NR, Tyagi BS and Singh GP (2023). Resilience to terminal drought, heat, and their combination stress in wheat genotypes. *Agronomy*, **13(3)**, 1-17.

157. Sarkar A, Maity PP, Ray M, Chakraborty D, Das B and Bhatia A (2022). Inclusion of fractal dimension in four machine learning algorithms improves the prediction accuracy of mean weight diameter of soil. *Ecological Informatics*, **74**, 101959. https://doi.org/10.1016/j.ecoinf.2022.101959

158. Sarkar KA, Jaggi S, Bhowmik A, Varghese E, Varghese C, Datta A and Dalal A (2022). Trend resistant general efficiency balanced block designs for two disjoint sets of treatments. *REVSTAT-Statistical Journal*. http://krishi.icar.gov.in/jspui/handle/123456789/79407

159. Sarker P, Basak P, Panda CS, Gupta DS, Ray M and Mitra S (2023). Prediction of major pest incidence in jute crop based on weather variables using statistical and machine learning models: A case study from West Bengal. *Journal of Agrometeorology*, **25(2)**, 305-311.

160. Saxena R, Pant DK, Sharma P, Paul RK and Kumar R (2023). Sustaining long-term agricultural exports from India. *Current Science*, **125(10)**, 1109-1115. https://krishi.icar.gov.in/jspui/handle/123456789/82825

161. Sharma D, Kumari A, Sharma P, Singh A, Sharma A, Ahmad MZ, Kumar U, Jan S, Parthiban M, Rouf MR, Bhati P, Pradhan AK, Yadav A, Mishra DC, Budhlakoti N, Yadav MC, Gaikwad KB, Singh AK, Singh GP and Kumar S (2023). Meta QTL analysis in wheat: progress, challenges and opportunities. *Theoretical and Applied Genetics*, **136 (12)**, 247. https://doi.org/10.1007/s00122-023-04490-z.

162. Sharma NK, Singh P, Saha B, Bhardwaj A, Iquebal MA, Pal Y, Nayan V, Jaiswal S, Giri SK, Legha RA, Bhattacharya TK, Kumar D and Rai A (2023). Genome wide copy number variations in Bhutia equine breed using SNP genotyping data. *Indian Journal of Animal Sciences*, **93(8)**, 802-805.https://doi.org/10.56093/ijans.v93i8.136161

163. Sharma S, Archak S, Majumdar S, Mishra DC and Rai A (2022). Comparison of supervised machine learning techniques in classifying vitamin biosynthesis genes. *Journal of the Indian Society of Agricultural Statistics*, **76(3)**, 141–146.

164. Sharma T, Das TK, Maity PP, Biswas S, Sudhishri S, Govindasamy P, Raj R, Sen S, Singh T, Paul AK, Roy A, Babu S and Rathi N (2023). Long-term conservation agriculture influences weed diversity, water productivity, grain yield, and energy budgeting of wheat in north-western Indo-Gangetic plains. *Sustainability*, **15(9)**, 7290. https://doi.org/10.3390/su15097290

165. Sikka P, Paul SS, Jerome A, Mishra DC, Chaturvedi KK, Singh I and Rai A (2023). Functional genes in relation to residual feed intake in Murrah buffalo Heifers. *Advances in Bioscience and Biotechnology*, **14(4)**, 210-236. https://doi.org/10.4236/abb.2023.144014

166. Sikka P, Singh KP, Singh I, Balhara A, Chaturvedi KK, Andonissamy J, Mishra DC, Rao AR, Paul SS and Rai A (2023). Whole blood transcriptome in lactating Murrah buffaloes divergent to contrasting genetic merits for milk yield. *Frontiers in Animal Science*, **4**, 1135429. https://doi.org/10.3389/fanim.2023.1135429

167. Singh AK, Sagar VR and Kumar R (2022). Effect of pasteurization methods on physicochemical constituents and optimization of blends for anthocyanin rich guava nectar. *Annals of Plant and Soil Research*, **24(4)**, 529-535.

168. Singh AK, Sethi S, Asrey and Kumar R (2023). Influence of hot water treatment on nutritional quality attributes of cold stored apple (*Malus domestica*). *Indian Journal of Agricultural Sciences*, **93(9)**, 1025-1031.

169. Singh D, Basak P, Kumar R and Ahmad T (2023). On the methodological framework of composite index under complex surveys and its application in development of food consumption index for India. *Frontiers in Applied Mathematics and Statistics*, **9**. https://doi.org/10.3389/fams.2023.1274530

170. Singh D, Sharma NL, Singh D, Siddiqui MH, Taunk J, Sarkar SK, Rathore A, Singh CK, Al-amri AA, Alansi S, Ali HM and Rahman MA (2023). Exogenous hydrogen sulfide alleviates chromium toxicity by modulating chromium, nutrients and reactive oxygen species accumulation, and antioxidant defence system in mungbean (*Vigna radiata* L.) seedlings. *Plant Physiology and Biochemistry*, **200**, 107767. https://doi.org/10.1016/j.plaphy.2023.

171. Singh DP, Bisen MS, Prabha R, Maurya S, Yerasu SR, Shukla R, Tiwari JK, Chaturvedi KK, Farooqi MS, Srivastava S, Rai A, Sarma BK, Rai N, Singh PM, Behera TK and Farag MA (2023). Untargeted metabolomics of *Alternaria solani*-challenged wild tomato specie*s Solanum cheesmaniae* revealed key metabolite biomarkers and insight into altered metabolic pathways. *Metabolites*, **13(5)**, 585. https://doi.org/10.3390/metabo13050585.

172. Singh KN, Kumar RR and Ray M (2023). Wavelet Extreme Learning Machine (W-ELM) Model for drought index forecasting. *Journal of the Indian Society of Agricultural Statistics*, **77(2),** 31-38.

173. Singh KN, Ray M, Satyapriya, Dahiya S, Pandey J and Kumar RR (2023) Genetic algorithms-based fuzzy analytical hierarchical process (GA-FAHP) for evaluating biofortified crop promotion strategies. *Current Science*, **125(3)**, 317-320.

174. Singh KN, Sharma K, Avinash G, Kumar RR, Ray M, Ramasubramanian V, Lama A and Lal SB (2023). LSTM based stacked autoencoder approach for time series forecasting. *Journal of the Indian Society of Agricultural Statistics*, **77(1),** 71-78.

175. Singh R, Sahoo PM, Rai A and Ahmad T (2023). Applications of remote sensing and GIS in crop surveys: An IASRI perspective. *Journal of the Indian Society of Agricultural Statistics*, **77(1)**, 49-57.

176. Singh SK, Singh R, Singh SK, Iquebal MA, Jaiswal S and Rai PK (2023). Prevalence of obesity in newly onset diabetes mellitus and its relationship with uric acid: an Indian cross-sectional study. *International Journal of General Medicine*, **16**, 1217-1226. https://doi.org/10.2147/IJGM.S402683

177. Sinha D, Dasmandal T, Paul K, Yeasin M, Bhattacharjee S, Murmu S, Mishra DC, Pal S, Rai A and Archak S (2023). MethSemble-6mA: An ensemble-based 6ma prediction server and its application on promoter region of LBD gene family in poaceae. *Frontiers in Plant Science*, **14**, 1256186. https://doi.org/10.3389/fpls.2023.1256186

178. Sinha D, Dasmandal T, Yeasin M, Mishra DC, Rai A and Archak S (2023). EpiSemble: A novel ensemble-based machine-learning framework for prediction of DNA N6-methyladenine sites using hybrid features selection approach for crops. *Current Bioinformatics*, **18(7)**, 587-597.

179. Soam SK, Srinivasa RN, Yasjavanth BS, Balasani R, Rakesh S, Marwaha S, Kumar P and Agrawal RC (2023). AHP Analyser: A decision making tool for prioritizing climate change mitigation options and forest management. *Frontiers in Environmental*

Science, **10**, 1099996. https://doi.org/10.3389/fenvs.2022.1099996

180. Sonkusale L, Chaturvedi KK, Sharma A, Lama A, Farooqi MS, Lal SB, Joshi P, Mishra DC and Kumar M (2023). Evaluating text preprocessing methods for discovering quality topics to improve the information retrieval mechanism. *ACTA Scientific Computer Sciences*, **5(9)**, 03-08.

181. Sowndarya CA, Dahiya S, Bharadwaj A, Marwaha S and Parsad R (2022). Publication recommendation system for scientific community in agriculture. *Journal of the Indian Society of Agricultural Statistics*, **76(3)**, 179-184. https://krishi.icar.gov.in/jspui/handle/123456789/767015.5144

182. Srinivasa AK, Praveen KV, Padmaja SS, Nithyashree ML and Jha GK (2023) Does a farmer's knowledge of minimum support price affect the farm-gate price? Evidence from India. *Journal of Economics and Development*, **25(4)**, 302-316. https://doi.org/10.1108/JED-04-2023-0079

183. Srivastav M, Radadiya N, Ramachandra S, Jayswal P, Singh N, Singh S, Mahato AK, Gupta A, Devi R, Subrayagowda SH, Kumar G, Prakash P, Singh S, Sharma N, Nagaraja A, Kar A, Gaur RS, Sethi S, Tandon G, Jaiswal S, Iquebal MA, Singh R, Singh SK and Singh NK (2023). High resolution mapping of QTLs for fruit color and firmness in Amrapali/Sensation mango hybrids. *Frontiers in Plant Science*, **17**. https://doi.org/10.3389/fpls.2023.1135285

184. Stephen SK, Yadav VK and Kumar RR (2022). Comparative study of statistical and machine learning techniques for fish production forecasting in Andhra Pradesh under climate change scenario. *Indian Journal of Geo Marine Sciences*, **51(09),** 776-784. https://doi.org/10.56042/ijms.v51i09.2337

185. Tara KK, Choudhary H, Yadav RK, Kumari J, Mishra DC and Shankar K (2023). Deciphering genetic variation in melon (*Cumis melo* L.) using morphological characters. *Vegetable Science*, **50(1)**:104-109.

186. Srivastav S, Michael M, Craig MCJ, Anil R, Chaturvedi KK, Angadi UB, Mishra CD and Rai SN (2023). Advanced multivariable statistical analysis interactive tool for handling missing data and confounding covariates for label-free LC-MS proteomics experiments. *Current Bioinformatics*, **18(5)**. https://dx.doi.org/10.2174/1574893618666230223150253

187. Taria S, Arora A, Krishna H, Manjunath KK, Meena S, Kumar S, Singh B, Krishna P, Malakondaiah AC, Das R and Alam B (2023). Multivariate analysis and genetic dissection of staygreen and stem reserve mobilisation under combined drought and heat stress in wheat (*Triticum aestivum* L.). *Frontiers in Genetics*, **14**, 1242048.https://doi.org/10.3389/fgene.2023.1242048

188. Thakur NS, Dimri U, Mondal DB, Ensha Lomiya MA, Kavitha K and Verma MR (2023). Evaluation of antioxidant potential of vitamin D3 in geriatric dogs. *The Pharma Innovation Journal*, SP-**12(11)**, 1463-1468.

189. Tyagi R, Paul A, Raj VS, Ojha KK, Kumar S, Panda AK, Chaurasia A and Yadav MK (2023). A drug repurposing approach to identify therapeutics by screening pathogen box exploiting SARS-CoV-2 main protease. *Chemistry & Biodiversity,* **20(2)**, e202200600. https://doi.org/10.1002/cbdv.202200600

190. Upadhyay D, Budhlakoti N, Kumari J, Chaudhary N, Padaria JC, Sareen S and Kumar S (2023). In-silico characterization of drought stress related WRKY2 transcription factor in wheat crop (*Triticum aestivum* L.): study of its physico-chemical properties and structural dynamics. *Genetic Resources and Crop Evolution*, **1-12**. https://doi.org/10.1007/s10722-023-01706-5

191. Upadhyay D, Budhlakoti N, Mishra DC, Kumari J, Gahlaut V, Chaudhary N, Padaria JC, Sareen S and Kumar S (2023). Characterization of stress-induced changes in morphological, physiological and biochemical properties of Indian bread wheat (*Triticum aestivum* L.) under deficit irrigation. *Genetic Resources and Crop Evolution,* **70**, 2353-2366. https://doi.org/10.1007/s10722-023-01693-7

192. Upadhyay PK, Singh VK, Rajanna GA, Dwivedi BS, Dey A, Singh RK, Rathore SS, Shekhawat K, Babu S, Singh T, Kumar Y, Singh C, Rangot M, Kumar A, Sarkar S, Dash S and Rawat S (2023). Unveiling the combined effect of nano fertilizers and conventional fertilizers on crop productivity, profitability, and soil well-being. *Frontiers in Sustainable Food Systems*, **7**. http://krishi.icar.gov.in/jspui/handle/123456789/80562

193. Varma M, Lama A, Singh KN and Gurung B (2023). Evaluating the performance of crop yield forecasting models coupled with feature selection in regression framework. *Current Science*, **125(6)**, 649-654.

194. Varshney N, Kashyap D, Behra SK, Saini V, Chaurasia A, Kumar S and Jha HC (2023). Predictive profiling of gram-negative antibiotics in CagA oncoprotein inactivation: a molecular dynamics simulation approach. *SAR and QSAR in Environmental Research*, **34(6)**, 501-521. https://doi.org/10.1080/1062936X.2023.2230876

195. Varshney N, Murmu S, Baral B, Kashyap D, Singh S, Kandpal M, Bhandari V, Chaurasia A, Kumar S and Jha HC (2023). Unraveling the aurora kinase A and Epstein Barr virus nuclear antigen 1 axis in Epstein Barr virus associated gastric cancer. *Virology*, **588**, 109901. https://doi.org/10.1016/j.virol.2023.109901

196. Vasisth P, Singh N, Limbalkar OM, Sharma M, Gokulan D, Meena ML, Jain P, Jaiswal S, Iquebal MA, Watts A, Gaikwad KB and Singh R (2023). Introgression of heterotic genomic segments from *Brassica carinata* into *Brassica juncea* for enhancing productivity. *Plants*, **12(8)**, 1677. https://doi.org/10.3390/plants12081677

197. Verma A, Jaggi S, Varghese E, Varghese C, Bhowmik A, Datta A and Hemavathi M (2023). On the construction of mixed-level rotatable response surface designs when experimental unit experiences overlap effects. *Communications in Statistics - Simulation and Computation*, **52(5)**, 1753-1768. http://krishi.icar.gov.in/jspui/handle/123456789/46261

198. Vinay ND, Matsumura H, Munshi AD, Ellur RK, Chinnusamy V, Singh A, Iquebal MA, Jaiswal S, Jat GS, Panigrahi I, Gaikwad AB, Rao AR, Dey SS and Behera TK (2023). Molecular mapping of genomic region and identification of possible candidate genes associated with gynoecious sex expression in bitter gourd. *Frontiers in Plant Science,* **14**. https://doi.org/10.3389/fpls.2023.1071648

199. Vinayak and Parsad R (2023). Resolvable and 2-Replicate PBIB designs based on higher association schemes using polyhedra. *Statistics and Applications*, **21(2)**, 141-154. http://krishi.icar.gov.in/jspui/handle/123456789/80950

200. Vinaykumar LN, Varghese C, Harun M and Karmakar S (2023). Resolvable dichotomized split-set PBIB designs. *Journal of the Indian Society of Agricultural Statistic*s, **77(2)**, 209-215. http://krishi.icar.gov.in/jspui/handle/123456789/80779

201. Vinaykumar LN, Varghese C, Jaggi S, Harun M, Karmakar S, Anbukkani P and Dahiya S (2023). A new series of efficient partially balanced incomplete block designs with minimal replications. *Journal of Community Mobilization and Sustainable Development*, **18(1)**, 299-303. http://krishi.icar.gov.in/jspui/handle/123456789/77046

202. Vinaykumar LN, Varghese C, Jaggi S, Varghese E, Harun M, Karmakar S and Kumar D (2023). A method of constructing p-rep designs. *Bhartiya Krishi Anusandhan Patrika*, **38(3)**, 223-226. http://krishi.icar.gov.in/jspui/handle/123456789/80648

203. Vinaykumar LN, Varghese V, Harun M and Karmakar S (2023). Minimally replicated PBIB designs for multi-environmental trials. *Communications in Statistics-Theory and Methods,* **53(13)**, 4696–4716.

204. Waghaye AM, Singh DK, Sarangi A, Sena DR, Sahoo RN and Sarkar SK (2023). Identification of suitable zones and sites for rainwater harvesting using GIS and multicriteria decision analysis. *Environmental Monitoring and Assessment*, **195**. https://krishi.icar.gov.in/jspui/handle/123456789/75550

205. Yadav AK, Singh CK, Kalia RK, Mittal S, Wankhede DP, Kakani RK, Ujjainwal S, Akash, Saroha A, Natahawat NS, Rani R, Panchariya P, Choudhary M, Solanki K, Chaturvedi KK, Archak S, Singh K, Singh GP and Singh AK (2023). Genetic diversity, population structure, and genome-wide association study for the flowering trait in a diverse panel of 428 moth bean (*Vigna aconitifolia*) accessions using genotyping by sequencing. *BMC Plant Biology*. **23**, 228.

206. Yadav B, Malav LC, Singh SV, Kharia SK, Yeasin M, Singh RN, Nogiya M, Meena RL, Moharana PC, Kumar N and Sharma RP (2023). Spatiotemporal responses of vegetation to hydroclimatic factors over Arid and Semi-arid Tropical climate. *Sustainability*, **15(21)**, 15191. https://doi.org/10.3390/su152115191

207. Yadav KK, Dash S, Mandal BN and Parsad R (2023). Row-column designs for two level factorial experiments. *Journal of the Indian Society of Agricultural Statistics*, **77(2),** 233-236. http://krishi.icar.gov.in/jspui/handle/123456789/80562

208. Yadav R, Jaiswal S, Singhal T, Mahto RK, Verma SB, Yadav RK and Kumar R (2023). Potentials of genotypes, morpho-physio-biochemical traits, and growing media on shelf life and future prospects of gene editing in tomatoes. *Frontiers in Genome Editing*, **5,** 1203485. https://doi.org/10.3389/fgeed.2023.1203485

209. Yadav S, Yadava YK, Meena S, Singh L, Kansal R, Grover M, Nimmy MS, Bharadwaj C, Paul V, Gaikwad K and Jain PK (2023). The SPL transcription factor genes are potential targets for epigenetic regulation in response to drought stress in chickpea (*Cicer arietinum* L.). *Molecular Biology Reports*, **50(6)**, 5509-5517. https://doi.org/10.1007/s11033-023-08347-y

210. Yogi AK, Swaroop BR, Godara S, Sangwan S, Choudhary AK, Nirmal RC, Bamboriya SD, Shivay YS, Singh D, Singh T, Yadav A, Nagar S and Singh N (2023). Elucidating the interactive impact of tillage, residue retention, and system intensification on pearl millet yield stability and biofortification under rainfed agroecosystems. *Frontiers in Nutrition*, **10**, 1205926. https://doi.org/10.3389/fnut.2023.1205926

Book Chapters

1. Arora A, Misra T, Kumar M, Marwaha S, Kumar S and Chinnusamy V (2023). Computer Vision Approaches for Plant Phenotypic Parameter Determination. In: *Digital Ecosystem for Innovation in Agriculture*. Eds. S. Chaudhary, C.M. Biradar, S. Divakaran, M.S. Raval. Studies in Big Data, Vol. 121. Springer, Singapore. https://doi.org/10.1007/978-981-99-0577-5_13

2. Banerjee R, Bharti, Das P, Srivastava V, Ankita Kataria S, Ahmed B and Varshney N (2023). An Overview of Statistical Techniques for Analysis of Data in Agricultural Research. In Emerging Issues in Agricultural Sciences Volume 8. Eds. Prof (Dr.) Abd Elmoneim Osman Elkhalifa. B P International, 27 Old Gloucester Street London WC1N 3AX, UK, pp. 190-206. https:// doi.org/10.9734/bpi/eias/v8/6853C

3. Das P, Banerjee R, Bharti, Rangi A and Varshney N (2023). An Overview of Data Analytics in Smart Agriculture. In: *Research and Reviews in Agriculture Science,* Volume IV, pp 14-30,(Eds. R. Dhankar, A. Sharma, M. Mangla and P. Dhanker), Bhumi Publishing India. ISBN: 978-93-95847-30-8.

