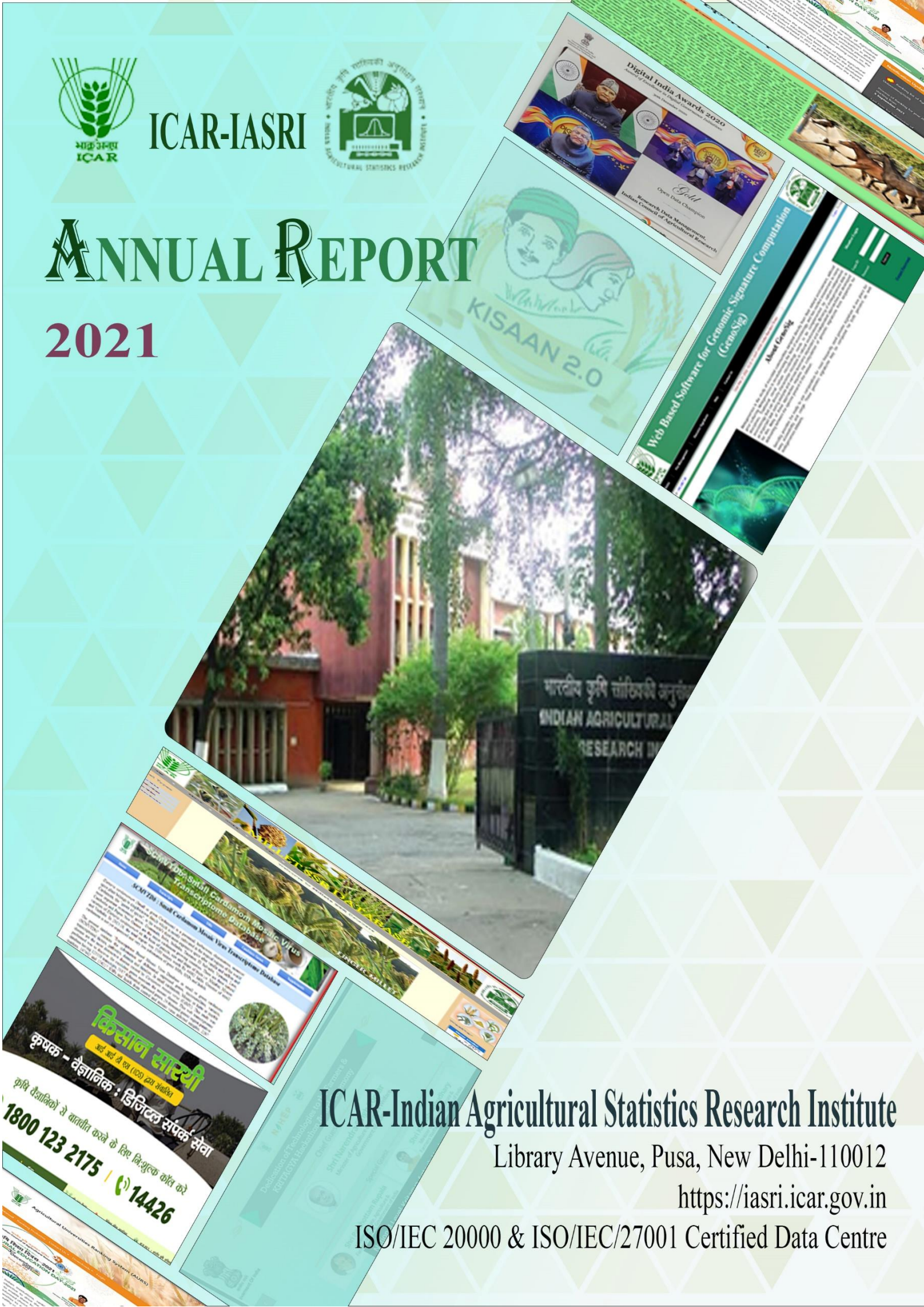
ICAR-IASRI

ANNUAL REPORT

2021



ICAR-Indian Agricultural Statistics Research Institute

Library Avenue, Pusa, New Delhi-110012

https://iasri.icar.gov.in

ISO/IEC 20000 & ISO/IEC/27001 Certified Data Centre

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CONTENT

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 – 31 July 2017
Dr. A.K. Choubey (A)..... 01 August 2017 – 21 Jan 2018
Dr. L.M. Bhar (A)..... 22 Jan 2018 onwards
Dr. Tauqueer Ahmed ..... 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)

Preface

It is a matter of proud privilege, immense pleasure and great satisfaction to present the Annual Report 2021 (January-December) of ICAR-Indian Agricultural Statistics Research Institute (ICAR-IASRI with proven track record and science based commitment of carrying out research, teaching and training in the area of Agricultural Statistics (Sample Surveys, Design of Experiments, Statistical Modeling & Forecasting and Statistical Genetics) and Informatics (Computer Applications and Bioinformatics). This report highlights the research achievements that came to fruition in the year 2021, new methodologies developed, consultancy services provided, significant methodological and computational support, dissemination of knowledge acquired and human resource development, particularly post graduate and doctoral level teaching and research guidance. The esteemed scientists, technical personnel, administrative, finance and other staff have rose to the occasion and put in their best efforts in fulfilling the mandate of the Institute.

During the year 2021, twenty new research projects (07 Institute funded, 04 in collaboration with other Institute and 09 outside funded) were initiated and progress of seventy-nine on-going research projects (20 Institute funded, 15 in collaboration with other Institute and 44 outside funded) were reviewed and twenty-two research projects were declared as complete.

Sampling methodology for 2019/20 Lao Agriculture Census has been developed as part of a study funded by Food and Agriculture Organization of the United Nations. Estimation procedure was developed as per the proposed sampling strategy. Estimation procedure document including calculation of sample weights, effect of non-response and step by step method of calculation of estimates along with standard errors has been prepared. Remote assistance in implementing estimation procedures for variables of interest and estimation of standard errors, percent coefficient of variation and in calculation of sampling weights has been provided to the officials of Lao Statistics Bureau (LSB), Lao PDR.

In agricultural, animal, fisheries and industrial experimentation under block design setup, systematic trend may affect the response under consideration. Considering this, a method of constructing classes of Trend Free Partially Balanced Incomplete Block (TR-PBIB) designs based on different association scheme has been developed. For providing readymade solutions to the end users, SAS macros for the generation of such designs have also been developed and made available in public domain.

KISAN-SARATHI: System of Agri-information Resources Auto-transmission and Technology Hub Interface, is an Information Communication and Technology (ICT) based interface solution with an ultimate goal to an intelligent online platform for supporting agriculture at local niche with national perspective. This also intends to provide a seamless, multimedia, multi-ways connectivity to the farmers with the latest agricultural technologies, knowledge base and the pool of large number the subject matter experts. This has been launched during 93rd foundation day of ICAR on 16 July 2021 to support the emerging need of multi-ways and multi-lingual communication among various agricultural stakeholders. This initiative will be implemented in phased manner by ICAR-Indian Agricultural Statistics Research Institute, Agricultural Extension Division, ICAR and Digital India Corporation,

MietY, Government of India. Currently the services have been started in four major states of India viz. Bihar, Madhya Pradesh, Maharashtra, and Uttar Pradesh.

Developed, a novel machine-learning algorithm called Multi-Branch Ferns (MBFerns) to build multi-branch ferns (multi-branch decision tree) and to generate key features from training dataset employing Naïve Bayesian probabilistic model as classifier. The proposed algorithm performs well for general classification problems and extracting actionable knowledge from training data.

Various training programmes were also conducted during the year (twenty training programs with more than 1000 participants). One scientist of the Institute was conferred with ICAR-Lal Bahadur Shastri Outstanding Young Scientist Award-2020 on ICAR Foundation Day on 16th July 2021 The Institute received five Copyrights during the year. The Institute has published 159 research papers in National and International refereed Journals along with other publications.

We would like to express my gratitude to Dr. Trilochan Mohapatra, Secretary (DARE) & Director General (ICAR) for his invaluable guidance, encouragement and support. We are grateful to Dr. R.C. Agrawal, DDG (Agricultural Education), ICAR for his constant direction, inspiration and support. My sincere appreciation are to all Heads of Divisions, scientists and other staff of the Institute for their devotion, whole-hearted support and cooperation in carrying out various functions and activities of the Institute. The services of the PME Cell in compiling and timely publication of the Annual Report are highly appreciated. I wish to express my sincere thanks to all my colleagues in PME Cell specifically Dr. Ajit, In-Charge-PME-Cell.

We are hopeful that the scientists in NARES/NASS will find this publication quite informative and useful and will be immensely benefitted from the information contained in it. We look forward to any suggestions and comments for its improvement.

(Rajender Parsad)

Director

Milestones

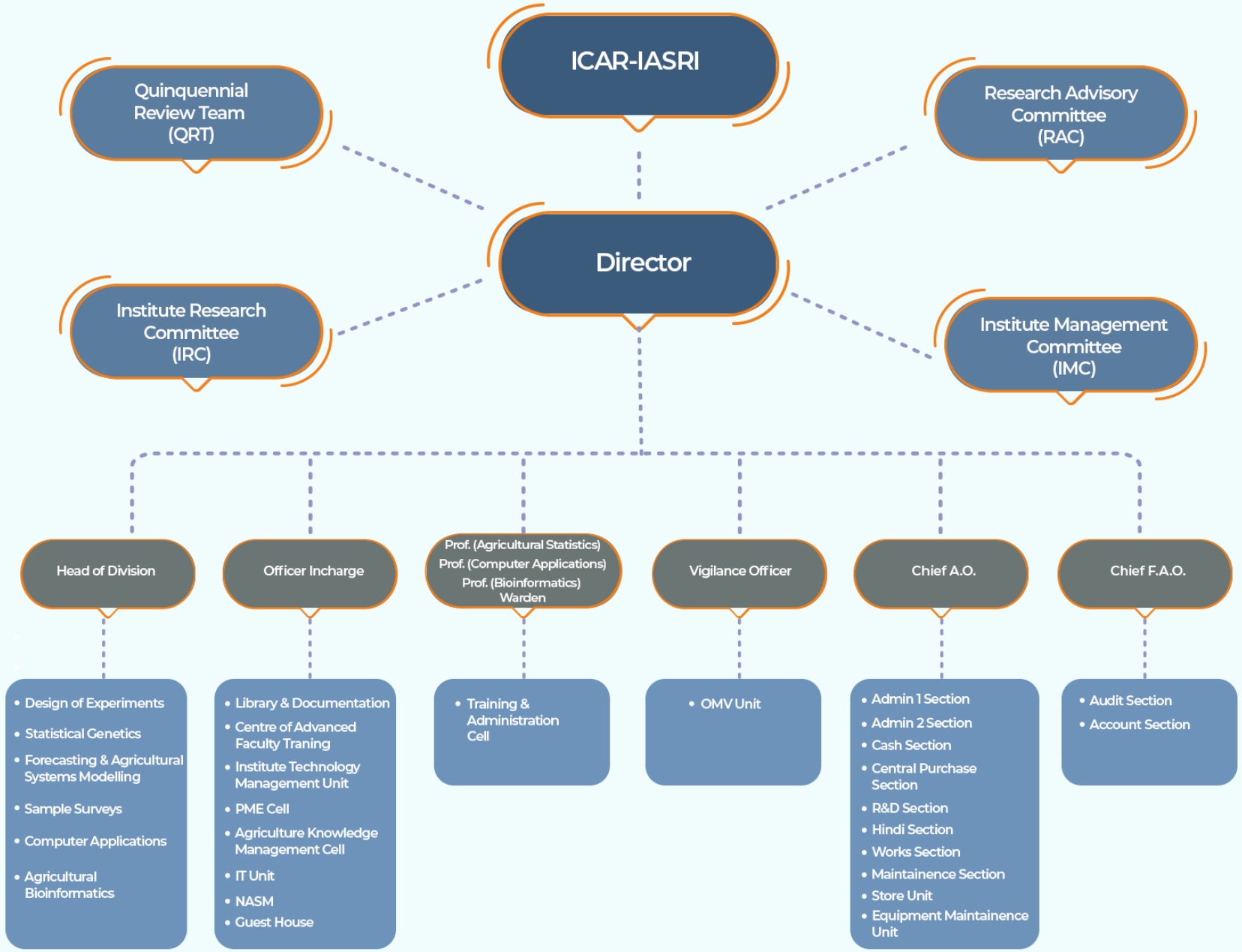
1930	*	**Statistical Section created under ICAR**
1940	*	Activities of the Section increased with appointment of Dr. PV Sukhatme
1945	*	Re-organisation of Statistical Section into Statistical Branch as a centre for research and training in the field of Agricultural Statistics.
1949	*	Re-named as Statistical 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
1956	*	Collaboration with AICRP initiated
1959	*	Re-designated as Institute of Agricultural Research Statistics (IARS)
1964	*	Installation of IBM 1620 Model-II Electronic Computer
	*	Signing of MOU with IARI, New Delhi to start new courses for M.Sc. and Ph.D. degree in Agricultural Statistics
1970	*	Status of a full fledged Institute in the ICAR system, headed by Director.
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	*	New Course leading to M.Sc. degree in Computer Application in Agriculture initiated
1989	*	Commercialization of 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	*	M.Sc. degree in Computer Application in Agriculture changed to M.Sc. in Computer Application
1995	*	Centre of Advanced Studies in Agricultural Statistics & Computer Application established by Education Division, ICAR
1996	*	Establishment of Remote Sensing & GIS lab with latest software facilities
	*	Outside funded projects initiated
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	*	Four Divisions of the Institute re-named as Sample Survey, Design of Experiments, Biometrics and Computer Applications
	*	Revolving Fund Scheme on Short Term Training Programme in Information Technology initiated.
	*	Training programmes in Statistics for non-statisticians in National Agricultural Research System initiated.
1999	*	Strengthening of LAN & Intranet with Fibre optics & UTP cabling.
	*	Substantial growth in outside funded projects and training programmes.
2000	*	Two Divisions re-named as Division of Forecasting Techniques and Division of Econometrics
2001	*	Data Warehousing activities (INARIS project under NATP) initiated
2002	*	Development of PIMSNET (Project Information Management System on Internet) for NATP
2003	*	Establishment of National Information System on Long-term Fertilizer Experiments funded by AP Cess Fund

	*	**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 NARS initiated
2006	*	Organisation of International Conference on Statistics and Informatics in Agricultural Research
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 initiated
	*	Division of Biometrics re-named as Division of Biometrics and Statistical Modelling
	*	Division of Forecasting Techniques and Division of Econometrics merged to form Division of Forecasting and Econometrics Techniques
	*	A new centre namely Centre for Agricultural Bioinformatics [CABin] created
2011	*	Maize AgriDaksh and Expert System on Seed Spices launched
	*	Indian NARS Statistical Computing Portal initiated
	*	M.Sc. degree in Bioinformatics initiated
2012	*	Software for Survey Data Analysis (SSDA) 2.0 released
	*	Division of Biometrics and Statistical Modelling re-named as Division of Statistical Genetics
	*	Division of Forecasting & Econometrics Techniques re-named as Division of Forecasting & Agricultural Systems Modelling
	*	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	*	High Performance Computing (HPC) System for Biological Computing established
	*	Ph.D. degree in Computer Application initiated
	*	Certified as ISO 9001:2008 (Quality Management System) Institute
	*	Advanced Supercomputing Hub for OMICS Knowledge in Agriculture (ASHOKA) inaugurated.
	*	ICAR-ERP system implemented.
	*	Ph.D. degree in Bioinformatics initiated.
	*	IASRI Campus Wi-Fi enabled.
	*	ICAR Data Centre, Unified Communication and Web Hosting Services for ICAR started
	*	FAO Sponsored Study under the Global Strategy for Improvement of Agricultural Statistics initiated.
2015	*	KRISHI (http://krishi.icar.gov.in/) Knowledge based Resources Information

		Systems Hub for Innovations in agriculture portal has been launched as a centralized data repository system of ICAR.
	*	ICAR-IASRI has been declared as National Level Agency (NLA) under MIDH (Mission for Integrated Development of Horticulture).
	*	ICAR Data Centre established at IASRI acquired the certification for ISO/IEC 20000 and ISO/IEC 27001 for IT-service management and information security legislation respectively.
2016	*	KVK-Portal (Krishi Vigyan Kendra Knowledge Network) and Mobile Application (http://kvk.icar. gov.in/) developed and launched.
	*	MAPI (http://sample.iasri.res.in/ssrs/android.html/) Mobile Assisted Personal Interview- An android application developed.
	*	Developed sampling methodologies for estimation of crop area and yield under mixed and continuous cropping for different situations prevailing in different countries and field tested in the three identified countries by the FAO, one each in Asia-Pacific, Africa and Latin America/ Caribbean region, i.e. Indonesia, Rwanda and Jamaica respectively.
	*	Developed methodology for estimation of area and production of Horticultural crops, tested and validated in four states. The methodology will be implemented at national level.
	*	Developed Personnel Management System, for managing the cadre strength and transfer of the scientific staff and implemented in ICAR.
2017	*	Suitable sampling methodology (aligned with existing Input Survey of Agriculture Census) for estimation of private foodgrain stock and post-harvest losses at farm level has been 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 have been developed and will be tested in the two countries (Namibia and Mexico).
	*	Produced Poverty map of spatial inequality in distribution of poverty incidence in different districts of Bihar State
2018	*	Education Portal-ICAR (https://education.icar.gov.in) developed and launched.
	*	Mobile Apps: Pashu Prajanan (Animal Reproduction) and Sukar Palan (Pig Farming) developed in collaboration with ICAR-IVRI.
2019	*	Webserver and Mobile App, VISTa (Variety Identification System of Triticum aestivum)
2020	*	Gold Icon Award in Open Data Championship Category from MEITY, Govt. of India for ICAR Research Data Management Initiative
		Sampling methodology for estimation of postharvest losses of horticultural crops (fruits and vegetables), livestock (meat and milk) and fish products has been accepted by FAO of the United Nations (FAO), Rome, Italy for adoption and were field tested in four countries namely Mexico, Zambia, Nepal and Thailand.
	*	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: An aggregator app providing an Interface to 300+ Agricultural related apps
	*	Virtual Classroom & Agri-Diksha Web Education Channel: The new paradigm of digital learning in agricultural education system has been established in 18 Agricultural Universities across India by ICAR-IASRI under the aegis of NAHEP.
	*	Kisan-SARATHI- System of Agri-information Resources Auto-transmission and Technology Hub Interface, is an Information Communication and Technology (ICT) based interface solution with an ultimate goal to an intelligent online platform for supporting agriculture at local niche with national perspective.

Organogram


ICAR-IASRI
Quinquennial Review Team (QRT)
Research Advisory Committee (RAC)
Director
Institute Research Committee (IRC)
Institute Management Committee (IMC)
Head of Division
Officer Incharge
Prof. (Agricultural Statistics)
Prof. (Computer Applications)
Prof. (Bioinformatics)
Warden
Vigilance Officer
Chief A.O.
Chief F.A.O.
• Design of Experiments
• Statistical Genetics
• Forecasting & Agricultural Systems Modelling
• Sample Surveys
• Computer Applications
• Agricultural Bioinformatics
• Library & Documentation
• Centre of Advanced Faculty Traning
• Institute Technology Management Unit
• PME Cell
• Agriculture Knowledge Management Cell
• IT Unit
• NASM
• Guest House
• Training & Administration Cell
• OMV Unit
• Admin 1 Section
• Admin 2 Section
• Cash Section
• Central Purchase Section
• R&D Section
• Hindi Section
• Works Section
• Maintainence Section
• Store Unit
• Equipment Maintainence Unit
• Audit Section
• Account Section

1 Executive Summary

Statistical tools/techniques:

Developed sampling methodologies for the different commodity groups and corresponding three guidelines for estimation of post-harvest losses of fruits and vegetables, livestock (meat and milk) and fish products which are accepted by FAO of the United Nations (FAO), Rome, Italy for adoption and were field tested in four countries namely Mexico, Zambia, Nepal and Thailand.

Methods of construction for obtaining pairwise and/or variance balanced SIRC (Structurally Incomplete Row-Column)/BILS (Balanced Incomplete Latin Square) designs have been obtained using symmetric BIB designs.

Developed, a novel machine-learning algorithm called Multi-Branch Ferns (MBFerns) to build multi-branch ferns (multi-branch decision tree) and to generate key features from training dataset employing Naïve Bayesian probabilistic model as classifier. Method of constructing classes of Method Trend Free Partially Balanced Incomplete Block (TR-PBIB) designs based on different association scheme have been developed. For providing readymade solutions to the end users, SAS macros for the generation of such designs have also been developed.

Developed an online platform, "Web-SpikeSegNet" based on a deep-learning framework for spike detection and counting from the wheat plant's visual images and digital image analysis. As spike detection and counting in wheat phenotyping are closely related to the yield, "Web-SpikeSegNet" is a significant step forward in the field of wheat crop yield phenotyping. Established estimation technique of ARIMAX and ARIMAX-GARCH models using Bayesian framework and developed a product "BayesARIMAX" which is freely accessible will provide researchers a vast opportunity to implement this model working in the domain of time series forecasting.

Developed a new hybrid model (NBPFCROS) based on parametric and non-parametric statistic for the identification of DE-genes (differentially expressed).

Proposed an innovative statistical approach and tool, namely GSQSeq (Gene Set analysis with QTL sequences), to analyse gene sets with genetically rich trait data, such as QTL.

Developed twelve R-packages:

1. eemdTDNN: EEMD and Its Variant Based Time Delay Neural Network Model
2. EEMDelm: Ensemble Empirical Mode Decomposition and Its Variant Based ELM Model
3. EMDANNhybrid: Ensemble Machine Learning Hybrid Model
4. ECTTDNN: Co-integration Based Time-delay Neural Network Model
5. MARSANNhybrid: Multivariate Adaptive Regression Spline (MARS)
6. MARSSVRhybrid: MARS SVR Hybrid
7. EMDSVRhybrid: Hybrid Machine Learning Model
8. grapesAgri1: Collection of Shiny Apps for simple Agricultural Research Data Analysis.
9. EEMDSVR: Ensemble Empirical Mode Decomposition and its Variant Based Support Vector Regression Model.
10. GreyModel: Fitting and Forecasting of Grey Model. 11. tsfngm: Time Series

Forecasting using Nonlinear Growth Models.

12. LARGB: Leaf Area Determination from Visual Image. (https://cran.r-project.org/package=LARGB).

Statistics have been developed for detection of outliers in presence of masking in survey weighted regression. A calibrated estimator has been developed for outlier imputation when auxiliary variables are available in sample surveys. The R code is written for evaluation of developed methodologies.

Contribution of ICAR-IASRI Mentioned in FAO-Guidelines on Measurement of Harvest and Post-harvest Losses of Livestock (Meat and Milk).

Sampling methodology for 2019/20 Lao Agriculture Census developed by

ICAR-IASRI has been recommended and adopted by FAO of the United Nations for conducting Agriculture Census and generating estimates for parameters of interests for Lao, PDR.

Informatics tools/techniques:

Virtual Classroom is the new paradigm of digital learning in agricultural education system, established at 18 Agricultural Universities across India. "Virtual Classroom & Agri-Diksha Web Education Channel" was inaugurated on 16th April 2021.

Developed ICAR-AU-Grievance Redressal & Monitoring System for Agricultural Universities.

"KISAN-SARATHI"- System of Agri-information Resources Auto-transmission and Technology Hub Interface, is an Information Communication and Technology (ICT) based interface solution launched on 16th July, 2021 to support the emerging need of multi-ways and multi-lingual communication among various agricultural stakeholders.

Developed and released the video film of "Agricultural University-Clean and Green Campus Awards" by Honourable Prime Minister in VC conference on 28th Sept. 2021. A booklet entitled "Strengthening the Agriculture Education through Digital Interventions" along with Agriculture Experts Information System (AEIS) and Management System for StudentREADY were released.

Developed a portal "Plant Trees" which provides a unified platform for KVKs/Institutes/AUs to record the number of trees planted, upload images of the events and record any other key information.

Developed a "BRICS Agricultural Research Platform" which allows officials of all BRICS countries to register and collaborate on various themes as per the objectives of BRICS 2020-2021 Agenda.

Mobile App for Integrated Sample Survey Solutions for Major Livestock Products: An android-based application-eLISS data collection app has been developed and is available on google play store to capture data from the field, which was collected manually using paper-based schedules by the enumerators. All the eight schedules of Integrated Sample Survey (ISS) scheme have been captured by the app.

KISAAN 2.0 (Krishi Integrated Solution For Agri Apps Navigation) App: Developed KISAAN 2.0 (Krishi Integrated Solution for Agri Apps Navigation) App envisaged to help e-agriculture and to drive smart phone based agriculture in India. This app integrates more than 300 Agricultural related apps developed by ICAR Institutes in an aggregator android mobile app. KISAN 2.0 has been developed based on data being provided through Webservices from ICAR Mobile App Gallery (KRISHI Portal).

The developing Institutes would provide data on KRISHI Portal and it would automatically be ported to KISAN 2.0. Therefore, any new application developed will be added to KISAN 2.0 and discontinued application would get removed from this mobile app. It has would get removed from this mobile app. It has been developed with an aim to make farming convenient for Indian farmer. KISAAN 2.0 app provides a single interface in multiple Indian languages for Indian farmers to access agricultural knowledge about crops, horticulture, livestock, fisheries, natural resource management, agricultural engineering, agricultural education and agricultural extension. This app will revolutionize the way how an Indian farmer avails information on advance agricultural technologies, seeds, varieties and livestock.

Salient Features:

Available in 12 regional languages.

Subject wise interactive Dashboard.

Includes 300+ Agri-Apps

Bioinformatics tools/techniques/databases/servers:

Developed 15 biological databases/web-servers in collaboration with various ICAR Institutes

1. LrSATDb:transcriptome database of seasonality associated genes of Carp fish, Rohu

2. WBMSTDb: Water Buffalo (Bubalus bubalis) Mastitis Database

3. PlantSSRDb: SSRs information accompanied with the primer pair information for 439 plants species.

4. TpGBNVDb: Thrips palmi transcriptome database

5. CsExSLDb: Cucumis sativus Extended Shelf-Life Database

6. miRbiom: Machine Learning based Webserver to Profile miRNAs

7. RBPSpot: Machine learning based webserver for RBP binding sites discovery

8. BSCM2TDb: a database on water buffalo that contain the data generated from differential DNA methylation extracted from MeDIP-seq data

9. BtChiLCVDb: online relational database of Silverleaf whitefly (transcriptome

10. SCMVTDb: transcriptome-based Mosaic Virus Database in small or green cardamom

11. ParkRoxTDB: Tree Bean (Parkia roxburghii) Transcriptome Database

12. SIReDAM: Systematic Information Resources for Dairy Animal Management

13. Levidb: Genomics of Virus in Legume Crops: Viral diagnostics of legume crop

14. Millet SSR: Computational tool stores catalogue of Millet microsatellites

15. BPDRTDb: Black Pepper Drought Transcriptome Database

Trainings conducted:

Conducted seventeen (17) on-line training programs (ranging from 2 to 21 days duration) which were attended by 1000 + participants

1. “Software and Tools for Bioinformatics” during January 11-13, 2021 with 20 participants.

2. "All India Training of Master Trainers on Web Portal and Android App for ISS Scheme" during 17-18 February 2021 with 356 participants

3. "Statistics for Social Science Scholars" for 30 M.F.Sc./ Ph.D. Fisheries Economics/ Extension students of ICAR-CIFE, Mumbai during 23rd February to 22nd March, 2021

4. "Recent Advances of Statistical Analysis in Agriculture" during 04-12 March, 2021with participants

5. "Advanced Designs for Product and Process Development Oriented Experiments" during 16-17 March, 2021.

6. "Design of experiments and Next Generation Sequencing Data Analysis" during March 16-17, 2021 for ICAR-NIBSM, Raipur.

7. सांख्यिकीय आनुवंशिकी और कृषि में इसके अनुप्रयोग" विषय पर एक हिन्दी कार्यशाला का आयोजन। (18-20 March, 2021)

8. "Next Generation Sequence Data Analysis" for Contractual staff during 22-27 March, 2021.

9. Hindi workshop on "Statistical Modelling and Forecasting in Agriculture" during 24-26 June, 2021. with 28 participants.

10. "e-Governance Applications in ICAR for Technical Staff" during 6-10 September 2021 with 56 participants.

11. "Transcriptomic Data Analysis under CRP on Genomics" during September 28-30, 2021with 118 Participants.

12. Hindi Workshop on "परीक्षण अभिकल्पना के अनुप्रयोग' during September 28-30, 2021 with 18 Participants.

13. "Statistical Techniques for Data Analysis in Agriculture" during 4-13 October 2021 with 125 participants.

14. "Experiments Data Analysis" for Technical Personnel during 20-29 October 2021 with 16 participants

15. "Molecular Structure Simulation and Modelling" during 27-30 October 2021 with 72 participants.

16. "Proteomics Data Analysis" during November 24-26, 2021 with 26 participants.

17. "SNP Mining, GWAS and Genomic Selection" during December 16-21, 2021.

Awards Received:

Dr. Prabina Meher conferred with ICAR-Lal Bahadur Shastri Outstanding Young Scientist Award-2020 on ICAR Foundation Day on 16th July, 2021.

Dr. Sayanti Guha Majumdar, IASRI Ph.D. Bioinformatics received award for best doctoral thesis in social sciences on thesis entitled "Development of Integrated Model for Genomics Selection".

Dr. D.C. Mishra received "Young Professionals Award" in the International Conference on Research Initiatives for Agriculture Biotechnology and Allied Sciences (ICRIABAS) held during 24-25, April, 2021 and organized by IIMT University, Meerut, UP.

Sh. Prakash Kumar received Young Scientist Award on the occasion of International web Conference on Global Research Initiatives for Sustainable Agriculture and Allied Science (GRISAAS, 2021) on 13th December 2021 organized by Society for Scientific Development in Agriculture & Technology(SSDAT).

2 Introduction

ICAR-Indian Agricultural Statistics Research Institute (IASRI) is a pioneer Institute of Indian Council of Agricultural Research (ICAR) undertaking research, teaching and training in Agricultural Statistics, Computer Application and Bioinformatics. Ever since its inception way back in 1930, as a small Statistical Section of the then Imperial Council of Agricultural Research, the Institute has grown in stature and made its presence felt both nationally and internationally. ICAR-IASRI has been mainly responsible for conducting research in Agricultural Statistics and Informatics to bridge the gaps in the existing knowledge. It has also been providing education/ training in Agricultural Statistics and Informatics to develop trained manpower in the country. The research and education is used in improving the quality and meeting the challenges of agricultural research in newer emerging areas.

Landmarks

The Institute has been serving the nation through the discipline of Agricultural Statistics for last 90 years (since 1930 with the initiation of Statistical Wing of the Imperial Council of Agriculture Research),
The discipline of Computer Applications in Agriculture for last 55 years (since 1965 with the installation of ICAR's first computing facility-IBM-1620 Data Processing System at IASRI), and
The discipline of Agricultural Bioinformatics for last 10 years (since 2010 with the establishment of NABG-National Agricultural Bioinformatics Grid at IASRI).

The Institute has been awarded an ISO 9001:2008 certificate in the year 2013. ICAR Data Centre established at ICAR-IASRI acquired the certification for ISO/IEC 20000 & ISO/IEC 27001 in October, 2015. ISO 20000:2011 & ISO 27001:2013. External Surveillance Audit was successfully completed at ICAR Data Centre on September 19, 2016 and it was recommended for continuation of the ISO 20000-1:2011 & ISO 27001:2013 standard by the BSI. ICAR Data Centre has been continuously providing the Unified Communication (Email, Audio, Video, Web conference etc.) and Webhosting service to ICAR and its Institutes.

The Institute has used the power of Statistics, as a science, blended judiciously with Informatics and has contributed significantly in improving the quality of Agricultural Research. To convert this vision into a reality, the Institute has set for itself a mission to undertake research, teaching and training in Agricultural Statistics and Informatics so that these efforts culminate into improved quality of agricultural research and also meet the challenges of agricultural research in newer emerging areas. 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. The Institute has made its presence felt in the National Agricultural Research and Education System (NARES). The Institute feels proud to have established the first supercomputing hub for Indian Agriculture, ASHOKA (Advanced Super-computing Hub for OMICS Knowledge in Agriculture). Linkages have been established with all National Agricultural Research organizations for strengthening statistical computing. For providing service oriented computing for the

users, Indian NARS Statistical Computing portal has been developed. Appropriate statistical techniques have been developed and recommended to researchers through advisory services. The Institute is also becoming progressively a repository of information on agricultural research data with the establishment of a Data Centre. The Institute also occupies a place of pride in the National Agricultural Statistics System (NASS) and has made several important contributions in strengthening NASS, which has a direct impact on the national policies. The Institute has contributed significantly by providing excellent human resource to NARES in the country in the disciplines of Agricultural Statistics and Informatics for meeting the challenges of Agricultural Research in the newer emerging areas. Conducting post graduate teaching and in-service courses in Agricultural Statistics, Computer Application and Bioinformatics for human resource development is an important activity.

The Institute has made some outstanding and useful contributions to research in Agricultural Statistics in the fields like Design of Experiments, Statistical Genetics, Forecasting Techniques, Statistical Modelling, Sample Surveys, Computer Applications in Agriculture, 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. It has also been very actively pursuing advisory services that have enabled to enrich the quality of agricultural research in the NARES. Besides, many projects funded by Government and Public Sector agencies like Department of Science and Technology, Directorate of Economics and Statistics, Ministry of Agriculture, Planning Commission, Ministry of Statistics and Programme Implementation (MoS&PI), Coconut Development Board have been undertaken. Some of these projects were taken on request from several Government agencies and others were awarded through competitive bidding. This has helped the Institute in resource generation as well. The Institute works in close collaboration with NARES organizations and many projects are being run in collaboration with All India Co-ordinated Research Projects and ICAR Institutes. Further linkages with the CGIAR organizations such as CIMMYT, IRRI and ICARDA have been developed.

Research-Attainments:

• Statistical Methodologies Developed: Accepted and Adopted by International Organizations

• Methodology for crop yield estimation using Crop Cutting Experiment (CCE) which was quickly adopted as the standard method recommended by the Food and Agriculture Organization of the United Nations (FAO), Rome, Italy to estimate crop production and is widely adopted by many African and Latin American countries also.

• Sampling methodology for 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.

• Sampling methodology for estimating crop area, yield and production under mixed, repeated and continuous cropping, field tested in Indonesia, Rwanda and Jamaica and accepted by FAO.

• Sampling methodology for estimation of private food grains stock at farmer level, accepted by FAO.

• For dissemination and e-advisory on designed experiments, developed a Design Resources Server (https://drs.icar.gov.in) which is being viewed and used throughout the globe and extensively in NARES.

• Statistical Methodologies Developed: Accepted and Adopted by National Organizations

• Integrated sampling methodology for estimation of harvest and post-harvest losses of major crops and commodities, adopted in conducting two national surveys on harvest and post-harvest losses in India.

• Alternative sampling methodology for estimation of area and production of horticultural crops accepted by MoA&FW, Govt. of India and adopted in Haryana State.

• Integrated methodology for crop acreage estimation in North-Eastern Hilly regions based on Remote Sensing, GIS and Ground Survey, adopted in Meghalaya, Tripura and other North-Eastern states.

• Sampling methodology for estimation of cotton production using double sampling approach, accepted by MoA&FW, Govt. of India and adopted in all major cotton growing states of the country.

• Sampling methodology for integrated sample surveys for livestock products, fish catch both from marine and inland sources, cost of production of crops as well as livestock products and adopted in all the states of the country.

• Methodology for obtaining estimates of slum population of different cities in India, adopted by Ministry of Housing and Urban Poverty Alleviation, Govt. of India.

• Methodology for producing district level poverty mapping adopted at state level.

• Experimental designs which 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.

• Designs for single factor experiments which include variance balanced, efficiency balanced, and partially efficiency balanced designs; designs for multi-response experiments; crossover designs; designs with nested structures; neighbor balanced designs; optimality and robustness aspects of designs.

• Designs for multi-factor experiments which include confounded designs for symmetrical and asymmetrical factorials; block designs with factorial structure; response surface designs, mixture experiments for single and multi-factor experiments; Orthogonal main effect plans; orthogonal arrays; supersaturated designs.

• Designs for bioassays; microarray experiments and agroforestry experiments.

• The methodology developed for forecasting based on weather variables and agricultural inputs used by Space Application Centre,

• Ahmedabad, to obtain the forecast of wheat yield at national level with only 3% deviation from the observed one.

• Methodologies Developed: Accepted and Adopted by NARES

• Analytical techniques based on mixed effects models 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.

• Procedures for estimation of genetic parameters; construction of selection

indices; studying GxE interactions; progeny testing and sire evaluations; detection of QTLs, classification of genotypes using molecular marker data.

• The modification in the procedure of estimation of genetic parameters for incorporating the effect of unbalanced-ness, presence of outliers, aberrant observations and non-normality of data.

• Procedures for studying genotype environment and QTL environments interactions for the analysis of data generated from crop improvement programmes.

• Construction of selection indices, progeny testing and sire evaluation for animal improvement programmes.

• Significant contributions in developing models for pre-harvest forecasting of crop yields using data on weather parameters; agricultural inputs; plant characters and farmers.

• Methodologies for forewarning important pests and diseases of different crops to enable the farmers to use plant protection measures judiciously and save cost on unnecessary sprays

• Forecasting of volatile data through non-linear time series models for forecasting onion price, marine products export, lac export, etc.; forecasting of India's marine fish production using Wavelet methodology.

• Methodology of small area estimation for skewed data suitable for agricultural, income and expenditure surveys.

• Methodology for spatial non-stationarity in small area estimation under area level model.

• Innovative approaches for small area estimation of crop yield, socio-economic and food insecurity parameters.

• Methodology of sample size determination for estimation of area and production of food grain crops.

• Methodology for estimation of seed, feed and wastage ratios of major food grains.

On-line-Statistical-Resources-Developed		
Statistical and computational resources hubs:	**Statistical packages:**	**CABin– Centre for Agricultural Bioinformatics:**
• Indian NARS Statistical Computing Portal • Design Resources Server • Sample Survey Resources Server • Information System on Designed Experiments • Integrated Sample Survey Solutions for Major Livestock Products	• 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) • Statistical Package for Agricultural Research (SPAR)	• National Agricultural Biocomputing Portal • Sequence Submission Portal • Advanced Super Computing Hub for Omics Knowledge in Agriculture

On-line-Digital-Informatics-Resources-Developed		
Information dissemination portals:	**Management Expert Systems:**	**E-governance:**
• KRISHI-portal **(**ICAR Research Data Repository for Knowledge Management) • KVK-portal (Krishi-Vigyan-Kendra-Knowledge-Network) • Farmers First Portal	• Academic Management System (AMS) • NISAGENET • AgriDaksh • Mushroom-AgriDaksh • Expert-System-Wheat • Expert-System-Seed-Spices • e-Platform-Seed-Spices	• ICAR-ERP (Enterprises Resources Planning) • MIS-FMS (Financial, Project, Material and Human Resource Management) • HYPM (Half-Yearly-Progress-Monitoring) • ICAR-PMS (Personal Management System) • ICAR-PIMS (Project Information and Management System) • CBP-portal (Capacity Building Program) • Education Portal (Strengthening and Development of Higher Agricultural Education in India)

Initiation of Computation facilities in ICAR-IASRI:
The institute has rich legacy of computing starting from
1965 with IBM-1620 Data Processing System
to Burroughs B4700 Mainframe Computer (1983)
to Personal Computer (1991) and to Pentium (1997)
***to RISC Server (2002) and* to supercomputing (2013),**
to Data Centre (2014) and presently
Artificial Intelligence (AI) and Cloud Computing & Disaster Recovery Centre (2020)

ICAR-National-Facilities: Strengthening, Maintenance and Updating

ICAR-Data-Centre:	**ASHOKA:**
• **ICAR DATA CENTRE**: is providing IT services efficiently to DARE, KVK, ICAR and its institutes, since Sept, 2014. The facilities are built in a state-of-art Data Centre, equipped with industry standard 960 Cores Computer, 6224 GB RAM, 400 TB Storage, Software, Application, Tools and other related technologies. There are more than 21,000 e-Mail boxes and more than 200 Portal /Website /Application. The listed DNS, Portals, Websites, Modules, Systems and Applications are being maintained and hosted at ICAR-DC. • **ARTIFICIAL INTELLIGENCE**: To pace with the emerging technologies and to provide computational solutions to NARES/NASS, 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. • **CLOUD COMPUTING & DISASTER RECOVERY CENTRE:** In the continuation expansion of ICAR Data Centre at ICAR-IASRI, ICAR is building Cloud Computing along with Disaster Recovery Centre (DRC) at NAARM, Hyderabad, which will enhance the quality, availability and easy accessibility of e-governance, research and education in the field of Agriculture in India.	• A **National Agricultural Bioinformatics Grid** (NABG), the first supercomputing hub for Indian Agriculture i.e. Advanced Supercomputing Hub for OMICS Knowledge in Agriculture – ASHOKA is built in a state-of-art Data Centre and out of nine super-computers of this grid, two super-computers are ranked at 11th and 24th in the list of top super-computers of India. A **National Bio-Computing Portal** has been launched through which authenticated users will be able to perform their biological data analysis. Also, a **Genome Submission Portal** is developed to assist our researchers for submission of their genomic data sets obtained through experimentations.

Bioinformatics-Resources-developed	Mobile-Apps-developed
• CattleAMP-Web application for antimicrobial peptides prediction in cattle • FishAMP-Web application for methodology of AMP prediction in fish • HRGPred-Web application for prediction of herbicide resistant genes • funbarRF: Web application for DNA barcode based identification of fungal species • nifPred-Web application for prediction of nitrogen fixation genes. • iAMPpred: Web application for improved prediction of Antimicrobial peptides • DIRProt: Web application for discriminating the insecticide resistance proteins • *ir*-HSP: Web application for improved recognition of Heat Shock Proteins • SPIDBAR: Web application for Species Identification using DNA Barcode • MaLDoSS: Web application for Donor Splice Site Prediction • DCDNC: Web application for discrimination of coding sequences (CDS) • Hsplice: Web application for predicting splicing junctions in vertebrates • PreDOSS: Web application for prediction of donor splice sites in eukaryotes • dssPred: Web application for prediction of donor splice sites in eukaryotic species. • TomSatDb-Tomato MicroSatellite Database • SBMDb-Sugarbeet whole genome marker discovery database • VISTa (Variety Identification System of Triticum aestivum) • BuffSatDb: Buffalo Microsatellite Database • OGR: The Onion Genomic Resources • BanSatDb: Banana Microsatellite Database • TaSSRDb: Wheat Microsatellite Database • VigSatDb: Vigna sp. Insilico and validated microsatellite database • CnTDB: Coconut Transcriptome Database • PMDTDb: Pearl Millet Drought Transcriptome Database • MiSNPDb: Mango SNP database • SCMVTDb: Small cardamom Mosaic Virus Transcriptome Database • VmTDb: Vigna mungo Transcriptome Database • WDRoTDB: Wheat drought root transcriptome database • PolyMorhPred: Polymorphism Prediction Server	• Animal Reproduction app • Pig Farming app • Landly Pig app • Artificial Insemination app • Dairy Manager app • Vaccination Guide app • Pig Ration app • Waste Management app • Veterinary Clinical app • Zoonoose app • Technologies and Services app • ICAR Technologies app • KVK app • MAPI app • Farmers First Program app • VISta app

Human Resource Development:

One of the thrust areas of the Institute is to develop trained manpower in the country in the disciplines of Agricultural Statistics and Informatics for meeting the challenges of agricultural research in the newer emerging areas

- The Institute conducts degree courses leading to M.Sc. and Ph.D. in Agricultural Statistics, M.Sc. and Ph.D. in Computer Application and M.Sc. in Bioinformatics in collaboration with Indian Agricultural Research Institute (IARI), New Delhi. Ph.D. degree in Bioinformatics has also been initiated from academic session 2014-15.

- The Institute is functioning as a Centre of Advanced Studies in Agricultural Statistics and Computer Application (CAS) which is later re-named as Centre of Advanced Faculty Training (CAFT). Under this programme, the Institute organizes training programmes on various topics of interest for the benefit of scientists of NARES. These training programmes cover specialized topics of agricultural sciences. which is later re-named as Centre of Advanced Faculty Training (CAFT). Under this programme, the Institute organizes training programmes on various topics of interest for the benefit of scientists of NARES. These training programmes cover specialized topics of agricultural sciences.

- The Institute conducts the Senior Certificate Course in Agricultural Statistics and Computing. This course is of six months 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 months duration each.
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Organizational Set-up

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

3 Research Achievements

Designing and Analysis of ON FARM Research Experiments Planned for AICRP on IFS

Resilience in agriculture production systems is closely linked to livestock, which again is not recognized or given sufficient importance. The integrated approach leads to increased-per-capita income, improved standard of living and building the resilience of the community and natural resources. Hence, integrated farming system plays critical role in increasing the income of small and marginal farmers besides production of multiple commodities within available resources and farmer's management ability, especially. AICRP on IFS initiated the farmer participatory research in 32 districts of 21 States from 2011-12 to systematically characterize the existing farming systems, identify the constraints, make collective, compatible and convenient farm interventions and study the changes. In-depth data on all components are being collected from the farmers' fields and these need to be stored and analyzed properly to give suitable recommendations. As a voluntary centre of AICRP-IFS, ICAR-IASRI handles analysis and software development for online data entry under the following three objectives:

- To provide suitable designs for layout of On-Farm Research Experiments and to identify appropriate statistical techniques for analysis of data collected
- To modify, upgrade and maintain web based software for online data entry and analysis of data pertaining to On-Farm Research Experiment 1 (Response of nutrients) and to consolidate the results
- To process and analyze the data pertaining to On-Farm Research Experiment 2 (Intensification/ diversification of the existing cropping system) and On-Farm Research
  Experiment 3 (Agronomic management practices for sustainable system.

Data Analysis (2019-2020)

1. Data pertaining to the year 2019-20 was received on 03.09.2021, for OFR2 and OFR3 both. Scrutinized the Data. Identified centre-wise gaps/errors in the data pertaining to OFR2 and OFR3 and communicated to ICAR-IIFSR.

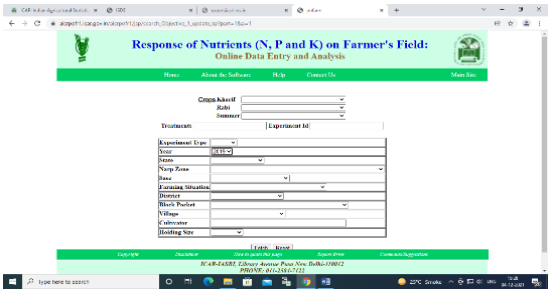
2. Processed and analysed the previous year data and analysed the data as follows:
   1) One way ANOVA is carried out to compare the performance of various FS within each centre.
   2) ANOVA has not been performed for those centres having only one type of FS.
   3) Wilcoxon signed-rank test is used to compare between existing vs. diversified systems, within each farming system, as number of households belonging to each FS are less.
   4) No statistical test is carried out to compare between existing vs. diversified systems, for those FS adopted by < 2 households.
   5) Within each centre, for overall existing vs. diversified FS comparison, paired t-test is used.

3. **Software developed and released**
   1) Following software developed for online data submission (OFR 1, 2 & 3) were released in the Annual Group Meeting of AICRP-IFS held during 18-20 December, 2021 at ICAR-IIFSR, Modipuram:
   2) **Response of nutrients on farmer's field** for online data entry and analysis of OFR 1 experiments
   3) **AICRP on IFS: Onfarm farming systems research – online data submission and analysis** for online data entry of OFR 2 experiments.
   4) **Onfarm evaluation of farming systems modules for improving profitability and livelihood of small and marginal farmers: online data entry**

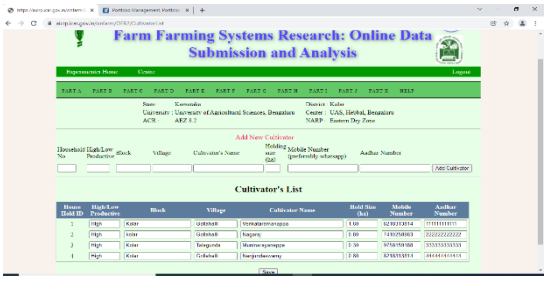
and analysis for online data entry of OFR 3 experiments.

