# ANNUAL REPORT
# 2023-24


भाकृअनुप – राष्ट्रीय कृषि आर्थिकी एवं नीति अनुसंधान संस्थान

**ICAR - National Institute of Agricultural Economics and Policy Research**

(Indian Council of Agricultural Research)

New Delhi 110 012

# Annual Report
# 2023-24

भाकृअनुप – राष्ट्रीय कृषि आर्थिकी एवं नीति अनुसंधान संस्थान

**ICAR - National Institute of Agricultural Economics and Policy Research**

(Indian Council of Agricultural Research)

New Delhi 110 012

ICAR-NIAP Annual Report 2023-24


***Editorial Team***
Dr. Khem Chand
Dr. Jaya Jumrani
Dr. Arathy Ashok
Dr. Vikas Kumar
Dr. Anil Kumar

***Technical Assistance***
Ms. Sonia Chauhan

***Published***

July 2024

***Published by***
Dr. Pratap Singh Birthal
Director
ICAR-NIAP, New Delhi- 110 012

***Printed at***

Chandu Press, 469, Patparganj Industrial Estate, Delhi 110 092
Phone No.: 011-42448841, 09810519841

# Preface

India's agricultural sector is at a crucial stage, facing a dual challenge of producing more, nutritious and healthy foods to meet the growing demand of burgeoning population from the limited resources amidst the increasing threat of climate change. By 2047, the centenary year of its independence, India is envisioned to enter the league of developed countries, and its food demand is expected to be more than double the current demand. Agriculture has, therefore, to traverse a path marked by quantitative and qualitative degradation of land and water resources, loss of biodiversity, and shifting patterns of climate.

Historically, policies have played a crucial role in transforming Indian agriculture. The success of the Green Revolution in turning India from a food deficit to a food surplus country is a testament to the impact that policies can have. The challenges, however, are now different. There is little scope for the extensification of agriculture, and its intensification will be constrained by the growing scarcity of water and energy. Notably, the current incentive structure for agriculture, including input subsidies and minimum price support, has continued for a long time and has become unsupportive of long-term sustainability of agriculture because of its negative externalities to natural resources and the environment.

The policies, therefore, need to be recalibrated to foster innovations for efficient, sustainable, and inclusive growth of agriculture. These also include agricultural research and extension. Right from its birth in 1991, this Institute, through its creditable research, has endeavoured to provide evidence-based feedback to policymakers and research administrators to help them devise appropriate strategies that can create an impact at scale. In 2023-24, the research focused on mapping agricultural sustainability on ecological, social, and economic interface, valuation of ecosystem services of the green technologies and practices for repurposing input subsidies, harnessing complementariness along the water-energy nexus, fertilizer use efficiency for soil health, commodity forecasts, outreach and effectiveness of price policy, food inflation, domestic and global supply chains, and institutional innovations in service delivery system. A recent study at this Institute has shown significant payoffs to investment in agricultural research and extension and argued for more support for research and development to spur innovations in crops, livestock, fisheries, and natural resource management including climate change adaptation and mitigation.

The role of policies in shaping the future of agriculture will be more critical than ever. As India aspires to become a developed nation by 2047, it must adopt a holistic research and policy framework to address the multiple challenges in enhancing productivity and resilience in agriculture, improving farm income, combating malnutrition, and reducing poverty.

The Institute has received exceptional support from the Indian Council of Agricultural Research. I am grateful to Dr. Himanshu Pathak, Secretary, Department of Agricultural Research and Education & Director General, ICAR, and Mr. Sanjay Garg, Secretary, ICAR, for their guidance and support for smooth functioning of the Institute. I am equally thankful to Dr. R. C. Agrawal, Deputy Director General (Education), ICAR, and Dr. A. S. Yadav, Assistant Director General (EQA&R) for their continuous support in administrative and research related matters.

I take this opportunity to place on record my sincere gratitude to the members of the Research Advisory Committee and the Institute Management Committee for their suggestions for mainstreaming research and administrative activities at the Institute.

Lastly, I am thankful to my colleagues, Dr. Khem Chand, Dr. Jaya Jumrani, Dr. Arathy Ashok and Ms. Sonia Chauhan for compiling and editing the report. I also thank Dr. Vikas Kumar and Dr. Anil Kumar for assisting the team in Hindi translation of the executive summary of the report.

Date: 10 July, 2024

**Pratap Singh Birthal**

Director

# Contents

# List of Tables

# List of Figures

# List of Acronyms

| | |
|---|---|
| AAEA | Agricultural and Applied Economics Association |
| ABIs | Agri-Business Incubation |
| ACASA | Atlas of Climate Adaptation in South Asian Agriculture |
| ACBP | Annual Capacity Building Plan |
| ADBI | Asian Development Bank Institute |
| ADG | Assistant Director General |
| ADRTC | Agriculture Development and Rural Transformation Centre |
| AERA | Agricultural Economics Research Association |
| AgGDP | Agricultural Gross Domestic Product |
| AHP | Analytic Hierarchy Process |
| AI | Artificial Intelligence |
| AKMU | Agricultural Knowledge Management Unit |
| APO | Asian Productivity Organization |
| ARDL | Autoregressive Distributed Lag |
| ARMS | Agricultural Research Management System |
| ASA | Andaman Science Association |
| ASDGCAE | Achieving Sustainable Development Goal in Challenged Agro- Ecosystems |
| ASI | Annual Survey of Industries |
| ASSOCHAM | Associated Chamber of Commerce and Industry of India |
| ATARI | Agricultural Technology Application Research Institute |
| ATT | Average Treatment effect on Treated |
| BAU | Business-As-Usual |
| BIMSTEC | Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation |
| BISA | Borlaug Institute for South Asia |
| CARDS | Centre for Agricultural and Rural Development Studies |
| CBO | Community Based Organisation |
| C-DAC | Centre for Development of Advanced Computing |
| CES | Crop Estimation Survey |
| CF&AO | Chief Finance and Account Officer |
| CGIAR | Consortium of International Agricultural Research Centers |
| CIAE | Central Institute of Agricultural Engineering |
| CIBA | Central Institute of Brackishwater Aquaculture |
| CIRC | Central Institute for Research on Cattle |
| COP | Conference of the Parties |
| CPRs | Common Property Resources |
| CRC | Collaborative Research Centres |
| CSPC | Cotton Seed Price Control |
| CSWRI | Central Sheep and Wool Research Institute |
| DAHD | Department of Animal Husbandry and Dairying |
| DARE | Department of Agricultural Research and Education |
| DiD | Difference-in-Differences |
| DMI | Department of Agriculture and Farmers' Welfare |
| DRPCAU | Dr. Rajendra Prasad Central Agricultural University |

| | |
|---|---|
| DSR | Direct Seeded Rice |
| eHRMS | Electronic Human Resource Management System |
| e-NAM | e-National Agriculture Market |
| EQAR | Education Quality Assurance and Reforms |
| ERP | Enterprise Resource Planning |
| FAO | Food and Agriculture Organization |
| FMS | Financial Management System |
| FVMS | Foreign Visit Management System |
| FPOs | Farmer Producer Organizations |
| GCA | Gross Cropped Area |
| GDP | Gross Domestic Product |
| GEAC | Genetic Engineering Appraisal Committee |
| GEDs | Groundwater Extraction Devices |
| GIS | Geographical Information System |
| GNCTD | Government of National Capital Territory of Delhi |
| GPF | General Provident Fund |
| GPT | Generative Pre-trained Transformer |
| GSDP | Gross State Domestic Product |
| GVA | Gross Value Added |
| GW | Gigawatts |
| HR | Human Resource |
| IARI | Indian Agricultural Research Institute |
| IASRI | Indian Agricultural Statistics Research Institute |
| ICAR | Indian Council of Agricultural Research |
| ICCAs | Indigenous Peoples and Local Communities Conserved Territories and Areas |
| ICRAF | International Centre for Research on Agroforestry |
| ICT | Information and Communication Technology |
| IFPRI | International Food Policy Research Institute |
| IGFRI | Indian Grassland and Fodder Research Institute |
| IGP | Indo-Gangetic Plains |
| IIMT | Intellectual Institute of Management & Technology |
| IIP | Index of Industrial Production |
| IISWC | Indian Institute of Soil and Water Conservation |
| IIT | Indian Institutes of Technology |
| IIWBR | Indian Institute of Wheat and Barley Research |
| IJSC | Institute Joint Staff Council |
| ILO | International Labour Organization |
| IMC | Institute Management Committee |
| INSAIT | Indian Society of Agriculture and Information Technology |
| IoT | Internet of Things |
| IP&TM | Intellectual Property & Technology Management |
| IPR | Intellectual Property Right |
| IRR | Internal Rate of Returns |
| IRRI | International Rice Research Institute |
| ISAM | Indian Society of Agricultural Marketing |

| | |
|---|---|
| ISEC | Institute for Social and Economic Change |
| ISEE | Indian Society of Extension Education |
| ITMU | Institute Technology Management Unit |
| ITU | International Telecommunication Union |
| IVRI | Indian Veterinary Research Institute |
| ISO | International Organization for Standardization |
| KVK | Krishi Vigyan Kendra |
| LDC | Lower Division Clerk |
| LPM | Livestock Production Management |
| LSD | Lumpy Skin Disease |
| MANAGE | National Institute of Agricultural Extension Management |
| mbgl | Metres Below Ground Level |
| Mha | Million hectare |
| MIS | Management Information System |
| INSEE | Indian Society for Ecological Economics |
| MM-TTC | Malaviya Mission Teacher Training Centre |
| MNRE | Ministry of New and Renewable Energy |
| MoA&FW | Ministry of Agriculture and Farmers Welfare |
| MPUAT | Maharana Pratap University of Agriculture and Technology |
| MSP | Minimum Support Price |
| NAARM | National Academy of Agricultural Research and Management |
| NAAS | National Academy of Agricultural Sciences |
| NABARD | National Bank for Agriculture and Rural Development |
| NARDL | Non-linear Autoregressive Distributed Lag |
| NARS | National Agricultural Research System |
| NASC | National Agricultural Science Complex |
| NBAGR | National Bureau of Animal Genetics Resources |
| NCIPM | National Research Centre for Integrated Pest Management |
| NDRI | National Dairy Research Institute |
| NGO | Non-Governmental Organization |
| NIAP | National Institute of Agricultural Economics and Policy Research |
| NICRA | National Innovations on Climate Resilient Agriculture |
| NITI | National Institution for Transforming India |
| NRCE | National Research Centre on Equines |
| NRLM | National Rural Livelihood Mission |
| NSSO | National Sample Survey Office |
| NTU | Nanyang Technological University |
| PDMC | Per Drop More Crop |
| PGDM | Post Graduate Diploma in Management |
| PISRF | Pragati International Scientific Research Foundation |
| PME | Priority setting, Monitoring and Evaluation |
| PMKSY | Pradhan Mantri Krishi Sinchayee Yojana |
| PMKUSUM | Prime Minister Kisan Urja Suraksha evam Utthaan Mahabhiyan |
| PPR | Peste-des-Petits Ruminants |
| PPV&FRA | Protection of Plant Varieties and Farmers' Rights Act |

| | |
|---|---|
| PRISMA | Preferred Reporting Items for Systematic Reviews and Meta-Analysis |
| PSM | Propensity Score Matching |
| PTR | Puddled Transplanted Rice |
| QRT | Quinquennial Review Team |
| R&D | Research and Development |
| RAC | Research Advisory Committee |
| RIS | Research & Information System |
| RSCA | Revealed Symmetric Comparative Advantage |
| RTI | Right to Information |
| SAO | South Asia Office |
| SC/ST | Scheduled Caste/Scheduled Tribe |
| SCM | Synthetic Control Method |
| SCOPUS | Comprehensive, multidisciplinary, trusted abstract and citation database |
| SCSI | Soil Conservation Society of India |
| SCSP | Scheduled Castes Sub Plan |
| SDiD | Synthetic Difference-in-Differences |
| SDVs | Short-duration varieties |
| SEM | Spatial Error Model |
| SEM | Structural Equation Model |
| SFP | Stochastic Frontier Production |
| SGP | Sheep & Goat Pox |
| SHC | Soil Health Card |
| SKNAU | Sri Karan Narendra Agriculture University |
| SMI | Soil Moisture Indicator |
| SPARROW | Smart Performance Appraisal Report Recording Online Window |
| SPS | Sanitary and Phytosanitary Measures |
| SPVs | Special Purpose Vehicles |
| SRIJAN | Self-Reliant Initiatives through Joint Action |
| SSD | Sub-Surface Drainage |
| TAAS | Trust for Advancement in Agricultural Sciences |
| TBT | Technical Barriers to Trade |
| TFP | Total Factor Productivity |
| TNAU | Tamil Nadu Agricultural University |
| UAS | University of Agricultural Sciences |
| UDC | Upper Divisional Clerk |
| UGA | University of Georgia |
| UGC | University Grants Commission |
| USA | United States of America |
| USDA | United States Department of Agriculture |
| WTO | World Trade Organization |
| ZTMC | Zonal Technology Management Centre |

# कार्यकारी सारांश

भाकृअनुप - राष्ट्रीय कृषि आर्थिकी एवं नीति अनुसंधान संस्थान, कृषि अर्थशास्त्र में शोध एवं कृषि नीति को दिशा देने हेतु देश में एक अग्रणी संस्था है| यह भारतीय कृषि अनुसंधान परिषद (भाकृअनुप) की एक प्रबुद्ध संस्था है जो नीतिगत मुद्दों में अपनी भागीदारी एवं विभिन्न क्षेत्रों में संसाधन आवंटन के संबंध में, निर्णय लेने की सुविधा के लिए विश्वसनीय शोध-आधारित सहयोग प्रदान करता है। संस्थान की शोध गतिविधियों को मुख्य तौर पर तीन विषयों में व्यवस्थित किया गया है जैसे कृषि वृद्धि और विकास, प्रौद्योगिकी और सतत कृषि एवं कृषि बाजार और व्यापार । 2023-24 में इन विषयों के तहत किए गए अध्ययनों से प्राप्त महत्वपूर्ण शोध उपलब्धियां संक्षेप में प्रस्तुत की गयी है|

## कृषि वृद्धि और विकास

भारत को 2047 तक एक विकसित राष्ट्र बनने के लिए अगले 25 वर्षों में लगभग 8% के आर्थिक विकास दर से बढ़ना होगा| इस दौरान पौष्टिक, सुरक्षित और प्रसंस्कृत खाद्य पदार्थों की मांग बढ़ेगी, जबकि सीमित भूमि और जल संसाधन, कृषि उत्पादन के लिए महत्वपूर्ण चुनौतियां सिद्ध होंगे| इसका तात्पर्य है कि बढ़ती मांगों को पूरा करने के लिए खाद्य आपूर्ति का सावधानीपूर्वक प्रबंधन करना होगा। अनुमान बताते हैं कि जैसे-जैसे आय बढ़ेगी, उच्च मूल्य वाली खाद्य वस्तुओं की मांग, अनाज की मांग की अपेक्षा अधिक तेजी से बढ़ेगी। सामान्य तौर पर, 2047 तक खाद्य पदार्थों की मांग 2.44% से 3.07% की वार्षिक दर से बढ़ेगी, जबकि सकल फसल क्षेत्र में 0.45% की वार्षिक वृद्धि की उम्मीद है। इसलिए, बढ़ती मांग को पूरा करने के लिए आवश्यक अतिरिक्त उत्पादन, फसल उपज में सुधार से आना चाहिए। अधिकांश फसलों में काफी उपज-अंतर मौजूद है, जो उत्पादन वृद्धि में तेजी लाने की सम्भावना प्रदान करता है।

कृषि-खाद्य प्रणालियों को बदलने हेतु कृषि अनुसंधान और विकास एक महत्वपूर्ण जरिया है और यह भविष्य की चुनौतियों का सामना करने के लिए महत्वपूर्ण है| यधपि समय के साथ कृषि अनुसंधान और विकास में निवेश बढ़ा है, लेकिन यह अभी भी अल्प निवेशित है। भारत अपने सकल घरेलू उत्पाद का केवल 0.55% कृषि अनुसंधान एवं विकास पर खर्च करता है, हालांकि, कृषि अनुसंधान एवं विकास में निवेश का प्रतिफल काफी आकर्षक है। कृषि अनुसंधान पर निवेश किया गया प्रत्येक रुपया, 13.85 रुपये का प्रतिफल देता है, जबकि विस्तार पर यह प्रतिफल 7.40 रुपये होने का अनुमान है। पशु विज्ञान अनुसंधान में निवेश का प्रतिफल 20.81 रुपये अनुमानित है, जो फसल विज्ञान अनुसंधान में निवेश से लगभग दोगुना है। अनुसंधान की क्षमता का समुचित दोहन करने के लिए अधिक निवेश और अनुसंधान एजेंडे को पुनः उन्मुख करने की आवश्यकता है।

दक्षता, समानता और स्थिरता के कई लक्ष्यों पर विचार करते हुए, उत्पाद वस्तुएँ और क्षेत्रीय अनुसंधान प्राथमिकताओं का मूल्यांकन किया गया है। उत्तर प्रदेश, बिहार, राजस्थान और महाराष्ट्र जैसे बड़े राज्यों को कृषि अनुसंधान में अधिक निवेश की आवश्यकता है| उत्पाद वस्तुओं (कमोडिटी) के हिसाब से, पशु विज्ञान अनुसंधान को सबसे अधिक (29.4%), तत्पश्चात बागवानी (16.0%), अनाज (15.7%), मत्स्य पालन (5.7%), तिलहन (4.1%), चीनी (3.9%), और दालों को 3.2% संसाधनों की आवश्यकताएं है। पशुधन और बागवानी अनुसंधान के लिए संसाधनों का अधिक आवंटन उनकी बढ़ती मांग, और कुपोषण से निपटने और गरीबी को कम करने में, गहरे प्रभावों को देखते हुए महत्वपूर्ण है।

भारतीय जिलों में कृषि आय वृद्धि समरूपता की ओर अग्रसर है हालाँकि यह गति धीमी है| उच्च आय वाले जिले समूह मुख्य रूप से उत्तरी, उत्तरपूर्वी और पश्चिमी क्षेत्रों में स्थित हैं, और कम आय वाले समूह पूर्वी क्षेत्र में हैं। दक्षिणी क्षेत्र में, यह समूह सांयोगिक ढंग से वितरित प्रतीत होते हैं। प्रारंभिक विश्लेषण से पता चलता है कि भारतीय जिले अभिसरण की ओर अग्रसर हैं, लेकिन हाल की अवधि में इसमें कमी आई है। कुल आय की तुलना में फसल आय में अभिसरण की प्रवृत्ति थोड़ी अधिक मजबूत हुई है।

सिंचाई अवसंरचना, फसल विविधीकरण और शहरी बाजारों से निकटता ने अभिसरण में महत्वपूर्ण भूमिका निभाई है। गरीब किसानों के लिए आय वृद्धि की गति धीमी रही है, जो मुख्य रूप से बाजारों की दूरी से प्रभावित है, जबकि विविधीकरण और बुनियादी ढांचे के निवेश से मुख्य रूप से मध्यम और उच्च आय वाले किसानों को अधिक लाभ होता है। न्यायसंगत आर्थिक विकास को बढ़ावा देने के लिए, गरीब लोगों को बाजारों से जोड़ना, बुनियादी ढांचे को मजबूत करना और मध्यम आय समूहों के लिए विविधीकरण को बढ़ावा देना और उच्च

आय वाले किसानों को मूल्य श्रृंखलाओं की ओर प्रेरित करना आवश्यक है।

## प्रौद्योगिकी और सतत कृषि

कृषि में भूजल का सतत उपयोग एक महत्वपूर्ण चिंता का विषय है, जिसके फलस्वरूप भूजल की गहराई तेजी से बढ़ रही है| भारत में सिंचाई का प्रमुख स्रोत भूजल है। 1982-83 में कुओं का घनत्व (संख्या/1000 हेक्टेयर शुद्ध बोया क्षेत्र) 42 से बढ़कर 2017-19 में 158 हो गया है। इसके अलावा, नए कुओं की संख्या में वृद्धि एवं विभिन्न तरह के कुओं में वृद्धि में भिन्नता रही है, जिससे इस क्षेत्र में संरचनात्मक परिवर्तन हुआ है। 1980 के दशक की शुरुआत में कुल कुओं में, 92% खोदे गए कुएँ थे, लेकिन धीरे-धीरे गहरे और उथले ट्यूबवेल ने इनकी जगह ले ली। यह परिवर्तन भूजल स्तर के कम होने की वजह से किसानो द्वारा उच्च शक्ति वाले भूजल निष्कर्षण उपकरणों को स्थापित करने की ओर संकेत देता है। तीन-चौथाई से अधिक भूजल दोहन–पम्पों का संचालन विधुत उर्जा से होता है। भूजल के सतत निष्कर्षण, ऊर्जा सुरक्षा और कम लागत में सिंचाई तक पहुंच की विभिन्न चिंताओं ने कृषि एवं किसान कल्याण मंत्रालय द्वारा प्रधानमंत्री कृषि सिंचाई योजना (पीएमकेएसवाई) के अभियान प्रति बूंद अधिक फसल (पीडीएमसी) जैसी योजनाओं के माध्यम से सूक्ष्म सिंचाई को बढ़ावा दिया, साथ ही नवीन एवं नवीकरणीय ऊर्जा मंत्रालय (एमएनआरई) द्वारा प्रधानमंत्री किसान ऊर्जा सुरक्षा एवं उत्थान महाभियान योजना (पीएम कुसुम) जैसी योजनाओं के माध्यम से नवीकरणीय ऊर्जा, विशेष रूप से सौर ऊर्जा को अपनाने को प्रोत्साहित किया। भारत में सूक्ष्म सिंचाई द्वारा 88 मिलियन हेक्टेयर सिंचाई करने की क्षमता है, लेकिन 2023 में इस क्षमता का केवल 17.2% ही साकार हो पाया है। इसी तरह, सिंचाई के लिए सौर ऊर्जा क्षमता का केवल 2.6% (102 गीगावाट्स) ही उपयोग हो पाया है। सूक्ष्म सिंचाई को सौर ऊर्जा के साथ जोड़ने के कई लाभ हैं। सूक्ष्म सिंचाई से पानी की बचत होती है और साथ ही भूजल दोहन के लिए ऊर्जा की भी बचत होती है। सौर ऊर्जा से चलने वाली सूक्ष्म सिंचाई से ऊर्जा लागत को कम करके कृषि लाभ में सुधार संभव है। इससे सौर पंपों पर होने वाली पूंजीगत लागत की वसूली भी जल्दी होगी। एक आंकलन से यह ज्ञात हुआ है कि एक डीजल पंप के सौर्यीकरण से प्रति वर्ष 963 लीटर डीजल की बचत हो सकती है साथ ही सालाना 2.1 टन $CO_2$ उत्सर्जन कम हो सकता है। इसके अलावा, यह जल-उपयोग दक्षता में 15-50% तक सुधार कर सकता है। इसलिए, केंद्र और राज्य स्तर पर सूक्ष्म सिंचाई और सौर संवर्धन योजनाओं के क्रियावन के लिये संस्थागत ढांचे को फिर से बनाने की आवश्यकता है।