4. Das R and Mishra DC (2023). Revolutionize One Health Through Quantum Computing. In: *Biotechnological Interventions Augmenting Livestock Health and Production*. Eds. C.S. Mukhopadhyay, R.K. Choudhary, H. Panwar and Y.S. Malik. Livestock Diseases and Management. Springer, Cham. ISBN 978-981-99-2208-6.https://doi.org/10.1007/978-981-99-2209-3_23.

5. Dheeraj A and Chand S (2022). Deep Learning Model for Automated Image Based Plant Disease Classification. In: *Proceedings of International Conference on Intelligent Vision and Computing* (ICIVC 2022). Eds. H. Sharma, A.K. Saha, M. Prasad (eds). ICIVC 2022. Proceedings in Adaptation, Learning and Optimization, Vol. 17. Springer, Cham. https://doi.org/10.1007/978-3-031-31164-2_3

6. Dheeraj A and Chand S (2022). Using Deep Learning Models for Crop and Weed Classification at Early Stage, Advances in Intelligent Systems and Computing. In: *Sentiment Analysis and Deep Learning*, Eds. S. Shakya, Ke-Lin Du, K. Ntalianis, Proceedings of ICSADL 2022, pp 931-942, Springer, Singapore.

7. Jain R, Nigam S, Kumasagi V, Shaloo Begam S and Saravanakumar R (2022). Technology Foresight: Anticipating Agricultural Applications. In: *Agri-base Technological Interventions for Entrepreneurship Development in Semi-Arid Zone* (Eds. R.K. Yogi, A.K. Sharma, Vinod Kumar, P.K. Rai, B. Renuka Rani and S.K. Jamanal), National Institute of Agricultural Extension Management (MANAGE), Hyderabad and ICAR-Directorate of Rapeseed Mustard Research, Bharatpur, India. ISBN: 978-93-91668-42-6.

8. Jaiswar A, Rai N, Arora D, Malhotra M, Jaiswal S and Iquebal MA (2023). Recent Advances in Genomics, Genetic Resources of Watermelon.

In: *The Watermelon Genome*. Eds. S.K. Dutta, P. Nimmakayala, U.K. Reddy. Compendium of Plant Genomes. Springer, Cham. ISBN 978-3-031-34715-3. https://doi.org/10.1007/978-3-031-34716-0_8

9. Jena RK, Moharana PC, Pradhan UK, Sharma GK, Ray P, Roy PD and Ghosh D (2023). Soil Fertility Mapping and Applications for Site-specific Nutrient Management – A Case Study. In: *Remote Sensing of Soils*: *Mapping, Monitoring, and Measurement*, pp 65-80, (Eds. S. Dharumarajan, S. Kaliraj, K. Adhikari, M. Lalitha and N. Kumar), ISBN: 9780443187735. https://doi.org/10.1016/B978-0-443-18773-5.00025-9

10. Kumar P, Paul RK, Roy HS, Yeasin M, Ajit and Paul AK (2023). Big Data Analysis in Computational Biology and Bioinformatics. In: *Reverse Engineering of Regulatory Networks*, pp 181-197, (Eds. S. Mandal). ISBN: 978-1-0716-3461-5. https://doi.org/10.1007/978-1-0716-3461-5_11.

11. Madhu, Singh A, Sinha D and Banavath SN (2023). Agricultural Insurance for Indian Farmers. In: *Research Trends in Multidisciplinary Research*, 49, pp 109-123, (Eds. R. Jayakumar, R.R. Duvvuru, A. Kumar and M.M. Laddunuri), AkiNik Publications, ISBN: 978-93-5570-932-5. https://doi.org/10.22271/ed.book.2509

12. Madhu, Banavath SN, Manasa S, Nigam S and Singh A (2023). Geographic Information Systems (GIS) and Its Applications. In: *Research Trends in Multidisciplinary Research*, 49, pp 125-150, (Eds. R. Jayakumar, R.R. Duvvuru, A. Kumar and M.M. Laddunuri), AkiNik Publications ISBN: 978-93-5570-932-5. https://doi.org/10.22271/ed.book.2509

13. Malhotra M, Jaiswar A, Shukla A, Rai N, Bedi A, Iquebal MA, Jiaswal S, Kumar D and Rai A (2023) Application of AI/ML Approaches for Livestock Improvement and Management. In: *Biotechnological Interventions Augmenting Livestock Health and Production*. Eds. C.S. Mukhopadhyay, R.K. Choudhary, H. Panwar and Y.S. Malik. Springer, Cham. ISBN 978-981-99-2208-6.https.doi.org/10.1007/978-981-99-2209-3

14. Marwaha S, Deb CK, Haque MA, Naha S and Maji AK (2023). Application of Artificial Intelligence and Machine Learning in Agriculture. In: *Translating Physiological Tools to Augment Crop Breeding*. Eds. M.H. Masthigowda, K. Gopalareddy, R. Khobra, G. Singh and G.P. Singh. Springer, Singapore. https://doi.org/10.1007/978-981-19-7498-4_21

15. Moharana PC, Jena RK, Yadav B, Naitam R, Kumar N, Pradhan UK and Sharma GK (2023). Digital Soil Mapping Algorithm for Soil Quality Assessment and Monitoring – A Case Study in Desert Ecosystem of India. In: *Remote Sensing of Soils: Mapping, Monitoring, and Measurement*, (Eds. S. Dharumarajan, S. Kaliraj, K. Adhikari, M. Lalitha and N. Kumar), ISBN: 9780443187735. https://doi.org/10.1016/B978-0-443-18773-5.00032-6

16. Pradhan UK and Meher PK (2023). Computational Prediction of RNA Binding Proteins: Features and Models. In *Bioinformatics and Computational Biology: Technological Advancements, Applications, and Opportuniti*es, (Eds. T.R. Singh, H. Saini, M.C. Junior), Chapman & Hall. ISBN: 9781032361581. https://www.routledge.com/Bioinformatics-and-Computational-Biology-Technological-Advancements-Applications/Singh-Saini-Junior/p/book/9781032361581

17. Rout AK, Das R, Mahanandia NC, Dey S, Parida SN, Mondal M, Panda SP, Jena R, Behera B and Behera BK (2023). Identifying Novel Antibiotic Resistance Genes (ARGs): Important Aspect of Metagenomic Research. In: *Biotechnological Tools in Fisheries and Aquatic Health Management,* pp 231-246, (Ed. B.K. Behera), Springer Nature, Singapore. ISBN: 978-9819929801. https://doi.org/10.1007/978-981-99-2981-8_12.

18. Singh K, Iquebal MA, Jaiswal S, Rai A, Kumar D (2023). Computational Genomics Approaches for Livestock Improvement and Management In: *Biotechnological Interventions Augmenting Livestock Health and Production*. Eds. C.S. Mukhopadhyay, R.K. Choudhary, H. Panwar and Y.S. Malik. Springer, Cham. ISBN 978-981-99-2208-6.

19. Varshney N, Ahmad T, Biswas A, Shrivastava A and Garde Y (2023). Adaptive Rectangular Sampling. In: *Research Trends in Mathematics and Statistics*. Eds. A.K. Bharti and V.K. Tripathi. AkiNik Publications, New Delhi, pp 119-138.

20. Varshney N, Ahmad T, Biswas A, Shrivastava A and Garde Y (2023). Resampling Methods of Variance Estimation in Two-Phase Sampling. In: *Research Trends in Mathematics and Statistics.* Eds. A.K. Bharti and V.K. Tripathi. AkiNik Publications, New Delhi, pp 139-160.

Edited Book/Proceedings

1. Special Proceedings of 25th Silver Jubilee (Annual) International Conference of the Society of Statistics, Computer and Application (SSCA)-2023 (Editors: V.K. Gupta, B.N. Mandal, R. Vishnu Vardhan, Ranjit Kumar Paul, Rajender Parsad and Dipak Roy Choudhary), pp1-215. ISBN: 978-81-950383-2-9. https://ssca.org.in/media/ 4_Combined_Volume_ Special_Proceedingds_2023__260923_ FINAL_Finally.pdf

2. RC Agrawal, Rajender Parsad, B Shamsiev, A Agrawal, S Marwaha, A Arora, A Bharadwaj and S Dahiya (2023) Proceedings and recommendations of the International Conference on Blended Learning Ecosystem for Higher Education in Agriculture' (ICBLE 2023), New Delhi, March 21-23, 2023. Indian Council of Agricultural Research, New Delhi, India. ISBN: No. 978-81-960628-8-0.

3. Action Taken Report, Agenda Notes & Status Report for XXVII Meeting of ICAR Regional Committee V held on April 27, 2023. (Editors: Ramasubramanian V, Anshu Bharadwaj, Prawin Arya, Susheel Kumar Sarkar, Ajit, Sanjeev Panwar, Rajender Parsad, Anil Kumar and R.C. Agrawal)

4. RC Agrawal, Rajender Parsad, B Shamsiev, A Agrawal, S Marwaha, A Arora, A Bharadwaj, S Dahiya, Ramasubramanian V, S Naha and Nikita (2023). Souvenir-International Conference on Blended Learning Ecosystem for Higher Education in Agriculture (ICBLE 2023). ICAR-Indian Agricultural Statistics Research Institute (ICAR-IASRI) and Project Implementation Unit, National Agricultural Higher Education Project (NAHEP), ICAR, New Delhi, 110012, India. https://icble2023.krishimegh.in/Uploads/Downloads/Souvenir%20_ICBLE%202023.pdf

Technical Bulletins

5. Ahmad T, Sahoo PM, Biswas A, Kumar R, Aditya K, Kumari V and Basak P (2023). Evaluation of Improvement of Agricultural Statistics Scheme. Technical Bulletin I.A.S.R.I./T.B.-01/2023. ICAR-IASRI, New Delhi.

6. Ahmad T, Sahoo PM, Biswas A, Kumar R and Singh D (2023). Evaluation of Comprehensive Scheme for studying Cost of Cultivation of Principal Crops. Technical Bulletin I.A.S.R.I./T.B.-02/2023. ICAR-IASRI, New Delhi.

Popular Articles

1. Agrawal RC, Parsad R, Agarwal A, Arora A, Marwah S, Ajit, Ramasubramanian V, Bharadwaj A, Dahiya S, Islam SN, Pal S, Naha S, Madhu and Godara S (2023). Pamphlet on Blended Learning Platform (Empowering Agricultural Higher Education Through Next-Generation Learning Solutions). ICAR-IASRI, New Delhi.

2. Banerjee R (2023). Integration of Agricultural Surveys: A Novel Approach to Improve Data Quality and Usability. *Times of Agriculture*-July Issue, 58-60. https://timesofagriculture.in/3d-flip-book/hydroponics-farming-july-issue-toa-magazine/

3. Chaurasia HS and Murmu S (2023). The Role of Artificial Intelligence in Image Classification for Agriculture. *Krishi Science* (KS-2900). ISSN:2583-4150

4. Devi, S., Bharti. (2023). Kuhl Irrigation System: a case study of Kangra Valley of Himachal Pradesh. *Times of Agriculture e-magazine*, 62-63.

5. Grover M, Mishra D and Jha GK (2023). Unlocking the Secrets of Nature with Physics-Informed Neural Networks. *Science Reporter*, A CSIR Publication, *pp* 48-50.

6. Grover M, Mishra DC, Chaturvedi KK and Jha GK (2023). Unveiling the Quantum Frontier in Agriculture. *Agriculture Today*, October issue, *pp* 48-49.

7. Madhu, Nigam A and Dheeraj A (2023) Artificial Intelligence in Agriculture: From Silicon to Soil. *Food and Scientific Reports*, **4(6)**, 27-32.

8. Mamta, Nidhi, Das R and Paul D (2023). Exploring Metagenomics for Gene Discovery and Potency of Growth-promoting Microbes in Agriculture. *Food and Scientific Reports*, **4(9)**,17-23. e-ISSN 2582-5437.

9. Nigam S, Jain R, Singh VK and Marwaha S (2023). Image-based Identification of Wheat Fungal Diseases using Artificial Intelligence. In: *Population Diversity, Pathogenomics and Development of Diagnostics of Emerging Fungal Plant Pathogens*, *pp*80-86 - A Training Manual, TB-ICN: 310/2023. Eds. Singh VK, Saharan MS, Kamil D, Bashyal BM and Gurjar MS. ICAR-IARI, New Delhi.

10. Pandey B, Murmu S and Saxena A (2023). Application of Data Science and Artificial Intelligence in Precision Livestock Farming: Application of Big data and AI in precision livestock. *Just Agriculture* (e-magazine). https://justagriculture.in/2023/july/publications.html.

सांख्यिकी विमर्श, भा.कृ.अनु.प.–भारतीय कृषि सांख्यिकी अनुसंधान संस्थान पत्रिका 2022 में प्रकाशित लेख

- शशि दहिया, सुदीप मारवाह, एन.के.जैन, ए. के. ब्यास, निहारिका। भारतीय कृषि अनुसंधान परिषद में मानव संसाधन प्रबंधन के लिए प्रबंधन सूचना प्रणाली, 11—16 ।

- अंकुर विश्वास, राजू कुमार, प्रदीप बसाक, दीपक सिंह, राहुल बनर्जी, भारती एवं पंकज दास। अनुकूली क्लस्टर प्रतिदर्शीकरण के अंतर्गत सहायक सूचना का उपयोग करते हुए परिमित जनसंख्या माध्य का अंशांकन अनुमानक, 17—25 ।

- दीपक सिंह, राहुल बनर्जी, भारती पंकज दास, समर्थ गोदारा, राजू कुमार, अंकुर विश्वास एवं कौस्तव आदित्य। प्रतिदर्श सर्वेक्षणों में परिमित समष्टि माध्य के अनुमानकों का एक बेहतर वर्ग, 26—30

- अनिंदित्ता दत्ता, सीमा जग्गी, सिनी वर्गीस, एल्ध्यो वर्गीज, अर्पण भौमिक, देवेन्द्र कुमार एवं मो. हारून। पशु परीक्षणों में नियंत्रण के साथ परीक्षण उपचारों की तुलना करने के लिए सामान्यीकृत पंक्ति–स्तंभ अभिकल्पना, 31—37 ।

- चंदन कुमार देव, अयोन तरफदार, मोहम्मद अशराफुल हक, सुदीप मारवाह, सुवर्णा भोज एवं ज्ञानेंद्र कुमार गौड़। कृत्रिम बुद्धिमत्ता (ए आइ) नियंत्रित प्रतिबिंब प्लेटफार्म में आधारित जीवित सुअर वजन अनुमान, 38—42 ।

- अलका अरोड़ा, संचिता नाहा, सौमेन पाल, सुदीप मारवाह एवं सौरभ कुमार। कृषि कल्याण अभियान III, 43—47 ।

- सारिका साहू, आलोक शिव, एवं सौम्या शर्मा। सकर्यूलर आरएनए: मूल अवधारणा और विभिन्न प्रक्रियाओं में उनकी भूमिका, 48—55 ।

- अमृत कुमार पॉल, हिमाद्रि शेखर रॉय, रणजीत कुमार पॉल, मो. यासीन, प्रकाश कुमार, एवं एस पी सिंह। सहसंबद्ध त्रुटियों के अंतर्गत हाफ–सिब मॉडल का उपयोग करके आनुवंशिकता का अनुमान, 56—69 ।

- आशुतोष दलाल, सिनी वर्गीस, मो. हारून एवं देवेन्द्र कुमार। आँकड़ों के रूपान्तरण तकनीकों का पुनरीक्षण, 70—75 ।

- सौमेन पाल, अलका अरोड़ा, सुदीप मारवाह, अजीत, आर. के. पॉल, एस एन इस्लाम, आर मालिक एवं पीटर क्राउफर्ड। कृषि विज्ञान केंद्र ज्ञान तंत्र पर फसलों के परिदृश्य नैदानिक सर्वेक्षण आँकड़ों की कल्पना, 76—84 ।

- रंजीत कुमार पॉल, अमृत कुमार पॉल, हिमाद्रि शेखर रॉय, मो. यासीन, प्रकाश कुमार एवं एस.पी. सिंह। दीर्घकाल अनुस्मरण समय श्रृंखला मॉडल का उपयोग करके सरसों की कीमत का पूर्वानुमान, 85—94 ।

- नेहा ताई वि. अगोशे, सिनी वर्गीस, मोहम्मद हारून एवं देवेन्द्र कुमार। परीक्षण अभिकल्पना में हैसे आरेख का अनुप्रयोग, 95—101 ।

8.

IRC, RAC, IMC and QRT

Institute Research Committee (IRC)

The Institute Research Committee (IRC) is an important forum to guide the scientists in the formulation of new research projects and it also prioritizes and reviews the progress of on- going research projects periodically. It also monitors the follow up action on the recommendations of the Quinquennial Review Team (QRT) and Research Advisory Committee (RAC) in respect of technical programmes of the Institute. Director, ICAR-IASRI is the Chairman and all scientists of the Institute are the members of IRC.

The 94th IRC meeting was held during September 22, 25-26 & October 03-04, 2023. Progress of 84 on-going research projects (29 Institute funded, 13 in collaboration with other organizations and 42 outside funded) were reviewed and 20 research projects were declared as complete in the 94th IRC meeting. Twenty-eight new research projects (15 Institute funded 06 in collaboration with other organizations and 07 outside funded) were approved and initiated during 93rd to 94th IRC period.