Some snapshots are given below:

OFR 1

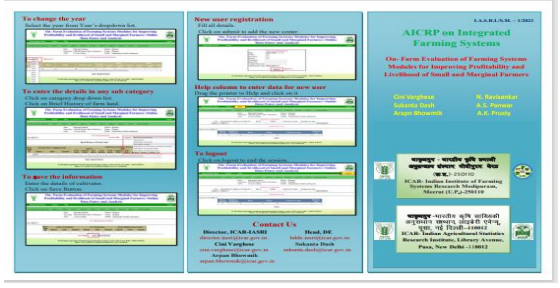


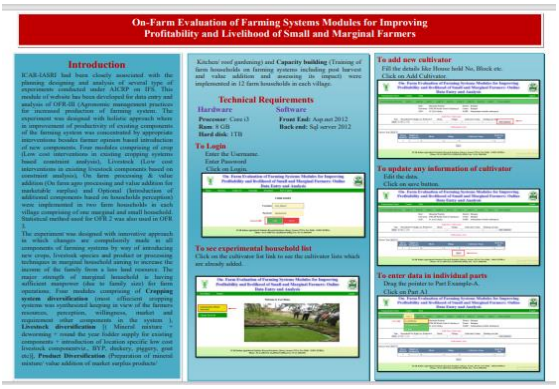
OFR 2



OFR 3

Brochure Published

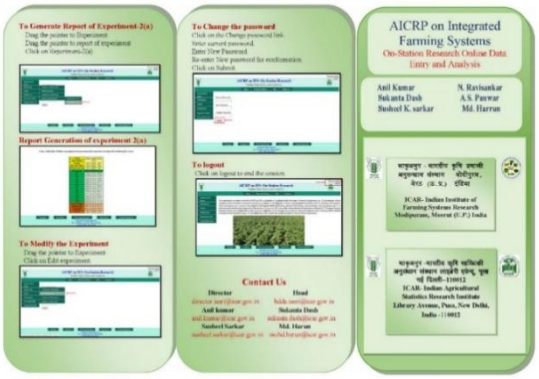


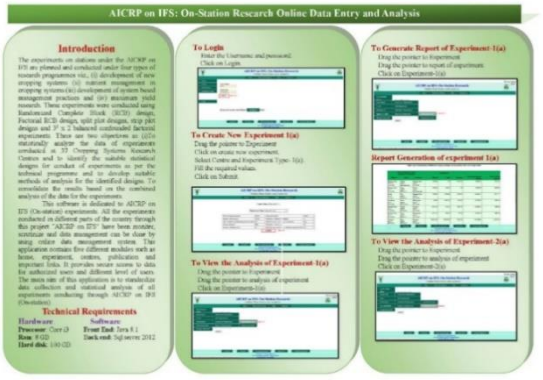


Planning, designing and analysis of experiments planned on stations under All India Coordinated Research Project on Integrated Farming Systems

Analysis of data received from 32 centers via Experiment 1(a) for the year 2019-20 have been carried out. The user end response-based rectification of newly hosted website https://aicrponstation.icar.gov.in/ for online data entry and analysis is being done. The Project Report for the period 2017-2018 to 2020-2021 is being prepared and submitted. Verification of data entry newly hosted website https://aicrponstation.icar.gov.in/ has been done and ready for use at user level. Newly hosted website https://aicrponstation.icar.gov.in/ for online data entry and analysis has been released on 18th December,2021 at ICAR-IIFSR, Modipuram in virtual mode. Online data entry and analysis of web server for On station experiments conducted under AICRP on IFS have been successfully deployed in IASRI server (URL: https://aicrponstation.icar.gov.in/) and the same has been released by Dr. S. Bhaskar, ADG(Agronomy, Agroforestry and Climate Change), ICAR on 18th December, 2021 in the Annual Group Meeting of AICRP-IFS at ICAR-IIFSR, Modipuram organized in hybrid mode by ICAR-IIFSR during 18-20 December, 2021.

Brochure Published

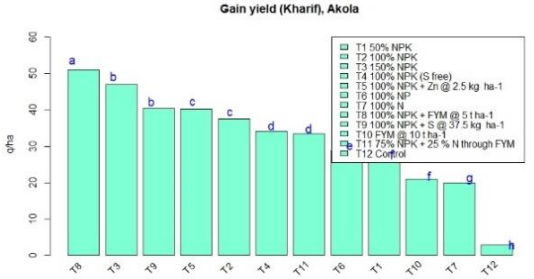


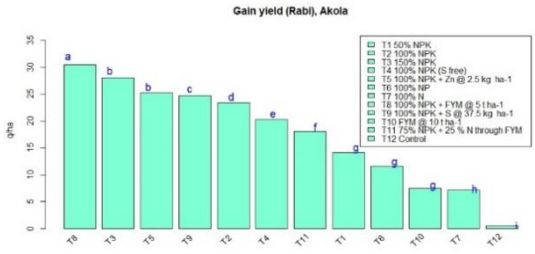


Planning, designing and analysis of data relating to experiments for AICRP on Long Term Fertilizer experiments

Long term fertilizer experiments are conducted every year at 17 cooperative centres during Summer, Kharif and Rabi seasons. Every centre has its own cropping system. Earliest experiments in some of these centres started from 1970-71 and experiments in other centres were initiated later. The main purpose of these experiments is to monitor soil health status under long term application of different fertilizer treatments in specific cropping systems. Crop productivity and soil health status is monitored by recording grain yield, macro and micro nutrients uptake by the crops and soil parameters under different fertilizer treatments.

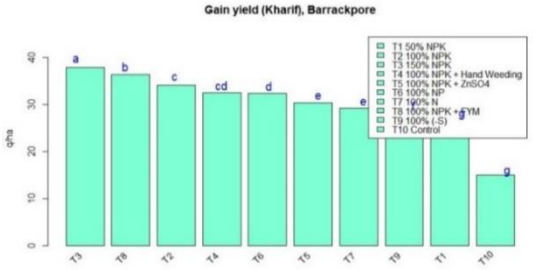
ICAR-IASRI is a voluntary centre and is mainly involved in data management and data analysis support to the project coordinating unit and the cooperating centres. During 2020, combined data analysis over years was taken up for four centres namely Akola, Barrackpore, Palampur and Raipur Analysis of 8 years (2007-08 to 2014-15) of grain yield data of Akola centre for Kharif Crop Sorghum revealed that Treatment T8 (100% NPK + FYM at 5 t/ha) gives highest grain yield of 51.12 q/ha followed by Treatment T3 (150%NPK) which gives 46.95 q/ha. Lowest grain yield (2.93 q /ha) is recorded for Treatment T12 (Control). Similarly, combined analysis was performed for 7 years of grain yield data of Akola centre for Rabi crop Wheat. Highest grain yield of 30.52 q/ha was observed for T8 (100% NPK + FYM at 5 t/ha) followed by 28.04 q/ha for T3 (150%NPK). Lowest grain yield of 0.534 q/ha was seen for T12 (Control). This clearly reveals that 100% NPK + FYM at 5 t/ha is best for grain yield sustainability in both Sorghum and Wheat in Akola region. Application of zero fertilizer cannot sustain grain yield in either crop.



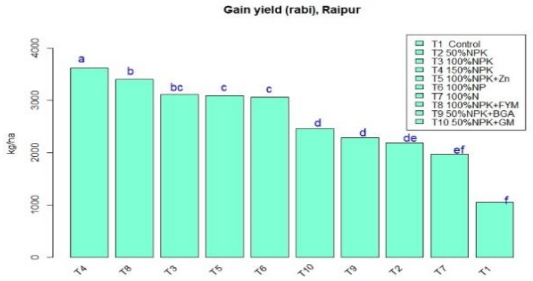


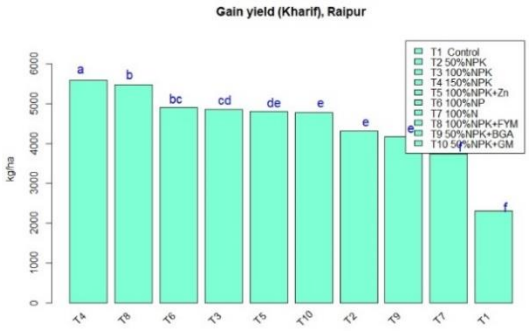
Combined analysis of Barrackpore centre has been performed for grain yield for Kharif crop (rice) based on 40 years of data (1972-73 to 2015-16). It was found that T3 (150% NPK) gives highest grain yield (37.9 q/ha) followed by T8 (100% NPK + FYM) which gives 36.4 q/ha grain yield and these two treatments are statistically at par. Lowest

grain yield (5 q/ha) was observed for T10 (unmanured control) for Kharif (rice) crop. The analysis revealed that zero application of fertilizer cannot sustain grain yield in Rice in the soil type of Barrackpore and application of 100% NPK coupled with FYM is able to maintain very good productivity level.



Combined analysis of Palampur centre has been performed for grain yield for Kharif and Rabi crops based on 45 years of data (1973-74 to 2017-18). It was found that T8 (100% NPK + FYM) gives highest grain yield (31 q/ha) and T10 (100% NPK + Lime) is also statistically at par with T8 for Wheat (Rabi) crop. Lowest treatment mean (1.83 q/ha) was observed for T7 (100% N) for Wheat (Rabi) crop. For Maize (Kharif), again T8 (100% NPK + FYM) gives highest grain yield (48.26 q/ha) followed by T10 (100% NPK + Lime) 43.23 q/ha and these were statistically at par. Lowest grain yield (3.5 q/ha) was observed for T7 (100% N) for Maize (Kharif). The analysis reveals that 100%N alone cannot sustain grain yield in Maize and Wheat in the soil type of Palampur. Similarly, zero fertilizer application also cannot sustain grain yield in Maize and Wheat in the soil type of Palampur. Combined analysis of Raipur centre has been performed for grain yield for Kharif and Rabi crops based on 5 years of data (2012-13 to 2016-16). It was observed that T4 (150% NPK) gives highest grain yield (55.84 q/ha) followed by T8 (100% NPK + FYM) which gives 54.73 q/ha. Both T4 and T8 are statistically at par with each other for Rice (Kharif) crop. Lowest grain yield of 23 q/ha was observed for T1 (Control) for rice crop. For wheat (Rabi), again T4 (150% NPK) gave highest grain yield (36.13 q/ha) followed by T8 (100%NPK + FYM) with 34.04 q/ha and these were statistically at par. Lowest grain yield (10.44 q/ha) was observed for T1 (Control) for wheat (rabi). The analysis revealed that zero fertilizer application alone cannot sustain grain yield in rice and wheat in the soil type of Raipur.





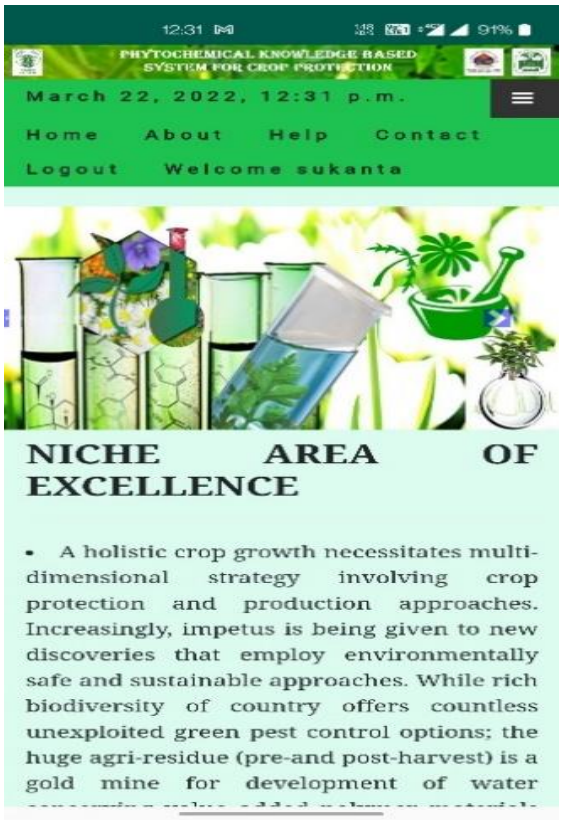
Plant source based environmentally safe crop protection and production technologies: Development and capacity building

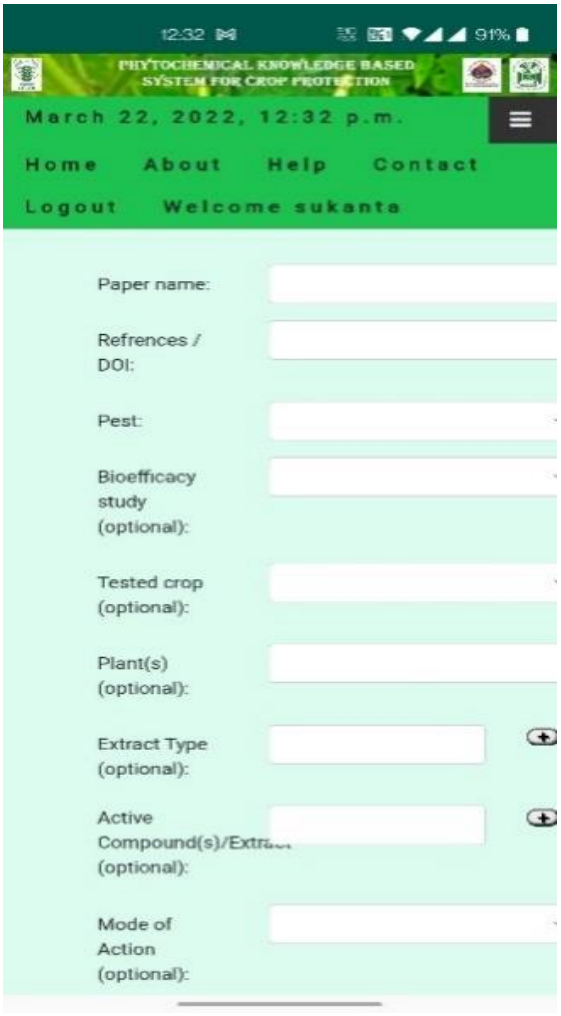
Optimization of the carrier-adjuvant ratio had been carried out using response surface methodology (Box Behnken Design).Field study was conducted at agronomy research farm of ICAR-Indian Agricultural Research Institute, New Delhi during kharif season of 2020 to evaluate the different coated slow release fertilizers in maize under maize-wheat system. The experiment consisted of 16 treatments [75% recommended dose of nitrogen (RDN)+ Oil 1; 75% RDN+ Oil 2; 75% RDN+ Oil 3; 100% RDN+ Oil 1; 100% RDN+ Oil 2; 100% RDN+ Oil 3; 75% RDN+ Oil blended 1; 75% RDN+ Oil blended 2; 75% RDN+ Oil blended 3; 100% RDN+ Oil blended 1; 100% RDN+ Oil blended 2; 100% RDN+ Oil blended 3; 75% RDN neem coated

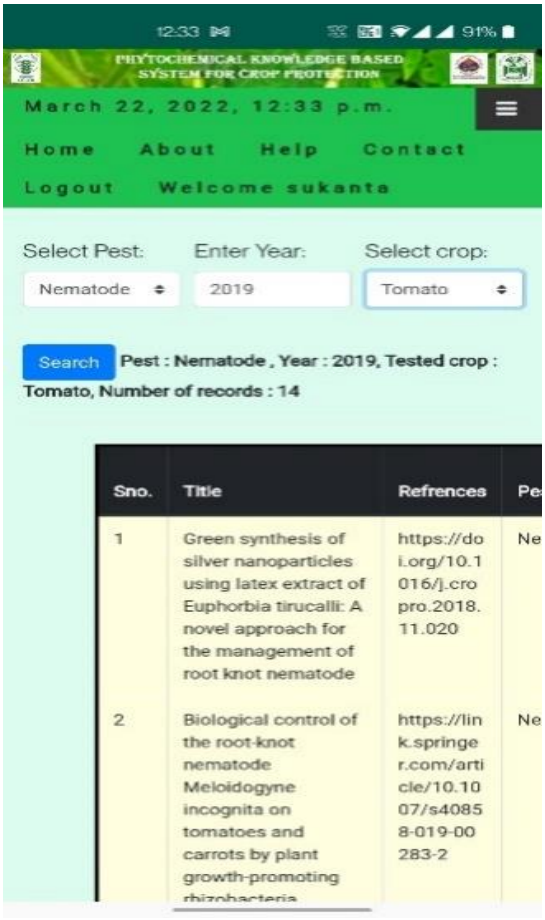
urea (NCU); 100% RDN NCU; 75% RDN Uncoated and 100% RDN Uncoated urea] using three replications. First year data showed that blended oil recorded maximum grain yield of both the crops but it remains statistically on par with NCU 100% N but significantly superior over uncoated urea at 100 % and 75%. Overall Blended oil 100% N had 3.96% and 3.77% higher maize and wheat grain yields over NCU-100% N, respectively. Web enabled phytochemical knowledge based system for crop protection" have been developed and deployed at IASRI server with URL http://naeagchem.icar.gov.in. An Android application has been developed with the aim to provide the adequate information regarding different type of diseases in crops, products [bio-pesticide(s), SPAW, coated fertilizer(s)] in relation to crop health in vegetable (tomato) and field crops (maize-wheat cropping system). There are five different sections on the home page of the mobile app viz. (i) Dashboard (ii) Field Crop (iii) Horticulture crop (iv) Gallery and (v) Agri-waste which are further divided into several sub groups.

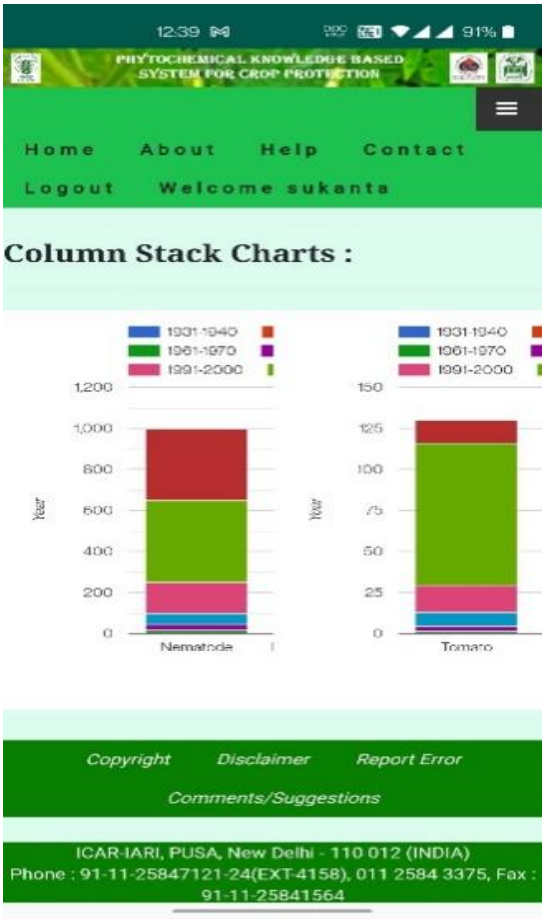
Mobile Application:

Mobile app has been available in Google play store with URL https://play.google.com/store/apps/details?id=com.nae.nae_app developed under Project "Plant source based environmentally safe crop protection and production technologies: Development and capacity building".









Efficient Designs for Order-of-Addition Experiments

In agricultural chemistry and other related disciplines there are many experiments in which new products are prepared by adding multiple number of components. The order in which these components are to be added to prepare a product such that the resultant product has some desirable properties is very important. For example, consider the situation when an animal nutritionist wants to prepare a cattle feed ration with several ingredients. Since the sequence in which feeds are added to the mixing equipment affects mixing adequacy, s/he wants to know in which order the components are to be added so that the final ration is properly formulated and mixed. This can be answered by a carefully conducted OofA experiment. Wagner (1995) [Wagner, J. (1995). Sequencing of feed ingredients for ration mixing. In 1995 Beef Report, Dept. of Animal Science, South Dakota State University, pp. 52-54. South Dakota State University] investigated the order of mixing of feed rations by such an experiment. Consider another situation when a biochemist wants to prepare an interpenetrating polymer network structure using different components. However, s/he is not sure which order the components are to be added. A suitably conducted OofA experiment can answer her question. Therefore, there are many experiments in which the final response depends on not only on components but also on the order of the addition of the components. OofA experiments have wide applications in bio-chemistry, chemistry and food science.

This project involves development of methodologies and/or algorithms for construction of efficient designs for order-of-addition experiments and listing the designs so obtained. Usage of such designs in agricultural experiments particularly in the field of agricultural chemistry will enable experimenters to develop new products with higher precision with optimal utilization of

resources. An algorithm for obtaining efficient designs for OofA experiments under pair-wise-ordering model has been developed. The proposed algorithm is being implemented in R language.

Efficient designs for double cross experiments under fixed/mixed effects model

Various types of breeding techniques are used as a tool for the development of commercial hybrids with potential phenotype, for which a major objective of plant and animal breeders is to raise the genetic potential. Breeding experiments are conducted for acquiring information regarding the general combining ability (gca) effects of the individual lines involved as parents and the specific combining ability (sca) effects of the crosses based on these individual lines. The information collected on gca and sca forms a basis for the breeders to select the best parental lines precisely. There are many cases of plant and animal breeding where double crosses are the commonly used techniques of producing commercial hybrids. Under this motivation, this project has been undertaken and started in collaboration with an animal breeding and a plant breeding institute.

During the year 2021, following partial double cross design is constructed for 7 Maize lines involving 21 crosses arranged in 3 Blocks and suggested for field demonstration trial at Division of Genetics, ICAR-IARI, New Delhi.

Block-1	Block-2	Block-3
(A×B)×(C×D)	(A×C)×(E×G)	(A×D)×(G×C)
(B×C)×(D×E)	(B×D)×(F×A)	(B×E)×(A×D)
(C×D)×(E×F)	(C×E)×(G×B)	(C×F)×(B×E)
(D×E)×(F×G)	(D×F)×(A×C)	(D×G)×(C×F)
(E×F)×(G×A)	(E×G)×(B×D)	(E×A)×(D×G)
(F×G)×(A×B)	(F×A)×(C×E)	(F×B)×(E×A)
(G×A)×(B×C)	(G×B)×(D×F)	(G×C)×(F×B)

Application of Next-Generation Breeding, Genotyping, and Digitalization Approaches for Improving the Genetic Gain in Indian Staple Crops

A separate BMS instance for ICAR-BMGF was created at ICRISAT, such that no one except ICAR has access to any data in that instance. http://bms.icrisat.ac.in/. Under ICAR-BMGF project, 10 selected ICAR breeding programs adopted digital breeding techniques for 08 crops and 5 All India Coordinated Research Programs (AICRP). These activities include, generation of experimental designs in Breeding Data Management System (BMS) and a regularly recording field data into BMS. Researchers of these programs have been trained in digitalization of breeding and trial activities and digital data recording. To support for ICAR-BMGF Project colleagues, conducted Weekly ICAR-BMGF Data Help Desk cum Clinic on every Thursday 03-12-2020 to 29-10-21 to look after implementation of BMS and to solve any questing related to data management including, digitalization, tablets uses, data upload and download, APIs based data upload, barcode readers, label printers, seed inventory, help in experimental design, data analysis, data & pedigree migration assistance, sequencing & genotyping data help, genomic selection, GWAS and etc. ICAR researches readily accepted BMS for past 3 years, several hundreds of trials and crossing nurseries have been created and uploaded into this system. ICAR-EiB Workshop on **"Basics of Genomic Selection"** during August 09-11, 2021. These data are stored into virtual platform of ICRISAT with support from EiB, our project and knowledge partner. BMS has been updated to V 20. Association of knowledge partner ICRISAT has been discontinued from November 2021. Now IASRI center will look after all data related work in BMS.

Data Migration

As per discussions in recent annual meeting, we are in process to transfer all these data into ICAR data center. Required infrastructure is created at ICAR data center to smoothly execute this task and follow-up operations in future to sustain the facility and services. Thorough testing of newly created server has been completed. Testing for all quality control parameters and throughput is completed. A separate BMS instance for ICAR-BMGF is configured at ICAR data center
http://bms.icar.gov.in/ibpworkbench/main

A. **ICAR Research Data Repository for Knowledge Management as KRISHI-Knowledge Based Resources Information Systems Hub for Innovations in Agriculture {ICAR-IASRI, New Delhi:** (Rajender Parsad, A.K. Choubey (till 20.01.2018), Mukesh Kumar, Anshu Bhardwaj, Susheel Sarkar, Arpan Bhowmik, Raju Kumar (till 04.06.2017: on study leave), Vandita Kumari Choudhary(till August 2016: on leave) and Sukanta Dash (since 03.04.2017); ICAR-NAARM, Hyderabad: A.Dhandapani; ICAR-NBSS&LUP, Nagpur: G.P. Obi Reddy, Nirmal Kumar, Sudipto Chattaraj; ICAR-IARI, New Delhi: Vinay Kumar Seghal, Joydeep Mukerjee; ICAR-DKMA, New Delhi: Himanshu and Mitali Ghosh Roy; ICAR-CMFRI, Kochi: J. Jayasankar and ICAR-CRIDA, Hyderabad: N.S. Raju, P.Vijaya Kumar (Since 17.12.2017), A.V.M.Subba Rao (Since 17.12.2017)}: Sponsored by ICAR Headquarter XII Plan Scheme: 24.07.2015-31.03.2020 and then extend under ICAR Hqrs. ICT include Data Center & Research Data Repository Fund 31.03.2023

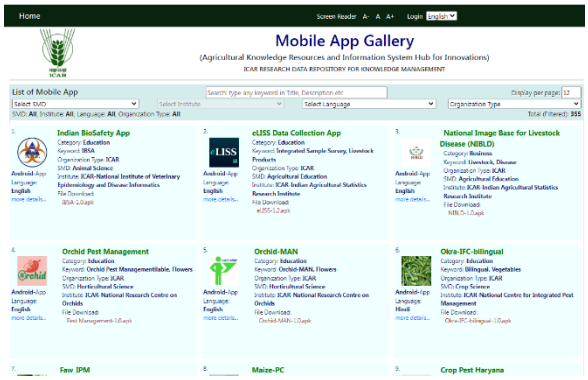
Strengthening and Maintenance of KRISHI Portal

KRISHI Portal has been enriched through providing links of several online resources available/developed at different ICAR institutes. Total number of links from ICAR and other sources on the KRISHI Portal are more than 350 online resources (other than mobile apps) under 16 broad headings bringing more visibility and single window access.

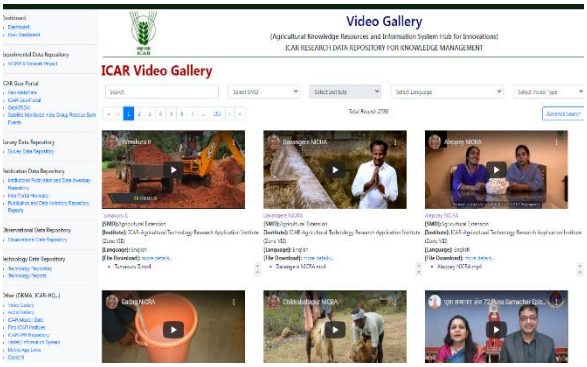
User Profile: ICAR User Profile for each scientist has been developed consisting of information on publications, technologies, varieties developed and IPRs (Copyright, Patent and Registered Variety with PPVFRA). Institute Profile has also been created for each of ICAR Institutes. A facility of generating link of embedding User profile in Institute website has been developed. For illustration, this has been embedded in ICAR-IASRI website. The module of exporting all details of Dashboard to CSV file have been developed. Developed module of displaying Year-wise release of Publications, Technologies, Data Submission on dashboard. The module of depicting the number and details of varieties developed has also been developed and made available on dashboard.

ICAR Mobile Apps: Mobile App Gallery Version 2.0 with a new interface has been developed using Angular JS with CAS Spring web App and hosted at https://krishi.icar.gov.in/mobileapp. Multi-keyword search, filtered search based on SMD, Institute within SMD, language and organization type is available. At present links of 355 Mobile Apps (319 reported earlier) (ICAR: 255; SAU/CAU: 40; KVK: 30 and Other Govt. Agencies: 30) are available for single window access. The 330 Mobile App files were also uploaded for archiving. At present 115 of mobile apps have 1000+ downloads. Out of these 115, one app has 50,000+downloads, 20 have 10,000+ downloads ((i) Fertilizer Calculator - Goa; (ii) IVRI - Pashu Prajanan (Animal Reproduction) App; (iii)IVRI-Shukar Palan(Pig Farming) App; (iv) ICAR - MUSHROOM; (v) Mango Cultivation IIHR; (vi) Pesticide Calculator; (vii) riceXpert; (viii)Soybean Gyan; (ix)Solapur Anar; (x) Tomato Cultivation IIHR; (xi) CIBA

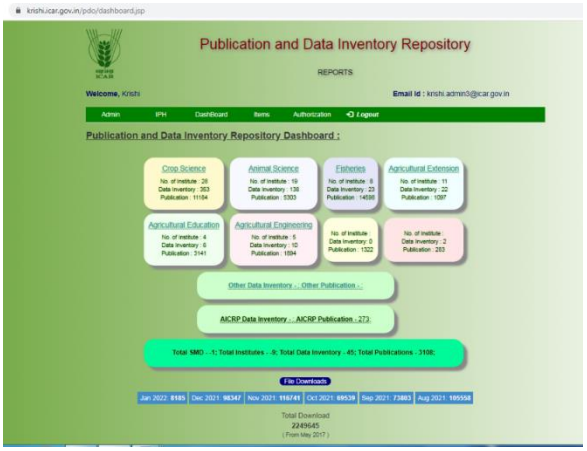
Shrimpapp; (xii) IVRI-Vaccination Guide App (टीकाकरण गाइड); (xiii) Fertilizer calculator; (xiv) Arka Bagwani; (xv) KISAAN; (xvi) ICAR-CIRB Bhains Poshahar (Buffalo Nutrition) App; I(xvii)CAR Technologies; (xviii)IVRI-Veterinary Clinical Care App; (xix) MATSYA SETU and (xx) eLISS Data Collection App) and 20 have 5,000+ downloads. This application was used to prepare material for Mobile Apps of ICAR for ICT presentation.



Video/Audio Gallery: Developed separate applications of Video and Audio Gallery version 2.0 which are workflow based application for submission of links of Video and Audios from Institutes. Search facility based on keyword, SMD, Institute within SMD and language has also been provided using Angular JS. Links of 2715 videos (2178 earlier) and 80 Audios (70 reported earlier). The video files for 2670 videos (1800 reported earlier) were also uploaded for archiving.



Publication and Data Inventory Repository: Enriched through populating data by Nodal Officers and other researchers. 64000+ (42000 reported earlier) publications and 795 dataset (727 reported earlier) have been submitted from 107 Institutes. 2529 researchers (1800 reported earlier) other than Nodal officers have registered themselves as submitters. Since May 2017, there are more than 18,15,000 (10,10,000 reported earlier) downloads from this repository inclusive of those fetched through computer programmes by other sites. A new parameter has been added in the JSON data of ARMS Application as Field name dc.publication.submitter to confirm the number data to KRISHI Publication Repository from ARMS.



Comparative Analysis publications of ICAR during 2007-20 was performed using the Data retrieved from web of Science Core Collection Citation Indexes(Science citation index-expanded (SCI-E), available at http://webofknowledge.com. For publications during (i) 2007-13: Number of citations only during 2007-13 have been taken and (ii) 2014-2020: Number of citations only during 2014-20 have been taken. Citation analysis is based on calendar year. Total Impact Factor is based on SCI Journal Impact Factor in 2019. The results obtained are presented in the Table 1.

Table 1: Comparison of ICAR Publications for 2007-13 and 2014-20 (SCI-E Journals)

Group	No. of Papers in SCI-E: p	Total Impact Factor (IF)	Citations(c)	Impact Factor per paper (IF/p)	Citation per paper (c/p)	No. of Papers in IF ≥10	No. Papers in IF ≥4
2007-13	12596	17764.386	40343	1.410	3.203	37	862
2014-20	20381	34780.439	99318	1.707	4.873	68	1958
Total	32977	52544.825	139661	1.593	4.235	105	2820

Following gives comparison of ICAR Publications for 2007-13 and 2014-20 based on data retrieved from (SCI-E, CPCI-S, ESCI): (http://webofknowledge.com)

Table 2: Comparison of ICAR Publications for 2007-13 and 2014-20 (SCI-E, CPCI-S, ESCI)

Group	No. of Papers in SCI-E, ESCI and CPCI: p2	Total Impact Factor	Total Citations (c2)	IF/p2	C2/p2
2007-13	13533	17764.386	40759	1.313	3.012
2014-20	22348	34780.439	118056	1.556	5.283
Total	35881	52544.825	158815	1.464	4.426

Comparison with all publications of IRRI, CIMMYT, ICRISAT and IFPRI and most cited 200 papers each year from ICAR (Data Source: Web of Science Core Collection Citation Indexes(SCI-Expanded, CPCI-S, ESCI) (http://webofknowledge.com)) is given in table 3

Table 3: Comparison with all publications of IRRI, CIMMYT, ICRISAT and IFPRI and most cited 200 papers each year from ICAR

Organization/Item		**2007-2013**	**2014-20**
ICAR	Publications@	1400	1400
	Total Citations during same period	22777	49601
	Average citations per paper during same period	15.91	35.43
IRRI	Total Publications	969	1360
	Total Citations during same period	11076	23065
	Average citations per paper during same period	11.14	16.96
CIMMYT	Total Publications	963	1676
	Total Citations during same period	11505	25177
	Average citations per paper during same period	11.95	15.02
ICRISAT	Total Publications	955	1631
	Total Citations during same period	7799	21223
	Average citations per paper during same period	8.17	13.01
IFPRI	Total Publications	683	1275
	Total Citations during same period	5079	18053
	Average citations per paper during same period	7.44	14.16

The analysis of publications in Science Citation expanded List were also performed for 2017-20, the results of compartyive analysis of ICAR Publications with publications of CAAS, China; EMPRAPA, Brazil and CSIRO, Australia re given in Tables 4 and 5.

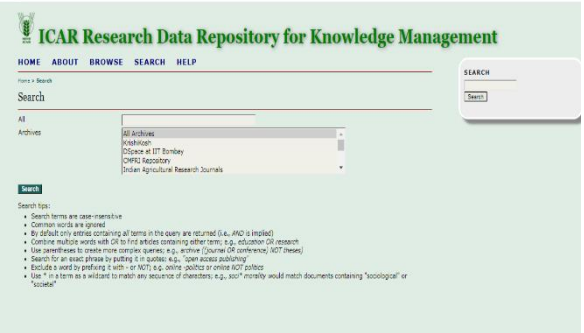
Table 4: Number of Publications and Average Citations per Publication 2017-20 (calendar Years): Science Citation Index-Expanded

Organization	Total Number of Publications in SCI-E	Average Citations per paper (c/p)	h-index	Total IF	IF/p
ICAR	12481	4.52	61	22521.446	1.80
CAAS_China	18447	7.88	85	69069.413	3.74
EMBRAPA, Brazil	7278	5.58	55	17380.495	2.39
CSIRO Australia	13487	13.02	122	-	-

Table 5: Comparison Based on 500 most cited Papers each year (Total of 2000 Publications): Science Citation Index-Expanded

Item	ICAR	CAAS, China	CSIRO, Australia	EMPRAPA, BRAZIL
c/p for 500 most cited papers per year	18.18	32.61	51.3	15.07
Publications ≥100 citations	19	62	178	23
Publications ≥50 citations	103	265	559	67

Total Publications of ICAR as per Science Citation Index Expanded, Emerging Sources Citation Index, Social Sciences Citation Index, Conference Proceedings Index-Science and Social Sciences and Humanities is 13831 (2017: 3309; 2018: 3201; 2019: 3472; 2020: 3849). This does not include the papers appeared in journals that are not listed in Web of Science http://webofknowledge.com

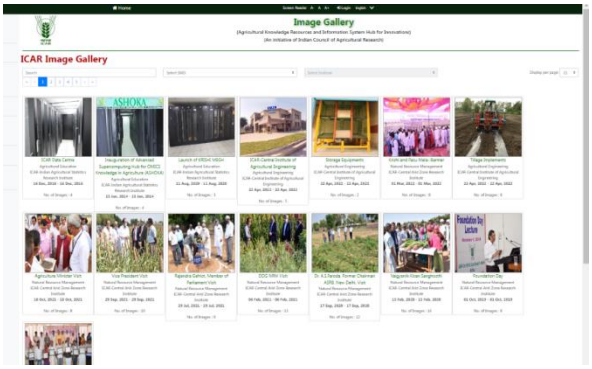


Interportal Harvester: In order to bring agricultural research publications collected by various organizations within and as well as outside of ICAR Meta Data has been harvested from Open Archives

Initiative Protocol for Metadata Harvesting (OAI-PMH) protocol enabled web applications. Unified search is ready for 37 repositories for 6,07,997 (5,94,839 reported earlier) records at https://krishi.icar.gov.in/iph/.

Technology Repository: Workflow based information system for submission of proven technologies (https://krishi.icar.gov.in/Technology/login.jsp) and generation of reports can be access though https://krishi.icar.gov.in/Technology/Record

List.jsp. At present 1790 (1320 reported earlier) technologies are available from 79 (68 reported earlier) Institutes. ICAR Technology Mobile App now has 10000+ downloads. Password Reset feature for non-ICAR users has been updated User Profile application that would enable submission by AICRP centres in Technology repository. The efforts are being made to convert Technology Repository application in spring boot with CAS enable system. Development of the facility of Full text search with exact string matching and adding two more fields (Nutrient Related Technology, Pest related technology) in Technology repository search key is in the pipeline



Variety Information System: Workflow based application of variety information system has been opened for data entry. Information on 180 varieties has been uploaded by the 10 Institutes.

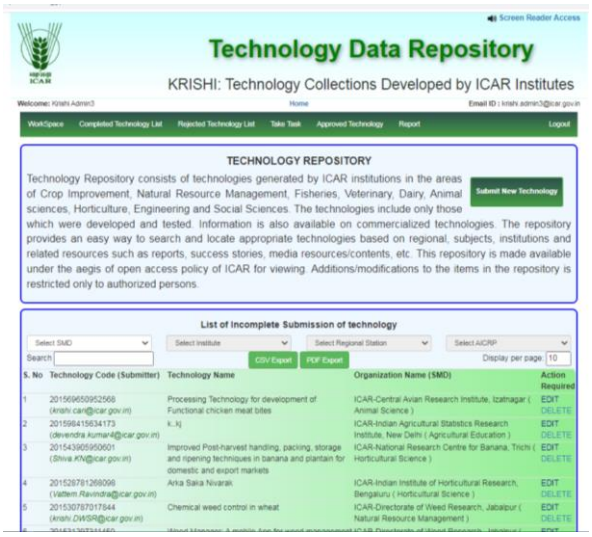
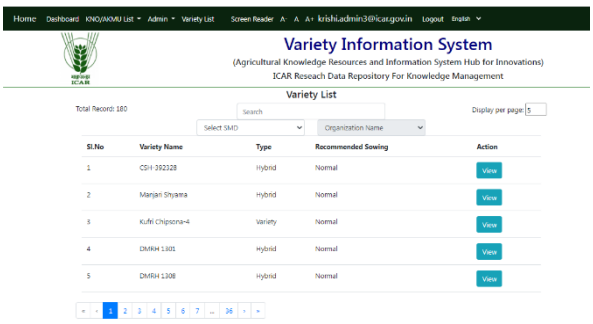
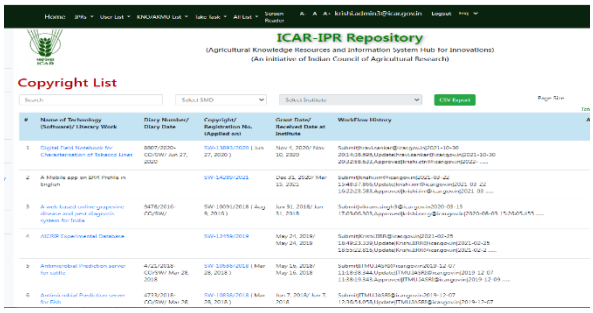
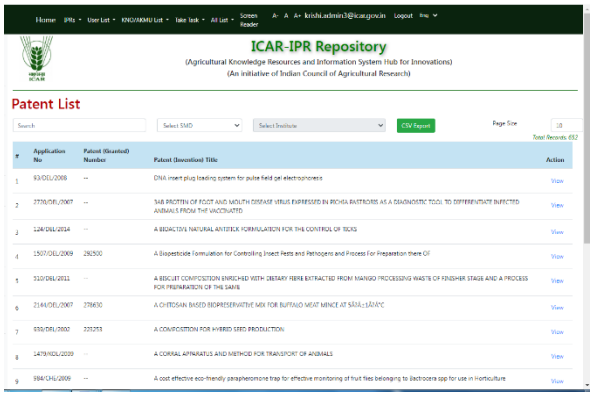


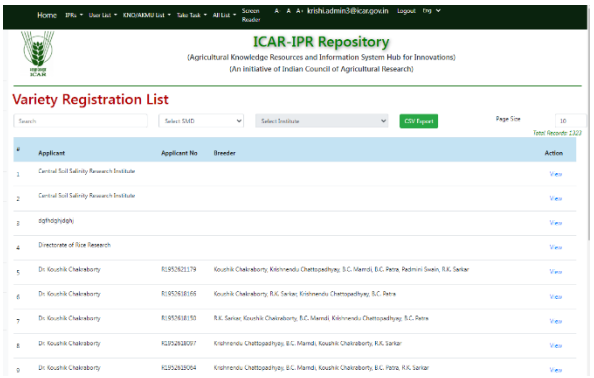
Image Gallery: Workflow based application for CAR Image Gallery has been developed in spring boot CAS enabled system and deployed on server at https://krishi.icar.gov.in/image. Officer Incharge, Data Management can upload single/multiple images with delete and set thumbnail options for one image per event. The records can be filtered on the basis of SMD, Organization within SMD and keyword.



ICAR IPR Repository: ICAR IPR Repository Version 2.0 with a new interface has been developed using Angular JS with CAS Spring web App. Strengthened work flow based ICAR IPR Repository consisting of three inbuilt applications on Copyrights, Patents and Registered varieties. It has been strengthened by adding 2 new fields and updating labels of Plant Variety Registration. At present partial/complete information on 106 copyrights (63 reported earlier), 652 patents (616 reported earlier) and 1300+ variety registration is available in this repository.







Unit Level Data Repository

Developed CMS based Website:

AICRP on Linseed launched by Dr. T.R. Sharma, DDG (Crop Sciences) in the Annual Group Meeting of Safflower and Linseed organized by ICAR-IIOR on 18.08.2021

Feedback form of AICRP on UAE to prevent spam email.

Experimental Data Repository: Protoypes for Information System for All-India Coordinated Research Projects to plan and design experiments, generate data, analyse and preparing report of AICRP experiments have been developed for AICRP on Linseed (based on single crop) and AICRP on PET is in progress. The prototypes has been cusomized for 06 AICRP : AICRPs on Castor; AICRP on vegetable crops; AICRP on Pearlmillet, AICRP on Mustard, AICRP on Safflower, AICRP on Sunflower and AICRP on Castor. Facility of download and upload of data sheet for Factorial Design and Split Plot design for Information Systems on AICRPs on Pearlmillet, Wheat and Sunflower.

Based on the information received from stakeholders, redesigned and strengthened website for following 10 AICRPs: (i) AICRP on Goat; (ii) AICRP on Plastic Engineering in Agriculture structure; (iii) AICRP

on Potential Crops; (iv) AICRP on Pig; (v) AICRP on Poultry breeding; (vi) AICRP Pearlmillet; (vii) AICRP on Mustard; (viii) AICRP on Safflower; (ix) AICRP on Sunflower and (x) AICRP on Castor;.

ICAR Observational Data Repository: Strengthened the application developed to harvest meteorological data (using python script) from different ICAR Institutes. At present besides harvesting data from 10 AWS centres of AICRP on Agrometeorology. Uploaded new Daily data for old AICRP on AM for all Station from about 1980 to 2018. Updated Python Scripts for harvesting weather data from ICAR-IARI, New

Delhi; ICAR-CRIJAF, Barrackpore; ICAR-CCARI, Goa; ICAR-NIASM, Baramati; ICAR-CSWRI, Avikangar and ICAR-CSSRI, Karnal. Updating the Observation Data Application with CAS is under process.

ICAR Geo-Portal: Strengthened Geo portal by Updated/Uploaded daily layers of (i) All India crops residue burning points for the period are regularly being depicted on India map (by ICAR-IARI, New Delhi) since June 01, 2019 (latest depiction of points is for December 31, 2021) and Paddy Residue burning in states of Punjab, Haryana, UP, Delhi, Rajasthan and MP (latest depiction is of November 26, 2021). The thematic maps for breeding tracts of Camel, Horse, Donkey, Yak breeds in India were uploaded (data from NBAGR, Karnal and layers by ICAR-IARI, New Delhi). PGRClim: An Online Tool to Achieve Climate –Ready Genebank was launched on August 02, 2021 by Dr. T.R. Sharma, DDG (Crop Science) during Foundation Day Celebrations of ICAR-NBPGR, New Delhi. The application is developed and designed by ICAR-NBPGR and ICAR-IASRI, New Delhi and hosted on ICAR Geo-Portal.

Master Tables: Developed (i) Master Tables and Master vocab two different web applications merges with spring boot CAS enable with one application; (ii) Extra field added in AICRP like (a) adding a field History Update; (b) adding a new column as Cropname; (iii) added more than one Social Media link in Master Table; added new field in Unit table 'unitfullname; (iv) Multiple selection field has been successfully made in JSON under Master table (v) Observation table updated with multiple data in new single fields; (vi) Latitude & longitude of the Universities. Updated URLs of the 11 ICAR Institutes.

Capacity Building and Sensitization

Virtual Meetings/Review Organized: (i) Review meeting and presentation on AICRP Information System. DDG(NRM), DDG(Crop Science and DDG(Agricultural Education) reviewed the Information System, January 03, 2021; (ii) Meeting with KRISHI Team, contractual Staff members at IASRI and other partner centres to discuss the Popularization, and Use of Existing Resources; Strengthening Existing frameworks and Analytics on January 20, 2021; (iii) Interaction meeting with Officer Incharge of ICAR Institute to discuss the issue during implementation and new facilities developed on January 25, 2021.

Webinar/Workshop/Interactive Sessions:

Webinar on KRISHI Portal for the Scientists and Technical staff of ICAR-CIRCOT, Mumbai on July 15, 2021. The webinar was attended by 36 participants (Coordinators: Sh. Himanshushekhar Chairasoa, Dr. Senthilkumar T. and Dr. Apran Bhowmik; Speaker: Dr Rajender Parsad);

Interactive session with Officer Incharge Data Management for KRISHI Portal on July 17, 2021 at 12:00 noon. The session was attended by 85 Nodal Officers and team members. (Conveners: Rajender Parsad and Anshu Bharadwaj);

Webinar on ICAR Research Data Repository for Knowledge Management for the Scientists and Technical staff of ICAR-NBFGR, Lucknow on July 30, 2021. The webinar was attended by 34 participants (Coordinators: Dr. Ajey Pathak, and Dr. Susheel Sarkar; Speaker: Dr. Anshu Dixit);

Online Workshop-cum-training on September 25, 2021 for the scientists of ICAR Research Complex for NEH Region, Umiam, Meghalaya. The workshop was attended by 56 participants form ICAR Research Complex for NEH Region, Umiam, (Conveners: Dr. Debasis Chakraborty, Dr. Rajender Parsad, Dr. Anshu Bharadwaj and Dr. Arpan Bhowmik from ICAR-IASRI, New Delhi).

Webinar on ICAR Research Data Repository for Knowledge Management was organized for ICAR-CIFRI on September 29, 2021 and joined by 45 scientists.

Meetings: (i) Steering Committee Meeting on July 26, 2021; (ii) Partners meet was held on December 23, 2021 under the Chairmanship of Dr. SK. Chaudhary, Chairman Steering Committee and DDG (NRM) and Dr. RC Agarwal, DDG (Agricultural Education) as Co-Chair.

Sensitization: (i) Several Whatsapp messages and E-mails were sent to all Nodal Officers for uploading publications, technologies and providing links of KRISHI Portal on their respective websites; (ii) E-mail and Whatsapp message was sent to all ICAR Scientists regarding image gallery and updated Institute Profile and Individual scientist Profile; (iii) Individual E-mails were sent to the Institutes who have not yet initiated submission of technologies; Individual E-mails were sent to the Institutes who have not yet initiated submission of technologies. (c) ICAR Video Gallery, ICAR Mobile App Gallery and ICAR Technology Mobile App was presented to farmers in Webinar organized jointly with ICAR-ATARI, Ludhiana: Mobile Apps for Farmers by (Conveners: Dr Alka Arora and Dr Pragya Bahaduria) on December 07, 2021) and on Kisan Diwas December 23, 2021; (d) Honourable Secretary DARE and DG, ICAR directed all ICAR Institutes to upload all their data in ICAR Data Inventory Repository.

Reset Password: (i) for 26 KRISHI Officers Incharge

Help in reset OU: Change the name of the Institute of 55+ Scientists of ICAR Institute.

New Officer Incharge: (i) ICAR-Central Portato Research Institute, Shimla; ICAR-Central Agroforestry Research Institute, Jhansi; ICAR- Indian Institute of Soil and Water Conservation, Dehradun; ICAR-Central Institute of Temperate Horticulture, Srinagar; ICAR-Directorate of Floricultural Research, Pune, ICAR-Central Institute of Agricultural Engineering, Bhopal; ICAR-Indian Agricultural Statistics Research Institute, New Delhi; ICAR- Central Institute of sub-tropic Horticulture; Lucknow and ICAR Research Complex for NEH Region, Umiam, Meghalaya and (iii) ICAR-Central Institute of fisheries Technology, Cochin; CAR-National Research Centre on Pomegranate, Solapur; ICAR-Directorate of Onion and Garlic, Pune; ICAR- Directorate of Floriculture, Pune; ICAR- Directorate of

Mushroom Research, Sola; ICAR-Central Coastal Agricultural Research Institute, Goa; (ii) Nomination of Nodal Officers for development of information systems and websites of AICRPS/Network project (a) AICRP on RM (ICAR-DRMA, Bharatpur): Dr. K.H. Singh and Dr. Vinod Kumar; (b) AICRP on Cotton (ICAR-CICR, Coimbatore): Dr. M. Sabesh; ICAR-Central Institute for Research on Cotton Technology (ICAR-CIRCOT).

Updated Alias Name in User Profile (i) Dr. Senthilvel Senapathy updated as S. Senthivel; (ii) Dr Mulpuri Sujatha as M. Sujatha; Dr. Mulpurisujatha as M. Sujatha; (iii)Jaya Kishan as Jaya Bharati (iv) ICAR-VPKAS, Almora: Dr. Mahipal Choudhary.