इसके अतिरिक्त, उप-राष्ट्रीय स्तर पर भूजल संरक्षण के लिए नीतिगत विकल्पों का मूल्यांकन किया गया है। सिंचाई के लिए पानी की आवश्यकता और भूजल स्तर की स्थिति पर विचार करते हुए उत्तर प्रदेश में उपभोग स्तर-आधारित बिजली शुल्क नीति की व्यवह्किता, स्लैब-आधारित बिजली शुल्क नीति का कार्यान्वयन अपेक्षित है, जिसके अंतर्गत किसानों को न्यूनतम आवश्यक ऊर्जा इकाइयां मुफ्त प्रदान की जा सकती हैं, और फिर धीरे-धीरे बिजली शुल्क में वृद्धि की जा सकती है। यह किसानों को भूजल का विवेकपूर्ण उपयोग करने के लिए प्रेरित करेगा और राज्य पर बिजली सब्सिडी का बोझ भी कम करेगा।

ऐसे अनेक उदाहरण भी हैं जिनमें अंधाधुंध भूजल उपयोग को रोकने के उद्देश्य से कुछ नीतिगत नियम अप्रभावी रहे हैं। पंजाब/हरियाणा उप-भूमि जल संरक्षण अधिनियम 2009 के प्रभाव विश्लेषण से पता चलता है कि इन नियमों का कोई महत्वपूर्ण प्रभाव नहीं पड़ा है। नियमों के बावजूद, भूजल स्तर में गिरावट जारी रही है। यह भूजल प्रबंधन के लिए एक समग्र दृष्टिकोण का सुझाव देता है, जिसमें नीतियों, प्रौद्योगिकियों, प्रोत्साहनों, संस्थाओं और विनियमों को शामिल किया गया है।

सतत कृषि प्रणालियों से पारिस्थितिकी तंत्र सेवाओं का आर्थिक मूल्यांकन यह इंगित करता है कि गैर-व्यापारिक योग्य सेवाओं का मौद्रिक मूल्य व्यापार योग्य सेवाओं से अधिक है। सीधे बोए गए चावल, जैविक खाद और कृषि वानिकी द्वारा फसल की उपज और अमूर्त पारिस्थितिकी तंत्र सेवाओं के बीच एक पारस्परिक सम्बन्ध प्रदर्शित करते हैं। अतः पारिस्थितिकी तंत्र और प्राकृतिक संसाधनों के संरक्षण के लिए प्रौद्योगिकियों और प्रथाओं को अपनाने के लिए उचित प्रोत्साहन तंत्र विकसित करने की आवश्यकता है।

गंगा के मैदानों में जिला स्तर पर फसल की पैदावार पर जलवायु परिवर्तन के प्रभाव का आकलन किया गया। यह प्रभाव धान, मक्का, गेहूं और बाजरा की पैदावार पर नकारात्मक और कपास, चना और तोरिया और सरसों पर सकारात्मक है। हालाँकि, यह प्रभाव राज्यों और जिलों में समान है, जो कृषि पर जलवायु परिवर्तन के प्रभावों को कम करने के लिए क्षेत्रीय स्तर पर विभेदित रणनीतियों की आवश्यकता का सुझाव देता है।

उर्वरक उपयोग में असमानताओं का आकलन फसलों, राज्यों और खेतों के आकार के आधार पर किया गया है। सिंचित कृषि में प्रति हेक्टेयर उर्वरक का उपयोग वर्षा आधारित कृषि की तुलना में 2.4 गुना अधिक है। सीमांत किसान बड़े किसानों की तुलना में दोगुना उर्वरक का उपयोग करते हैं। सभी फसलों में, गन्ना, कपास, फल और सब्जियों जैसी वाणिज्यिक फसलों में उर्वरक उपयोग की तीव्रता अधिक है। तेलंगाना और गंगा के मैदानी क्षेत्रो के राज्यों में उर्वरक-उपयोग की तीव्रता सबसे अधिक है, और राजस्थान में सबसे कम है। भारतीय कृषि में NPK अनुपात 6.8: 3.3: 1 है, जो पोषक तत्वों के उपयोग में असंतुलन को दर्शाता है। भारत में उर्वरकों के कुशल उपयोग के लिए कुछ विकल्पों में, पोषक तत्वों की कीमतों में समानता लाना, मृदा स्वास्थ्य कार्ड (एसएचसी) से सब्सिडी को जोड़ना, नई पीढ़ी के उर्वरकों, जैव-उर्वरकों, जैविक खादों और दलहनी फसलों को बढ़ावा देना एवं उच्च पोषक तत्व-उपयोग दक्षता के लिए अनुसंधान को बढ़ावा देना शामिल है।

कृषि में आर्टिफिशियल इंटेलिजेंस के अनुसंधान और अनुप्रयोग में खासकर COVID-19 महामारी के बाद से तेजी आई है। भारतीय कृषि अनुसंधान परिषद (भा.कृ.अनु.प.) और भारतीय प्रौद्योगिकी संस्थान (आई.आई.टी.) जैसे शैक्षणिक संस्थान, कृषि में AI पर अनुसंधान को आगे बढ़ा रहे हैं, जबकि निजी क्षेत्र भी समानांतर रूप से AI से संबंधित अनुसंधान एवं विकास में निवेश कर रहा है। सार्वजनिक क्षेत्र के AI अनुसंधान में फसल उत्पादन से संबंधित पहलुओं पर काफी ध्यान दिया गया हैं। कई निजी संस्थान, AI द्वारा विभिन्न आपूर्ति श्रृंखला घटकों जैसे ई-कॉमर्स और इनपुट की ट्रेसबिलिटी, मशीनरी किराए पर लेना, सटीक खेती, वित्तीय सेवाएं, वास्तविक समय में खेत की निगरानी, खेत-विशिष्ट सलाहकार सेवाएं, उपज का विपणन, कटाई के बाद का रसद और कृषि उत्पादों की ट्रेसबिलिटी पर ध्यान केंद्रित कर रही हैं। सार्वजनिक-निजी भागीदारी रूप में अवसरों की खोज करते हुए कृषि और संबद्ध क्षेत्रों में AI नवाचारों को जिम्मेदारी से बढ़ाने के लिए नीति दिशानिर्देशों की आवश्यकता है।

भाकृअनुप में विभिन्न संस्थानों द्वारा विकसित कृषि और संबद्ध क्षेत्रों में बेहतर प्रौद्योगिकियों और प्रथाओं का प्रभाव-मूल्यांकन किया गया हैं। उप-सतही जल निकासी, रेत के टीलों का स्थिरीकरण, भेड़ और बकरी चेचक के लिए टीके, प्रत्यक्ष बीजित चावल, चारा फसल की किस्में, मृदा नमी सूचक, और मछली की पिंजरा पालन जैसी प्रौद्योगिकियों में उपज बढ़ाने और आर्थिक लाभ उत्पन्न करने की महत्वपूर्ण क्षमता पाई गई है।

भारत में पशुधन उत्पादन विभिन्न जोखिमों, मुख्य रूप से बीमारियों के प्रति संवेदनशील है, जिससे काफी आर्थिक नुकसान होता है। 2022-23 में लम्पी स्किन डिजीज (LSD) के प्रकोप से 4.03 मिलियन मवेशी प्रभावित हुए, जिससे कुल 7,607 करोड़ रुपये का आर्थिक नुकसान हुआ। राजस्थान (39.6%) में सबसे अधिक मौद्रिक नुकसान होने का अनुमान है, उसके बाद महाराष्ट्र (15.8%), पंजाब (12.5%) और कर्नाटक (10.2%) का स्थान है। पशु चिकित्सा सेवाओं, विशेष रूप से टीकाकरण अभियानों ने बाद के वर्षों में रोग की घटनाओं को कम करने में महत्वपूर्ण भूमिका निभाई है।

डेयरी किसानों की विभिन्न पशु चिकित्सा स्वास्थ्य और प्रजनन सेवाओं तक पहुँच उप-इष्टतम है, और कुछ क्षेत्रीय असमानताएँ भी हैं। पंजाब और हरियाणा में, बिहार, उत्तर प्रदेश, मध्य प्रदेश और गुजरात की तुलना में बेहतर पशु-चिकित्सा बुनियादी ढाँचा है। सतत उत्पादन और उत्पादकता में सुधार करने के लिए, प्रमुख दूध उत्पादक राज्यों में पशु चिकित्सा सेवाओं को मजबूत करना आवश्यक है।

## कृषि बाज़ार और व्यापार

भारत में न्यूनतम समर्थन मूल्य (एम्एसपी) का उद्देश्य किसानों के लिए उचित मूल्य सुनिश्चित करना और अनौपचारिक व्यापारियों द्वारा शोषण को कम करना है। हालाँकि, एम्एसपी पर जागरूकता और इस मूल्य पर उत्पाद की बिक्री अभी भी कम है। परंपरागत रूप से, पंजाब और हरियाणा जैसे राज्य केंद्रीय पूल के लिए धान और गेहूं की खरीद पर निर्भर थे, लेकिन विकेंद्रीकरण के फलस्वरूप छत्तीसगढ़, ओडिशा और मध्य प्रदेश जैसे गैर-पारंपरिक राज्यों से खरीद में वृद्धि हुई है। खुले बाजार में बिक्री से उत्पाद मूल्य प्राप्ति, खरीद एजेंसियों को बिक्री से काफी कम है – जो कि धान के लिए 18 प्रतिशत और गेहूं के लिए 6 प्रतिशत कम है। एमएसपी किसानों को अधिक उत्पादन करने के लिए भी प्रोत्साहित करता है। आंकड़े यह दर्शाते है कि एमएसपी-आधारित खरीद प्रणाली में भाग लेने वाले किसान, अधिक फसल उपज भी दिखाते हैं – जो कि धान के मामले में 9 प्रतिशत और गेहूं के मामले में 14 प्रतिशत अधिक हैं। कुल मिलाकर, एमएसपी-आधारित खरीद प्रणाली किसानों को बेहतर

आय प्रदान करती है जो कि धान में 23 प्रतिशत अधिक आय और गेहूं में 19 प्रतिशत अधिक है।

जनवरी 2010 से दिसंबर 2022 तक विभिन्न बाजारों में प्रमुख खाद्य वस्तुओं की कीमतों में उतार-चढ़ाव का विश्लेषण दर्शाता है कि सब्जियों और मसालों की कीमतें अत्यधिक अस्थिर हैं, जबकि अनाज की कीमतें सबसे कम अस्थिर हैं। बाजार में आने वाली वस्तुओं में मौसमी बदलाव और वर्षा, व्यापार नीति में बदलाव, भंडारण सीमा, गैर-प्रतिस्पर्धी व्यापार प्रथाएँ और अपर्याप्त बुनियादी ढाँचा जैसे अन्य कारक मूल्य अस्थिरता में योगदान करते हैं। फसल कटाई के बाद मूल्य श्रृंखला संस्थानों को मजबूत करना, सहनशील फसलों को बढ़ावा देना, बाजार की जानकारी तक पहुँच आदि, अस्थिरता को प्रभावी ढंग से संचालित करने के लिए महत्वपूर्ण है।

दीर्घ अवधि में, खाद्य मूल्य में मुद्रास्फीति को प्रभावित करने वालो में अंतर्राष्ट्रीय खाद्य मूल्य, मजदूरी दरें, कृषि जीडीपी और कम अवधि की ब्याज़ दरें (कॉल मनी दरें) हैं। मुद्रा आपूर्ति, कच्चे तेल की कीमतों और विनिमय दरों के असममित प्रभाव भी खाद्य मुद्रास्फीति को प्रभावित करते हैं। नीति निर्माताओं को खाद्य मूल्य मुद्रास्फीति के प्रबंधन के लिए प्रभावी रणनीति विकसित करने हेतु इन कारकों पर विचार करना आवश्यक है।

कृषि में सकल मूल्य वर्धन में कृषि निर्यात का योगदान समय के साथ बढ़ा है। चावल, काली मिर्च और चाय के निर्यात में भारत का तुलनात्मक लाभ अधिक है, लेकिन क्रस्टेशियन और गोजातीय मांस के मामले में यह कम है। उत्पाद की गुणवत्ता और सुरक्षा अनुपालन सुनिश्चित करने के लिए प्रभावी मूल्य-श्रृंखला प्रबंधन महत्वपूर्ण है। कोविड-19 महामारी ने शुरू में कृषि निर्यात में कमी की, लेकिन बाद में सक्रिय नीतियों ने निर्यात को बढ़ावा दिया। रूस-यूक्रेन युद्ध ने बासमती चावल और खाद्य तेल के निर्यात के अवसर पैदा किए।

मांस उद्योग में कुल कारक उत्पादकता (टीएफपी) ने 2002 से 2016 के दौरान 7.9% की उल्लेखनीय वृद्धि दर्ज की है। पंजाब, हरियाणा, राजस्थान, पश्चिम बंगाल, मध्य प्रदेश, बिहार, असम, तेलंगाना और आंध्र प्रदेश में टी.एफ.पी. वृद्धि अधिक रही है। मांस उद्योग में, पोल्ट्री और बीफ में उच्च टी.एफ.पी. वृद्धि देखी गई है। मांस प्रसंस्करण उद्योग की क्षमता को बढ़ाने करने के लिए तकनीकी दक्षता को बढ़ाना होगा और इन्हें बदलते सामाजिक-आर्थिक और कानूनी ढाँचों के अनुकूल होना आवश्यक है।

छोटे किसानों द्वारा कृषि के विस्तार और लाभप्रदता को बढ़ाने में किसान उत्पादक संगठनों की संभावित भूमिका को ध्यान में रखते हुए, इसके प्रभावों का अनुमान लगाने के लिए एक अध्ययन किया गया। एफपीओ का फसल की पैदावार (3.59%) और दूध उत्पादन (18.23%), और उत्पादन के मूल्य (फसलों के लिए 44% और दूध के लिए 33%) पर महत्वपूर्ण सकारात्मक प्रभाव पड़ता है। यह किसानों को बाज़ारों से जोड़ने में एफपीओ की महत्वपूर्ण भूमिका को इंगित करते हैं।

## अन्य गतिविधियाँ

2023-24 के दौरान, भाकृअनुप – निआप ने पांच नीति पत्र और पांच नीति संक्षिप्त विवरण प्रकाशित किए। संकाय ने उच्च मानक के राष्ट्रीय और अंतर्राष्ट्रीय पत्रिकाओं में 50 शोध लेख प्रकाशित किए। इसके अलावा, पत्रिकाओं और समाचार पत्रों में कई लोकप्रिय लेख भी प्रकाशित हुए। संकाय ने विभिन्न अवसरों पर जन-संचार माध्यम द्वारा नीतिगत चर्चाओं द्वारा कृषि नीति की सकारात्मक आवश्यकता पर बल दिया।

इस अवधि के दौरान संस्थान ने "कृषि नीति विश्लेषण के लिए मात्रात्मक तकनीक" पर एक शीतकालीन स्कूल का आयोजन किया। इसने NARS में कृषि अर्थशास्त्रियों और सामाजिक वैज्ञानिकों और हाशिए पर मौजूद ग्रामीण समुदायों के लिए क्षमता निर्माण कार्यक्रम भी आयोजित किए। कृषि में समकालीन मुद्दों पर नीति व्याख्यान श्रृंखला भी निरंतर जारी रही।

यह संस्थान कृषि और किसान कल्याण मंत्रालय और नीति आयोग का बौधिक भागीदार है, और इसने कृषि कार्यक्रमों और नीतियों में सुधार के लिए नीति और तकनीकी इनपुट प्रदान किए हैं। इसके अलावा, इसने अन्य मंत्रालयों और राज्य सरकारों को साक्ष्य-आधारित नीतिगत इनपुट भी दिए हैं।

# Executive Summary

The ICAR-National Institute of Agricultural Economics and Policy Research plays a leadership role in strengthening agricultural economics and policy research in the National Agricultural Research System (NARS). It acts as a think tank of the Indian Council of Agricultural Research (ICAR). It provides credible research-based inputs to the Council to facilitate its participation in policy debates and decision-making regarding research priorities and resource allocations. The research activities of the Institute are broadly organized into three core themes, viz., Agricultural Growth and Development, Technology and Sustainable Agriculture, and Agricultural Market and Trade. Significant research outputs of the studies carried out under each of these themes in 2023-24 are summarized below:

## Agricultural Growth and Development

India aims to become a developed nation by 2047. Hence, the economy has to grow at an accelerated rate of around 8% over the next 25 years. Higher-income growth and changing lifestyles will influence food consumption and demand. The demand for nutritious, safe, and processed foods will increase. At the same time, the limited land and water resources will pose significant challenges to increasing production. This calls for careful management of food supply to meet the growing demand. Projections show that as income increases, the demand for high-value food commodities will grow faster than the demand for cereals. In general, demand for food will grow annually from 2.44% to 3.07% until 2047. Gross cropped area will expand at an annual rate of 0.45%. Thus, the additional production needed to meet the rising demand has to come from yield improvements. A considerable yield gap exists in most crops, which offers scope to accelerate production growth.

Agricultural research and development (R&D) can significantly address the current and future challenges to transforming agri-food systems. Although investment in agricultural R&D has increased over time, it remains underinvested. However, India spends about 0.55% of its overall gross domestic product on agricultural R&D. The payoffs to investment in agricultural R&D are pretty attractive. Every rupee spent on agricultural research pays back Rs. 13.85, while on extension, it is estimated at Rs. 7.40. The payoff to investment in animal science research is estimated at Rs. 20.81, almost double that from investment in crop science research. Harnessing the potential of research requires more investment and reorientation of the research agenda.

The commodity and regional research priorities have been assessed, considering the multiple goals of efficiency, equity, and sustainability. Bigger states like Uttar Pradesh, Bihar, Rajasthan, and Maharashtra must invest more in agricultural research. By commodity, animal science research needs more resources (29.4%), followed by horticulture (16.0%), cereals (15.7%), fisheries (5.7%), oilseeds (4.1%), sugar (3.9%), and pulses (3.2%). More allocation of resources to livestock and horticultural research is crucial given their increasing demand and more significant effects in combating malnutrition and reducing poverty.

Farm income growth across Indian districts is converging but at a slower pace. High-income clusters are located primarily in northern, northeastern, and western regions, and low-income clusters are in the eastern region. In the southern region, clusters appear to be distributed randomly. Findings show an absolute convergence but a slowdown in the recent period. The tendency to converge is slightly stronger in crop income than in total income. Irrigation infrastructure, crop diversification, and proximity to urban markets have played a crucial role in convergence. Income growth has been slower for poor farmers, primarily influenced by distance to markets, while diversification and infrastructure investments mainly benefit medium and high-income farmers. To promote equitable economic development, connecting the poorest to the markets, strengthening infrastructure and diversification for the middle-income groups, and nudging high-income farmers towards value chains are a must.

## Technology and Sustainable Agriculture

The sustainability of groundwater resources is a significant concern due to the fast pace of depletion. Groundwater is the dominant source of irrigation in India. The well density (no./1000 ha net sown area) has increased from 42 in 1982-83 to 158 in 2017-19. Further, the growth of new wells has differed significantly across types of wells, leading to a structural change in their composition. Dug wells comprised 92% of total wells in the early 1980s, but deep and shallow tubewells have gradually replaced these. This transition indicates farmers chasing depleting groundwater levels by installing high-powered groundwater extraction devices. Electricity is the primary source of power for pumping out groundwater, energizing more than three-fourths of the pumps. Multiple concerns of sustainable use of groundwater, energy security, and economic access to irrigation led to the promotion of micro-irrigation through schemes like Per Drop More Crop (PDMC) component of the *Pradhan Mantri Krishi Sinchayee Yojana* (PMKSY) by the Ministry of Agriculture and Farmers Welfare (MoA&FW) and incentivizing adoption of renewable energy, especially solar power, through schemes like Prime Minister *Kisan Urja Suraksha Evam Utthaan Mahabhiyan Yojana* (PM KUSUM) by the Ministry of New and Renewable Energy (MNRE). India has the potential to irrigate 88 million ha (Mha) using micro-irrigation, but only 17.2% of this potential was realized in 2023. Similarly, only 2.6% of the 102 Gigawatts (GW) solar potential for irrigation was harnessed. Establishing proper synergy between the schemes and coupling micro-irrigation with solar pumps will provide several economic and environmental benefits. There are several benefits of coupling micro-irrigation with solar power. Micro-irrigation saves water and, therefore, energy for pumping out groundwater. By reducing energy costs, solar-powered micro-irrigation improves farm profits. This will also reduce the lag in recovering capital costs incurred on solar pumps. Calculations indicate that the solarization of a diesel pump can save 963 litres of diesel per annum. Further, solarization of an electric or diesel pump can reduce $CO_2$ emissions by 2.1 tonnes annually. Besides, it can improve water-use efficiency by 15-50%. Hence, there is a need to restructure the institutional setup of planning and implementation of the micro-irrigation and solar promotion schemes at the central and state levels.

Further, policy alternatives for groundwater conservation have been assessed at the sub-national level. The study of slab-based power tariff policy in Uttar Pradesh, considering irrigation water requirements and groundwater level status, suggests implementing the slab-based power tariff policy where the farmers can be provided with the minimum required energy-free. Then electricity tariffs can be increased gradually. It will prompt the farmers to use groundwater judiciously and reduce the electricity subsidy burden on the state.

There are also instances in which some policy regulations intended to prevent indiscriminate groundwater use have been ineffective. Impact analysis of "Punjab/Haryana Preservation of Subsoil Water Act 2009" shows that regulations had no significant impact. Even with the regulations in place, the groundwater level has declined. This perverse outcome could be due to policy offsets such as highly subsidized electric power for irrigation, excessive procurement of paddy at minimum support price, stagnation in investment in major and medium irrigation schemes, and lack of incentives for crop diversification and adoption of water-saving technologies. It suggests a holistic approach to groundwater management, encompassing policies, technologies, incentives, institutions, and regulations.

The economic valuation of ecosystem services from sustainable agricultural practices suggests that the monetary value of non-tradable services outweighs that of tradable services. Direct-seeded rice, organic manure, and agroforestry exhibit a trade-off between crop yield and intangible ecosystem services. There is a need to devise appropriate incentive mechanisms for the adoption of technologies and practices to conserve ecosystems and natural resources.

The impact of climate change was assessed on crop yields at the district level in the Indo-Gangetic plains. Its effects are adverse on yields of paddy, maize, wheat, and pearl millet and upbeat on yields of cotton, chickpea, and rapeseed & mustard. However, the impact varies across districts, suggesting the need for regionally differentiated strategies to mitigate the effects of climate change on agriculture.

Disparities in fertilizer use have been assessed across crops, states, and farm sizes. Per hectare fertilizer use in irrigated agriculture is 2.4 times higher than in rainfed agriculture. Marginal farmers use fertilizers twice as much as large farmers. Across crops, fertilizer intensity is higher in commercial crops like sugarcane, cotton, fruits, and vegetables. Fertilizer-use intensity is the highest in Telangana and states in the Indo-Gangetic plains, and the lowest is in Rajasthan. The NPK ratio in Indian agriculture stands at 6.8: 3.3: 1, indicating an imbalance in nutrient use. Some options for efficient use of fertilizers in India include bringing parity in nutrient prices, linking subsidies to the Soil Health Card (SHC), promoting new-generation fertilizers, bio-fertilizers, organic manures, legumes, and research for higher nutrient-use efficiency.

There has been a surge in research and application of Artificial Intelligence in agriculture, especially after the COVID-19 pandemic. Academic institutions like the Indian Council of Agricultural Research and the Indian Institutes of Technology drive the research on AI in agriculture, whereas the private sector is also parallelly investing in AI-related R&D. While crop production-related aspects received considerable attention in public sector AI research, many private AI initiatives are focusing on various supply chain components like e-commerce and traceability of inputs, machinery hiring, precision farming, financial services, real-time farm monitoring, farm-specific advisory services, marketing of produce, post-harvest logistics, and traceability of agricultural products. There is a need for policy guidelines for responsible upscaling of AI innovations in agriculture and allied sectors while exploring opportunities in a public-private partnership mode.