Research Advisory Committee (RAC)

The 22nd meeting of the Research Advisory Committee (RAC) was held on November 28, 2023. The meeting was Chaired by Professor Bikas K Sinha, Former Professor of Statistics, Indian Statistical Institute, Kolkata and Former Member, National Statistical Commission, Govt. of India. Professor K. Muralidharan, Professor, Department of Statistics, Faculty of Science, The Maharaja Sayajirao University of Baroda, Vadodara, Gujarat; Dr. Indrarnil Mukhopadhyay, Professor, Human Genetics Unit, Indian Statistical Institute, Kolkata (attended On-Line); Dr. Bimlesh Mann, Assistant Director General (Education Planning & Home Science), ICAR, New Delhi; Dr. Rajender Parsad, Director, ICAR-IASRI, New Delhi as Members also graced the occasion. Dr. Ajit as Member Secretary organized the meeting.

Dr Mausam, Professor, Jai Gupta Chair, Department of Computer Science and Engineering, IIT Delhi; (ii) Dr. Punam Bedi, Professor and Former Head of Department of Computer Science, University of Delhi, Delhi and (iii) Dr. Sitabhra Sinha, Institute of Mathematical Sciences, C.I.T Campus, Taramani, Chennai, all three members of RAC could not attend the meeting because of personal reasons. Head of Divisions and Professor of teaching disciplines were also present as invitees.

At the outset, Dr. Rajender Parsad, Director, ICAR-IASRI, welcomed all the members of RAC. Thereafter, Professor Bikas Sinha, Chairman welcomed all the members of the RAC and other invitee. Professor Sinha congratulated all scientists of the Institute to work in the direction of fulfilling the recommendations of last RAC. He emphasized that the research programs of the Institute are in accordance with the Government of India Programs. He further said that although few projects are linked with Sustainable Development Goals (SDGs), yet more emphasis should be laid on linking the research projects with SDGs.

Action taken report on the recommendations of 21st RAC meeting was presented by the Member Secretary. The research, education, training and developmental activities of the Institute were presented by Director, ICAR-IASRI along with genesis and growth of the Institute. He appraised that the Institute is catering to the needs of (i) National Agricultural Research and Education System (NARES); (ii) National Agricultural Statistics System (NASS); (iii) E-Governance activities of ICAR and simultaneously prove to peers on Basic Research in Statistical Sciences. He emphasized that efficient design of experiments, statistical methodologies, information systems/portals, bioinformatics tools developed by the Institute are widely being adopted in NARES, NASS and several African and Latin American countries. The contributions of the Institute in terms of human resource development were also presented. He also presented the significant research achievements of the Institute during last one year.

RAC members highly appreciated the contributions and achievements made by the Institute in all spheres of research, teaching, training, advisory services and e-governance services. From the day long deliberations, presentations and discussions on the research, teaching and training activities of the Institute, the following action points/ recommendations emerged:

- The Institute should conduct more refresher courses and training programmes for the teachers/faculty/researchers at SAUs and scientific colleagues from ICAR-Institutes to make them aware about the recent tools, techniques, and packages in the disciplines of

Agricultural Statistics, Computer Applications and Agricultural Bioinformatics.

- ICAR-IASRI has acquired the expertise to develop mobile apps, accordingly the Institute should collaborate/help the extension scientists of other Institutes/SAUs in developing commodity-specific mobile apps. AI enabled applications should be made as user friendly as possible.

- Research efforts on using remote-sensing-data in research studies should be strengthened. Efforts should also be made to take research projects on early forewarning systems for crops pests and diseases.

- E-courses developed and available on E-learning Portal and Agri-Diksha Web Channel should be advertised to reach out to more stakeholders.

- The Institute should plan online Hackathon on the topics related to Statistical Sciences.

- A Virtual Centre of excellence on AI be in place at the Institute.

- The Institute should initiate PG Diploma/Diploma Courses on Data-Science

Quinquennial Review Team (QRT)

The QRT usually reviews the progress of the Institute for preceding five-year period. The last QRT team reviewed the progress of the Institute during 01.04.2011 to 31.03.2018. The QRT submitted its report in the year 2020. Dr. G.C. Manna was the Chairman, and the members include Professor Rita Saha Ray, Dr. Ashish Kumar, Dr. N. Balakrishna, Dr. BVS Sisodia, Dr. Sridhar Sivasubbu and Dr. Hukum Chandra as Member Secretary.

The last QRT recommended that the mandate of Division of Statistical Genetics may be merged with Division of Agricultural Bioinformatics. This recommendation has been implemented with the concurrence of the Council (SMD). The QRT also recommended that a new Division should be created to focus on methodological improvement for Policy Research for Development. Tentative name for this Division can be "Analytics for Policy Research and Development". This has been discussed with all scientists of the Institute. Since there is already an Institute "National Institute of Agricultural Economics and Policy Research (NIAP)" under ICAR in the same campus, and our Institute is having several collaborative projects with NIAP, it was thought that giving direct name as "Analytics for Policy Research and Development" would be an overlap with the NIAP. As per discussions within the Institute, the new Division is proposed as "Division of Statistical Ecology and Environmental Statistics". Proposed mandate is to develop statistical techniques/algorithms pertaining to environmental and ecological research for sustainable agriculture and integrating them with machine learning. The proposal has been submitted to the Council (SMD) for concurrence and the approval of the same is under process. The constitution of the next QRT of the Institute is due in the year 2024. Diploma Course in data Science and Analytics has been approved. The proposal to initiate this course in 2024 has been sent to Graduate School, IARI, New Delhi.

Institute Management Committee

Two Non-Official Members representing rural/agricultural interest (namely Sh. Sombir Kodaan from District Jhajjar, Haryana and Sh. Aakash Rathi from Meerut, Uttar Pradesh) have been nominated to the Institute Management Committee (IMC) for a period of three years w.e.f. 30/05/2023 to 29/05/2026 vide FN:Agril.Edn.14(12)/2018-A&P(e32131) dated June 20, 2023.

9.

Conferences, Workshops, Webinars, Symposium, Meetings and Special Events Organized

Conference

ICBLE (International Conference on Blended Learning Ecosystem for Higher Education in Agriculture) 2023

ICAR-IASRI and PIU NAHEP organized the International Conference on Blended Learning Ecosystem for Higher Education in Agriculture during March 21- 23, 2023.The conference was jointly hosted by ICAR and the World Bank in hybrid mode. The conference and exhibition was inaugurated by the Honourable Minister of Agriculture and Farmers' Welfare, Shri Narendra Singh Tomar. In his Inaugural speech, Shri Tomar ji applauded ICAR and ICAR-IASRI's efforts to organize the first-of-its-kind conference on the blended learning ecosystem for higher education in agriculture. During the inaugural function RAES, the blended learning platform was released along with 75-lecture series, the latest Model Act amendment for Higher Agricultural Educational Institutions in India and new training modules for technical and administration staff.

A total of 3,412 participants (2,505 male and 907 female) registered for this conference, attending either in person or through online platforms. There were 222 personnel nominated form different State Agricultural Universities and Delhi based Institutions. 2,761 participants across the globe and PAN-India participated in the conference through online mode. There were 24 international participants, who joined in online/offline from 9 countries viz. Bangladesh, Malawi, Australia, Austria, USA, Netherlands, UK, Philippines, and Canada (from five continents viz. Europe, Asia, Australia, Africa, and North America).

Day 1: there was one plenary session and one panel discussion. The plenary session was dedicated to the discussion on *Modernization of Agricultural Education*. In the panel discussion, *the idea of exploring effective strategies of blended learning for higher education in Agriculture* was discussed.

Day 2: there were two plenary session and two panel discussions. The first plenary session was on the topic of *Blended Learning Through the Lens of Emerging Technologies*. The panel discussion was on the topic of *Making Agricultural Education*

Future Ready with 3 E's: Emerging Technologies, Employability and Entrepreneurship. This was followed by another panel discussion on the topic *Accelerating Digital Development through Effective Capacity Building and Change Management*. The last session for the day was another plenary session on the topic *Models and Studies on Blended Learning Ecosystem*.

Day 3: Two plenary sessions, one panel discussion and valedictory session were organized along with the release of Delhi Declaration. The plenary session was on the topic *Sustainable Digital Transformation in Education System*. The panel discussion on *Digital Transformation in Education Sector* saw an interesting exchange of ideas among various speakers. In the fifth and last Plenary session, discussions were held on *Blended Learning Ecosystem and Community Outreach*.

The valedictory session was graced by the presence of Dr. Auguste Tano Kouame, Country Director of the World Bank and Chaired by Dr. R.B. Singh. Dr. Trilochan Mohapatra, fomer Secretary, DARE and Director General, ICAR was the Guest of Honour. At the end the Delhi Declaration about the blended learning platform for higher education in agriculture was released.

Workshop/Symposium

- **Online Workshop on Farmer FIRST Programme:** One-Day online Workshop on 'FFP Portal and Mobile App' was organized on January 12, 2023 at ICAR-IASRI in which 130+ personnel participated. The demonstrations were made on FFP Portal and Mobile App. Dr. V.P. Chahal, ADG (Agricultural Extension) in his address appreciated the efforts made by the Institute FFP team and appealed all FFP centres to update timely information in the portal for its enrichment. Dr. Rajender Parsad, Director, ICAR-IASRI also provided his valuable suggestions for betterment of the portal as well as the Mobile App. He emphasized that efforts should be made to synchronize the information with KRISHI Portal. Dr. S.R.K. Singh, Director, ICAR-ATARI, Jabalpur and Dr. P.P. Rohilla, Nodal Officer, FFP, ICAR-ATARI, Jodhpur also emphasized on timely information uploading in the portal for the benefits of stakeholders.

- **4th Workshop on Applied Deep Learning:** The 4th Indian workshop on Applied Deep Learning (IWADL), hosted at Birla Institute of Technology and Science (BITS), Pilani, K.K. Birla, Goa campus from June 12-16, 2023, was organized jointly by BITS Pilani, Indian Institute of Technology (IIT), Mandi and ICAR-Indian Agricultural Statistics Research Institute (ICAR-IASRI) in a blended learning platform. It was an absolute game-changer! From sequences and natural language processing to deep reinforcement learning, and covered a wide range of cutting-edge topics. The agricultural community has seized this golden opportunity to enhance their knowledge through this incredible training program using NARES - Blended Learning Platform (NARES-BLP). NARES-BLP has successfully employed in this workshop. Professor Phalguni Gupta, Vice Chancellor, GLA University and Dr. Rajender Parsad, Director, ICAR-IASRI, New Delhi expressed their views about the importance of IWADL workshop and NARES-BLP during the inaugural session.

NARES-BLP enabled researchers, experts, and enthusiasts in the field of deep learning to explore and learn the subject in a cohesive environment. Prominent researchers from various institutions and companies, including IIT Mandi, IIT Delhi, IIT Kharagpur, International Institute of Information Technology (IIIT) Hyderabad, BITS Pilani, Harman DTS, Fujitsu, and Sahaj AI focuses on the application of different deep learning algorithms such as Convolutional Neural Networks (CNNs), Recurrent Neural Networks (RNNs), Autoencoders, Generative Adversarial Networks (GANs), Transformers, Diffusion models, and more. These architectures have shown great potential in addressing a wide range of problems in diverse domains such as agriculture, healthcare, finance, transportation, education, manufacturing, and entertainment. Dr. Suman Kundu, Director BITS Pilani, K.K. Birla Campus was the chief guest during the valedictory session. He emphasized greater collaboration among the participating institutions. A total of 203 participants across India from agriculture and general universities and industry, joined the training programme. Out of these 98 participants joined online through BLP and 105 participants joined in person. Fifteen faculty from BITS Pilani, IIT Mandi, IIT Delhi, IIT Kargpur, IIIT Hyderabad, Texas State University, Fujitsu, Sahaj AI and Herman delivered lectures in the training programme. Following are some of the highlights of the workshop: (i) The workshop was organized on the Main tenant of NARES-BLP (https://icarblp.krishimegh.in); (ii) For five days, 90+ Participants attended virtual/online classes of the IWADL workshop 2023 using the ICAR BLP; (iii) Three Assessments (Quiz 1, 2 and 3) were successfully conducted over the NARES-BLP. 190+ Participants successfully attempted assessment over the NARES-BLP; (iv) Customization Email sent for all users for registration purposes; (v) Throughout the workshop, optimal and flawless video-conferencing performance was observed; (vi) IWADL workshop Feedback taken via NARES-BLP and (vii) Learners expressed their satisfaction on the topics covered and practical exercises given to understand the actual applications of deep learning.

- **Compilation of Food Loss Index for India:** A workshop on Compilation of Food Loss Index for India was organized on May 09, 2023 at ICAR-IASRI in hybrid mode in which participants

from FAO, Rome, FAO-India, MoSPI, MoFPI, SSER and ICAR-IASRI project team members participated. The participants were trained/ capacitated on compilation of Food Loss Index (FLI) for India during the workshop. The report on Compilation of FLI for India demonstrating the possibility of computing and reporting the food loss index for India using the FAO methodology and the data collected by the Government of India was shared with MoSPI for their comments, if any, so that the SDG Indicator 12.3.1a (Food Loss Index) may be included in the National Indicator Framework of India for official reporting of FLI for India by MoSPI to FAO, the custodian agency for this indicator. (Conveners: Tauqueer Ahmad and Prachi Misra Sahoo)

- **Statistical Meta-Analysis:** Online workshop on Statistical Meta-Analysis (SMA) was organized at ICAR-IASRI on June 19, 2023. This workshop was chaired by Professor Bimal K Sinha, Department of Mathematics and Statistics, University of Maryland, Baltimore, County, US and Professor Bikas K Sinha, Former Member, National Statistical Commission, Government of India. Dr. Guido Knapp, Department of Statistics, TU Dortmund University, Germany covered the topics on Meta-analysis of normal and binary data; Methods for assessing publication bias and Meta-regression and General Introduction to meta-analysis; Review of basic SMA methods and SMA using R software. (Conveners: Rajender Parsad and Ajit)

- **Celebrating Statistics in Memory of Professor CR Rao:** Online workshop on "Celebrating Statistics in Memory of Professor CR Rao" was organized at ICAR-IASRI, New Delhi on his birthday on September 10, 2023. The workshop was chaired by Dr. R.C. Agrawal, DDG (Agricultural Education), ICAR, New Delhi. Speakers in the workshop were (i) Dr. Saumyadipta Pyne, Professor, Department of Statistics and Applied Probability, University of California, Santa Barbara, USA delivered a talk on "Rao's Weighted Distributions for Modeling the Dynamics of Wildfires and Air Pollution"; (ii) Dr. TJ Rao, Retired Professor, Indian Statistical Institute, Kolkata delivered a talk on "Remembering Professor CR Rao"; (iii) Dr. N Balakrishna, Visiting Professor, IIT, Tirupati delivered a talk on "Models for Count time series" and (iv) Dr. Rajender Parsad, Director, ICAR-IASRI, New Delhi delivered a talk on "Professor CR Rao Influence on Designing of Experiments with a special reference to Agricultural Sciences".


Floral Tribute to Professor C.R. Rao: 10.09.1920–22.08.2023

"If chance is the antithesis of law, then we need to discover the laws of chance" - C. R. Rao

"All knowledge is, in final analysis, history. All sciences are, in the abstract, mathematics. All judgements are, in their rationale, statistics"... C. R. Rao

"Statistics is not a discipline like physics, chemistry or biology where we study a subject to solve problems in the same subject. We study statistics with the main aim of solving problems in other disciplines." ...CR Rao
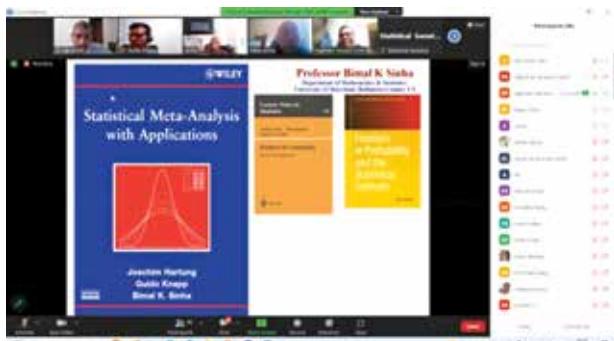
- **Statistical Methods of Data Integration in Agricultural Sciences** : Online Workshop on Statistical Methods of Data Integration in Agricultural Sciences was organized at ICAR-IASRI, New Delhi on November 07, 2023. The workshop was chaired by Professor Indranil Mukhopadhyay, Human Genetics Unit, Indian Statistical Institute, Kolkata. Speakers in the workshop were (i) Professor Mamunur Rashid, Department of Mathematical Sciences, DePauw University, USA delivered a talk on "Data Integration Techniques in Agricultural Sciences"; (ii) Professor George Tseng, Vice Chair (Research), Departments of Biostatistics, School of Public Health, University of Pittsburgh, USA delivered a talk on "Selective introduction to Multi-omics Integrative Analysis" and (iii) Professor Gauranga deb Chattopadhyay, Head, Department of Statistics, University of Calcutta, India delivered a talk on "An Introduction to Multiple Testing". Over 130 participants attended the workshop.

Exhibition Stalls

- **Pusa Krishi Vigyan Mela 2023:** The Pusa Krishi Vigyan Mela - 2023 was organized during March 02-04, 2023 by the ICAR-Indian Agricultural Research Institute, New Delhi on the theme "Nutritional, food and Environmental Security Through Millets". ICAR-IASRI demonstrated its developed technologies and advisories to farmers. Different technologies for welfare of farmers were displayed during this mela like KVK portal and KVK app, KRISHI Portal, AI-DISC, Farmer FIRST (Farm, Innovations, Resources, Science and Technology) programme, National Agricultural Science Museum, Crop Cutting Experiments (CCE), End-to-End Solution for generation of estimates of Major Livestock Products and KISAN SARATHI.

- **ICAR Foundation Day and Technology Day:** The Institute participated in the 95th ICAR Foundation Day and Technology Day celebrations organized at Dr. C. Subramaniam Auditorium of NASC Complex, New Delhi during July 16-18, 2023 and showcased different technologies including virtual reality modules.

- **XVI Agriculture Science Congress organized by CMFRI, Kochi:** Showcased KVK portal and KVK app, KRISHI Portal, AI-DISC, Blended Learning Platform, E-Learning Portal through stall on Data Science and Digital Agriculture during XVI Agriculture Science Congress organized by CMFRI, Kochi during October 10-13, 2023.

- **Showcasing ICAR Technologies:** Showcased Technologies from ICAR-IASRI during the exhibition at residence of Honourable Union Minister of Agricultural and Farmers Welfare August 15, 2023

- **Showcasing Digital Initiatives to School Students:** A student visit to Institute and NASM was organized on December 08, 2023 under SCSP scheme. This was attended by 35 students.