KVK Authorization: 48 KVKs under ATARI, Bengaluru to upload the data in KRISHI Repositories.

Summary:

The Indian NARS Statistical Computing Portal is being extensively used throughout NARES and helped the researchers in analyzing their data in an effective manner. Based on the user logged information, the total number of logged in users from Indian NARES during April 01, 2017- March 31, 2018 are 1,12,032 which is on an average more than 300 logged in per day.

Strengthened Design Resources Server (www.iasri.res.in/design) by adding the links of online generation of (i) A-optimal BTIB designs; (ii) A-optimal GDT designs; (iii) A-optimal BBPB designs and (iv) Weighted A-optimal BTIB designs. During April 01, 2017 to March 31, 2018, Google Analytics gave 11,688 page views across 353 cities of 81 countries. Average time taken on page is 3.12 minutes.

Obtained A-optimal completely randomized designs for three factors considering all possible sets of treatment contrasts of interest after excluding triple placebo or both double and triple placebo.

Developed and implemented Information Systems for AICRP on Linseed. At present we have 15 developed/under development informations systems viz. (i) Based on Single Crop: 10 (3 Fully functional; 04 Implemented; 01 implemented for one trial and 02 under testing); (ii) Based on Multiple and/or Perennial Crops: 02; Based on Observational Studies 02 and Based on NRM experiments: 01 Developed work flow based application of (i) ICAR Image Gallery and (ii) version 2.0 of ICAR IPR Repository;

Interportal Harvester: Unified search is ready for 37 repositories for 6,07,997 records (earlier 4,00,427 records) at https://krishi.icar.gov.in/iph/

Video/Audio Gallery: Developed an application for Audio /Video links. At present links of more than 2715 (530 videos reported earlier) and more than 80 (50 Audios reported earlier) are available. Also uploaded files of 2600+ videos for archiving

ICAR Mobile Apps: Links of a total of 355 (319 reported earlier) mobile apps {(ICAR: 255; SAU/CAU: 40; KVK: 30 and Other Govt. Agencies: 30)} are available in this application. Also uploaded the *.apk of around 330 mobile apps on this portal for archiving

Technology Repository: At present 1790 (1320 earlier) technologies are available in public domain from 76 Institutes. ICAR Technologies Mobile App has 10000+ downloads.

ICAR publication and data inventory repository has been enriched through populating data by Nodal Officers and other researchers. At present 64000+ (4990 Reported earlier) publications and 795 dataset (291 reported earlier) have been submitted from 107 Institutes. 2529 researchers other than Nodal officers have

registered themselves as submitters. A comparative publication analysis of ICAR vis-a-vis CIMMYT, IRRI and ICRISAT (as on 16.04.2020) and INRAE, France; CAAS, China; EMBRAPA, Brazil; AAFC, Canada and CSIRO, Australia (as on 29.05.2020) during 2010-2019 using the data retrieved from Web of Science Core Collection Citation Indexes (http://webofknowledge.com) was prepared. The report consisted of number of publications, average citations, h-index year-wise as well as for two quinquennial periods (2010-14; 2015-19).

Dashboard: (i) Developed framework for graphical and table display on dashboard for data status for publications, technologies, video, audio, mobile apps, geo-metadata, copyrights, patents, registered varieties and varieties developed available in open access. The module of exporting all details of Dashboard to CSV file have been developed; **(ii)** User Profile for each of Scientists consisting of information on publications, technologies, varieties developed and IPRs (Copyright, Patent and Registered Variety with PPVFRA); (iii) Institute Profile has also been created for each of ICAR Institutes.

Variety Information System: Workflow based application of variety information system has been opened for data entry. Information on 180 varieties has been uploaded by the 10 Institutes.

ICAR IPR Repository: At present partial/complete information on 106 copyrights 652 patents and 1300+ variety registration is available in this repository.

Visibility: KRISHI Portal has attracted 6,00,000+ (4,12,000+ reported earlier) page views since May 2015 across 1000+ cities of 120+ countries. There are 2.0 million+ views across 400+ cities of 100+ countries on ICAR Publication and Data Inventory Repository. KRISHI Publication and Data Inventory is now being indexed by Google Scholar; Base: Bielefeld Academic Search Engine and GARDIAN. It provides enhanced visibility to the publications. ICAR Publication and Data Inventory Repository, there are 1.81 Million+ (1.01 million reported earlier) downloads that includes documents fetched through computer programme by other sites. The Portal has been developed by ICAR-IASRI as a centralized data repository system for Research Data Management in the Council Impacts and Achievements: (a) Gold Icon Award in Open Data Championship Category for ICAR Research Data Management Initiative under Digital India Awards 2020 of MEITY, Govt. of India. Conferred by Honourable President of India Sh Ramnath Kovind ji on December 30, 2020; (b) First LDAP Authentication: Paved the way for other systems in ICAR. It helped in faster implementation of E-office in the period of Covid 19 pandemic. Now it is being used in ARMS, FVMS and other systems of the Council;

(c) Postgresql: ICAR Publication Repository as part of KRISHI Portal helped in capacity building of handling Enterprise version of PostGreSql database. This capacity building has helped in faster implementation of E-office that also requires PostGreSql Enterprise version of database; (d) KISAN 1.0 and KISAN 2.0: ICAR Mobile App Gallery is a Mobile App Store for all Mobile apps being developed by ICAR/SAUs. This repository and data facility through Webservices has powered KISAN 1.0 and KISAN 2.0; (e) Research Papers Published: Several journals require making available data in open domain. At least three papers have been published where the URL of data availability has been shown as ICAR Data Inventory Repository; (f) MasterVocab and Webservices: Developed master vocabulary to be used across applications for interoperability and mechanism of sharing through webservices and (g) Comments About KRISHI in DGQI 2.0 (Data Governance Quality Index 2.0 DMEO NITI AAYOG): (i) Synergistic data use within M/D: M/D has created systems for ensuring data exchange among its divisions by

creating a centralized data repository of all schemes called the KRISHI Portal; (ii) Good practices: KRISHI Portal brought knowledge resources to all stakeholders at one place. This portal has been sharing data with the Government of India's Open Data Initiative; (iii) Ministry/Department has following data management

Frameworks in place: Data architectures, data ownership norms, risk and value assessment of data, ethical use of data frameworks; (iv) Further, the M/D has a nodal officer for regularly verifying compliance against these frameworks and (v)MIS data is stored on a single server for all schemes. DARE/ICAR got a score of 4.02; (h) listed at GFAR (The Global Forum for Agricultural Research). Open Government Data Platform (data.gov.in) team (NIC) also appreciated ICAR Research Data management initiative and asked to share the experiences in Workshop for Chief Data Officers of Open Government Data Platform on April 11, 2019.

(i) Summary highlighting important achievement

Role of Research and Development in Indian Agriculture: An Economic Analysis.

State wise data on area, production and productivity of major cereal crops (rice, wheat, maize and jowar), four major pulse crops (red gram, bengal gram, green gram and black gram) and two major oilseed crops (groundnut and soybean) from the period 2004-05 to 2018-19 for major states were extracted from the Directorate of Economics and Statistics, Ministry of Agriculture, Govt. of India, New Delhi. The basic input data for the estimation of Total Factor Productivity (TFP) growth was collected from the reports of "Comprehensive Scheme for Cost of Cultivation of Principal Crops" carried out by the DES, Ministry of Agriculture, Government of India, New Delhi. The data for the missing years were approximated by interpolations. The output variable was yield per hectare reported by the Ministry of Agriculture. Five input variables were used in the analysis which includes seeds, fertilizers, manure, human labour and animal labour. Crop-wise Total Factor Productivity at all India level was estimated using the state level data on cost of cultivation and yield of the major crops grown in different states during the period 2004-05 to 2018-19. Multiple regression analysis has been carried out to discern the determinants of Total Factor Productivity growth at all India level.

Crop Diversification: Pattern, Determinants and its Impact on Nutritional Security in India.

Analysis for determining the factors influencing extent of crop diversification was done. Data related to district wise irrigation share has been compiled from the land area statistics published by Directorate of Economics and Statistics, Ministry of Agriculture and Farmers Welfare, Government of India. Data related to number share of marginal households, household share based on social group and house hold share based on gender has been compiled from Agricultural census (2015-16).

Forecasting Onion Prices Using Deep Learning Techniques.

Based on the share in the total market arrivals for the respective state, a total of fourteen onion markets price data have collected from agmarknet portal. Three markets from Delhi, five markets from Karnataka, five markets from Maharashtra and one market from Madhya Pradesh are selected. Finally, three major onion markets viz., Azadpur, Bangalore and Mumbai have been considered for univariate time series analysis under deep learning framework. These markets are selected based on the arrival and consumer point of view in that particular onion market. A framework has been developed to perform the comparative analysis among different time series forecasting models in the context of onion market price data under statistical,

machine and deep learning techniques. Statistical and machine learning models which are utilized in this study are generalized autoregressive conditional heteroscedasticity (GARCH) model and time delay neural network (TDNN), support vector regression (SVR) model respectively. Different deep learning architectures viz., long short-term memory (LSTM), bidirectional-LSTM (Bi-LSTM), deep-LSTM, convolutional neural networks (CNN) and the hybrid network of two deep learning models (CNN-LSTM) are implemented. Before conducting the investigation, testing of stationarity, presence or absence of seasonality, nonlinearity and volatility in all the price series are checked. Non-stationarity check is performed by augmented Dickey-Fuller (ADF) test whereas presence of nonlinearity and volatility are assessed by Brock, Dechert and Scheinkman (BDS) test and ARCH-LM test respectively. It has been confirmed that all the price series exhibit the behavior of non-stationarity having nonlinearity and volatility in them. After confirming nonlinearity, non-stationarity and volatility, GARCH, TDNN and SVR models as well as different deep learning architectures viz., LSTM, Bi-LSTM, deep-LSTM, CNN and CNN-LSTM are implemented with the advantage of their unique price forecasting capabilities. The out-of-sample forecast performance of these deep learning models are then compared with statistical (GARCH) and machine learning (TDNN and SVR) models. Among these deep learning models CNN based deep learning models outperformed all the counterparts followed by Bi-LSTM, and its variants. The findings have also revealed the superiority of deep learning models over statistical and machine learning models in terms of forecast accuracy measure criteria.

Development of Spatio-Temporal Neural Network Models for Forecasting Space-time data.

The formulation of STNN model is in progress Prospects of Irrigation in India: Trends, Determinants, and Impact on Agricultural Productivity

Irrigation has always played a dominant role in agricultural development in India through drought-proofing and enhancing productivity. The present study assesses the inter-regional disparities in the development of irrigation infrastructure and public irrigation investment in India using secondary data collected from various sources from 1992 to 2017. The study also analyses the status and drivers of groundwater extraction using district-level panel data for 535 districts of 16 major agricultural states. To assess the impact of irrigation access on crop productivity, we use data from the nationally representative Situation Assessment Survey of Agricultural Households conducted in 2013. We used a propensity score matching method to estimate the productivity gains from irrigation access, eliminating selection bias on observable differences between farmers with access to irrigation and those who cultivate under rainfed condition. There is a structural shift favouring groundwater irrigation while the share of surface irrigated area has declined. The northern region of India had an impressive performance in irrigation development. Despite abundant water resources, irrigation infrastructure in the eastern region is underdeveloped. The southern region had the highest share of capital investment in public expenditure on surface irrigation development. In the northern region, revenue expenditure accounted for the major share. The cost of creation of irrigation potential was highest in the southern region because of the high cost and time over-runs. The unsustainable groundwater depletion in north western states coexists with the underutilisation in eastern states of the country. The panel data analysis revealed a significant favourable influence of electrified tube well density on the rate of groundwater exploitation. Districts with poor rainfall had a higher rate of groundwater exploitation. The propensity score matching method revealed that irrigation access is

beneficial to farmers and would lead to increased crop productivity in India, highlighting the need to expand irrigation coverage further. These findings provide a platform for policy reframing related to sustainable development and management of surface irrigation, rationalising power tariffs for groundwater irrigation, improving irrigation use efficiency and promoting water-efficient cropping pattern in over-exploited districts.

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ICT based extension strategies for nutrition sensitive agriculture in the states of UP and Odisha

A genetic algorithm-based Fuzzy AHP technique has been developed that can compute the priority weight without the use of a pair wise comparison matrix by dealing directly with expert-provided data. The developed method was used to rank several factors related to nutrition and health consciousness, biofortified crops, and perception of the effects of climate change. The proposed Fuzzy AHP approach outperforms the traditional AHP approach in terms of consistently ratio, according to the research findings. Agri Nutri Information System (ANIS) has been developed and hosted in ICAR-IASRI Data Centre. The system is available at https://anis.icar.gov.in/. This is a web-based nutrition information system that provides detailed information on the nutrition-rich (nutridense and biofortified) crops grown in India. It offers the option of translating the entire information system into Hindi, Oriya, and ten other Indian regional languages. Agri Nutri Mobile App which provides complete information about nutrition rich (Nutridense and Biofortified) crops sown in India in Hindi, Oriya and 10 other Indian local languages has also been developed

Modelling dynamics of institutional credit to agriculture in India

Credit is considered as one of the most important and basic input in agricultural production process. The prime source of agricultural credit in India is institutional source and estimation of grass root level agricultural credit requirement helps in formulation of effective policy initiatives for further equitable and effective distribution. Agricultural credit involves direct and indirect components. Primarily direct agricultural credit composes of short term agricultural advances and term agricultural advances (investment loans). A procedure for estimation of direct credit requirement for agriculture of the district is developed and estimated based on certain assumptions. Short term and term credit requirement of the district is arrived separately by using the district level data on area under crops, scale of finance and unit cost. Term credit requirement of southern region districts like Guntur and Belgaum is relatively high and in districts of north eastern region viz, West Tripura and Papumpure it is very low. Similarly the case in short term credit too.

Hence there is need for counterproductive policy of first estimation of agricultural credit requirements depending on crop patterns and later meeting the requirements through effective policies.

Parameter estimation of time series models using Bayesian technique

In time series literature, use of exogenous variable(s) is done to enhance the modelling as well as forecasting efficiency of the model. In this study, we have used the two popular models viz. ARIMAX and ARIMAX-GARCH and proposed Bayesian technique for parameter estimation. We have applied these two models on agricultural data sets and attempted to enhance the Bayesian time series literature by documenting the superiority of these models over the classical ones. We strongly believe that the proposed models will find wide application in agricultural domain ranging from price forecasting to forecasting rainfall, etc. The product developed in form of R package ("BayesARIMAX", Downloads: 13,500+) which is freely accessible will provide researchers a vast opportunity to implement this model working in the domain of time series forecasting.

Forecasting Agricultural Output using Space Agrometeorology and Land based observations (FASAL)

Using the variable selection techniques models were developed and efficiencies were compared based on standard statistical measures such as RMSE (Root Mean Square Error), MAPE (Mean Absolute Percentage Error), etc. The models developed based on machine learning techniques (LASSO and Random Forest) has shown an improvement of 3-5% over the other models (Stepwise Regression, ARIMAX and Bayesian) on rice yield of 3 districts of Assam. These models were also applied on wheat yield from Baran district of Rajasthan, which too provided findings in similar lines.

(ii) Name the new research fields introduced by Scientists

1. ACHIEVEMENTS

Role of Research and Development in Indian Agriculture: An Economic Analysis

The trends in total factor productivity of four major cereal crops (rice, wheat, maize, jowar and bajra), four major pulse crops (red gram, bengal gram, green gram and black gram) and two major oilseed crops (groundnut and soybean) from the period 2004-05 to 2018-19 for major states of India was analyzed. The Divisia-Tornqvist index has been used in this study for computing the total output, total input and TFP indices for major states of India. At the state level, Andhra Pradesh and Madhya Pradesh witnessed moderate to high rate of TFP growth in major cereal crops, whereas Maharashtra has shown stagnant to moderate TFP growth in case of major pulse crops. The results relating to TFP growth indicated that much technological gains have not been experienced in a number of crops in many states as they have shown a stagnant or low growth in the total factor productivity. Few states have shown a significant performance of productivity growth which has moved the average productivity gain at the country level to a comfortable position, leading to the impression that technological gains have taken place in almost all the crops at the country level.

Crop Diversification: Pattern, Determinants and its Impact on Nutritional Security in India

The present study examined the determinants of crop diversification in India by using regression analysis model. It was observed that irrigation share, share of marginal farm households and share of households having males as heads are negatively influencing crop diversification, whereas share of farmers belonging to social groups other than SC and ST are positively influencing crop diversification in India.

Forecasting Onion Prices Using Deep Learning Techniques.

A framework has been developed to perform the comparative analysis among the statistical (GARCH), machine learning (TDNN and SVR) and deep learning models viz., long short-term memory (LSTM), Bi-LSTM, deep LSTM, CNN, hybrid architecture of two deep learning (CNN-LSTM) models and out-of-sample forecast performance comparison are obtained for the individual model for onion price forecasting. The findings have revealed the superiority of deep learning models over statistical and machine learning models in terms of forecast accuracy measure criteria for all the market prices. Among these deep learning models CNN based deep learning models provide the best performance in accuracy as compared to all the counterparts followed by Bi-LSTM and its variants, machine learning and statistical model for the given price forecasting problems.

Prospects of Irrigation in India: Trends, Determinants and Impact on Agricultural Productivity

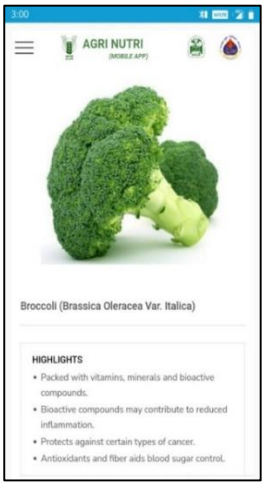
The results of the random effect model showed that irrigation is a significant factor affecting the value of output from agriculture. The positive marginal effect of irrigation coverage was more substantial than other variables, as shown by the higher value of estimated coefficients. Therefore, improving irrigation coverage will have significant improvement in the value of output from agriculture. This analysis supports the strong push being made for expanding irrigation coverage through a convergence of different irrigation related programmes under one umbrella programme, Pradhan Mantri Krishi Sinchayee Yojana. A simple t-test showed a significant difference between the irrigated and unirrigated yields of major cereals and pulses. Polynomial regression further revealed a significant influence of irrigation on the yields of major cereals and chickpea. However, in the case of pigeonpea, the significant effect of irrigation on yield was not found. The results of Propensity Score Matching technique revealed that irrigation access has a significant positive impact on yields of all the major crops. Irrigation access in case of rice had a significant positive impact on yield in the range from 890.26 kg/ha to 933.52 kg/ha. Kernel-based matching estimates showed an average increase of 922.21 kg/ha. In case of wheat, the average increase due to irrigation was in the range between 1131.55 kg/ha and 1210 kg/ha. There was an increase of 606.45 to 628.23 kg/ha in case of maize. In chickpea, the estimated ATT effect of irrigation on increasing yield is ranged between 265.55 and 296.4 Kg/ha. Whereas in case of pigeonpea, the increased yields are ranged between 223.3 and 300.8 Kg/ha. Kernel-based matching estimates show that the average increase in yields was 271.7 Kg and 290.5 kg in chickpea and pigeonpea, respectively.

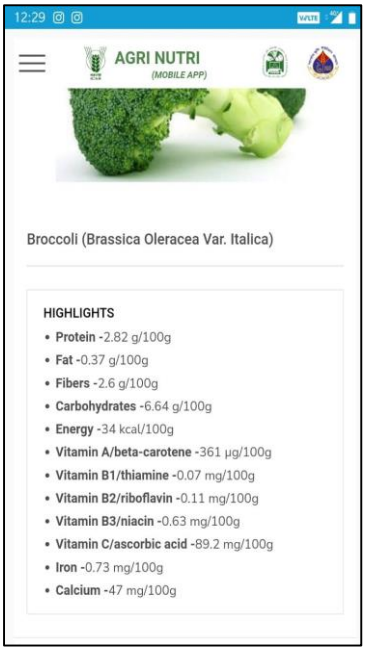
ICT based extension strategies for nutrition sensitive agriculture in the states of UP and Odisha

A genetic algorithm-based Fuzzy AHP technique has been developed that can compute the priority weight by dealing directly with expert-provided data without the use of a pair wise comparison matrix. The developed method has been used to rank several factors related to nutrition and health consciousness, biofortified crops, and perception of climate change effects. According to the research findings, the proposed Fuzzy AHP approach outperforms the traditional AHP approach in terms of consistently ratio. The K-Means clustering algorithm was used to group the 3200 farmers based on their knowledge score. TOPSIS approach has been utilized to rank the factors related to mobile based extension advisory services. Agri Nutri Information System (ANIS) has been developed and hosted in ICAR-IASRI Data Centre. The system is available at https://anis.icar.gov.in/. This is a web-based nutrition information system which provides complete information about

nutrition rich (Nutridense and Biofortified) crops sown in India. It provides the option to translate the complete information system into Hindi, Oriya and 10 other Indian local languages. User can generate brief and detailed crops information under the categories of Vegetables,

Agri Nutri Mobile App is an android application which provides complete information about nutrition rich (Nutridense and Biofortified) crops sown in India in Hindi, Oriya and 10 other Indian local languages. User can generate brief and detailed crops information under the categories of Vegetables, Fruits, Pulses, Cereals, Oilseeds and Nutri cereals.





Modelling dynamics of institutional credit to agriculture in India

A procedure/methodology for estimation of direct agricultural credit requirement of a district is developed. Primarily direct agricultural credit composes of short term agricultural advances and term agricultural advances (investment loans). Components of direct credit i.e. short term and term credit (medium and long) are first estimated individually and summed later.

Short-term loans are advanced for raising crops against pledge/hypothecation of standing crops. In finance institutions, the crop loan requirement of a farmer is arrived by multiplying the area under cultivation of a crop with its scale of finance. So in order to obtain the short term loan requirement of a district the area under different crops is multiplied with its scale of finance. Considering the fact that not all farmers may require loan facility and they may have their own capital for crop production. So we have used 4 scenarios where 100, 75, 50 and 25 per cent of gross sown area under different crops (irrigated as well rainfed) is financed. First the individual crop wise calculation is made and later it is summed for the district. The 30 per cent of crop loan component is

incorporated in the short term credit requirement to meet the post-harvest/household/consumption requirements and repairs and maintenance expenses of farm assets, crop insurance and/or accident insurance including PAIS, health insurance & asset insurance.

Crop loan component = ∑_(i=1)^n▒[Area under cultivation of ith crop (ha)* Scale of finance of ith crop (Rs.)]

Short term credit requirement = Crop loan component + 30 % of crop loan component

Term agricultural advances include both medium and long-term loans provided directly to farmers for financing production and development needs of the farmer. The activities considered for financing under term agricultural advances includes 1. Minor Irrigation2.Land Development3. Farm Mechanisation 4.Plantation & Horticulture 5.Animal Husbandry (Dairy, Pooultry, Sheep, Goatetc) 6.Fisheries7.Forestry & Wasteland Development 8.Storage structures 9. Sericulture and 10.Other agriculture & allied activities.

Term loan requirement =∑_(i=1)^10▒[Area or Number of units under ith activity * Unit cost of ith activity (Rs.)]

Direct credit requirement of the district = Short term credit requirement + Term credit requirement

Term credit requirement of the Belgaum district is estimated to be Rs. 1777.51crores in 2016-17. Among the selected districts term credit requirement is high in southern region district i.e. Guntur (1796.59 crores) and least in north eastern region districts viz West Tripura (33.29 crores) and Papumpure (33.40 crores). Consider Belgaum district under the scenario cent per cent of the area under cultivation is financed. This is the case where all the farmers are need of credit for crop cultivation. In this case the short term credit requirement is 7371.95 crores. Under the next scenario 75 per cent area under cultivation is financed and the estimated short term credit requirement is 5528.97 crores. Suppose half of the area under cultivation needs finance then the estimated credit requirement for crop cultivation is 3685.97crores. In the last scenario i.e. 25 per cent of the area under cultivation is assumed to be financed then the short term credit requirement is 1842.98 crores. Among the selected districts the short term credit requirement estimated to be high in southern districts viz, Belgaum and Guntur and least in Papumpure and West Tripura.

Forecasting Agricultural Output using Space Agrometeorology and Land based observations (FASAL)

For ease of implementation and reaching out to more researchers and users we have developed a webtool, WIAYFS (Weather Indices based Automated Yield Forecasting System). In this webtool we have implemented the stepwise regression model based on weather variables along with other models such as ARIMAX, LASSO regression, Bayesian Regression model and Random Forest technique. In this webtool the calculation of weather indices from raw weather data process has been automated along with fitting of various models. At the end user is delivered with the best fitted model for the dataset fed into the webtool. WIAYFS is being implemented by IMD (India Meteorological Department), New Delhi at various locations across the country at district levels for forecasting yields of different crops (e.g., Rice, Wheat) on pilot basis. The URL for webtool is http://wiayfs.icar.gov.in/wiayfs. The developed methodologies have been presented at different national and international forums such as Annual Review Meeting of Agromet component under Forecasting of Agricultural Output using Space Agrometeorology and Land based Observations (FASAL), Indo-French Knowledge Summit, Workshop on Artificial Intelligence held during November 25-26, 2021, etc.

Screenshots of the developed webtool

Figure: Home screen

Figure: Analysis page

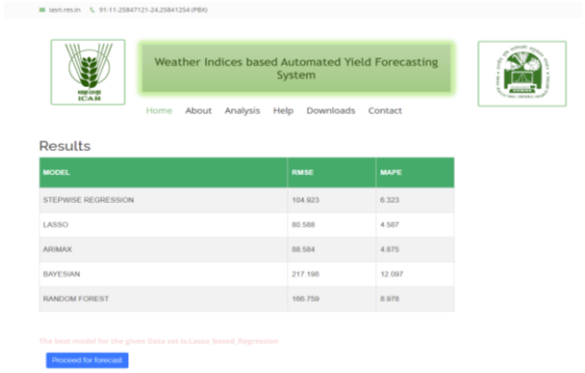


Figure: Result screen

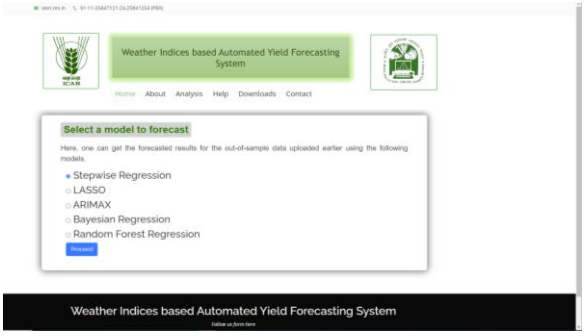


Figure: Forecast screen

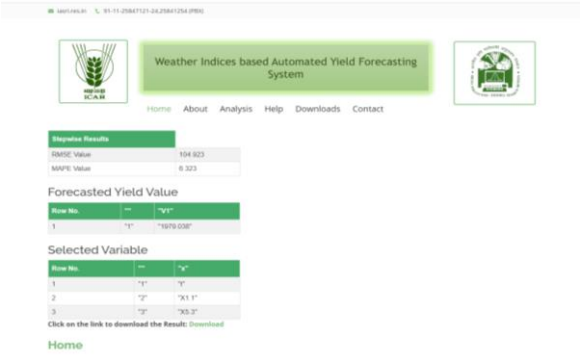


Figure: Forecasted values along with selected variables

Institute Funded Projects:

Detection of outliers in presence of masking and imputation of data when auxiliary variables are available in sample surveys

When analysing complex survey data with a linear regression model, analysts usually use the survey-weighted estimator, which takes sample weights into account appropriately. As a result, combinations of outlying Y values, outlying X values, or extreme sample weights make points influential in survey-weighted regression. Survey-weighted diagnostic statistics in the presence of masking have been developed using a similar approach to traditional OLS diagnostics by including survey weights and design parameters. Survey-weighted diagnostics can identify different points as being more influential than OLS diagnostics. OLS approaches may not recognise an observation with moderate Y and X values as influential, while SW methods may recognise it as

significant if it is assigned an extreme sample weight.

A measure for assessing the masking effect in survey-weighted linear regression for unclustered and clustered sample data has been developed. At first, Extended Cook's distance has been worked out for a particular case after deleting another case. Thereafter, Extended conditional cook statistics was obtained in survey-weighted linear regression to measure the masking effect.

After developing diagnostics procedures to detect outliers in presence of masking, outlier(s) imputation for outlying survey values has been developed when auxiliary variables are available. This method can also be helpful in correcting gross errors in survey data, as well as in imputing missing values. The performance of the method has been illustrated using a survey data set.

Based on simulation and real data analysis for developed sampling methodologies, it has been observed that if survey weights are not considered in regression diagnostic procedure for survey data, it can mislead inferences. Developed outlier(s) imputation methodology for outlying survey observations perform well. This method can also be helpful in correcting gross errors in survey data, as well as in imputing missing values.

A Study on Domain Calibration Estimators under Two Stage Sampling Design

In many medium to large scale surveys, it is very often the case that we do not have a sampling frame. In some cases, the population could be spread over a wide area entailing very high travel expenses for the personal interviewers and efficient supervision of the field work can be difficult. In these situations, we prefer to use multistage sampling designs. Many a times, besides the overall estimates, the estimates for different subgroups of population are also required (Hartley, 1959) called as domains. For example, in a household survey, the survey statistician may be asked to provide separate estimates for the different household types, like one-member households, two-member households, etc. or in Agricultural Census Surveys, separate estimates may be generated based on operational holding size groups like marginal, small, semi-medium, medium and large or in case of estimation of crop area and yield at district level under mixed cropping scenario one can ask to estimate the mixture wise crop statistics which is a common case of domain estimation. To address the problem of domain estimation and to improve the domain specific estimators under two stage sampling design scenario, a domain calibration estimator is developed under two stage sampling design when population level domain specific auxiliary information is available at cluster level. The variance of the proposed estimator was also developed.

Estimation of Finite Population Proportion from Geo Referenced Survey Data

The objective of the study is to develop efficient estimation procedure of finite population proportions of binary study variables from geo-referenced complex survey data.

During this reporting period, the work on development of estimator under the first objective has been undertaken.

A new estimator for population proportion has been developed for geo-referenced binary survey data. Variance of the proposed estimator using Taylor Linearization Technique has been developed.

Externally Funded Projects:

Feasibility Study for Developing Renewable Energy Systems for Tea Plantations in Assam (Funded by ICAR Extramural Fund (in collaboration with

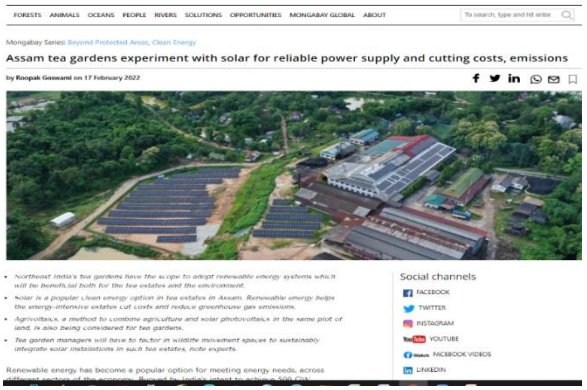
Indian Institute of Technology, Delhi (IITD) under Research collaboration between ICAR and IITD).

Under the project, survey was carried out in the State of Assam and in North Bengal where tea industries/Estates prevail. Three questionnaires were developed for the survey: a. Enumeration Schedule,

b. Listing of Tea Estates/Industries,

c. Detailed Input/ Output Survey Schedule.

Questionnaire has been tested with the help of Tocklai Tea Research Institute, Assam. Assam and Northern part of West Bengal are the major tea growing regions in India. Therefore, tea gardens and industries were selected from this region. Questionnaire was developed in the google form and was sent to various tea gardens and industries in the selected tea gardens and industries in the State of Assam and West Bengal for collecting responses. The survey data have been collected on various activities involved in tea cultivation and production of tea in these regions. A stratified two stage random sampling design with domain specific information related to the size of the tea estates/industries were developed and used for the survey. Criteria for determination of sample sizes specific to the location i.e. Assam and North Bengal and type of tea estates i.e. organic/ inorganic were also developed and used for the survey. A training manual for the developed questionnaires for training of the field investigators was also developed. The data collection is under process for the survey. For implementation of alternative source of energy in tea production, a small-scale tea drier for production of tea using solar energy in under development at IIT, Delhi. A progress report of the project for the period of 01.02.2020 to July 31, 2021 was submitted to ICAR. A review meeting of the project jointly organized by the ICAR and IIT Delhi was held on 22 January 2021. The progress of the project was appreciated by the review team committee.



ICAR-All India Coordinated Research Project on Energy in Agriculture & Agro-based Industries (ICAR-AICRP on EAAI).

Under the ICAR-All India Coordinated Research Project (AICRP) on Energy in Agriculture and Agro-based Industries (EAAI)-Sampling design and Analysis, it was decided to conduct energy audit in agro-industrial sector for most prominent crop in the region by the cooperating centres of the project Energy Auditing in Production Agriculture and Agro-Industries. To achieve this, energy audit survey was to be conducted on the selected crops. The crops that are significantly present in the state and have higher use of energy are included in the survey. To conduct the survey, a suitable sampling design has been developed by ICAR-IASRI, New Delhi. In this survey, stratified two-stage sampling design is being used. Here, agro-climatic zones (ACZs) in the state having significant area of the crop under the study are considered as strata. The sample size within each stratum will be allocated using proportional allocation. Under this project, three schedules have been developed i.e. a. Listing Schedule–Village Enumeration Questionnaire, b. List of Selected Farm Households in Selected Village, c. Detailed operational holding survey – Farmer's Questionnaire Energy inputs and outputs in agriculture production system. A manual on the proposed sampling methodology was published under the project. Here, Agro-climatic zones (ACZs) in the state having significant area of the crop under study are considered as strata. The

sample size within each stratum is allocated using proportional allocation. Under this project, three schedules were developed i.e. a. Listing Schedule – Village Enumeration Questionnaire, b. List of Selected Farm Households in Selected Village, c. Detailed operational holding survey – Farmer's Questionnaire Energy inputs and outputs in agriculture production system. A manual on the proposed sampling methodology has been published under the project.

Integrated Sample Survey Solutions for major Livestock Products. (Funded by Animal Husbandry Statistics Division, Department of Animal Husbandry & Dairying, Ministry of Fisheries, Animal Husbandry & Dairying, Govt. of India).

Under this study a web portal has been developed named as "ISS Web Portal" running live on https://iss.icar.gov.in. This portal has three modules i.) Sample Selection Module ii.) Data Entry and Analysis Module iii.) GIS Map Module. Sample Selection Module allows state to draw sample for complete enumeration and detailed survey for all three seasons (summer, rainy and winter) in a year according to the ISS methodology for estimation of production and number of all four livestock commodities i.e. Milk, Meat, Egg, Wool. The most important function of this portal presently is sample selection of first stage unit i.e. villages/urban wards in each district. This sample is used for data collection in all the three seasons. Once district estimates are entered in the portal, state level and national level estimates of production and number of all four commodities (Milk, Meat, Egg, Wool) can be obtained using this portal.

Under this study, an eLISS web Portal and an android app for sample selection and data collection has been developed named as "eLISS Data Collection App".

During the period under report, the following activities were carried out:

Development of Query module for the developed Portal and Application

Queries Related to following points have been compiled and stored as Dataset and currently a model is under development to provide system generated replies using the queries

- Clarification of sample size and format of sample.
- Second Stage Sample Selection
- Sample Allocation
- Updating User Profile
- Option to Reset Sync
- Communicating with support team using the app.
- Updation of villages/wards.
- Downloading and sharing the sample with district users.
- Sign up Issues for districts.
- Clarification of data entry fields.

Development of module for scrutiny and cleaning of captured data by App

Validation checks are provided in all the schedules which designing in the data collection app itself. Besides this an additional module has been developed to process a range validation for every State/UT for each animal and group.

For this, a new database has been created with the help of State/UT in which minimum value and maximum value of yield for each animal and group for every commodity has been added. Further, use of the developed database system, scrutinizes the data while data collection is going on and creates a

suggestion table for every state/UT in which scrutinized data have been stored.

Maintaining and upgrading the android application developed for data collection

The App was released as eLISS V1.0. Since then, the following three updates have been released since launch along with additional features:

eLISS V1.1 (July 2021)

- Bug Fixes and Improvements.
- Added New Contact Support Button accessible throughout the app.
- Added More Details for Enumerator Level user in Help Section.
- Added New Reset Sync Button to reset sync in Logout Activity.
- Updated Second Stage Sampling Algorithm for better and quick selection.
- Added More Validation Checks for better data quality.

eLISS V1.2 (23 August 2021)

- DNO and Supervisor can see the refresh date and time on Dashboard.
- New methods have been added to maintain the data integrity over sync.
- Force Logout option removed.
- Various bug fixes and improvements.
- Share Query and Responses with other apps.
- Request Data on Mail Option (Beta Mode).
- Few UI changes for few devices.
- Auto Refresh Toggle for Supervisors and DNO.
- Fixed Mark Schedule issue for multiple rounds.

eLISS V1.21 (18 October 2021)

- Added Goat dung weight input in Schedule-III.
- Schedule-I Priggery Yes/No issue.
- Data will be synced for each season and year independently
- Updated Sync Design which reduces sync time drastically.
- Some UI changes to improve data collection.

Construction of a complete and updated sampling frame of first stage units i.e. villages pertaining to livestock

To capture the change in sampling frame of villages/urban wards in every district, a new module named “Sampling Frame” has been created which is currently live. Using this module AHS/ State/ UT/ District users can download the current available sampling frame at State/UT and District level in excel sheet. Also using the module State/UT users can submit a change request of sampling frame i.e. villages/urban wards for any of their districts if there is a change in the available sampling frame. State/UT can upload the new sampling frame in proper formatted (sample format available for download on the portal) excel file for any of their districts. System checks the uploaded file and confirms that the file is in the proper format and stores that into server with proper naming and once all the files for a state/UT have been received system automatically, processes the uploaded files and updates the sampling frame.

Maintaining and upgrading the web portal for providing end-to-end solution

Updation and Optimization

1. In coordination with funding agency, new Home Page for the eLISS web portal has been designed and developed.

2. In coordination with funding agency new dashboard for Admin level users and State/UT level users has been designed and developed.

3. New Instruction Page and About Scheme page has been added. In Instruction page, pdf Tutorials, FAQs, Video Tutorials and Some common problems and solutions are available.

4. Various procedures and functions have been optimised for faster performance and less load time.

5. Various sections have been moved to other relevant sections for maintaining a connected flow.

Additional modules developed

1. Allocation of Village-Enumerator Module

A Module has been developed to allocate Village/Urban ward selected in first stage sample for every year. Using this module, District level users can see the list of selected villages/urban wards for every year and season. Further users can map a village/urban ward to any active enumerator in that particular district by selecting the name of the enumerator in the provided control. Relationship between enumerators and villages/urban wards is a one-to-many relationship (one enumerator can have multiple village/urban ward).

2. Allocation of Enumerator-Supervisor Module

With the allocation module a new module has been developed to map the enumerators with supervisors. Using this module, district level users can map their enumerators with supervisors. Relationship between supervisors and enumerators is a one-to-many relationship (one supervisor can have multiple enumerator). By implementing the mentioned two relationships (enumerators with villages/urban wards and supervisors with enumerators) a one-to-many relationship between supervisors and villages/urban wards is also formed (On Supervisors can have many villages/urban wards).

3. Real-time summary of Complete Enumeration and Detailed Survey

New module has been developed for viewing the real time summary of complete enumeration and detailed survey. Using this module AHS/State/UT can view and download the Year/Season/Round-wise summary of survey status of all villages/urban wards (around 62,000 for a year for complete enumeration) at All India/State/UT level in real time.

4. Report Section to view All-India report

New report section under the data analysis module has been developed to form commodity/ animal/ year/ season wise report of number of animals, yield and production at all India/State/UT level.

5. Module for re-allocating a village/urban ward during the survey

A Module has been developed to change the allocated enumerator in ongoing survey for a year and season. Using this developed module, district level users can re-allocate a village/urban ward to another enumerator in case enumerator leaves the job or is not available. This re-allocation module shows the last sync data of the currently working enumerator and the next enumerator can continue the survey from that date. All the

collected data (till the last sync) by current enumerator will the transferred to next enumerator after successful re-allocation.

6. Module for detecting and applying multiple device constraint to a user

A module has been developed for detecting number of devices in which enumerator is logged in. Also this module automatically adds a pause constraint for syncing the data if multiple devices has been detected for a user. In the developed end-to-end solution to keep the real time status updated one device per enumerator has been implemented.

7. 10 Stage survey status of every selected village/urban ward for each year and season

A module has been developed under the survey status module to present the survey status in 10 different stages for first stage sample i.e. village/urban ward selected. Each stage has an icon and represents the current status. These stages help to visualize the current status of a village/urban ward in a glance. All the 10 stages have been explained on the portal for better clarifications.

8. Module for downloading the raw data captured using the app in excel format for any village/urban ward for any schedule

A module has been developed to view and download the data collected using the data collection app for a village/urban ward in real time. Using this module AHS/State/UT/District can view and download the year/season wise collected data of Schedule-I, Schedule-II, Schedule-III, Schedule-IV and Schedule-VI for every village/urban ward at any point of time.

9. Module for downloading the raw data captured using the app in excel format for any village/urban ward for any schedule

A module has been developed to view and download the data collected using the data collection app for a village/urban ward in real time. Using this module AHS/State/UT/District can view and download the year/season wise collected data of Schedule-I, Schedule-II, Schedule-III, Schedule-IV and Schedule-VI for every village/urban ward at any point of time.

Survey Status for rainy season through eLISS Data Collection App:

- 11 States/UTs have successfully completed the survey
- 5 States/UTs have successfully completed the survey more than 90%.
- 12 States/UTs have successfully completed the survey more than 50%.

Statistics

- All 36 States/UTs officials are currently using the developed end-to-end solution.
- All 730 districts of country are currently signed up on eLISS Web Portal.
- More than 20,000 enumerators are active and using the developed end-to-end solution.
- More than 7,100 supervisors are active and using the developed end-to-end solution.
- More than 33,000 villages/urban wards have been surveyed using the developed data collection app.
- More than 24,000 commercial poultry farms have been surveyed using the developed data collection app.
- More than 51 lakh households/enterprises have been surveyed using the developed data collection app.

- More than 672 commercial poultry farms have been surveyed using the developed data collection app.

- More than 50,829 villages/urban wards have been allocated using the developed allocation module.

- As of now more than 1 lakh login requests have been successfully processed on the eLISS web portal.

- As of now more than 1,53,000 login requests have been processed on the eLISS Data Collection App.

Inter-Institute Funded Projects:

All India Coordinated Research Project on Honey Bees and Pollinators

The effect of spray of Imidacloprid and Thiamethoxam insecticides on honey bee colonies is needed to be ascertained. Therefore, two varieties of honey bees i.e. Apis mellifera and Apis cerena were considered to study the effect of these insecticides under field and semi-field conditions. The data on the effect of insecticidal sprays on different characters of honey bees in case of mustard crop was collected from four locations. The data was processed, arranged in analytical framework and analyzed. The results were shared with the AICRP.

Consultancy Projects:

Technical Guidance on the sampling strategy and developing sampling methodology for 2019/20 Lao Agriculture Census

A new project entitled "Technical Guidance on the sampling strategy and developing sampling methodology for 2019/20 Lao Agriculture Census" was awarded to ICAR-IASRI by FAO-Laos for providing technical guidance on the sampling strategy to the officials of Lao Statistics Bureau (LSB), Lao PDR and developing sampling methodology for 2019/20 Lao Agriculture Census. This study was funded by Food and Agriculture Organization of the United Nations-Laos (FAO-Laos), Vientiane, Lao PDR.

The study was initiated w.e.f. 27.02.2021 under Institutional Consultancy Project mode. Approval for conducting the study and signing Letter of Agreement (LoA) was received from ICAR Headquarters/DARE on 26.02.2021. LoA was signed between FAO-Laos and ICAR-IASRI on 27.02.2021 for conducting this study funded by FAO-Laos.

Under this study, literature related to Lao Agriculture Census (LAC) conducted twice so far in the country, the first one in 1998/99 and the second in 2010/11 which covered the whole of Lao PDR, including urban areas, was critically reviewed. Sampling methodologies adopted in the first LAC 1998/99 and second LAC 2010/11 were also critically reviewed. Development of sampling strategies and methodologies for 2019/20 Lao Agriculture Census was completed.

The proposed sampling strategy report for the 2019/20 Lao PDR Agriculture Census was finalized and submitted to the funding agency. Training on the developed sampling strategy was imparted (remotely) to the officials of Lao Statistics Bureau (LBS), Lao PDR and FAORAP, Bangkok. Remote assistance was provided in drawing sample using the proposed sampling strategy.

Sampling methodology for 2019/20 Lao Agriculture Census has been developed. Estimation procedure was developed as per the proposed sampling strategy. Estimation procedure document including calculation of sample weights, effect of non-response and step by step method of calculation of estimates along with standard errors using SPSS with screen shots was prepared, finalized and submitted to the funding agency. Remote assistance in implementing estimation procedures for variables of interest

and estimation of standard errors, % CV and in calculation of sampling weights was provided to the officials of Lao Statistics Bureau (LSB), Lao PDR and developing sampling methodology for 2019/20 Lao Agriculture Census. This study was funded by Food and Agriculture Organization of the United Nations-Laos (FAO-Laos), Vientiane, Lao PDR.

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Final report of the project was submitted to Food and Agriculture Organization of the United Nations Regional Office for Asia and the Pacific (FAORAP), Bangkok on 31.07.2021 for its onward submission to the funding agency, FAO-Laos, Lao PDR.

In order to discuss the sampling methodology for 2019/20 Lao Agriculture Census developed under the project, a meeting was held in virtual mode under the Chairpersonship of

Ms. Sangita Dubey, Regional Statistician for Asia-Pacific, Food and Agriculture Organization of the United Nations Regional Office for Asia and the Pacific (FAORAP), Bangkok on

August 26, 2021 in which Sampling Experts in Asia Pacific were also invited. The developed methodology under the project was discussed in detail and it was desired by the Chairperson that a paper on country (Lao PDR) experience for 2019/20 Lao Agriculture Census may be prepared in future with main focus on developed sampling methodology which was implemented in the country.

The final report of the project has been accepted by Food and Agriculture Organization of the United Nations (FAO). Acceptance of the report was received from Food and Agriculture Organization of the United Nations Regional Office for Asia and the Pacific (FAORAP), Bangkok on 01.10.2021.

Technical Guidance in Implementation of Methodology for Estimation of Area and Production of Horticultural Crops developed by ICAR-IASRI under CHAMAN Project

Under this study, technical guidance for implementation of methodology developed for estimation of area and production of horticultural crops by ICAR-IASRI under CHAMAN program was provided to Haryana State Government for obtaining State and district level estimates of area and production of various fruits and vegetables for 2019-20 and 2020-21. Technical guidance was provided to the concerned officials of Department of Horticulture, Haryana State Government in sample selection for complete enumeration as well as detailed survey, primary data collection (to FIs also), scrutiny of schedules, data entry using Data Entry Software provided by ICAR-IASRI, scrutiny of entered data etc. Status of data collection, data entry and data scrutiny was obtained from the funding agency. The funding agency granted extension of duration of project till 28.02.2022 without additional fund as the funding agency needed further guidance in analysis of data.

Completed Projects:

1. **Estimation of breeding value using generalized estimation equation and Bayesian Approach.**

(07-02-2018 to 29-01-2021)

Estimation of heritability is done using Bayesian paradigm for the collected dataset. Analysis was carried out using multiple trait app. For the collected dataset, Generalized estimating equation is applied using different correlation structure and applied the dataset using Integrated Nested Laplace approximation technique and heritability is estimated. The most Significant Research achievements in this project are:

- Generalized linear mixed model and integrated nested Laplace approximation was used to estimate the heritability.
- Bayesian model was used to estimate heritability of Karan Fries cattle using both univariate and bivariate linear mixed model. Also developed model was compared with other existing procedures.

2. **A study on detection and interpretation of expression quantitative trait loci (eQTL) mapping.**

(03-02-2018 to 02-02-2021)

Appropriate statistical methods have been developed to detect the expression Quantitative Train Loci. Detection of eQTL is done by using false discovery rate calculated by using two component mixture model. Under this project, detection and identification of eQTL hotspot is also done by Hierarchical integrated Bayesian model for eQTL mapping. Two real dataset are collected, analyzed and interpreted. The method was also compared with existing methods i.e. Matrix eQTL, Random Forest, IBMQ model and shows significant contribution for identifying eQTLs in both the datasets. The most Significant Research achievements in this project are:

- A novel statistical procedure was established to detect expression Quantitative Trait Loci using modified t-test and two component mixture model.

- Hierarchical integrated Bayesian model was used for identifying significant hotspot.

- The method was also compared with existing methods i.e. Matrix eQTL, Random Forest, IBMQ model and shows significant contribution for identifying eQTLs in both the datasets.

3. A Study on Robust Estimation of Heritability.

(22-03-2018 to 21-03-2021)

In the present study we considered both half sib and full sib model for data generation. Here we used both AR(1) and AR(2) errors. Different cases different combination are identified for better results. Sire component and error component are generated following different combination of distribution i.e. normal, beta, Cauchy and t-distribution with different heritability values and estimate of heritability and RMSE values obtained by four different methods i.e. ANOVA, ML, REML and MIVQUE methods with different parametric values of heritability. From the results it is noticed that when we increase correlation value –ve to zero the rmse values decrease. If we increase from zero to higher i,e. nearer to +1 it is noticed that rmse values increased for all the combinations of distribution. In this study, we used robust heritability estimation methodologies to estimate SNP-based heritability when observations in the dataset were contaminated with outlying observations. The robust approaches were applied to a real dataset, and several procedures were followed, such as estimating heritability and variance components using both original and contaminated data (1%, 3% and 5%). Finally the robust approach is compared with classical approach. It is seen that as contamination percentage increase, the estimated heritability decreases.