Impact assessment of improved technologies and practices in agriculture and allied sectors developed by various institutes in ICAR was taken up in network project mode. Technologies like sub-surface drainage (SSD), sand dune stabilization, vaccines for sheep and goat pox, Direct Seeded Rice (DSR), forage crop varieties, Soil Moisture Indicator, and cage farming of fish have been found to have significant potential in incrementing yield and generating economic returns.

Livestock production in India is susceptible to different risks, mainly diseases, leading to substantial economic losses. The outbreak of Lumpy skin disease (LSD) in 2022-23 affected 4.03 million cattle, leading to a total economic loss of Rs. 7,607 crores. The monetary loss is estimated to be the highest for Rajasthan (39.6%), followed by Maharashtra (15.8%), Punjab (12.5%) and Karnataka (10.2%). Veterinary services, especially vaccination campaigns, have played a crucial role in reducing the incidence of the disease in subsequent years.

Dairy farmers' access to various veterinary health and breeding services is sub-optimal, and there exist some regional disparities. Punjab and Haryana have better veterinary infrastructure than Bihar, Uttar Pradesh, Madhya Pradesh, and Gujarat. Southern states, Punjab, and Haryana have better livestock breeding infrastructures. To achieve sustainable production and improve productivity, it is essential to strengthen veterinary services in major milk-producing states.

## Agricultural Market and Trade

The minimum support price (MSP) in India aims to ensure fair prices for farmers and reduce exploitation by informal traders. However, awareness and actual sales at MSP remain low. Traditionally, states like Punjab and Haryana dominated paddy and wheat procurement for the Central pool, but decentralization has led to increased procurement from non-traditional states, such as Chhattisgarh, Odisha, and Madhya Pradesh. Price realization from sales in the open market is significantly lower than that from sales to procurement agencies — 18% for paddy and 6% for wheat. MSP also incentivizes farmers to produce more. Findings also show higher crop yields for farmers participating in the MSP-based procurement system — 9% in the case of paddy and 14% in the case of wheat. Overall, the MSP-based procurement system could make farmers better off — 23% higher income from paddy and 19% from wheat.

An analysis of price volatility of major food commodities across markets from January 2010 to December 2022 indicates high volatility in prices of vegetables and spices. Prices of cereals are the least volatile. Seasonality in market arrivals and other factors like rainfall, trade policy changes, stocking limits, non-competitive trade practices, and inadequate infrastructure contribute to price volatility. Strengthening post-harvest value chain institutions, promoting resilient crops, access to market information, etc., are crucial for managing volatility effectively.

In the long run, significant contributors to food price inflation are international food prices, wage rates, agricultural GDP, and call money rates. Asymmetric effects of money supply, crude oil prices, and exchange rates also lead to food inflation. Policymakers must consider these factors to develop effective strategies for managing food price inflation.

Agricultural exports' contribution to gross value added in agriculture has increased over time. India has a significant comparative advantage in rice, pepper, and tea exports, but it is less in the case of crustaceans and bovine meat. Effective value-chain management is crucial for ensuring commodity quality and safety compliance. The COVID-19 pandemic initially had an adverse effect on agricultural exports, but proactive policies later boosted these. The Russia-Ukraine war created opportunities for exports of Basmati rice and oil meals.

Total Factor Productivity (TFP) in the meat industry has registered a significant growth of 7.9% from 2002 to 2016. TFP growth has been higher in Punjab, Haryana, Rajasthan, West Bengal, Madhya Pradesh, Bihar, Assam, Telangana, and Andhra Pradesh. In the meat industry, poultry and beef have experienced higher TFP growth. Enhancing technical efficiency and adapting to changing socioeconomic and legal frameworks are essential for maximizing the potential of the meat processing industry.

Considering the potential role of Farmer Producer Organizations in achieving scale and profitability of smallholder agriculture, a study was conducted to estimate its impacts. FPOs have a significant positive effect on crop yields (3.59%), milk production (18.23%), and value of output (44% for crops and 33% for milk). These indicate the crucial role of FPOs in linking farmers to markets.

## Other Activities

During 2023-24, ICAR-NIAP published five Policy Papers and five Policy Briefs. The faculty published 50 research articles in peer-reviewed national and international journals. Besides, many popular articles were published in magazines and newspapers. The faculty actively participated in mass media and policy debates on various platforms.

The Institute organized a Winter School on "Quantitative Techniques for Agricultural Policy Analysis" during the period. It also organized capacity-building programmes for agricultural economists and social scientists in the NARS and for marginalized rural communities. Policy lecture series on contemporary issues in agriculture has been a continuous activity of the Institute.

The Institute is a knowledge partner of the Ministry of Agriculture and Farmers' Welfare and NITI Aayog and has provided policy and technical inputs for reforming agricultural programmes and policies. Besides, it has also offered evidence-based policy inputs to other ministries and state governments.

# 1 ICAR-NIAP: An Overview

The National Institute (formerly Centre) of Agricultural Economics and Policy Research (NIAP) was established in 1991 by the Indian Council of Agricultural Research (ICAR) to strengthen agricultural economics and policy research in the National Agricultural Research System (NARS) and to act as a think tank for the ICAR by providing credible research-based inputs to enhance its participation in policy debates and decisions. The Institute also offers evidence-based inputs to NITI Aayog, the Ministry of Agriculture and Farmers Welfare, other ministries of the Central Government, and the state governments.

## Vision

Leveraging innovations for attaining efficient, inclusive, and eco-friendly agricultural growth through agricultural economics and policy research

## Mission

Strengthen agricultural economics research for providing economically viable, socially acceptable, and environmentally feasible policy options for science-led agricultural growth

## Mandate

- Agricultural economics and policy research on markets, trade, and institutions
- Growth and development models for sustainable agriculture
- Technology policy, evaluation, and impact assessment

ICAR-NIAP has significantly contributed to the growth of the agricultural economics discipline in the NARS. It has guided the Council in prioritizing its research agenda to improve the efficiency, sustainability, and equity of research investment. The Institute has made notable contributions in areas such as demand and supply projections, returns to investment in R&D, impacts of technological change, total factor productivity, climate change impacts on agriculture and effectiveness of adaptation measures, sustainability of agri-food systems, management of groundwater resources, agricultural diversification, structural change in agriculture, international trade in agriculture, institutional innovations, crop insurance, market intelligence, commodity outlook, value chains, price volatility and transmission, market integration, etc.

The Institute strives to foster partnerships with national and international organizations for research on common economic and social problems and directs the trajectory of agricultural growth through policy-oriented research and communication. Its vision and mandate focus on:

1. Policy studies on agricultural development issues through in-house, collaborative, and consultancy research
   - R&D policy and technology management
   - Natural resource and environmental economics
   - Agricultural development, markets, and trade
2. Strengthening agricultural economics and policy research
   - Capacity development through facilitation and networking
   - Enhance ICAR's participation in policy decisions through policy dialogues and institutional linkages

## Institute Activities

### Research activities

The scientific activities are organized under three broad themes:

- Agricultural Growth and Development
- Technological and Sustainable Agriculture
- Agricultural Market and Trade

### Capacity building

The ICAR-NIAP plays a key role in building the capacity of human resources engaged in agricultural economics and policy research. Towards this, formal linkages have been established within and outside the NARS through networking and training on advanced analytical skills.

### Policy interface and communication

The ICAR-NIAP contributes to policy formulation through the participation of its faculty in policy dialogues, debates, and committees of the central and state governments. The Institute regularly publishes policy papers and policy briefs on contemporary issues.

## Organization and Management

Director of the Institute is advised and assisted by several committees to manage research and administration. The Research Advisory Committee (RAC) guides in planning research capacity building, policy communication and research evaluation. Dr. H.K. Bhanwala, Former Chairman, NABARD, was the Chairman of the RAC during the reporting period. The Institute Management Committee (IMC) supervises the functioning of the Institute.

There are several internal committees to assist the Director in the efficient management of the Institute. The Institute Joint Staff Council (IJSC) enables consultative decisions on safeguarding and promoting the interests of the staff.

The Institute also regularly meets with its scientific, technical, and administrative staff to discuss scientific and management issues.

The organogram of the Institute is shown in Figure 1.1.

## Information, Data and Facilitative Services

### Agricultural Knowledge Management Unit (AKMU)

The Agricultural Knowledge Management Unit (AKMU) facilitates knowledge exchange, dissemination, and capacity building initiatives of the Institute.

It maintains digital repositories, databases, and information portals. It also manages various information system (MIS) modules, including the Financial Management System (FMS), Foreign Visit Management System (FVMS), Agricultural Research Management System (ARMS), and Electronic Human Resource Management System (eHRMS).

ICAR-National Institute of Agricultural Economics and Policy Research (NIAP) takes pride in its website, https://niap.icar.gov.in/, which serves as a dynamic platform to disseminate information and showcase the latest activities of the Institute. Available in English and Hindi, the website offers a wealth of resources and serves as a central hub for stakeholders to access valuable information about our research, publications, employment opportunities, tenders, Right to Information (RTI) details, infrastructure, and staff profiles.

### Surveillance audit for ISO 9001:2015

To maintain our commitment to the highest standards of quality and excellence, ICAR-NIAP has completed the surveillance audit for ISO 9001:2015. This reaffirms our dedication to adhering to internationally recognized quality

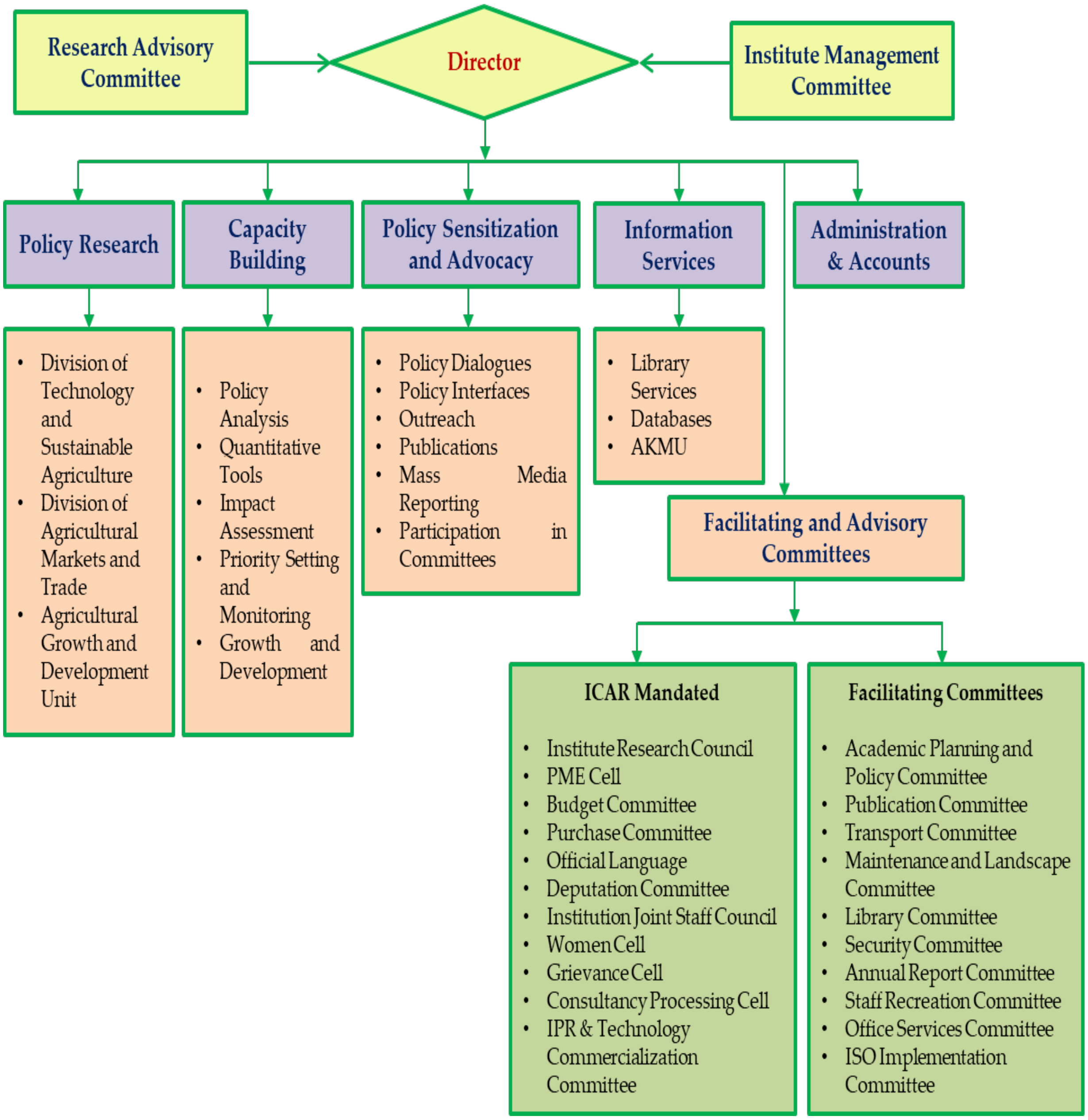



**Figure 1.1: Organogram of ICAR-NIAP**

management practices. We continue to prioritize systematic approaches to ensure consistent quality in our products and services, enhancing organizational efficiency and customer satisfaction.

## MIS: Implementation of centralized ERP system

ICAR-NIAP has implemented the centralized Enterprise Resource Planning (ERP) system to enhance efficiency and streamline operations. This comprehensive system encompasses various modules, including financial management, project management, material management, human resources, and payroll.

- **Financial Management**: Our ERP system provides solutions for General Ledger, Account Payable, Account Receivable, Cash Management, Fixed Assets Management, Budget Management, Grants, and Payroll, ensuring robust financial controls and accurate reporting.

- **Project Management**: With dedicated modules for Project Information, Costing, Project Documents, Contract Management, and Collaboration, our ERP system enables seamless project execution and monitoring, contributing to improved project outcomes.
- **Material Management**: The ERP system offers solutions for Purchase and Inventory Management, optimizing procurement processes and ensuring adequate inventory levels to support our operations.
- **Human Resource Management**: The ERP system offers comprehensive modules for Employee Information, HR Policies, Leave Management, Performance, and Appraisal System, ensuring efficient management of human resources and fostering a productive workforce. In alignment with directives from headquarters, efforts were undertaken this year to migrate toward the new eHRMS module. This proactive step has prepared us for the transition to the new system, scheduled to be implemented from 2024-2025, further enhancing our HR management capabilities.
- **Payroll System**: The ERP system includes comprehensive solutions for Salary, GPF, Pension Payment, Retirement Benefit Calculation, and Income Tax Calculation, streamlining payroll processes and ensuring compliance with statutory requirements.

## ICAR-eHRMS at ICAR-NIAP

The ICAR-NIAP is committed to the successful implementation of the ICAR-eHRMS (Indian Council of Agricultural Research - e-Human Resource Management System). The ICAR-eHRMS is a comprehensive digital platform designed to streamline and automate human resource management processes. Through this system, the ICAR-NIAP plans to effectively manage employee records, attendance, and leave applications, amongst many others.

## Human Resources

The staff position at ICAR-NIAP during 2023-24 is given below in Table 1.1.

**Table 1.1: Staff position at ICAR-NIAP during the year 2023-24 (as on 31.03.2024)**

| S. No. | Class of Posts | Total Posts Sanctioned | Total Employees in Position |
|---|---|---|---|
| 1 | RMP | 1 | 1 |
| 2 | Head of Division | 2 | 2 |
| | **Scientific Posts** | | |
| 3 | Principal Scientist | 1 | 2 |
| 4 | Senior Scientist | 6 | 3 |
| 5 | Scientist | 21 | 20 |
| | **Technical Posts** | | |
| 6 | Technician (T-1) | 3 | 1 |
| 7 | Technical Assistant (T-3) | 4 | 3 |
| | **Administrative Posts** | | |
| 8 | Administrative Officer | 1 | 1 |
| 9 | Finance & Accounts Officer | 1 | 1* |
| 10 | Assistant Administrative Officer | 1 | 1 |
| 11 | Personal Secretary | 1 | 1# |
| 12 | Assistant | 4 | 3 |
| 13 | UDC | 1 | 0 |
| 14 | Personal Assistant | 2 | 1 |
| 15 | LDC | 2 | 2 |
| 16 | Multi-Tasking Staff | 2 | 1 |
| | **Total** | **53** | **43** |

*Assistant Finance & Accounts Officer is working against the post of Finance & Accounts Officer

# 2 Research Achievements

## Agricultural Growth and Development

### Food demand and supply projections for 2047

*S. K. Srivastava, N. Sivaramane, P. S. Birthal and R. K. Paul*

India is envisioned to enter the league of developed nations by 2047. To realize this vision, the economy has to grow at an annual rate of about 8%, from 6.34% in the recent decade. Thus, people would be more affluent and will demand more nutritious, safe, and processed foods. The demand for food commodities as feed, fibre, and fuel will also increase.

On the other hand, the country has limited land and water resources, which will shrink due to their competing demand for domestic, energy, and industrial uses. Thus, managing the food supply to meet the growing demand would be a significant challenge. This study has projected demand and supply of different food commodities upto 2047.

Different components of food demand (i.e., human consumption, feed, seed, wastages, and raw material for processing and other industries) and supply (i.e., domestic production, carry-over stock, and imports) for the base year (i.e., 2011-12) have been estimated, and projections are made upto 2047 under a Business-As-Usual scenario (BAU- continuation of 6.34% growth in real income, and High-Income-Growth scenario (HIG) (7% to 8%) over the next 25 years. Similarly, production forecasts have been made under the BAU and High-Yield-Growth (HYG) (closing the gap between the existing and realizable potential yield) scenario.

The demand and supply projections for different food commodities for 2047 are presented in Figure 2.1. The overall food demand is projected to grow at 2.44 – 3.07% per annum under different income growth scenarios. Gross cropped area is expected to expand at an annual growth of 0.45%. Hence, the additional production needed to meet the demand has to come from yield improvements. A considerable yield gap exists in most crops, which offers scope to accelerate production growth. For several food commodities, domestic production will be higher than the demand.

### Convergence in farm income

*Balaji S. J. and Gopinath M.*

Farm investments by poor farmers are lower than their wealthier counterparts. Hence, returns should be relatively higher for the additional investment made by the poor. In other words, there should be an inverse relation between farm income growth and initial income level, known as convergence in literature.

This study has tested the farm income convergence hypothesis in India. Possible heterogeneities in the steady state arising from exogenous factors make convergence conditional. The study has included investment in irrigation and market infrastructure, crop diversification, and distance to urban markets variables as control.

Both conditional and unconditional convergence hypotheses are tested. Spatial spillovers need to be accounted for in the models. Moran's I and Geary's C indices were constructed to diagnose the presence of spatial dependence. The Geary index diagnosed the presence of spillover in residuals, and hence, a Spatial Error Model

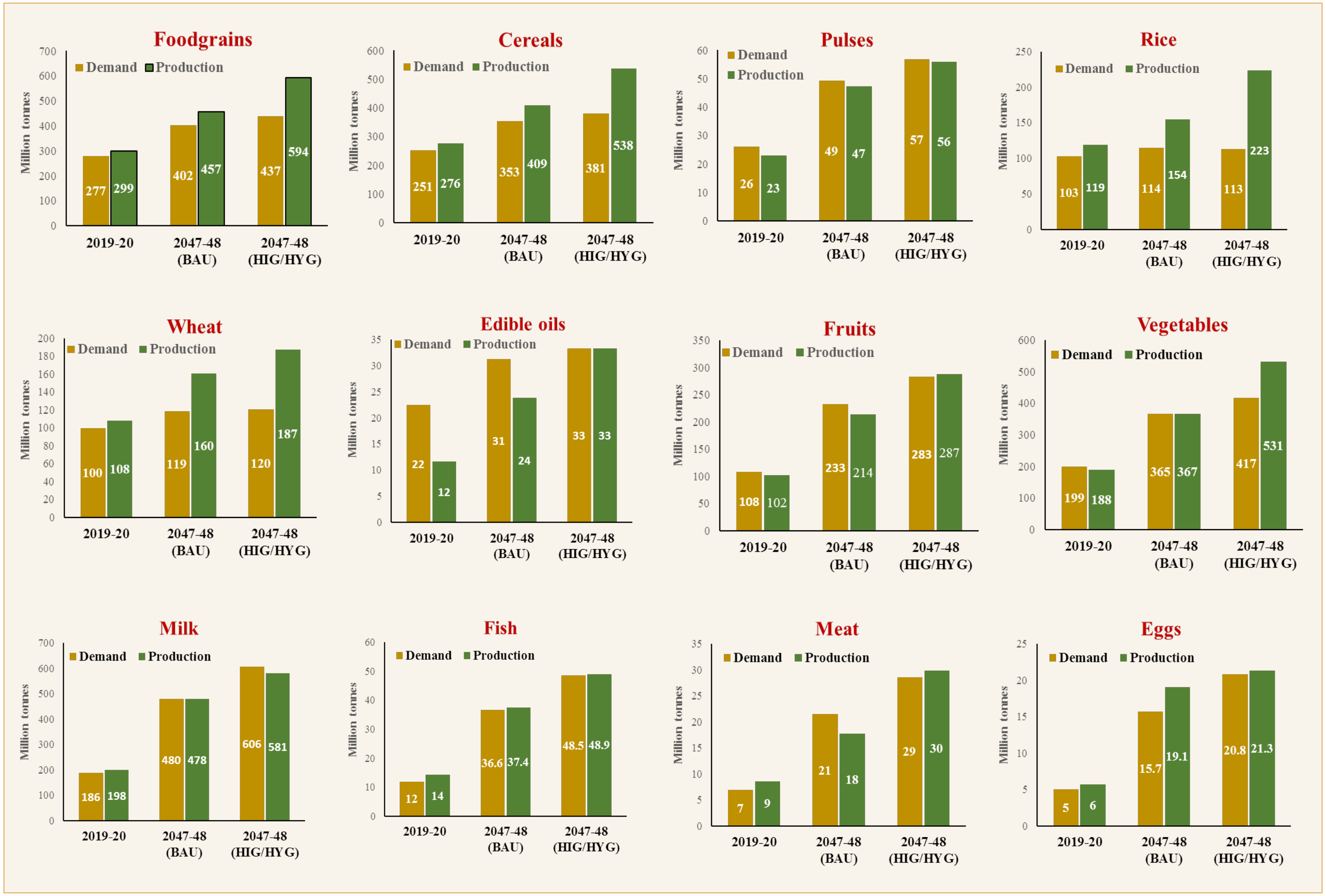



**Figure 2.1: Projections of food demand and production of food commodities under alternative scenarios in India**

(SEM) was estimated. Household farm income was estimated in 599 districts using three pan-India Situation Assessment Surveys (2003, 2013, 2019) conducted by the National Sample Survey Office. Two time periods were considered for testing convergence in farm income: 2003–2013 and 2003–2019. The district-level income by source was derived from the household income distribution. The median crop income distribution in a district was presumed to be the district's income from crops. Likewise, the median incomes from livestock and overall agriculture were derived. To assess the distributional impacts, 20th, 50th, and 80th income percentiles were estimated. Nominal income was converted into real income using the gross state domestic product (GSDP) deflator, with 2011–12 as the base period.