Visits of Special Guests

- **Honourable Ms. Raksha Nikhil Khadse, Member of Parliament, Raver (LokSabha), Maharashtra** visited the Institute on February 07, 2023. She had a discussion on application of Artificial Intelligence for solving issues related to Plant Protection and Production Technology of Banana for Raver Farmers. She also visited ICAR Data Center and ASHOKA.

- **Dr. Gurdev Singh Khush**, **World Food Laureate popularly known as Rice Man** who has developed 300+ rice varieties visited the Institute on March 10, 2023. During his visit, he interacted with the faculty, staff and students of the Institute and planted a tree sapling of Chandan (*Santalum Album*). In his address, he appreciated the contributions of the Institute in several areas of statistical sciences. In the Institute Visitor Book, he wrote, "*I am delighted to visit the very famous Institute and feel fortunate that got the opportunity to visit for the first time. The Institute has very important mandate to help ICAR and the country in numerous ways. Besides selecting and training younger generation in India as well as from other countries. Very best wishes for the continued good work.*" He also visited National Agricultural Science Museum.

- **Institutes Participation in Zonal Sports Meet:** Institute participated in the Central Zonal Sport Meet 2022 organized during January 03-06, 2023 at ICAR-Indian Institute of Soybean Research, Indore (M.P.). The Institute won Table

Tennis and Chess (Men and Women). In Kabbadi and Volleyball, the Institute is runners up and in Javelin throw won the third prize.

Celebrations

- **Republic Day Celebrations:** Institute celebrated 73rd Republic Day on January 26, 2023 in which all staff and students of the Institute participated.

- **National Science Day:** The Institute celebrated National Science Day on February 28, 2023 and students made presentation on relevance of Global Science for Global Well Being and Role of Statistical Sciences. (Convener: Rajender Parsad and Cini Varghese)

- **International Women's Day 2023:** The Institute celebrated International Women's Day 2023. On this day a painting competition was organized on the theme Digit All: Innovation and Technology for Gender Equality. Posters of Women Force (Scientists, Technical and administrative staff) (n-1)th, nth and (n+1)th generation of ICAR-IASRI Family and Students of ICAR-IASRI family were shared on Social Media. Following are some glimpse of celebrations:

- **World Environment Day:** Institute celebrated World Environment Day on June 05, 2023 and planted guava, orange, peach and lemon plants. Also launched single use plastic free campus campaign. Dr. Rajender Parsad, Director, ICAR-IASRI requested to all IASRI family members to keep the campus clean, free from single use plastic, effective use of electric appliances and judicious use of water. (Convener: Rajender Parsad)

- **International Yoga Day:** The Institute celebrated 9th International Yoga Day on June 21, 2023 with the theme "Vasudhaiv Kutumbkam" to achieve the objective of "Yoga for humanity". "योग करें,

रोज करें, स्वस्थ रहें और सुरक्षित रहें". The focus of the session was aimed to focus on "Aasan and Pranayam" and "Lifestyle: Eating and behavioral habits" with common yoga protocol. Shri Vedraj Soni, Member, Delhi State Yog Karya karini, Bhartiye Yog Sansthan, and Shri Ved praksh Sachdeva, District Yog Adhikari, Bhartiya Yog Sansthan conducted the Yoga session on this special day. Dr. Rajender Parsad, Director, ICAR-IASRI urged the participants to practice Yoga for good mental and physical health. The session covered the usefulness of Yoga, Pranayam and eating habits(s) including type of food intake and schedule. Participants: 120. (Convener: K.K. Chaturvedi)

- **17th National Statistics Day:** Institute organized National Statistics Day Lecture and Walkathon on the eve of 17th National Statistics Day on June 28, 2023. The theme of 17th National Statistics Day is Alignment of State Indicator Framework with National Indicator Framework for Monitoring Sustainable Development Goals. Shri Ashish Kumar, Former Director General, Central Statistics Office, Ministry of Statistics and Programme Implementation, Government of India, Chief Guest delivered the keynote address online on National and International Experience in Official Statistics System and Capacity Building with Special Reference to Agricultural Statistics. He shared his valuable insights regarding the importance of official statistics in efficient policy formulation. Further, he emphasized the applicability of Machine Learning/Artificial Intelligence in the field of statistics. He appreciated the role of ICAR-IASRI for building quality human resources. Sh. Rakesh Kumar Tyagi, Former Director General, National Sample Survey Office, Ministry of Statistics and Programme Implementation, Government of India and Guest of Honour shared his experiences as alumnus of ICAR-IASRI, New Delhi and his experiences in national Statistics

System. He also highlighted the rich heritage and the significant contributions made by the Institute in National Agricultural Research and Education System and National Agricultural Statistics System.

Earlier in his welcome address, Dr Rajender Parsad, Director, ICAR-IASRI gave the genesis and growth of the Institute. He also enumerated the significant contributions of the Institute during last 93 years since its beginning as a small statistical section of the Imperial Council of Agricultural Research. He also emphasized on the importance of National Statistics Day highlighting the contribution of Professor P.C. Mahalanobis. Students of ICAR-IASRI made a presentation on the inspiring journey of Professor P.C. Mahalanobis and other eminent national and international statisticians. Alumni of ICAR-IASRI currently working in various sectors viz., Indian Statistical Service, Agricultural Research Service, Agricultural Universities and Multinational companies interacted online with the students. A two-hour offline interaction session with alumni working in the corporate

sector was also organized to make the students prepared for corporate sector and entrepreneurs. Logo designing and poster making competitions were organized for students. The event brought together the staff, students, and alumni of ICAR-IASRI. Some interesting competitions for M.Sc. and Ph.D. students were organized on this occasion. A *Walkathon* was organized on June 28, 2023 starting from ICAR-IASRI to KAB-II, Director Office, ICAR-IARI and IARI Library and back to the Institute. Dr. R.C. Agrawal, Deputy Director General (Agricultural Education), Dr. Seema Jaggi, Assistant Director General (HRD), Dr. Viswanathan Chinnusamy, Joint Director (Research), ICAR-IARI and other officials from KAB-II and ICAR-IARI joined the Walkathon. A total of 200+ participants including staff, students and alumni took part in the celebrations.

- **Institute Annual Day :** Celebrated Annual Day of the Institute on July 03, 2023. Dr. Himanshu Pathak, Secretary, DARE & Director General, ICAR was the Chief Guest; Dr. R.C. Agrawal, DDG (Agricultural Education), ICAR & ND (NAHEP), Guest of Honour and distinguished

speaker Dr. Santanu Chaudhury, Director, IIT Jodhpur delivered 33rd Nehru Memorial Lecture on the topic entitled "Artificial Intelligence in Agriculture". The celebrations started with planting the saplings of Rudraksh by the Chief Guest. The dignitaries lit the lamp and after that IASRI song was played, this started the formal annual day function of the Institute.

Dr. Rajender Parsad, Director of the Institute delivered welcome address and presented the activities and accomplishments of the institute. He also gave a glimpse of major achievements, honours & awards, collaborations & linkages, statistical methodologies and their impact, human resource development, products, digital initiatives, etc. of the Institute. The crisp yet elaborative presentation covering all the aspects of the Institute was well appreciated by Secretary DARE and Director General, ICAR and others. The dignitaries had all applauded the Institute for its achievements and ongoing efforts. Chief Guest, Dr. Himanshu Pathak, Secretary, DARE &Director General, ICAR delivered Presidential address and congratulated the entire IASRI fraternity on the occasion of the Annual day and also appreciated the efforts of past and present IASRIians for it. He also mentioned that the Institute which is contributed significantly to the system immensely in the area of Statistical Sciences and e-Governance activities. He also described following three points need to be done on Annual day: (i) exchange of the pleasantries among the colleagues and fraternity, (ii) present and discuss what has been done so far and (iii) think upon what to do in the future to make the Institute progress further. He also emphasized about the importance of quality data, correct data and authenticated data for well informed decisions.

Dr. Santanu Chaudhary, Director, Indian Institute of Technology, Jodhpur, graced the event as a distinguished speaker and delivered the 33rd Nehru Memorial Lecture on "Artificial Intelligence in Agriculture." Guest of Honour and IASRI alumni Dr. R.C. Agrawal, DDG (Agricultural Education), ICAR & National Director (NAHEP), in his remarks, not only mentioned about the glorious past of IASRI but also shed light on the contributions and importance of the Institute at present not only for ICAR but for entire NARES. He called IASRI as the "heart of entire ICAR and NARES". Following four publications were

also released on the occasion: (i) Agricultural Research Data Book (ARDB) 2023; (ii) Technical Bulletin on "Evaluation of Comprehensive Scheme for Cost of Cultivation of Principal Crops (CS Scheme)"; (ii) Technical Bulletin on "Evaluation of Improvement of Agricultural Statistics (IAS) Scheme" and Brochure on Augmented Reality/Virtual Reality Brochure. Authors of the paper publishing the research paper with 10+ Impact factor in which IASRI as lead were awarded appreciation certificate. Students also prepared beautiful rangoli during the celebrations.

- **Independence Day Celebrations:** The Institute celebrated 77th Independence Day on August 15, 2023. Dr. Rajender Parsad, Director, ICAR-IASRI hoisted the flag in the Institute Campus and addressed the staff and students. A cultural programme was organized by the students, staff members and children of staff members on the occasion. The staff and students of the Institute also took Panch Pran Pledge on this occasion.

- **Role of ICAR-IASRI: Director's Interview on DD KISAN**

  - Dr Rajender Parsad, Director, ICAR-IASRI gave an Interview on Role of ICAR-IASRI in the Service of the Nation to the DD KISAN

Journalist OP Yadav interviewed Dr. Rajender Parsad, Director, ICAR-IASRI, New Delhi

Channel that was broadcasted in Kisan Samachar on August 16 and August 17, 2023.https://youtu.be/CFPswTtI038

- A **medicinal garden** has also been initiated in the Institute Campus on August 14, 2023 as part of celebrations of "Meri Maati, Mera Desh" during August 13-15, 2023.

- **Institute participated in the 95th ICAR Foundation day** and Technology Day celebrations organized at Dr. C. Subramaniam Auditorium of NASC Complex, New Delhi during July 16-18, 2023

- **Teacher's Day Celebrations:** The Institute celebrated Teacher's Day on September 05, 2023 in Hybrid mode. Dr. Pranesh Kumar, Professor (Statistics), Department of Mathematics & Statistics, University of Northern British Columbia, Price George, Canada was honored on this occasion and presented the Teachers' day Lecture. Dr. Rajender Parsad, Director, ICAR-IASRI presided over the function. Students organized cultural program and decorated beautiful Rangolis.

- **Vigilance Awareness Week**: Institute organized the Vigilance Awareness Week during October 30 – November 05, 2023. All the staff member took oath on October 20, 2023 with the Director of the Institute. A webinar was organized jointly with ICAR-NIMR, Hyderabad. Mr. Somnath, Under Secretary (Vigilance), ICAR delivered the talk on the topic "CCS (CCA) Rules 1965".

- **Swachhata Special Campaign 3.0 (October 02-31, 2023) (Swachhata Pakhwara):** Staff and students took the Swachhta Pledge on October 03, 2023. A campus tour was conducted to ensure comprehensive cleanliness throughout the IASRI campus. During the campaign, organized a debate competition on 'Time spent on Swachhta mission is time well spent'. Several initiatives were taken for campus wide cleaning. Dr. Bimlesh Mann, ADG (EP&HS) was the Chief Guest during the valedictory session. She also planted a sapling of Basil Plant and addressed the staff on the occasion. Dr. Rajender Parsad, Director, ICAR-IASRI, addressed the staff and reiterated for clean and green campus.

- **Constitution Day 2023:** Institute celebrated Constitution Day on November 26, 2023. The staff and students read Preamble along with Director, ICAR-IASRI, New Delhi.

- **Communal Harmony Day:** Institute celebrated Communal Harmony Day (Sadbhavana Diwas) on November 19, 2022.

- **Swachhata Campaign (December 16-31, 2023):** The cleanliness activities during Swachhata Pakhwada (December 16-31, 2023) were initiated with a Swatchhta pledge on December 16, 2023 in online mode. The members were also encouraged to take pledge on https://pledge.mygov.in/swachhta-pledge-2022/. Discussions were held on water saving and its reuse, efficient and effective use of electricity, single use plastic free campus, participation in plantation drive, etc. During Swatchhata Pakhwada several other activities were performed by ICAR-IASRI Staff/Students and Contractual staff viz. stock taking on digitization of office records/e-office implementation; review of progress Swachhata Action Plan (SAP); Cleanliness and Sanitation drives in residential colony near IASRI campus; cleaning awareness in vicinity of IASRI Campus; promoting clean & green technologies and organic farming practices. The residents of the colony were counseled on cleaning of their premises and surroundings. Staff members were requested to perform cleaning in their respective residential colonies and nearby market places. Video shows on the following topics were organized: (i) Campaign on cleaning of sewerage & water lines, awareness on recycling of waste water; (ii) Recycling of waste water; (iii) भारत का प्लास्टिक अपशिष्ट संकट÷ और (इकोइंडिया) क्या प्लास्टिक कचरे से उत्पन्न ईंधन जीवाश्म ईंधन की जगह ले सकता है और ऊर्जा जरूरतों को पूरा कर सकता है?; (iv) Documentary film on Swachch Bharat Mission Grammeen. A debate was also organized on Swachhata amongst staff and contractual members on the topic Time spent on Swachhata mission is time well spent. Students carried out swachhata activities in their rooms, hostel premises and in the vicinity of Hostel. The International Training Hostel was renovated and refurbished. The Boundary wall was painted. The Institute campus was maintained as clean and green campus. The different flowers are blooming in the campus. All pots and trees haves been painted for a better look. A swachhta campaign was also run on social media. As part of valedictory function, Honorable Deputy Director General (Agricultural Education), ICAR; Assistant Director General, Human Resource Management, ICAR and Director, ICAR-CIWA, Bhubaneswar made campus visit

and appreciated the clean and green campus with rooftop solar panels, rainwater harvesting system.

- **Kisan Diwas (National Farmers' Day) 2023:** Kisan Diwas was celebrated online on December 23, 2023. Director, ICAR-IASRI inaugurated the celebrations and explained the importance of Celebrating Kisan Diwas on the Birthday of Late Choudhary Charan Singh, Former Prime Minister of India. In 2001, the Government of India announced that December 23 (his birthday) would be celebrated as National Farmer's Day to honour Chaudhary Charan Singh's contributions for the welfare of farming community. Director, ICAR-IASRI, also welcomed the farmers (i) Sh. Jagpal Singh, IARI Innovative Farmer Awardee and IARI Fellow Awardee from Jhajhhar Haryana; (ii) Sh. Thakur Gopal from Bharatpur, Rajasthan; (iii) Sh. Anil Kumar, Krishi Karman Awardee Farmer from Khagria, Bihar and (iv) Sh. Kulwant Singh from Buland shahar, Uttar Pradesh. The invited farmers also delivered talks on the Kisan Diwas on various topics like Bee Keeping: Crop Management, Bee Management and Pollination; Biogas Plant Use: its installation, organic farming and water harvesting; Poly house farming and Seed Production respectively. Dr. Alka Arora, Dr. Soumen Pal and Dr. K.K. Chaturvedi presented the various digital initiatives of ICAR such as ICAR Video Gallery, ICAR Mobile App Gallery, Technology Repository, KVK Portal, KISAAN 2.0 (Krishi Integrated Solution for Agri Apps Navigation), Mobile apps developed in collaboration with ICAR-Indian Veterinary Research Institute (IVRI), Izatnagar, Kisan Sarathi - System of Agri-information Resources Auto-transmission and Technology Hub Interface. The farmers while expressing their views lauded the efforts of ICAR scientists and also stressed the need for further improvement in the farmer research community interaction. They also stressed on the need of more advertisement of Kisan Haat.

- **Exhibition Visit:** Dr. Rajender Parsad, Director, ICAR-IASRI and Dr Ajit visited the exhibition organized as part of the Global Partnership on Artificial Intelligence Summit 2023 during December 12-14, 2023. ICAR Video Gallery https://krishi.icar.gov.in/video/ has been embedded in the AI Chatbot developed by Digital Greens for Ministry of Agriculture and farmers Welfare. Also visited the stall of BHASINI.

Meetings organized

- Meeting of committee for Modernizing and Strengthening of National Agricultural Science Museum on January 04, 2023 and January 13, 2023. (Rajender Parsad)

- Meeting of committee constituted to review Standard operating Procedure (SoP) for monitoring quality of food grains stocks procured under Decentralized Procurement (DCP) Scheme by Ministry of Consumer Affairs, Food and Public Distribution on January 20, 2023. (Rajender Parsad)

- Meeting for the feedback, improvement, enrichment and resolving the issues of KVKs in KISAN SARATHI on January 13 and 27, 2023 and on February 10 and 24, 2023. (Sanjeev Kumar)

- The meeting of IOMC (Implementation and Operation Monitoring Committee) was organized on 11th August 2023.

- **XXVII Meeting of ICAR Regional Committee-V:** The XXVII Meeting of ICAR Regional Committee-V was organized in hybrid mode at National Agricultural Science Complex, New Delhi on April 27, 2023 under the Chairmanship of Dr. Himanshu Pathak, Secretary, DARE & Director General (DG), ICAR, New Delhi for discussing the Centre-State relations in the domain of

agricultural and allied sciences pertaining to the Zone-V constituent states viz., Punjab, Haryana and Delhi. Thereafter, Dr. Pratap Singh Birthal, Director, ICAR-National Institute of Agricultural Economics and Policy Research (NIAP), New Delhi gave a presentation on Agricultural Status and Development Perspective of the states of Punjab, Haryana and Delhi vis-à-vis other states of India. Dr. Rajender Parsad, Director, ICAR-IASRI, New Delhi and Member Secretary, RCV presented the Action Taken Report on the Action points of the last RC-V Meeting (i.e. XXVI Meeting held on December 07, 2020). Shri Jai Parkash Dalal, Minister for Agriculture and Farmer Welfare; Animal Husbandry and Dairying Fisheries; Government of Haryana graced the RC-V Meeting in online mode. He delivered his special remarks by raising the issues faced by Haryana state in the agricultural, horticultural, livestock and fisheries sectors. The detailed points flagged by him have been included in the Action points which have been annexed subsequently. The state-wise problems and research needs and developmental issues were flagged by the senior officials of State Departments and responses were provided by the DDGs/ Vice Chancellors/ Scientists of ICAR/ SAUs. Post lunch session was presided over by Secretary, DARE and Director General, ICAR. The meeting ended with suggestions by Governing Body Members of RC-V and also Remarks given by Dr. R.C. Agrawal, DDG (Agricultural Education), ICAR & Nodal Officer of the RC-V meeting.

10.
Paper Presentations in Conferences, Workshops and Symposium

- International Conference on Statistics, Probability, Data Science and Related Areas (ICSPDS-2023) organized in conjunction with XXXII Annual Convention of Indian Society for Probability and Statistics (ISPS) & CUSAT, Cochin during January 04-06, 2023

  - R.K. Paul. Integration of stochastic, machine learning and wavelet based models. (Invited Talk)
  - Vinayaka*, Rajender Parsad and B.N. Mandal. Partially balanced nested block designs for comparing test treatments with more than one control.