4. Studying Dynamics of market integration and price transmission of agricultural commodities: ICAR funded Lal Bahadur Shastri Outstanding Young Scientist Project.

(02.04.2018-31.03.2021)

The impact of consecutive lockdowns on the quantities traded and wholesale prices of three perishable food commodities, viz, onions, potatoes and tomatoes that comprise an important component of the regular diet of Indians has been assessed. We use a granular data on daily markets arrivals and wholesale prices of these commodities from three metropolitan markets and applied IGARCH model to understand the impact of consecutive lockdowns on market arrivals and wholesale prices. Expectedly, our findings show that implementation of lockdowns had a significant negative impact on the quantities traded of all the three commodities and a positive impact on their prices. The impact was variable over time; the first lockdown had a significant positive impact on wholesale prices in all the markets, and the impact became bigger in the subsequent lockdown. However, we find considerable heterogeneity in the lockdown effects across commodities and markets.

On-going Projects:

Modelling and forecasting from time –to-event analysis in agriculture. (22-06.2020 to 21.03.2023)

Seed germination data has been obtained from ICAR-NBPGR for eight varieties of paddy where genotypes were selected based on tolerance to abiotic stresses like heat and drought. Five varieties like Lalat, N-22, IR 64, NL-44, and DRR 42 are tolerant genotypes and three varieties like Pusa 44, Swarna, and PB 1121 are popular varieties. The data comprises of number of germinated seeds at two- hourly intervals. Thermal time model has been fitted to the data to estimate cardinal temperatures viz. Base, optimal and

ceiling temperatures. The possible range of base temperature has been obtained by obtaining the intercepts along the temperature axis of the regression line between germination rate at a given fraction g, say, and temperature for various values of g=.1, .25, .5,.75 and .9. A constrained least square regression has been applied to find the common base temperature for all the above fractions. To this end, the base temperature for PUSA44 has been obtained as 9c with thermal time (scale used in degree days) values are 579.68, 603.49, 640.45, 716.08 and 799.68 degree days for g=.1,.25, .5,.75 and .9 respectively which has been observed to be in increasing mode. The fitted model enables to determine temperature required to obtain particular g fraction of seed germination in the given time to achieve those g fraction of seeds to germinate. Degree-days or thermal time is used widely in crop and insect pest management. Insects develop according to degree-days also, so one can determine when to spray a pesticide, for example. If one knows the daily ambient temperatures, then he can correct for their variation and know when the seeds (or crop flowering, for example) will occur.

1. Doubling Farmers' Income in India by 2021-22: Estimating Farm Income and Facilitating the Implementation of Strategic Framework. Funded by Ministry of Agriculture and Farmers Welfare, Govt. of India.

a. The cointegration among the revealed comparative advantage (RCA) of India, Ecuador and Canada has been studied over a period indicating a great advantage for them in the international markets. The causality in RCA is directed from Canada to India and Canada to Ecuador. It is seen that the RCA of Ecuador is rising at a much faster rate than India. An attempt has also been made to forecast the revealed comparative advantage (RCA) of India, Ecuador and Canada using combination of decomposition approach (wavelets), stochastic models (ARIMA) and machine learning technique (ANN).

Multivariate GARCH models namely DCC and BEKK have been applied for modeling the price volatility of potato in five major potato markets of India i.e. Agra, Delhi, Bengaluru, Mumbai and Ahmedabad. It is observed that Agra market has the highest price variability whereas Mumbai has the least price variability. All the studied market prices showed significant presence of conditional heteroscedasticity. To this end, Volatility Impulse Response Function (VIRF) has been used to see the impacts of a specific shock on the price volatility spillovers of potato among the studied markets. The impact of the volatility shock appears not only in the expected conditional variances but also evident in the expected conditional covariances.

2. Modelling insect pests and diseases under climate change and development of digital tools for pest management, NICRA Project, Funded by CRIDA

(20.06.2017-31.03.2022)

Classification of occurrence of pest and diseases in rice in West Bengal, India has been done using CART. Pest Incidence for Pigeon Pea (Kharif) at selected Locations in Warangal district of Telangana State during 2011-20 has also been classified. Machine learning techniques namely random forest (RF), generalized regression neural network (GRNN), feed forward neural networks (FFNN), support vector regression (SVR) and gradient boosting machine (GBM) were used to analyze the leaf miner infestation for eight consecutive years of kharif 2011-18 in Rajendranagar (AP), Telangana and compared with the traditional approach of multiple linear regression (MLR) model. Present study revealed that Leaf miner infestation appeared as early as during 27 SMW in 2014, 2015 and 2016 and latest by 31 SMW during 2018. Peak population of leaf miner appearance also varied across the

seasons with higher incidence during 2012 closely followed by 2014 with lowest peak recorded during 2015.

4. **Leveraging Institutional Innovations for Inclusive and Market led Agricultural Growth in Eastern India, NASF Funded** (01.12.2019-30.11.2022)

Price forecasting of perishable crop like vegetables has important implications to the farmers, traders as well as consumers. Timely and accurate forecast of the price helps the farmers switch between the alternative nearby markets to sale their produce and getting good prices. Brinjal is one of the important vegetables consumed all over the country. For forecasting price of agricultural commodities, several statistical models have been applied in past but those models have their own limitations in terms of assumptions. Recently, Machine Learning (ML) techniques have been much successful in modeling time series data. Though, numerous empirical studies have shown that ML approaches outperform time series models in forecasting different financial assets, but their application in forecasting vegetables prices in India is scared. In the present investigation, an attempt has been made to apply efficient ML algorithms e.g. Generalized Neural Network (GRNN), Support Vector Regression (SVR), Random Forest (RF) and Gradient Boosting Machine (GBM) for forecasting wholesale price of Brinjal in major markets of Odisha, India. An empirical comparison of the predictive accuracies of different models with that of the usual Autoregressive integrated moving average (ARIMA) model is carried out and it is observed that ML techniques particularly GRNN performs better in most of the cases.
5. Statistical Approaches for Analysis of Zero-inflated and Over-dispersed Counts Data and their Applications in Single-cell Studies.

5. **Statistical Approaches for Analysis of Zero-inflated and Over-dispersed Counts Data and their Applications in Single-cell Studies.**

(November 25, 2021 – July 24, 2024)

During the reported period, reviewed the recently published statistical approaches for differential expression analysis of zero-inflated and over dispersed single-cell data. Sufficient time has been devoted to collect secondary single-cell datasets for human, mouse, and plant experimental studies from Gene Expression Omnibus (GEO) database of NCBI. Based on the progress, one review article entitled as “Differential Expression Analysis of single-cell RNA-seq Data: Current Statistical Approaches and Future Challenges” has been prepared and will be submitted to suitable journal.

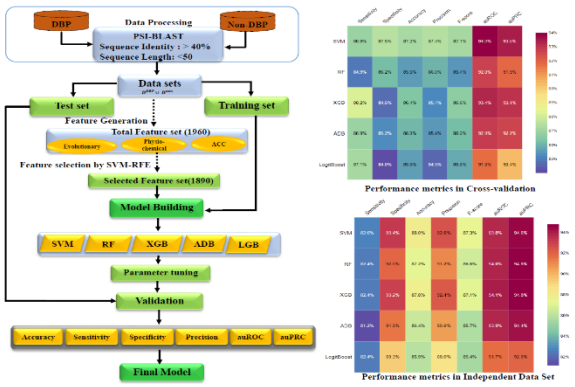
6. **Development of Machine learning models and Bayesian network for discovery of Nucleic acid-binding protein and their application in disease/pest surveillance.**

(November 25, 2021 – July 24, 2024)

DNA-binding proteins (DBPs) are crucial for various cellular processes, such as recognition of specific nucleotide, regulation of transcription, and regulation of gene expression in plants. Various structure and sequence-based computational methods have been proposed to identify DBPs which are exclusively for human and mouse. Some models have been developed for Arabidopsis only. However, these methods suffer from lower accuracy, for other model plants. Besides, there is no generalized tool available for predicting DBPs particularly for plant species. Thus, developing an efficient model for identifying the DBPs is the need of the hour. We have developed a predictor called PlDBPred for DBPs identification in plants by employing the SVM-based machine learning technique with evolutionary features. Higher accuracy of 91% was achieved with SVM which outperformed the

other state-of-art machine learning algorithms such as Logit Boost, Random Forest, AdaBoost and XGBoost, while evaluated with 5-fold cross validation. Further, we compared the developed method with seven different existing tools. The prediction accuracy of the developed generalized model was more than 90%, whereas for the existing models it was below 70%. The results showed that the developed computational model is more efficient compared to the existing models for predicting DBPs in plants. To the best of our knowledge, this is perhaps the first computational method for identifying plant specific DBPs. The detail workflow and performance metrics of different machine learning techniques are illustrated in below figure.

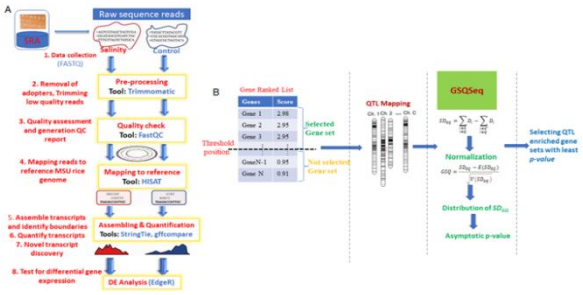
Figure: Illustration of the basic workflow and performance of PlDBPred



Methodology/Algorithm Developed

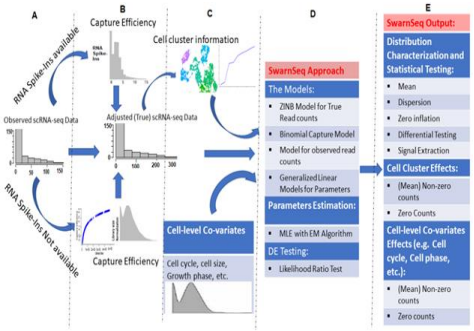
1. **'GSQSeq' Statistical Method for Gene Set Analysis with Quantitative Trait Loci for Crop Gene Expression Studies (developed in collaboration with the University of Louisville, USA)**

We developed an innovative statistical approach, GSQSeq, to analyze the gene sets with trait enriched QTL data. This approach considers the associated differential expression scores of genes while analyzing the gene sets. The performance of the developed method was tested on five different crop gene expression datasets obtained from real crop gene expression studies. Our analytical results indicated that the trait-specific analysis of gene sets was more robust and successful through the proposed approach than existing techniques. Further, the developed method provides a valuable platform for integrating the gene expression data with QTL data



2. **'SwarnSeq' Method for Differential Expression Analysis of single-cell RNA-sequencing data (Samarendra Das developed in collaboration with the University of Louisville, USA)**

The scRNA-seq data is characterized by the presence of dropout events, which severely bias the results if they remain unaddressed. There are limited Differential Expression (DE) approaches which consider the biological processes, which lead to dropout events, in the modeling process. So, SwarnSeq, an improved method, was developed for DE analysis that considers the molecular capture process in scRNA-seq data modeling. The performance of the SwarnSeq method was benchmarked with 11 existing methods on 10 different real scRNA-seq datasets under three comparison settings. The findings indicated that SwarnSeq method has improved performance over the existing methods.



3. Machine learning on the Bayesian networks successfully predicts miRNA profiles(UK Pradhan developed in collaboration with CSIR-IHBT, Palampur)

Here we have proposed for the first time an XGBoost based machine learning approach to predict miRNA expression levels from the RNA-seq expression data. For model development our developed Bayesian network approach was used for feature selection. The average accuracy was calculated over the 10 times sampled test sets, where every time the data was split in 70:30 ratio between training and test sets, and model was built from the scratch every time. The models were developed for 1,204 miRNAs whose accurate expression level could be detected directly from the RNA-seq data alone without any need of doing separate miRNA profiling experiments like miRNA-seq or arrays. A first of its kind, these models performed consistently well with high average accuracy (91%) when tested across a large number of experimentally established data from several conditions. The observed and predicted expression levels obtained for all miRNAs shows the high level of accuracy when studied across a large number (431) of samples.

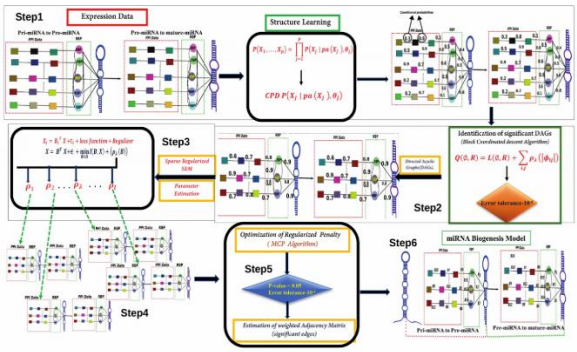
4. DNN based Deep-Learning implementation of the RBP binding site models consistently achieved high accuracy for Prediction of binding spot of RBP on RNA(developed in collaboration with CSIR-IHBT, Palampur)

Here we applied DNN based deep learning algorithm to develop RBP binding models. In this study efficient motif anchoring helps to get good quality contextual information on binding. Realistic and high granularity datasets ensure better performance of the classifiers. It also showcased that when a DNN is trained properly on suitable properties with appropriate biological insights, the developed system could easily outperform much complex deep-learning based approaches where such learning is done through an automated feature extraction process using complex layers like CNN and LSTM.

5. Development of a Bayesian network approach in high dimensional data framework to decipher the causal association between RBP and miRNA(developed in collaboration with CSIR-IHBT, Palampur)

Here we propose a novel Bayesian network approach to decipher the directed causal relationship between different components in a network. As there are very limited methods are available which can work in a high dimensional data framework. The developed approach was bench-marked for its performance against a standard molecular network dataset for testing the applied algorithm's performance. Performance was evaluated and compared with well-established established R-package “bnlearn”. It was found that our approach was able to significantly recover more true edges, similar to bnlearn at a 95% confidence interval. Our Approach outperformed in comparison with bnlearn in accuracy and Precision. The different steps followed for development of Bayesian network approach are illustrated in below figure.

Figure. Different steps followed to develop the Bayesian network Approach.



6. PK Meher developed a new computational model to predict the 9 different localizations of mRNAs such as cytoplasm, cytosol, endoplasmic reticulum, exosome, mitochondrion, nucleus, pseudopodium, posterior and ribosome were considered. The Random Forest supervised learning algorithm was employed for predicting the localizations with the K-mer features. The developed approach also achieved higher accuracies than the existing localization prediction tools.

7. PK Meher proposed a new computational method to identify the proteins encoded by the circadian genes. Support vector machine (SVM) with seven kernels, i.e., linear, polynomial, radial, sigmoid, hyperbolic, Bessel and Laplace was utilized for prediction by employing compositional, transitional and physico-chemical features. To the best of our knowledge, this is the first computational method to identify the circadian genes with the sequence data.

R- Packages

1. GSQSeq (https://github.com/sam-uofl/GSQSeq). (developed in collaboration with the University of Louisville, USA)

2. SwarnSeq (https://github.com/sam-uofl/SwarnSeq). (developed in collaboration with the University of Louisville, USA)

3. PredCRG (https://cran.r-project.org/web/packages/PredCRG/index.html) for the scientific community for proteome-wide identification of circadian genes.

Webserver developed

1. "miRbiom: A Machine Learning Approach to Profile miRNAs" (https://scbb.ihbt.res.in/miRbiom-webserver). (developed in collaboration with CSIR-IHBT, Palampur).

2. "RBPSpot:A tool to identify RBP spot on RNA" (https://scbb.ihbt.res.in/RBPSpot/) (developed in collaboration with CSIR-IHBT, Palampur)

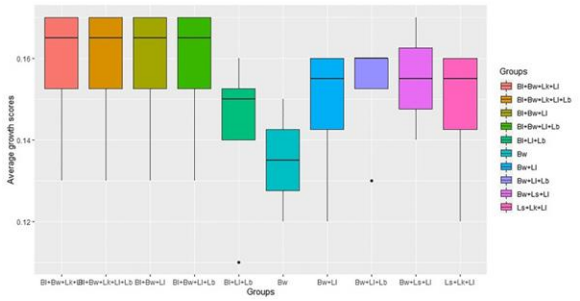
3. "mLoc-mRNA" for predicting the multiple localization of mRNAs, and the server is freely accessible at http://cabgrid.res.in:8080/mlocmrna/.

Achievements of Projects

Investigations on dietary alterations in shrimp for abiotic stresses using nutrigenomics approach

The constraint-based genome-scale metabolic modeling approach to screen and identify the beneficial bacteria capable of limiting the growth of V. harveyi, a common pathogen in shrimp culture was used. Genome-scale models were built for 194 species (including strains from the genera Bacillus, Lactobacillus, and Lactococcus and the pathogenic strain V. harveyi) to explore the metabolic potential of these strains under different nutrient conditions in a consortium. In silico-based phenotypic analysis on 193 paired models predicted six candidate strains with growth enhancement and pathogen suppression. Growth simulations reveal that mannitol and glucoronate environments mediate parasitic interactions in a pairwise community. Furthermore, in a mannitol environment, the shortlisted six strains were purely metabolite consumers without donating metabolites to V. harveyi. The production of acetate by the screened species in a paired community suggests the natural metabolic end product's role in limiting pathogen survival. Our study employing in silico approach successfully predicted three novel candidate strains for probiotic applications, namely, Bacillus sp 1 (identified as B. licheniformis in this study), Bacillus weihaiensis Alg07, and Lactobacillus

lindneri TMW 1.1993. The study is the first to apply genomic-scale metabolic models for aquaculture applications to detect bacterial species limiting Vibrio harveyi growth.



Community model groups with highest average growth rates (Bw, B. weihaiensis; Ll, L. lindneri; Bl, B. licheniformis; Ls, L. sakei; Lk, L. Koumiss; Lb, L. buchneri).

The investigations which aimed to understand primarily the gene content in the hepatopancreas of juvenile Indian white shrimps along with the intestinal microbial communities were conducted, which would act as a useful resource for future studies.

The draft genome sequences of unique potato genotypes i.e. somatic hybrid P8 (J1), wild species S. pinnatisectum (J2), progeny MSH/14-112 (P8 × cv. Kufri Jyoti) (J3), and S. tuberosum dihaploid C-13 (J4) were deciphered. Further, 39,260, 25,711, 39,730 and 30,241 genes were identified in J1, J2, J3 and J4 genotypes. Total of 17,411 genes were found common in the genotypes particularly late blight resistance genes (R3a, RGA2, RGA3, R1B-16, Rpi-blb2, Rpi and Rpi-vnt1). Phylogeny analysis showed relatedness with potato and other plant species.

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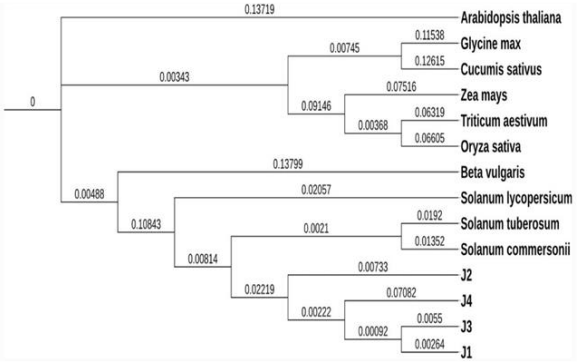
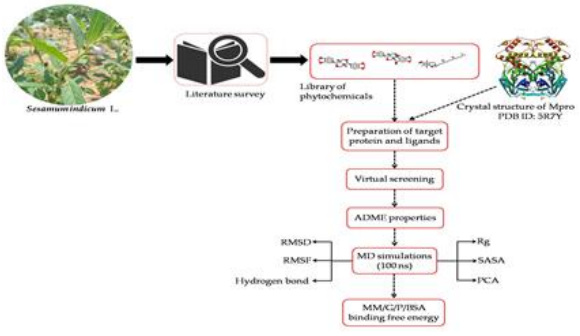


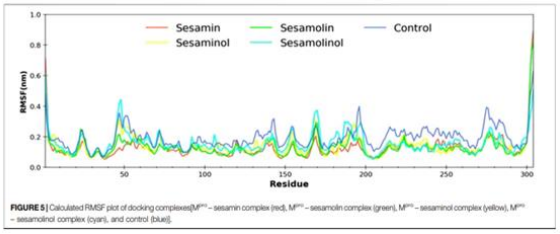
Phylogeny analysis using the nucleotides sequences of J1, J2, J3 and J4 genotypes, reference potato, and wild S. commersonii genomes and other plant species based on the Neighbour-Joining (NJ) algorithm of the AAF tool. J1 (P8), J2 (S. pinnatisectum), J3 Mainstreaming sesame germplasm for productivity enhancement and sustainability through genomics assisted core development and trait discovery. External funded: Department of biotechnology, Govt. of India, New Delhi, Start date:29-2-2020, End-date28-2-2025, Project code: code AGEDIASRICOP202100200169, Associate as CCo_PI

Developed database and Wikipedia of Sesame using collected general information on sesame taxonomy, species and varieties, package of practices and also bioinformatics information available in public domain on miRNAs , TFs, abiotic and biotic stresses.

Apart from this work, a research study has been done on Inhibition potencies of phytochemicals from sesame natural components against SARS-CoV-2 main protease using molecular docking and simulation. The ongoing COVID-19 pandemic, caused by SARS-CoV-2, has now spread across the Q7 nations with high mortality rates and multifaceted impact on human life. The proper treatment methods to overcome this contagious disease are still limited. The main protease enzyme (Mpro, also called 3CLpro) is essential for viral replication and has been considered as one of the potent drug targets for treating COVID-19. In this study, virtual screening was performed to find out the molecular interactions between 36 natural compounds derived from sesame and the Mpro of COVID-19. Four natural metabolites, namely, sesamin, sesaminol, sesamolin, and sesamolinol have been ranked as the top interacting molecules to Mpro based on the affinity of molecular docking. Moreover, stability of these four sesame-specific natural compounds has also been evaluated using molecular dynamics (MD) simulations for 200 nanoseconds. The molecular dynamics simulations and free energy calculations revealed that these compounds have stable and favorable energies, causing strong binding with Mpro. These screened natural metabolites also meet the essential conditions for drug likeness such as absorption, distribution, metabolism, and excretion (ADME) properties as well as Lipinski's rule of five. Our finding suggests that these screened natural compounds may be evolved as promising therapeutics against COVID-19. Below diagram is overall flow of study.



Below mentioned figure is final RMSD graph represents stability and free energy status of binding of four sesame natural compound with main protease Mpro of COVID-19



Computational and Analytical Solutions for High-throughput Biological Data under CRP Genomics Platform

The eTM lncRNAs were identified and characterized in various tissue like leaf, stem and flower of cluster bean. The miRNA participated in eTM-lncRNA were identified and target of these were predicted. psRobot server was deployed for the prediction of miRNA target gene.

Table 1: list miRNAs and their target

miRNA	score	mRNA	target's protein function
>Gor-miR_bud-3117	2.2	EGG991235.1	A0A072TKE2_MEDTR MADS-box transcription factor OS=Medicago truncatula GN=MTR_0003s0590 PE=4 SV=1
>Gor-miR_leaf-3165	2.5	EGG991222.1	A0A0B2R4W1_GLYSO Calcium calmodulin-dependent serine threonine- kinase 1 OS=Glycine soja GN=glysoja_049798 PE=4 SV=1
>Gor-miR_leaf-3165	2.5	EGG991162.1	A0A0B2S1S4_GLYSO 60S ribosomal L7-4 OS=Glycine soja GN=glysoja_007119 PE=4 SV=1

>Gor-miR_leaf-3165	2.5	EG99 1132.1	K4D7T6_SOLLC Peroxidase OS=Solanum lycopersicum PE=3 SV=1
>Gor-miR_leaf-3165	2.5	EG99 0886.1	A0A151RJH3_CAJCA Ankyrin repeat domain-containing 13B OS=Cajanus cajan GN=KK1_035840 PE=4 SV=1
>Gor-miR_root-3162	2.5	EG99 1172.1	A3AK08_ORYSJ FRIGIDA OS=Oryza sativa japonica GN=_11593 PE=3 SV=1

Machine Learning Approach for Binning of Metagenomics Data.

Clustering in metagenomics is the process of grouping of microbial contigs in species specific bins. An R Package named 'metaCluster' is developed and is available in CRAN (CRAN - Package metaCluster (r-project.org)). This package contains functions that extract genomic features from metagenome data, find the number of clusters for that given data and find the best clustering algorithm for binning. A novel method, MetaConClust, is developed for binning of metagenomics data using a consensus-based clustering approach using coverage information for grouping of contigs and automatically finding the optimal number of clusters. Applying unsupervised clustering techniques for binning requires finding the optimal number of clusters beforehand and is observed to be a difficult task. The coverage of contigs in a metagenomics sample has been observed to be directly proportional to the abundance of species in the sample and is used for grouping of data in the first phase by MetaConClust. The Partitioning Around Medoid (PAM) method is used for clustering in the second phase for generating bins with the initial number of clusters determined automatically through a consensus-based. Finally, the quality of the obtained bins is tested using silhouette index, rand Index, recall, precision, and accuracy.

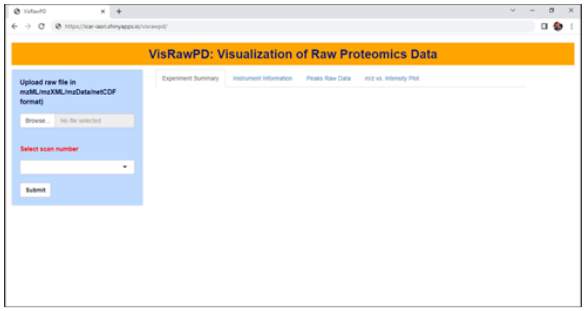
Fig. (1). Workflow of MetaConClust

Performance of MetaConClust is compared with recent methods and tools using benchmarked low complexity simulated and real metagenomic datasets and is found better for unsupervised and comparable for hybrid methods. This is suggestive of the proposition that the consensus-based clustering approach is a promising method for automatically finding the number of bins for metagenomics data

Development of statistical and computational approach for preprocessing and analyzing high-throughput proteomics data with missing values

1. Web-based application "VisRawPD" for visualization of raw mass spectrometry (MS) data: A web-based application "VisRawPD" for visualization of raw MS data has been developed. The user has to upload raw MS data. It supports data in mzML, mzXML, mzData, netCDF formats. Then, the user can select any scan number to get various information such as experiment summary, instrument information, peak data and interactive plot of m/z vs. intensity for the selected scan

number. It can be accessed freely by users from https://icar-iasri.shinyapps.io/visrawpd/.



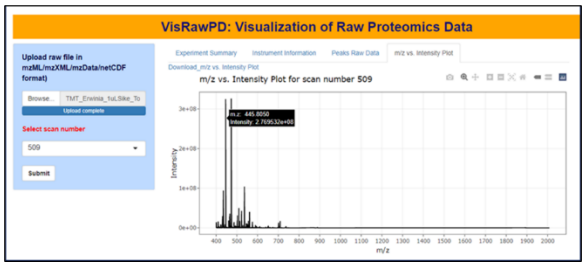


Fig. m/z vs. Intensity plot for the selected scan number

2. Web-based application "VisIdentPD" for visualization of peptide and protein identification data: A web-based application "VisIdentPD" for visualization of peptide and protein identification data has been developed. The user has to upload identification file and hit the "Submit" button. It will give the results such as identification information, peptide-to-spectrum (PSM) matches, modification information, PSM score and table of MS identification data. It can be accessed freely by users from https://icar-iasri.shinyapps.io/visidenpd/.

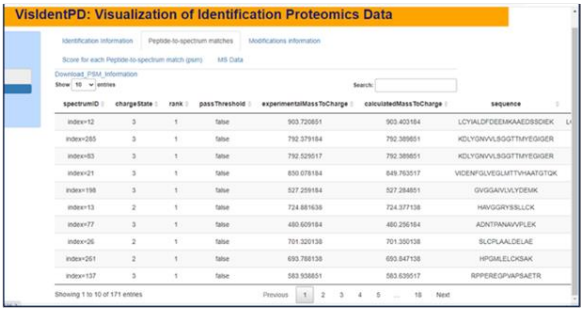


Fig. Screenshot of the tool "VisIdentPD"

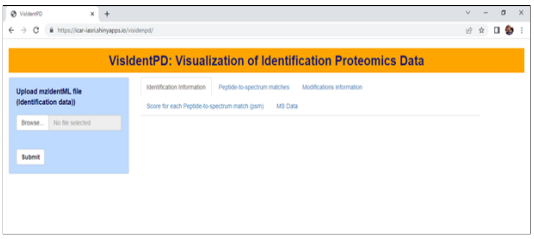


Fig. Portion of table showing the various information of identification proteomics data

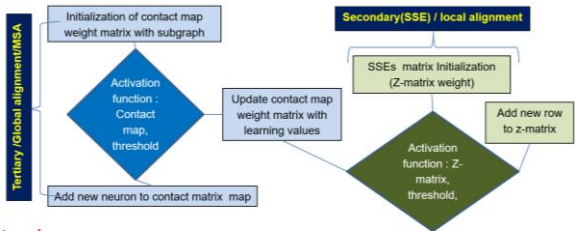
Development of Artificial Intelligence Framework for Prediction of Protein 3D Structure

Project code:

Progress:

Protein is biological macromolecule and primary functional unit of living organisms regulating important biological activities. Activities such as signaling, inhibition of external bodies, mobility, catalysis, shape, ordering, and stability. Proteins are polymeric chains of amino acids (or residues) - primary structure/protein sequence. Proteins are synthesized within living cells and then immediately fold into a three-dimensional (3D) structure. Protein 3D structure is a primary unit in structural biology. Protein sequence uniquely determines a 3D structure in its native environment. This 3D structural information is vital in understanding the function of a protein. 3D structure has attracted attention in protein engineering along with application in agriculture, biomedicine and other allied industries. The ultimate goal is to unearth the relationship between the sequence, structure and function including relationship between genotype and phenotype this leads to sustainable production and productivity in agriculture. In view of these, project proposed with objectives such as; to construct AI framework for Protein structure prediction; to test, refine and evaluate the developed AI framework; and to develop web based AI framework for structure prediction. During report period, collected data for training at initial stage 100

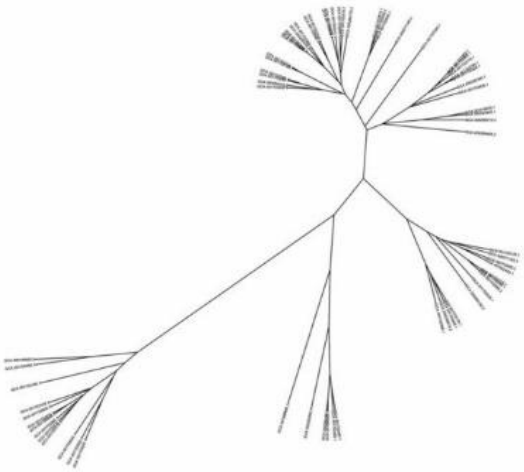
benchmark data. The benchmark data has proteins belongs to all major classes and residues are ranging from 51 to 105. Shiny Mobile app developed to calculate graph properties from protein 3D structure. R code developed for 3D matrix to Z-matrix and SSEs weight matrix. R code developed for Z-matrix to 3D structure. Generation of contact maps and contact map weight matrix at 3D structure level and SSEs Z-matrix weight matrix at secondary structure level have been implemented using R as mentioned in the below figure.



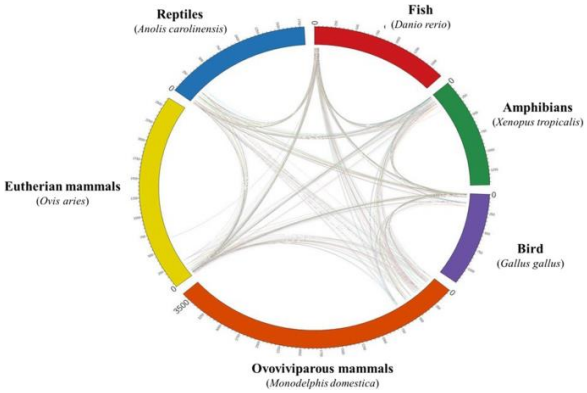
1. Development of Methodology for Trait Specific Genes Identification (PI)

Many feature selection algorithms (FSA) are introduced in past decade but most of them do not perform well on high-dimensional datasets with a large number of redundant features. Thus in the present project, it was planned to develop the methodology for obtaining relevant set of trait specific genes from gene expression data. Under this project trait specific gene selection tool (TSGS) has been developed by applying combination of two conventional machine learning algorithms, support vector machine (SVM) and a genetic algorithm (GA). They are integrated effectively based on a wrapper approach. GA is used to control and optimize the subset of genes sent to the SVM for classification and evaluation. Using SVM as the classifier performance and the Genetic algorithm for feature selection a set of informative gene set can be obtained. The classification accuracy of the obtained gene set from the developed methodology was compared with the gene sets obtained from methods such as Boot-MRMR, MRMR, t-score and F-score of R- package "GSAQ". For the easy availability of the TSGS to the user a web tool using shiny app has been created, further the tool is also provided access through Biocomputing portal ASHOKA for the user to analyze their high dimensional gene expression data.

2. **Fungal Genomic Resources for Stra in Identification and Diversity Analysis of Fungal Species:** Developed whole genome sequence-based world's largest microsatellite database, FungSatDB having >19M loci obtained from >1900 fungal species/strains using >4000 assemblies across globe. Genotyping efficacy of FungSatDB has been evaluated by both in-silico and in-vitro PCR. By in silico PCR, 66 strains of 8 countries representing four continents were successfully differentiated. Genotyping efficacy was also evaluated by in vitro PCR in four fungal species. This approach overcomes limitation of ITS in species, strain signature, and diversity analysis. It can accelerate fungal genomic research endeavors in agriculture, industrial, and environmental management.

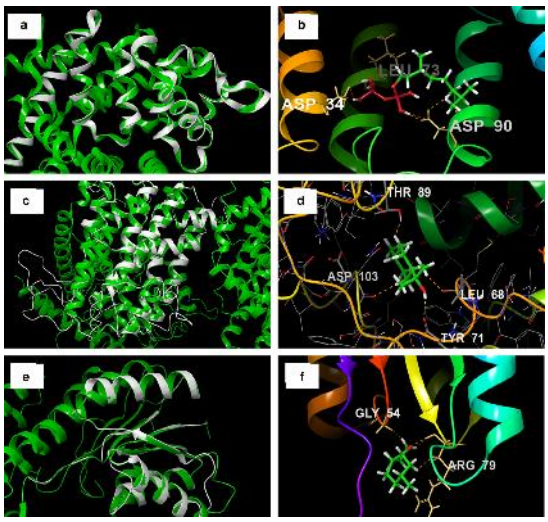


3. Revealing Alteration in the Hepatic Glucose Metabolism of Genetically Improved Carp, Jayanti Rohu Labeo rohita Fed a High Carbohydrate Diet : We identified molecular events that occur due to the inclusion of high carbohydrate levels in the diets of genetically improved 'Jayanti rohu' Labeo rohita. To reveal transcriptional changes in the liver of rohu, a feeding experiment was conducted with three doses of gelatinized starch (20% (control), 40%, and 60%). Transcriptome sequencing revealed totals of 4464 up- and 4343 down-regulated differentially expressed genes. Up-regulated transcripts associated with glucose metabolisms, such as hexokinase, PHK, glycogen synthase and PGK, were found in fish fed diets with high starch levels. Interestingly, a de novo lipogenesis mechanism was found to be



enriched in the livers of treated fish due to up-regulated transcripts such as FAS, ACCα, and PPARγ. The insulin signaling pathways with enriched PPAR and mTOR were identified by Kyoto Encyclopedia of Genes and Genome (KEGG) as a result of high carbohydrates. This work revealed for the first time the atypical regulation transcripts associated with glucose metabolism and lipogenesis in the livers of Jayanti rohu due to the inclusion of high carbohydrate levels in the diet.

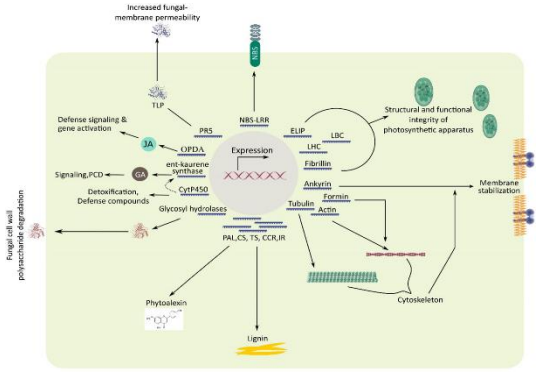
4. **Transcriptome based identification of terpene synthases genes from black pepper berry:** The entire terpene synthase family responsible for the biosynthesis of the flavor-imparting volatiles in black pepper berries was profiled using a combinatorial approach. It shows 98 terpene synthases from various terpene synthesis pathways. Three important monoterpene synthases were also validated. This study provides the first of its kind information on the terpene synthase family profile in *Piper nigrum*, which is potentially a major step for further characterization of the functional terpene synthase genes in black pepper.



5. Transcriptome profiling reveals basis of differential sheath blight disease in rice: Rice sheath blight (ShB) disease, caused by the fungal pathogen Rhizoctonia solani AG1-IA, is one of the devastating diseases and causes severe yield losses all over the world. No completely resistant germplasm is known till now, and as a result, the progress in resistance breeding is unsatisfactory. In this study, we report the identification of a new ShB-tolerant rice germplasm, CR 1014. Further, we investigated the basis of tolerance by exploring the disease responsive differentially expressed transcriptome and comparing them with that of a susceptible variety, Swarna-Sub1. A total of 815 and 551 genes were found to be differentially regulated in CR 1014 and Swarna-Sub1, respectively, at two different time points. The result shows that the ability to upregulate genes for glycosyl hydrolase,

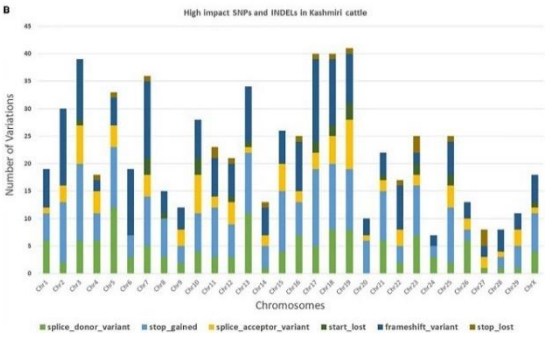
secondary metabolite biosynthesis, cytoskeleton and membrane integrity, the glycolytic pathway, and maintaining photosynthesis make CR 1014 a superior performer in resisting the ShB pathogen. The knowledge could be utilized to devise strategies to manage the disease better.

6. Genome wide prediction, mapping of Mastitis associated genes in Buffalo: Mastitis disease of Water Buffalo has been a major constraint in productivity in India and other countries. This disease is rising with high milk yielders and antibiotics used in treatment are ineffective due antimicrobial resistance (AMR). GWAS has not been effective in genomic selection (GS) thus there is a need for case control association studies. We reported world's first Buffalo specific



web genomic resources to be used as targeted Gene Panel (TGP) for extremely low frequency variant mining at 1000x coverage require for mastitis resistance bleeding program in India and other countries.

7. SNPs in mammary gland unravelling potential difference in milk production between Jersey and Kashmiri cattle: Deep RNA sequencing experiment was employed to detect putative SNP in mammary epithelial cells between two diverse cattle breeds (Jersey and Kashmiri) to understand the variations in the coding regions that reflect differences in milk production traits. A total of 607 (442 SNPs and 169 INDELs) and 684 (464 SNPs and 220 INDELs) high-impact variants were found specific to Jersey and Kashmir cattle, respectively. Based on our results, we conclude that in Jersey cattle, genes with high-impact SNPs were enriched in nucleotide excision repair pathway, ABC transporter, and metabolic pathways like glycerolipid metabolism, pyrimidine metabolism, and amino acid synthesis (glycine, serine, and threonine). Whereas, in Kashmiri cattle, the most enriched pathways include endocytosis

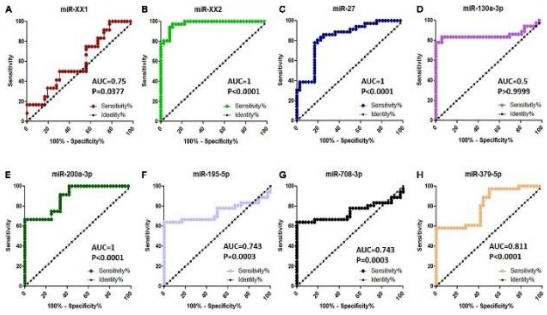


pathway, innate immunity pathway, antigen processing pathway, insulin resistance pathway, and signaling pathways like TGF beta and AMPK which could be a possible defense mechanism against mammary gland infections. A varied set of SNPs in both breeds, suggests a clear differentiation at the genomic level; further analysis of high-impact SNPs is required to delineate their effect on these pathways.

8. Establishment of the repertoire for placentome associated microRNA and their appearance in blood plasma to identify early pregnancy in buffalo: Precise early pregnancy diagnosis in dairy animals is of utmost importance for an efficient dairy production system. The present study was aimed at establishment of the microRNA (miRNA) repertoire of the placentome in buffaloes, which could capture the event of the cross talk between a growing embryo and a dam,

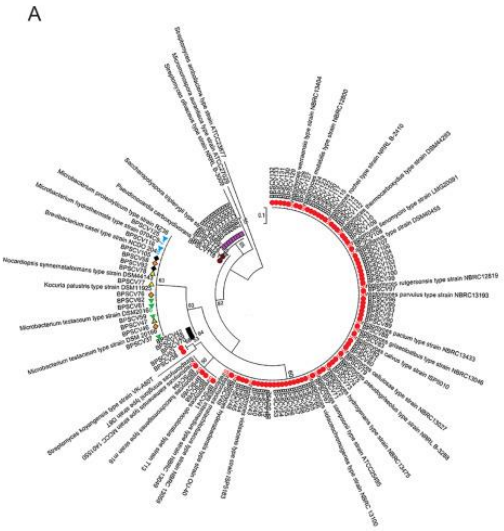
through fetal cotyledons and maternal caruncles, and thus could hint at the early pregnancy establishment event in ruminants. A total of 2,199 miRNAs comprising 1,620 conserved and 579 non-conserved miRNAs were identified. Stringent functional miRNA selection criteria could predict 20 miRNAs worth evaluating for their abundance in the plasma of pregnant, non-pregnant, cyclic non-bred, and non-cyclic prepubertal animals. Eight of them (viz., miR-195-5p, miR-708-3p, miR-379-5p, miR-XX1, miR-XX2, miR-130a-3p, miR-200a-3p, and miR-27) displayed typical abundance patterns in the plasma samples of the animals on Day 19 as well as Day 25 post-insemination, thus making them ambiguous candidates for early pregnancy detection. We concluded that circulatory miR-XX1 and miR-XX2 in blood plasma could be the potential biomarkers for early pregnancy detection in buffaloes.

9. Microbiome of Pukzing Cave in India shows high antimicrobial activity against plant and animal pathogens: Study revealed Pukzing cave, the largest cave of Mizoram, India ecosystem as a unique source of endemic and moderate thermophilic microorganisms. Amplicon sequencing of PKSI, PKSII and NRP specific genes revealed presence of AMP

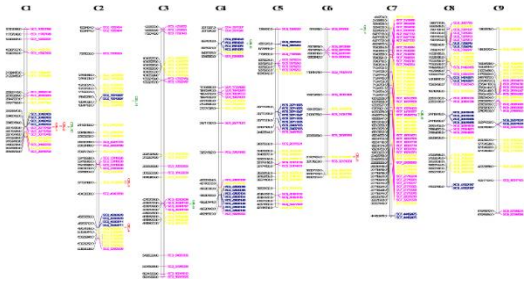


genes in the microbial population. Cave environment harbours unique microbial flora and hypervariable region V4 was found to be more informative. The study concludes that cave microbial communities could be potential source of future genomic resources.

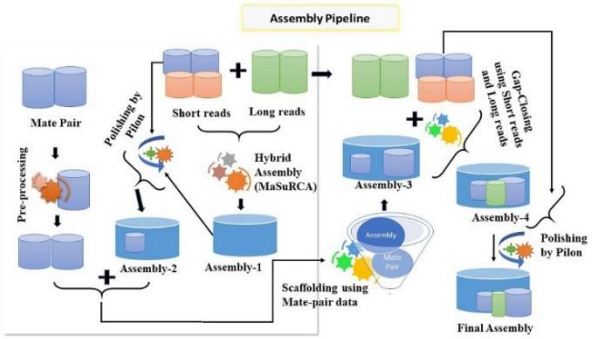
10. **Population structure and detection of QTLs for curding related traits in Indian cauliflower:** Curd initiation and development are complex traits and highly responsive for different temperature ranges in cauliflower. The present study was aimed to identify QTLs for eight traits associated with curding behaviour in diverse germplasm of Indian cauliflower. For this, 92 genotypes of



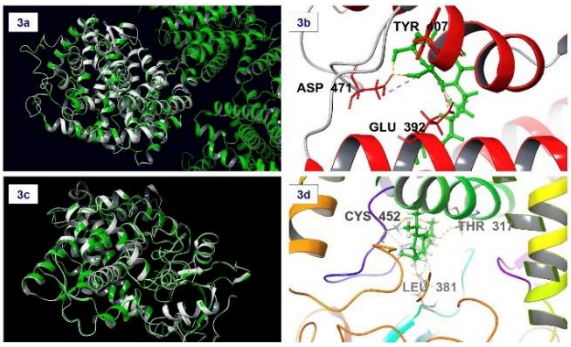
cauliflower and 2 each of tropical broccoli and cabbage were genotyped through genotyping by sequencing (GBS). A total of 121 significant SNPs was detected for eight traits. Twelve QTLs were detected for traits associated with regulation of curd formation and development, The SNPs identified will be useful for development of markers for curding-related traits and their use in breeding varieties with wider curding plasticity.



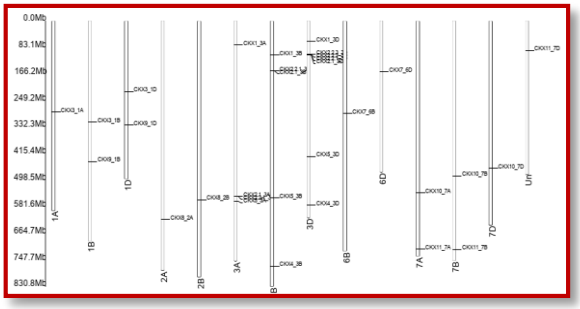
11. Whole genome sequencing of Magur: The Asian catfish locally known as magur fish is an important air- breathing cat fish with good market especially in North-Eastern parts of West Bengal where it fetches a higher price than the major carps. The whole genome sequencing is successfully completed and published. This can be used as a model computation work to explore urea cycle, vision, locomotion, olfactory and vomeronasal receptors, immune system, anti-microbial properties, mucus, thermoregulation, osmoregulation, air-breathing, detoxification related genes. The genome information will be valuable resource for its propagation and conservation management and comparative genomics with other catfish species.



12. **Identification of peppery aroma compound 'rotundone' backbone genes from black pepper:** Rotundone, an oxygenated sesquiterpene compound, responsible for the peppery aroma. The importance of the rotundone in the flavor industry warrants search for the precursor genes in plants. We report in this study, the first on the identification of rotundone backbone genes viz., α-guaiene synthase & α-guaiene oxidase in black pepper. We identified the precursor genes of rotundone using berry transcriptome profiling. The metabolite profiling using head space mass spectrometry showed the presence of the direct precursor compounds for rotundone biosynthesis in black pepper berries. The identification of the genes & compounds of the guaiene skeleton is expected to help in bioprospecting of black pepper varieties & also in recombinant production of the aroma compound.



13. **Genome-wide study of Cytokinin Dehydrogenase (Triticum aestivum) genes:** Cytokinin dehydrogenase (CKX; EC.1.5.99.12) regulates the level of cytokinin (CK) in plants and is involved in CK regulatory activities. In different plants, a small gene family encodes CKX proteins with varied numbers of members. These genes are expanded in the genome mainly due to segmental duplication events. Despite their biological importance, CKX genes in Triticum aestivum have yet to be studied in depth.



A total of 11 CKX sub-families were identified with similar gene structures, motifs, domains,

cis-acting elements and an average signal peptide of 25 amino acid length was found. Introns, ranging from one to four, were present in the coding regions at a similar interval in major CKX genes. Putative cis-elements like abscisic acid, auxin, salicylic acid, low-temperature, drought and light-responsive cis-regulatory elements were found in the promoter region of the majority of CKX genes. Variation in the expression pattern of CKX genes were identified across different tissues in Triticum. Phylogenetic analysis shows that the same subfamily of CKX clustered into a similar clade that reflects their evolutionary relationship. We performed genome-wide identification of CKXs family members in Triticum aestivum genome to get their chromosomal location, gene structure, cis-element, phylogeny, synteny, tissue and stage-specific expression along with the gene ontology. The detailed analysis of CKX gene distribution in the wheat genome, motif characteristics, evolutionary and syntenic relationships, presence of cis-elements in the promoter regions were performed followed by gene ontology analysis. This study provides a resource for further analysis of CKX in regulation of biotic and abiotic stress resistance, growth and development in Triticum and other cereals in endeavour for higher production and proper management

Software Databases and Tools Developed

1. GenoSig: Web Based Software for Genomic Signature Computation (GenoSig)

Metagenomics is the study of microbial communities sampled directly from their natural environment, without prior culturing. Metagenomics is revolutionizing the field of microbiology, and has excited researchers in many disciplines. Binning of metagenomics data is an important task during analysis and various taxonomy dependent and independent approaches are developed for this. Many of these approaches requires the computation of genomic signatures from sequences for delineating between the species present in the dataset.