Findings show a notable transition across states — both in the composition of crop and livestock incomes and progress therein. High-income clusters are located primarily in northern, northeastern, and western regions, and low-income clusters are in the eastern region. In the southern region, clusters appear to be distributed randomly. Initial analysis shows an absolute convergence but a slowdown in the recent period. The tendency to converge is slightly stronger in crop income than in total income. Differential growth in livestock income is the reason for the difference in convergence rates of crop income and total farm income. The deceleration in growth across districts during 2013–19 is the reason behind the slowdown (Figure 2.2).

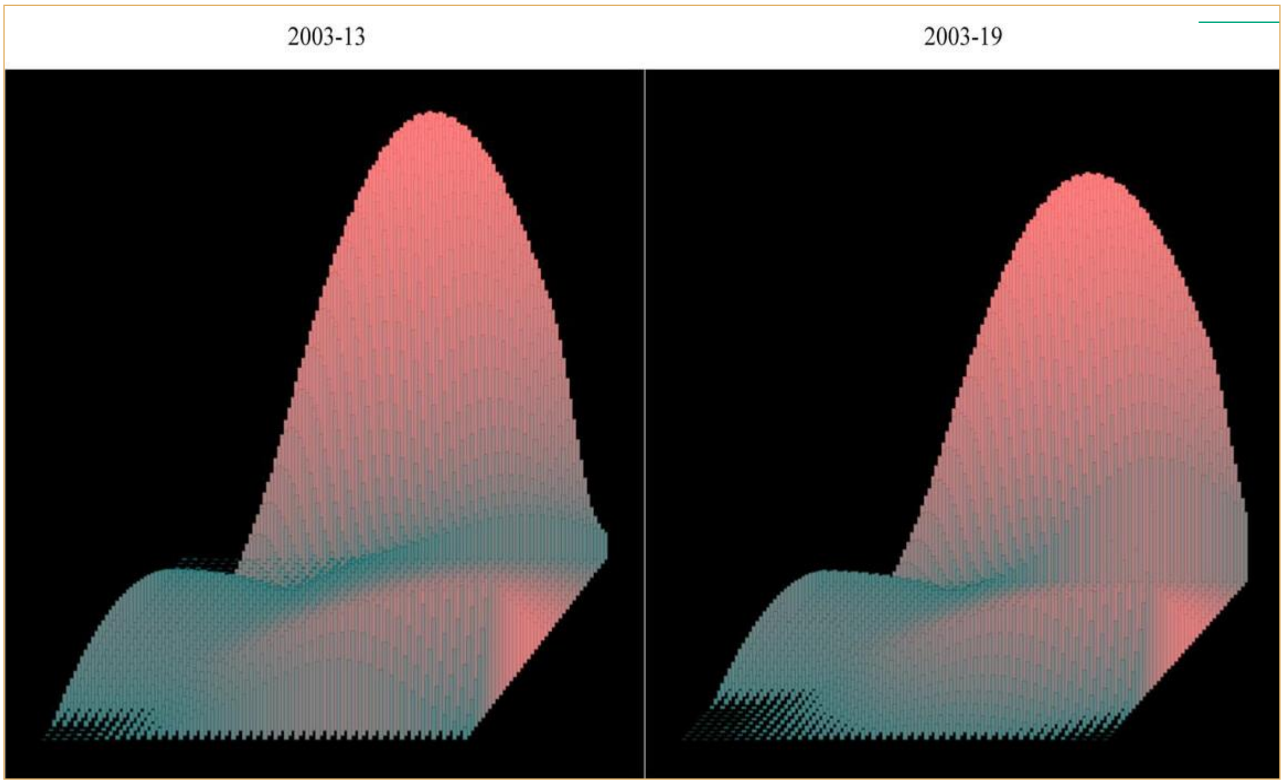



**Figure 2.2: Bivariate kernel density distribution of districts' income growth during 2003–2013 (left panel) and 2003–2019 (right panel) against income level in 2003**

**Table 2.1: Drivers of income growth: Structural Equation Model (SEM) estimates**

| | 2003-13 | | | 2003-19 | | |
|---|---|---|---|---|---|---|
| | $P_{20}$ | $P_{50}$ | $P_{80}$ | $P_{20}$ | $P_{50}$ | $P_{80}$ |
| ln Income $_{2003}$ | −0.004** (0.002) | −0.014*** (0.003) | −0.025*** (0.003) | −0.001 (0.001) | −0.008*** (0.001) | −0.016*** (0.002) |
| ln irrirgattion$_{2003}$ | 0.005 (0.006) | 0.012** (0.006) | 0.032*** (0.006) | 0.005 (0.003) | 0.012*** (0.003) | 0.022*** (0.003) |
| ln market distance$_{2003}$ | −0.066*** (0.024) | −0.093*** (0.025) | −0.058*** (0.020) | −0.025* (0.014) | −0.024* (0.012) | −0.019* (0.011) |
| ln Diversification$_{2003}$ | 0.007 (0.005) | 0.007* (0.004) | 0.008** (0.003) | −0.001 (0.003) | 0.002 (0.002) | 0.004** (0.002) |
| Constant | 0.479*** (0.168) | 0.693*** (0.176) | 0.445*** (0.144) | 0.179* (0.097) | 0.179** (0.088) | 0.153* (0.079) |
| ϱ | 0.241*** (0.059) | 0.434*** (0.051) | 0.486*** (0.047) | 0.237*** (0.057) | 0.339*** (0.055) | 0.476*** (0.048) |

Note: Figures in parentheses are standard errors.
***, **, and * indicate significance at 1%, 5%, and 10% levels, respectively.

Conditional models show convergence in farm income but at a slower rate in recent years. Irrigation infrastructure, crop diversification, and distance to the urban market explain farm income growth and spatial disparities in income. Farm income grew slowly for poor farmers, and the distance to market was the primary factor. The medium- and high-income farmers have benefitted more from diversification and infrastructural investment. Technology spillovers—captured in residuals also have a positive impact (Table 2.1). As expected, the spillovers increased with income levels. The study suggests connecting the poor to markets, strengthening infrastructure and diversification for middle-income groups, and nudging high-income farmers towards value chains will help attain equitable economic development.

## Investment in agricultural R&D

*Ankita Kandpal, P. S. Birthal and Shruti Mishra*

Investment in agricultural research and development (R&D) has increased between 1980-81 to 2020-21 from Rs. 22,235 million to Rs. 1,64,310 million, with research accounting for about 80% of the total throughout (Figure 2.3). From 1980-81 to 2020-21, research investment grew at an annual rate of 5.4%, but the growth therein decelerated to 4.4% during 2011-2020. Similarly, the growth in investment in agricultural extension has decelerated to 4.5% during 2011-2020, compared to 7.6% growth in the previous decade.

The R&D intensity, measured as the proportion of agricultural Gross Domestic Product (AgGDP) spent on agricultural research and extension, increased from 0.53% during 1981-1990 to 0.76% during 2001-2010, but after that, it has remained almost stagnant. The research intensity rose from 0.38% during 1981-90 to 0.56% during 2001-2020. However, the intensity of agricultural extension investment improved slightly from 0.12% during 1981-90 to 0.16% during 2011-20 (Table 2.2).

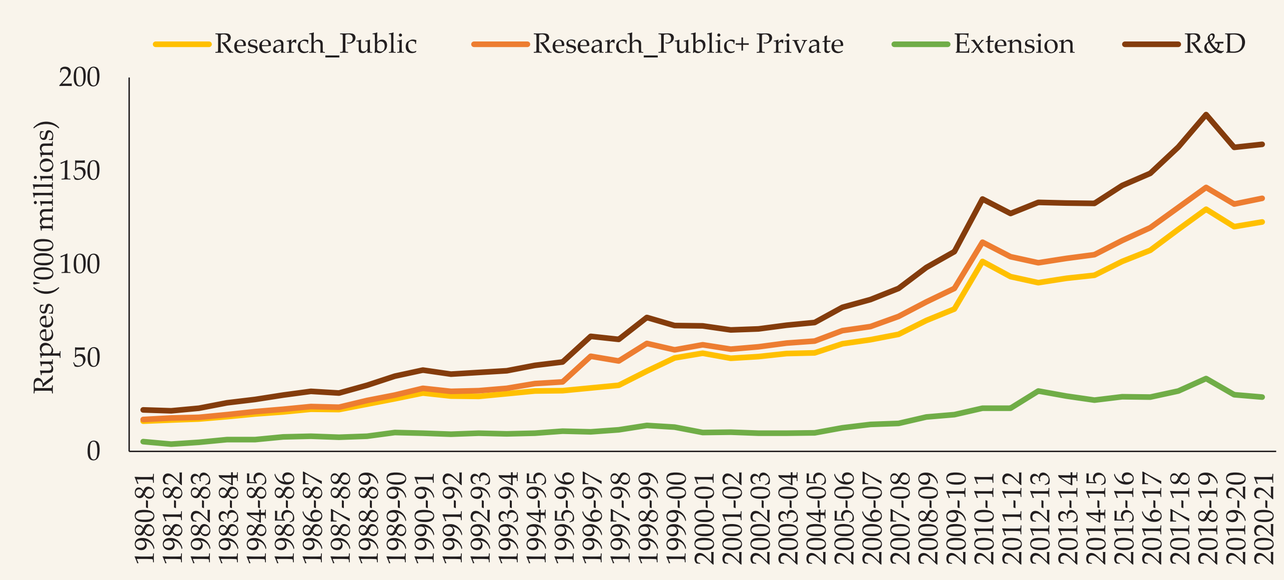



**Figure 2.3: Trend in annual investment in R&D (1981-90 to 2011-20).**

**Table 2.2: Investment in agricultural R&D as percent of agricultural GDP**

| Period | Research | | | Extension | Total R&D |
|---|---|---|---|---|---|
| | Public | Private | Total | | |
| 1981-1990 | 0.38 | 0.03 | 0.41 | 0.12 | 0.53 |
| 1991-2000 | 0.44 | 0.08 | 0.52 | 0.13 | 0.65 |
| 2001-2010 | 0.56 | 0.07 | 0.63 | 0.13 | 0.76 |
| 2011-2020 | 0.55 | 0.06 | 0.61 | 0.16 | 0.77 |

However, there exists an imbalance in agricultural R&D investment across sub-sectors. From 2010-11 to 2020-21, crops accounted for 82.9% of research and 92.1% of extension investments. In comparison, animal sciences received only 10.2% of research and 6.2% of total extension investments (Figure 2.4).

Further, payoffs to investment in agricultural R&D were estimated. The payoff to investment in agricultural research is quite attractive, Rs. 13.85 for every rupee spent (Figure 2.5). The payoff to investment in extension is estimated at Rs. 7.40. The payoff to investment in animal science research is even the higher Rs. 20.80, compared to Rs. 11.69 from crop science research. On the other hand, investment in crop extension pays more than investment in livestock extension.

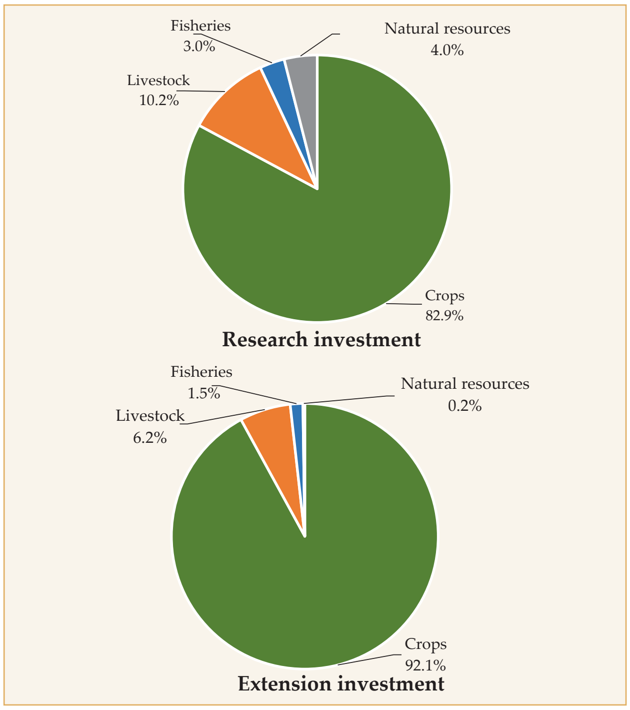



**Figure 2.4: Composition of agricultural research and extension investment**

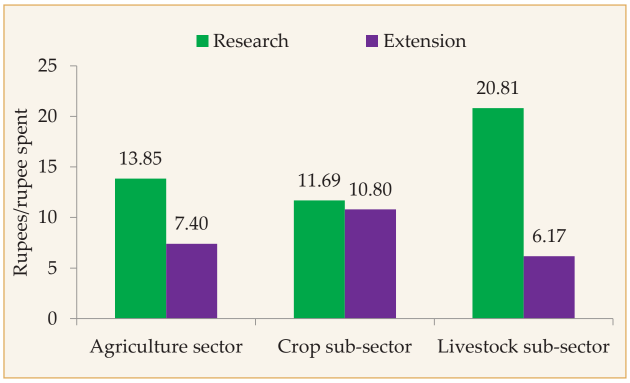



**Figure 2.5: Returns to investment in R&D in agriculture and its sub-sectors**

These findings suggest more investment in agricultural R&D and revisiting the agricultural research agenda, considering the emerging challenges and opportunities in agriculture. Research on livestock and natural resource management need more investment.

## Research priorities in Indian agriculture

*S. V. Bangararaju Tatipudi, Raka Saxena and P. S. Birthal*

Using the multi-criteria scoring approach, commodity and regional priorities have been assessed for agricultural research, considering the goals of efficiency, equity, and sustainability. Uttar Pradesh, Bihar, Rajasthan, and Maharashtra need to invest more. By theme/ commodity, animal science research needs more resources (29.4%), followed by horticulture (16.0%), cereals (15.7%), fisheries (5.7%), oilseeds (4.1%), sugars (3.9%), and pulses (3.2%) (Figure 2.6). More allocation of resources to livestock and horticultural research is crucial, given their increasing demand and significant effects in combating malnutrition and reducing poverty.

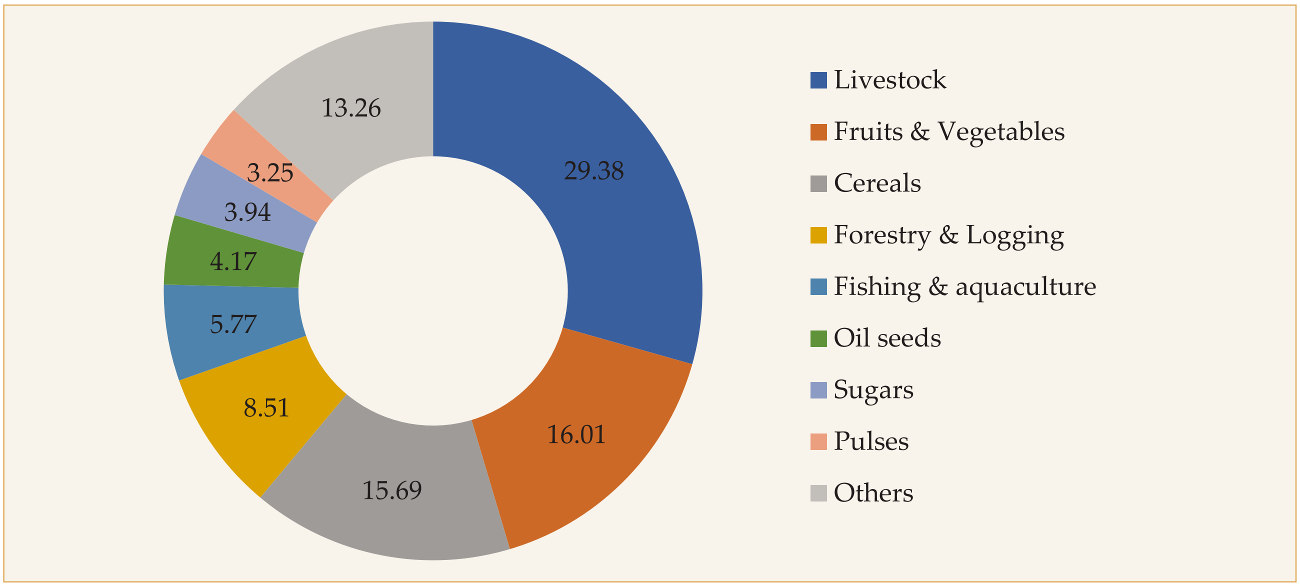



**Figure 2.6: Priorities for agricultural research**

# Technology and Sustainable Agriculture

## Groundwater and energy use patterns for irrigation

*S. K. Srivastava and Prabhat Kishore*

Groundwater has emerged as the dominant source of irrigation in India, raising its share of net irrigated area from 30.36% in 1964-65 to 60.45% in 2021-22. The successive Minor Irrigation (MI) Censuses indicate a four times increase in the number of wells for irrigation. The well density (no./1000 ha net sown area) has increased from 42 in 1982-83 to 158 in 2017-19.

Further, the growth of new wells has differed significantly across the types of wells, leading to a structural change in their composition (Figure

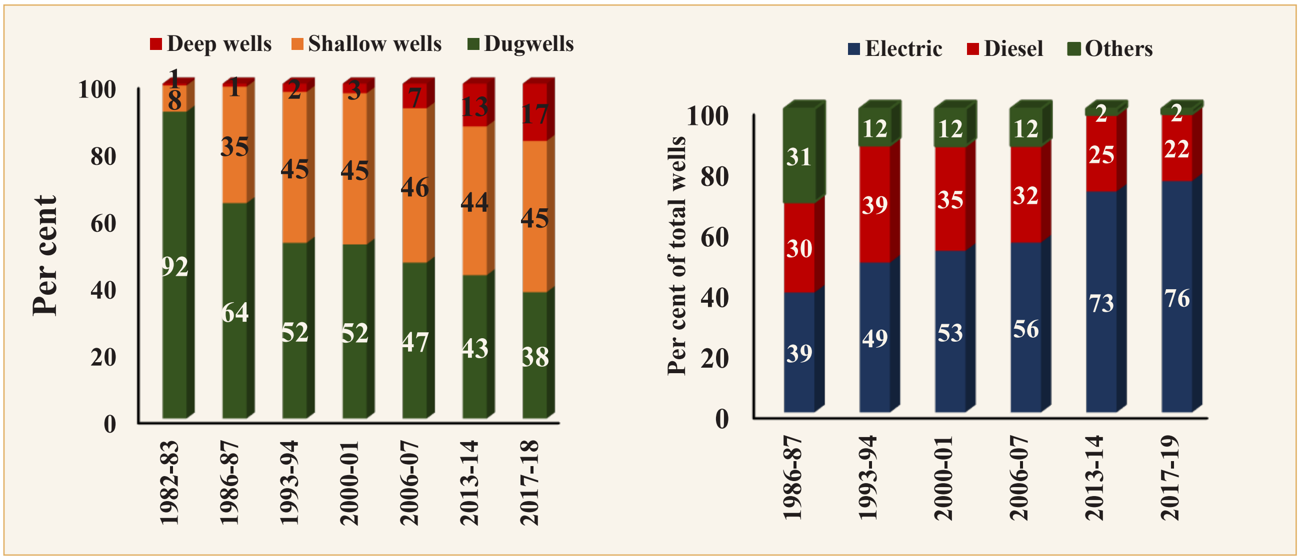



**Figure 2.7: Changing composition of groundwater wells (left panel) and energization sources (right panel) in India**

2.7). Dug wells comprised 92% of total wells in the early 1980s, but deep and shallow tubewells have gradually replaced them. This transition indicates farmers chasing depleting groundwater levels by installing high-powered groundwater extraction devices (GEDs). However, there are wide inter-state variations in the composition of GEDs.

With the increasing number and changing composition of the GEDs, the pattern of energy consumption in agriculture and its sources are also changing. Electricity is the main source of energy for groundwater extraction. In 1986-87, electricity, diesel, and other sources (manual, animal, solar, wind, etc.) energized 39%, 30%, and 31% of the total GEDs, respectively. Electricity energizes 76% of the total GEDs, followed by diesel (22%). The rising cost of diesel, subsidies on electricity, and deepening groundwater have driven the transition towards electricity. To promote energy security and economic access to irrigation, the government incentivizes adopting renewable energy, especially solar power, through schemes like Prime Minister *Kisan Urja Suraksha Evam Utthaan Mahabhiyan Yojana* (PM KUSUM). The number of solar pumps in the country has increased from 11,626 in 2013 to 5,01,673 in 2022.

## Effectiveness of groundwater regulation in India

*Prabhat Kishore, Devesh Roy, P. S. Birthal and S. K. Srivastava*

The governments of Punjab and Haryana in 2009 brought out almost an identical regulation — 'Punjab/Haryana Preservation of Subsoil Water Act 2009'— to prevent excessive and indiscriminate use of groundwater in paddy cultivation. This study analyzed if these regulations were successful.

Table 2.3 presents the estimated average treatment effects (ATTs) of the Acts in Punjab and Haryana for pre-monsoon groundwater levels using coefficients from three different methods, viz., difference-in-differences (DiD), synthetic control method (SCM), and Synthetic difference-differences (SDiD). All ATTs indicate a significant decline in groundwater level despite the regulation being in force.

**Table 2.3: ATTs for pre-monsoon groundwater level**

| | DiD | SCM | SDiD |
|---|---|---|---|
| **Punjab** | -4.203*** (0.951) | -4.079* (2.319) | -4.639*** (1.078) |
| **Haryana** | -3.329*** (0.951) | -4.332* (2.319) | -4.798*** (1.078) |
| **Combined** | -3.766*** (0.700) | -4.483*** (1.010) | -4.694*** (0.802) |

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

There could have been several possible offsets to the policy of delayed paddy transplantation to restrict groundwater extraction, including the extensification of paddy, switching over to higher capacity pumps, and free or subsidized electricity supply for irrigation.

## Enabling policies for solar-powered micro-irrigation

*S. K. Srivastava, Prabhat Kishore, P. S. Birthal, and P. B. Shirsath*

For sustainable use of natural resources, the Government of India has been promoting micro-irrigation and solar power in agriculture through schemes like Per Drop More Crop (PDMC) component of *Pradhan Mantri Krishi Sinchayee Yojana* (PM KSY) by the Ministry of Agriculture and Farmers Welfare (MoA&FW), and solar power through *Pradhan Mantri Kisan Urja Suraksha Evam Utthaan Mahabhiyan* (PM KUSUM) by the Ministry of New and Renewable Energy (MNRE). Despite a strong association between water and energy, these schemes have little synergy. This study explored the possibility of PDMC and PM KUSUM convergence, as well as the policy and institutional requirements to make this happen.

India has the potential to irrigate 88 million ha (Mha) using micro-irrigation, but only 17.2% of this potential was realized in 2023 (Figure 2.8). Similarly, only 2.6% of the 102 Gigawatts (GW) solar potential for irrigation was harnessed. Significant inter-state variation exists, with 80% of micro-irrigation and solar pump use concentrated in a few states. States that excel in micro-irrigation lag in solar energy adoption and vice versa.