- VII Biennial workshop of AICRP on Integrated Farming Systems organized at Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra during January 18-21, 2023

  - S.K. Sarkar*, S. Dash, and Mohd Harun. Planning, designing and analysis of experiments planned On Station under AICRP on IFS.

- National Conference on Agro-Ecology based Agri-Food Transformation Systems organized at ICAR-Indian Institute of Farming Systems Research, Modipuram, Meerut, India during January 27-28, 2023

  - R.K. Paul. Machine learning techniques for forecasting yield of rice.
  - Soumen Pal. Determinants of wheat yield in Bihar and Eastern Uttar Pradesh of India.

- National Conference on Recent Trends on Applied Statistics and Data Science in the Memory of 100th Birthday of Late Professor MN Das organized by P.C. Mahalanobis Department of Statistics, Saurashtra University, Rajkot during January 28-29, 2023

  - Rajender Parsad. Response Surface Designs for Agricultural Experimentation. (Invited Talk)

- Late Dr. M.N. Das Birth Centenary Celebrations by Society of Statistics, Computer and Applications in online mode on February 01, 2023

  - Rajender Parsad. Life and Achievements of Late Professor MN Das. (Invited Talk)

- International Conference on Significance of Statistical Sciences in Emerging Scenario (25th Conference of Society of Statistics and Computer Application (SSCA)) organized at Department of Statistics, University of Jammu, Jammu during February 15-17, 2023

  - Ramasubramaniam, V. A comparison of classification trees, Kohonen networks and rough sets for applications in agriculture. (Invited Talk)
  - Alka Arora. Education Portal: e-Governance application for agricultural education programs.(Invited Talk)
  - Mukesh Kumar. Web based digital repository for agricultural technologies of ICAR. (Invited Talk)
  - Anu Sharma. Metagenomics insights into microbial communities involved in major biogeochemical cycles in agriculture.
  - S. Dahiya. Language and crop specific agricultural nutrition platform. (Invited Talk)
  - Md. Samir Farooqi. Integrated web interface for the analysis of gene expression data using different gene selection tool.
  - M.A. Iquebal. AI/ML guided discovery of novel antimicrobial peptides in animal kingdom.
  - Sarika. Statistical aspects in genome-wide association studies.
  - R.K. Paul. Long memory with volatility: application of fractionally integrated GARCH model. (Invited Talk)
  - D.C. Mishra. Statistical significance of genomics data analysis.
  - Kaustav Aditya. Domain calibration estimators under two stage sampling design when population level auxiliary information is available at cluster level.
  - Saurav Guha*, Rajender Parsad, Saumyadipta Pyne and Sudeep. Spatially correlated multivariate Fay–Herriot models for small area estimation. (Dr. MN Das Young Scientist Award Session)

- International Conference on "Blended Learning Ecosystems for Higher Education in Agriculture" hosted jointly by ICAR and the World Bank under

NAHEP organized by ICAR-IASRI, New Delhi during March 21-23, 2023 at NASC Complex

- Sudeep Marwaha. NAHEP - Blended Learning Platform and Associated IT Initiatives. (Keynote Note in Plenary Session on-Blended Learning through the Lens of Emerging Technologies)

- 6th International Conference on Advances in Agriculture Technology and Allied Science at Hyderabad on June 20, 2023

  - S.N. Islam. Strengthening agriculture and education with ICT and other allied technology for consolidating farmer's income: an ICAR-NAHEP initiative.

- 9th International Conference on Agricultural Statistics (ICAS IX) held at World Bank in Washington, DC, USA during May 17-19, 2023

  - Prachi Misra Sahoo*, Tauqueer Ahmad, Ankur Biswas, Anil Rai and Chirag Vasudev. Neoteric and innovative end-to-end solution for generating livestock statistics in India: eLISS portal and eLISS data collection app.

- XXVII Meeting of ICAR Regional Committee No. V Comprising the States of Punjab, Haryana, and Delhi on April 27, 2023 at NASC Complex, New Delhi in hybrid mode (Online / In-Person)

  - Rajender Parsad. Action taken report of XXVI ICAR regional committee-V meeting.

- International Conference on Current Advances in Agriculture, Animal Husbandry and Allied Sciences-CAAAAS-2023 during July 10-11, 2023

  - Sneha Murmu. A machine learning architecture for prediction of protein-protein interactions between plants and pathogens.

- 8th National Conference on Computer Vision, Pattern Recognition, Image Processing and Graphics (NCVPRIPG 2023) at IIT Jodhpur, India during July 21-23, 2023

  - Chandan Kumar Deb*, Madhurima Das, Mahesh Kumar, Sudhir Kumar, Md. Ashraful Haque, Alka Arora, Sudeep Marwaha, Biswabiplab Singh, Dhandapani Raju and Viswanathan Chinnusamy. MuSiCv1.0: a software solution for automated mustard silique count using YOLOv5.

- CSISA-ICAR- KVK Workshop organized by Agricultural Extension Division, ICAR-IARI, New Delhi at NASC on September 27, 2023

  - Rajender Parsad*, R.K. Malik, Alka Arora and Soumen Pal. Analytics and dashboard of MEL data. (Invited Talk)

- National Symposium on Crop Health Management: Safeguarding Crop through Diagnostics and Innovations organized by ICAR-Vivekananda Parvatiya Krishi Anusandhan Sansthan, Almora, Uttarakhand on September 29-30, 2023

  - Samarth Godara*, Rajender Parsad, Shruti Godara, Sudeep Marwaha. Revitalizing Punjab Agriculture: A decade of farmer query calls analysis for sustainable crop health management. (Online Presentation)

  - Sudeep Marwaha*, R.C. Agrawal, Rajender Parsad, Ramasubramanian V., Alka Arora, et al. AI-DISC (Artificial Intelligence-based Disease Identification System for Crops) Mobile Application: a step towards intelligent crop health management. (Online Presentation)

- 6th CWSS International Conference on Agricultural Innovations for Sustainable Development Goals with Special Focus on Natural Farming organized at Farmers' Academy & Convention Centre, BCKV, Kalyani, Nadia, West Bengal during September 30-October 02, 2023

  - Ritwika Das*. CNN_FunBAR: deep learning technique for fungi taxonomic classification based on DNA barcode sequences.

  - Bappa Saha, Ankur Biswas*, Tauqueer Ahmad, Prachi Misra Sahoo, Kaustav Aditya and Nobin Chandra Paul. Geographically weighted regression based model-calibration approach under two stage sampling design.

- International Conference on Statistical Theory and its Application organized at Department of Statistics Bharathiar University, Coimbatore, Tamil Nadu during September 01-02, 2023

  - Surya Prakash Tripathi*, Kaustav Aditya, Ankur Biswas and Tauqueer Ahmad. Population total estimation in two stage sampling with known study variable variance utilizing two auxiliary calibration.

- National Conference on Spices, Aromatic and Medicinal Plants for Economic Prosperity and Ecological Sustainability-2023 held at ICAR-Central Island Agricultural Research Institute, Port Blair, Andaman Nicobar Islands during October 05-06, 2023

  - Sneha Murmu. Identification of potent phytochemicals against *Magnaporthe oryzae* through vitual screening and molecular dynamics simulation approach.

- International Conference on Structural Biology and Drug Discovery organized by University School of Biotechnology, Gautam Buddha University, Greater Noida during October 11-12, 2023
  - Anu Sharma. Prediction of anti-microbial resistance gene using deep learning approach for *in silico* drug designing.

- 6th International Rice Congress, Manila, Philippines during October 16-19, 2023
  - Girish Kumar Jha. Determinants of expenditure on inorganic and organic fertilizers among Indian paddy growers.

- 5th International Conference on Sustainable Natural Resource Management under Global Climate Change at NASC Complex, New Delhi during November 07-10, 2023
  - Bharti. Data envelopment analysis-based study on onion farming efficiency and sustainable development.
  - Pankaj Das. Spatial prediction and mapping of soil properties using machine learning techniques in India.

- International Conference on Drive Agriculture Forward: Recent Trends and Innovation in Agricultural Market Intelligence held at Anand Agriculture University, Anand during December 11-13, 2023
  - Girish Kumar Jha. AI-based agricultural price forecasting models: An innovative market intelligence system.

- VIII International Conference on Global Research Initiatives for Sustainable Agriculture and Allied Sciences organized by Aastha Foundation, Meerut and University of Agricultural Sciences, Raichur, Karnataka during December 18-20, 2023
  - Sudhir Srivastava. An improved model-based normalization approach for addressing heterogeneity in LC-MS proteomics expression data.

- 5th International Conference on Deep Learning, Artificial Intelligence and Robotics organized by NIT, Kurukshetra held during December 07-09, 2023
  - Md. Ashraful Haque, Chandan Kumar Deb, Sudeep Marwaha, Subrata Dutta, Mehraj Ul Din Shah, Ananta Saikia and Abhishek Shukla*. Rice disease identification using vision transformer (ViT) based network.
  - Vaibhav Kumar Singh, Bishnu Maya Bashyal, Sudeep Marwaha, Rajender Parsad, Sapna Nigam*. Image-based rice weed identification using deep learning and attention mechanisms.
  - Sudeep Marwaha, Sapna Nigam, Md. Ashraful Haque, Madhu, Akshay Dheeraj*. ADNet: An attention embedded DenseNet121 model for weed classification.

- International Conference on Systems and Technologies for Smart Agriculture organized by C-DAC, Kolkata during December 19-20, 2023
  - Md Ashraful Haque*, Chandan Kumar Deb, Akshay Dheeraj, Sudeep Marwaha and Mehraj Ul Din Shah. Swin transformer-based disease identification model for apple plants.
  - Chandan Kumar Deb*, Sudeep Marwaha and Ashraful Haque. Leveraging autoencoders for accurate plant disease diagnosis in the face of unbalanced data.

- International Conference on Communication and Intelligent System organized by Malaviya National Institute of Technology, Jaipur during December 16-17, 2023
  - Chandan Kumar Deb*, Sudeep Marwaha and Ashraful Haque. Convolution Neural Network (CNN) based live pig weight estimation in controlled imaging platform.

- International Conference on Statistics, Data Science and Reliability: Exploring Trends, Methods & Application organized at Maharshi Dayanand University, Rohtak during December 24-26, 2023
  - Bharti*, K. Aditya, T. Ahmad, R. Banerjee and D. Singh. Generalized regression estimator in dual frame surveys under two-stage sampling.

- 9th International Conference on Statistics for Twenty-first Century – 2023 organized by Department of Statistics, University of Kerala during December 15-18, 2023 (online presentations)
  - Cini Varghese. Minimally replicated PBIB designs (invited paper session on statistical designs for experimentation).
  - Susheel Kumar Sarkar. Basic Design of Experiments with Co-Variates (invited paper session on statistical designs for experimentation).
  - Sukanta Dash. Designs for cropping sequence experiments (invited paper session on statistical designs for experimentation).
  - Anindita Datta. Efficient statistical designs under row – column setup with multiple units

- (invited paper session on statistical designs for experimentation).
- Mohd. Harun. Incomplete block designs using Hadamard matrices (invited paper session on statistical designs for experimentation).

(*denotes the author who presented the paper)

Foreign Visit

- **Dr. Susheel Kumar Sarkar** attended a training programme on Intensive GS & Modern Experimental Design organized at International Rice Research Institute, Philippines during February 13-24, 2023
- **Dr. Alka Arora** and **Dr. Soumen Pal** attended Workshop on Designing Digital Survey Tool organized by EiA-CSISA in Bangkok, Thailand during April 19-21, 2023.
- **Dr. Prachi Misra Sahoo** winner of USDA scholarship, for presenting paper titled "Neoteric and Innovative end-to-end solution for generating livestock statistics in India: eLISS Portal and eLISS Data Collection App" in the International Conference on Agricultural Statistics (ICAS) organized by World Bank in Washington, DC, USA during May 17-19, 2023.
- **Dr. Girish Kumar Jha** attended 6th International Rice Congress in Manila, Philippines organized during October 16-19, 2023.

(n-1)th, nth and (n+1)th generations

IWD-2023 Sketching Competition: DigitALL

IWD-2023 Painting Competition: DigitALL

IWD-2023 Painting Competition

Students' Gallery

"There is no gate, no lock, no bolt that you can set upon the freedom of my mind" - Virginia Woolf

Technical, Administrative and Financial Staff of ICAR-IASRI: 2022-23

संस्थान में हिन्दी के प्रगामी प्रयोग की रिपोर्ट

भा.कृ.अनु.प.—भारतीय कृषि सांख्यिकी अनुसंधान संस्थान

हिन्दी के प्रगामी प्रयोग की रिपोर्ट

भा.कृ.अनु.प.—भारतीय कृषि सांख्यिकी अनुसंधान संस्थान में दिन प्रतिदिन हिन्दी के प्रगामी प्रयोग में अभिवृद्धि हो रही है। राजभाषा नीति को संस्थान में सुचारू रूप से कार्यान्वित किया जा रहा है। भारत सरकार, गृह मंत्रालय, राजभाषा विभाग द्वारा जारी वार्षिक कार्यक्रम में निर्धारित लक्ष्यों को संस्थान में लगभग पूरा कर लिया गया है। संस्थान द्वारा समस्त प्रशासनिक कार्य शत–प्रतिशत हिन्दी में किया जाता है तथा धारा 3(3) का भी पूर्ण रूप से अनुपालन किया जा रहा है।

संस्थान में राजभाषा हिन्दी की प्रगति का जायजा लेने के लिए उपमहानिदेशक (कृषि शिक्षा), भारतीय कृषि अनुसंधान परिषद् मुख्यालय द्वारा समय–समय पर संस्थान का राजभाषा संबंधी निरीक्षण किया गया। उपमहानिदेशक (कृषि शिक्षा), ने निरीक्षण रिपोर्ट में संस्थान में हिन्दी में हो रहे कार्यों की प्रगति पर संतोष व्यक्त करते हुए संस्थान की सराहना की। संस्थान के अलग–अलग प्रभागों/अनुभागों में हिन्दी में किए जा रहे कार्यों की समीक्षा करने के लिए हिन्दी एकक के अधिकारियों द्वारा कुल 20 प्रभागों/अनुभागों का निरीक्षण किया गया।

संस्थान में प्रशासनिक कार्य के साथ – साथ वैज्ञानिक प्रकृति के कार्यों में भी हिन्दी के उपयोग को प्रोत्साहित किया जाता है। संस्थान के वैज्ञानिक प्रभागों द्वारा आयोजित प्रशिक्षण कार्यक्रमों की ई–संदर्भ पुस्तिकाओं में आमुख एवं आवरण पृष्ठ द्विभाषी रूप में प्रस्तुत करने के साथ–साथ परियोजना रिपोर्टों के आवरण पृष्ठ, आमुख, एवं सारांश द्विभाषी रूप में प्रस्तुत करने के साथ–साथ कुछ हिन्दी के व्याख्यान भी शामिल किए। संस्थान के वैज्ञानिकों द्वारा हिन्दी में वैज्ञानिक विषयों पर हिन्दी कार्यशालाओं का भी आयोजन किया गया। इसके अतिरिक्त, संस्थान में एम.एससी. तथा पीएच.डी के विद्यार्थियों ने अपने शोध–प्रबन्धों के सार द्विभाषी रूप में प्रस्तुत किए। वैज्ञानिकों एवं तकनीकी कर्मियों द्वारा कुछ शोध–पत्र भी हिन्दी में प्रकाशित किए गए।

प्रतिवेदनाधीन अवधि के दौरान संस्थान में राजभाषा कार्यान्वयन समिति की 04 बैठकें क्रमशः मार्च 29, 2023, जून 23, 2023, सितम्बर 27, 2023 एवं दिसम्बर 28, 2023 को आयोजित की गई। इन बैठकों में राजभाषा नियम एवं अधिनियम को कारगर ढंग से लागू करने तथा इसमें दिए गए प्रावधानों के अनुसार वार्षिक कार्यक्रम में निर्धारित लक्ष्यों की प्राप्ति हेतु चर्चा की गई तथा आवश्यक कदम उठाए गए।

संस्थान के समस्त कर्मियों को 02 वर्ष की अवधि में कम से कम एक बार हिन्दी कार्यशाला में सहभागिता करने का अवसर मिले, इस अनिवार्यता के संबंध में भारत सरकार, गृह मंत्रालय, राजभाषा विभाग द्वारा समय – समय पर जारी कार्यालय ज्ञापन द्वारा निर्धारित लक्ष्य की प्राप्ति के लिए प्रोत्साहित किया गया।

प्रतिवेदनाधीन अवधि के दौरान संस्थान में विभिन्न वर्गों के कर्मियों एवं राष्ट्रीय कृषि अनुसंधान प्रणाली के अन्य संस्थानों के वैज्ञानिकों के लिए पाँच हिन्दी कार्यशालाएं आयोजित की गई। पहली कार्यशाला संस्थान में वैज्ञानिक एवं तकनीकी वर्ग के कर्मियों के लिए परीक्षण अभिकल्पना प्रभाग के वैज्ञानिकों, डॉ. सुकान्त दाश, एवं डॉ. सुशील कुमार सरकार द्वारा मार्च 28–29, 2023 (02 दिवसीय) के दौरान ''परीक्षण अभिकल्पना के अनुप्रयोग'' विषय पर ऑन–लाइन आयोजित की गई, जिसमें 06 वक्ताओं द्वारा विषय से संबंधित 09 उप–विषयों पर व्याख्यान दिए गए। इस कार्यशाला में कुल 14 प्रतिभागियों (संस्थान के 06 वैज्ञानिकों, भारतीय कृषि अनुसंधान परिषद के अधीनस्थ अन्य संस्थानों से 08 वैज्ञानिकों) ने सहभागिता की।

दूसरी कार्यशाला संस्थान में प्रशासनिक वर्ग के कर्मियों के लिए हिन्दी एकक द्वारा मई 30, 2023 को ''सरकारी काम काज को हिन्दी में करने के लिए ई–टूल्स एवं राजभाषा नियम अधिनियम की जानकारी'' विषय पर ऑफ–लाइन आयोजित की गई, जिसमें 02 वक्ताओं द्वारा विषय से संबंधित 02 उप–विषयों पर व्याख्यान दिए गए। इस कार्यशाला में कुल 28 प्रतिभागियों (संस्थान के 07 अधिकारी एवं 21 कर्मचारी) ने सहभागिता की।

तीसरी कार्यशाला संस्थान में वैज्ञानिक एवं तकनीकी वर्ग के कर्मियों के लिए सांख्यिकी आनुवंशिकी प्रभाग के वैज्ञानिकों, डॉ. कंचन सिन्हा, डॉ. मृन्मय राय एवं डॉ. राजीव रंजन कुमार द्वारा जून 06–12, 2023 (07 दिवसीय) के दौरान ''कृषि में