GenoSig provides the ready to use computation for most frequently used genome signature at one place for easy accessibility and usage. These genomic signatures may be computed for both genomic as well metagenomics datasets. This software has modules for file management, computation of genomics signatures and online help for using software. This application is based on client-server technology and is developed using JSP, JavaScript, HTML and R package. This web based solution is available at web address: http://backwin.cabgrid.res.in:8080/GenomicSignatureWeb/index.jsp

2. SIReDAM: Systematic Information Resources for Dairy Animal Management (http://webtom.cabgrid.res.in/SIReDAM/) : SIReDAM is a dedicated Management Information System (MIS) for bovines. Database has been developed and implemented in MySQL as back-end RDBMS and PHP used as server side scripting language for database connectivity and server side processes. Front-end tools and mobile apps developed using HTML and JAVA for data entry, analysis and visualization. The web-based system is implemented in Linux based apache and MySQL server at ICAR-IASRI, New Delhi server to store data.

It is established to record overall data of individual and herd wise daily activities covering the phenotypic and genotypic information such as animal basic details, growth, breeding, calving, milking, feeding,

semen collection, semen analysis, vaccinations, health and etc. Four levels users profile management module has been integrated in the system to manage hierarchy of users with different privileges. Well established data flow from entry to validation, acceptance, rejection, modification and view among the users is integrated. Advisories and forecasting activities of animals and messaging module is included with email.

This software is well equipped with standard detailed reports and user-defined generic reports with graphical and tabular presentation of information. Standard registry provision has been made to maintain registry by herd, center and institute wise. Dashboard and daily advices facilities has been given with summarized information and message inbox. Incorporated breeding Descriptive Statistics, Least Square

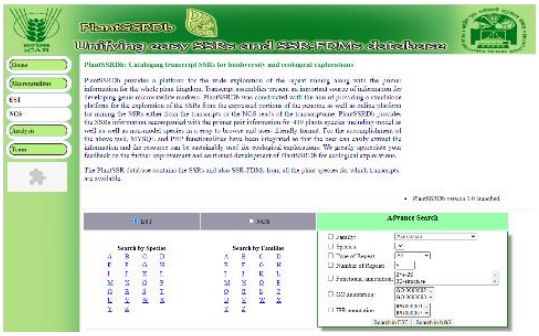
Analysis, BLUP analysis using R Software. Economic analysis module has been made to improve efficiency and effectiveness of operational activities for enhancing the productivity and profitability of dairy farm. This software developed under Inter-Institutional project with ICAR-CIRC, Meerut.

3. **Water Buffalo Mastitis Database (WBMSTDb)http://webtom.cabgrid.res.in/wbmstdb:** Water Buffalo Mastitis Database (WBMSTDb): Water buffalo (Bubalus bubalis), is a very important animal resource which contributes milk, meat, leather, dairy products and power for ploughing and transport. However, mastitis, a bacterial disease affecting milk production and reproduction efficiency, is most prevalent in populations having intensive selection for higher milk yield, especially where inbreeding level is also high. An attempt was made on the application of targeted gene panels (TGPs) in screening for candidate gene association analysis, and how this approach overcomes the limitation of genome wide association studies. This will facilitate the targeted sequencing of buffalo genomic regions with high depth coverage required to mine extremely rare variants potentially associated with buffalo mastitis. Though, whole genome assembly of water buffalo is available but neither mastitis genes are predicted nor TGP in the form of web-genomic resource is available required for future variant mining and association studies. Water Buffalo-MSTdb a web-genomic resource was developed with 3-tier architecture to retrieve mastitis associated genes having genomic coordinates with chromosomal details for TGP sequencing for mining of minor alleles for further association studies. It aids in mining of variants of TGP in buffalo for mastitis resistance breeding in endeavor to ensure improved productivity and reproductive efficiency of water buffalo. This database developed under Network Project on Agricultural Bioinformatics and Computational Biology in collaboration with ICAR-CIRB, Hisar.

4. **BrassicaSatDB: Brassica Microsatellite Database with primer generation tool http://webtom.cabgrid.res.in/brassica_ssrdb/:** Under the CABin scheme, Brassica SSR database with "three-tier architecture" was developed using PHP and MYSQL. It uses de novo Brassica genome assembly of ensembl genome database and NCBI database as an invaluable resource to mine putative SSR markers and generate their primers. The web-resource catalogues SSR information of five Brassica cultivars, namely, Brassica Olarecea, Brassica Rapa,

Brassica Juncea and Brassica Nigra, all assembled chromosome-wise while Brassica Napus is available scaffold-wise. The data was retrieved in FASTA format. Individually, Brassica Olarecea has 9 chromosome, Brassica Rapa has 10-chromosome, Brassica Juncea has 18-chromosome and Brassica Nigra has 8-chromosome. A total of SSR 202313, 135767, 142191 and 300096 SSR markers were mined using MISA tool in Brassica olarecea, Brassica napa, Brassica nigra and Brassica junecea, respectively. It is available at http://webtom.cabgrid.res.in/brassica_ssrdb/ for scientific community. This database developed under Network Project on Agricultural Bioinformatics and Computational Biology.

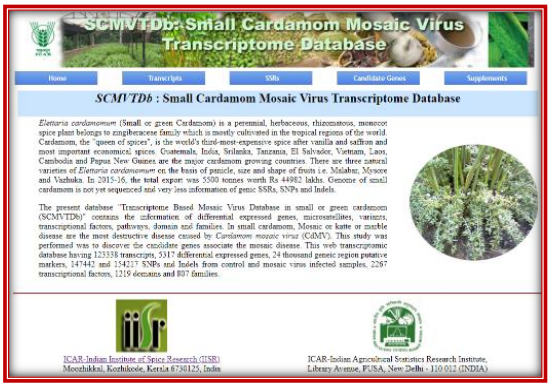
5. **PlantSSRDb: Unifying easy FDRs and SSR-FDMs Database (**http://webtom.cabgrid.res.in/plantssr/**):** We developed world's largest database, PlantSSRs of 364 plant species with more than 4.5 million SSRs with detailed annotations for easy functional browsing of SSRs distributed across the plants. This comprehensive on-line portal unifies mining of SSRs, corresponding primer pairs and associated in-depth functional annotation such as GO annotation, GO terms, gene interactions and its identification from protein databases, from both first and next generation sequencing (NGS) datasets. In addition, it presents SSR-FDMs (SSR-Functional domains markers) with information on primer pairs and associated functional domains, which can be leveraged to identify functional, based genic variability among the species of interest, which might of particular interest in varietal improvement molecular breeding programme. PlantSSRs database cum web-server is freely accessible at: http://webtom.cabgrid.res.in/plantssr/. This database developed under Network Project on Agricultural Bioinformatics and Computational Biology.



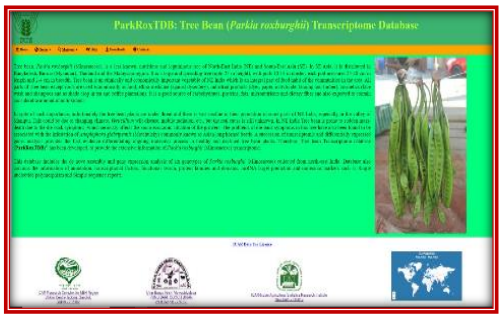
6. **Millet SSR Database (http://webtom.cabgrid.res.in/mille_ssr_db/):** This computational tool Millet SSR Database stores catalogue of microsatellites fetched from Pearl Millet, Fox Millet, Proso Millet and Sorghum Millet genome. The chromosome-wise sequences were used to extract microsatellite markers using MIcroSAtellite tool (MISA). The output of MISA was processed using PERL scripts. The data were assembled in proper format in order to create the data file which was further imported to MySQL database. The query for SSRs may be made chromosome wise along with the microsatellite characteristics such as motif type, repeat motif and repeat kind. Furthermore, the advance search may be made with the range of chromosomal location, GC content, number of base pairs and copy number. For the graphical user interface, PHP was used. The primers are generated using primer3 standalone tool. This database has been developed under Network Project on Agricultural

Bioinformatics and Computational Biology.

7. **SmCarTDB: Small Cardamom Transcriptome database (http://webtom.cabgrid.res.in/scmvtdb) : SmCarTDB (small cardamom transcriptome database):** Small cardamom associated with capsule rot (Azhukal disease) Transcriptome Database is based on "three-tier architecture" consisting of client tier, middle tier and database tier and available freely for non-commercial use at http://webtom.cabgrid.res.in/scmvtdb. In client tier, web pages have been developed using HTML and Javascript for user queries and browsing. In middle tier, scripting has been done using PHP for database connectivity, performing query and fetching data. Database tier has been developed using MySQL for storing information of DEGs, putative molecular markers (SSRs, SNPs and InDels) along with primers, blast results, transcription factors and KEGG pathways. This database has been developed under Network Project on Agricultural Bioinformatics and Computational Biology.



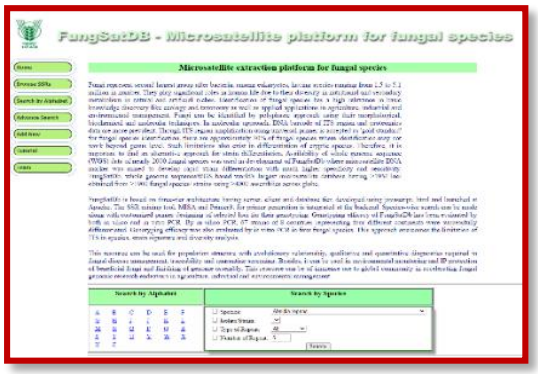
8. **ParkRoxTDB: Tree Bean (Parkia roxburghii) Transcriptome Database (http://backlin.cabgrid.res.in/parkroxtdb/): ParkRoxTDB:** Tree Bean (Parkia roxburghii) Transcriptome Database is an online relational database of cucumber (Parkia roxburghii) transcriptome based on "three-tier architecture" having, client-, middle- and database tier, that catalogues the information pertaining to assembled transcripts, differentially expressed genes (transcripts) and the pathways they are involved, transcription factors, putative SSR markers, their primers and variants (SNPs and InDels). All these information are in the form of tables in MySQL in the database. For the user queries, fetching and execution, scripting in PHP has been done in the middle tier. For database browsing, web pages are developed in client tier. This resource is freely available for academic use at http://backlin.cabgrid.res.in/parkroxtdb/. This database has been developed under DBT Funded project Molecular characterization, development of molecular markers and metabolite analysis of Tree bean (Parkia roxburghii) landraces of North-East India.



9. **FungSatDB: Fungal Genomic Resources http://webtom.cabgrid.res.in/fungsatdb/:** FungSatDB based on 3-tier architecture was designed for developing microsatellites in fungal genomes using LAMP (Linux-Apache-MySQL-PHP) technology. FungSatDB, freely

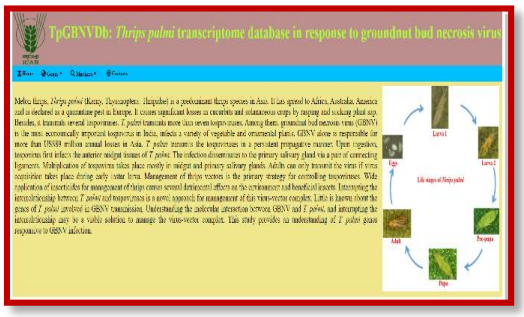
accessible at http://webtom.cabgrid.res.in/fungsatdb/ (accessed on 22 March 2020) is an exclusive database of microsatellite repeats for various fungal genome cataloguing information of 19,079,777 repeats which contains 10,235,086 simple, 1,459,190 compound, and 56484 complex markers from 3903 assemblies of 1973 species. User can obtain different types and motifs of microsatellites (simple, compound, and complex), along with their location and length in the genome assembly of these fungal species. This database is developed under Network Project on Agricultural Bioinformatics and Computational Biology.

10. **Database developed: Levidb: Genomics of Virus in Legume Crops**



http://webtom.cabgrid.res.in/levidb/: To develop viral diagnostics of legume crop extensive literature survey was made. It's reported that 16 legume crops are there which are infected by 86 viruses. Public domain database were used to mine viral sequence. A total of 2574 viral sequence of legume crop has been mined having 1835 partial, 737 full genome and 2 genomic RNA to create database of legume virus. It was found that among 2574 genes, 515 genes are reported from India and rest 2059 from other countries. The extensive legume virus database has been created and it is freely available at http://webtom.cabgrid.res.in/levidb/. This database is developed under Network Project on Agricultural Bioinformatics and Computational Biology.

11. **TpGBNVDb: Thrips palmi transcriptome database in response to groundnut bud necrosis virus (http://backlin.cabgrid.res.in/tpgbnvdb/): TpGBNVDb:** Thrips palmi transcriptome database in response to groundnut bud necrosis virus is an online

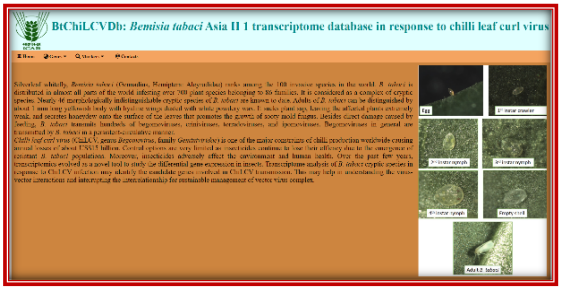


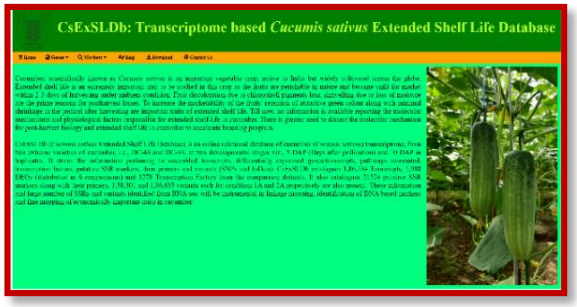
relational database of Melon thrips (Thrips palmi) transcriptome based on "three-tier architecture" having, client-, middle- and database tier, that catalogues the information pertaining to assembled transcripts, differentially expressed genes (transcripts) and the pathways they are involved, transcription factors, putative SSR markers, their primers and variants (SNPs and InDels). All these information are in the form of tables in MySQL in the database. For the user queries, fetching and execution, scripting in PHP has been done in the middle tier. For database browsing, web pages are developed in client tier. This resource is freely available for academic use at http://backlin.cabgrid.res.in/tpgbnvdb/.

This database is developed under Network Project on Agricultural Bioinformatics and Computational Biology in collaboration with ICAR-IARI, New Delhi.

12. **BtChiLCVDb: Bemisia tabaci Asia II 1 transcriptome database in response to chilli leaf curl (http://backlin.cabgrid.res.in/btchilcvdb/):** BtChiLCVDb: Bemisia tabaci Asia II 1 transcriptome database in response to chilli leaf curl virus is an online relational database of Silverleaf whitefly (Bemisia tabaci) transcriptome based on "three-tier architecture" having, client-, middle- and database tier, that catalogues the information pertaining to assembled transcripts, differentially expressed genes (transcripts) and the pathways they are involved, transcription factors, putative SSR markers, their primers and variants (SNPs and InDels). All these information are in the form of tables in MySQL in the database. For the user queries, fetching and execution, scripting in PHP has been done in the middle tier. For database browsing, web pages are developed in client tier. This resource is freely available for academic use at http://backlin.cabgrid.res.in/btchilcvdb/.
This database is developed under Network Project on Agricultural Bioinformatics and Computational Biology in collaboration with ICAR-IARI, New Delhi.

13. **CsExSLDb: Transcriptome based Cucumis sativus Extended Shelf Life Database(http://backlin.cabgrid.res.in/csexsldb/):** CsExSLDb (Cucumis sativus Extended Shelf Life Database) is an online relational database of cucumber (Cucumis sativus) transcriptome based on "three-tier architecture" having, client-, middle- and database tier, that catalogues the information pertaining to assembled transcripts, differentially expressed genes (transcripts) and the pathways they are involved, transcription factors, putative SSR markers, their primers and variants (SNPs and InDels). All these information are in the form of tables in MySQL in the database. For the user queries, fetching and execution, scripting in PHP has been done in the middle tier. For database browsing, web pages are developed in client tier. This resource is freely available for academic use at http://backlin.cabgrid.res.in/csexsldb/.
This database is developed under Network Project on Agricultural Bioinformatics and Computational Biology in collaboration with ICAR-IARI, New Delhi.





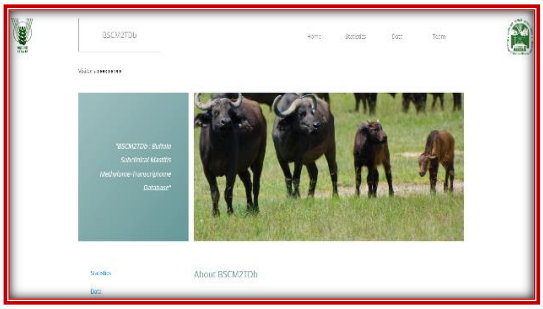
14. **LncR-CsExSLDb: LncRNA based Cucumis sativus Extended Shelf Life Database(http://webtom.cabgrid.res.in/lncrcsexsldb):** LncR-CsExSLDb (Long non-coding RNA Cucumis sativus Extended Shelf Life Database) is an online database for predicted lncRNA and circular RNA in cucumber (Cucumis sativus) transcriptome. All the data has been stored in MySQL tables. The database provides various types of information like differentially expressed lncRNA (DElncRNA), miRNA which could target the predicted lncRNA and mRNA targets of lncRNA. It also provides information on the miRNA targets in terms of mRNA. Additionally, it provides information on putative circular RNA that were also predicted. miRNA that can possibly target circRNA were also listed. For database browsing, web pages are developed in html, in combination with CSS and javascript. This resource is freely

available for academic use at http://webtom.cabgrid.res.in/lncrcsexsldb. This database contains a total of 22071 predicted lncRNA. Out of this 69 lncRNAs have been identified as differentially expressed lncRNA (DElncRNA). 99 miRNAs were identified which can target the identified DElncRNA and these miRNAs in turn can also target 1228 mRNAs. 3049 mRNAs were identified as putative targets of lncRNA. In this study, as total of 238 circular RNAs have been identified which were possible targets of 2250 miRNAs. This database is developed under Network Project on Agricultural Bioinformatics and Computational Biology in collaboration with ICAR-IARI, New Delhi.

15. **BSCM2TDb: Buffalo Subclinical Mastitis Methylome-Transcriptome Database(http://webtom.cabgrid.res.in/BSCM2TDb/):** Buffalo Subclinical Mastitis Methylome-Transcriptome Database (BSCM2TDb) is a three-tier architecture-based relational database, freely accessible at http://webtom.cabgrid.res.in/BSCM2TDb/. All the analyses result like DMRs, DMGs, DM-lncRNAs (methylation-

regulated lncRNAs), DM-miRNAs (methylation-regulated miRNAs), DM-TEs, and DM-TAGs from MeDIP-Seq data analysis along with DEGs and DM-DEGs from RNA-Seq data analysis were catalogued and stored in the backend in a MySQL database. The web interface was developed in PHP. The BSCM2TDb web resource has four main tabs, namely, Home, Statistics, Data, and Team. The Home page has a brief introduction about the database. The navigation key Statistics included a pie chart, showing the proportion of all included data, i.e., 7,900 DMRs, 370 DMGs, 208 DMG-KEGG pathways, 8 DM-miRNAs, 138 DM-lncRNAs, 3,377 DM-TEs, 131 DM-TAGs, 4,638DEGs, and 64 DM-DEGs. The Data page is the main analyses result page that provides the options in the drop-down menu to navigate to the complete table of selected option. This database is developed under Network Project on Agricultural Bioinformatics and Computational Biology in collaboration with ICAR-CIRB, Hisar.

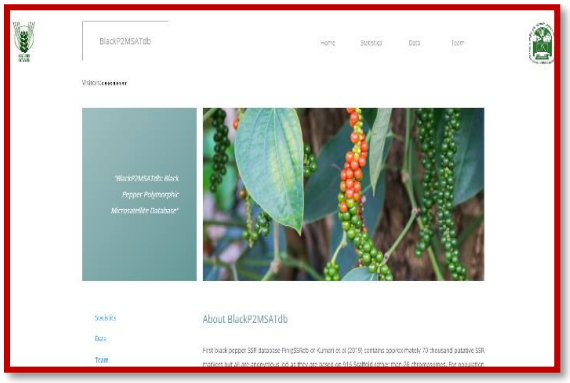
16. **BlackP2MSATdb: Black Pepper Polymorphic Microsatellite Database (http://webtom.cabgrid.res.in/blackp2msatdb/):** BlackP2MSATdb: Black Pepper Polymorphic Microsatellite Database is based on three-tier architecture based relational database having client, middle and database tie and available at http://webtom.cabgrid.res.in/blackp2msatdb/. The analyses results obtained in this study are catalogued in BlackP2MSATdb.



A database was prepared in MySQL database and its web-interface was prepared in PHP and HTML, which includes following steps of data retrieval: (a) a request generates from user's system to web-server, (b) a query sends to MySQL database, (c) a database response generates and sends to web-interface (d) finally, a web-server response sends to user's system. Web hosting of this database was done by Apache2 server. BlackP2MSATdb include details of SSR markers and polymorphic SSRs of black pepper obtained from GBS data analysis of 29 black pepper genotypes. The output

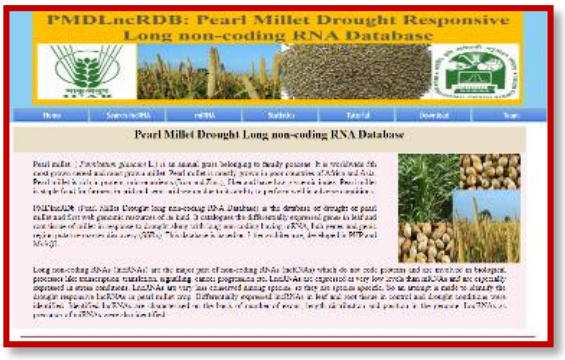
Table of SSR markers gives the information of each marker in terms of its chromosome number, marker type, markers size, start position, end position, forward primer, reverse primer and the link to genome. This database is developed under Network Project on Agricultural Bioinformatics and Computational Biology in collaboration with ICAR-IISR, Kozhikode.

17. **PMDlncRDB: Pearl millet lncRNAs database (https://webtom.cabgrid.res.in/pmdlncrdb):** A web genomic resource, Pearl millet lncRNAs database (PMDlncRDB) was developed which contains the information about identified lncRNAs in response to drought stress in pearl millet. The database also contains the publicly available lncRNAs of pearl millet crop. The



developed web transcriptome database is based upon the "three tier architecture" of a database system consisting of client tier, middle tier and the database tier. The client layer was developed using HTML and JavaScript for browsing the database and defining queries. The middle tier was made using the PHP which functions in database connectivity, executing queries and fetching data from the database. The last tier, database tier was made using MySQL, which will be having the data about the identified lncRNAs, publicly available lncRNAs in pearl millet, GO (gene ontology) terms etc. It is accessible freely at https://webtom.cabgrid.res.in/pmdlncrdb. This database is developed under Network Project on Agricultural Bioinformatics and Computational Biology.

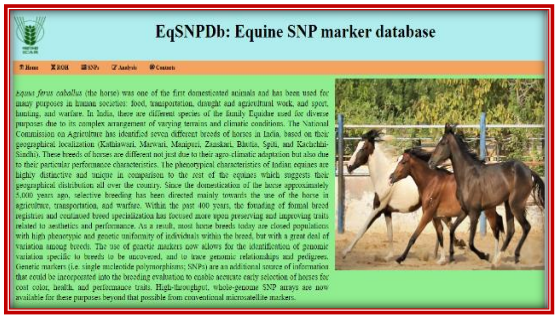
18. **EqSNPDb: Equine SNP marker database(http://webtom.cabgrid.res.in/horse_snps/):** EqSNPDb (Equine SNP marker database) is a relational database which provides information about the Runs of Homozygosity (ROH) deciphered from SNPs. Being a relational database, it follows three-tier architecture which consists of a database, an application layer (server) and a presentation layer (client).



ROHs have been provided for all the seven breeds and for all the samples. All the information about ROHs have been saved in form of tables in MySQL at the database level. For fetching and queries provided by user, scripting in PHP has been done in the middle tier i.e. the application layer. For browsing the database by the clients, web pages are developed in form of presentation layer. All these resources as a whole can be accessed at: http://webtom.cabgrid.res.in/horse_snps/The database has been provided under four tabs i.e. Home, ROH, SNPs and contacts. Home page provides the brief information about the Equus ferus caballus that includes its domestication, important breeds in India and major characteristics corresponding to them. ROH page provides the interactive interface where the user can choose the breed name as well as the chromosome number for retrieving the information of a particular breed. The result table provides the sample names corresponding to that breed, chromosome

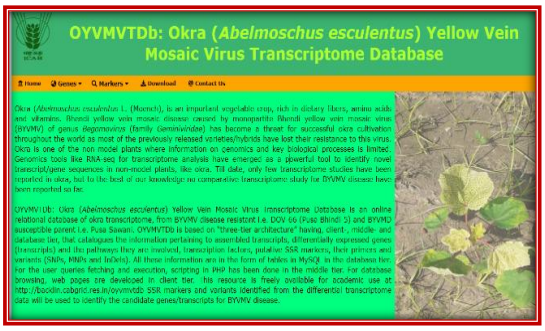
number, SNP ID, SNP position, length of ROH and the number of SNPs in that ROH. SNPs page provide the genotype details of all the 620721 SNPs in a tabular form. This SNP information is given on the sample basis. Next the Analysis web page provides a brief of how the work has been done in form of the flowchart along with some other figures. This database has been developed under Inter-Institutional project Explicating genomic insights of Indigenous equines breed population through Computational Genomics and Artificial Intelligence based approaches in collaboration with ICAR-National Research Centre on Equines, Hisar.

19. **OYVMVTDb: Okra (Abelmoschus esculentus) Yellow Vein Mosaic Virus Transcriptome Database (http://backlin.cabgrid.res.in/oyvmvtdb):** OYVMVTDb: Okra (Abelmoschus esculentus) Yellow Vein Mosaic Virus Transcriptome Database is an online relational database of okra transcriptome, from BYVMV disease resistant i.e. DOV-



66 (Pusa Bhindi-5) and BYVMD susceptible parent i.e. Pusa Sawani. OYVMVTDb is based on "three-tier architecture" having, client-, middle- and database tier, that catalogues the information pertaining to assembled transcripts, differentially expressed genes (transcripts) and the pathways they are involved, transcription factors, putative SSR markers, their primers and variants (SNPs, MNPs and InDels). All these information are in the form of tables in MySQL in the database tier. For the user queries fetching and execution, scripting in PHP has been done in the middle tier. For database browsing, web pages are developed in client tier. This resource is freely available for academic use at http://backlin.cabgrid.res.in/oyvmvtdb
SSR markers and variants identified from the differential transcriptome data will be used to identify the candidate genes/transcripts for BYVMV disease. This database has been developed under Network Project on Agricultural Bioinformatics and Computational Biology in collaboration with ICAR-IARI, New Delhi.

20. **LrSATDb: A transcriptome database of seasonality associated genes in carp fish, Labeo rohita (http://webtom.cabgrid.res.in/lrsatdb/):** An online relational database of rohu fish transcriptome was developed which catalogues tissue wise transcripts/contigs, putative SSRs, SNPs, Indels, transcription



factors, miRNA targets representing two reproductive phases (IGA and PSR). The architecture is "three-tier architecture" viz., client-, middle- and database tier. This genomic resource is freely accessible for non-commercial use at http://webtom.cabgrid.res.in/lrsatdb/. In order to browse and query, user can go through the web pages in client tier. All the information is available in various tables corresponding to MySQL in the database tier. Server side scripting in PHP was done in the middle tier for database connectivity, query execution and

fetching. In order to generate primers over selected markers, Primer3 executable was integrated at the backend. It houses 75554 differentially expressed transcripts, 142145 SSRs, 65584 SNPs, 514 pathways, 5379 transcription factors, 187 mature miRNA which regulates candidate genes represented by 1576 differentially expressed transcripts. This database has been developed under Network Project on Agricultural Bioinformatics and Computational Biology in collaboration with ICAR-CIFA, Bhubaneshwar.

Methodology Developed

(1) **A novel method, MetaConClust, is developed for binning of metagenomics data using a consensus-based clustering approach using coverage information for grouping of contigs and automatically finding the optimal number of clusters.** Applying unsupervised clustering techniques for binning requires finding the optimal number of clusters beforehand and is observed to be a difficult task. The coverage of contigs in a metagenomics sample has been observed to be directly proportional to the abundance of species in the sample and is used for grouping of data in the first phase by MetaConClust. The Partitioning Around Medoid (PAM) method is used for clustering in the second phase for generating bins with the initial number of clusters determined automatically through a consensus-based. Finally, the quality of the obtained bins is tested using silhouette index, rand Index, recall, precision, and accuracy. Performance of MetaConClust is compared with recent methods and tools using benchmarked low complexity simulated and real metagenomic datasets and is found better for unsupervised and comparable for hybrid methods. This is suggestive of the proposition that the consensus-based clustering approach is a promising method for automatically finding the number of bins for metagenomics data.

(2) **Methodology for Trait Specific**

Genes Identification. Selection of informative genes from available high dimensional gene expression data is a challenging task. The complicated relations among different genes make analysis more difficult and removing excess and redundant genes can improve the quality of the result. In the project "Development of Methodology for Trait Specific Genes Identification", combination of Genetic Algorithm and Support Vector Machine techniques were used to develop a methodology which is a heuristic approach for informative gene selection. In this methodology fitness value is used to evaluate individual genes present in the population. Those genes with the highest fitness values are given more opportunities to reproduce and the offspring share features taken from their parents. This ensures that the selected genes are carried to the next generation. The classification accuracy of the obtained gene set from the developed methodology was found to be better when compared with the gene sets obtained from methods such as Boot-MRMR, MRMR, t-score and F-score of R- package "GSAQ". The developed methodology will help the genome researchers and experimental biologists to select informative gene set scientifically and objectively.

(3) Methodology for identification and ranking of differentially expressed genes from RNA-Seq data.

RNA sequencing (RNA-seq) is being increasingly applied for transcript identification and quantification of gene expression. Several statistical methods have been developed for quantifying gene expression levels from RNA-seq data but it is still difficult to assess whether they provide accurate estimations and inferences. Gene expression estimates in RNA-seq experiments presents statistical and computational challenges due to presence of biological and technical variability, small sample sizes, large number of responses used in the study, proper sequencing depth or library size and optimal number of replicates for desired statistical power. In this study a rank order statistic based hybrid model (NBPFCROS) based on parametric and non-parametric statistic for identification of differentially expressed (DE) genes has been developed. This model is used to derive gene significance score π-value by combining expression fold change (f value) and statistical significance (P-value). Statistical significance (P-value) is obtained using a negative binomial power (NBP) model based on compound mixture of Poisson–gamma distribution and Fold change value is derived using fold change rank ordering statistics (FCROS). f-values are the probabilities associated to fold change ranks ordering statistics and assign a ranking statistic to differentially expressed genes. The performance of the developed hybrid model was compared with NBP model and FCROS model using synthetic and real RNA-seq datasets and it was found that the hybrid model (NBPFCROS) is more robust as compared to the other two models.

(4) **Identification of key genes regulating heat stress in wheat.** Wheat is an important cereal crop, which holds the second rank globally in terms of production after maize. However, its productivity is highly sensitive to heat stress, which is one of the most serious threats due to global warming. Therefore, development of heat tolerance variety of wheat through molecular breeding approach is an urgent need of the hour for not only reducing productivity loss but also improving crop yield for feeding growing population. In this context, identification of heat-related genes is the first step for this molecular breeding. In this regard, several studies have been conducted in the past, but due to identification of large number of genes, it was found to be practically difficult to use them in molecular breeding programs. In order to address this issue, in this study, system biology approach has been followed to identify set of key genes related to heat stress in wheat which contributes significantly to regulating this entire process. Here, high throughput RNAseq data were generated using control and treated samples of two contrasting wheat varieties, namely HD2967 (thermo-tolerant) and BT-Schomburgk (thermo-susceptible). Further, in order to identify important key genes, an advanced statistical framework called weighted gene co-expression network analysis (WGCNA) has been used. Moreover, functional annotation of these identified key genes has also been carried out, which confirms their association with the heat stress. These results will provide important lead to experimenters involved in the development of new heat-stress-tolerant wheat cultivars to mitigate effects of global warming.

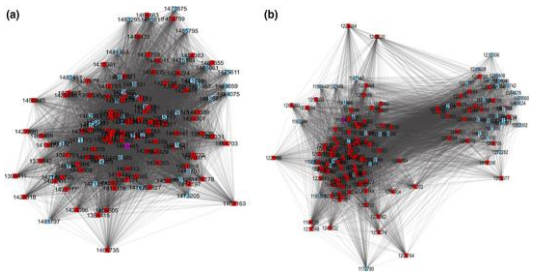


Fig. Network was constructed for HD2967 (a) and BT-Schomburgk (b). Here, pink node is identified as important hub gene

and red nodes are the connected nodes to

Table 2 Significant marker-trait associations identified in cotton for morphological traits using MLM and CMLM models at a threshold value of $p < 0.01$

Trait	SSR	Allele	Chr	Position (cM)	Allele-state association	p value		r^2 (PVE)	
					State of expression	CMLM	MLM	CMLM	MLM
LC	BNL2544	230	18	192	Green	0.0066*	0.0076*	0.1766	0.1753
	BNL3099	185	9	144	Green		0.0079*		0.1744
	BNL3423	220	26	45.5	Light green		0.0084*		0.1732
	BNL3368	180	26	111	Green	0.0093*		0.1697	
	CGR5282	166	2	10	Green	0.0097*		0.1689	
LH	BNL409	100	20	91	Sparse	0.0019**	0.0020**	0.1810	0.1554
	CGR5193	168	12	110	Strong	0.0048**	0.0062*	0.1622	0.1314
LA	CGR5732	206	19	130	Flat	0.0063*	0.0044**	0.1227	0.1242
PSH	BNL4108	180	6	139	Sparse	0.0028**	0.0017**	0.1308	0.1240
	CGR5193	168	12	110	Strong	0.0085*	0.0048**	0.0970	0.1005
FAC	BNL1721	187	18	31	Cream	0.0027**	0.0027**	0.1818	0.1818
FPC	BNL1066	150	3	35.6	Yellow	0.0013**	0.0013**	0.1307	0.1327
	BNL3398	170	3	124	Cream	0.0058*	0.0057*	0.0969	0.1000
FSP	BNL2495	195, 205	19	152	Exserted, embedded	0.0028**	0.0028**	0.1997	0.1997
BPT	BNL3452	170	19	18.9	Blunt	0.0042**	0.0033**	0.1368	0.1432
	CGR5282	156	2	10	Pointed	0.0045**	0.0051*	0.1354	0.1339
BO	BNL3563	245	10	42.1	Open	0.0046**	0.0046**	0.1862	0.1862
	BNL1421	200	13	119	Open	0.0049**	0.0049**	0.1849	0.1849
	BNL827	158	10	26.3	Open	0.0088*	0.0088*	0.1735	0.1735

*$p < 0.01$; **$p < 0.005$, *Chr* chromosome

consecutive years (2018 and 2019) in early, normal, and late sown environments. Out of 168 SSR markers screened over the 96 genotypes, a total of 97 polymorphic markers containing 293 alleles were used for analysis. Three different models, i.e., mixed linear model (MLM), compressed mixed linear model (CMLM), and multiple locus mixed linear model (MLMM), were used to detect the significant marker–trait associations for six different environments separately. A total of 38 significant marker–trait associations that were common to at least two environments were considered as promising associations and detailed annotation of the significant markers has been carried out. Twenty-two marker–trait associations were found to be novel in the current study. These results will be very useful for crop improvement programs using marker-assisted cotton breeding.

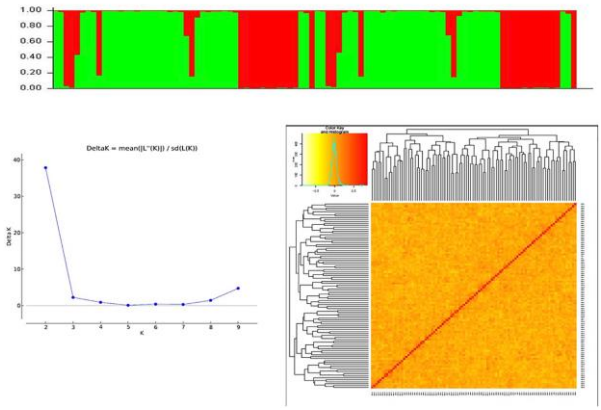


Fig. (A) Bar graph for population structure of cotton genotypes performed by admixture method in STRUCTURE, which grouped all accessions into two clusters. (B) Estimation of number of clusters using 1K values for K ranging from 2 to 10. (C) Heat map plot displaying relationships of 96 cotton genotypes based on SSR markers.

(6) Identification of novel SSR based marker trait association in relation to morphological traits for the cotton crop. A total of 96 different genotypes of upland cotton (Gossypium hirsutum) were selected from breeding material and germplasm available at CCS HAU, India, to find the novel marker-trait associations for morphological traits used for registration of variety in upland cotton. Twenty-three morphological traits of the selected genotypes were recorded in field trials conducted in two replication of randomized block design during Kharif 2018 and 2019. A total of 11 traits showed sufficient variations in the screened germplasm and the same were further used for association mapping. A total of 168 SSRs were used for genotyping, of which 97 SSRs showed polymorphism amplifying 293 different alleles with an average of 3.02 alleles per SSR. Clustering, principal component analysis, and population structure analysis advocated that the current. germplasm panel has enough diversity to be considered for association mapping. A total of 20 significant marker-trait associations were identified by the mixed linear model
(MLM) and compressed mixed linear model (CMLM), of which 15 were common to both models, hence considered as promising associations. To the best of our knowledge, it is a firs attempt to identify the linked markers in relation to morphological traits for the cotton crop. Results of the present study will be highly useful in speeding up variety registration programmes of upland cotton complementing to Distinctiveness, Uniformity, and Stability (DUS) testing.

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	BNL827	158	10	26.3	Open	0.0088*	0.0088*	0.1735	0.1735

*$p < 0.01$; **$p < 0.005$, *Chr* chromosome

(7) **Crosses with spelt improve tolerance of South Asian spring wheat to spot blotch, terminal heat stress, and their combination** Spot blotch and terminal heat are two of the most important stresses for wheat in South Asia. A study was initiated to explore the use of spelt (Triticum spelta) to improve tolerance to these stresses in spring wheat (T. aestivum). We assessed 185 recombinant inbred lines (RILs) from the cross T. spelta (H + 26) × T. aestivum (cv. HUW234), under the individual stresses and their combination. H + 26 showed better tolerance to the single stresses and also their combination; grain yield in RILs was reduced by 21.9%, 27.7% and 39.0% under spot blotch, terminal heat and their combined effect, respectively. However, phenological and plant architectural traits were not affected by spot blotch itself. Multivariate analysis demonstrated a strong negative correlation between spikelet sterility and grain yield under spot blotch, terminal heat and their combination. However, four recombinant lines demonstrated high performance under both stresses and also under their combined stress. The four lines were significantly superior in grain yield and showed significantly lower AUDPC than the better parent. This study demonstrates the potential of spelt wheat in enhancing tolerance to spot blotch and terminal heat stresses. It also provides comprehensive evidence about the expression of yield and phenological traits under these stresses.

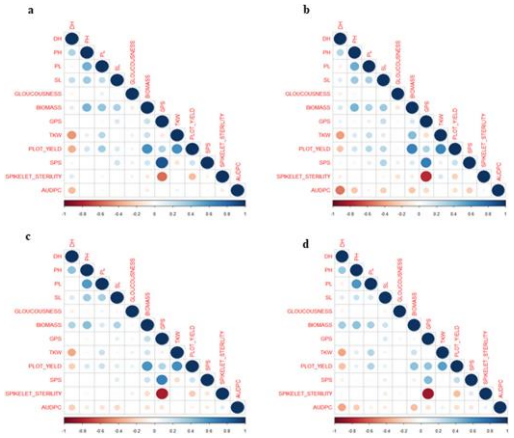


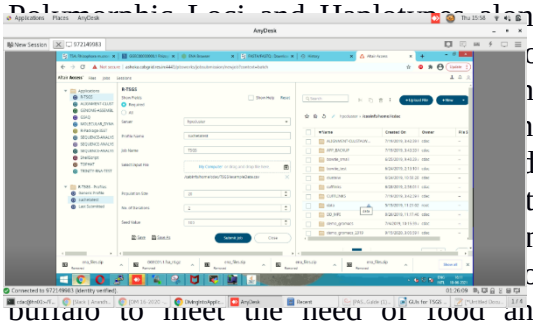
Fig. Correlation among traits in control (a); spot blotch (b); terminal heat stress (c); and combined stresses of spot blotch and terminal heat (d).

IT based – database, software, etc.

(1) Software/Database: SNPRBb: economically important trait specific SNP resources of buffalo (Bubalus bubalis). URL: http://snprbb.icar.gov.in/

Throughout Asian countries including India, water buffalo (Bubalus bubalis) plays a crucial role in socio-economic status of the farmers by providing nutritional security. The concept of genomic selection through genetic markers has been widely used in various livestock species and this is extended to buffalo species as well. Molecular markers have been extensively used in animal breeding for improvements of desirable animal traits. Single Nucleotide Polymorphism (SNP), one of the important molecular markers is widely used in animal breeding program. In this study, SNPs related to four important traits of buffalo i.e., milk volume, age at first calving, post-partum cyclicity and feed conversion efficiency have been identified based on genome sequence data generated using ddRAD (double digest Restriction-site Associated DNA) sequencing technology. These identified SNPs have been compiled as database accessible through Web and can be used in molecular breeding program of buffalo species. This database facilitates easy search of SNPs,

Polymorphic Loci and Haplotypes along



buffalo to meet the need of food and nutritional security of the world including India.

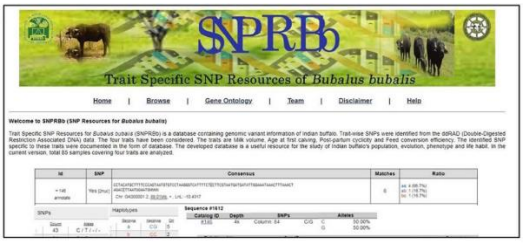


Fig. Home page of database SNPRB

(2) Germplasm Line: Developed and registered wheat germplasm line IC290156 (INGR21187) by Plant Germplasm Registration Committee (PGRC) of ICAR Resistant to stripe rust pathotypes. 46S119 and 47S103 due to presence of favorable alleles for resistance against these prominent races and thus, showed less disease severity.

(3) Germplasm Line: Developed and registered wheat germplasm line IC321906 (INGR21188) by Plant Germplasm Registration Committee (PGRC) of ICAR. Registered as terminal heat tolerance germplasm line. Presence of QTLs with favorable alleles for 3 different traits viz. grain yield, grain filling rate and biomass

(4) A database for Amaranthus plant was populated with the information on the identified lncRNAs, miRNAs, circular RNAs and their targeted genes, noncoding RNA-possessing-SSRs. It is made available at http://backlin.cabgrid.res.in/Amaranthus_database/index.php.This database may be a valuable repository for the scientific community.

Home page Amaranthus hypochondricus Noncoding RNA Database

R package Published

1. Mohammad Samir Farooqi, D. C. Mishra, K. K. Chaturvedi, and Sudhir Srivastava, R package TSGS along with the accompanying documentation and model real data example has been published at CRAN and GITHUB. This package contains functions that extract set of informative gene from high dimensional gene expression data using combination of two conventional machine learning algorithms, support vector machine (SVM) and a genetic algorithm (GA). This package can be freely downloaded from https://cran.r-project.org/web/packages/TSGS/index.html. The package is also available at GITHUB repository (https://github.com/Sudhirsrivastava/TSGS). TSGS has also been integrated with National Agricultural Biocomputing Portal ASHOKA (ashoka.cabgrid.res.in:4443/pbsworks/login), to provide access to users to analyze their large data using the Linux cluster HPC facility

Fig: Integration of TSGS at Bio computing Portal

Web tool and Developed

A user-friendly web tool for TSGS (Trait Specific Gene Selection) has been developed using "shiny ", package. The tool is available at https://icar-iasri.shinyapps.io/tsgs/

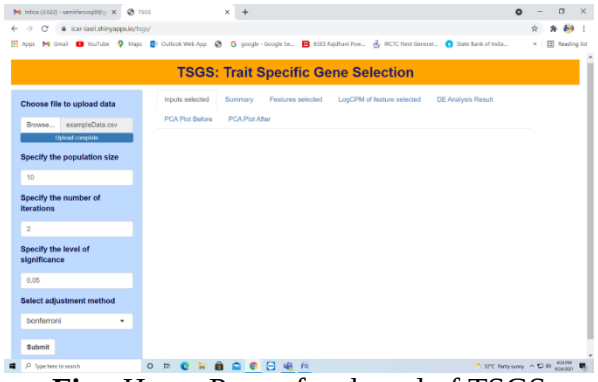


Fig: Home Page of web tool of TSGS

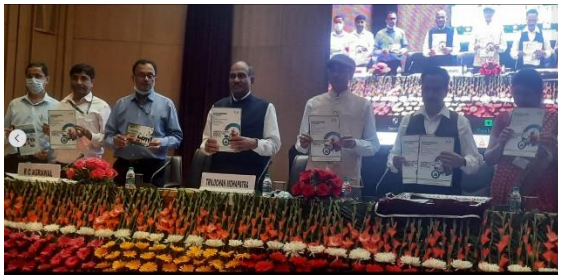
2. Dipro Sinha, Sayanti Guha Majumdar, Anu Sharma, Dwijesh Chandra Mishra (2021). Developed a R Package named 'metaCluster' available in CRAN (CRAN - Package meta Cluster (r-project.org)). Clustering in metagenomics is the process of grouping of microbial contigs in species specific bins. This package contains functions that extract genomic features from metagenome data, find the number of clusters for that given data and find the best clustering algorithm for binning. R package version 0.1.0. https://CRAN.R project.org/package=metaCluster

Computer Applications

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

- The Agricultural University Ranking System (AURS) has been strengthened with new reports and functionality for ADG level user, Data Validation Committee users and users at Apex Committee level. AURS system was opened for filling the data by different universities for the university ranking 2021and results were declared second time using the system
- Grievance Redressal Mechanism System (AU-GRMS) has been developed and operationalized. In this system, student/teacher can register their complaint to College/University/Education division.
- Student READY Module has been developed and linked with Education Portal 2.0. In this system, functionalities have been developed for different users (Student, College Nodal Office, University Nodal Officer and Education Division). Information have been captured on different parameters; student training, major issues addressed, major learning, Input provided by student and increase in production. MIS reports have been developed on those parameters.
- Student READY(RAWE/IPT/Internship) module released on 28 Sept. 2021
- Education Portal V2.0 home page design has been developed. Student READY (EL) Module has been customized and linked with Education Portal 2.0.

- Student USID report has been customized as per suggestion by Education Division
- API has been developed to generate USID directly from the Academic Management System.

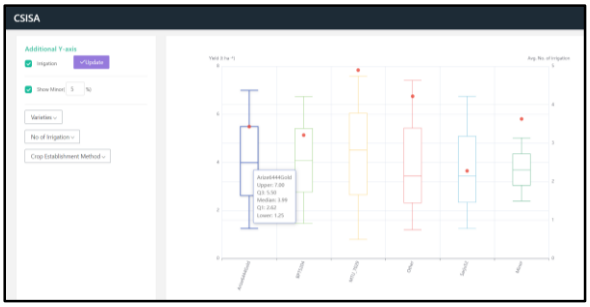


- For generating Unique Faculty ID (UFID) through API, stored procedure and tables have been created.
- Changes have been done in Student READY and NAE sanction letters.
- Forms have been modified to capture data at University level.
- Netaji Subhas - ICAR International Fellowship forms and report has been developed.
- Support has been provided to nodal officer to complete their pending task and filling the information in different systems (AURS/Acrredition etc.)
- USID has been generated for Approx. 197024 students covering 74 universities.

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

A dynamic dashboard has been designed and developed for the data collected through Landscape Diagnostic Survey (LDS). In this dashboard, the following functionalities have been employed in the graph:

- In the x-axis, provision has been made to depict one or two parameters (either variety or crop establishment method or both) as box plot (crop yield in Y-axis).
- An additional Y-axis depicting average number of irrigations across the varieties/crop establishment methods has been introduced.
- In a particular category (variety/crop establishment method), if number of observations is less than a threshold value of the total observations, then a minor category has been introduced. User has been provided the option to set the criteria (say, for example, 5% or 10% or any other value) for consideration of minor category dynamically. Provision has also made whether to show all the sub-categories under minor category in the graph or not.
- Complete flexibility has been provided to the user to select/deselect any of the categories against each of the parameters (under variety, crop establishment method, number of irrigations) appearing in the graph.
- The data table has been generated dynamically as per the selection criteria.