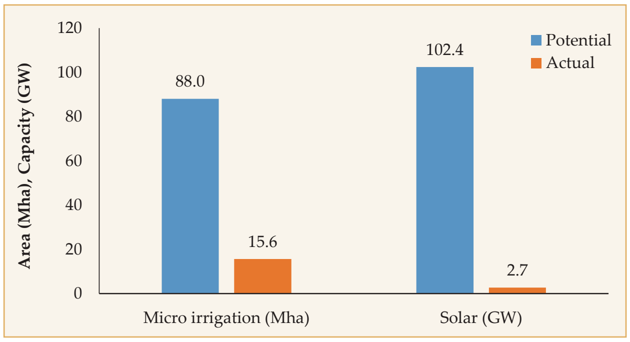



**Figure 2.8: Potential of micro-irrigation and solar power exploited in agriculture, 2023**

There are several benefits of coupling micro-irrigation with solar power. Micro-irrigation saves water and, therefore, energy for pumping out groundwater. By reducing energy costs solar-powered micro-irrigation improves farm profits. This will also reduce the lag in recovering capital costs incurred on solar pumps. Calculations indicate that the solarization of a diesel pump can save 963 litres of diesel per annum. Further, solarization of an electric or diesel pump can reduce $CO_2$ emissions by 2.1 tonnes annually. Besides, it can improve water-use efficiency by 15-50%.

Solar-powered micro-irrigation is a capital-intensive system. It requires 17-20% additional cost of coupling micro-irrigation with solar pumps. Substitution of a diesel pump with a solar-powered micro-irrigation system is economically viable. At the existing level of subsidy on micro-irrigation and solar pumps, the incremental cost can be covered in two years by saving diesel. The payback period extends to four years if there is no capital subsidy. Substitution of an electric pump with a solar-based micro-irrigation system is not economically viable if the savings in electricity cost at subsidized tariff are considered. If there is no subsidy on electricity tariff, it is possible to recover the capital cost in 11 years. However, an additional capital subsidy of 20% (over the current 60%) on solar pumps coupled with no subsidy on electricity tariff reduces the payback period to five years. These findings suggest rationalizing power tariffs and re-purposing electricity subsidy to adopt solar-powered micro-irrigation.

The study suggests restructuring the institutional setup of planning and implementing the micro-irrigation and solar promotion schemes at the central and state levels. PDMC and PM KUSUM schemes should be jointly implemented by either a single agency or in coordination. The other option is to promote Special Purpose Vehicles (SPVs) to implement these schemes in tandem, like in Andhra Pradesh and Gujarat. To improve economic viability, electricity subsidies may be repurposed to support the adoption of solar-powered micro-irrigation systems, with additional subsidies if needed. A single financial package for both schemes is advised to reduce transaction and administrative costs for financial institutions and farmers. Micro-irrigation should focus on high-value crops like fruits and vegetables for quicker investment recovery. There is an apprehension that excessive use of solar power for irrigation may aggravate the over-extraction of groundwater because of farmers' behavioral response in terms of switching over to water-intensive crops and bringing more area under irrigation. Hence, budgeting and regulating groundwater at lower spatial scales (district or block) within its replenishable limit is imperative.

## Slab-based power tariff policy in Uttar Pradesh

*S. K. Srivastava and Prabhat Kishore*

Uttar Pradesh exhibits wide regional variation in water endowment and agro-climatic conditions. Groundwater resources in most parts of the western region are over-exploited, while they are largely under the safe category in the central and eastern parts. During 2022-23, the state government provided a 50% subsidy on electricity bills for irrigation, which was increased to 100% in 2023-24. However, it has definite implications for the sustainability of groundwater resources.

The existing energy use pattern for irrigation in deep and shallow water levels was assessed, and the feasibility of slab-based power tariff policy considering irrigation water requirement and groundwater level status at the regional level was evaluated. This analysis is based on a primary survey of 350 farmers conducted in Baghpat (western region) and Sitapur (central region) districts.

Baghpat has groundwater at a depth of >10 metres below ground level (mbgl), and suffers from over-exploitation of groundwater. On the other hand, Sitapur has groundwater at a shallow level. The cropping pattern in both districts is dominated by water-intensive crops such as paddy, wheat, and sugarcane. The average rainfall in these districts is less than the state average of 792 mm, enhancing farmers' dependence on groundwater for irrigation. Irrigation coverage in Sitapur and Baghpat districts were 88.50% and 99.42%, respectively, with groundwater as the main source. However, energy sources differ. Diesel is the main source (87.4%) in Sitapur, whereas electricity is the main source in Baghpat. The dominance of diesel in Sitapur could be due to groundwater availability at shallow level, and thus lower horsepower requirement. Nevertheless, the number and use of electric-operated submersible pumps is rising. The measured discharge rate of irrigation water varies from 5.5 to 24.5 litres/second in Sitapur and 27-30 litres/second in Baghpat.

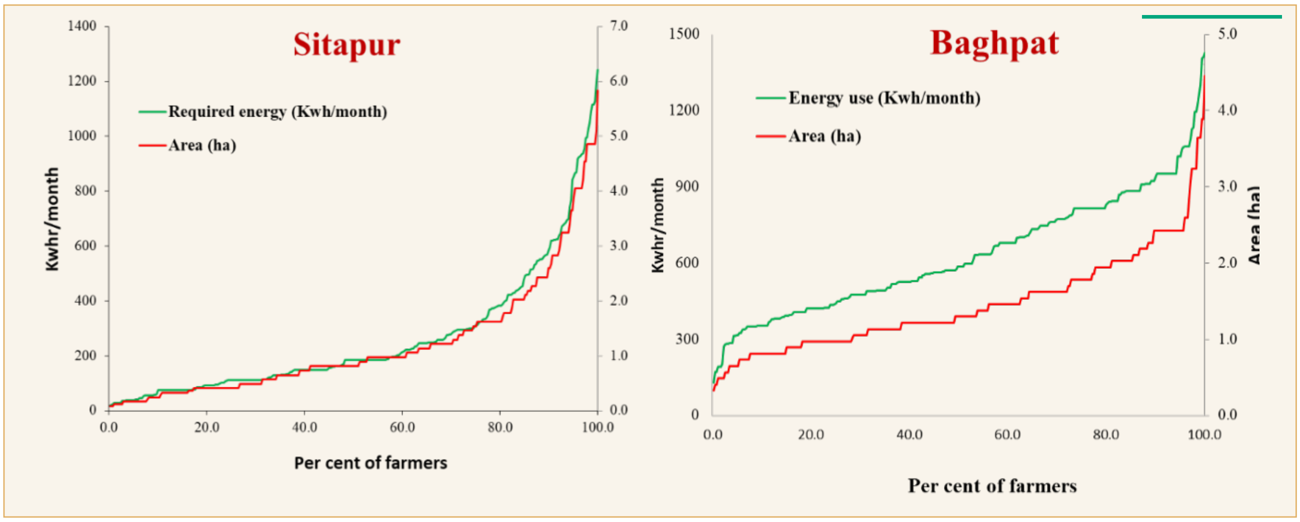



**Figure 2.9: Cumulative distribution of curve of required energy and area cultivated by sample farmers in 2022-23**

Figure 2.9 presents the cumulative distribution curves for the energy required and area cultivated in Sitapur and Baghpat districts. Marginal farmers require less than 200 units/ month of electricity to meet their irrigation requirements of the existing cropping pattern. About 80% of farmers (marginal and small) can meet their irrigation requirements with only 400 units of electricity in a month. On the other hand, in Baghpat, 80% farmers (marginal and small) require about 800 units/ month. Hence, instead of providing electricity at a highly subsidized rate or free, farmers can be provided minimum required energy units free, and then the electricity tariff can be increased gradually. This "slab-based power tariff policy" will encourage farmers to use groundwater judiciously as well as reduce the subsidy burden. Successful implementation of such a policy will require estimation of required energy at the gross-root level (e.g., block-level) based on existing cropping patterns and groundwater level scenarios.

## Economic values, trade-offs and synergies of ecosystem services from sustainable agricultural practices

*Kiran Kumara T. M., P. S. Birthal and D. C. Meena*

Agriculture is multi-functional, producing economic services in terms of food, feed, fibre, and fuel and intangible or non-tradable services. However, markets for intangible services are missing, depriving farmers of their contribution to society. Through a meta-analysis, this study has estimated the value of ecosystem services and the trade-offs between tradable and non-tradable ecosystem services. The findings show a positive response of ecosystem services to improved agricultural practices. The monetary value of the non-tradable services, resulting from most of these interventions, is quite attractive, 34–77% of the total value of ecosystem services (Table 2.4).

However, not all practices generate win-win outcomes. Direct-seeded rice, organic manure, and agroforestry exhibit a trade-off between crop yield and intangible ecosystem services. Over 60.78% of studies on DSR show a trade-off, i.e., an improvement in ecosystem services and a fall in crop yield. Similarly, the exclusive application of organic manure is associated with loose-loose and trade-off relationships. Agroforestry has a trade-off between crop yield and carbon sequestration. This evidence suggests that not all agricultural technologies and practices are economically beneficial for

**Table 2.4: Economic value of ecosystem services from improved agricultural practices in India (Rs./ha/year)**

| Ecosystem services | Direct seeded rice | No-tillage | Legumes | Organic manure | Integrated nutrient management | Agroforestry |
|---|---|---|---|---|---|---|
| Provisioning services | -11832 | 1700 | 17531 | -6247 | 15314 | - |
| Regulating services | 3666 | 1085 | 4591 | 2010 | 1829 | 849 |
| Supporting services | 9669 | 4899 | 10572 | 2235 | 6174 | 6909 |
| Value of traded services | -11832 | 1700 | 17531 | -6247 | 15314 | - |
| Value of non-traded services | 15163 | 5984 | 15163 | 4245 | 8003 | 7758 |
| Total economic value | 1503 | 7684 | 32694 | -2002 | 23317 | 7758 |
| Value of externality | 13335 | 5984 | 15163 | 4245 | 8003 | 7758 |

Note: Provisioning services: Crop yield; Regulating services: Carbon sequestration, Water saving & Greenhouse gas emission; Supporting services: Soil fertility, Biological nitrogen fixation & Soil retention

farmers despite their higher environmental benefits. These findings imply providing incentives for the adoption of technologies and practices to conserve ecosystems and natural resources.

## Economic impact of lumpy skin disease

*Khem Chand, P. S. Birthal and Subhash Kachhawaha*

Lumpy skin disease (LSD) is a transboundary disease in cattle caused by LSD virus (LSDV). In 2022-23, there was an outbreak of LSD, affecting 4.03 million cattle, equalling 2.08% of their total population. Rajasthan accounts for nearly 39% of the LSD-affected cattle, followed by Maharashtra (16%) and 11% in Assam (Figure 2.10).

The disease caused substantial financial losses to livestock farmers. The total economic loss due to LSD is estimated at Rs. 7,607 crores. Loss in milk output alone accounts for 90.5% of this. The cost of treatment and mortality loss, respectively, share 6.4% and 3.1% of the total loss. The economic loss is the highest (Figure 2.11) for Rajasthan (39.6%), followed by Maharashtra (15.8%), Punjab (12.5%) and Karnataka (10.2%).

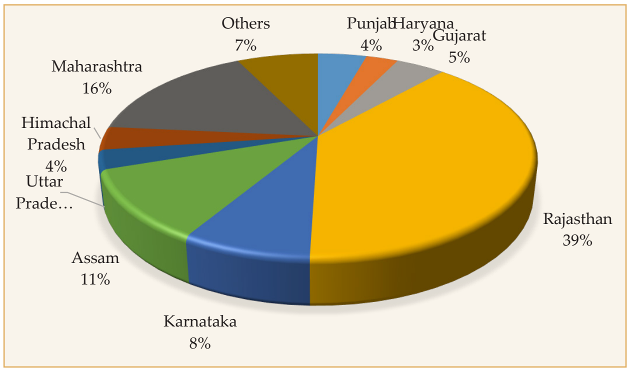



**Figure 2.10: Distribution of LSD-affected cattle population, 2022-23**

The significant losses are a matter of serious concern. The Government of India initiated a vaccination campaign. If 85% of the cattle population is immunized in three consecutive years, the country can save Rs. 15,210 crores. Alongside, there is also a need to make farmers aware of the sanitary and phytosanitary measures, such as disinfecting the animal sheds, quarantining the diseased animals, proper disposal of the dead animals, limiting the movement of infected animals, etc. to prevent the spread of the disease. Efforts are also needed to strengthen the public livestock extension system.

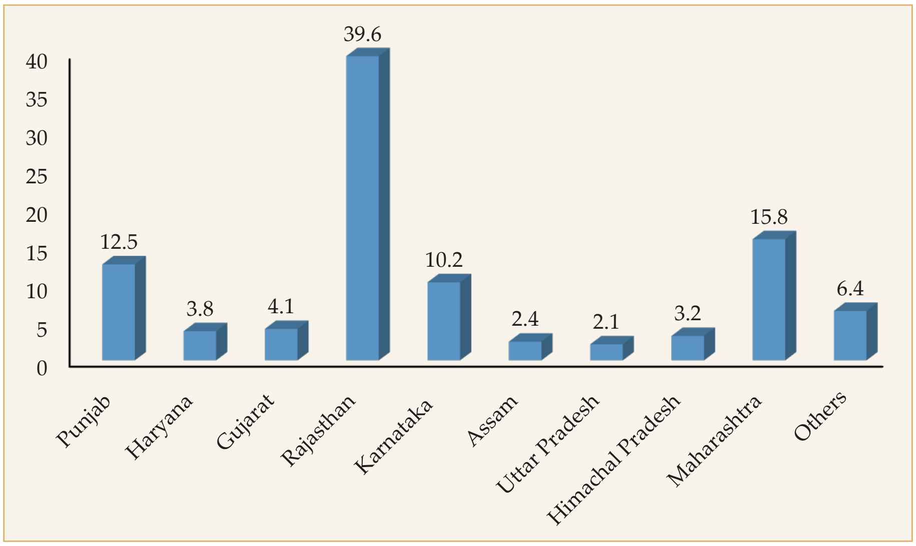



**Figure 2.11: State-wise total economic losses due to LSD (%)**

## Access to dairy breeding and health services in India

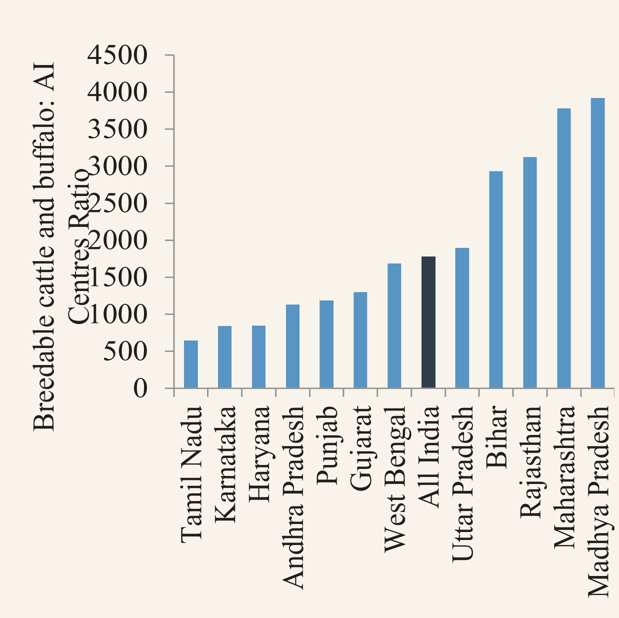
*Arathy Ashok, Vikas Kumar and Vinayak R. Nikam*

Veterinary services play a crucial role in augmenting productivity and production. However, farmers' access to many of these services is sub-optimal. Figure 2.12a illustrates the availability of livestock infrastructure facilities for health services in important milk-producing states. The livestock population to veterinary infrastructure ratio highlights their better availability in Punjab and Haryana, while not in Bihar, Uttar Pradesh, Madhya Pradesh, and Gujarat. The number of artificial insemination centres in relation to adult female cattle and buffalo population indicates that southern states, along with Punjab and Haryana, are relatively better positioned (Figure 2.12 b). However, major milk-producing states such as Uttar Pradesh, Rajasthan, Madhya Pradesh, Maharashtra and Bihar must improve their artificial insemination infrastructure.

The preliminary evidence from a field survey in Alwar district of Rajasthan shows the utilization of these services form different sources. Artificial insemination and disease diagnosis and treatment are primarily done by para-veterinary professionals, while vaccination is carried out by government agencies (Table 2.5). The adoption of advanced breeding techniques, such as sex-sorted semen-based artificial insemination, is extremely low. Additionally, a differential pricing structure for artificial insemination is observed by type of artificial insemination, agency providing the service, and location of service providers.

**Table 2.5: Acquisition of dairy services by households in Rajasthan**

| Type of service | Source of service (% of households) | | | | |
|---|---|---|---|---|---|
| | Government | Private | NGO | Cooperative | Para-veterinary professionals |
| Artificial insemination | 9.09 | 12.73 | 5.45 | 1.82 | 60.00 |
| Vaccination | 49.09 | 0.00 | 5.45 | 1.82 | 34.55 |
| Disease diagnosis and treatment | 3.64 | 3.64 | 3.64 | 0.00 | 85.45 |



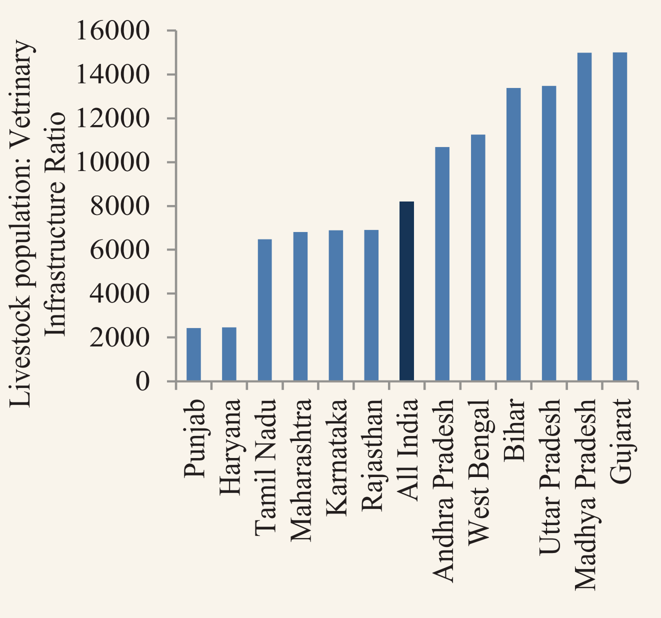




**Figure 2.12a: Ratio of population to veterinary infrastructure**

**Figure 2.12 b: Ratio of breedable bovine to artificial insemination centres**

## Status of common property resources (CPRs)

*Khem Chand, Prem Chand, Kiran Kumara T. M., Ravinder Shekhawat and Kalu Naik*

The study assessed the status and degradation of common property resources, and households' dependence on these in the Internal Drainage Dry Zone (IIA) of agro-climatic zone of Rajasthan. The major CPRs in this zone are pastures, wasteland, and water bodies. The percentage of total area under CPRs across locations ranges from 3.76% to 12%, with the per capita availability of 0.006 to 0.042 ha. The CPRs provide food, fibre, and fuel and conserve biodiversity and the environment. The contribution of CPRs to animal feed varies from 8% during the summer to 16% during the rainy season. The average value of goods derived from CPRs is estimated Rs. 13,725/ha/year. CPRs, however, have deteriorated because of the invasion of exotic species such as *Prosopis juliflora*, encroachments, and lack of participatory management.

## District-level effects of climate change in Indo-Gangetic Plains (IGP) of India

*Nalini Ranjan Kumar and S. K. Srivastava*

Impact of climate change was assessed on crop yields at the district level in the Indo-Gangetic plains. Figure 2.13 and Figure 2.14 provide the marginal effects. The districts marked in dark are severely affected, while those in lighter shades are less affected. Climate change will reduce yields of paddy, maize, wheat, and pearl millet, while cotton, chickpea, and rapeseed & mustard will benefit from it. However, the impact varies across districts in a state and across states. The findings suggest the need for regionally differentiated strategies to mitigate the impacts of climate change.

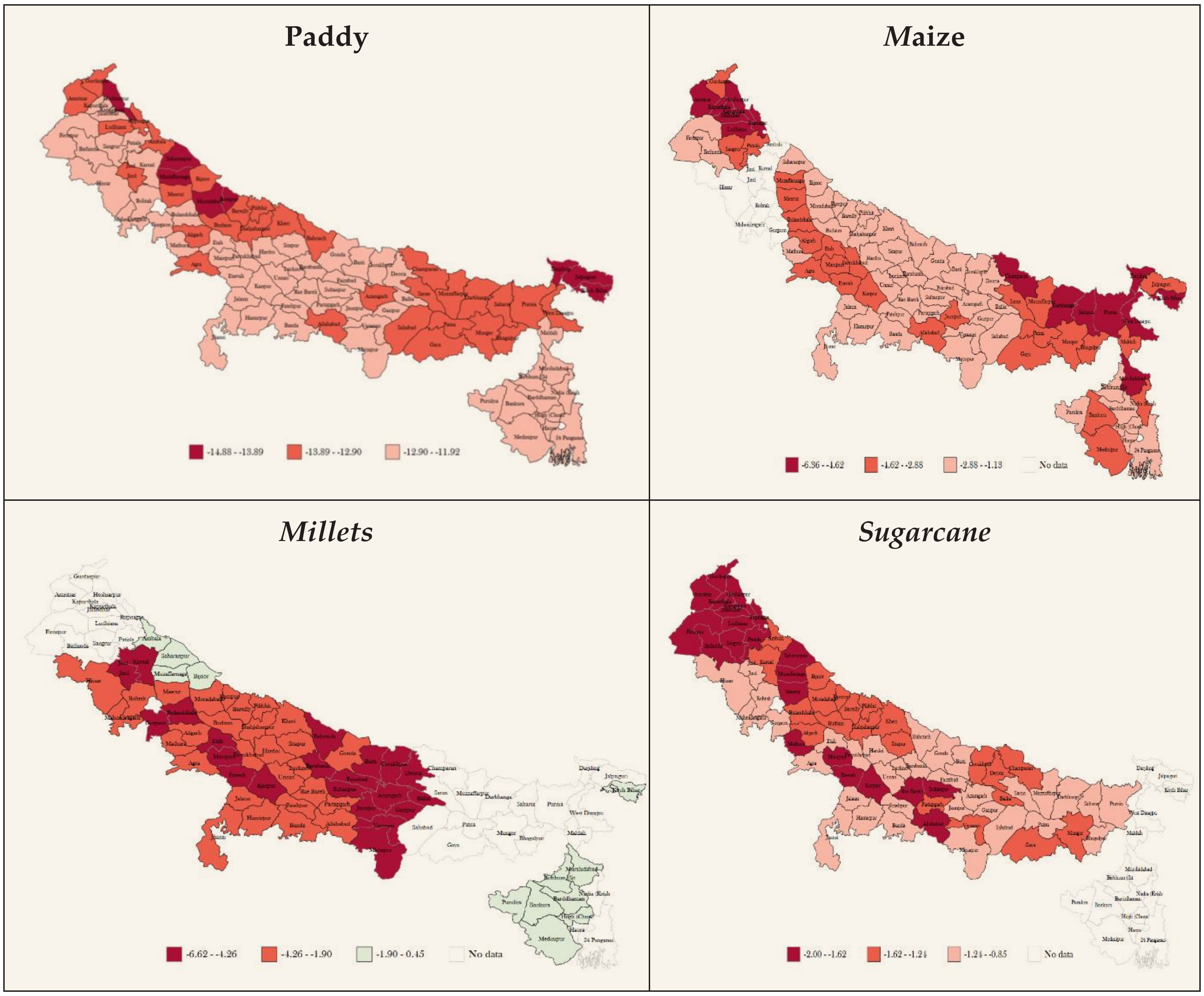
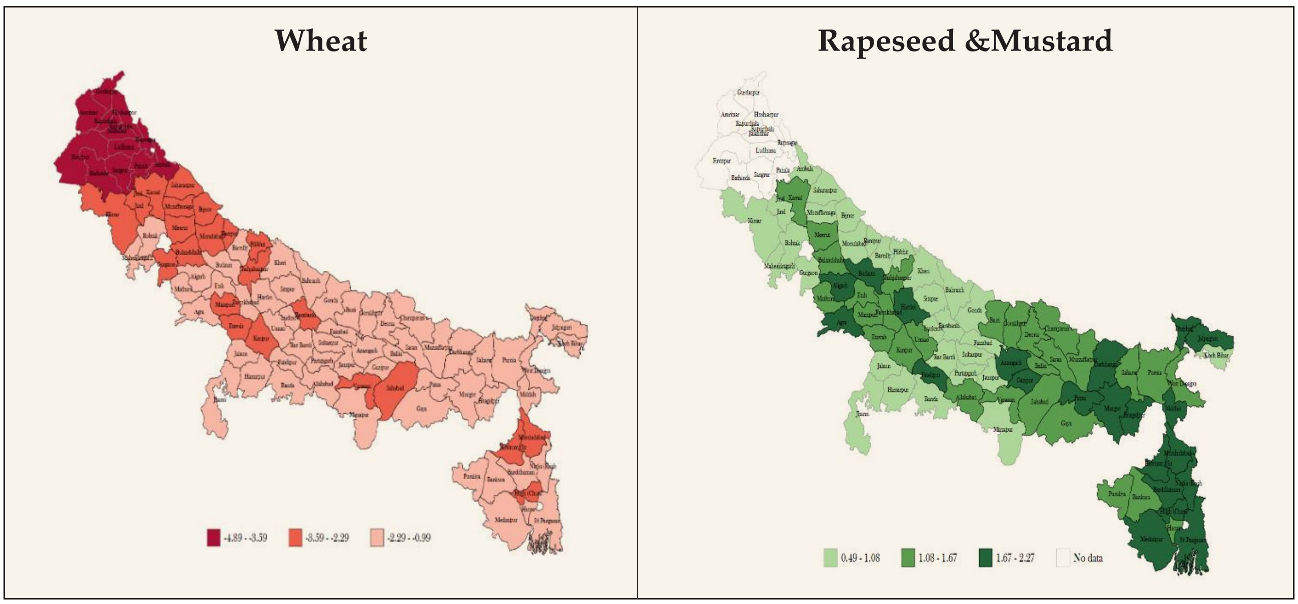