सांख्यिकीय और मशीन लर्निंग तकनीक का परिचय" विषय पर ऑन लाइन आयोजित की गयी जिसमें 16 वक्ताओं द्वारा विषय से संबंधित 19 उप–विषयों पर व्याख्यान दिए गए। इस कार्यशाला में कुल 25 प्रतिभागियों (संस्थान के 01 वैज्ञानिक, 02 तकनीकी अधिकारी एवं भा.कृ.अनु.प. के बाह्य संस्थानों से 12 वैज्ञानिक तथा 06 तकनीकी अधिकारी के अलावा 04 तकनीकी सहायकों) ने सहभागिता की।

चौथी कार्यशाला संस्थान में वैज्ञानिक एवं तकनीकी वर्ग के कर्मियों के लिए प्रतिदर्श सर्वेक्षण प्रभाग के वैज्ञानिकों, डॉ. पंकज दास, डॉ. राहुल बनर्जी एवं डॉ. भारती द्वारा सितम्बर 06–13, 2023 (08 दिवसीय) के दौरान "कृषि एवं प्रतिदर्श आँकड़ो का विश्लेषण हेतु सांख्यिकीय सॉफ्टवेयर का अनुप्रयोग" विषय पर ऑन–लाइन आयोजित की गई। जिसमें 11 वक्ताओं द्वारा विषय से संबंधित 15 उप–विषयों पर व्याख्यान दिए गए। इस कार्यशाला में कुल 42 प्रतिभागियों (संस्थान के 04 वैज्ञानिक तथा 01 तकनीकी सहायक तथा भा.कृ.अनु.प. के बाह्य संस्थानों से 32 वैज्ञानिक और 01 तकनीकी अधिकारी के अलावा 04 तकनीकी सहायक) ने सहभागिता की।

पाँचवी कार्यशाला संस्थान में वैज्ञानिक एवं तकनीकी वर्ग के कर्मियों के लिए पूर्वानुमान एवं कृषि प्रणाली मॉडलिंग प्रभाग के वैज्ञानिकों, डॉ. कंचन सिन्हा, डॉ. मृन्मय राय एवं डॉ. राजीव रंजन कुमार द्वारा दिसम्बर 07–13, 2023 (07 दिवसीय) के दौरान "सांख्यिकीय एवं मशीन लर्निंग तकनीक के माध्यम से समय श्रृंखला का पूर्वानुमान" विषय पर ऑन–लाइन आयोजित की गई। जिसमें 17 वक्ताओं द्वारा विषय से संबंधित 19 उप–विषयों पर व्याख्यान दिए गए। इस कार्यशाला में कुल 15 प्रतिभागियों (संस्थान के 08 वैज्ञानिक, 01 तकनीकी अधिकारी तथा 01 तकनीकी सहायक और भा.कृ.अनु.प. के बाह्य संस्थानों से 04 वैज्ञानिक और 01 तकनीकी अधिकारी) ने सहभागिता की।

राजभाषा विभाग द्वारा जारी वार्षिक कार्यक्रम में निहित लक्ष्यों को पूरा करते हुए संस्थान के अधिकारियों/कर्मचारियों द्वारा समस्त पत्राचार हिन्दी में अथवा द्विभाषी रूप में किया गया। संस्थान के विभिन्न वैज्ञानिक प्रभागों तथा प्रशासनिक अनुभागों द्वारा आयोजित बैठकों की कार्यसूची तथा कार्यवृत्त हिन्दी अथवा द्विभाषी रूप में जारी किए गए। संस्थान में अपना कार्य शत–प्रतिशत हिन्दी में करने के लिए 12 अनुभागों को विनिर्दिष्ट किया गया है। गृह मंत्रालय, राजभाषा विभाग द्वारा जारी विभिन्न नकद पुरस्कार योजनाएँ संस्थान में लागू हैं तथा संस्थान के कर्मियों ने इन योजनाओं में बढ़–चढ़कर भाग लिया।

संस्थान में कार्यरत सभी हिन्दीतर अधिकारियों/कर्मचारियों द्वारा हिन्दी ज्ञान संबंधी प्रशिक्षण पूरा किया जा चुका है। आज तक की स्थिति के अनुसार, संस्थान में अब कोई ऐसा हिन्दीतर अधिकारी/कर्मचारी शेष नहीं रह गया है जिसे हिन्दी ज्ञान संबंधी प्रशिक्षण दिया जाना शेष हो।

संस्थान की वेबसाइट पर 'हिन्दी सेवा लिंक' उपलब्ध है। जिसमें सांख्यिकीय एवं प्रशासनिक शब्दावली के वर्ण क्रमानुसार कुछ शब्द, कुछ द्विभाषी प्रपत्र, दैनिक काम–काज के प्रयोग में आने वाली कुछ टिप्पणियाँ, द्विभाषी पदनाम, वाक्यांश इत्यादि उपलब्ध हैं। संस्थान के कर्मियों द्वारा अपना दैनिक कार्य हिन्दी में सरलता से करने के लिए इस सेवा का उपयोग किया जाता है।

संस्थान द्वारा प्रकाशित वार्षिक हिन्दी पत्रिका 'सांख्यिकी–विमर्श' का नियमित प्रकाशन किया जा रहा है तथा 18वें अंक का प्रकाशन प्रतिवेदनाधीन अवधि के दौरान किया गया।

संस्थान में 14 से 29 सितम्बर, 2023 के दौरान हिन्दी पखवाड़े का आयोजन किया गया। इस वर्ष हिन्दी पखवाड़े का शुभारम्भ अर्थात उद्घाटन हिन्दी दिवस एवं तृतीय अखिल भारतीय राजभाषा सम्मेलन के अवसर पर 14 सितम्बर, 2023 को पुणे (महाराष्ट्र) में श्री अजय कुमार मिश्रा, माननीय गृह राज्य मंत्री जी द्वारा किया गया था। हिन्दी पखवाड़े का आयोजन एवं इससे संबन्धित प्रतियोगिताएं संस्थान में दिनांक 14 से 29 सितम्बर, 2023 के दौरान आयोजित की गयी। दिनांक 14 सितम्बर, 2023 को काव्य–पाठ प्रतियोगिता का आयोजन किया गया। हिन्दी पखवाड़ा के दौरान डॉ दरोगा सिंह स्मृति व्याख्यान के साथ–साथ वैज्ञानिक प्रभागों में हिन्दी में सर्वाधिक वैज्ञानिक कार्य करने के लिए प्रभागीय चल–शील्ड, डिजिटल हिन्दी शोध–पत्र प्रस्तुतिकरण प्रतियोगिता (वैज्ञानिक वर्ग के कर्मियों के लिए), डिजिटल हिन्दी पोस्टर प्रस्तुति प्रतियोगिता (प्रशासनिक वर्ग के कर्मियों के लिए), हिन्दी श्रुतलेख प्रतियोगिता, हिंदीतर कर्मियों के लिए शब्दार्थ लेखन प्रतियोगिता, अंताक्षरी प्रतियोगिता तथा प्रश्न मंच प्रतियोगिता भी आयोजित की गईं। सभी प्रतियोगिताओं में संस्थान के विभिन्न वर्ग के कर्मियों ने बढ़–चढ़कर हिस्सा लिया। संस्थान में प्रत्येक वर्ष हिन्दी दिवस के अवसर पर डॉ दरोगा सिंह स्मृति व्याख्यान का आयोजन किया जाता है। इस वर्ष इस कड़ी का बत्तीसवाँ व्याख्यान भारतीय विश्वविद्यालय संघ की महासचिव, डॉ. (श्रीमती) पंकज मित्तल द्वारा दिया गया और इस कार्यक्रम की अध्यक्षता संस्थान के निदेशक महोदय द्वारा की गई। दिनांक 29 सितम्बर, 2023 को हिन्दी पखवाड़ा के समापन समारोह के अवसर पर इस दौरान आयोजित प्रतियोगिताओं के सफल प्रतियोगियों के साथ–साथ वर्ष

2022—23 के लिए सरकारी काम—काज मूल रूप से हिन्दी में करने के लिए प्रोत्साहन योजना के अंतर्गत भी नकद पुरस्कारों की घोषणा की गयी। इसके अतिरिक्त इस अवसर पर अक्टूबर, 2022 से अगस्त, 2023 तक की अवधि के दौरान संस्थान में आयोजित हिन्दी कार्यशालाओं के वक्ताओं को प्रशस्ति—पत्र प्रदान किए जाने की भी घोषणा की गयी।

हिन्दी पखवाड़ा के समापन दिवस पर (श्रीमती) पंकज मित्तल, महासचिव भारतीय विश्वविद्यालय संघ संस्थान के प्रांगण में पौधारोपण एवं बत्तीसवाँ डॉ दरोगा सिंह स्मृति व्याख्यान देते हुए

नार्म में राष्ट्रीय संगोष्ठी आयोजित

⚠ Forwarded many times

▶ YouTube

#ahmednagar #rahuri कृषी शैक्षणिक क्षेत्र डिजिटलाइज होणे गरजेचे -कुलगुरू डॉ. पी.जी...

youtube.com

https://youtube.com/watch?v=R-2SiP3t1_s&feature=share9

#ahmednagar #rahuri कृषी शैक्षणिक क्षेत्र डिजिटलाइज होणे गरजेचे -कुलगुरू डॉ. पी.जी पाटील पहा सविस्तर बातमी.

शिक्षा का भविष्य तय करने में अकादमिक प्रबंधन प्रणाली अति महत्त्वपूर्ण : कुलपति डॉ. पीके मिश्रा

National Conference on Academia-Industry-Govern[ment] Agricultural Higher Education in India held at ICA[R]

कृषी शिक्षण डिजिटलाइज व्हावे

कुलगुरू पाटील : विद्यापीठात शैक्षणिक व्यवस्थापन कार्यशाळा

लोकमत

हिन्दुस्तान

मरीज की सांस से फेफड़ों के कैंसर का पता लगाया

Annexure-I

LIST OF RESEARCH PROJECTS
01 January to 31 December, 2023

DEVELOPMENT AND ANALYSIS OF EXPERIMENTAL DESIGNS FOR AGRICULTURAL SYSTEMS RESEARCH

On going

Institute Funded

1. Efficient designs for order-of-addition experiments. (AGEDIASRISIL202100800179)

   B.N. Mandal (till 22.08.2022 and Co-PI since 23.08.2022), Sukanta Dash (PI since 23.08.2022 & Co-PI till 22.08.2022), Rajender Parsad: 09.09.2021-08.06.2024

2. Efficient designs for double cross experiments under fixed/mixed effects model (AGEDIASRICIL202101300184)

   ICAR-IASRI: Harun, Cini Varghese; ICAR-DPR: L. Leslie Leo; ICAR-IARI: Mallikarjuna M.G: 11.11.2021-10.11.2024

Outside Funded

3. Designing and analysis of On-farm and On-station research experiments planned under AICRP on IFS. Funded by AICRP on IFS as Voluntary Centre, ICAR-IIFSR, Modipuram. (AGEDIASRISOL202300900223)

   Cini Varghese, Sukanta Dash, Susheel Kumar Sarkar, Harun: 15.03.2023-31.03.2026

4. Planning, designing and analysis of data relating to experiments for AICRP on Long Term Fertilizer Experiments. Funded by AICRP on Long Term Fertilizer Experiments as Voluntary Centre, ICAR-IISS, Bhopal (AGEDIASRISOL 201702100107)

   B.N. Mandal (till 22.08.2022), Aninditta Datta, Sunil Kumar Yadav (till 10.04.2023): 01.04.2017-31.03.2026

5. Application of next-generation breeding, genotyping, and digitalization approaches for improving the genetic gain in Indian staple crops. (AGEDIASRICOP201900200148)

   ICAR-IARI: A.K. Singh, Ranjith Kumar Ellur, S. Gopala Krishnan, C. Bharadwaj, Shailesh Tripathi, Rajbir Yadav, Harikrishna, Neelu Jain, M. Ganapathi, Jyoti Kaul, R.S. Raje, G. Rama Prashat, Durgesh Kumar; ICAR-IIMR: T. Nepolean, Madusudhana, B. Aruna, Sanjana Reddy; ICAR-IIPR: Abhishek Bohra, B. Mondal; ICAR-CPRI: Vinay Bhardwaj, Vinod; ICAR-NRRI: J.N. Reddy, Anandan; ICAR-IIRR: L.V. Subbarao, Abdul Fiaz; ICAR-IIWBR: Satish Kumar, Ravish Chatrath; ICAR-Project Coordinating Unit (Pearl millet): Vikas Khandelwal; ICAR-Project Coordinating Unit (Chickpea): A.K. Srivastava; ICAR-IASRI: Susheel Kumar Sarkar; ICRISAT/Excellence in Breeding Platform, CIMMYT: Abhishek Rathore: 22.01.2019-31.03.2024

6. Biomass and carbon mapping across altitudinal gradient of major Darjeeling and Sikkim Himalayan land uses: implications for carbon sink management and mitigation. Funded by DST (AGEDIASRICOP202100400175)

   UBKV: Sumit Chakravarty, Gopal Shukla and Ganesh Banik; ICAR-IASRI: Arpan Bhowmik (till 08.04.2022), Ankur Biswas (since 09.04.2022): 10.02.2021-09.05.2024

7. Diversified farming through livestock and agriculture under farmer farm, innovations, resources, science and technology programme. (ICAR-CIRB Farmer First) (AGEDIASRICOP202101500186)

   ICAR-CIRB: Sarita Yadav, Ashok K. Boora, P.C. Lailer, Sajjan Singh, Bharat Singh; ICAR-IARI: Manjeet Singh; ICAR-IASRI: Anil Kumar, Sukanta Dash: 25.11.2021-31.03.2024

Completed

Outside Funded

8. Sustainable biochar production and use through rice-cotton based agro-forestry system in Odisha: A climate resilient soil management approach. (AGEDIASRICOP202100700178)

   ICRAF: Javed Rizvi, Shiv K. Dhyani, Aqeel Hasan Rizvi, Archna Singh; ICAR-IISS: Brij Lal Lakaria,

Promod Jha, A K Biswas; ICAR-IASRI: B.N. Mandal (till 22.08.2022), Ajit (PI since 23.08.2022 & Co-PI till 22.08.2022), Rajender Parsad: 25.08.2021-31.05.2023

New Initiated

Institute Funded

9. Statistical analysis and online solution of neutrosophic data derived from designed experiments. (AGEDIASRISIL202300600220)
    Cini Varghese, Sukanta Dash, Susheel Kumar Sarkar, Anindita Datta, Harun: 07.08.2023-06.08.2026

FORECASTING, MODELLING AND SIMULATION TECHNIQUES IN BIOLOGICAL AND ECONOMIC PHENOMENA

On-going

Institute Funded

10. Potential irrigated area mapping through remotely sensed high-resolution data. (AGEDIASRICIP202102100192)
    CAR-IIWM: R.K. Jena, R.R. Sethi; ICAR-NBSS&LUP: Nirmal Kumar; Office of Climate Research and Services, IMD, Pune: S. Khedikar; ICAR-IASRI: Upendra Kumar Pradhan: 05.09.2021-04.09.2024
11. An effective approach for combining time series and deep learning models. (AGEDIASRISIL202101600187)
    Yeasin, Ranjit Kumar Paul: 25.11.2021-24.04.2024
12. Development of spatio-temporal neural network models for forecasting space-time data. (AGEDIASRISIL202101900191)
    Mrinmoy Ray, K.N. Singh, Kanchan Sinha, Rajeev Ranjan Kumar: 21.12.2021- 20.06.2024
13. Modelling of proportional data for forewarning pest attacks in crops. (AGEDIASRISIL202200700200)
    Bishal Gurung (till 18.08.2023), Achal Lama (since 19.08.2023), K.N. Singh: 21.05.2022-20.11.2024
14. Forest cover trend and above ground biomass estimation using advanced statistical technique based on remote sensing data. (AGEDIASRISIL202201700210)
    ICAR-IASRI: Yeasin, Ranjit Kumar Paul, Ajit; IIRS, ISRO: Dipanwita Haldar: 22.10.2022-21.10.2025
15. A novel approach for time series forecasting of demand and supply of food grains in India. (AGEDIASRISIL202201900212)
    Wasi Alam, Kanchan Sinha, Prawin Arya: 28.11.2022-27.05.2024

Outside Funded

16. Market information system. ICAR-NIAP (AGEDIASRICOP202200100194) ICAR-NIAP: Purushottam Sharma; ICAR-IASRI: Ranjit Kumar Paul, Yeasin, A.K. Paul, Ajit: 22.01.2022- 31.03.2026

Completed

Institute Funded

17. Forecasting onion prices using deep learning techniques. (AGEDIASRISIL202100300174)
    Kanchan Sinha, K.N. Singh, Mrinmoy Ray, Harish Kumar H.V. (till16.10.2022): 20.02.2021-19.04.2023
18. Modelling and forecasting for time-to-event analysis in agriculture. (AGEDIASRISIL202000500164)
    Himadri Ghosh, A.K. Paul; ICAR- NBPGR: Sherry Jacob: 22.06.2020-21.06.2023

Outside Funded

19. Forecasting agricultural output using space agrometeorology and land based observations (FASAL) (AGENIASRICOP201600700076)
    IMD: K.K. Singh; ICAR-IASRI: K.N. Singh, Achal Lama (since 31.10.2018): 13.04.2016-04.10.2023
20. Doubling farmers' income in India by 2021-22: Estimating farm income and facilitating the implementation of strategic framework. Funded by Department of Agriculture, Cooperation and Farmers Welfare, Ministry of Agriculture, and Farmers Welfare, Govt. of India. (AGENIASRICOP201700600092)
    ICAR-NIAP: Suresh Pal, Raka Saxena, Naveen P. Singh, Usha R Ahuja; ICAR-IASRI: R.K. Paul: 31.03.2017- 31.03.2023

21. Modeling insect pests and diseases under climate change and development of digital tools for pest management, National Innovations in Climate Resilient Agriculture (NICRA). (AGEDIASRICOP201701500101)
   ICAR-NCIPM: S. Vennila, M.N. Bhat, Niranjan Singh; ICAR-CRIDA: M. Prabhakar, M.S. Rao; ICAR-IASRI: Ranjit Kumar Paul: 20.06.2017-31.03.2023

New Initiated

Institute funded

22. An AI-based approach for modelling evapotranspiration using remote sensing observations. (AGEDIASRISIL202301300227)
   Himadri Shekhar Roy, Yeasin, Ranjit Kumar Paul, Prakash Kumar: 14.11.2023-13.05.2026

DEVELOPMENT OF TECHNIQUES FOR PLANNING AND EXECUTION OF SURVEYS AND STATISTICAL APPLICATIONS OF GIS AND REMOTE SENSING IN AGRICULTURAL SYSTEMS