(iii.) Training Management Information System for ICAR (TMIS)

Indian Council of Agricultural Research is attaching tremendous importance to the management and development of their employees. Training Management Information System for ICAR (TMIS) has been designed, developed, and implemented as a web-based application for systematic operation, processing, and management of training activities. The system (https://hrm.icar.gov.in) has been designed and developed as a web application using the modified three tier client server architecture. The lightweight directory access protocol has been used in the architecture to fetch the user and training information from the Enterprise Resource Planning System of ICAR. The training information captured at various levels for different parameters can be used for measuring the effectiveness factor. It helps tracking the different aspects of training that include identification of competencies required for each cadre to plan trainings, implement the training programmes and collection of feedback and performance

evaluation information after the training. All ICAR institutes have adopted the system for planning, operation and management of staff training. The training processes and approval mechanism have become online in TMIS. The institutes assess training needs of their staff through the system and prepares and submits the Annual Training Plan through the system. The Training application process, Feedback submission and Performance Evaluation by the employee are also online. The approvals in all training processes are done through the system. Various management reports at levels of the reporting officers, reviewing officers, HRD nodal officer, Director, DDG and ADG, HRM have been developed in the system for systematic management and capacity building of employee. Functionality has been developed to open the system for Midterm review of the approved ATP during September every year to revise the Annual Training Plan. Functionality has also been provided to the Director to merge existing ATP with the new training needs sent by Nodal officer. Functionality provided to Nodal officer to add new training needs in the second spell and send them to the Director and to Delete training needs from ATP that has been submitted to Training manager and submit revised ATP. Report developed for Director to see the status of all Training Needs Submitted by Institute staff, Training Applications and Training Needs assigned by Nodal Officer for the Institute. Report developed for Training Manager to view ATP from all Institutes and download in single excel /pdf. Report developed for DDG of an SMD to view ATP of their SMDs. The project completion seminar has been delivered and the final project report has been approved and published.

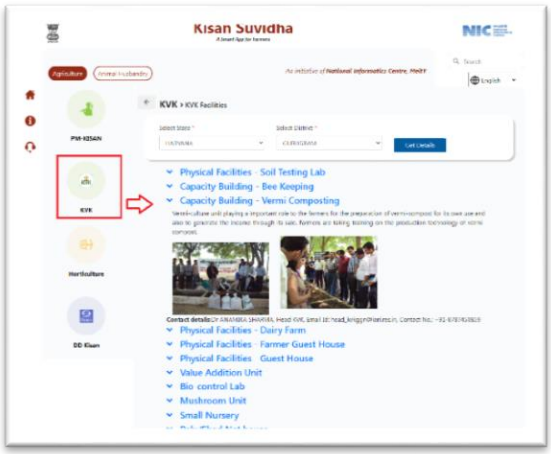
A. Externally Funded Project

(i.) Knowledge Management System for Agriculture Extension Services in Indian NARES

- KVK's enter their Monthly Progress Report(MPR) on key parameters in the system. Reports have been developed to download the monthly data at the KVK and ATARI level. Summarized reports have been developed at ATARI and Extension Division level. New parameters were added as per feedback from users.
- Dashboard for KrishiKalyanAbhiyan (KKA-III) has been developed. State level and District level reports have been added in the dashboard. There are 14 activities planned under KKA-III. For some activities, data is mapped through API's and for rest of activities data is filled by state level agencies in KVK Portal.
- Month wise KVK KPIs data is submitted in DARPAN dashboard for the following KPIs 'Farmer Training', 'Mobile Agro Advisories' and 'Agriculture Extension Activities'
- Jal Shakti Abhiyan(JSA) was initiated by Govt. Of India. KVK's have organised training/awareness programs/events under JSA. Web API has been developed for sharing the data with NIC. District wise cumulative JSA data (from 30 April to 30 November 2021) in the JSON format was shared every week.
- Online training was provided to demonstrate the MPR functionality to KVK's under ATARI Patna and ATARI Kanpur.
- Data from KVK Portal has been integrated with KisanSuvidha Portal/APP. 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)



- Functionality have been developed to update the host institute details (NGO's details) and its unique id in the KVK portal. Functionality has been developed at ATARI level, so that ATARI's can upload the fund details of all NGO KVK in the portal.
- Support has been provided for various issues related to data entry in the KVK portal.

B. Interinstitutional Collaborative Projects

(i.) Development and assessment of educational mobile apps for improving livestock health and production – Collaboration with IVRI

IVRI-Biosecurity and Biosafety (Jaiv Suraksha) App has been designed and developed. This app is targeted to impart knowledge and skills to livestock and poultry farmers, field veterinarians and healthcare personnel about the concept of Biosecurity and Biosafety measures in Livestock and Poultry farms. The various aspects covered under this app includes the basic concept of biosecurity and its advantages, detailed information about the measures pertaining to biosecurity and biosafety in farms viz., location and design of farms, restricted movement, isolation and quarantine, cleaning and disinfection, management of feed and water, disposal of carcass, disposal of clinical and other wastes, disposal of farm effluents/manure, personal hygiene, health management, reproductive management, documentation and record keeping, actions during disease outbreak and examples of disinfectants used. An electronic score to check the biosecurity and biosafety of a farm has also been provided. By using the electronic

- score, a farm owner can assess the existing biosecurity level of his/her concerned farm and take measures to improve it. This app will be very much useful for the livestock (dairy and pig) and poultry entrepreneurs in safe and disease free livestock and poultry production and will act as a training tool to strengthen the biosecurity and biosafety of their farms, thus protecting the overall environment and health status of the animals/birds as well as the farm owners. This app is presently available in English and Hindi languages.
- CARI-Backyard Poultry Farming App is designed and developed in collaboration with ICAR- Central Avian Research Institute and ICAR- Indian Veterinary Research Institute. The app is specifically targeted to impart knowledge and skills to the entrepreneurs/farmers, rural youth and farm women about the backyard poultry farming as a livelihood option. The app contains information about the Importance of backyard poultry (especially the features and nutritional benefits), its breeds & varieties, housing management (including housing needs, space requirements etc.), bird's

management (chicks, grower & adult management), feeding management, innovative feeding resources, water management, health care (diseases, vaccination & medications), organic poultry farming & marketing of the products. The app additionally contains the banking projects as well as frequently asked questions (FAQs).

• Antimicrobial Resistance App has been designed and developed. This app attempts to shed light on the burning problem of Antimicrobial resistance (AMR is the ability of microbes such as bacteria, viruses, parasites or fungi to grow in presence of chemicals that would normally kill it or limit its growth) and highlights the various mechanisms through which AMR is acquired. Further, the app intends to educate various stakeholders and general public regarding the AMR problem with the ultimate aim of creating awareness.

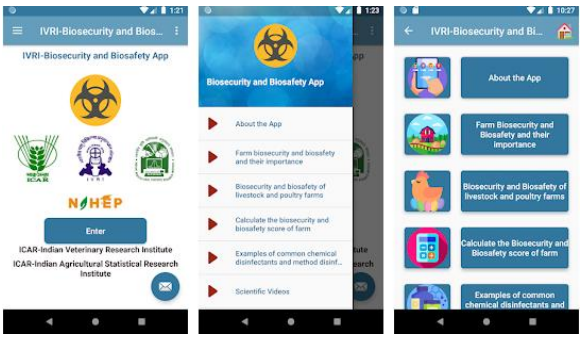


Image1: IVRI-Biosecurity and Biosafety (Jaiv Suraksha) App

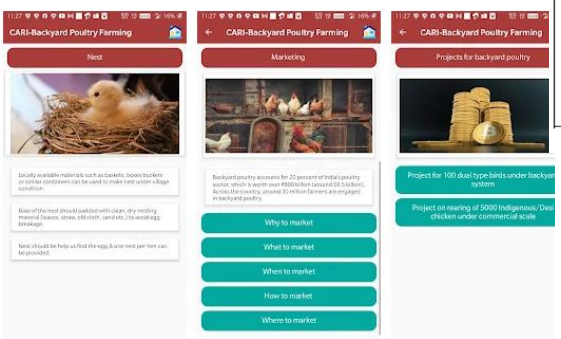


Image 2: CARI-Backyard Poultry Farming App

(ii.) Artificial intelligence based mobile app for identification and advisory of maize diseases and insect pests

Artificial intelligence based mobile app for identification and advisory of maize diseases and insect pests" is a collaborative inter-institutional project with ICAR-IIMR, Ludhiana, and IIT-Delhi. This is a National Agricultural Science Fund(NASF), ICAR-funded project. From the outset of the project, a large number of images of pests and diseases of maize has collected, validated, and annotated. One Intelligent mobile app and a web portal have also been developed in this project. During 2020-21 following activities have been conducted.

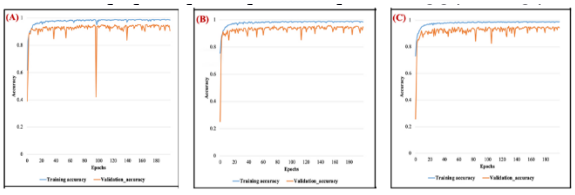
Data Collection:

A total of 14420 images have been collected in this project. Last year (2020-21) 7523 images were collected. The distribution of different pests and disease images have been described in the following table

Table: The data collection status during the project tenure

Model development for identification of diseases of maize

There are several deep learning model has been experimented for both disease and pest identification. The disease identification models were trained,



Inception-v3_flatten-fc Inception-v3_GAP Inception-v3_GAP-fc

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v3_flatten-fc: 95.42% and Inception-v3_GAP-fc: 95.38%).

Figure: Accuracy of different Inception-V3 model

Object detection with classification approach has been used to develop the insect detection model The insect detection model has been developed by integrating a framework of VGGNet with a bounding box regressor with Fall Army worm (FAW): 2,527 images.

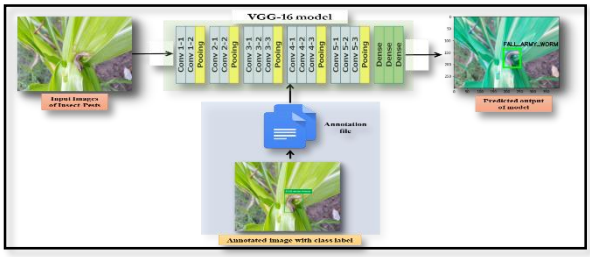


Figure: Process flow of insect detection module

Regression loss obtained during training and validation were 0.0002 and 0.0025.

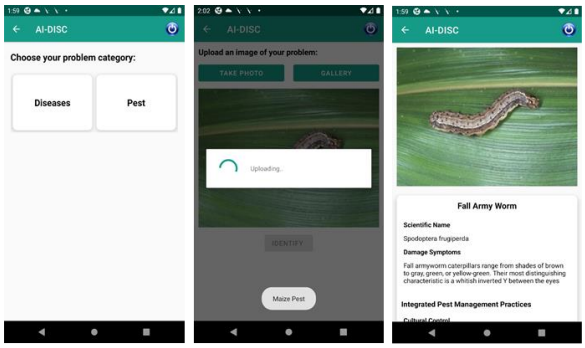


Figure: Pest Detection Module of NIBPP App for Maize crop

Field validation of NIBPP Mobile Application:

For field validation of the NIBPP Mobile Application around 130 farmers have been registered from different agroclimatic zone of India. The application will be validating in the kharif season of 2022.

C. Consultancy Projects:

(i.) Knowledge Management System for DUS Characteristics of Crops has been initiated in collaboration with PPVFRA.

This project has been carried out under Institutional Consultancy mode funded by 'Protection of Plant Varieties and Farmers' Rights Authority' (PPV&FRA), Ministry of Agriculture Cooperation & Farmers Welfare, Government of India.

A Web Based Knowledge Management System for DUS Characteristics of Crops(https://ppvfradus.icar.gov.in) has been developed for implementation of functionalities followed in PPV&FRA and DUS Centers.

- Training and support was done for PPV&FRA along with DUS Centers.

- Modification was done in the system as per user feedback.

- Web API data was shared on all master data elements like Crop, Variety, DUS Centres and Variety characteristics with NIC Officials for integration with other software.

D. World Bank Funded

1. "Investment in ICAR Leadership for Agriculture Higher Education" under National Agricultural Higher Education Project Component 2

A. Digital Initiatives

- Virtual Classrooms and Agri-DIKSHA Agri Web Education Channel established at 18 locations was inaugurated by Hon'ble Union Minister of Agriculture and Far... April 2021.

• AU-GRMS (Grievance Redressal Management System) was designed and developed by ICAR – IASRI, launched by Deputy Director General, Education, ICAR.

• IT Helpdesk system for Academic Management System was designed and developed by ICAR – IASRI. The same system is now being extended for Agri-DIKSHA, FMS, AU-PIMS, KVC-ALNET and E-Learning.

• More than 110 e-learning courses have been finalized under Call 1, 2 and 3. Further, 45+ course have been enhanced with 10+ introductory videos. Email notification system was developed by ICAR – IASRI in E-learning portal to ensure timely completion of the courses by the faculties

• Facilitated discussions with online payment gateway provider (PayGov) for various AUs

• Implementation of security measures like security certification and automatic backup and recovery mechanism is AMS and Agri-DIKSHA

• Provisions made for relevant solutions for identified vulnerability in the system (SQL injection attacks)

• Agricultural Experts Information System (AEIS) designed by ICAR – IASRI was launched by Director General, ICAR. Agricultural Experts Information System (AEIS) aims at creating a network of subject matter experts in agriculture sector and build a repository of the work done by these experts across various fields of agriculture. The current database has 1081 Experts/ Researchers, 1397 Government Institutions, 1061 Professors and Ph.D., and 1595 Expertise / Disciplines.

• Kritagya Hackathon 2.0 on 'Innovations for Precision and Economical Animal Farming' was organized through Kritagya Portal designed and developed by ICAR – IASRI. 850+ teams participated in the hackathon.

• National Competitive Bid document was prepared and published for on-boarding of a system integrator for design and development of Financial Management Software (FMS) and Supply of AR/VR equipment's and development of AR/VR modules. Procurement process was undertaken including pre-bid conferences, technical and financial evaluation, and contract signing.

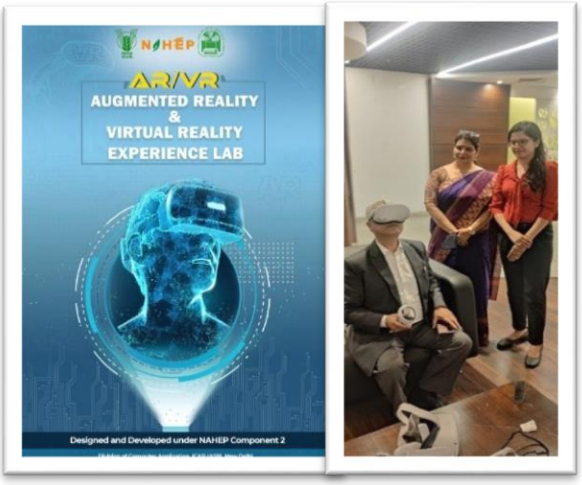
• Accreditation Portal (Accreditation System of Higher Agricultural Educational Institutions) has been strengthened with filter-based reports at

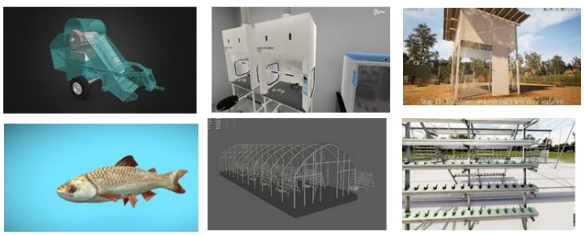
NAEAB secretariat level to search application by application Id, application applied for like college, programme, university and college/university name. So far, more than 100 registered users have applied for ICAR accreditation of their respective university/college/programme.

• Financial Management Software (FMS) has been implemented in 2 agricultural universities namely RLBCAU Jhansi and BASU Patna. The system supports more than 200 users and has provisioning of MIS dashboards, Training of end-users at the selected universities and at ICAR-IASRI, and Customization and enhancement of the functionality in the modules as per the requirements of the selected universities. ICAR – IASRI has successfully conducted the UAT and Go-Live of the FMS at aforementioned locations. The MoU has been signed by both the universities.

• The Virtual Reality (VR)/ Augmented Reality (AR) facilities are established in 10 Agricultural Universities and ICAR – IASRI will lead this establishment as a Centre of Excellence (COE) to strengthen agricultural education through ICT interventions. 50 AR/VR kits, 1 MR Kit, and VR/AR/MR software licenses are set up. Modules of VR - Paddy straw collector cum chopper, Pusa-Farm Sun Fridge, Protected cultivation technologies, Hydroponics, Phenomics, Aquatic Animal Health Management, Bacterial Disease in Aquatic animals'

diagnosis, Assisted reproductive technologies (OPU-IVF and cloning) in dairy animals, Advanced Irrigation Methods and Technologies to Improve Water Use Efficiency, Seed Life Cycle - Genesis, Science, Seed Parts, Germination, Histo-biochemical and molecular studies in Drought/salinity stress in sugarcane during various growth stages, Nematology - Study of Nematodes, Artificial Insemination, Tractor Simulation.





- Green and Clean Campus Award Portal was designed and developed by ICAR – IASRI, the award to the winners was presented by Hon'ble P Green and Clean Campus Award Portal was designed and
- developed by ICAR – IASRI, the award to the winners was presented by Hon'ble Prime Minister of India. Customization of Green and Clean Campus Award Portal 2.0 is completed and development and testing of the portal is underway. Prime Minister of India. Customization of Green and Clean Campus Award Portal 2.0 is completed and development and testing of the portal is underway.

- More than 39,000+ alumnus have been registered on KVC – ALNET during this reporting period. This includes users from India Africa, Australia, Europe, UK and USA.
- More than 2500 hours of content has been created of Virtual Classrooms and Agri-DIKSHA
- Total number of users added in AMS increased from 61,000 to 83,000 in the last financial year
- More than 1000+ projects and 1600+ project investigators have been added in AU-PIMS
- Data warehouse has been developed for AMS and Education Portal, and, BI Dashboard has been developed.

• Implementation of USID and UFID has approved and in process of implementation

• Various quick help videos have been developed for AMS and Agri-DIKSHA to guide users about the process.

• Two mobile applications namely "NIBPP (National Image Base for Plant Protection)" and "NIBLD (National Image base for Livestock Diseases) have been developed for collecting, validating, annotating, securely storing of images of plants and animal stresses respectively. Both the applications are hosted on Krighi megh cloud infrastructure. Around 2.5 lakhs images of 61 crops with 242 diseases and 277 pests have been collected from several ICAR institutes and State Agricultural Universities in the NIBPP mobile application. Till now AI based disease identification models for 54 diseases of 30 crops have been developed with 75.47% to 99.58% accuracy. NIBPP is in the expert-level evaluation stage. The crop models have been deployed in another light-weighted mobile application called AI-DISC (Artificial Intelligent based Disease Identification System for Crops). It is an AI-enabled mobile application that can identify a broad range of diseases and pests in the field condition through images. There are 25711 images of 27 diseases of 8 livestock that have been collected in the NIBLD application in collaboration with ICAR-IVRI, Izatnagar.

• KISAAN 2.0 (Krishi Integrated Solution for Agri Apps Navigation) was designed and developed by ICAR – IASRI which is envisaged to help e-agriculture and drive smartphone-based agriculture in India. The app integrates more than 100+ multi-lingual agricultural relate apps for Indian farmers to access agricultural knowledge about crops, horticulture, livestock, fisheries, natural resource management, agricultural engineering, agricultural education, and agricultural extension.

B. Workshop/ Trainings and Capacity Building Sessions

- A workshop entitled "Mainstreaming of Agriculture as a Subject in School Curriculum" was organised by ICAR-IASRI held virtually on Zoom Platform on 16th June 2021. The Workshop primarily aimed at deliberating on the need to integrate agriculture with K-12 curriculum to develop students' knowledge and understanding of agricultural enterprises and the practices and skills required in producing plant and animal products. Delegates from NCERT, CBSE and various schools participated in the workshop.
- More than 20+ capacity building sessions were conducted for more than 3800+ participants and 30+ review sessions were conducted by ICAR – IASRI
- More than 15+ capacity building sessions were conducted by ICAR – IASRI for more than 1800+ participants
- 9 capacity building sessions were conducted by ICAR – IASRI for more than 1100 participants
- 3 capacity building sessions were conducted by ICAR – IASRI for E-learning for more than 800 participants
- 3 capacity building and upskilling sessions were conducted by ICAR – IASRI along with vendor for AR/VR for more than 60 participants

C. Meetings

- Progress review meeting of NAHEP Comp-II and RAES project under the chairman ship of DDG (Agri. Edu.) and ND (NAHEP) was held on 14th March 2022.
- Second NAHEP External Advisory Panel Meeting was held on 10th November 2021 organized under NAHEP Comp-2 project by ICAR-NAARM, Hyderabad.
- Meetings were held with World Bank on 6th And 22nd September 2021.
- World Bank Mission Review Meeting of NAHEP Comp-II project was held on 22nd July 2021.
- Cost Committee Meeting for NAHEP Comp-II project was held on 15th June 2021.

2. Resilient Agricultural Education System (RAES)

- Conceptualization and DPR approval by world bank: A DPR was submitted for the project NAHEP-RAES and approved by the World Bank.
- The institution of a Resilient Agricultural Higher Education System is important, timely, and critical to foster sustained teaching-learning outcomes. This, in turn, is enabled by three digital elements:

- Digital Infrastructure, Digital Content and Digital Capacity Building

- To initiate the work for the project, a procurement plan was developed and approved by the World Bank and ICAR.
- Procurement of various items as per the plan have been started.
- Virtual Classrooms have been established and made operational in 58 Agricultural Universities under RAES.
- To leverage the emerging technologies, AR/VR experience centres are proposed to be set up in 64 AU's. Vendor has been finalised through National Competitive Bidding Process.

- Strengthening of Krishi-Megh with HCI Nodes with required software is in progress. Order has been given to the vendor and contract has been signed.
- Procurement of ESRI ARC Info GIS Software has been completed and the software is installed.
- A series of meeting with World Bank was held for conceptualisation and jointly organising an International Conference Blended Learning Ecosystem for Higher Education in Agriculture. Preparation for the conference organisation has been started. Concept note for the Conference has been prepared.
- RFP for Empanelment of vendors for development of e-content repository has been prepared.
- Expression of Interest for hiring of Program Management Unit has been prepared.
- Workshop for discussing the requirement for e content RFP was organised with UHS Bagalkot on 10th November 2021.
- Meetings with World bank for discussing the progress in preparation of International Conference were held on 6th September, 22nd September, 8th and 15th December 2021.
- Industry Consultations were held on 20-21 December 2021 for hiring of Event Management Agency to organise the International workshop. Five Industries/ companies participated and presented their work.
- Review meeting for Progress of Procurement was held on 1st October 2021in the chairmanship of national Coordinator, NAHEP.
- Industry Consultations were held on 4th and 11th August 2021 for Empanelment of vendors for development of e-content repository. Total seven Industries/ companies participated and presented their work.

Others Activities

1) Agricultural Research Management System (ARMS)

Agricultural Research Management System (ARMS) has been developed for monitoring and evaluation of scientific performance on monthly basis. Scientist fill the information on significant achievements on monthly basis and the same will be reviewed by Reporting and Reviewing officers at Institute. Scores will be auto computed by system based on ASRB score card criteria's. The system is accessible at https://arms.icar.gov.in.

- At Nodal officer level, Report on reporting and reviewing has been developed.
- Provision for ICAR email updation of respective institute scientist has been made.
- Change role option has been added at Admin level.
- Report on tracking the progress for no. of scientist submitted the information has been added institute wise at Admin level.
- Director Dashboard & Head-level dashboard have been developed.
- Custom Report MPR has been developed, with project details at Reporting officer level.
- Co-PI updation page in the projects has been modified.
- 2021 NAAS Rating for Journals has been added and accordingly Research Paper Page has been modified.
- Publication duplication check functionality have been added.
- Publication are directly send to KRISHI and mail alert for same goes to krishi admin for the same.

- Submission Status check Reports have been developed at Reporting and Reviewing officer level.
- Presentation of the system was done in meetings with Secretary DARE& DG ICAR.
- Support was provided for ARMS activities.

2) **Capacity Building Program(CBP) Vortal and Research Leadership Building System (RLBS) CBP Vortal (Lead):** CBP vortal (https://cbp.icar.gov.in) has been implemented for online management of all training programs (Centre for Advanced Faculty Training (CAFT), Summer-Winter Schools (SWS) and Short Courses (21/10 days duration)) under Capacity Building Program (CBP) sponsored by Agricultural Education Division, ICAR.
- During the year 2021-22, a total of 254 training program proposals were received online, out of which 72 programs have been organized using vortal and it was attended by 1901 personnel. Training proposals were also invited through the system.
- Sanction letters were modified for CAFT, Summer/Winter School and Short Courses training program and sent online to approved training programs.
- Liaison with Course Coordinators and users for the problem faced by them and solution via email and phone.

Figure: Homepage of RLBS.

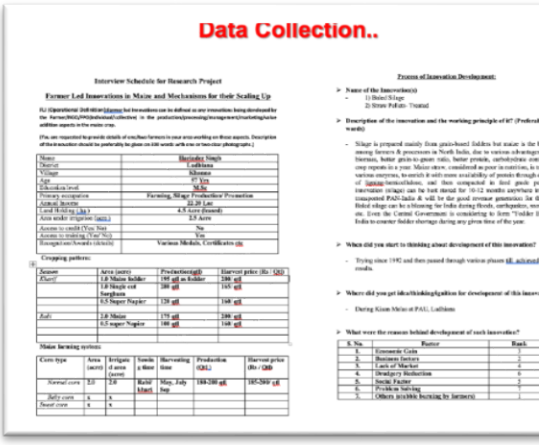
Research Leadership Building System (RLBS)

RLBS has been developed for inviting online applications to the position of ICAR-National Fellow(NF)/National Professor(NP)/Emeritus Scientist(ES)/Emeritus Professor(EP). The system can be accessed from the URL https://rlbs.icar.gov.in.
- RLBS portal was opened for inviting the applications for Emeritus scientist in online mode for the year 2021-22.131 applications were received online.
- Dashboard has been developed at ADG level for monitoring the application status for Emeritus scientist.
- Dashboard has been developed for the Emeritus scientist so as to maintain their records and reports.
- For application evaluation, process flow has been developed so that application can be moved to DDG or Expert level along with system generated letters for evaluation. Functionality for evaluation has been developed.
- Applications proforma design and development for the National Professor level. Forms and database have been designed and developed for National professor application. After filling all information, application can be printed for National professor. Functionality for inviting applications has been rolled out.
- Reports have been developed and added at ADG dashboard for monitoring the application status.
- Liaison with Course Coordinators and users for the problem faced by them and solution via email and phone.

3. **Farmer led Innovations (FLI) in Maize and Mechanisms for their Scaling up**

This research activity is carried out in collaboration with Dr. Priyajoy Kar,

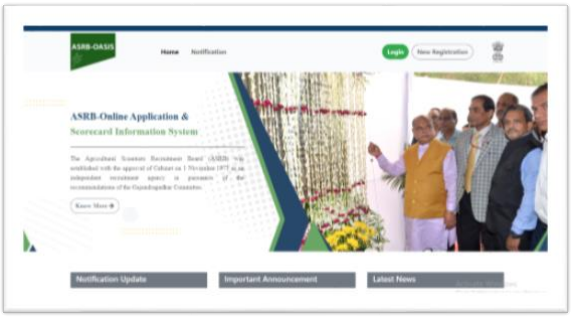
Scientist, ICAR-IIMR, and Ludhiana. Ms. Sapna Nigam and Dr. Piyajoy collected data in the form of Questionnaire from the farmers across India. Ms. Sapna Nigam developed the database schema and ER Diagram according to the data collected.

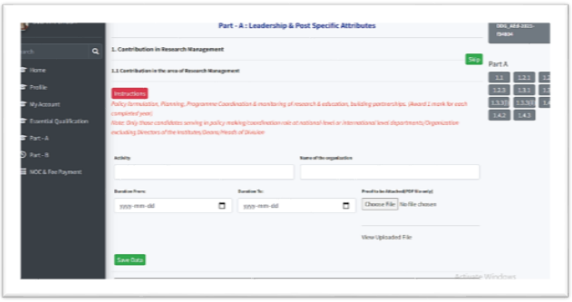


1) ASRB-Online Application & Scorecard Information System(ASRB-OASIS)

This application has been developed for inviting online applications for the RMP positions at ASRB level.

- Regular meetings were held with ASRB officials for requirement study, system design and development
- Database has been designed and stored procedures created
- Different forms and dashboard have been designed, developed and integrated
- Complete applications were designed and developed for DDG and ADG level. Application has been designed in a manner that user has to fill the information once for different positions.
- MIS reports have been developed at different levels.
- Payment gateway has been integrated with the system.
- Logic has been developed into system to compute the scores automatically as per filled information. Scores have been computed for different RMP positions
- Meetings were held with Secretary(ASRB), Secretary (DARE) & DG(ICAR) for system demonstration and discussion.
- Security audit of the system was conducted.
- Module has been developed for inviting experts.
- System was made live for inviting applications for various positions advertised by ASRB.
- User Manuals were prepared
- Extensive support was provided for queries.





2) BRICS Agri-Research Platform

Web based platform (http://barp.org.in/) has been developed that allows officials of all BRICS countries to register and collaborate on various themes as per the objectives of BRICS 2020-2021.The platform allows users to download/upload multiple documents, create projects/events, upload pictures, ability to collaborate using discussion forums and a dashboard for a decision support system.

- Home page of the BRICS Agri-research platform was created in discussion with ADG (International Relations), ICAR

- Documents were uploaded in different sections.
- Database was created.
- Functionality was created to create events and upload information related to the same.
- Site was hosted at ICAR Data Center.
- Hon'ble Union Minister of Agriculture and Farmer's Welfare launched "BRICS Agricultural Research Platform" during the 11th meeting of Agriculture Ministers of BRICS countries.

IT-Unit

Achievements of Projects

Management and Impact Assessment of Farmer FIRST Project (CPI)

Farmer FIRST Programme (FFP) Portal is a knowledge management and dissemination system in the field of agricultural extension. This portal provides detailed information of all projects under FFP programme. This portal acts as a single hub of collection of information related to events, trainings, activities and interventions of the projects under FFP. At present, 1318 interventions, 1059 events, 3223 images, 118 videos and 439 publications related to FFP have been uploaded on the portal of different projects running under FFP. Mobile Application: Android application which consists of two modules viz. (i) Capturing of Data and (ii) Knowledge Dissemination has been modified. Notification facility has been provided in the mobile application using firebase technology. The Mobile App available in google paly store and FFP portal. Enhanced the dashboard functionality which include annual project report and publications detail ATARI-WISE. "Dashboard" added at all levels after login to get work progressed i.e DDG, ADG, ATARI and PI Centre. Latest News, media and publications related information have been uploaded in the portal. Support is being provided to PIs for uploading the information on the portal and technical issues have been resolved over email.

Kisan Sarathi - System of Agri-information Resources Auto-transmission and Technology Hub Interface

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 93rd foundation day of Indian Council Agricultural Research jointly by the honourable ministers Shri Narendra Singh Tomar ji, Agriculture and Farmers' Welfare and Shri Ashwini Vaishnaw ji, Information and Communication Technology Government of India in the presence of Shri Parshottam Rupala ji, Minister Fishries, Animal Husbandry and Dairying, Shri Kailash Choudhary ji, Minister of State for Agriculture and Farmers' Welfare and Smt Shobha Karandlaje ji, Minister of State for Agriculture and Farmers' Welfare. 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 the subject matter experts. The project is developed by ICAR-Indian Agricultural Statistics Research Institute and Digital India Corporation, MietY, Government of India under a MoU between ICAR and DIC, MietY and implemented in association with Agriculture Extension Division, ICAR. Initially the services have been started in four major states of India viz. Bihar, Madhya Pradesh, Maharashtra and Utter Pradesh later on in December services were extended to two more states viz. Andhra Pradesh and Telangana. In the end of reporting period, a total of 265+ KVKs are enrolled with the system, where more than thousand subject matter experts are extending their advisory services to more than fourteen lakh farmers. Number of training program has been organised in the reporting period for the Officials of concerned ATARIs and associated KVKs. Online live interactive sessions between the subject matter experts of KVKs and Kisan Sarathi support team were conducted on every working Fridays since August 20st, 2021. The IVR based calling services of Kisan Sarathi is available at toll free number 1800-123-2175 and also on a short number 14426 for the farmers. It has been decided that the services will be extended to all the states and UTs in coming months.

➢ ICAR-ERP

Customized the bill report for adding new tax under Section 194(Q) and customized the notification for Join Report. Online issue is being resolved. The financial year 2020-21 successfully closed. Support has been provided to ERP users and resolved the queries through helpdesk. ICAR-ERP has been maintained and resolved the issues faced by the users of ICAR institutes as and when required. The Support team has actively answered the queries of all ICAR users. The ICAR-ERP application and oracle database has been managed by IT support team.

➢ ICAR Data Centre

A total 23182 Active Directory and 22212 mmailbox users have been managed. Presently 319 websites/web applications/web portal are running from ICAR datacentre. All websites/web applications backup has been configured in DC and same has been replicated at the DR location. Four new -Nutanix Exchange Servers (SRDELEXG11, SRDELEXG12, SRDELEXG13 and SRDELEXG14) have been added in DAG of ICAR mail domain servers. Databases (Total 8 Databases per server) migration has been performed from old Exchange infra to New-Nutanix Exchange infra. Database mounting process has been done on Nutanix Exchange Servers.

ISO 20000-1:2011 & ISO 27001:2013 External Audit is successfully completed at ICAR DC (IASRI) and obtained ISO 20000-1:2011 & ISO 27001:2013 certification.

- **ASHOKA**

Administering, Managing and maintaining the various services running in ASHOKA infrastructure. There are four portals viz., PBS Portal, CLC-Bio Portal, DSS Portal, Bio Computing Portal, Sequence Submission Portal along with 177 web resources. 33 HPC and 05 users have been created. In total 4922 jobs have been successfully run. The new hardware has been added i.e 01 SMP Cluster with 1.5TB RAM and 02 GPU Nodes for enhancing the efficiency of the ASHOKA.

- **Agricultural Research Management System (ARMS):**

ARMS has been customized with following reports i.e retrieving various types of information for the scientists, status of data uploading by the scientists of ICAR institutes, monitoring report for reporting officers and other levels and data status report entered by ICAR institutes SMD wise. Duplication check functionality has been created in publication for author /co-author. Integration has been made for publications between ARMS and KRISHI. The publications from ARMS to KRISHI are being transferred. Instant response option has been added in the Feedback option. Graphical Dashboard has been developed for publications.

Two Virtual Trainings were organized on "Implementation and Use of Agricultural Research Management System (ARMS) for Nodal Officers" on 8th June and 11th October, 2021. Six webinars were organized on "Implementation and Use of Agricultural Research Management System (ARMS) 20th and 22nd Oct, 25th Nov, 2, 9 and 23 Dec, 2021 for all scientists of ICAR. The ARMS is accessible at https://arms.icar.gov.in.

- **Land Record Management System (LRMS)**

The LRMS system has been modified as suggested by the various institutes. The LDAP functionality has been created for authentication to login the system. The LRMS is accessible at https://lrms.icar.gov.in.

- **E-Office implementation**

The e-office has been implemented in all ICAR Institutes along with their Regional Stations/Sub-Stations to make paperless/environmentally friendly office. This e-office platform has been successfully running in ICAR Data Center. Online support has been provide on the followings – e-Office login, DSC issue and DSC registration, EMD, AMS role, Local Admin regarding Transfer of employees/Receipts, Removal/ Deletion of Additional Charges from the various employees of ICAR for different institutes, MIS Reports, Files Missing Issue, disable employee, Master Data Management update to add entries required by institutes. E-Office eFile has been updated with version 6.2.

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. A brief description of human resource development during the year is given in the sequel.

1. DEGREE COURSES

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

i) Ph.D. (Agricultural Statistics)

ii) M.Sc. (Agricultural Statistics)

iii) Ph.D. (Computer Application)

iv) M.Sc. (Computer Application)

v) Ph.D. (Bioinformatics)

vi) M.Sc. (Bioinformatics)

Both Ph.D. and M.Sc. students are required to study courses not only in Agricultural Statistics but also in Agricultural Sciences like Genetics, Agronomy, Agricultural Economics, etc. The Courses in Mathematics, Agricultural Statistics and Computer Application are offered at this Institute while the courses in Agricultural Sciences are offered at 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)	09	05
2	M.Sc. (Agricultural Statistics)	08	06
3	Ph.D. (Computer Application)	06	0
4	M.Sc. (Computer Application)	03	07
5	Ph.D. (Bioinformatics)	05	02
6	M.Sc. (Bioinformatics)	06	03

2. DISSERTATIONS APPROVED

Brief of research work carried out by students who had completed various courses during 2021 is as follows:

Ph.D. (Agricultural Statistics)

Name: Mohd. Harun

Chairman: Dr. Cini Varghese

Title of Thesis: Efficient statistical designs for triallel and tetra-allel cross experiments Under a fixed effects model including specific combining abilities, the estimates of combining abilities have been obtained for both triallel and tetra-allele crosses. A method of construction of partial triallel crosses arranged in blocks has been obtained based on two-associate triangular association scheme along with the information matrices, eigenvalues, variance factors, efficiency factor and degree of fractionation. Another two methods of constructing partial triallel cross designs have been obtained using various types of Lattice designs and Kronecker product of incidence matrices respectively. All these methods are efficient along with lower degree of fractionation. A class of orthogonal tetra-allele cross designs for estimating contrasts pertaining to general combining ability effects has been obtained under a reduced model including lower order specific combining ability effects using mutually orthogonal Latin squares. The obtained class satisfies the condition of optimality for equi-replicated designs for tetra-allele crosses and are having low degree of fractionation. Also, under a random effect model excluding specific combining ability effects for tetra-allele crosses, the Best Linear Unbiased Predictor (BLUP) for yielding capacity of cross has been obtained. A lower bound to mean square prediction error for characterizing optimal class of designs has been obtained. The unbiased estimates of variance components along with sampling distribution have been obtained following Henderson Method III. The robustness of designs against missing observation using connectedness and efficiency criteria has been studied and a list of efficient robust designs for triallel and tetra-allele crosses has been tabulated. Programs have been written in SAS [PROC IML] software for computing efficiency factor of the designs involving triallel crosses for estimating gca effects to investigate the robustness of designs against missing observation by calculating the canonical efficiency.

Name: Rajeev Ranjan Kumar

Chairman: Dr. G.K. Jha

Title of Thesis: Agriculture Price Forecasting with Structural Break in Time Series Data

An effort has been made to account for the structural break along with the other complex patterns like non-stationarity, non-linearity, long memory and cointegration present in the agricultural price series. Generally, single model may not be able to capture all complex patterns present in the data series concurrently. Therefore, to capture various complex patterns in the data along with structural break, hybridization of statistical model that account for structural break with artificial intelligence model has been done. Accordingly, for agricultural price volatility forecasting in the presence of structural break, a hybrid model based on Markov-Switching GARCH (MS-GARCH) and Extreme Learning Machine (ELM) is proposed. The performance of the proposed hybrid MS-GARCH–ELM model is evaluated on the weekly potato price of Delhi market, monthly international Groundnut oil and Palm oil price series, and it is found that the proposed model outperformed its counterparts. Empirical results of agricultural price series that contain long memory property with structural break show that the forecasting performance of the proposed hybrid model based on ARFIMA with dummy variable combined with ELM is better than the individual model. Further, the effect of structural break in the co-integrated system has also been evaluated. The overall co-integration test results indicated that selected potato markets in India are well integrated and have long-run price association across them.

Student name: Peter Tindukin Birteeb

Chairman: Cini Varghese

Title of Thesis: Designing Agroforestry Systems for Sustainable Livelihood

A linear network effects model incorporating tree effects from adjacent plots has been considered and six classes of tree network balanced designs (designated NetBD1, NetBD2, NetBD3, NetBD-mTC1, NetBD-mTC2 and NetBD-mTC3) have been constructed for use in agroforestry experiments. General methods of constructing designs of each class have been developed. The characterization properties of the designs have been studied and NetBD1, NetBD2 and NetBD3 which are for multi-tree monocrop trials, have been found to be variance balanced for the estimation of both direct and network effects of trees. The multi-tree multi-crop species designs (NetBD-mTC1 and NetBD-mTC2) are partially variance balanced for estimation of direct effects of tree-crop combinations, with the tree-crop combinations following a two-associate class Group Divisible (GD) association scheme. NetBD3 and NetBD-mTC3 have been found to be universally optimal for estimation of direct effects of trees and tree-crop combinations respectively, while rest of the designs exhibit very high efficiencies. Also, an index, herein called Agroforestry System Productivity Index (ASPI) has been developed for use as a tool in comparing agroforestry systems. The use of these designs in agroforestry trials could bring about improvement in agroforestry systems as the recommendations from the experiment will be associated with a high precision.

Name- Pramod Kumar Moury

Chairman- Dr. Tauqueer Ahmad

Title of Thesis: Estimation of Finite Population Total using Robust Geographically Weighted Regression Approach

Outlier robust estimators of finite population total have been proposed which are based on Geographically Weighted Regression (GWR) model to capture the spatial non-stationarity present in the survey data. The proposed Outlier Robust Geographically Weighted Regression (ORGWR) estimators have been developed under the five different shapes of spatial weighting functions (i.e. bi-square, boxcar, exponential, Gaussian, tri-cube). Based on the simulation study, some of the proposed ORGWR estimators have been found better as compared to a non-robust GWR estimator as well as a robust estimator proposed by Chamber (1986). For estimation of variance of non-robust GWR estimator of finite population total, three bootstrap techniques of variance estimation have been proposed. Spatial Weighted Residual Bootstrap (SWRB) method of variance estimation technique for ORGWR estimator under the five different shapes of spatial weighting functions (i.e. bi-square, boxcar, exponential, Gaussian, tri-cube) have been proposed. Further, a Proportional Spatial Weighted Residual Bootstrap (PSWRB) technique to estimate the variance of ORGWR estimator in the presence of missing observations in the survey data set has been proposed. GWR model-based imputation has been found to be the most efficient imputation technique in estimating the variance using the PSWRB technique in the presence of missing observations in survey data. The proposed methodology (ORGWR) has been applied to the real data set and it has resulted in obtaining reliable estimates of average yield of cotton with significantly reduced number of CCEs.

Name- Pratish P Gopinath

Chairman- Dr. Rajender Parsad

Title of Thesis: Statistical Design for Factorial Treatment Structure

In the present study, two methods have been developed to obtain incomplete resolvable block designs with factorial treatment structure, where main effects can be estimated with full efficiency and two factor interactions with the highest efficiencies. Designs obtained will be having Orthogonal Factorial Structure (OFS). Two methods have been proposed to obtain incomplete row-column designs with OFS, where main

effects are estimated with full efficiency and balance. Two methods are developed for obtaining structure resistant designs. Designs obtained are strongly globally structure resistant and on losing any level of a particular factor design will be an Extended Group Divisible (EGD) design or Extended Group Divisible designs for Unequal block sizes (EGUD design). One method is devised for the construction of non-proper block designs that are EGUD designs for s × 22 factorial experiments. These designs also have structure resistant property. Fractional factorial plans for estimating all main effects and two-factor interactions between consecutive factors with high efficiency for symmetrical factorial experiments are obtained by implementing a search algorithm in FACTEX procedure of SAS.

Name: Rishab Singh Shyam

Chairman: Dr. Wasi Alam

Title of Thesis: Development of Time Varying Smoothing Models

An effort has been made to develop a model based on the approach of the time varying parameters which is a function of lagged observations. The approach is then compared with various time series namely ARIMA, Exponential Smoothing and Naïve model using monthly datasets such as price of onion traded in Hyderabad market and price of tea traded in Kolkata market. One year short term price forecasting is the goal of the study. The proposed model is able to capture the sudden fluctuations present in the time series. Also, the approach performs well from the linear time series models for twelve months ahead forecasting in terms of minimum absolute percentage error, root mean square error and minimum absolute error.

Name: Sandip Garai

Chairman: Dr. L.M. Bhar (Dr. Ranjit Kumar Paul)

Title of Thesis: Wavelets and machine learning techniques for forecasting agricultural commodity prices

Through Wavelet analysis at two different levels of decomposition using two different wavelet filters original time series data is decomposed into high and low frequency components to capture useful information at multi-resolution levels. The decomposed and denoised components can then be forecasted using SVR or ANN model to form wavelet-based hybrid AI models. And finally, all forecasted values are summed up to produce the forecast of original time series. The novelty of these hybrid models lies in the fact that they can handle both nonstationary, nonlinear and non-normal features of datasets simultaneously. Different measures viz, RMSE, MAD and MAPE are used to evaluate the results of wavelet analysis at intra- and inter-filter performance to compare wavelet-based Machine Learning forecasting techniques with the traditional techniques

Name: B. Manjunata

Chairman: Dr. Rajender Parsad

Title of Thesis: Construction of Structurally Incomplete Row-Column Design

Some methods of construction for obtaining pairwise and/or variance balanced structurally incomplete row-column (SIRC) / Balanced incomplete Latin square (BILS) designs have been obtained using symmetric BIB designs, union of two variance balanced SIRC/BILS designs or adding treatments in existing variance balanced SIRC designs. For a ready reckoner, the catalogues of variance balanced SIRC/BILS designs that are obtainable from methods of construction for v (number of treatments), b1 (number of rows), b2 (number of columns), k1 (number of non-empty nodes in rows) and k2 (number of non-empty nodes in columns) ≤ 15 along with their layouts have also been prepared. Further, in some experimental situations, interest may only be in a subset of comparisons like in comparing test treatments with control treatment(s). For such experimental situations, structurally

incomplete balanced treatment row-column/ balanced bipartite row-column designs have been obtained using reinforcement technique in pairwise balanced block designs and variance balanced row-column designs. The catalogues of structurally incomplete BTRC/BBPRC designs for v1 (number of test treatments), b1, b2, k1 and k2 ≤ 15 along with their layouts have also been given. An R code for generating the information matrix given the layout of the design has also been given. M.Sc (Computer Application)

Name: Mohit Kumar

Chairman: Dr. Alka Arora

Title of Thesis: Wheat Plant Senescence Quantification using Machine Learning Algorithms

Wheat plant image data was taken from Nanaji Deshmukh Plant Phenomics Centre installed at ICAR-IARI, New Delhi. Six machine learning algorithms, Naïve Bayes, k-nearest neighbours, Decision Tree, Random Forest, Gradient Boosting classifier, and Artificial Neural Network algorithms were trained on five specified classes; light green, dark green, yellow, pale yellow and finally brown for wheat plant. All the algorithms performed well and ANN outperformed among the above trained algorithms with 97.28% accuracy. A GUI based desktop application, m-Senescencica, is developed with the functionality to parallel process the images over the more than one CPU cores. Processing of images provides senescence and green-ness percentage, segmentation images for the senescence and green-ness portion and total plant area for each input image. After processing the images, result are automatically saved to the disk. m-Senescencica is beneficial for the researchers working in the field of plant phenotyping and they don't require prior knowledge of image processing and programming languages to use the software.

Name: Ms. Sahana M.R

Chairman: Dr. Shashi Dahiya

Title of Thesis: Mobile based Decision Support System for evaluation of postural ergonomics using Rapid Entire Body Assessment

The development of Mobile based DSS has been proposed for postural assessment of agricultural activities with Rapid Entire Body Assessment (REBA) technique. This DSS has been developed as an Android application which can be downloaded by the evaluator or farmer on their mobile phones easily. By using this mobile application, physiological parameters and posture can be evaluated and farmers may be suggested /recommended the correct posture to avoid developing musculoskeletal disorders.

Name: Tamal Kundu

Chairman: Dr. Mukesh Kumar

Title of Thesis: Decision Support System for Biomechanical Evaluation of Agricultural Activities with Human Physical Drudgery Index (HPDI)

An app named HPDI Ergon is developed to remove the drudgery involved in the work. In this app farmers are assessed based on different physiological parameters and conclusion is drawn regarding their efficiency and constraints. The app is developed using Android Studio and Java programming language. In the app there will be registration for both the users and the farmers under the users. Individual registered farmers are selected to undergo different ergonomic analysis and drudgery analysis. Based on the results of all the ergonomic analysis and drudgery analysis using HPDI conclusion is drawn regarding whether there is any need of changing or improving the working condition or not. Accordingly, different suggestions and various improved tools are provided to the farmers for reducing their both physiological stress and drudgery in their working environment and

consequently making them more efficient in their working environment.

Name: Lalit Birl

Chairman: Dr. S.B. lal

Title of Thesis: Soil Nutrient Based Mobile App for Crop-Wise Fertilizer Recommendation

A mobile application called ‘SoilNutro" has been developed to achieve the nutrient status of a specific location of users. The app also recommends the combination of fertilizer doses required for crops based on current nutrient status for efficient use of various fertilizers. In this study, the 'SoilNutro' application with a minimum SDK version of API 24: Android 7 (Nougat) was built on the android platform. The developed Android application 'SoilNutro' will be of great use to provide farmers with a specific location of nutrients and recommend crop-wise fertilizer based on the available nutrient.

Name: Ms. V.T. Shalini

Chairman: Md. Samir Farooqi

Title of Thesis: Development of Integrated Web Based Solution for Feature Selection from Genomic Data

Name: Ms. Sowndarya

Chairman: Dr. Shashi Dahiya

Title of Thesis: Publication Recommendation System for Scientific Community in Agriculture

This thesis presents a Publication Recommendation System for Scientific Community in Agriculture. The developed system uses the keywords and title of the publications stored in the agricultural publication repository to find out the similarity. The TF-IDF model of Text Mining and the Cosine similarity measure have been used in this research for finding out the similarity between the newly added publication and all existing publications in the publication repository. The recommendation of the new publication is sent to the authors and co-authors of the top five similar publications through mail. The system has been tested using the data from KRISHI Publication and Data Inventory Repository. The system has been built in such a way that it can be easily integrated with any agricultural publication repository with slight modifications in the database as per the requirement.