**Figure 2.13: District-wise combined average marginal effects of climatic variables on crop yield in kharif season in IGP (1966-2020)**



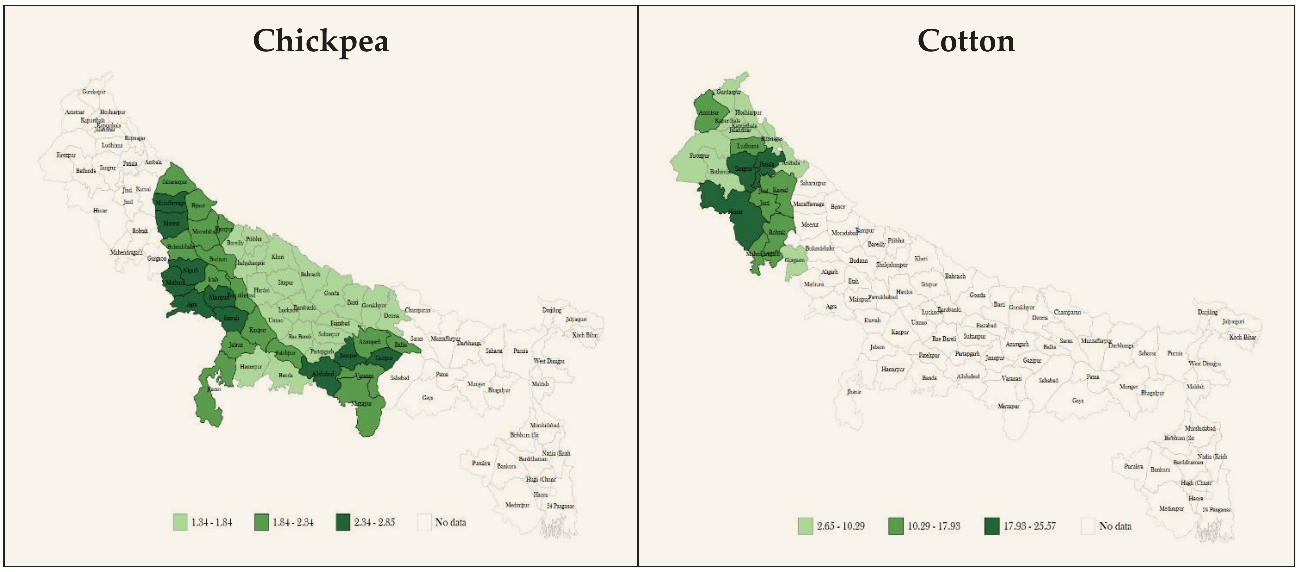



**Figure 2.14: District-wise marginal effects of climatic variables on crops yields in rabi season in IGP (1966-2020)**

## Disparity in fertilizer use in India

*Sant Kumar, P. S. Birthal and Kingsly Immanuelraj T.*

This study examines disparities in fertilizer use in India across ecologies, crops, and farm-size classes. Irrigated agriculture, which occupies about half of the gross cropped area (GCA), accounts for about 70% of the total fertilizer use. Irrigated agriculture uses 2.4 times more fertilizer per ha than rainfed agriculture (Figure 2.15). Fertilizer use is inversely related to farm size in irrigated and rainfed environments. On marginal farms (≤1 ha), the average fertilizer use is 151 kg/ha, which is more than twice that on large farms (10 ha and above). The marginal farms, which account for 25.3% of GCA, utilize 30.1% of the total fertilizer consumption. On the other hand, the share of large farms in the overall fertilizer consumption is only half of their share in the GCA (7.8%). Higher fertilizer use on marginal farms is due to higher cropping intensity and larger allocation to input-intensive crops like vegetables. Notably, marginal and small farms (<2ha) account for about 55% of the total area under vegetables in the country.

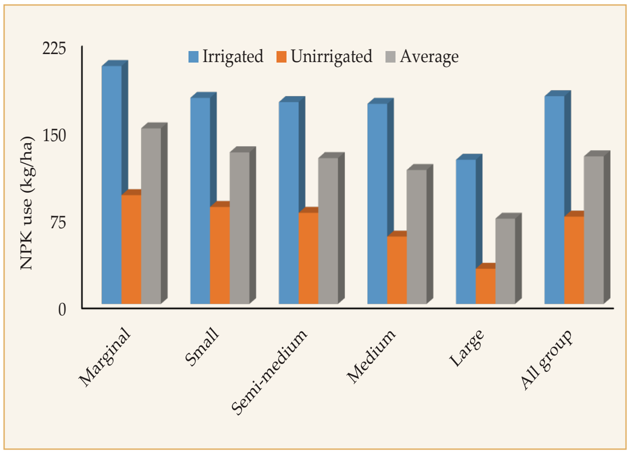



**Figure 2.15: Fertilizer use in irrigated and rainfed agriculture, 2016-17**

Fertilizer-use intensity (measured as NPK per ha of GCA) is higher in commercial crops like sugarcane, cotton, fruits and vegetables. Together, these account for 13.3% of GCA and 22.5% of fertilizer consumption (Figure 2.16). Rice and wheat, India's staple food crops, occupy 47% of the GCA and consume 52% of total fertilizers. Coarse cereals, pulses and oilseeds, mostly grown in rainfed environments, account for only 20% of fertilizer consumption as against their share of 31% in GCA.

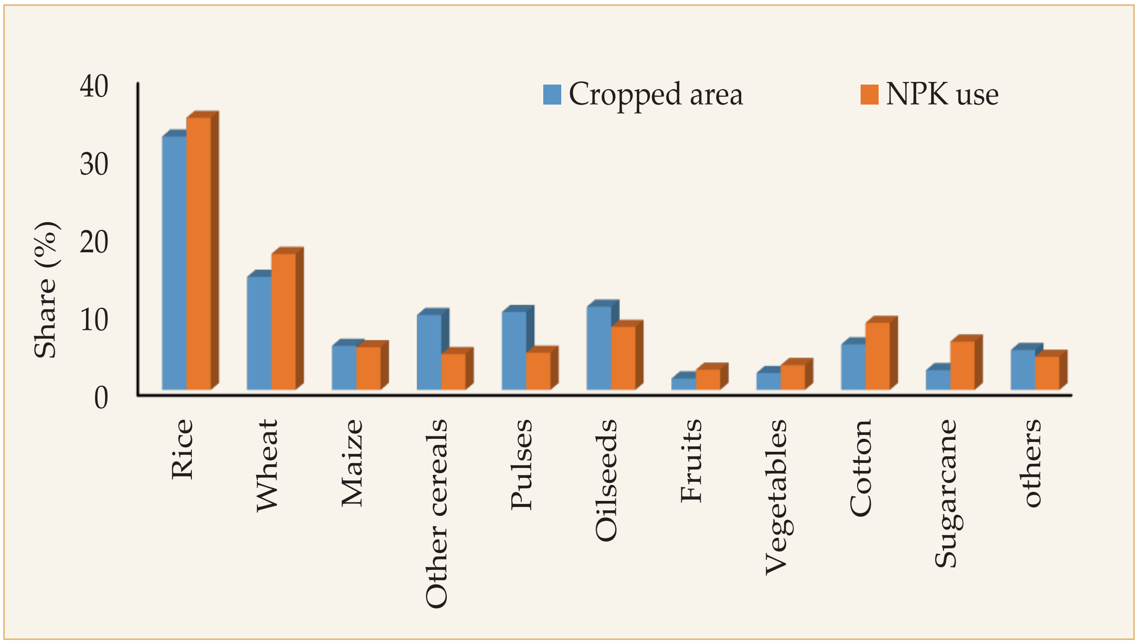



**Figure 2.16: Percent share of cropped area and fertilizer (NPK) use by crop, 2016-17**

Significant inter-state disparities in fertilizer use are due to differences in irrigation coverage, cropping pattern, and cropping intensity (Figure 2.17). The NPK use is highest in Telangana (232.8 kg/ha) and lowest in Rajasthan (54.5 kg/ha). Fertilizer use intensity is also considerably high in Punjab, Haryana, Uttar Pradesh, Bihar and West Bengal (140-170 kg/ha).

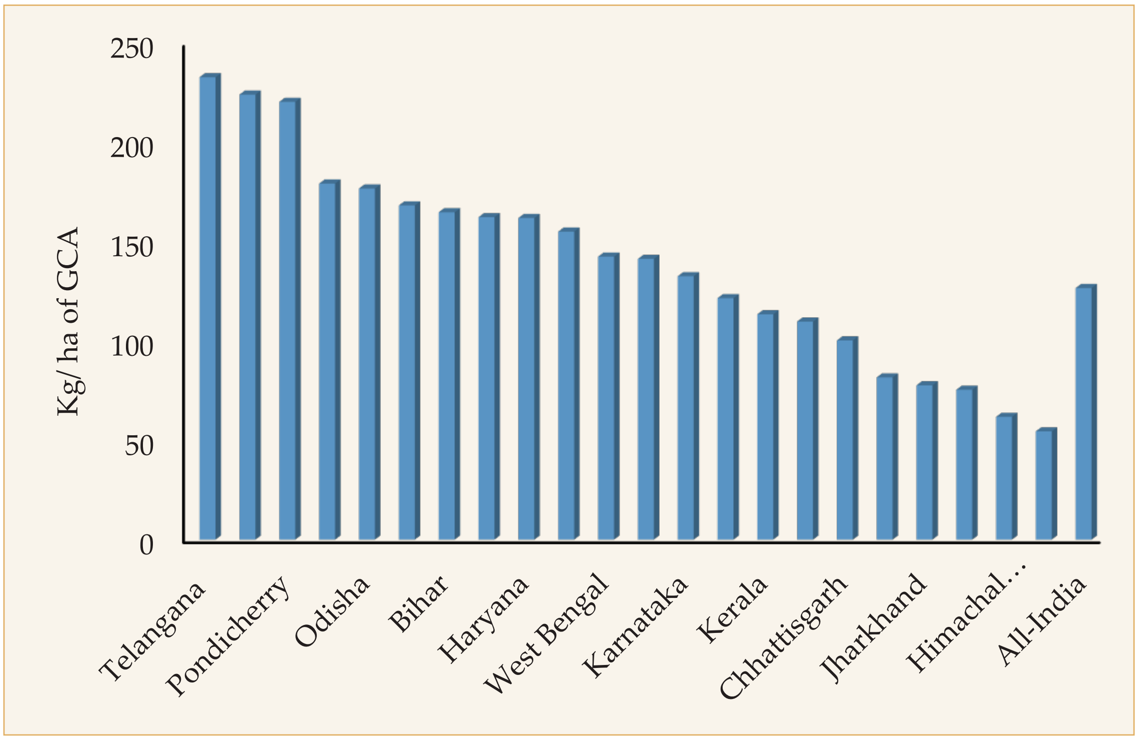



**Figure 2.17: Average fertilizer use (kg/ha) by state, 2016-17**

## Imbalance in NPK application

*Sant Kumar, P. S. Birthal and Kingsly I.T.*

Balanced use of nitrogen, phosphorous, and potassium (NPK) is crucial to reduce excessive and indiscriminate use, improve use efficiency, reduce production costs, and lower environmental pollution. In Indian agriculture, a N:P:K ratio of 4:2:1 is considered ideal. It is at 6.8: 3.3: 1 (Table 2.6). From a ratio of 8.2:3.5:1 in 1991-92. There are significant differences in the proportions of NPK across farm classes. The NPK use is more balanced on marginal farms than on others. It is highly unbalanced on large farms (>10 ha). This implies that smallholder farmers although apply more fertilizers, but in a balanced manner.

Across states, the imbalance in NPK use is significantly higher in the north-western state of Rajasthan, the lowest user of NPK per unit of GCA, and in Punjab and Haryana, where the fertilizer use intensity is very high (Figure 2.18). The N: P: K ratio is closer to the optimum in Maharashtra, Assam, West Bengal, Telangana, Karnataka, Tamil Nadu, and Kerala.

**Table 2.6: NPK ratio by farm size**

| Farm class | 1991-92 | 1996-97 | 2001-02 | 2006-07 | 2011-12 | 2016-17 |
|---|---|---|---|---|---|---|
| Marginal (<1 ha) | 6.7:2.5:1 | 5.7:2.4:1 | 3.8:1.7:1 | 5.1:2.1:1 | 5.6:2.3:1 | 5.3:2.5:1 |
| Small (1.0-1.99 ha) | 7.2:3.0:1 | 5.6:2.7:1 | 4.3:2.1:1 | 4.8:2.3:1 | 4.9:2.4:1 | 6.5:3.2:1 |
| Semi-medium (2.0-3.99 ha) | 8.4:3.6:1 | 7.4:3.5:1 | 5.0:2.5:1 | 6.4:2.9:1 | 5.8:2.9:1 | 7.1:3.1:1 |
| Medium (4.0-9.99 ha) | 9.5:4.3:1 | 11.3:5.2:1 | 7.5:3.5:1 | 8.8:3.8:1 | 7.5:3.7:1 | 10.2:5.6:1 |
| Large (10 ha and above) | 13.5:5.9:1 | 21.5:9.7:1 | 13.4:5.9:1 | 13.4:5.6:1 | 10.5:4.4:1 | 14.6:6.5:1 |
| **All class** | **8.2:3.5:1** | **7.4:3.4:1** | **4.9:2.3:1** | **6.0:2.6:1** | **5.8:2.7:1** | **6.8:3.3:1** |

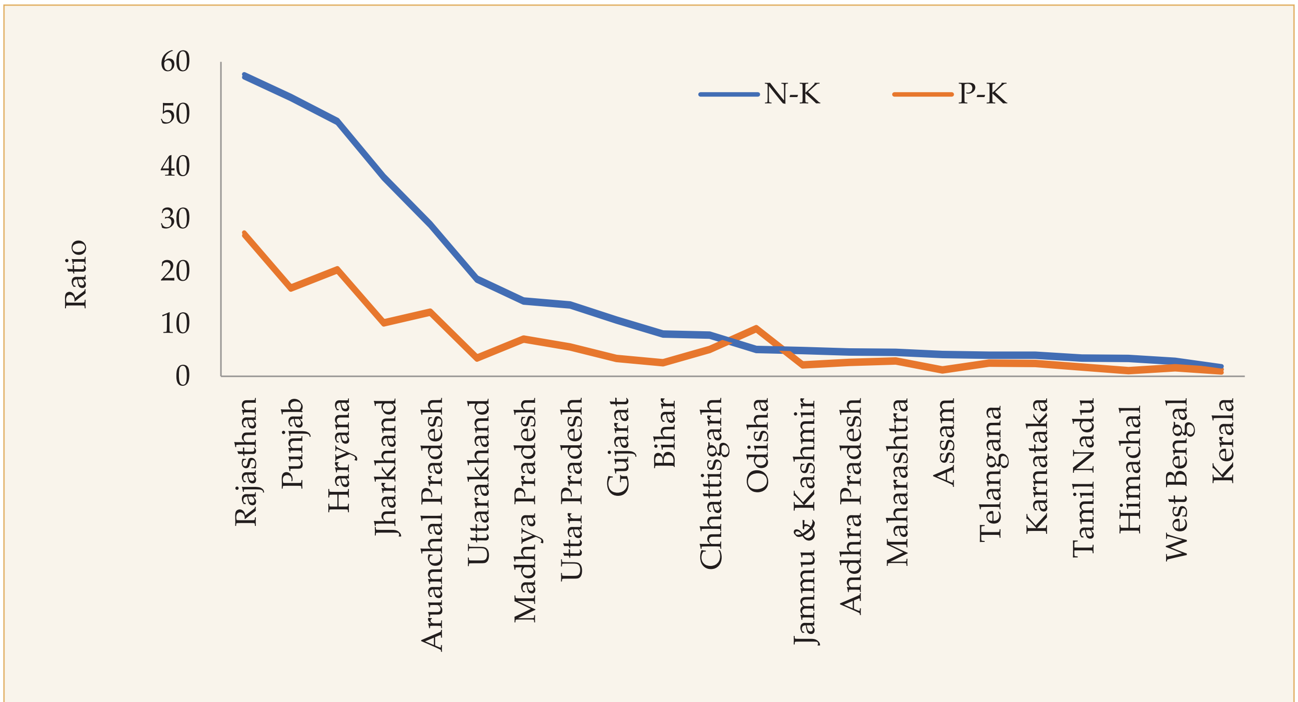



**Figure 2.18: N: K and P: K ratio across states of India, 2016-17**

## Artificial intelligence-led innovations in agriculture

*Raka Saxena, Devesh Kumar Pant, Satish Chandra Pant, Laxmi Joshi and R. K. Paul*

This study analyses the landscape of artificial intelligence (AI) research in Indian agriculture. There has been a significant increase in research on AI in agriculture, especially after the COVID-19 pandemic. Machine learning, robots, and remote sensing have emerged prominently in research (Figure 2.19). Notably, the Indian Council of Agricultural Research and the Indian Institutes of Technology drive the research on AI in agriculture.

The study highlights the need for dedicated funds for AI research in ICAR institutes, IITs, and universities to foster multi-institutional collaborations focusing on high-value sectors like livestock and fisheries. While crop-related aspects receive considerable attention, there is a relative neglect of AI applications in effective supply chain management. Furthermore, the emphasis should be on food safety and traceability to boost exports (Table 2.7).

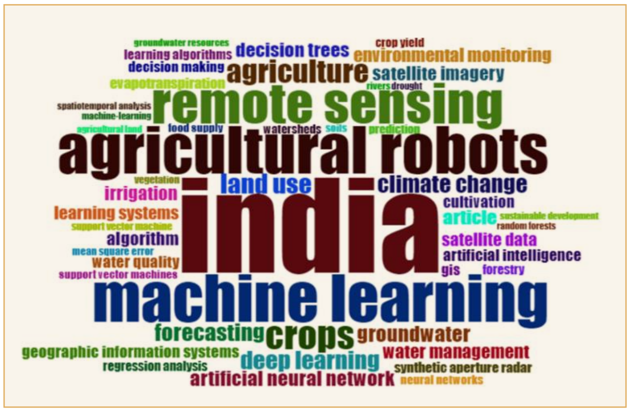



**Figure 2.19: Word cloud of author's keywords**

**Table 2.7: Priority areas for AI research applications**

| Broad theme | Sub-theme | Sub-sector priority | | | |
|---|---|---|---|---|---|
| | | Field crops | Horticulture | Livestock | Fisheries |
| ***Precision agriculture and sustainability*** | Right cultivars and seed traceability | *** | *** | - | ** |
| | Crop and soil health | *** | *** | - | - |
| | Water management and quality | *** | ** | ** | *** |
| | Disease diagnostics | *** | ** | *** | ** |
| | Pest and nutrient management | *** | ** | ** | ** |
| | Predicting yields | *** | *** | ** | ** |
| | Potential production zones | ** | *** | ** | ** |
| ***Mitigating climate impacts*** | Predicting extreme climate events | *** | *** | ** | *** |
| | Effective carbon sequestration | ** | ** | ** | * |
| | Estimating carbon and water credits | *** | ** | *** | ** |
| ***Efficient supply chains*** | Mapping outputs and marketable surplus | *** | *** | ** | ** |
| | Price advisories and market intelligence | ** | *** | ** | ** |
| | Mechanized and robotic operations | * | *** | ** | ** |

| Broad theme | Sub-theme | Sub-sector priority | | | |
|---|---|---|---|---|---|
| | | Field crops | Horticulture | Livestock | Fisheries |
| | Storage and inventory management | ** | *** | ** | ** |
| | Simplifying procedures and ensuring ease of doing business | ** | ** | *** | *** |
| | Product traceability and tracking | ** | *** | *** | *** |
| | Food safety and export compliances | ** | *** | *** | ** |
| ***Policy and management*** | Leveraging real-time data in repurposing policies | *** | *** | *** | *** |
| | Effective extension and dissemination | ** | *** | *** | ** |

## Digital innovations in the agricultural supply chain

*Rajni Jain, Arathy Ashok and Vikas Kumar*

The agri-food system faces multiple challenges, including increasing demand for safe and quality food, mitigating climate risks, and managing natural resources. Digital technologies can play a crucial role in making agri-food systems more resilient and sustainable. Applying digital technologies across the agri-food supply

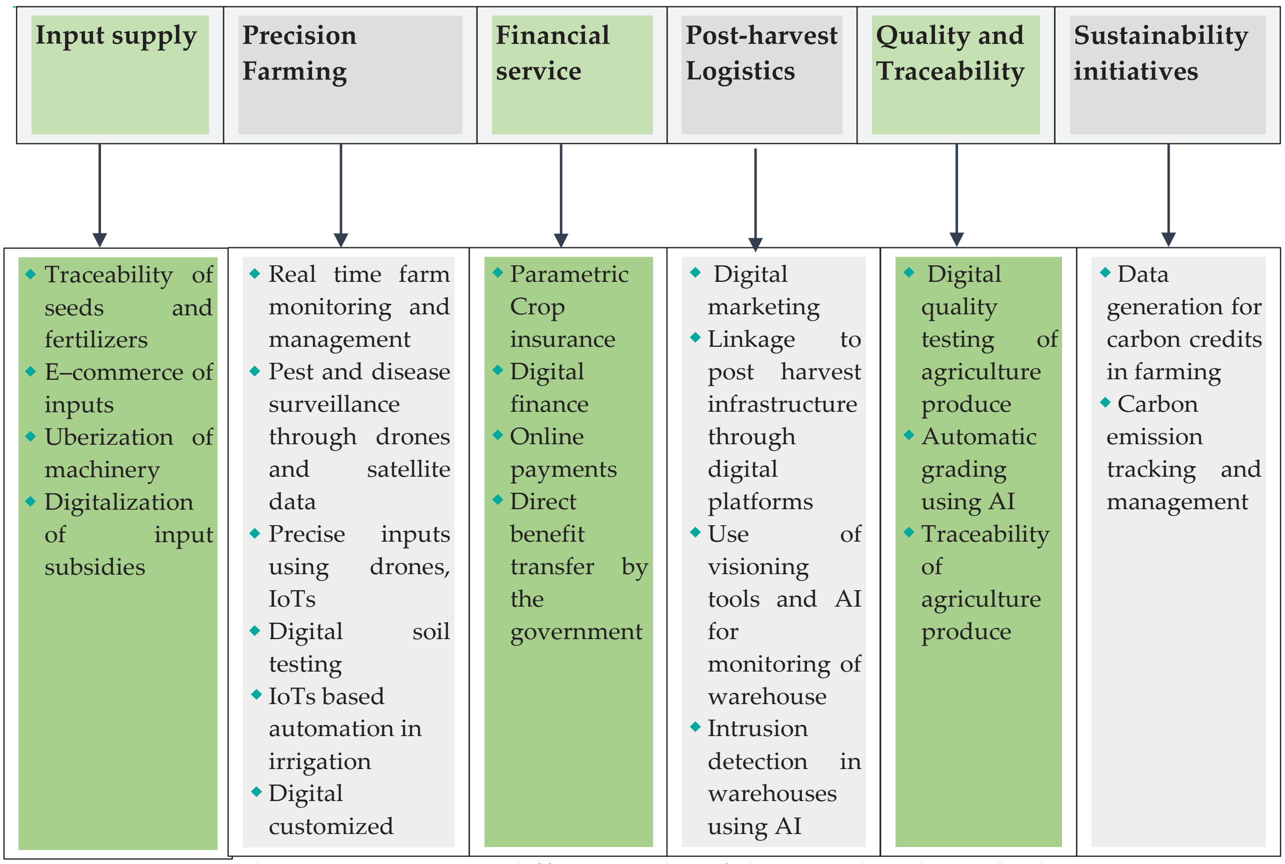



**Figure 2.20: Digital innovations across different nodes of the agricultural supply chain**

chain helps optimize operations and reduce inefficiencies.