On-going

Institute Funded

23. A regression type estimator in dual frame surveys under two-stage sampling. (AGEDIASRISIL202200800201) Bharti, Kaustav Aditya, Deepak Singh, Rahul Banerjee: 01.08.2022-30.11.2024
24. Machine learning models in complex surveys for crop yield estimation. (AGEDIASRISIL202200900202) Pankaj Das, Ankur Biswas, Tauqueer Ahmad, Prachi Misra Sahoo: 02.09.2022- 01.09.2025
25. Model-assisted estimators using survey weighted artificial neural networks in complex surveys. (AGEDIASRISIL202201500208)
   Deepak Singh, Raju Kumar, Samarth Godara, Bharti: 10.10.2022- 31.03.2025
26. Development of robust estimator by integrating data from different surveys. (AGEDIASRISIL202202000213)
   Rahul Banerjee, Pankaj Das, Raju Kumar, Ankur Biswas: 28.11.2022-27.11.2024

Outside Funded

27. Energy audit survey of AICRP on EAAI: sampling design and analysis. Funded by AICRP on EAAI as Voluntary Centre, ICAR-CIAE, Bhopal. (AGEDIASRICOP201802000129)
   ICAR-CIAE: K.C. Pandey (till 17.02.2022), M. Din (since 18.02.2022); ICAR-IASRI: Hukum Chandra (till 26.04.2021), Kaustav Aditya (since 27.04.2021) Susheel Kumar (till 05 07.2018), Pradeep Basak (till 30.11.2020), Ajit, Bharti (since 23.11.2021): 01.06.2018-31.05.2026
28. Integrated sample survey solution for major livestock products. Funded by Animal Husbandry Statistics Division, Department of Animal Husbandry, Dairying & Fisheries Ministry of Agriculture and Farmers Welfare, Govt. of India. (AGEDIASRISOL201900800154)
   Prachi Mishra Sahoo, Tauqueer Ahmad, Ankur Biswas, Pradip Basak (till 30.11.2020), Anil Rai (till 23.01.2023), S.B. Lal: 28.03.2019-31.01.2025
29. Planning of survey and analysis of AICRP data on honey bees and pollinators (AGEDIASRICOP202100600177) ICAR-IARI: Balraj Singh; Project Coordinator, AICRP on Honey Bees & Pollinators: Kumaranag, K.M; ICAR-IASRI: Deepak Singh: 30.03.2021- 31.03.2026
30. Agri-drone in ICAR: ICAR-IASRI component. Funded by ICAR HQ through ATARI, Jodhpur. (AGEDIASRICOL202201200205)
   Tauqueer Ahmad, Prachi Mishra Sahoo, K.K. Chaturvedi, Ankur Biswas, Pankaj Das: 21.07.2022-31.03.2024
31. Planning and data analysis of FSSAI and NeTSCoFAN surveys. Funded by FSSAI. (AGEDIASRICOL202201300206)
   ICAR-IASRI: Deepak Singh, Raju Kumar, Ankur Biswas, Tauqueer Ahmad, Prachi Mishra Sahoo, Kaustava Aditya, Bharti, Pankaj Das, Rahul Banerjee; ICAR- IIHR: R. Venugopalan; ICAR- CARI: Sandeep Saran; ICAR- CIFT: Satyen Kumar Panda, Girish Patil, S.; ICAR-NRCM: Yogesh Gadekar; ICAR-NRCG: Ahammed Shabeer T.P. : 22.07.2022-20.10.2023

Completed

Institute Funded

32. A study on domain calibration estimators under two stage sampling design. (AGEDIASRISIL202100100172)
Kaustava Aditaya, Vandita Kumari (till 16.10.2021), Hukum Chandra (till 26.04.2021), Pankaj Das, Raju Kumar (since 23.11.2021): 18.01.2021-17.09.2023

New Initiated

Outside Funded

33. Development of methodology for CCE on squash and methodological improvement for CCE on Cashewnut, Pineapple and Arecanut etc. in Meghalaya, Funded by DES, Govt. of Meghalaya. (AGEDIASRISOL202301000224)
Tauqueer Ahmad: 26.07.2023-25.01.2025

DEVELOPMENT OF STATISTICAL TECHNIQUES FOR GENETICS/COMPUTATIONAL BIOLOGY AND APPLICATIONS OF BIOINFORMATICS IN AGRICULTURAL RESEARCH

On-going

Institute Funded

34. Network project on agricultural bioinformatics and computational biology. (AGEDIASRISOL202000900168)
Anil Rai (PI till 23.01.2023), Rajender Parsad (PI 24.01.2023-12.07.2023), Girish Kumar Jha (PI since 13.07.2023), Dinesh Kumar (till 02.12.2021 and again from 01.03.2023 onwards), Monendra Grover, U.B. Angadi, Sunil Kumar, K.K. Chaturvedi, S.B. Lal, Anu Sharma, Sarika, M.A. Iqueabal, Samir Farooqui, Sanjeev Kumar, Dwijesh Chandra Mishra (till 04.09.2023), Sudhir Srivastava, Neeraj Budhlakoti, Ratna Prabha (till 09.03.2023), Sarika Sahu: 12.07.2020-31.03.2025

35. Development of artificial intelligence framework for prediction of protein 3D structure. (AGEDIASRISIL202100500176)
U.B. Angadi, K.K. Chaturvedi, Sudhir Srivastava: 16.03.2021-15.03.2024

36. Development of machine learning models and Bayesian network for discovery of nucleic acid-binding protein and their application in disease/pest surveillance. (AGEDIASRISIL202101700188)
Upendra Kumar Pradhan, Samarendra Das (till 02.04.2022), Prabina Kumar Meher, Sanchita Naha (since 06.12.2022): 25.11.2021-24.05.2024

37. Statistical approaches for analysis of zero-inflated and over-dispersed counts data and their application in single cell studies. (AGEDIASRISIL202101800189)
Samarendra Das (till 02.04.2022 as PI), Upendra Kumar Pradhan (since 03.04.2022 as PI), Upendra Kumar Pradhan (till 02.04.2022 as Co-PI), Sudhir Srivastava, Prakash Kumar, ICAR/DFMD: Samarendra Das (since 13.09.2022 as Co-PI): 25.11.2021-24.05.2024

38. Improving seed health and storage system. (AGEDIASRICIP202200200195)
ICAR-IISS: Arvind Nath Singh; ICAR-IASRI: Sunil Kumar: 25.01.2022-31.03.2026

39. Development of artificial intelligence and big data analytics-based framework for predicting protein-ligand interaction. (AGEDIASRISIL202200600199)
Sneha Murmu, Soumya Sharma, Bharati Pandey (till 29.12.2022), Samir Farooqi, Ritwika Das (since 06.02.2023): 11.05.2022-11.02.2025

40. Meta-analysis of crop rhizosphere microbiome for identification of abiotic stress responsive microbial signatures and development of integrated information system. (AGEDIASRISIL202201000203)
Ratna Prabha (till 09.03.2023), Sudhir Srivastava (since 10.03.2023), Sarika Sahu: 02.09.2022-01.03.2025

41. Mining agricultural microbiome datasets for Antibiotic Resistance Genes (ARG) diversity and prediction of microbial resistome. (AGEDIASRICIP202201400207)
ICAR-NBAIM: Kumar M., Harsh Vardhan Singh, Abhijeet Shankar Kashyap, Jyoti Prakash Singh; ICAR-IASRI: Ratna Prabha (till 09.03.2023), Sunil Kumar (since 10.03.2023), Sneha Murmu (since 27.11.2023), Ritwika (since 27.11.2023): 03.10.2022- 02.04.2025

42. Development of computational pipeline(s) for identification, characterization and functional analysis of ncRNAs in agriculturally important species. (AGEDIASRISIL202201600209)

Sarika Sahu, Ratna Prabha (till 09.03.2023), Soumya Sharma, (since 20.10.2023): 18.10.2022-17.10.2024

43. Development of an integrated framework for the analysis of biogeochemical cycles from metagenomics data (AGEDIASRISIL202201800211)

Ritwika Das, Sneha Murmu, Anu Sharma: 28.11.2022- 28.05.2025

Outside Funded

44. Computational and analytical solutions for high-throughput biological data. Funded by ICAR platform on CRP Genomics. (AGENIASRISOL201502400061)

ICAR-NBFGR: Vindhya Mohindra; ICAR-IASRI: Anil Rai (till 23.01.2023), Anu Sharma, Dwijesh Chandra Mishra (till 04.09.2023), Sudhir   Srivastava, Neeraj Budhlakoti, Sarika Sahu: 04.09.2015-31.03.2026

45. Molecular markers for improving reproduction of cattle and buffaloes. Bill &   Melinda   Gates Foundation Funded, USA. (AGEDIASRICOP201803000139)

ICAR-NDRI: T.K. Datta; ICAR-CIRB: Varij Nayan; ICAR-IASRI: Dinesh Kumar (till 02.12.2021 and again from 01.03.2023 onwards), M.A. Iquebal (since 03.12.2021-28.02.2023 as a PI and again 01.03.2023 onwards as a Co-PI), Sarika, U.B. Angadi, Anil Rai (till 23.01.2023): 19.09.2018-31.07.2024

46. Characterization of genetic resources: germplasm characterization and trait discovery in wheat using genomics approaches and its integration for improving climate resilience, productivity and nutritional quality. Funded by DBT. (AGEDIASRICOP202000400163)

ICAR-NBPGR, Director: Kuldeep Singh; ICAR-IASRI: Dinesh Kumar (till 02.12.2021 and again from 01.03.2023 onwards), M.A. Iquebal (since 03.12.2021-28.02.2023 as a PI and again 01.03.2023 onwards as a Co-PI), U.B. Angadi, Dwijesh Chandra Mishra (till 04.09.2023), Neeraj Budhlakoti, Sarika: 01.04.2020-28.02.2025

47. Mainstreaming rice landraces diversity in varietal development through genome wide association studies: A model for large-scale utilization of gene bank collections of rice. Funded by DBT. (AGEDIASRICOP202000300162)

ICAR-IARI, Director: Ashok Kumar; ICAR-IASRI: Sarika, Dinesh Kumar (till 02.12.2021 and again from 01.03.2023 onwards), M.A. Iquebal: 01.05.2020-30.04.2025

48. Development of artificial intelligent based computational tools for genomic data analysis in domestic animal species (AGEDIASRISOL202101400185)

M.A. Iquebal: 12.11.2021-11.11.2024

49. Establishment of centre for bioinformatics and computational biology in agriculture-BIC at ICAR-ISRI. Funded by Department of Biotechnology. (AGEDIASRISOL202102200193)

Anil Rai (till 23.01.2023), Sunil Kumar (PI 24.01.2023-27.07.2023 and Co-PI since 16.12.2021), Girish Kumar Jha (PI since 28.07.2023), K.K. Chaturvedi, Sanjeev Kumar, MA Iquebal, Sarika, Anu Sharma, Dinesh Kumar (till 02.12.2021 and again from 01.03.2023 onwards), Monendra Grover, Dwijesh Chandra Mishra (till 04.09.2023), Samir Farooqi. U.B. Angadi, Sudhir Srivastava, Neeraj Budhlakoti: 16.12.2021-14.11.2026

50. Genomic prediction for micro-nutritional traits in bread wheat: a study on machine learning algorithm. ICAR-LBS young scientist award scheme (AGEDIASRISOL202200500198)

P.K Meher: 01.04.2022-31.03.2025

51. Genome wide association studies in giant freshwater prawn, M rosenbergii: Linkage mapping and QTL identification. NASF Funded. (AGEDIASRICOP202201100204)

ICAR- CIFA: P. Das, B.R. Pillai, Lakshman Sahoo, Debabrata Panda; ICAR-IASRI: P.K. Meher: 01.09.2022-31.08.2025

52. Minor oilseeds of Indian origin: Mainstreaming sesame germplasm for productivity enhancement and sustainability through genomics assisted core development and trait discovery. Funded by Department of Biotechnology. (AGEDIASRICOP202100200171)

NBPGR, Director: Kuldeep Singh, Rashmi Yadav & Ashok Kumar; ICAR-IASRI: U.B. Angadi, Dinesh Kumar (up to 02.12.2021 and again from 01.03.2023 onwards), Dwijesh Chandra Mishra (till 04.09.2023): 29.02.2020- 28.02.2025

Completed

Institute Funded

53. Development of statistical and computational approach for preprocessing and analysis high-throughput proteomics data with missing values. (AGEDIASRISIL202000200161)

Sudhir Srivastava, Dwijesh Chandra Mishra, U.B. Angadi, K.K. Chaturvedi: 13.03.2020- 12.06.2023

54. Assessing genetic variability in duck of eastern states (AGEDIASRICIP202100300173)

ICAR-RCER: Shanker Dayal, Rajni Kumari, P.K. Ray, Reena Kamal; ICAR-IASRI: Ratna Prabha: 08.02.2021-31.07.2023

Outside Funded

55. Genomics assisted crop improvement and management. Funded by NAHEP (AGEDIASRICOP201803200141)

ICAR-IARI: Viswanathan Chinnusamy; ICAR-IASRI: A.R. Rao (till 19.02.2020), Seema Jaggi.(20.02.2020-27.04.2021), Sudeep (28.04.2021 to till date)-CC-PI Seema Jaggi (till 19.02.2020), Sudeep (till 27.04.2021), Sanjeev Kumar, Soumen Pal, Anindita Datta: 26.09.2018-31.03.2023

56. Characterization, evaluation, genetic enhancement and generation of genomic resources for accelerated utilization and improvement of minor pulses. Funded by DBT. (AGEDIASRICOP201803500144)

ILS, Bhubaneshwar: Ajay Kumar Parida; ICAR-NBPGR: Kuldeep Singh, D.P. Wankhede; ICAR-IASRI: Sanjeev Kumar, Anu Sharma; UAS, Bangalore: Niranjana Murthy; PAU, Ludhiana: Dharminder Bhatia; CSKHPKVV, Palampur: Rajan Katoch; VNMKV, Parbhani, Maharashtra: Deepak K. Patil; ICAR-CAZRI, Jodhpur: Rajwant Kaur Kalia; World Vegetable Centre, South Asia, Hyderabad: R.M. Nair: 24.10.2018-23.04.2023

57. Identification and functional characterization of the key resistance/susceptible determinants for Sclerotinia stem rot disease in oilseed Brassica. Funded by DST. (AGEDIASRICOP202001100170)

ICAR-NIPB: Navin Chandra Gupta, Mahesh Rao, Ramcharan Bhattacharya; ICAR-IASRI: Dwijesh Chandra Mishra: 30.12.2020-04.09.2023

New Initiated

Institute Funded

58. CRP Biofortification in black rice. Funded by CRP(AGEDIASRICIP202300200216)

ICAR-IARI: Haritha Bollinedi; ICAR-IASRI: Sarika Sahu: 15.03.2023-14.03.2026

59. Statistical approach to study the ecological effects on an integrated framework for GWAS and genomic selection. (AGEDIASRISIL202300300217)

Prakash Kumar, Himadri Shekhar Roy, Neeraj Budhlakoti, Amrit Kumar Paul: 17.03.2023-16.09.2025

60. Development of prediction server for internal ribosomes entry sites in agricultural important species. (AGEDIASRISIL202300400218)

Sarika Sahu, Soumya Sharma, Dwijesh Chandra Mishra (till 04.09.2023): 14.06.2023-13.06.2025

Outside Funded

61. Genomic selection accuracy for key quality traits in potato (*Solanum Tuberosum L.*). Funded by DST. (AGEDIASRICOP202300800222)

ICAR-CPRI: Salej Sood, Vijai Kishor Gupta, Bandana Kaundal; ICAR-IASRI: P.K. Meher: 17.07.2023-16.07.2026

62. Global Challenges Research Fund (GCRF) South Asian Nitrogen Hub. (Collaborative Projects-International). (AGEDIASRICOP202300500219)

ICAR-IARI: Arti Bhatia; ICAR-IASRI: Girish Kumar Jha: 03.08.2023-28.02.2024

63. NNP Project: Sequence to Systems (S2S): Development of a genome to systems discovery software and server platform using high throughput data and Machine Learning. Funded by DBT. (AGEDIASRICOP202301100225)

CSIR-IHBT, Palampur: Ravi Shankar, Vishal Acharya, Rituraj Purohit; IISER, Mohali: K.S Sandhu; ICAR-IASRI: U.K. Pradhan, Prakash Kumar; IIT, Mandi: Samar Agnihotri, Manoj Thakur: 05.10.2023- 04.10.2028

DEVELOPMENT OF INFORMATICS IN AGRICULTURAL RESEARCH

On-going

Institute Funded

64. AI and machine learning for supply forecasts (AGEDIASRICIP202200300196)

    ICAR-NIAP: Rajni Jain, Dilip Kumar, Abimanyu Jhajhria; ICAR-IASRI: Anshu Bharadwaj, Sapna Nigam: 03.03.2022-31.03.2026

65. Development and assessment of conversational virtual agents 'Chatbots' for improving livestock, pet and poultry health and production. (AGEDIASRICIP202202100214)

    ICAR-IVRI: Rupasi Tiwari; ICAR-IASRI: Sanchita Naha, Chandan Kumar Deb: 10.10.2022-31.08.2025

Outside Funded

66. ICAR research data repository for knowledge management as KRISHI: Knowledge based Resources Information System Hub for Innovations in Agriculture. (AGENIASRICOL201503100068)

    ICAR-IASRI: Rajender Parsad, A.K. Choubey (till 20.01.2018), Anil Kumar, Mukesh Kumar, Anshu Bharadwaj, Susheel Sarkar, and Sukanta Dash (since 03.04.2017); ICAR-NAARM: A. Dhandapani; ICAR-NBSS&LUP: G.P. Obi Reddy, Nirmal Kumar, Sudipto Chattaraj; ICAR-IARI: Vinay Kumar Sehgal, Joydeep Mukerjee, Rajkumar Dhakar (since 18.01.2019); ICAR-DKMA: S.K. Singh (07.08.2019-28.02.0222), H.K. Tripathi (since 07.08.2019), Mitali Ghosh Roy; ICAR-CMFRI: J. Jayasankar; ICAR-CRIDA: N.S. Raju, P.Vijaya Kumar (Since 17.12.2017-31.03.2020), A.V.M. Subba Rao (Since 17.12.2017), Shantanu Kumar Bal (since 21.12.2018): 24.07.2015-31.03.2026

67. Knowledge management system for agriculture extension services in Indian NARES. Funded by ICAR Extramural Research Projects-Agricultural Extension Division. (AGENIASRICOL201600500074)

    ICAR-IASRI: Alka Arora, A.K. Choubey (till 20.01.2018), N.S. Rao (till 24.09.2016), S.N. Islam, Soumen Pal, Sudeep, Ajit (since 29.08.2018), R.K. Paul (since 29.08.2018); ICAR: P. Adiguru: 04.03.2016-31.03.2026