Name: Harsh Sachan

Chairman: S.N. Islam

Title of Thesis: Image-based Weed Identification of Wheat Crop using Convolutional Neural Network (CNN)

In this thesis, an attempt has been made for automatically identification of weeds in wheat crop by applying artificial intelligence and its component. Convolution Neural Networks (CNNs) has been utilized for analyzing and classifying images of weeds taken directly from the field. Using a dataset of 2552 weed images from Agronomy field ICAR-IARI, New Delhi, we proposed a methodology to 5 classes of weeds related to wheat crop. Ph.D (Bioinformatics)

Name: Neeraj Budhlakoti

Chairman: Dr. Anil Rai

Title of Thesis: Development of Robust Methods for Genomic Selection

The idea behind this study is to identify best suitable model from parametric and nonparametric model under different genetic architecture. First we have gone through various parametric models and evaluated there performance on real and simulated datasets. Under parametric models we have studied most commonly used methods i.e. linear regression, RR, BLUP, GBLUP, LASSO, Bayesian. For nonparametric models we have studied models like RKHS, SVM, NN and RF. For additive architecture, GBLUP performed quite well and among

nonparametric methods, performance of SVM was found to be encouraging. A robust model has been developed for genomic selection studies which can handle additive and epistatic effects simultaneously by minimizing their error variance. Developed integrated model has been evaluated using the prediction accuracy and error variance. Proposed model is either performing better or at par with the existing models. Proposed model is robust to the diverse genetic architecture i.e. additive and epistatic. A new efficient method using meta-analysis for outlier detection in genomic data has been proposed. Comparative study has been made among various existing methods of outlier detection in high dimensional genomic data for their impact on accuracy of genomic estimated breeding value. Proposed method has outperformed among existing methods.

M.Sc (Bioinformatics)

Name: Sharanbasappa

Chairman: Dr. D.C. Mishra

Title of Thesis: A Deep Clustering based binning approach for Metagenomic data

A Deep learning-based clustering approach has taken to cluster the metagenome with K-means clustering algorithm. For this Python libraries such as Numpy, Keras, TensorFlow, Pandas, Sklearn, Matplotlib are used. Dataset contains TNF, HNF and GC content where Convolutional Autoencoder was used to develop a model with reduced or transformed features. The proposed model is tested by adapting different resizing techniques and with varying hyperparameters such as batch size, no. of epochs, no of features extraction, No of clusters. Among the results obtained from TNF, it has been observed that a model obtained from a data of size 64×64 with 25 epochs and 100 batch size and 7 clusters is an optimal model whose Silhouette index is 0.67 but its Rand index is 0.28. Whereas, on the basis of results obtained from HNF dataset, a model with data of size 512×512 with 10 epochs, 256 batch size and 10 clusters are having Silhouette value 0.65 and Rand index 0.77 is chosen as best model.

Name: Pranita Das

Chairman: Dr. Monender Grover

Thesis title- Study on Differential expression of Coding and Non-Coding RNAs and Post-Translational Modifications in wheat rust resistance

The study aims at identification of differentially genes in response to wheat stripe rust between the susceptible line PBW343 and resistant line FLW29 and their transcriptional profiling, identification and characterizations of lncRNAs in stress conditions, transcription factors, pathways etc and lastly the prediction of PTM sites in the translated DEGs. A total of 164095 transcripts, 409 differential expressed genes,1503 transcriptional factors, and several protein domains and families were identified from reference based assembly. Myeloblastosis related proteins (MYB), WRKY domain, Basic helix-loop-helix (bHLHs) found in this study are reported to be associated with plant tolerance against biotic stress. A total of of 6807 putative lncRNAs have been identified under three different time points out of which only 13 are differentially expressed. These are related to the pathogenesis-related protein 1 and disease resistance protein RGA2. Lastly, the study on PTM has been carried out on the protein coded DEGs in sequence level and palmitoylation sites has been found more in case of downregulated genes compared to the upregulated ones indicating palmitoylation may play some important role in disease resistance mechanism.

Name: Mailarlinga

Chairman: Dr. S.B. Lal

Title of Thesis: Development of web based tool for computation of genomic signatures

In this study, a web-based tool has been developed that act as a single comprehensive

platform for providing genome signatures for genomic sequence data. By this web-tool genomic signature indices can be computed by providing the input genomic sequence data and compatible parameters. In this study, software modules for AMIP and OFDEG have been developed and researchers and biologist can easily compute these index values. This web-tool saves the time of those researchers who needs to generate all signature indices at once.

3. AWARDS TO STUDENTS

- Mr. Bijoy Chanda, M.Sc. (Agricultural Statistics)

- Received Nehru Memorial Gold Medal 2021 of IASRI for being Best M.Sc. (Agricultural Statistics) Student during the Annual Day of the Institute

- Mr. Tamal Kundu, (Computer Application)

Received Nehru Memorial Gold Medal 2021 of IASRI for being Best M.Sc. (Computer Application) Student during the Annual Day of the Institute

- Ms. Parinita Das, (Bioinformatics)

Received Nehru Memorial Gold Medal 2021 of IASRI for being Best M.Sc. (Bioinformatics) Student during the Annual Day of the Institute.

4. ANNUAL DAY CELEBRATIONS

The Annual Day of the Institute was celebrated on July 3, 2021 in which Former Director, International Food Policy Research Institute-South Asia Region, Secretary, National Academy of Agricultural Sciences, Dr. P.K. Joshi delivered the Nehru Memorial Lecture entitled "Agricultural Transformation in India".

The Annual Day of the Institute was celebrated on July 3, 2021 in which Dr. R.C. Agrawal, DDG,(Edu) ICAR was Guest of Honour.

5. TEACHER'S DAY CELEBRATIONS

The Teacher's Day was celebrated on September 05, 2021 in which Dr. P Sreenath, Ex Head Design of experiments & Professor (Agricultural Statistics) IASRI was honored on this occasion. Dr. Rajender Parsad Director presided over the function and the following students gave lecture.

1. Introduction to Teacher's Day Ms. Ankita Negi, Ph.D (Bioinformatics)

2. Role of Machine learning techniques in agriculture by Mr. Arpan Kumar Manji, Ph.D (CA)

3. Role of women in agricultural system by Mr. Vaijnath Shivlingappa, Ph.D (CA)

4. Present Indian Statistical System By Mr. Vinayaka, Ph.D (Ag. Stat)

5. The man who knew infinity (R.A Fisher) by Mr. Debopam Rakshit, Ph.D (Ag. Stat)

6. Geographic information system (GIS) by Ms. Anupama Roy, Ph.D (Bioinformatics)

7. New education policy by Mr. Soutrik Mukherjee, M.Sc (Bioinformatics)

6. RESEARCH FELLOWSHIPS

During 2021-22, 56 Ph.D. and 37 M.Sc. students received research fellowship. 48 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. 01 Ph.D. student received Rajeev Gandhi National Fellowship @31,000/-, 05 Ph.D. students received UGC fellowship

@ 31,000/- per month and Contingency Rs.10,000/-, 02 students received Maulana Azad National Fellowship @ Rs.31,000/- per month and Rs.10,000 per annum as contingency grant. 12 M.Sc. students received ICAR Junior Research Fellowship @ Rs.12,640/- per month in addition to Rs.6,000/- per annum as contingency grant and 25 M.Sc. students received IASRI fellowship @ Rs.7,560/- per month and Rs.6,000/- per annum as contingency grant.

S.No.	**Name**	**Year of Induction**
1.	Dr. Rajender Parsad, Principal Scientist & Director	1995
2.	Dr. Tauqueer Ahmad, Principal Scientist & Director (A)	1998
3.	Dr. Seema Jaggi, Professor (Agricultural Statistics) till 27.04.21	1995
4.	Dr. L.M. Bhar, Principal Scientist	1998
5.	Dr. Anil Rai, Principal Scientist	1995
6.	Dr. K.N. Singh, Principal Scientist	2011
7.	Dr. Amrit Kumar Paul, Principal Scientist	1998
8.	Dr. Girish Kumar Jha, Principal Scientist (at IARI)	1999
9.	Dr. Cini Varghese, Professor (Agricultural Statistics) from 16.09.21	2000
10.	Dr. Himadri Ghosh, Principal Scientist	2004
11.	Dr. Ajit, Principal Scientist	2015
12.	Dr. Anil Kumar, Principal Scientist	2010
13.	Dr. Prawin Arya, Principal Scientist	2003
14.	Dr. Hukum Chandra, National Fellow	2003
15.	Dr. Prachi Misra Sahoo, Principal Scientist	2002
16.	Dr. V. Ramasubramanian, Principal Scientist	2017
17.	Dr. Amrender Kumar, Senior Scientist (at IARI)	2003
18.	Md. Wasi Alam, Senior Scientist	2003
	Dr. Ranjit Kumar Paul, Senior Scientist	2011
20.	Dr. B.N. Mandal, Senior Scientist	2011
21.	Dr. Susheel Kumar Sarkar, Senior Scientist	2011
22.	Dr. Mir Asif Iqubal, Senior Scientist	2011
23.	Dr. Kaustav Aditya, Scientist	2012
24.	Dr. Sukanta Dash, Scientist	2013
25.	Dr. Arpan Bhowmik, Scientist	2014
26.	Dr. Ankur Biswas, Scientist	2015
27.	Dr. Anindita Datta, Scientist	2017
28.	Dr. Sarika, Senior Scientist	2018
29.	Mr. Deepak Singh, Scientist	2018

30.	Dr. Achal Lama, Scientist	2018
31.	Dr. Pradip Basak, Scientist	2018
32.	Dr. Mrinmoy Ray, Scientist	2018
33.	Dr. Raju Kumar, Scientist	2019
34.	Dr. Vandita Kumari, Scientist	2019
35.	Dr. Kanchan Sinha, Scientist	2019

S. No.	**Name**	**Year of Induction**
1.	Dr. Sudeep Marwaha, Head & Professor (Computer Application) till 2002	17.09.21
2.	Dr. Alka Arora, Professor (Computer Application) from 18.09.21	2001
3.	Dr. K.K.Chaturvedi, Principal Scientist	2002
4.	Dr. Anshu Bhardwaj, Principal Scientist	2004
5.	Dr. S.B. Lal, Principal Scientist	2004
8. FACULTY MEMBERS OF P.G. SCHOOL, IARI IN COMPUTER APPLICATION		
8.	Dr. Mukesh Kumar, Principal Scientist	2014
9.	Dr. Shashi Dahiya, Senior Scientist	2001
10.	Md. Samir Farooqi, Senior Scientist	2001
11.	Dr. Anu Sharma, Senior Scientist	2004
12.	Dr. Sangeeta Ahuja, Scientist 2002	
13.	Sh. Pal Singh, Scientist	2010
14.	Ms. Shaloo, Scientist (at WTC, IARI) 2016	
15.	Sh. S,N. Islam, Scientist	2018
Dr. Soumen Pal, Scientist		2019

9. FACULTY MEMBERS OF P.G. SCHOOL, IARI IN BIOINFORMATICS

S. No.	Name	Year of Induction
1.	Dr. Rajender Parsad, Principal Scientist & Director	2010
2.	Dr. Anil Rai, Head (CABin) & ADG(ICT) Professor (Bioinformatics)	2010
3.	Dr. Seema Jaggi, Principal Scientist till 27.04.21	2010
4.	Dr. S.S. Marla, Principal Scientist	2010
5.	Dr. Sudeep Marwaha, Principal Scientist	2010
6.	Dr. Kishore Gaikwad, Principal Scientist (at NRCPB)	2010
7.	Dr. P.K. Singh, Principal Scientist (at IARI)	2010
8.	Dr. A.K. Mishra, Principal Scientist (at IARI)	2010
9.	Dr. S.B. Lal, Principal Scientist	2010
10.	Dr. Monendra Grover, Principal Scientist	2013
11.	Dr. K.K. Chaturvedi, Principal Scientist	2014
12.	Dr. U.B. Angandi, Senior Scientist	2014
13.	Mohd. Samir Farooqi, Senior Scientist	2010
14.	Dr. Anu Sharma, Senior Scientist	2010
15.	Dr. Sunil Archak, Principal Scientist	2010
16.	Dr. D.C. Mishra, Senior Scientist	2010
17.	Dr. Sarika, Senior Scientist	2010
18.	Sh. Sanjeev Kumar, Scientist	2010
19.	Dr. Mir Asif Iquebal, Scientist	2013
20.	Dr. M.G. Mallikarjuna, Scientist (at IARI)	2017
21.	Dr. Yasin Jeshma K., Scientist (at NBPGR)	2018
22.	Dr. Sudhir Shrivastava, Scientist	2019

10. Board of Studies for Academic Year 2021-22

Agricultural Statistics

1.	Dr. Cini Varghese, Professor (Agricultural Statistics)	Chairperson
2.	Dr. Rajender Parsad, Director	Member (Ex-officio)
3.	Dr. Ramasubrananian V, Principal Scientist	Member
4.	Dr. Ranjit Kumar Paul, Senior Scientist	Member
5.	Dr. Anindita Datta, Scientist	Member Secretary
6.	Mr. Vinay Kumar L.N, Student Representative	Students'

Computer Application

1.	Dr. Alka Arora, Professor (CA)	Chairman
2.	Dr. Rajender Parsad, Director	Member (Ex-officio)
3.	Dr. Sudeep Marwaha, Principal Scientist	Member
4.	Dr. Md. Samir Farooqi, Scientist	Member Secretary
5.	Dr. Chandan Kumar Deb, Scientist	Member
6.	Ms. Lakshmi Mahadev Sonkusale Representative	Students'

12. 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 and State Government Departments, etc.& 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 September 27, 2021 to March 05, 2022. The Course comprise of two independent modules of three months duration each. Two officers participated in both the modules. Module – I was organized during September 27, 2021 to December 11, 2021. Module-II was organized during December 14, 2021 to March 05, 2022. Three officers participated in Module – I and Three officer 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 was the course coordinator of the course.

Topic	**Instructor**
Module-I	
Statistical Methods	Md. Harun, Rahul Banerjee & Dr. Bharti
Official Agricultural Statistics	Dr. Kaustav Aditya Sh. Deepak Singh & Dr. Raju Kumar
Use of Computers in Agricultural Research	Dr. Madhu, Dr Rajeev Ranjan & Dr Pankaj Das
Module-II	
Sampling Techniques	Dr. Raju Kumar, Dr. Bharti & Dr. Pankaj Das
Statistical Genetics	Dr. Amrit Kumar Paul, Dr. Upendra Kumar, Dr. Samarendra Das & Dr. Prakash Kumar
Design of Experiments	Anindita Datta, Md. Harun & Sunil Kumar Yadav

Training Programmes under HRM

S. No	**Title**	**No. of Participants**	**Course Coordinators**	**Period**
1.	Statistical Modelling and forecasting in Agriculture (HRM)	29	Dr. Wasi Alam	24.06.21 to 26.06.21
2.	Experimental Data Analysis (HRM) online	16	Dr. B.N. Mandal Md. Harun	20.10.21 to 29.10.21

Other Training Programmes

S.No	Title	No. of Participants	Course Coordinators	Period
1.	Software and tools for Bioinformatics	20	Dr. K.K. Chaturvedi Dr. U.B. Angadi Dr. Sudhir Srivastava	11.01.2021 to 13.01.2021
2.	E-File (E-Office)	32	Dr. Sudeep	12.01.2021
3.	E-File (E-Office)	33	Dr. Sudeep	18.01.2021
4.	Website Content Management using wordpress of AICRP on Plastics Engineering in Agricultural Structure & Environment Management (PEASEM)	2	Dr. Rajender Parsad Dr. Arpan Bhowmik	28.01.2021
5.	E-File (E-Office)	34	Dr. Sudeep	29.01.2021
6.	E-File (E-Office)	33	Dr. Sudeep	11.02.2021
7.	All India Training of Master Trainers on Web Portal and Android App for ISS Scheme	275	Dr. Prachi Misra Sahoo	17.02.2021 to 18.02.2021
8.	Statistics and Informatics for Experimental Data Management and Analysis	137 M86, F51	Dr. Seema Jaggi Dr. Sudeep Dr. Anindita Datta Dr. Soument Pal Mr. Sanjeev Kumar	23.02.21 to 04.03.21
9.	"Statistics for Social Science Scholars" using R/SPSS software for M.F.Sc./Ph.D Fisheries Economic /Extention students of ICAR-CIFE, Mumbai	23 M13, F10	Dr. Susheel Kumar Sarkar Dr. V.Ramasubramanian Sh. Upendra Kumar Pradhan	23.02.2021 to 22.03.21

10.	Designs of experiments and Next Generation Sequencing Data Analysis	15	Dr. M.A. Iquebal Dr. B.N. Mandal Dr. S.K. Jain	16.03.2021 to 17.03.2021
11.	"Advanced Designs for Product and Process Development Orientation Experiments" under NAE scheme of ICAR Jointly by ICAR-IASRI	92 M 62, F30	Dr. Sukanta Dash Dr. Anil kumar	16.03.2021 to 17.03.2021
12.	साख्यिकी अनुवंशिकी और कृषि में इसके अनुप्रयोग	38 M28, F10	Samarendra Das Upendra Das	18.03.21 to 20.03.21
13.	Next Generation Sequence Data Analysis	167	Dr. Anil Rai Mr. Sanjeev Kumar Dr. D.C Mishra Dr. K.K. Chaturvedi	22.03.21 to 27.03.21
14.	A course on Basic Statistical Methods in Agriculture	M.Sc. students of Batch 4 (Agronomy) of Afghanistan National Agricultural Science and Technology University (ANASTU)	Seema Jaggi Course Faculty: Seema Jaggi, Rajender Parsad, Sukanta Dash and Arpan Bhowmik	05.04.21 to 17.04.21
15.	AMS, Academic Management System, implementation at SAU's, KVASU, Wayanad	65	Dr. Sudeep	21.04.21
16.	AMS, Academic Management System, implementation at SAU's, TNAU, Coimbatore	30	Dr. Sudeep	22.04.21

17.	AMS, Academic Management System, implementation at SAU's, SVVU, Tirupati & SKUAST, Jammu	70	Dr. Sudeep	26.04.21
18.	AMS Training East-Zone	120	Dr. Sudeep	05.05.2021
19.	Agri DIKSHA Basic Training	147	Dr. Sudeep, Dr. Anshu Bharadwaj	07.05.2021
20.	AU-PIMS Training	122	Dr. Sudeep, Dr.Alka Arora	08.05.2021
21.	AMS training North Zone	247	Dr. Sudeep	12.05.2021
22.	AU-PIMS Training	157	Dr. Sudeep, Dr.Alka Arora	13.05.2021
23.	Agri DIKSHA Basic Training	136	Dr. Sudeep, Dr. Anshu Bharadwaj	14.05.2021
24.	AMS Training-South Zone	495	Dr. Sudeep	19.05.2021
25.	Agri DIKSHA Basic Training	232	Dr. Sudeep, Dr. Anshu Bharadwaj	21.05.2021
26.	AU-PIMS Training	134	Dr. Sudeep, Dr.Alka Arora	22.05.2021
27.	AMS Training West zone	359	Dr. Sudeep	26.05.2021
28.	Agri DIKSHA Basic Training	70	Dr. Sudeep, Dr. Anshu Bharadwaj	28.05.2021

29.	AU-PIMS Training	98	Dr. Sudeep, Dr. Alka Arora	29.05.2021
30.	Agri DIKSHA Basic Training	292	Dr. Sudeep, Dr. Anshu Bharadwaj	09.06.2021
31.	AMS Basic Training	871	Dr. Sudeep	10.06.2021
32.	AU-PIMS Training	167	Dr. Sudeep, Dr. Alka Arora	10.06.2021
33.	Agri DIKSHA Basic Training	131	Dr. Sudeep, Dr. Anshu Bharadwaj	14.06.2021
34.	AMS Advance Training	180	Dr. Sudeep	15.06.2021
35.	AU-PIMS Training	145	Dr. Sudeep, Dr. Alka Arora	15.06.2021
36.	Brainstorming on mainstreaming of Agriculture as a subject in the school curriculum	28	Dr. Anshu Bharadwaj, Dr. Sudeep	16.06.2021
37.	Agri DIKSHA Basic Training	89	Dr. Sudeep, Dr. Anshu Bharadwaj	23.06.2021
38.	AU-PIMS Training	139	Dr. Sudeep, Dr.Alka Arora	24.06.2021
39.	Statistical Modelling and forecasting in Agriculture (HRM)	29	Dr. Wasi Alam	24.06.21 to 26.06.21
40.	AMS Advance Training	514	Dr. Sudeep	24.06.2021
41.	Application of OMICS Tools and Techniques for Veterinary Sciences using NGS data	35	Sarika, Mir Asif Iquebal (with Archana Pathak, Deepak Sharma, Avinash Kumar, Brijesh Yadav from DUVASU, Mathura)-NAHEP	06 July-10 July, 2021
42.	Agri DIKSHA Basic Training	168	Dr. Sudeep, Dr. Anshu Bharadwaj	14.07.2021
43.	AMS Training- North Zone	35	Dr. Sudeep	15.07.2021
44.	AU-PIMS Training	161	Dr. Sudeep, Dr. Alka Arora	15.07.2021

45.	Agri DIKSHA Basic Training	112	Dr. Sudeep, Dr. Anshu Bharadwaj	11.08.2021
46.	Agri DIKSHA Basic Training	129	Dr. Sudeep, Dr. Anshu Bharadwaj	12.08.2021
47.	AMS Training-South Zone	76	Dr. Sudeep	12.08.2021
48.	AMS Training-West Zone	45	Dr. Sudeep	26.08.2021
49.	Training Programme on " E-Goverance Applications in ICAR" HRM, online	59	Dr. K.K. Chaturvedi	06.09.21 to 10.09.21
50.	Applications of Bioinformatics Tools in Agricultural Research"	248	Sarika, MA Iquebal (NanditaSahana, Somnath Mandal from UBKV, Coochbehar)-NAE	20th - 30th September, 2021
51.	An online training program "Zone-wise training for eLISS Web Portal and eLISS Android App" under project "Integrated Sample Survey Solution for major Livestock Products"	2739	Dr. Prachi Misra Sahoo	22.09.21 to 28.09.21
52.	Recent Developments in KRISHI portal	Scientific and technical staffs of ICAR Research Complex for NEH Region, Umiam, Meghalaya	Debasish Chakraborty, Rajender Parsad, Anshu Bharadwaj and Arpan Bhowmik	25.09.21

53.	Transcriptomic Data Analysis	118	Dr Samir Farooqi and Dr Sudhir Srivastava	28.09.21 to 30.09.21
54.	Experimental Data Analysis (HRM) online	16	Dr. B.N. Mandal Md. Harun	20.10.21 to 29.10.21
55.	Protein Structure Modelling and Dynamics	72	Dr. Anil Rai Dr. Sunil Kumar Dr. U.B. Angadi	27.10.21 to 29.10.21
56.	AMS Basic Training	65	Dr. Sudeep	16.11.2021
57.	AMS Advance Training	268	Dr. Sudeep	17.11.2021
58.	Agri DIKSHA Basic Training	127	Dr. Sudeep, Dr. Anshu Bharadwaj	17.11.2021
59.	AMS Training-East Zone	52	Dr. Sudeep	24.11.2021
60.	राजभाषा नितिः कार्यान्वयन	40	Hindi Section	26.11.2021
61.	Agri DIKSHA Basic Training	124	Dr. Sudeep, Dr. Anshu Bharadwaj	27.11.2021
62.	Protein Data Analysis	26	Dr. Rajender Parsad Dr. Anil Rai Dr. Sudhir Srivastava Dr. K.K. Chaturvedi	24.11.21 to 26.11.21
63.	Application of Sampling Techniques in Agriculture (HINDI)	40	Dr. Rahul Baneerjee, Dr. Pankaj, Dr. Bharti	30.11.21 to 02.12.21
64.	AMS Training-North Zone	32	Dr. Sudeep	03.12.2021
65.	Agri DIKSHA NAARM	48	Dr. Sudeep, Dr. Anshu Bharadwaj	12.12.2021
66.	AMS Training-South Zone	81	Dr. Sudeep	15.12.2021
67.	AMS Training-West Zone	69	Dr. Sudeep	16.12.2021

68.	AMS Basic Training	71	Dr. Sudeep	16.12.2021
69.	AMS Advance Training	76	Dr. Sudeep	17.12.2021
70.	AMS Training-East Zone	42	Dr. Sudeep	17.12.2021
71.	AMS Training-North Zone	100	Dr. Sudeep	17.12.2021
72.	SNP Mining, GWAS & Genomics	98	Dr. Anil Rai Dr. D.C Mishra Dr. Neeraj Budhlakoti	16.12.21 to 21.12.21
73.	AR-VR DEMO for AUs	27	Dr. Sudeep, Dr. Anshu Bharadwaj	20.12.2021
74.	AMS Training-South Zone	268	Dr. Sudeep	22.12.2021

5 Linkages and Collaborations

Linkages and Collaborations in India and abroad including externally funded projects (January - December 2021)

Sr. No.	Title	Collaborative /Funding agency	Date of Start	Date of completion
1.	Planning, designing and analysis of experiments planned ON STATION under AICRP on IFS	ICAR-IIFSR	01.04.2017	31.03.2022
2.	Designing and analysis of ON FARM research experiments planned under AICRP on IFS	ICAR-IIFSR	01.04.2017	31.03.2022
3.	Planning, designing and analysis of data relating to experiments for AICRP on Long Term Fertilizer experiments	AICRP LTFE	01.04.2017	31.03.2022
4.	ICAR research data repository for knowledge management as KRISHI: Knowledge based resource information system hub for innovations in agriculture.	ICAR Headquarters EFC Scheme: NAARM, NBSSLUP, IARI, CRIDA, CMFRI, DKMA as partners and all other ICAR Institutes as Nodal Centers	24.07.2015	31.03.2022
5.	Application of next-generation breeding, genotyping, and digitalization approaches for improving the genetic gain in Indian staple crops.	IARI, New Delhi	22.01.2019	21.01.2023
6.	Plant source based environmentally safe crop protection and production technologies: Development and capacity building	IARI, New Delhi	27.03.2019	31.12.2021
7.	Statistical approach for genome-wide association studies and genomic selection for multiple traits in Structured plant and animal population.	Funded by Science and Engineering Research Board, DST Government of India	20.06.2017	15.03.2021

8.	Doubling farmers' income in India by 2021-22: Estimating farm income and facilitating the implementation of strategic framework.	Ministry of Agriculture and farmer welfare	31.03.2017	31.03.2022
9.	Modelling insect pests and diseases under climate change and development of digital tools for pest management.	NICRA project funded by CRIDA(DBT funded)	20.06.2017	31.03.2022
10.	Studying dynamics of market integration and price transmission of agricultural commodities.	ICAR Funded	02.04.2018	31.03.2021
11.	Energy audit survey of AICRP on energy in agriculture & agro-based industries: Sampling design and analysis	ICAR-All India Coordinated Research Project on "Energy in Agriculture & Agro-based Industries	01 June, 2018	31 .05 2021
12.	Integrated sample survey solution for major livestock products.	DAHDF, MoAFW, Govt. of India	27.03.2019	31.01.2023
13.	Development and assessment of educational mobile apps for improving livestock health and production.	ICAR-IVRI	28.06.2017	31.03.2021
14.	Knowledge management system for agriculture extension services in Indian NARES.	ICAR-Extramural Research Project funded by Agricultural Extension Division	04.03.2016	31.03.2022
15.	Management and impact assessment of farmer FIRST Project.	ICAR-NIAP and Funded by ICAR	01.02.2017	31.03. 2022
16.	ICT based extension strategies for nutrition sensitive agriculture in the states of UP and Odisha.	NASF	01.11.18	31.10 2021
17.	ICAR network project on functional genomics and genetic modification (Earlier ICAR network project on transgenic in crops.	NRCPB, New Delhi	27.01.2015	30.06.2021
18.	Improving the usability of buffalo spermatozoa by sperm surface remodeling and immune acceptance in female reproductive tract (NASF).	ICAR-NDRI	12.07.2018	11.07.2021
19.	Molecular markers for improving reproduction of cattle and buffaloes - Funded by Bill and Melinda Gates Foundation (BMGF).	ICAR-NDRI, ICAR-CIRB	19.09.2018	30.09.2023

20.	Molecular characterization, development of molecular markers and metabolite analysis of Tree bean (Parkia roxburghii) landraces of North-East India (DBT Funded).	ICAR Research Complex for NEH Region (Gangtok, Sikkim Centre) and UBKV, West Bengal	15.03.2019	14.03.2022
21.	Development of web server for phenotype and genotype analysis for cattle breeding management.	ICAR-CIRC, Meerut	12.03.2018	31.03.2021
22.	Genome and transcriptome sequencing of coriander (Coriandrum sativum) to reveal insight of its genomic architecture and breeding targets.	JAU, Junagarh	14.03.2018	31.03.2021
23.	Genomics assisted crop improvement and management - Centre for Advanced Agricultural Science and Technology (CAAST) project funded by National Agricultural Higher Education Project (NAHEP).	ICAR-IARI, ICAR-NBPGR and ICAR-NIPB	26.09.2018	31.03.2023
24.	Computational and analytical solutions for high-throughput biological data.	All Bureaux /ICAR Consortium Research Platform on Genomics	04.09.2015	30.09. 2021
25.	Genome wide association study in Indigenous poultry breeds/varieties.	ILRI, ICAR-DPR	21.05.2020	31.03.2022
26.	Feasibility study for developing renewable energy systems for Tea plantations in Assam	Indian Institute Technology, Delhi	01.02.2020	31.0.2022
27.	Explicating genomic insights of Indigenous equines breed population through “Computational Genomics” and “Artificial Intelligence” based approaches.	ICAR-NRCE, Hissar	17.08.2020	30.11.2022
28.	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)	ICAR-IARI	01.05.2020	30.04.2025
29.	Germplasm characterization and trait discovery in Wheat using genomics approaches and its integration for Improving climate resilience, productivity and nutritional quality. (DBT)	ICAR-NBPGR	01.04.2020	31.03.2025

30.	Minor oilseeds of Indian origin: Mainstreaming sesame germplasm for productivity enhancement and sustainability through genomics assisted core development and trait discovery. Funded by DBT.	ICAR-NBPGR	01.03.2020	28.02.2025
31.	Identification and functional characterization of the key resistance/susceptible determinants for Sclerotinia stem rot disease in oilseed Brassica. (DST).	ICAR-NIPB	30.12.2020	31.12.2023
32.	Efficient designs for double cross experiments under fixed/mixed effects model.	ICAR-DPR, ICAR-IARI	11.11.2021	10.11.2024
33.	Biomass and carbon mapping across altitudinal gradient of major Darjeeling and Sikkim Himalayan land uses: Implications for carbon sink management and mitigation. (DST)	UBKV	10.02.2021	09.02.2024
34.	Diversified farming through livestock and agriculture under farmer farm, innovations, resources, science and technology programme (ICAR-CIRB Farmer First). Funded by Farmer First programme, ICAR.	ICAR-CIRB, ICAR-IARI	25.11.2021	Continuing
35.	Forecasting Agricultural output using Space Agrometeorology and Land based observations (FASAL).	IMD	13.04.2016	31.03.2022
36.	Leveraging institutional innovations for inclusive and market led agricultural growth in eastern India. Funded by NASF.	ICAR-IARI, BHU, Varanasi, ICAR-NRRI, Cuttack,CCS NIAM, Jaipur	01.12.2019	30.11.2022
37.	ICT based extension strategies for nutrition sensitive agriculture in the states of UP and Odisha. Funded by NASF	ICAR-IARI, ICAR-ATARI Zone-IV, Kanpur, Directorate of Extension Education OUAT, Bhubaneswar,	01.11.2018	31.10.2021
38.	Molecular characterization, development of molecular markers and metabolite analysis of tree bean (Parkia roxburghii) landraces of North-East India. [BT/PR24912/NER/95/904/2017]. Funded by DBT.	Uttar Banga Krishi Viswavidyalaya, ICAR Research Complex for North East Hill Region, Mizoram	15.03.2019	14.03.2022
39.	Genome wide association study in Indigenous poultry breeds/varieties	ILRI, ICAR-DPR	21.05.2020	31.03.2022

40.	Characterization, evaluation, genetic enhancement and generation of genomic resources for accelerated utilization and improvement of minor pulses. Funded by DBT.	Institute of Life Sciences, ICAR-NBPGR	24.10.2018	23.10.2022
41.	Improving seed health and storage system. Funded by IISS Kusmaur, Mau.	ICAR-IISS	25.01.2022	31.03.2026
42.	Assessing genetic variability in duck of Eastern states.	ICAR-RCER	01.08.2018 (Association of IASRI 08.02.2021)	31.08.2022
43.	Potential irrigated area mapping through remotely sensed high resolution data.	ICAR-IIWM, ICAR-NBSS & LUP, Office of Climate Research and Services, IMD, Pune	05.09.2021	04.09.2024
44.	Network Program on Precision Agriculture (NePPA) at ICAR-IARI New Delhi	ICAR-IARI	04.09.2021	31.03.2026
45.	Investments in Indian Council of agricultural research leadership on agricultural higher education under the National Agricultural Higher Education Project (NAHEP).	ICAR-NAARM, ICAR-NIAP	28.02.2019	30.11.2022
46.	Development of artificial intelligence integrated big-data based system for automatic query-response generation and analysis of Indian farmers' queries.	ICAR-IARI	09.12.2021	08.12.2024

6 Publications

S.No	2021	NAAS Rating
1.	Afroz S, Singh R, Nain MS, Mishra JR, Kumar P, Iquebal MA and Khan SA (2020). Problem Tree Analysis for Delay in Starting Agribusiness by Trained Candidates under ACABC Scheme. Indian Journal of Extension Education, **56(2)**, 22-27.	**5.59**
2.	Ahmad T, Rai A, Sahoo PM, Jha SN and Vishwakarma RK (2021). Sampling methodology for estimation of harvest and post-harvest losses of major crops and commodities. Journal of the Indian Society of Agricultural Statistics, **75(1)**, 37-46.	**N.A**
3.	Angadi UB, Rai A and Uma G (2021). MBFerns: classification and extraction of actionable knowledge using Multi-Branch Ferns-based Naive Bayesian classifier. Soft Computing (2021), **25(13)**, 8357-8369, DOI: 10.1007/s00500-021-05759-5	**9.64**
4.	Bana RS, Grover M, Kumar V, Jat GS, Kuri BR, Singh D, Kumar H and Bamboriya SD (2022). Multi-micronutrient foliar fertilization in eggplant under diverse fertility scenarios: Effects on productivity, nutrient biofortification and soil microbial activity. Scientia Horticulturae, **294**, 110781, DOI: 10.1016/j.scienta.2021.110781	**9.46**
5.	Banerjee M, Al-Eryani L, Srivastava S, Rai SN, Pan J, Kalbfleisch, TS and States JC (2021). Delineating the Effects of Passaging and Exposure in a Longitudinal Study of Arsenic-Induced Squamous Cell Carcinoma in a HaCaT Cell Line Model. *Toxicol Sciences.* 2021 Nov 3:kfab129, **185(2)**, 184-196, DOI: 10.1093/toxsci/kfab129. Epub ahead of print. PMID: 34730829	**10.85**

6.	Banerjee, M, Cardoso AF., Al-Eryani L, Pan J, Kalbfleisch TS, Srivastava S, Rai SN and States JC (2021). Dynamic alteration in miRNA and mRNA expression profiles at different stages of chronic arsenic exposure-induced carcinogenesis in a human cell culture model of skin cancer. Archives of Toxicology, **95(7)**, 2351-2365, DOI: 10.1007/s00204-021-03084-2	**11.15**
7.	Banerjee R, Jaggi S, Varghese E, Bhowmik A, Datta A and Varghese C (2021). Construction of saturated designs for mixture experiments. Bhartiya Krishi Anusandhan Patrika, **36(2),** 81-84.	**N.A**
8.	Barman S, Basak P and Chandra H (2020). Prediction of finite population total for geo- referenced data. . Journal of the Indian Society of Agricultural Statistics, **74(3)**, 195-200.	**N.A**
9.	Begam S, Jain R, Arora A and Marwaha S (2021). Particle Swarm Optimization based Multi-objective Optimization for crop Planning: A case study of Bundelkhand. The Journal of Indian Society of Agricultural Statistics, **75(1)**, 47-57.	**5.51**
10.	Bhardwaj DR, Tahiry H, Sharma P, Pala N, Kumar D, Kumar A and Bharti (2021). Influence of aspect and elevational gradient on vegetation pattern, tree characteristics and ecosystem carbon density in Northwestern Himalayas. Land, **10**, 1109.	**9.40**
11.	Bishnoi S, Singh S, Singh KN, Ray M, Dahiya S, Dubey SK, Singh A, Mishra P, Pattanaik B and Singh A (2021). Development and Standardization of Perception Scales for Farmers and Extensionists Regarding Impact of Climate Change on Nutrition. Journal of Community Mobilization and Sustainable Development, **16(1)**, 234-244.	**5.67**

12.	Biswakarma N, Pooniya V, Zhiipao RR, Kumar D, Verma AK, Shivay YS, Lama A, Choudhary AK, Meena C, Bana, RS, Pal M, Das, K, Sudhishri S, Jat RD. and Swarnalakshmi K (2021). Five years integrated crop management in direct seeded rice–zero till wheat rotation of north-western India: Effects on soil carbon dynamics, crop yields, water productivity and economic profitability. Agriculture, Ecosystems and Environment, **318**, 107492**,** DOI: 10.1016/j.agee.2021.107492	**11.57**
13.	Biswas A, Kumar R, Singh D and Basak P (2021). Calibration Estimator of Finite Population Mean using Auxiliary Information under Adaptive Cluster Sampling. Journal of the Indian Society of Agricultural Statistics, **75(1)**, 47–53.	**N.A**
14.	Chanda B, Bhowmik A, Jaggi S, Varghese E, Datta A, Varghese C, Saha ND, Bhatia A and Chakrabarti B (2021). Minimal Cost Multifactor Experiments for Agricultural Research Involving Hard-to-change Factors: Construction Methods and Analytical Procedure. Indian Journal of Agricultural Sciences. **91(7)**, 97-100. http://krishi.icar.gov.in/jspui/handle/123456789/62026	**6.37**
15.	Chandra H (2021). District-level estimates of poverty incidence for the state of West Bengal in India: application of small area estimation technique combining NSSO survey and census data. Journal of Quantitative Economics, **19**, 375–391. DOI: 10.1007/s40953-020-00226-8	**N.A**
16.	Chandra H, Aditya H, Gupta S, Guha S and Verma B (2020). Food and nutrition in Indo Gangetic Plain region -A disaggregate level analysis. Current Science, **119(11)**, 1783- 1788.	**7.10**

17.	Chiranjib S, Parsad R, Mishra DC and Rai A (2021). A Web Tool for Consensus Gene Regulatory Network Construction. Frontiers in Genetics: **2194**. http://krishi.icar.gov.in/jspui/handle/123456789/68518	**10.60**
18.	Choudhary P, Bhowmik A, Chakdar H, Khan MA, Selvaraj C, Singh SK, Murugan K, Kumar S and Saxena AK (2020). Understanding the biological role of PqqB in Pseudomonas stutzeri using molecular dynamics simulation approach. Journal of Biomolecular Structure & Dynamics, **40(9)**, 4237-4249, DOI: 10.1080/07391102.2020.1854860.*http://krishi.icar.gov.in/jspui/handle/123456789/47461*	**N.A**
19.	Das S and Rai SN (2021). Statistical Approach for Biologically Relevant Gene Selection from High-Throughput Gene Expression Data. Statistical Inference from High Dimensional Data, edited by Carlos Fernandez-Lozano. *MDPI*, 2021, 35 -57.	**N.A**
20.	Das S and Rai SN (2021). Statistical Approaches for Gene Set Analysis with Quantitative Trait Loci for Crop Gene Expression Studies. *Entropy* (Spl. Issue Statistical Inference from High Dimensional Data II), **23(8)**, 945, DOI: 10.3390/e23080945	**N.A**
21.	Das S and Rai SN (2021). Statistical methods for single-cell RNA-sequencing data analysis. MethodsX, **8**, 101580, DOI: 10.1016/j.mex.2021.101580	**N.A**
22.	Das, S. and Rai, S.N. (2021). SwarnSeq: An improved statistical approach for differential expression analysis of single-cell RNA-seq data. *Genomics*, **113(3)**, 1308-24. DOI: 10.1016/j.ygeno.2021.02.014http://krishi.icar.gov.in/jspui/handle/123456789/68628	**11.74**

23.	Das S, Das R, Sangwan S, Singh R and Aditya K (2021). Potassium solublizing micro organism technology-A boon to Sustainable Agriculture. Kerala Karshan, **9(2)**, e-journal.	**N.A**
24.	Das S, McClain CJ and Rai SN (2021). Fifteen Years of Gene Set Analysis for High- Throughput Genomic Data: A Review of Statistical Approaches and Future Challenges. Statistical Inference from High Dimensional Data, edited by Carlos Fernandez-Lozano, MDPI, 2021, pp. 149-171.	**N.A**
25.	Das S, Rai A, Merchant M, Cave M and Rai SN (2021). A Comprehensive Survey of Differential Expression Analysis Approaches in Single Cell RNA-sequencing Studies. Genes, **12(12)**, 1947, DOI:10.3390/genes12121947	**10.10**
26.	Das SK, Ghosh GK, Avasthe R, Kundu MC, Choudhury BU, Baruah K and Lama A (2021). Innovative biochar and organic manure co-composting technology for yield maximization in maize-black gram cropping system. Biomass Conversion and Biorefinery. DOI: 10.1007/s13399-021-01519-5	**10.99**
27.	Dasgupta U, Mishra GP, Dikshit HK, Mishra DC, Bosamia T, Roy AP, Aski M, Kumar RR, Singh, AK, Kumar, A, Sinha SK, Chaurasia S, Praveen S, Nair RM and Bhati J (2020). Comparative RNA-Seq analysis unfolds a complex regulatory network imparting yellow mosaic disease resistance in mungbean. PLoS ONE, **16(1)**, e0244593, DOI:10.1371/journal.pone.0244593.	**9.24**
28.	Datta A, Jaggi S, Varghese C, Varghese E, Harun M and Bhowmik A (2021). Mating Plans for Breeding Trials using Generalized Row-Column Designs. Indian Journal of Agricultural Sciences, **91(10)**, 1542-1545.	**6.37**
29.	Deb C and Marwaha S (2021). A Machine Learning Approach for the Non-destructive Estimation of Leaf Area in Medicinal Orchid Dendrobium nobile L., Scientia Horticulturae, **12**, 4770.	**9.46**

30.	Debnath S, Attri BL, Kumar A, Kishor A, Narayan R, Sinha K, Bhowmik A, Sharma A and Singh DB (2020). Influence of peach (PrunuspersicaBatsch) phenological stage on the short-term changes in oxidizable and labile pools of soil organic carbon and activities of carbon-cycle enzymes in the North-Western Himalayas. Pedosphere, **30(5)**, 638-650 http://krishi.icar.gov.in/jspui/handle/123456789/45248	**9.91**
31.	Deo MM, De D, Mani I and Iquebal MA (2021). Design and evaluation of vertical cup metering mechanism for urea briquette application. Indian Journal of Agricultural Sciences, **91(3)**, 359-363.	**6.37**
32.	Dev I, Singh R, Garg KK, Ram A, Singh D, Kumar N, Dhyani SK, Singh A, Anantha KH, Akuraju V, Dixit S, Tewari RK, Dwivedi RP and Arunachalam A (2022). Transforming livestock productivity through watershed interventions: A case study of Parasai-Sindh watershed in Bundelkhand region of Central India. *Agricultural Systems*, **196**, DOI: 10.1016/j.agsy.2021.103346.	**11.37**
33.	Dey S, Sinha K, Chand AK, Pandit P, Singh H and Sahu PK (2021) Measuring Price Transmission, Causality and Impulse Response: An Empirical Evidence from Major Potato Markets in India, *Journal of the Indian Society of Agricultural Statistics*, **75(1)**, 55- 62	**N.A**
34.	Dhami KS, Asrey R, Sharma RR, Sagar VR, Dash S and Dubey AK (2021) Pre- harvest methyl jasmonate spray maintains postharvest quality of Kinnow mandarin (Citrus reticulata) fruits. *Indian Journal of Agricultural Sciences*, **91(10)**, 1495–1499.	**6.37**
35.	Dutta A, Mandal A, Kundu A, Malik M, Chaudhary A, Khan MR, Shanmugam V, Rao U, Saha S, Patanjali N, Kumar R, Kumar A, Dash S, Singh PK and Singh A (2021). Deciphering the Behavioral Response of Meloidogyne incognita and Fusarium oxysporum towards Mustard Essential Oil, *Front. Plant Sci*, **12**, DOI: 10.3389/fpls.2021.714730	**11.75**
36.	Ekka U, Kumar A and Roy HS (2021). Particulate Matter Exposure of Combine Harvester Operator during Wheat Harvesting in northern India. *Indian Journal of Agricultural Sciences*.	**6.37**

37.	Farooqi MS, Kumar D, Mishra DC, Rai A and Singh NK (2021). A hybrid method for differentially expressed genes identification and ranking from RNA-Seq data. *International Journal of Bioinformatics Research and Applications*, **17(1)**, 38–52.	**N.A**
38.	Gautam A, Kumar M and Kumar R (2021). Treatment of periodontal disease using xanthan based chlorhexidine gel. *Bioinformation*, **17(2)**, 326-330.	**N.A**
39.	George JK, Shelvy S, Fayad AM, Angadi UB, Iquebal MA, Jaiswal S, Rai A and Kumar D (2021). De novo transcriptome sequencing assisted identification of terpene synthases from black pepper (Piper nigrum) berry. *Physiology and Molecular Biology of Plants* (2021), DOI: 10.1007/s12298-021-00986-4	**8.39**
40.	George JK, Shelvy S, Fayad M, Shabeer ATP, Umadevi P, Kale R, Angadi UB, Iquebal MA, Jaiswal S, Rai A and Kumar D (2021). In silico assisted identification of peppery aroma compound 'rotundone' backbone genes from black pepper. *Journal of Bimolecular Structure and Dynamics*, 1-7.	**N.A**
41.	Ghosh S, Das TK, Shivay YS, Bhatia A and Yeasin Md.et.al (2021). Conservation agriculture effects on weed dynamics and maize productivity in maize- wheat- greengram system in north-western Indo-Gangetic Plains of India. *Indian Journal of Weed Science*, **53(3)**, 244–251.	**5.84**
42.	Gogoi BB, Borgohain A, Konwar K, Handique JG, Paul RK, Khare P, Malakar H, Saikia J and Karak T (2021). National highway induced selected chemical properties of soils across tea bowl of India: scale and assessment. *International Journal of Environmental Science and Technology*. **53**, DOI: 10.1007/s13762-021-03789-y	**8.86**
43.	Gopinath PP, Parsad R, Joseph B and Adarsh VS (2021). grapesAgri1: Collection of Shiny Apps for Data Analysis in Agriculture. *Journal of Open Source Software*, **6(63)**, 3437. DOI: 10.21105/joss.03437 https://joss.theoj.org/papers /10.21105/joss.03437.	**N.A**

44.	Gora JS, Kumar R, Sharma BD, Ram C, Berwal MK, Singh D, Bana RS and Kumar P (2022). Performance evaluation of Fremont mandarin on different rootstocks under the hot arid environment of India. *South African Journal of Botany*, **144,** 124-133. DOI: 10.1016/j.sajb.2021.08.037	**8.32**
45.	Guha S and Chandra H (2021). Improved estimation of finite population mean in two- phase sampling with sub-sampling of the non-respondents. *Mathematical Population Studies*, **28(1)**, 24-44. http://krishi.icar.gov.in/jspui/handle/123456789/35413	**N.A**
46.	Guha, S and Chandra H (2021). Measuring and mapping disaggregate level disparities in food consumption and nutritional status via multivariate small area modelling. *Social Indicators Research*, **144**, 251–273. DOI: 10.1007/s11205-020-02573-8	**N.A**
47.	Guha S and Chandra H (2021). Measuring disaggregate level food insecurity via multivariate small area modelling: evidence from rural districts of Uttar Pradesh, India. *Food Security*, **13**, 597–615. http://krishi.icar.gov.in/jspui/handle/123456789/45080	**9.30**
48.	Gupta S, Kushwaha A, Singh A, Dikshit HK, Mishra GP, Aski M and Bhowmik A (2021). Nutritional profiling and antioxidant assessment of Indian and exotic accessions of lentil. *Indian Journal of Genetics and Plant Breeding*, **81(3)**, 440-449	**6.51**
49.	Gurung B, Sarkar KP, Singh KN and Lama A (2021). Modelling annual maximum temperature of India: A distributional approach. *Theoretical and Applied Climatology*, **145:** 979–988. *http://krishi.icar.gov.in/jspui/handle/123456789/64743*	**9.18**
50.	Haque MA, Marwaha S, Arora A, Paul RK, Hooda KS, Sharma A and Grover M (2021). Image-based identification of maydis leaf blight disease of maize (Zea mays) using deep learning. *Indian Journal of Agricultural Sciences*, **91(9)**, 1362–1367.	**6.37**