Recognizing the potential of digital innovations, a study was conducted to map the digitalization status across the agricultural supply chain. The digital revolution is driven by the private sector for e-commerce, traceability of inputs, machinery hiring, precision farming, access to credit, customizable crop insurance, real-time farm monitoring, farm-specific advisory services, marketing of produce, post-harvest logistics, and traceability of agricultural products. (Figure 2.20).

However, there are several challenges, including a lack of clear regulatory guidelines, inadequate financial incentives for start-ups, high investment requirement in R&D, and poor coordination among stakeholders. Policy interventions such as incentivizing agritech start-ups, encouraging farmers to adopt digital technologies, and improving regulatory guidelines are required to scale up digital innovations in agriculture.

## Impact of sub-surface drainage

*Suresh Kumar, Rajni Jain and Ankita Kandpal*

Sub-surface drainage (SSD) has proven to be an effective means of reclaiming waterlogged saline soils. The potential area for treatment is 69,836 hectares in Haryana and 1,84,089 hectares in Maharashtra. The available estimates show that only 16.65% of the affected area in Haryana and 5.44% in Maharashtra are treated with SSD. Based on focused group discussions and primary data, the economic impact of the SSD has been estimated using the economic surplus model.

In Haryana, the estimated yield advantage due to adoption of SSD is 30.90% for wheat and 46.35% for rice. By 2030, the adoption of SSD is expected to increase to 21.14% in Haryana and 19.28% in Maharashtra. The estimated incremental yield due to SSD is 60.8% for sugarcane in Maharashtra. The economic surplus from wheat and rice in Haryana for 1998-2023 is estimated at Rs. 1,632 crores and Rs. 5,083 crores, respectively. For sugarcane in Maharashtra, it is estimated at Rs. 2,896 crores for 2018-2023.

## Impact of sand dune stabilization

*R. S. Shekhawat, Prem Chand, Kiran Kumara T. M, P. S. Birthal and V.S. Rathore*

The mobility of sand dunes significantly threatens transportation, communication, surface irrigation, agriculture, industry, and human settlements in any region. This study assessed the adoption and impact of vegetative methods of sand dune stabilization, which involve protecting dunes from biotic interferences through fencing, establishing micro wind-breaks using locally available shrubs to shield dunes prone to blowouts, and promoting vegetative cover on dunes. Findings reveal that sand dune stabilization has happened on 4.35 lakh ha in the Thar Desert of Rajasthan. With the adoption of measures for the stabilization of sand dunes, crop yields increased by 5-39% (Figure 2.21).

The overall economic surplus attributed to sand dune stabilization (from provisioning goods and services like food, fodder, fuel wood, reduction in canal de-siltation costs, and drudgery reduction) is estimated at Rs. 19,817 crores.

Besides, sand dune stabilization profoundly affects soil properties (Figure 2.22). The stabilized sand dune soils have 1.4, 1.8, 2.1, and 2.2 times more potassium, nitrogen, phosphorus, and organic carbon content, respectively. The stabilized sand dune has accumulated 11.7 Mg/ha more carbon compared to unstabilized sand dunes, generating Rs. 12,409 crores from soil carbon and plant biomass.

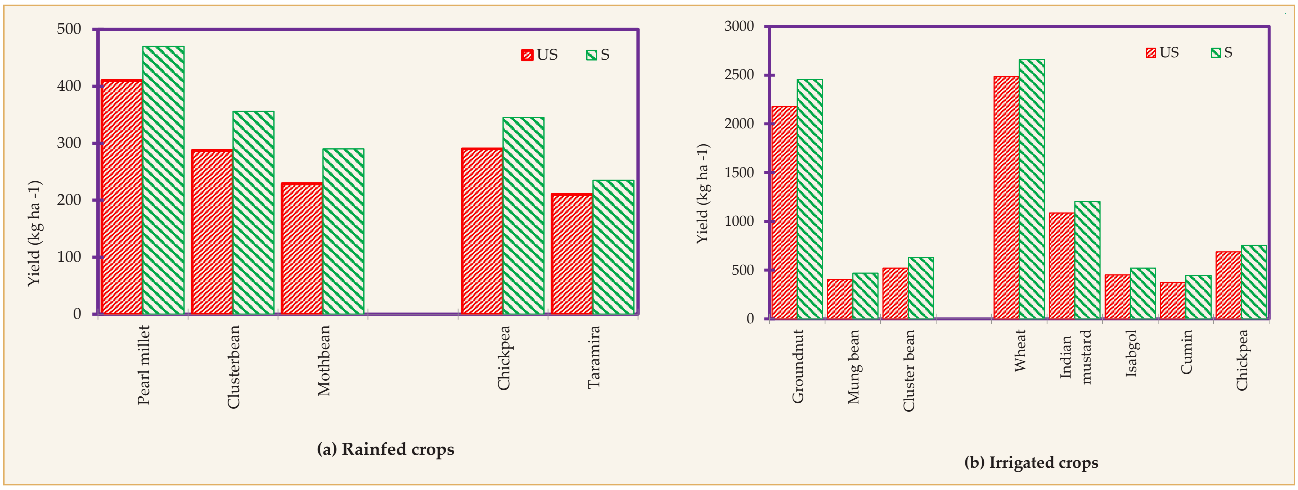



**Figure 2.21: Crop yield in stabilized (S) and unstabilized (US) sand dunes**

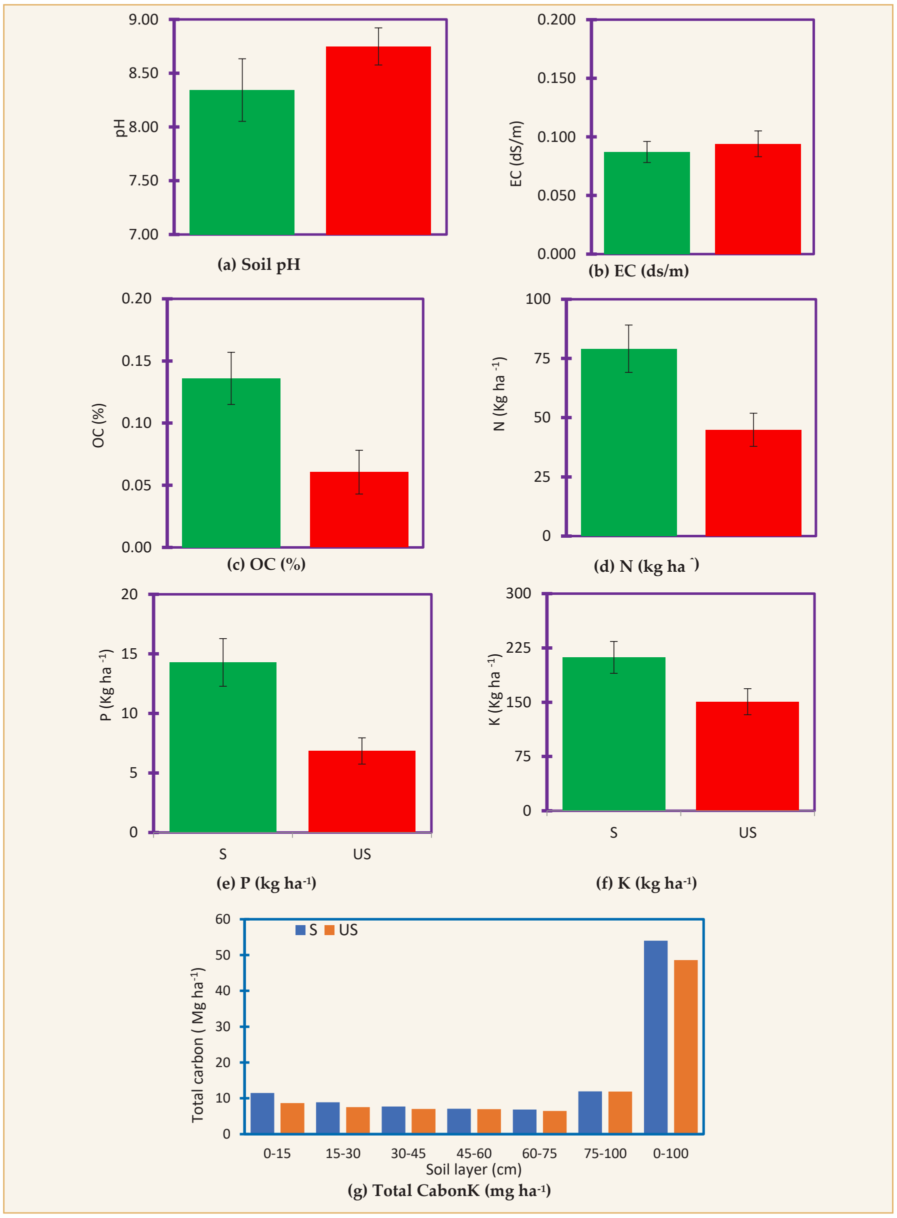



**Figure 2.22: Soil properties (averaged across locations) of stabilized and unstabilized sand dunes**

## Impact assessment of vaccines

*D. Bardhan, Rajni Jain and Vinayak R. Nikam*

Diseases such as peste-des-petits Ruminants (PPR) and sheep & goat pox (SGP) are still prevalent in India, causing significant economic losses. At the national level, the economic losses due to PPR have been reported Rs. 4,235 crores under the medium incidence scenario and Rs. 9,735 crores under the high incidence scenario. This study evaluated the economic feasibility of investments made to control PPR and SGP. By projecting the costs and benefits from the start of research and marketing of vaccines till 2030, the investment in vaccination is highly profitable, with the internal rate of returns (IRR) ranging from 39 to 144 % (Table 2.8).

## Impact of direct seeding of rice in Punjab

*Kamal Vatta, Rajni Jain, Baljinder Sidana, Laishram Priscilla, Ankita Kandpal and Gurleen Kaur*

Direct Seeded Rice (DSR) offers certain advantages such as savings in irrigation, labour, and energy, and reduction in the emission of greenhouse gases. The economic impact of DSR was estimated using the economic surplus approach. Its maximum adoption rate is assumed to reach 30% by 2035. This will result in the adopted area under DSR reaching 9.49 lakh hectares (Figure 2.23) with production touching 7.6 million tonnes. The pooled analysis (2010-2035) revealed that if the current policy of free electricity were to continue, then by reaching this level of adoption, and a similar level of yield as with PTR, between 2010 and 2035, the DSR would generate a potential surplus of Rs. 20,774 crores or Rs. 799 crores per annum (Table 2.9). Expectedly, it almost doubles if there is a yield advantage of 3%. It remains positive even with a yield penalty of 3%. If the government withdraws subsidy on electricity, in all situations of yield change, the total economic surplus will be higher than with free electricity. It will be 21% higher in case of DSR being yield-neutral, 11% in case of a 3% yield advantage, and 80% in case of yield penalty of 3%.

**Table 2.8: Economic feasibility indicators for vaccines targeted against PPR & SGP**

| Vaccines | Adoption Rate % (2023) | Benefits (Rs. In crores / annum) | NPV (Rs. in crores) | BCR | IRR (%) |
|---|---|---|---|---|---|
| Vaccine against PPR (goat) | 80.00 | 2540.70 | 13268.60 | 20.64 | 83 |
| Vaccine against PPR (Sheep) | 80.00 | 550.22 | 2677.91 | 8.99 | 60 |
| Goat Pox Vaccine | 30.00 | 121.43 | 405.39 | 6.04 | 39 |
| Sheep Pox Vaccine | 5.00* | 30.00 | 32.49 | 6.71 | 79 |
| PPR + Goat Pox Vaccine | 3.00* | 29.61 | 1427.26 | 61.11 | 144 |
| PPR + Sheep Pox Vaccine | 3.00* | 47.36 | 79.58 | 30.72 | 104 |
| Combined | -- | 3319.32 | 17876.70 | 16.88 | 74 |

*- estimated at 2025

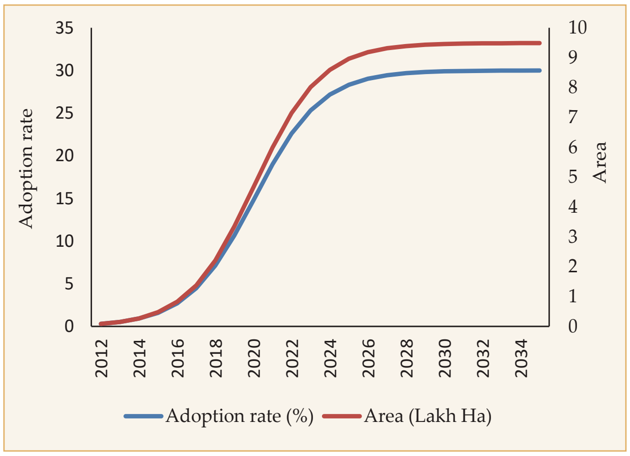



**Figure 2.23: Area and adoption rate (%) of paddy sown with DSR technology in Punjab, 2012-2035**

**Table 2.9: Economic surplus from adoption of DSR for 2010-2035 (Rs. Crores)**

| Yield change | Consumer surplus | Producer surplus | Total surplus | Total surplus/ annum |
|---|---|---|---|---|
| **Cost reduction: 14% with free electricity** | | | | |
| 0 | 10150 | 10624 | 20774 | 799 |
| – 3% | 1245 | 1303 | 2549 | 98 |
| + 3% | 19099 | 19989 | 39088 | 1503 |
| **Cost reduction: 17% with full cost recovery of electricity** | | | | |
| 0 | 12332 | 12906 | 25238 | 971 |
| – 3% | 3485 | 3647 | 7133 | 274 |
| + 3% | 21224 | 22213 | 43436 | 1671 |

## Impact of soil moisture indicator on sugarcane production

*P. Murali and Rajni Jain*

Soil Moisture Indicator (SMI) is a handy and helpful tool for assessing soil moisture status and scheduling irrigation. Over 2.2 lakh units of SMI are operational in India. On an average, 35-40 units of electricity is consumed per irrigation, and using SMI saves six irrigations. This means a saving in electricity of 225-240 units per ha, and an additional yield of 4.6 tons per ha.

**Table 2.10: Conventional vs SMI based irrigation**

| Item | Conventional Irrigation | Irrigation based on SMI |
|---|---|---|
| Cane yield (t/ acre/crop) | 55.8 | 60.4 |
| No. of irrigations/crop | 42 | 36 |

The potential water saving and additional yield of sugarcane was estimated for Tamil Nadu, Uttar Pradesh, Madhya Pradesh, Maharashtra, Karnataka, Gujarat, Haryana, Uttarakhand and Punjab, which account for more than 85% of the total sugarcane area. Currently, more than two lakhs units of SMI was distributed to farmers and estimated that it is adopted about 4% of the total cane area in India. At the national level, it is expected that by 2031-32, SMI will be used on 38% of sugarcane area. This would save about 9,034 lakh cubic litres of water and increase in sugarcane production by 161 lakh tonnes (Figure 2.24).

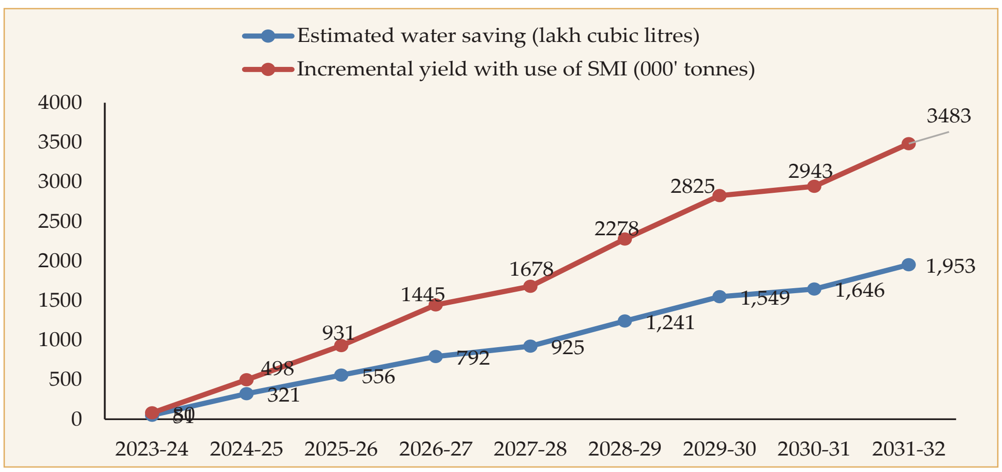



**Figure 2.24:** ***Ex-ante*** **assessment of water savings and incremental yield with SMI (2023-2032)**

## Economic impact of dominant varieties of forage crops

*Bishwa Bhaskar Chaudhary, Rajni Jain and Ankita Kandpal*

The economic impact of nine popular varieties of forage crops, namely IGFRI-727 (Anjan grass), JHO-822 and UPO-212(Oat), African tall and J-1006 (Maize), EC-4216 (Cowpea), AL-3, RL-88 and Ananad -2 (Lucerne) was assessed (Table 2.11). The estimation of area for Anjan grass (IGFRI-727) relied on TFL seed production, while the estimation for Oat (JHO-822 and UPO-212), Maize (African Tall and J-1006), Cowpea (EC- 4216) and Lucerne (AL-3, RL-88 and Anand-2) was based on breeder seed production.

During 1999-2023, African Tall generated highest economic surplus, followed by Anand-2 (Lucerne variety), with an economic surplus of Rs. 1452.11 crores for the same timeframe. The estimated surplus from another maize variety, J-1006, was around Rs 82 crores for 1999-2023. The estimated surplus from the RL-88 variety of lucern was Rs. 1106 crores, and that from AL-3 was Rs. 624 crores (period 2009-2023). The surplus generated from cowpea variety EC-4216 was 1334.15 crores.

## Fish cage culture in Chhattisgarh

*Arun Pandit, Rajni Jain, Anjana Ekka and Vinayak R. Nikam*

Over the past decade, Chhattisgarh has achieved remarkable progress in fish production due to the adoption of cage culture (Figure 2.25). The impacts of cage culture in reservoirs include increased fish production, income and employment, and women empowerment. The average production from *Pangasius* and *Tilapia* species in one cage is estimated to be 2.5 -3.0 tons annually. Average reservoir productivity has increased by 136%. The cage culture added about 5,092 tons to the state's fish production in 2023.

**Table 2.11: Summary of economic impact of forage varieties**

| Forage crop | Variety | Estimation period | Existing adoption rate (%) | Estimated maximum adoption rate (%) | CS | PS | TES | AES |
|---|---|---|---|---|---|---|---|---|
| | | | | | (Rs. Crores) | | | |
| Anjan grass | IGFRI-727 | 2010-2022 | 2.32 | 2.32 | 4 | 3 | 7 | 0.6 |
| Dinanath grass | BD-2 | 2012-2023 | 0.63 | 3.36 | 2 | 1 | 3 | 0.3 |
| Oat | JHO-822 | 2002-2022 | 12.23 | 18.24 | 18 | 12 | 30 | 1.4 |
| | UPO-212 | 2000-2023 | 18.81 | 18.81 | 23 | 15 | 38 | 1.6 |
| Maize | J-1006 | 1999-2023 | 17.43 | 56.77 | 50 | 33 | 83 | 3.3 |
| | African Tall | 1999-2023 | 68.66 | 77.73 | 22119 | 14746 | 36865 | 1475 |
| Cowpea | EC-4216 | 1999-2023 | 43.94 | 86.54 | 800 | 534 | 1334 | 53 |
| Lucerne | AL-3 | 2009-2023 | 14.58 | 69.24 | 374 | 250 | 624 | 42 |
| | RL-88 | 1999-2023 | 1.36 | 25.38 | 664 | 443 | 1107 | 44 |
| | Anand-2 | 1999-2023 | 17.43 | 42.81 | 871 | 581 | 1452 | 58 |

Note: CS-Consumer Surplus, PS- Producers Surplus, TES- Total Economic Surplus, AES-Annual Economic Surplus

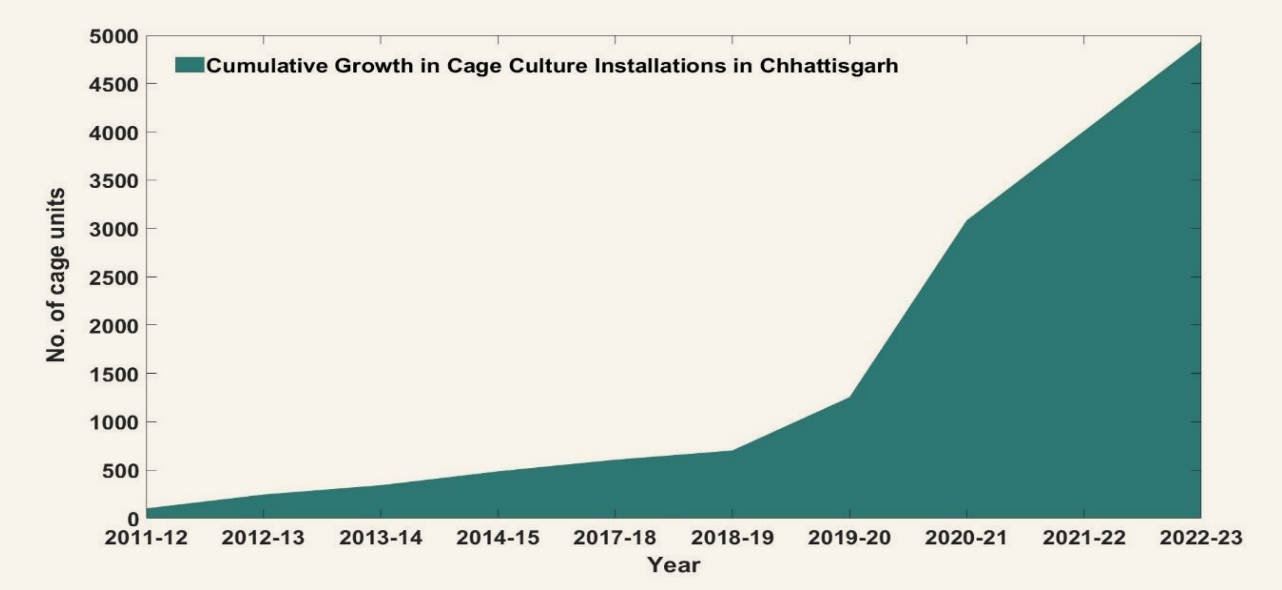



**Figure 2.25: Trend of installation of cages in Chhattisgarh**

Each cage unit generates 53 person-days per annum, and with 4,936 cages in operation, the estimated employment generation is 2.5 lakh person-days. The net return from each cage unit is estimated at Rs. 75,420 annually. Of all the sampled cage culture sites, 20% are owned and cultured by women, enabling them to support themselves and their families and improve their overall socioeconomic status.