68. Management and impact assessment of farmer FIRST project. Funded by ICAR farmer FIRST programme under KVK scheme (ATARI-I). (AGENIASRICOP201700200088)

    ICAR-NIAP: Shiv Kumar, Rajni Jain, Vinayak R. Nikam, Kinsly IT, Abhimanyu Jhajhria; ICAR-NAARM: P. Venkatesan, Bharat S. Sontakki, N. Sivaramane; ICAR-IASRI: Mukesh Kumar, Anshu Bharadwaj, Soumen Pal; ICAR-DKMA: Aruna T. Kumar, Mitali Ghosh Rai: 14.02.2017-31.03.2026

69. Investments in Indian Council of Agricultural Research leadership on agricultural higher Education (NAHEP Component-2 Funded). (AGEDIASRISOL201900500151)

    ICAR-IASRI: Sudeep, Alka Arora, Anshu Bharadwaj, Mukesh Kumar, Shashi Dahiya, Pal Singh (till 30.06.2021), S.N. Islam, Soumen Pal, Ajit, V. Ramasubramanian (till 12.07.2023), Mrinmoy Ray, Achal Lama, Arpan Bhowmik (since 13.12.2019 to 08.04.2022); ICAR-NAARM: S.K. Soam, D. Thammi Raju, N. Srinivasa Rao, Alok Kumar, V.V. Sumanthkumar, Sanjiv Kumar, Surya Rathore; ICAR-NIAP: Rajni Jain: 28.02.2019-31.08.2024

70. Cereal Systems Initiative for South Asia (CSISA) integration with KVK portal. Funded by International Maize and Wheat Improvement Center (CIMMYT) through Extension Division, ICAR. (AGEDIASRICOP202000700166)

    Soumen Pal, Alka Arora, Sudeep, S.N. Islam, Ajit, R.K. Paul: 01.04.2020-31.03.2025

71. Resilient Agricultural Education System (RAES). (AGEDIASRISOL202101000181)

    Sudeep, Alka Arora, Anshu Bharadwaj, Ajit, V. Ramasubramanian (till 12.07.2023), Shashi Dahiya, S.N. Islam, SoumenPal, Sanchita Naha, Madhu, Samarth Godra: 29.07.2021-31.08.2024

72. KISAN SARATHI (Powered by IIDS): System of agri-information resources auto-transmission and technology hub interface: ICT and ICAR Data Repository. (AGEDIASRICOL202100900180)

    Sanjeev Kumar, K.K. Chaturvedi, S. B. Lal, Mukesh Kumar: 09.08.2021-31.03.2026

73. Network program on Precision Agriculture (NePPA) (AGEDIASRICOP202101100182)

    ICAR- IARI: Rabi N. Sahoo; ICAR-IASRI: K.K. Chaturvedi, Sanjeev Kumar, S.B. Lal, Mukesh Kumar, Ankur Biswas, Rajeev Ranjan Kumar, Samarth Godara: 04.09.2021-31.03.2026

74. Development of artificial intelligence integrated big-data based system for automatic query-response generation and analysis of Indian farmers' queries. (AGEDIASRICIL202101900190)

    ICAR-IASRI: Samarth Godara, Madhu, Sanchita Naha; ICAR-IARI: J.P.S. Dabas: 09.12.2021-08.12.2024

Completed

Institute Funded

75. Development of an intelligent system for determining pig live weight. (AGEDIASRICIP202200400197)
ICAR-IVRI: Ayon Tarafdar, Triveni Dutt, Gyanendra K. Gaur, Rupasi Tiwari, Anuj Chauhan, Mukesh Singh; ICAR-IASRI: Chandan K. Deb, Ashraful Haque, Samarth Godara: 21.03.2022- 17.09.2023

New Initiated

Institute Funded

76. Development of precision engineering technologies for agricultural input production management and value addition to ensure profitability, sustainability and environmental safety. (AGEDIASRICIP202300100215)
ICAR-IARI; P.K. Sharma; ICAR-IASRI: Samarth Godara, Himadri Shekhar Roy: 20.01.2023-31.03.2026

77. Development of improved attention based deep learning network for analysis of agricultural image dataset. (AGEDIASRISIL202300700221)
Ashraful Haque, Chandan Kumar Deb, Akshay Dheeraj: 10.08.2023- 09.02.2026

78. Development of artificial intelligence based model and tools for genomic studies. (AGEDIASRICIP202101200183)
ICAR-NIPB: Shbana Begam; ICAR-IASRI: Samarth Godara: 11.09.2023- 10.09.2026

79. Landscape diagnostic survey of cotton production practices and crop performance in Maharashtra. Funded by Rajiv Gandhi Science and Technology Commission, Govt. of Maharashtra (AGEDIASRICIP202301200226) ICAR-CICR: Ramkrushna G.I., Y.G. Prasad, A.R. Reddy (ATARI-Hyderabad), M.V. Venugopalan, Shailesh Gawande, Rahul M. Phuke, M. Sabesh, R. Jaya Kumarvaradan ICAR-IASRI: Soumen Pal, Ranjit Kumar Paul: 10.10.2023-31.05.2024

80. Development of advanced information and communication technologies (ICTs)-based communication and education tools for millets promotion. (Collaboration with IIMR, Hyderabad). (AGEDIASRICIP202301400228)
ICAR-IIMR: Rajendra R. Chapke, I.K. Das, J. Stanley; ICAR-IASRI: Sudeep Marwaha, Shashi Dahiya, Chandan Kumar Deb, Asharaful Haque, Akshay Dheeraj: 30.11.2023-30.09.2026

CONSULTANCY/CONTRACT PROJECTS ACROSS PROGRAMS

Completed

81. To conduct IDA election through e-voting for the 15 positions for Indian Dairy Association (IDA). Contract research from Indian Dairy Association.
Sudeep Marwaha: 21.02.2022-20.02.2023

82. Study on reviewing the food loss index estimates for India and preparing assessment report for inclusion of the SDG indicator12.3.1 in the National Indicator Framework. Consultancy from FAO of the United Nations, Rome through FAO-India.
Tauqueer Ahmad, Anil Rai, Rajender Parsad, Prachi Misra Sahoo and Ankur Biswas: 11.11.2022-10.05.2023

New Initiated

83. Recruitment management system for Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya (RMS-RVSKVV). Contract research from Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya (RVSKVV), Gwalior.
Sudeep Marwaha, Chandan Kumar Deb: 25.09.2023-24.08.2024

84. Sampling procedure for selection of representative sample for food grain quality check for DCP and Non-DCP System. Consultancy from Ministry of Consumer Affairs, Food & Public Distribution (MCAFPD), Government of India.
Tauqueer Ahmad, Prachi Misra Sahoo, Rajender Parsad, Ankur Biswas, Raju Kumar and Manish Kumar: 31.10.2023-30.10.2025

85. To enhance and support the e-voting system for the Indian Dairy Association (IDA). Contract research from Indian Dairy Association.
Sudeep Marwaha: 01.03.2024-12.06.2024

DISTINGUISHED VISITORS

Following dignitaries visited the Institute in person during 2023

	Dr. G.S. Khush World Food Laureate Adjunct Professor, University of California, Davis, USA		**Dr. A.K. Singh** Director, ICAR-IARI, New Delhi
	Ms. Raksha Nikhil Khadse Honourable Member of Parliament, Raver (LokSabha), Maharashtra		**Dr. Dalip Singh** Additional Director General Economic Statistics Division, Ministry of Statistics and Programme Implementation
	Dr. Himanshu Pathak Secretary, DARE & Director General, ICAR, New Delhi		**Dr. Seema Jaggi** ADG (HRD) ICAR, New Delhi
	Dr. R.C. Agrawal DDG (Agricultural Education) and National Director, NAHEP, ICAR, New Delhi		**Dr. Bimlesh Maan** ADG (EP&HS) ICAR, New Delhi
	Dr. J.K. Jena DDG (Fisheries Science) ICAR, New Delhi		**Dr. S.K. Sharma** ADG (HRM) ICAR, New Delhi
	Dr. Tilak Raj Sharma DDG (Crop Science) ICAR, New Delhi		**Dr. D.K. Yadava** ADG (Seed) ICAR, New Delhi
	Dr. Santanu Chaudhury Director, IIT Jodhpur		**Dr. Bikas Sinha**, Former Member, National Statistical Commission, Govt. of India & Former Professor of Statistics, ISI, Kolkata

	Dr. Padam Singh Former Member, National Statistical Commission, Govt. of India & Former Assistant Director General, ICMR, New Delhi
	Sh. Rakesh Kumar Tyagi Former DDG, NSSO, Ministry of Statistics and Programme Implementation, Govt. of India
	Dr. Pankaj Mittal Secretary General, Association of Indian Universities
	Dr. K. Muralidharan Professor, Department of Statistics, The Maharaja Sayajirao University of Baroda. Vadodara, Gujarat

	Dr. Partha P Lahiri Professor and Director, Joint Programme in Survey Methodology, Department of Mathematics, University of Maryland, College Park, USA
	Dr. Maxwell Mkondiwa, Associate Scientist, Spatial Economist, CIMMYT, New Delhi
	Dr. P.S. Birthal Director, ICAR-NIAP New Delhi

ICAR-NATIONAL AGRICULTURAL SCIENCE MUSEUM (NASM)

ICAR-National Agricultural Science Museum (NASM) was conceived by the ICAR and executed by the National Council of Science Museum (NCSM), Ministry of Culture, Government of India during 2004. This museum is the only one of its kind in the country and is located in a sprawling two-storey building spread over 2000 sq. m. In this museum, the development of civilizations and Indian Agriculture since pre-historic age to the present time is displayed in a vibrant and vivid detail. Global issues pertaining to agriculture have also been presented. All this knowledge has been made available using computers, posters, models, audios as well as visuals. The responsibility of up-keep and maintenance of NASM rests with ICAR-IASRI. NASM is situated at NASC Complex, New Delhi. The major sections of the museum are:

1. Six Pillars of Agriculture

2. Agriculture in Pre-historic Period

3. Agriculture during Indus-valley Civilization

4. Agriculture during Vedic and Post Vedic Period

5. Agriculture during Sultanate and Mogul Period

6. Agriculture during British Period

7. Agricultural Science in Independent India

8. Global Issues Related to Agriculture

9. Golden Future of Indian Agriculture

10. Children Section

Following committee looks after Management, Strengthening and Modernization of NASM till June 22, 2023

1. Dr. R.C. Agrawal, DDG (Agricultural Education), ICAR	:	Chairman
2. Dr. Rajender Parsad, Director, ICAR-IASRI	:	Nodal Officer and Member
3. Assistant Director General (Farm Engineering)	:	Member
4. Dr. D.K. Yadav, ADG (Seeds), ICAR	:	Member
5. Director (Finance), ICAR	:	Member
6. Director (Works), ICAR	:	Member
7. Deputy Secretary (GAC), ICAR	:	Member
8. Dr. Seema Jaggi, ADG (HRD), ICAR	:	Member
9. Sh. V.R. Senthilkumar, ACTO (Civil), ICAR-IASRI	:	Member Secretary (till January 31, 2023)

June 23, 2023 onwards

1. Dr. R.C. Agrawal, DDG (Agricultural Education), ICAR	:	Chairman
2. Dr. Rajender Parsad, Director, ICAR-IASRI	:	Nodal Officer and Member
3. Dr. Ashok Kumar, ADG (Animal Science), ICAR	:	Member
4. Dr. S.C. Dubey, ADG (PP&B), ICAR	:	Member
5. Joint Secretary (Finance), ICAR	:	Member
6. Director (GAC), ICAR	:	Member

7. Shri Kumar Rajesh, Director (Agricultural Education), ICAR : Member

8. Director (Works), ICAR : Member Secretary

The responsibility of upkeep and maintenance of NASM rests with the Institute. Sh. RA Joshi, Chief Technical Officer, ICAR-IASRI is the In-Charge, NASM. Under the guidance of the management committee of museum, the activities of the museum relating to up-keep and maintenance are looked after. The fully air-conditioned Museum remains open to visitors on all days from 10:30 hrs to 16:30 hrs except Monday (weekly holiday). There is a nominal fee of Rs. 10/- per head, but the groups of farmers, children from school/ college are exempted from entry fee. During COVID 19, the museum was closed for some time for general public.

Attractive posters of NASM exhibits were presented during Pusa Unnati Krishi Mela, 2023 held at IARI mela ground, New Delhi during March 02-04, 2023, to the general visitors, researchers, students and farmers to give them adequate knowledge about NASM also distributed NASM Booklets & Pamphlets to the visitors.

During 2023, a total of 12,579 visitors (9397 students, 2582 NARES and Government Officials, 422 farmers, 39 foreign delegates, 127 trainees from different training programmes conducted by ICAR Institutes and other Government Departments, 10 Media personnel and 02 VIPs) visited NASM.

Dr. G.S. Khush at NASM on March 10, 2023

ACRONYMS

AICRP: All India Coordinated Research Project

ADG: Assistant Director General

ASRB: Agricultural Scientists Recruitment Board

ATARI: Agricultural Technology Application Research Institutes

ATIC: Agricultural Technology Information Centre

BASU; Bihar Animal Sciences University

BAU: Bihar Agricultural University

BHU: Banaras Hindu University

CAFT: Centre for Advanced Faculty Training

CARI: Central Avian Research Institute

CAU: Central Agricultural University

CAZRI: Central Arid Zone Research Institute

CBSE: Central Board of Secondary Education

CCS NIAM: Chaudhary Charan Singh National Institute of Agricultural Marketing

C-DAC: Centre for Development of Advanced Computing

CIAE: Central Institute of Agricultural Engineering

CICR: Central Institute of Cotton Research

CIFA: Central Institute of Freshwater Aquaculture

CIFE: Central Institute of Fisheries Education

CIFRI: Central Inland Fisheries Research Institute

CIRB: Central Institute for Research on Buffaloes

CIRG: Central Institute for Research on Goats

CMFRI: Central Marine Fisheries Research Institute

CIMMYT: International Maize and Wheat Improvement Center

CIPHET: Central Institute of Post Harvest Engineering & Technology

CPRI: Central Potato Research Institute

CRIDA: Central Research Institute on Dryland Agriculture

CSKHPKV: Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya

DAHD: Department of Animal Husbandry and Dairying

DARE: Department of Agricultural Research and Education

DBT: Department of Biotechnology

DFMD: Directorate of Foot and Mouth Disease

DG: Director General

DDG: Deputy Director General

DES: Department of Economics and Statistics

DKMA: Directorate of Knowledge Mangement in Agriculture

DFPD: Department of Food and Public Distribution

DPR: Directorate of Poultry Research

DRMR: Directorate of Rapeseed Mustard Research

DST: Department of Science and Technology

EAAI: Energy for Agriculture and Agro-based Industries

FAO: Food and Agriculture Organization of the United Nations

FSSAI: Food Safety and Standards Authority of India

GKVK: Gandhi Krishi Vigyan Kendra

IARI: Indian Agricultural Research Institute

ICAR-RCER: ICAR Research Complex for Eastern Region

ICARDA: International Center for Agriculture Research in the Dry Areas

ICRAF: International Center for Research in Agroforestry

ICRISAT: International Crops Research Institute for the Semi-Arid Tropics

ICT: Information and Communications Technology

IFS: Integrated Farming Systems

IIFSR: Indian Institute of Integrated Farming Systems

IIHR: Indian Institute of Horticultural Research

IGFRI: Indian Grassland and Fodder Research Institute

IMD: India Meteorological Department

IIMR: Indian Institute of Maize Research

IIMilletsR: Indian Institute of Millets Research

IPR: Intellectual property rights

IIPR: Indian Institute of Pulses Research

IIRR: Indian Institute of Rice Research

IISeedS: Indian Institute of Seed Science

IISR: Indian Institute of Soybean Research

ISO: International Organization for Standardization

ISRO: Indian Space Research Organization

IISS: Indian Institute of Soil Sciences

IIWBR: Indian Institute of Wheat and Barley Research

IIWM: Indian Institute of Water Management

IIVR: Indian Institute of Vegetable Research

IVRI: Indian Veterinary Research Institute

KCC: Kisan Call Center

KVK: Krishi Vigyan Kendra

LTFE: Long Term Fertilizer Experiments

MCAF&PD: Ministry of Consumer Affairs, Food and Public Distribution

MeitY: Ministry of Electronics and Information Technology

NAARM: National Academy of Agricultural Research and Management

NAAS:National Academy of Agricultural Sciences

NABARD: National Bank for Agriculture and Rural Development

NADCL: National Agriculture Development Co-operative Ltd

NASC: National Agricultural Science Complex

NAHEP:National Agricultural Higher Education Project

NARES: Indian National Agricultural Research & Education System

NBAIM: National Bureau of Agriculturally Important Microorganisms

NBAIR: National Bureau of Agricultural Insect Resources

NBFGR: National Bureau of Fish Genetic Resources

NBPGR: National Bureau of Plant Genetic Resources

NBSSLUP: National Bureau of Soil Survey and Land Use Planning

NCERT: National Council of Educational Research and Training

NCIPM: National Research Centre for Integrated Pest management

NDKSP: Nanaji Deshmukh Krushi Sanjivani Prakalp

NDRI: National Diary Research Institute

NIAP: National Institute of Agricultural Economics and Policy Research

NIC: National Informatics Centre

NICRA: National Innovations on Climate Resilient Agriculture

NIFMD: National Institute of Foot and Mouth Disease

NIPB: National Institute For Plant Biotechnology

NRCB: National Research Centre for Banana

NRCE: National Research Centre on Equines

NRCG: National Research Centre for Grapes

NRCM: National Meat Research Centre on Meat

NRRI: National Rice Research Institute

OFR: On Farm Research

PAU: Punjab Agricultural University

POCRA: Project on Climate Resillient Agriculture

PPVFRA: Protection of Plant Varieties and Farmers' Rights Authority

RCER: Research Complex for Eastern Region

RCNEHR: Regional Complex for North Eastern Hilly Region

RLBCAU: Rani Lakshmi Bai Central Agricultural University

RVSKVV: Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya

SAARC: South Asian Association for Regional Cooperation

SAUs: State Agricultural Universities

SDGs: Sustainable Development Goals

SKNAU: Sri Karan Narendra Agriculture University

SMD: Subject Matter Division

UAS: University of Agricultural Sciences

UBKV: Uttar Banga Krishi Viswavidyalaya

VNMKV: Vasantrao Naik Marathwada Krishi Vidyapeeth

WTC: Water Technology Centre

IASRI
Annual Report-2023

Digital India
Power To Empower

हर कदम, हर डगर
किसानों का हमसफर
भारतीय कृषि अनुसंधान परिषद

*Agri*search *with a* **h**uman touch

स्वच्छ भारत
एक कदम स्वच्छता की ओर

ICAR-Indian Agricultural Statistics Research Institute
Library Avenue, Pusa, New Delhi - 110012
https://iasri.icar.gov.in
ISO 9001:2015 Certified Institute