51.	Harun M, Varghese C, Jaggi S and Varghese E (2021). Resolvable mating- environmental designs for partial triallel cross experiments. *The Indian Journal of Genetics and Plant Breeding*, **81(1)**, 111-118. http://krishi.icar.gov.in/jspui/handle/123456789/46257	**6.51**
52.	Harun M, Varghese C, Jaggi S and Varghese E (2021). Robust designs involving partial triallel crosses for breeding experiments. *International Journal of Ecology and Environmental Sciences*, **3(1)**, 36-41. http://krishi.icar.gov.in/jspui/handle/123456789/45004	**4.76**
53.	Iquebal MA, Jaiswal S, Singh BP, Prabha R, Jasrotia RS, Angadi UB, Singh DP, Gupta V, Rai A and Kumar D (2021). Fungal genomic resources for strain identification and diversity analysis of 1900 fungal species. *Journal of Fungi*, **7(4),** 288. DOI: 10.3390/jof7040288	**11.82**
54.	Iquebal MA, Mishra P, Maurya R, Jaiswal S, Rai A and Kumar D (2021). Centenary of Soil and Air borne wheat Karnal bunt disease research: A Review. *MDPI Biology*, **10(11),** 1152. https://www.mdpi.com/2079-7737/10/11/1152	**N.A**
55.	Iquebal MA, Passari AK, Jaisri J, Ahmad F, Deka P, Jaiswal S, Rai A, Kumar D, Singh BP (2021). Microbiome of Pukzing Cave in India shows high antimicrobial activity against plant and animal pathogens. *Genomics*, **113(6)**, 4098-4108. https://www.sciencedirect.com/science /article /pii /S0888754321003670.	**1.74**
56.	Jaiswal S, Jaisri J, Kumari J, Iquebal MA, Nayan V, Angadi, UB, Kumar, S, Kumar, R, Datta TK, Rai A and Kumar D (2021). Genome wide prediction, mapping and development of genomic resources of Mastitis associated genes in Buffalo. *Frontiers in VeterinarySciences.*https://www.frontiersin.org/articles/10.3389/fvets.2021.593871/abstract.	**N.A**

57.	Jaiswal S, Samiran N, Iquebal MA, Jasrotia RS, Patra S, Mishra G, Udit UK, Sahu DK, Angadi UB, Meher PK, Routray P, Sundaray JK, Verma DK, Das P, Jayasankar P, Rai A and Kumar D (2021). Revelation of candidate genes and molecular mechanism of reproductive seasonality in carp fish (Labeo rohita Ham) by RNA sequencing. *BMC Genomics*, **22**, 685. (https://bmcgenomics.biomedcentral.com/articles/10.1186/s12864-021-08001-6#Sec2).	**11.74**
58.	Jin J, Wahlang B, Thapa M, Head KZ, Hardesty JE, Srivastava S, Merchant ML, Rai SN, Prough RA and Cave MC (2021). Proteomics and Metabolic Phenotyping Define Principal Roles for the Aryl Hydrocarbon Receptor in Mouse Liver, *Acta Pharmaceutica, Sinica B*, **11(12)**, 3806-3819. https://doi.org/10.1016/j.apsb.2021.10.014 [IF: 11.413]	**17.41**
59.	Karmakar S, Varghese C, Jaggi S and Mohd H (2021). Partially balanced t-designs. *Communications in Statistics - Simulation and Computation*. Volume, Issue Number and Page numbers missing, DOI:10.1080/03610918.2021.2008436	**7.12**
60.	Khode N, Singh BP, Chander M, Bardhan D, Verma MR and Paul AK (2020). Impact of dairy trainings on productivity of herd, generation of income and employment. *Indian Journal of Animal Sciences*, **90 (8)**, 1191–1194.	**6.32**
61.	Kohli V, Ramasubramanian V, Balange AK, Nayak BB and Kumar SH (2021). Distribution of *Vibrio Parahaemolyticus* in Farmed Shrimp *Penaeusvannamei*, Farm Water and Sediment, *Journal of Pure and Applied Microbiology*, **15(3)**, 1608-1616. DOI:10.22207/JPAM.15.3.57.	**5.05**
62.	Krishna DK, Kumbhare NV, Sharma JP, Rao DUM, Sharma DK and Bhowmik A (2020). Comparison of expectation and experience values of various agritourism aspects: a multi-stakeholders' analysis. *Journal of Community Mobilization and Sustainable Development*, **15(1)**, 201-206. http://krishi.icar.gov.in/jspui/handle/123456789/462633	**5.67**

63.	Krishna DK, Kumbhare NV, Sharma JP, Rao DUM, Sharma DK, Kumar P and Bhowmik A (2020). Impact of agritourism as perceived by multiple stakeholders. *International Journal of Current Microbiology and Applied Sciences*, **9(7)**, 2499-2508.	**N.A**
64.	Krishna DK, Kumbhare, NV, Sharma JP, Rao DUM, Sharma DK and Bhowmik A (2020). Status and growth prospects of agritourism: multi-stakeholder analysis. International Journal of Agriculture Sciences. **12(13)**, 10015-18. http://krishi.icar.gov.in/jspui/handle/123456789/46262	**4.58**
65.	Krishna DK, Kumbhare Sharma JP, Rao DUM, Sharma DK, Kumar P and Bhowmik A (2021). A Comparison of Impact of Agri-tourism as Perceived by Multiple Stakeholders in Maharashtra and Goa. *Indian Journal of Extension Education*. **57(3)**, 71- 76. http://krishi.icar.gov.in/jspui/handle/123456789/47442	**5.59**
66.	Krishnan M and Ramasubramanian V (2021). Financing and technology options for fish business startups in north east India, Seminar Proceedings on Agribusiness potential in north eastern region with special reference to Tripura , Ed. Lahiri, D., Burark, S.S. and Satyanarayana, T., National Seminar organized by ISAM at College of Fisheries, Tripura during September 08-09, 2021, pp 43-52. http://krishi.icar.gov.in/jspui/handle/123456789/73367	**N.A**
67.	Kumar A, Mishra DC, Angadi UB, Yadav R, Rai A and Kumar D (2021). Inhibition Potencies of Ph ytochemicals Derived from Sesame Against SARSCoV-2 Main Protease: A Molecular Docking and Simulation Study. *Front. Chem*, **9**, 744376, DOI: 10.3389/fchem.2021.744376	**11.22**
68.	Kumar KR, Dashora K, Krishnan N, Sanyal S, Chandra H, Dharmaraja S and Kumari, Vandita (2021). Feasibility assessment of renewable energy resources for tea plantation and industry in India - A review. *Renewable and Sustainable Energy Reviews*, **145**, Article 111083; https://doi.org/10.1016/j.rser.2021.111083 Impact Factor: 14.982	**20.00**

69.	Kumar P, Badal, PS, Jha GK, Paul RK, Venkatesh P, Kamalvanshi V, Balasubramanian M, Anbukkani P and Patel P (2021). Enabling Informed Resource Allocation Decision by Vegetable Growers of Varanasi, Uttar Pradesh: Price Forecasting using ARIMA. *Agricultural Situation in India*, **LXXVII (10)**, 16-24.	**4.53**
70.	Kumar P, Badal PS, Paul RK, Jha GK, Venkatesh P, Kamalvanshi V, Anbukani P, Balasubramanian M and Patel P (2021). Forecasting onion price for Varanasi market of Uttar Pradesh, India. *Indian Journal of Agricultural Sciences*, **91(2)**, 249–53	**6.37**
71.	Kumar P, Badal PS, Paul RK, Jha GK, Venkatesh P, Kingsly IT, Kamalvanshi V, Balasubramanian M and Anbukkani P (2020). Empowering farmers through future price information: A case study of price forecasting of Brinjal in eastern Uttar Pradesh. *Indian Journal of Economics and Development*, **16(4)**, 479-488.	**5.15**
72.	Kumar P, Malik R, Tikle AN, Budhlakoti N and Verma RPS (2021). Microsatellite markers based association mapping for yield contributing traits in exotic barley (Hordeum vulgare) accessions from ICARDA. *Indian J. Genet*, **81**, 3.	**N.A**
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74.	Kumar P, Nimbal S, Budhlakoti N, Singh V, and Sangwan RS (2021). Genetic diversity and population structure analysis for morphological traits in upland cotton (Gossypium hirsutum L.). *Journal of Applied Genetics*, **63(1)**, 87-101.	**9.24**

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76.	Kumar R, Kundu A, Dutta A, Saha S, Das A and Bhowmik A (2021). Chemoprofiling of bioactive metabolites from Chaetomium globosum for biocontrol of Sclerotinia rot and plant growth promotion. *Fungal Biology*, **125 (3)**, 167-176. *http://krishi.icar.gov.in/jspui/handle/123456789/47463*	**9.10**
77.	Kumar RR, Dubey K, Arora K, Dalal M, Rai GK, Mishra D, Chaturvedi KK, Rai A, Kumar SN, Singh B, Viswanathan C and Praveen S (2021). Characterizing the putative mitogen-activated protein kinase (MAPK) and their protective role in oxidative stress tolerance and carbon assimilation in wheat under terminal heat stress. *Biotechnology*	**N.A**
78.	Kumar RR, Goswami S, Rai GK, Jain N, Singh PK, Mishra D, Chaturvedi KK, Kumar S, Singh B, Singh GP, Rai A, Chinnusamy V and Praveen S (2021). Protection from Terminal Heat Stress: a Trade-Off between Heat-Responsive Transcription Factors (HSFs) and Stress-Associated Genes (SAGs) under Changing Environment. *Cereal*	**9.85**
79.	Kumar V, Jain P, Venkadesanm S, Karkute SG, Bhati J, Abdin MZ, Mithra SAV, Mishra D, Chaturvedi KK, Rai A, Sharma TR and Solanke AU (2021). Understanding rice-Magnaportheoryzae interaction in resistant and susceptible cultivars of rice under panicle blast infection using a time-course transcriptome analysis. *Genes*, **12(2),** 301, DOI:	**10.10**
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82.	Kundu A, Dutta A, Mandal A, Negi L, Malik M, Puramchatwad R, Antil J, Singh A, Rao U, Saha S, Kumar R, Patanjali N, Manna S, Kumar A, Dash S and Singh PK (2021). A Comprehensive in vitro and in silico analysis of nematicidal action of essential oils. Frontiers in Plant Science, **11**, 614143	**11.75**
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84.	Kushwaha B, Pandey M, Das P, Joshi CG, Nagpure NS, Kumar R, Kumar D, Agarwal S, Srivastava S, Singh M, Sahoo L, Jayasankar P, Meher PK, Shah TM, Hinsu AT, Patel N, Koringa PG, Das SP, Patnaik S, Bit A, Iquebal MA, Jaiswal S and Jena, J. (2020). The genome of walking catfish Clariasmagur (Hamilton, 1822) unveils the genetic basis that may have facilitated the development of environmental and terrestrial adaptation systems in air-breathing catfishes. *DNA Research*, **28(1)**, dsaa031, DOI: 10.1093/dnares/dsaa031	**10.46**
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139.	Shree S, Sharma RR, Rudra SG, Grover M, Singh D and Kumar R (2021). Edible coatings and plant extract influence decay and biochemical attributes of nectarines, *Journal of Agricultural Sciences*, **91(2)**, 240–243.	**6.37**
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141.	Singh DK, Pandey A, Choudhary SB, Kumar S, Tribhuvan KU, Mishra DC, Bhati J, Kumar M, Tomar JB, Bishnoi SK, Mallick MA, Bhadana VP, Sharma TR, Pattanayak A and Singh BK (2021). Development of genic-SSR markers and their application in revealing genetic diversity and population structure in an Eastern and North-Eastern Indian collection of Jack (Artocarpus heterophyllus Lam.) Ecological Indicators. 131, 108143, DOI: 10.1016/j.ecolind.2021.108143	**10.96**
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152.	Varghese C, Jaggi S, Varghese E, Mohd H, Kumar D (2021). Designs involving sequences of treatments with residuals proportional to direct effects. *Bharatiya Krishi Anusandhan Patrika*. https://www.arccjournals.com/journal/bhartiya-krishi-anusandhan-patrika/BKAP254	**N.A**
153.	Varghese E, Kumar J, Jaggi S, Varghese C and Bhowmik A (2020). A note on constructing small rotatable designs under first order response surface interference model. *Utilitas Mathematica*, **115**, 171-180.	**6.28**

7 Trainings Organized

SN	Title	Venue	Period	Number of applicants
1.	Software and Tools in Bioinformatics Course Directors: U.B.Angadi K.K. Chaturvedi	ICAR-IASRI, New Delhi (Online)	11.01.2021 To 13.01.2021	20
2.	Statistics and Informatics for Experimental Data Management and Analysis (sponsored by NAHEP-CAAST project of ICAR-IARI, New Delhi). Course Directors: Seema Jaggi, Sudeep Course Coordinators: Anindita Datta, Soumen Pal and Sanjeev Kumar	ICAR-IASRI, New Delhi (Online)	23.02.2021 To 04.03.2021	140 (Research scholars from different ICAR institutes, SAUs and CAUs)
3.	Recent Advances of Statistical Analysis in Agriculture (in collaboration with Assam Agriculture University). Course Directors: B.N. Mandal Sukanta Dash and Borsha Neog (Assam Agricultural University)	ICAR-IASRI, New Delhi	04.03.2021 To 12.03.2021	24 (Faculty from Assam Agricultural University, Jorhat)
4.	Statistics for Social Science Scholars of CIFE, Mumbai. Course Co Ordinators: Susheel Kumar Sarkar Ramasubramanian V. Upendra K. Pradhan	ICAR- ICAR-IASRI, New Delhi (online)	23.02.2021 To 22.03.2021	23 (M.F.Sc./ Ph.D. students)
5.	Designs of experiments and Next Generation Sequencing Data Analysis for Scientists from ICAR-National Institute of Biotic Stress Management, Raipur. Course Coordinators: ICAR-IASRI: Mir Asif Iquebal and BN Mandal ICAR-NIBSM: SK Jain	ICAR-IASRI, New Delhi (Online)	16.03.2021 To 17.03.2021	20
6.	Advanced Designs for Product and Process Development Oriented Experiments (in Collaboration with Division of Agricultural Chemicals, ICAR-IARI, New Delhi) Course Directors: ICAR-IASRI: Sukanta Dash, Anil Kumar; ICAR-IARI: Anupama Singh		16.03.2021 To 17.03.2021	97
7.	Next Generation Sequence Data Analysis" for Contractual staff such as RA/SRF/JRF/YPs working in research projects at NARES institutions Course Coordinators: Sanjeev Kumar, D.C. Mishra and K.K. Chaturvedi	ICAR-IASRI, New Delhi (Online)	22.03.2021 To 27.03.2021	176
8.	Modular Course on Basic Statistical Methods in Agriculture for Batch of M.Sc. (Agronomy) (Course Coordinators: Seema Jaggi, Rajender Parsad, Sukanta Dash and Arpan Bhowmik)	ICAR-IASRI, New Delhi (Online	April 05-17, 2021	04

8.	Modular Course on Basic Statistical Methods in Agriculture for Batch of M.Sc. (Agronomy) (Course Coordinators: Seema Jaggi, Rajender Parsad, Sukanta Dash and Arpan Bhowmik)	ICAR-IASRI, New Delhi (Online	April 05-17, 2021	04
9.	Hindi workshop " कृषि में सांख्यिकीय मॉडलिंग एवं पूर्वानुमानः Statistical modelling and Forecasting in Agriculture" (Coordinators:Wasi Alam, Prawin Arya and Kanchan Sinha)	ICAR-IASRI, New Delhi (Online	June 24-26, 2021	28
10.	Training Programme on Application of OMICS Tools and Techniques for Veterinary Sciences using NGS data (Course Advisors: Dinesh Kumar and Anil Rai; Course Coordinators: Sarika, Mir Asif Iquebal)	ICAR-IASRI, New Delhi (Online) in collaboration with DUVASU, Mathura	July 06-10, 2021	35
11.	Training Programme on E-Goverance Applications in ICAR (K.K. Chaturvedi and SB Lal)	ICAR-IASRI, New Delhi (Online)	September 06-10, 2021	59
12.	Online National Workshop on Data Management, Analysis and Interpretation (Course Directors: V.B. Singh and Sudeep, Course Coordinators: Shashi S Yadav, Ekta Joshi, Soumen Pal and Arpan Bhowmik	ICAR-IASRI, New Delhi (Online) in collaboration with RSVVV, Gwalior	September 06-10, 2021	250
13.	Applications of Bioinformatics Tools in Agricultural Research (Course Coordinators: IASRI - Mir Asif Iquebal and Sarika, UBKV: S. Mandal, N. Sahana, PM Bhattacharya, B. Roy and AK Chowdhury)	ICAR-IASRI, New Delhi (Online) in collaboration with UBKV, West bengal	September 20-30, 2021	248
14.	Training Programme on Transcriptomic Data Analysis (Course Coordinators: Samir Farooqi and Sudhir Srivastava)	ICAR-IASRI, New Delhi (Online)	September 28-30, 2021	118
15.	Hindi Workshop on "*परीक्षण अभिकल्पना के अनुप्रयोग*" (Coordinators: Anil Kumar and Susheel Kumar Sarkar)	ICAR-IASRI, New Delhi (Online)	September 28-30, 2021	18
16.	Statistical Techniques for Data	ICAR-IASRI,	October 04-13,	125

16.	Statistical Techniques for Data Analysis in Agriculture (Course Coordinators: Ajit,Ranjit Paul and Soumen Paul)	ICAR-IASRI, New Delhi	October 04-13, 2021	125
17.	Experimental Data Analysis (Coordinators: Cini Varghese, B.N. Mandal and Mohd. Harun)	ICAR-IASRI, New Delhi	October 20-29, 2021	16
18.	Molecular Structure Simulation and Modelling (Program Director: Anil Rai; Coordinator: Sunil Kumar and U.B. Angadi)	ICAR-IASRI, New Delhi	October 27-30, 2021	72
19.	Proteomics Data Analysis (Coordinator: K.K. Chaturvedi)	ICAR-IASRI, New Delhi	November 24-26, 2021	26
20.	SNP Mining, GWAS and Genomic Selection (Coordinator : D.C. Mishra)	ICAR-IASRI, New Delhi	December 16-21, 2021	101

Workshops/Webinars/Meetings/Celebrations etc. Organized

Workshops/Webinars

- Workshop-cum Training on Scrutiny of filled-in questionnaires and digitized data, data entry using Data Entry Software and Data Quality for the officials of Horticulture Department, Haryana State, under the project Technical Guidance in Implementation of Methodology for Estimation of Area and Production of Horticultural Crops developed by ICAR-IASRI under CHAMAN Project funded by Haryana State Government on January 18, 2021 (Tauqueer Ahmad, Prachi Misra Sahoo and Ankur Biswas)

- One day online Workshop-cum-Training Programme on Integrated Sample Survey (ISS) App developed for data collection for all the four commodities i.e. milk, meat, egg and wool to the officials of three states namely Karnataka, Jharkhand and Andhra Pradesh for the pilot survey under the project Integrated Sample Survey solutions for major livestock products funded by Animal Husbandry Statistics Division, Department of Animal Husbandry, Dairying & Fisheries, Ministry of Fisheries, Animal Husbandry & Dairying, Govt. of India on January 20, 2021 (Tauqueer Ahmad and Prachi Misra Sahoo)

- Workshop on Website content management using wordpress for AICRP on Plastic Engineering in Agriculture Structures and Environment Management under KRISHI Portal on January 28, 2021 (Rajender Parsad and Arpan Bhowmik)
- One day online training programme on E-Office on February 11, 2021 for the Scientists and Staff working at ICAR-CAFRI Jhansi and PME Cell of ICAR-IASRI. (K.K. Chaturvedi and S.B. Lal)

- Felicitation Function on February 12, 2021 for 22 degree recipients in the

disciplines of Agricultural Statistics Computer Application and Bioinformatics of 59th convocation of PG School, ICAR-IARI

- All India Training-Cum-Workshop on Web Portal and Android App for Integrated Sample Survey Scheme during February 18-19, 2021 for Master Trainers of Animal Husbandry Statistics Division, Department of Animal Husbandry, Dairying & Fisheries, Ministry of Fisheries, Animal Husbandry & Dairying, Govt. of India In this online training program, a hands-on training for web portal and data collection App providing end-to-end solution for major livestock products was provided

- Hindi Workshop on " सांख्यिकीय आनुवंशिकी और कृषि में इसके अनुप्रयोग " during March 18-20, 2021(Samarendra Das and Upendra Kumar Pradhan)

- Organized three one/half day online training sessions for AMS (Academic-Management-System) implementation at (i) KVASU, Wayanad (April 21, 2021; Participants: 65); (ii) TNAU, Coimbatore (April 22, 2021; Participants: 30) and (iii) SVVU, Tirupati & SKUAST, Jammu (April 26, 2021; Participants: 70)

- Organized four one/half day online training sessions on Agri-DIKSHA-The-Agri-Web-Education-Channel for Nodal-Officers, Master-Trainers and Faculty-Members of various Agricultural Universities on May 07, 14, 21 and 28, 2021. These sessions were attended by 500+ faculty members from more than 15 Agricultural Universities

- 04 Online Workshop-cum-Training Webinars were organized on ICAR Research Data Repository for Knowledge Management for (i) Scientists and Technical staff of ICAR-CIRCOT, Mumbai on July 15, 2021: Participants 36 (Coordinators: Himanshu Shekhar Chourasia, Senthil Kumar T. and Arpan Bhowmik; Speaker: Rajender Parsad); (ii) Scientists and Technical staff of ICAR-NBFGR, Lucknow on July 30, 2021: Participants 34. (Conveners: Ajey Pathak and Susheel Kumar Sarkar; Speaker: Anshu Dixit); (iii) Scientists of ICAR Research Complex for NEH Region, Umiam, Meghalaya on September 25, 2021: Participants 56 [Conveners: Debasis Chakraborty (ICAR Research Complex for NEH Region, Umiam, Meghalaya), Rajender Parsad, Anshu Bharadwaj and Arpan Bhowmik (ICAR-IASRI)] and (iv) ICAR-CIFRI on September 29, 2021: Participants 45 [Conveners: Malaya Naskar (ICAR-CIFRI) and Susheel Sarkar (ICAR-IASRI)]

8 LIST OF RESEARCH PROJECTS

1st January to 31st December, 2021

DEVELOPMENT AND ANALYSIS OF EXPERIMENTAL DESIGNS FOR AGRICULTURAL SYSTEMS RESEARCH

On-going

Institute Funded

Outside Funded

1. Planning, designing and analysis of experiments planned on stations under All India Coordinated Research Project on Integrated Farming Systems. Funded by AICRP on IFS, IIFSR, Modipuram.AGEDIASRISOL201701900105 Anil Kumar, Md. Harun (till 11.09.2018 rejoin 12.03. 2020), Susheel Kumar Sarkar and Eldho Varghese (upto 22.07. 2017), Sunil Kumar Yadav (since 20.11.2021):01.04.2017-31.03.2022

2. Planning, designing and analysis of data relating to experiments for AICRP on Long Term Fertilizer Experiments. Funded by AICRP on Long Term Fertilizer Experiments, IISS, Bhopal. AGEDIASRISOL201702100107 B.N. Mandal, Aninditta Datta, Sunil Kumar Yadav: 01.04.2017-31.03.2022

3. Designing and Analysis of ON FARM Research Experiments Planned under AICRP on IFS. Funded by AICRP on IFS, IIFSR, Modipuram. AGEDIASRISOL201702000106 Cini Varghese, Sukanta Dash, Arpan Bhowmik: 01.04.2017-31.03.2022 ICAR Research Data Repository for Knowledge Management as KRISHI: Knowledge based Resources Information System Hub for Innovations in Agriculture. Funded by ICAR Headquarter Plan Scheme. AGENIASRICOL201503100068

4. ICAR-IASRI: Rajender Parsad, A.K. Choubey (till 20.01.2018), Mukesh Kumar, Anil Kumar, Anshu Bharadwaj, Susheel Sarkar, Arpan Bhowmik, Raju Kumar (till 04.06.2017: on study leave), Vandita Kumari Choudhary (till August 2016) 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: Himanshu (till 06.08.2019), S.K. singh (since 07.08.2019), 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), A.V.M. Subba Rao (Since 17.12.2017), Shantanu Kumar Bal (since 21.12.2018): 24.07.2015-31.03.2022

5. Application of Next-Generation Breeding, Genotyping, and Digitalization Approaches for Improving the Genetic Gain in Indian Staple Crops. Funded by ICAR and Bill and Melinda Gates Foundation (BMGF). 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: Shusheel Kumar Sarkar

ICRISAT: Abhishek Rathore: 22.01.2019-21.01.2023

Completed

Institute Funded

Outside Funded

6. Plant source based environmentally safe crop protection and production technologies: Development and capacity building" under the Niche Area of Excellence (NAE) Programme of ICAR at IARI, New Delhi AGEDIASRICOP201900600152 Development and capacity building" under the Niche Area of Excellence (NAE) Programme of ICAR at IARI, New Delhi AGEDIASRICOP201900600152 ICAR-IARI: Anupama Singh, Rajesh Kumar, Supradip Saha ICAR-IASRI: Sukanta Dash, Anil Kumar: 07.02.2019 (Association of ICAR-IASRI w.e.f. 27.03.2019) -31.12.2021

New Initiated

Institute Funded

7. Efficient Designs for Order-of-Addition Experiments.AGEDIASRISIL202100800179 BN Mandal, Sukanta Dash, Rajender Parsad: 09.09.2021-08.06.2024

8. Efficient designs for double cross experiments under fixed/mixed effects model. AGEDIASRICIL202101300184 ICAR-IASRI: Md. Harun, Cini Varghese: 11.11.2021-10.11.2024

ICAR-DPR: L. Leslie Leo,

ICAR- IARI: Mallikarjuna M.G

Outside Funded

9. Biomass and Carbon Mapping Across Altitudinal Gradient of Major Darjeeling and Sikkim Himalayan Land Uses: Implications for Carbon Sink Management and Mitigation. (DST) AGEDIASRICOP202100400175

   UBKV: Sumit Chakravarty, Gopal Shukla and Ganesh Banik

   ICAR-IASRI: Arpan Bhowmik, Ankur Biswas: 10.02.2021-09.02.2024

10. Sustainable Biochar Production and Use through Rice-Cotton based Agro-forestry System in Odisha: A Climate Resilient Soil Management Approach. (in Collaboration with World Agroforestry Centre). Funded by External AGEDIASRICOP202100700178 CRAF: Javed Rizvi, Shiv K. Dhyani, Aqeel Hasan Rizvi, Archna Singh ICAR-IISS: Brij Lal Lakaria, Promod Jha, A K Biswas, ICAR-IASRI: BN Mandal, Ajit, Rajender Parsad: 25.08.2021-31.05.2023

11. Diversified Farming through Livestock and Agriculture under Farmer Farm, Innovations, Resources, Science and Technology programme (ICAR-CIRB Farmer First). Funded by Farmer First programme, ICAR. AGEDIASRICOP202101500186 ICAR-CIRB: Sarita Yadav, Ashok K. Boora, PC Lailer, Sajjan Singh, Bharat Singh ICAR-IARI: Manjeet Singh ICAR-IASRI: Anil Kumar, Sukanta Dash: 25.11.2021-Continuing

FORECASTING, MODELLING AND SIMULATION TECHNIQUES IN BIOLOGICAL AND ECONOMIC PHENOMENA

On-going

Institute Funded

12. Enhanced Classification and Regression Tree (CART) models for forecasting in Agriculture.AGEDIASRISIL201900700153

Ramasubramanian V., Mrinmoy Ray, Md. Wasi Alam: 31.03.2019-15.02.2022

Outside Funded

13. Modeling insect pests and diseases under climate change and development of digital tools for pest management National Innovations in Climate Resilient Agriculture (NICRA). Funded by ICAR. AGEDIASRICOP201701500101 ICAR-NCIPM: S. Vennila, M.N. Bhat, Niranjan Singh ICAR-CRIDA: M. Prabhakar, M.S. Rao ICAR-IASRI: Ranjit Kumar Paul: 20.06.2017-31.03.2022

14. Creation of Policy and Strategy Cell (PSC) at ICAR-NIAP for 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: Raka Saxena, Naveen P. Singh, Usha R. Ahuja ICAR-IASRI: Ranjit Kumar Paul: 31.03.2017-31.03.2022

15. Forecasting Agricultural output using Space Agrometeorology and Land based observations (FASAL). Funded by IMD, New Delhi. AGENIASRICOP201600700076 IMD: K.K. Singh, ICAR-IASRI: K.N. Singh, Bishal Gurung (on Deputation 20.07.2018 till 10.08.2021), Achal Lama: 13.04.2016-31.03.2022

Completed

Institute Funded

17. Parameter estimation of time series models using Bayesian technique. AGEDIASRISIL201702200108

18. Achal Lama, Bishal Gurung, Santosha Rathod (till 13 June 2018): 01.11.2017-30.03.2021 Crop diversification: Pattern, determinants and its impact on nutritional security in India AGEDIASRISIL201802800137 Anuja AR (till 25.01.2021), Rajesh T., Harish H.V., Mrinmoy Ray: 05.09.2018-01.10.2021

19. Modelling dynamics of institutional credit to agriculture in India. AGEDIASRISIL201900400150 Harish Kumar H.V., Shivaswamy G.P. (till 01.10.2021), Anuja A.R. (till 25.01.2021), Achal Lama: 02.02.2019-28.12.2021

20. Role of research and development in Indian agriculture: An economic analysis. AGEDIASRISIL201802500134 Rajesh T., Shivaswamy G.P., Anuja A.R. (till 25.01.2021), Ravindra Singh (till 07.11.2020): 03.07.2018-01.10.2021

21. Prospects of irrigation in India: Trends, determinants and impact on agricultural productivity.AGEDIASRISIL201802600135 Shivaswamy G.P., Rajesh T., Anuja A.R. ((till 25.01.2021)), Harish Kumar H.V., Achal Lama: 19.07.2018-01.10.2021

Outside Funded

1. ICT based extension strategies for nutrition sensitive agriculture in the states of UP and Odisha. Funded by NASF. AGEDIASRICOP201803600145 ICAR-IARI: Premlata (Lead Centre) ICAR-ATARI Zone-IV, Kanpur: Shantanu Dubey Directorate of Extension Education OUAT, Bhubaneswar: P.J. Mishra

ICAR-IASRI: K.N. Singh, Shashi Dahiya, Mrinmoy Ray: 01.11.2018-31.10.2021

2. Studying Dynamics of market integration and price transmission of agricultural commodities. Funded by ICAR. AGENIASRISOL201801600125 Ranjit Kumar Paul: 02.04.2018-31.03.2021

New Initiated

Institute Funded

24. Development of Spatio-Temporal Neural Network Models for forecasting Space-time data. AGEDIASRISIL202102000191 Mrinmoy Ray, KN Singh, Kanchan Sinha, Rajeev Ranjan Kumar: 21.12.2021-20.06.2024

25. Forecasting onion prices using deep learning techniques. AGEDIASRISIL202100300174 Kanchan Sinha, KN Singh, Mrinmoy Ray, Harish Kumar HV: 20.02.2021-20.11.2022

DEVELOPMENT OF TECHNIQUES FOR PLANNING AND EXECUTION OF SURVEYS AND STATISTICAL APPLICATIONS OF GIS AND REMOTE SENSING IN AGRICULTURAL SYSTEMS

On-going

Institute Funded

26. Detection of outliers in presence of masking and imputation of data when auxiliary variable are available in sample surveys. AGEDIASRISIL201901100157 Raju Kumar, Ankur Biswas, Lal Mohan Bhar, Deepak Singh: 23.07.2019-22.01.2022

27. Estimation of Finite Population Proportion from Geo-Referenced Survey Data. AGEDIASRISIL202000800167 Vandita Kumari (transferred as on 16.10.2021), Ankur Biswas (since 17.10. 2021), Pradip Basak (resigned), Hukum Chandra (expired as on 26.04.2021), Kaustava Aditya, Rahul Banerjee (since 23.11.2021), Deepak Singh (since 23.11. 2021) :02.10.2020-01.10.2022

28. A Study on Domain Calibration Estimators under Two Stage Sampling Design. AGEDIASRISIL202100100172 Kaustava Aditya, Vandita Kumari (transferred as on 16.10.2021), Hukum Chandra (expired as on 26.04.2021), Pankaj Das (expired as on 26.04.2021), Raju Kumar (since 23.11.2021): 18.01.2021-17.07.2023

Outside Funded

29. Feasibility study for developing renewable energy system for tea plantation in Assam. Under research collaboration between ICAR and IITD (Extramural Fund). AGEDIASRICOP202000100160 Centre for rural Development and Technology, IIT, Delhi: Prof. Kavya Dashora ICAR-IASRI: Hukum Chandra (expired as on 26.04.2021), Kaustav Aditya (since 27.04.2021), Pradeep Basak, Vandita Kumari (transferred), Raju Kumar (since 23.11.2021), Deepak Singh (since 23.11.2021): 01.02.2020-31.01.2022

30. Energy Audit Survey of AICRP on Energy in Agriculture & Agro-based Industries: Sampling Design and Analysis. Funded by ICAR-All India Coordinated Research Project on Energy in Agriculture & Agro-based Industries (ICAR-AICRP on EAAI). AGEDIASRICOP201802000129 ICAR-CIAE: K.C. Pandey ICAR-IASRI: Hukum Chandra (expired as on 26.04.2021), Kaustav Aditya (since 27.04.2021) Susheel Kumar (expired), Pradeep Basak (Transferred), Ajit, Bharti (since 23.11.2021): 01.06.2018-31.05.2021

31. 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 Misra Sahoo, Tauqueer Ahmad, Ankur Biswas, Pradip Basak (transferred), Anil Rai, S.B. Lal:28.03.2019-31.01.2023

New Initiated

Outside Funded

32. AICRP on Honey bees and Pollinators. (AICRP on Honey bees and Pollinators. AGEDIASRICOP202100600177

DEVELOPMENT OF STATISTICAL TECHNIQUES FOR GENETICS/ COMPUTATIONAL BIOLOGY ANDAPPLICATIONS OF BIOINFORMATICS IN AGRICULTURAL RESEARCH

On-going

Institute Funded

33. Machine Learning Approach for Binning of Metagenomics Data AGEDIASRISIL201901200158 Anu Sharma S.B. Lal, Sanjeev Kumar, D.C. Mishra: 24.07.2019-23.01.2022

34. Modelling and forecasting for time-to-event analysis in Agriculture. AGEDIASRISIL202000500164 ICAR-IASRI: Himadri Ghosh, AK Paul ICAR-NBPGR: Sherry Jacob Rachel: 22.06.2020-21.03.2023

35. Development of statistical and computational approach for preprocessing and analysis high-throughput proteomics data with missing values. AGEDIASRISIL202000200161 Sudhir Srivastava, DC Mishra, UB Angadi, KK Chaturvedi13.03.2020-12.09.2022

Outside Funded

36. Molecular characterization, development of molecular markers and metabolite analysis of tree bean (Parkia roxburghii) landraces of North-East India. [BT/PR24912/NER/95/904/2017]. Funded by DBT.AGEDIASRICOP201803100140 ICAR-IASRI: Mir Asif Iquebal, Sarika Uttar Banga Krishi Viswavidyalaya: Somnath Mandal, Nandita Sahana ICAR Research Complex for North East Hill Region, Mizoram: Ratankumar Akoijam, Vishambhar Dayal: 15.03.2019-14.03.2022

37. Computational and analytical solutions for high-throughput biological data. Funded by ICAR Consortium Research Platform on Genomics. (CRP-Genomics) AGENIASRISOL201502400061 ICAR-NBFGR: Vindhya Mohindra, ICAR-IASRI: Anil Rai, Dinesh Kumar, A.R. Rao, Monendra Grover, K.K. Chaturvedi, Sanjeev Kumar, Dwijesh Chandra Mishra: 04.09.2015-30.09.2021

38. Genome wide association study in Indigenous poultry breeds/varieties AGEDIASRICOP202001000169 ILRI: Hanotte Olivier, Dessie Tadelle, ICAR-Directorate of Poultry Research, Hyderabad: T.K. Bhattacharya, ICAR-DPR: R.N. Chatterjee, S.P. Yadav, Chandan Paswan ICAR-IASRI: Anil Rai, D. C. Mishra: 21.05.2020-31.03.2022

39. 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) AGEDIASRICOP202000300162 ICAR-IARI, Director: Ashok Kumar ICAR-IASRI: Sarika, Dinesh Kumar, MA Iquebal: 01.05.2020-30.04.2025

40. Genomics assisted crop improvement and management.AGEDIASRICOP201803200141 ICAR-IARI: Viswanathan Chinnusamy

ICAR-IASRI: Sanjeev Kumar, Sudeep, Seema Jaggi, Anindita Datta, Soumen Pal, Sanjeev Kumar: 26.09.2018-31.03.2023

41. Germplasm Characterization and Trait Discovery in Wheat using Genomics Approaches and its Integration for Improving Climate Resilience, Productivity and Nutritional Quality. (DBT) AGEDIASRICOP202000400163 ICAR-NBPGR, Director: Kuldeep Singh ICAR-IASRI: Dinesh Kumar (deputation), UB Angadi, DC Mishra, Neeraj Budhlakoti, Sarika, MA Iquebal: 01.04.2020-31.03.2025

42. Mainstreaming sesame germplasm for productivity enhancement and sustainability through genomics assisted core development and trait discovery. Funded by DBT. AGEDIASRICOP202100200169 ICAR-NBPGR: Kuldeep Singh, Rashmi Yadav & Ashok Kumar, ICAR-IASRI: UB Angadi, Dinesh Kumar (deputation), DC Mishra: 01.03.2020-28.02.2025

43. Molecular Markers for Improving Reproduction of Cattle and Buffaloes. Funded by Bill & Melinda Gates Foundation. USA. AGEDIASRICOP201803000139 ICAR-NDRI: T.K. Datta ICAR-CIRB: Varij Nayan ICAR-IASRI: Dinesh Kumar (deputation),M.A. Iquebal, Sarika, U.B. Angadi, Anil Rai:19.09.2018-30.09.2023

44. Identification and functional characterization of the key resistance/susceptible determinants for Sclerotinia stem rot disease in oilseed Brassica. (DST) AGEDIASRICOP202001100170

    ICAR-NIPB: Navin Chandra Gupta, Mahesh Rao, Ramcharan Bhattacharya

    ICAR-IASRI: Dwijesh Chandra Mishra: 30.12.2020-30.12.2023

45. Explicating genomic insights of Indigenous equines breed population through “Computational Genomics” and “Artificial Intelligence” based approaches. Funded by Inter-Institutional in collaboration with NRCE, Hisar AGEDIASRICIP202000600165 ICAR-NRCE, Hissar: Anuradha Bhardwaj, Yash Pal ICAR-IASRI: Sarika, MA Iquebal, Dinesh Kumar: 17.08.2020-30.11.2022

46. Characterization, evaluation, genetic enhancement and generation of genomic resources for accelerated utilization and improvement of minor pulses. Funded by DBT. AGEDIASRICOP201803500144 Institute of Life Sciences: Ajay Kumar Parida ICAR-NBPGR: Kuldeep Singh ICAR-IASRI: Sanjeev Kumar, Anu Sharma: 24.10.2018-23.10.2022

47. Network Project on Agricultural Bioinformatics and Computational Biology. Funded by Cabin scheme AGEDIASRISOL202000900168 Anil Rai, Dinesh Kumar, Monendra Grover, U.B.Angadi, Sunil Kumar, K.K.Chaturvedi, S.B.Lal, Anu Sharma, Sarika, M.A.Iqueabal, Samir Farooqui, Sanjeev Kumar, D.C.Mishra, Sudhir Srivastava, Neeraj Budhlakoti, Sarika Sahu: 12.07.2020-31.03.2025

48. Improving seed health and storage system. Funded by IISS Kusmaur, Mau. AGEDIASRICOP202200200195 ICAR-IISS: Arvind Nath Singh ICAR-IASRI: Sunil Kumar:25.01.2022-31.03.2026

49. Development of artificial intelligent based computational tools for genomic data analysis in domestic animal species. Funded by LBS outstanding young scientist scheme. AGEDIASRISOL202101400185 MA Iquebal:12.11.2021-11.11.2024

50. Kisan Sarathi (Powered by IIDS): System of Agriinformation Resources Auto-transmission and Technology Hub Interfac.AGEDIASRICOP202100900180 Sanjeev Kumar, K.K. Chaturvedi, S.B. Lal, Mukesh Kumar: 09.08.2021-31.03.2026

Completed

Institute Funded

51. Study on robust estimation of heritability. AGEDIASRISIL201801300122 Amrit Kumar Paul, Himadri Shekhar Roy, L.M. Bhar, Ranjit Kumar Paul:22.03.2018-13.09.2021

52. Estimation of breeding value using generalized estimating equation and Bayesian approach. AGEDIASRISIL201800100110 Himadri Shekhar Roy (since 07.02.2018),L.M. Bhar and Amrit Kumar Paul07.02.2018-04.09.2021

53. A study on detection and interpretation of expression quantitative trait loci (eQTL) mapping. AGEDIASRISIL201800200111 Himadri Shekhar Roy,L.M. Bhar, Ranjit Kumar Paul and Amrit Kumar Paul03.02.2018-04.09.2021

54. Development of web based system for phenotype and genotype analysis for cattle breeding management AGEDIASRICIP201801100120 ICAR-CIRC: Umesh Singh, Sushil Kumar, A.K. Das, T.V. Raja, Rani Alex ICAR-IASRI: U. B. Angadi, M.A. Iquebal, Sarika, Dinesh Kumar:12.03.2018-31.03.2021

55. Development of methodology for trait specific genes identification AGEDIASRISIL201900300149 M.S. Farooqui, D.C. Mishra, K.K. Chaturvedi, Sudhir Srivastava (since 28.02.2020): 02.02-2019-24.09.2021

Outside Funded

56. Improving the usability of buffalo spermatozoa by sperm surface remodelling and immune acceptance in female reproductive tract. Funded by NASF. AGEDIASRICOP201802700136 ICAR-NDRI: T.K. Datta, Rakesh Kumar, S.M. Deb, T.K. Mohanty, J.K. Kaushik ICAR-IASRI: Sarika, Dinesh Kumar, M.A. Iquebal: 12.07.2018-11.07.2021

57. ICAR- Network Project on Functional Genomics and Genetic Modification (Earlier: ICAR-Network project of transgenics in crops (NPTC). Funded by ICAR-NRCPB-Sub-Scheme. AGENIASRICOP201500400041 ICAR-NRCPB: N.K. Singh, ICAR-IASRI: M.A. Iquebal, Sarika, Dinesh Kumar, Anil Rai: 27.01.2015-30.06.2021

58. Genome and transcriptome sequencing of coriander (Coriandrumsativum) to reveal insight of its genomic architecture and breeding targets. Funded by External. AGEDIASRICOP201801200121 JAU, Junagadh: R.S. Tomar, M. V. Parakhia, Shradda B. Bhatt **ICAR-IASRI:** M.A. Iquebal, Sarika: 14.03.2018-31.03.2021

59. Statistical approaches for genome-wide association studies and genomic selection for multiple traits in structured plant and animal population. Funded by DST. AGEDIASRISOL2018011400123 L.M. Bhar (expired), P.K. Meher (since 04.05.2018), Himadri Shekhar Roy (since 04.05.2018) :16.03.2018-15.03.2021

New Initiated

Institute Funded

60. Assessing genetic variability in duck of Eastern states. AGEDIASRICIP202100300173 ICAR-RCER: Shanker Dayal, Rajni Kumari P.K. Ray, Reena Kamal

ICAR-IASRI: Ratna Prabha: 01.08.2018 (Association of IASRI 08.02.2021)-31.08.2022

61. Development of Artificial Intelligence Framework for Prediction of Protein 3D Structure. AGEDIASRISIL202100500176 UB Angadi, KK Chaturvedi, Sudhir Srivastava: 16.03.2021-15.03.2024

62. Potential irrigated area mapping through remotely sensed high resolution data. AGEDIASRICIP202102100192

64. Development of Machine learning models and Bayesian network for discovery of Nucleic acid-binding protein and their application in disease/pest surveillance AGEDIASRISIL202101700188 Md. Yeasin, Ranjit Kumar Paul: 25.11.2021-24.04.2024

64. 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, Prabina Kumar Meher: 25.11.2021-24.05.2024

65. Statistical Approaches for Analysis of Zero-inflated and Over-dispersed Counts Data and their application in single cell studies. AGEDIASRISIL202101800189 Samarendra Das, Upendra Kumar Pradhan, Sudhir Srivastava, Prakash Kumar: 25.11.2021-24.05.2024

Outside Funded

66. Establishment of Centre for Bioinformatics and Computational Biology in Agriculture-BIC at ICAR-IASRI. DBT. AGEDIASRISOL202102200193 Anil Rai, Sunil Kumar, KK Chaturvedi, Sanjeev Kumar, MA Iquebal, Sarika, Anu Sharma, Dinesh Kumar, Monendra Grover, DC Mishra, Samir Farooqi. UB Angadi, Sudhir Srivastava, Neeraj Budhlakoti: 16.12.2021-14.11.2026

67. Network program on Precision Agriculture (NePPA) at ICAR-IARI New Delhi. 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

DEVELOPMENT OF INFORMATICS IN AGRICULTURAL RESEARCH

On-going

Institute Funded

Outside Funded

68. Knowledge management system for agriculture extension services in Indian NARES. Funded by ICAR Extra Mural Research Projects-Agricultural Extension Division. AGENIASRICOL201600500074 ICAR-IASRI: Alka Arora,A.K. Choubey (till 20.01.2018), Sudeep, N.S. Rao (till 24.09.2016), S.N. Islam, Soumen Pal, Ajit, Sanchita Naha (since 17.03.2021) ICAR: P. Adhiguru: 04.03.2016-31.03.2022

69. 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, Ranjit Paul: 01.04.2020-31.03.2025

70. Management and Impact Assessment of Farmer FIRST Project. Funded by ICAR Farmer FIRST Programme under KVK Scheme (ATARI-I). AGENIASRICOP201700200088 ICAR-NIAP: Shiv Kumar, ICAR-IASRI: Mukesh Kumar, Anshu Bhardwaj, Soumen Pal14.02.201731.03.2022

71. Investments in Indian Council of Agricultural Research leadership on Agricultural Higher Education under the National Agricultural Higher Education Project (NAHEP). AGEDIASRISOL201900500151 ICAR-IASRI: Sudeep, Alka Arora, Anshu Bhardwaj, Mukesh Kumar, Shashi Dahiya, Pal Singh, S.N. Islam, Soumen Pal, Ajit, V. Ramasubramaniun, Mrinmoy, Achal Lama, Arpan Bhowmik (since 13.12.2019) ICAR-NAARM: S.K. Soam, D. Thammi Raju, N. Srinivasa Rao, Alok Kumar, V.V. Sumanth kumar, Sanjiv Kumar, Surya Rathore, ICAR-NIAP: Rajini Jain: 28.02.2019-30.11.2022

72. Artificial intelligence based mobile app for identification and advisory of maize diseases and insect pests. Funded by NASF ICAR Hq. AGEDIASRISOL201901000156 ICAR-IASRI: Sudeep, Alka Arora, Mukesh Kumar, SN Islam

73. Resilient Agricultural Education System (RAES) AGEDIASRISOL202101000181 Sudeep, Alka Arora, Anshu Bharadwaj, Ajit, V. Ramasubramanian, Shashi Dahiya, S. N. Islam, Soumen Pal Sanchita Naha, Madhu, Samarth Godra: 15.03.2021-31.12.2022

Completed

Institute Funded

74. Implementation of ICAR-ERP, unified communication and web hosting solution. AGENIASRISIL201500600043 A.K. Choubey (till 21.01.2018), Sudeep (since 22.01.2018), Alka Arora (on leave from 04.07.2016 to 22.03.2017 rejoins on 23.03.2017), N. Srini vasa Rao Transferred to NAARM from September 24, 2016), Mukesh Kumar, S.N. Islam, Anshu Bhardwaj, Sangeeta Ahuja, Shashi Dahiya (from 05.08.2017) :10.04.2015-31.03.2021

75. Development and assessment of educational mobile apps for improving livestock health and production. AGEDIASRICIP201701700103 ICAR-IVRI: Rupasi Tiwari, Triveni Dutt, Mahesh Chander, Sanjay Kumar, Amarpal, Putan Singh, J.K. Prasad, Bina Mishra, B.H.M. Patel, Bablu Kumar, Mahendran ICAR-IASRI: Sudeep, Mukesh Kumar, Soumen Pal: 28.06.2017-31.03.2021

76. National Information System on Agricultural Education Network in India (NISAGENET-IV) SIX1217 R.C. Goyal (till 30.06.2013), Sudeep (since 01.07.2013), Alka Arora, Pal Singh, Shashi Dahiya (on study leave from 3rd July, 2014 to 2nd July, 2017. Rejoins the project as associate from 25th October, 2017), Soumen Pal (till 30.09.2012), Anshu Bhardwaj (since 01.10.2014): 01.04.2012-31.03.2021

77. Management system for post graduate education –II. SIX1218 Sudeep, P.K. Malhotra (till September 2014), R.C. Goyal (till 30.06.2013), Yogesh Gautam (till July 2014), Pal Singh (since 01.10.2013): 01.04.2012-31.03.2021

78. Training Management Information System for ICAR (TMIS).AGEDIASRISIL201801900128 Shashi Dahiya, Sudeep, Sangeeta Ahuja: 01.05.2018-08.04.2021

New Initiated

Institute Funded

79. 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: JPS Dabas: 09.12.2021-08.12.2024