## Economic impact of cage farming

*P. Shinoj, Rajni Jain and Vinayak R. Nikam*

Cage farming became popular among coastal fisher folk in the late 2000s with technological breakthroughs in breeding, seed production, larval culture, and grow-out of commercially important marine fin and shellfish species. The impact of cage farming was ascertained by applying the propensity score matching (PSM) technique to the data collected from 130 adopters and an equal number of non-adopters in Kerala, Tamil Nadu, and Karnataka. The results show a statistically significant impact of cage farming on household income in Table 2.12. The gain in household income due to cage farming ranges from Rs. 6.73 to Rs. 8.83 lakh.

## Impact of Asian Seabass production in India_

*R. Geetha, Rajni Jain and Vinayak R. Nikam*

Based on the data on cost and returns collected from major seabass-producing states, viz., Tamil Nadu, Andhra Pradesh, and West Bengal on the east coast, and Kerala and Karnataka on the west show significant improvement in production and profits in Seabass farming, albeit requiring higher capital investments and skilled manpower (Table 2.13).

**Table 2.12: Average treatment effect (ATT) of cage farming on household income**

| Matching method | Number of matched observations | | ATT | Standard error | t-value |
|---|---|---|---|---|---|
| | Adopter | Non-adopter | | | |
| Nearest neighbour method | 120 | 29 | 7.85*** | 1.89 | 4.136 |
| Stratification method | 120 | 77 | 7.15*** | 1.84 | 3.661 |

**Table 2.13: Costs and returns from seabass farming (Rs./ha/annum)**

| Parameters | Nursery | Pre-grow out | Grow out | | | | |
|---|---|---|---|---|---|---|---|
| | | | Pond culture | | Cage culture | | |
| | | | Andhra Pradesh | West Bengal | Tamil Nadu | Kerala | Karnataka |
| Total fixed cost/ crop | 1,76,683 | 1,27,141 | 4,18,052 | 2,69,285 | 878 | 1,076 | 275 |
| Total operational cost | 6,41,764 | 12,09,315 | 31,24,659 | 7,29,542 | 6,914 | 8,468 | 2,899 |
| Total cost | 8,18,447 | 13,36,456 | 35,42,711 | 9,98,827 | 7,792 | 9,543 | 3,173 |
| Production (kg) | 2,566 | 2,111 | 13,677 | 4,263 | 20 | 27 | 14.13 |
| Gross Income | 12,61,167 | 21,67,606 | 60,22,599 | 18,73,730 | 9,980 | 13,510 | 5,652 |
| Net income | 4,42,719 | 8,31,151 | 24,44,498 | 8,98,605 | 2,187 | 3,966 | 2,479 |

Yet significantly higher net income indicates the economic feasibility of seabass farming. The main constraints are a lack of quality seed and feed and poor access to institutional credit and insurance.

## Economic impact of short duration rice varieties in Punjab

*Kamal Vatta, Rajni Jain, Baljinder Sidana, Laishram Priscilla, Ankita Kandpal and Gurleen Kaur*

Cultivating short-duration varieties (SDVs) of rice provides an extended window for showing wheat or any other crop, giving sufficient time to rice farmers for in-situ management and removal of excess paddy straw from fields. Economic surplus approach was followed to estimate the economic impact of PR 126 and PR 131, the latest SDV of rice compared to the existing long-duration PR121. The variety, PR 126, currently holds the largest area (21.7% of the total paddy area) and is anticipated to achieve a maximum adoption rate of 30% by 2030 (Figure 2.26). From present adoption rates at 14.2%, 7.6%, and 3.8% of PR 121, PR 128, and PR 131, respectively, their estimated adoption rates by 2030 will be 15%, 15%, and 20%. The total economic benefits generated by PR 126 from 2017-2030 will reach Rs. 1,16,503 crores or Rs. 8322 crores per annum (Table 2.14). For PR121 paddy variety, the cumulative surplus for 2013-2030 is Rs. 40,215 crores or Rs. 2234 crores annually. Newly released varieties, PR 128 and PR 131, are expected to generate a total surplus of about Rs. 15,757 crores (2020-30) and Rs. 18,507 crores (2022-30), respectively.

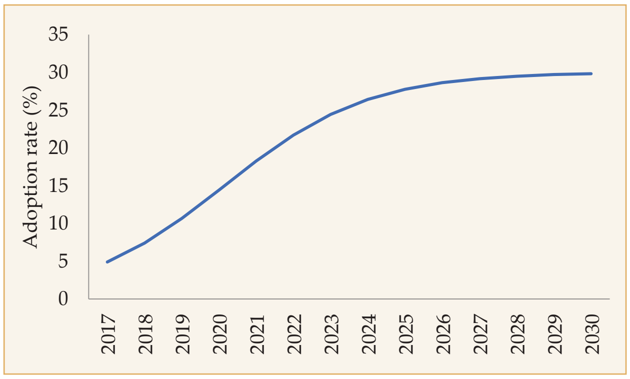



**Figure 2.26: Adoption curve of PR-126 in Punjab: 2017-2030**

**Table 2.14: Economic surplus from short-duration paddy varieties in Punjab (Rs. crores)**

| Variety | Ex-post | Ex-ante | Pooled | Annual |
|---|---|---|---|---|
| PR 121 | 15,494 | 24,721 | 40,215 | 2234 |
| PR 126 | 27,022 | 89,480 | 1,16,503 | 8322 |
| PR 128 | - | 115,757 | - | 1432 |
| PR 131 | - | 118,507 | - | 2056 |

## Database development for agricultural rural households with a special focus on weaker sections

*Subhash Chand, Rajni Jain, D. C. Meena, Dilip Kumar, Khyali Ram Chaudhary and M. S. Chauhan*

A longitudinal database is being developed on various socioeconomic parameters, including an inventory of assets, crops, and livestock production, information on agricultural practices, awareness about government schemes and food consumption patterns of the rural economy with a focus on weaker sections of the society from six villages of three districts—Panipat in Haryana, Bulandshahar in Uttar Pradesh and Jaipur in Rajasthan. In Rajasthan and Uttar Pradesh, Scheduled caste/tribe (SC/ST) households have smaller landholdings, less irrigated areas, and lower education levels (Table 2.15). Their engagement in agriculture is also low, and most depend on wage income for their livelihood. In Haryana, these households perform better on these parameters.

**Table 2.15: Key economic and social parameters for weaker sections**

| Particulars | Haryana | | | Rajasthan | | | Uttar Pradesh | | |
|---|---|---|---|---|---|---|---|---|---|
| | SC | Other Castes | Gap (%) | SC & ST | Other Castes | Gap (%) | SC | Other Castes | Gap (%) |
| Households (%) | 91.0 | 8.64 | - | 84.02 | 15.98 | - | 87.74 | 12.26 | - |
| Female head (%) | 23 | 14 | 9 | 26.35 | 15.38 | 10.97 | 12.26 | 12.20 | 0.06 |
| Family size (number) | 4.37 | 4.5 | -0.13 | 4.03 | 3.74 | 0.29 | 5.53 | 5 | 0.53 |
| Average size of land (ha.) | 0.27 | 0.11 | 0.16 | 0.59 | 1.32 | -0.73 | 0.44 | 0.53 | -0.09 |
| Total irrigated area (%) | 100 | 100 | 0 | 62 | 76.13 | -14.13 | 95.78 | 98.81 | -3.03 |
| **Landholding size (% households)** | | | | | | | | | |
| Landless | 50 | 92.9 | -42.9 | 31.29 | 19.35 | 11.94 | 50 | 13.41 | 36.59 |
| Marginal (<1 ha.) | 41.9 | 0 | 41.9 | 53.37 | 19.35 | 34.02 | 42.45 | 78.05 | -35.6 |
| Small (1-2 ha.) | 6.8 | 7.1 | -0.3 | 14.11 | 45.16 | -31.05 | 4.72 | 7.32 | -2.6 |
| Medium (>2 ha.) | 1.4 | 0 | 1.4 | 0.61 | 16.13 | -15.52 | 2.83 | 1.22 | 1.61 |
| Literacy rate | 75.68 | 64.29 | 11.39 | 50.92 | 54.84 | -3.92 | 80.2 | 79.3 | 0.9 |
| **Main occupation (% households)** | | | | | | | | | |
| Agriculture | 31.76 | 7.14 | 24.62 | 41.72 | 64.52 | -22.8 | 29.25 | 30.49 | -1.24 |
| Farm labour | 16.22 | 21.43 | -5.21 | 4.91 | 0 | 4.91 | 3.77 | 0 | 3.77 |
| Non - farm labor | 18.24 | 28.57 | -10.33 | 41.72 | 29.03 | 12.69 | 50.94 | 30.49 | 20.45 |
| Artisan | 0.68 | 0 | 0.68 | 11.66 | 6.45 | 5.21 | 0 | 0 | 0 |
| Other (Business, service) | 33.11 | 42.86 | -9.75 | 0 | 0 | 0 | 16.04 | 39.02 | -22.98 |

### *Impact of women' training in tailoring*

Under the SC sub-plan, women belonging to scheduled castes were provided sewing machines and given training to improve their skills for a better livelihood. The impact of training was evaluated using the Likert-type scale (1-5 score). The higher the score, the more impact it has on their livelihoods. On most of the parameters, the score is more than 3.0, indicating a positive impact of trainings (Figure 2.27).

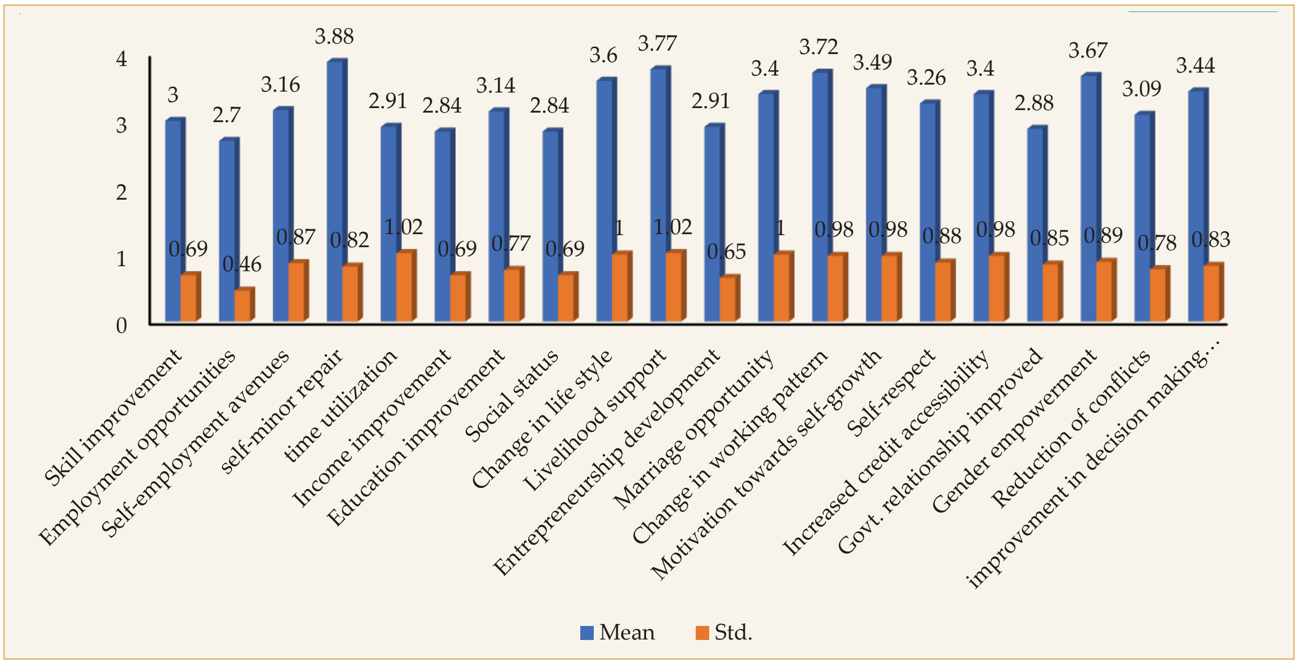



**Figure 2.27: Impact of training in tailoring on women empowerment**

## Insurance for agroforestry

*Prem Chand, Vinayak R. Nikam, Kiran Kumara T. M. and Kamlesh Acharya*

This study undertook a review of tree insurance. The increasing cover of trees outside the forest is often accompanied by increasing incidences of perils like cyclones and fire. However there is a lack of insurance for agroforestry insurance, perhaps because of a lack of valuation of tree species. It is high-value trees like pine, palm, mangrove, pulpwood, apple, eucalyptus, olive, peach, jatropha, redwood, orange, chestnut, coconut, avocado, fynbos, acacia, and walnut which are insured against the risks of storms, winds, hailstorms and fires (Figure 2.28).

Insurance premiums and payout are determined by tree species, age, location, and management standards. India has been implementing a multi-peril tree insurance programmes to address the impact of natural factors. Driven by increasing incidences of natural hazards, the research on tree insurance has attracted increasing attention during the past two decades.

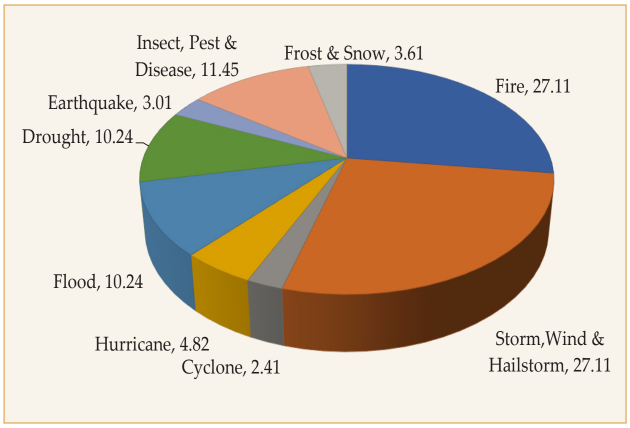



**Figure 2.28: Coverage of risks in tree insurance**

Tree insurance faces challenges of adverse selection and moral hazard. Premium calculation relies on historical data, but their scarcity makes it impractical. Estimating cost is complicated, and the scale of finance is limited to horticultural crops. Further, high premiums and lack of awareness hinder participation in insurance schemes. The evidences suggest the need to develop customized insurance products, and leverage the power of digital technology.

# Agricultural Market and Trade

## Effectiveness of minimum support price policy

*Prabhat Kishore, P. S. Birthal and S. K. Srivastava*

The minimum support price (MSP) policy aims at ensuring farmers remunerative prices for their produce. Utilizing data from the recent large-scale survey of agricultural households conducted by the National Sample Survey Office (NSSO), this study has examined farmers' awareness of MSP, their produce disposal pattern, and price realization (Figure 2.29a). Of the 44% of those selling paddy and 37% selling wheat are aware of the MSP. However, their awareness of the procurement agencies is limited. Hence, only 15% of sellers of paddy and 10% of wheat participate in the MSP-based procurement system (Table 2.16), respectively, selling 24% of the marketed surplus of paddy and 21% of wheat (Figure 2.29b).

MSP serves as a floor price. However, price realization from sales in the open market is significantly lower — 18% for paddy and 6% for wheat. MSP also incentivizes farmers to produce more. Findings also show higher crop yields for farmers participating in the MSP-based procurement system — 9 % in the case of paddy and 14% in the case of wheat. Overall, the MSP-based procurement system could make farmers better off — 23% higher income from paddy and 19% from wheat (Table 2.17).

**Table 2.16. Farmers' participation in MSP-based procurement system**

| Particulars | Paddy | Wheat |
|---|---|---|
| % farm households growing | 54.41 | 41.31 |
| % growers selling | 55.00 | 50.86 |
| % output sold | 67.46 | 65.54 |
| % market participants aware of MSP | 44.09 | 36.96 |
| % market participants aware of the procurement agency | 23.26 | 21.21 |
| % market participant selling to the procurement agency | 15.03 | 9.61 |
| % of total households selling to the procurement agency | 8.27 | 4.89 |
| % output sold at MSP | 23.70 | 20.80 |

**Table 2.17. Mean comparison of price, yield and income**

| Crop | Type of procurement | Price (Rs/kg) | Yield (Kg/ha) | Gross income (Rs/ha) |
|---|---|---|---|---|
| Paddy | Procurement agencies | 18.51 (0.09) | 4014 (38) | 76308 (717) |
| | Open market | 15.67 (0.04) | 3667 (17) | 61748 (318) |
| | Difference | 2.84*** | 348*** | 14560*** |
| Wheat | Procurement agencies | 18.04 (0.05) | 3782 (44) | 75118 (918) |
| | Open market | 17.02 (0.04) | 3330 (16) | 62933 (318) |
| | Difference | 1.02*** | 453*** | 12185*** |

Note: *** indicates significance at 1% level. Standard errors are in parentheses

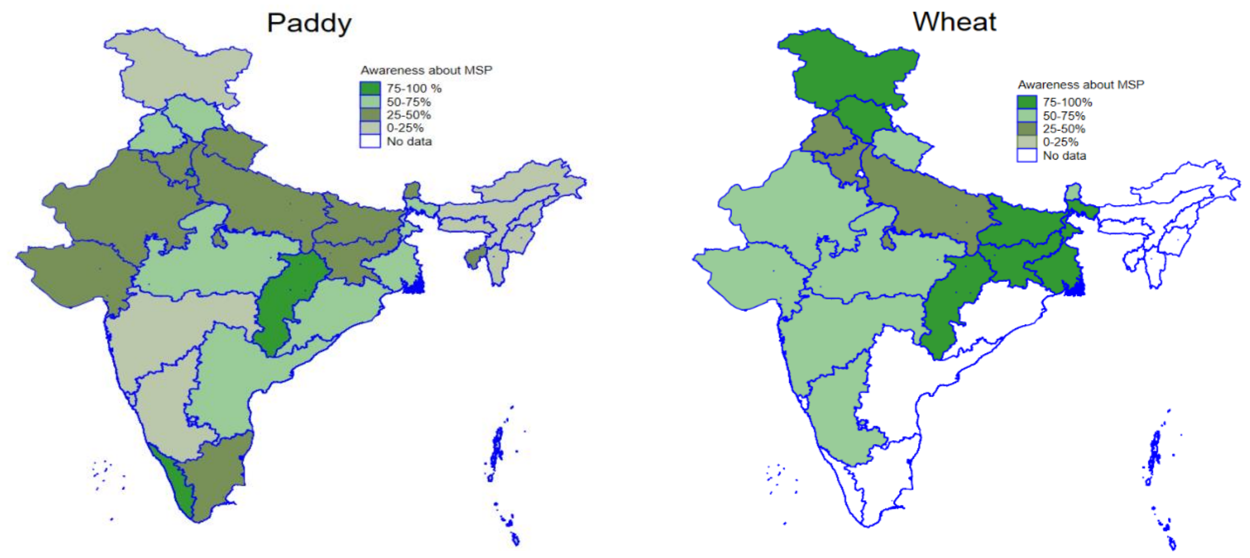



**Figure 2.29a: Farmers' awareness about MSP (%) across states**

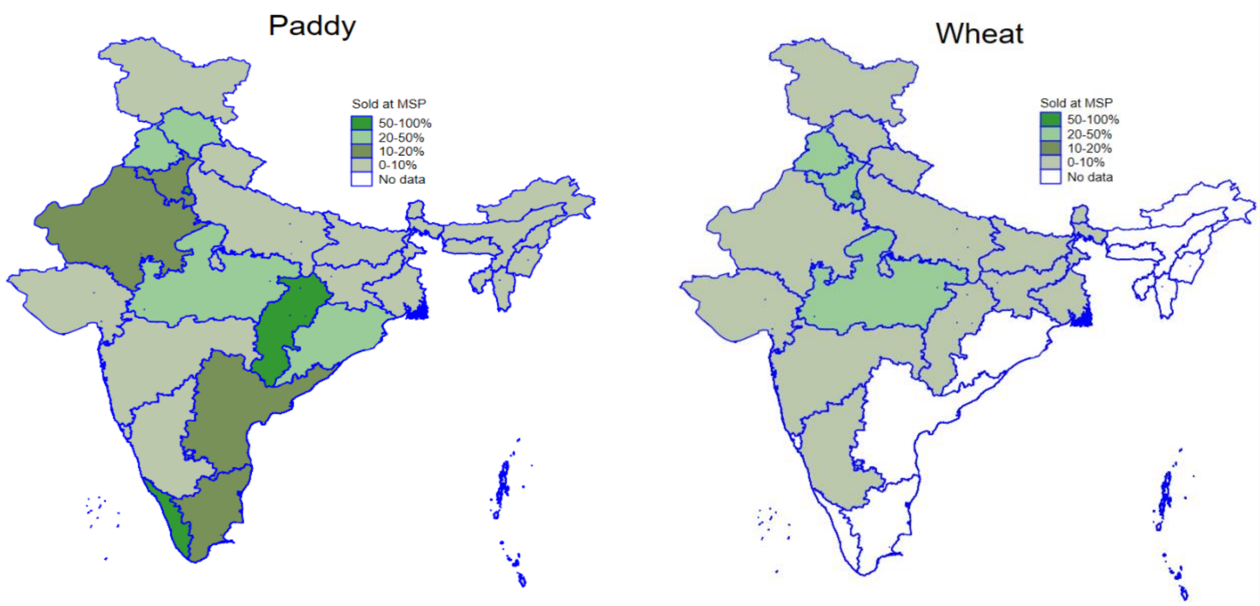



**Figure 2.29b: Farmers who sold crop produce at MSP across states**

## Patterns and determinants of food price volatility

*Purushottam Sharma, Md. Yeasin, Ranjit Kumar Paul, D. C. Meena and Md. Ejaz Anwer*

The study analyses price volatility in 19 food commodities using the monthly data from January 2010 to December 2022 from 159 markets. Price volatility is the highest for vegetables (0.22-0.43), followed by spices (0.05-0.12), pulses (0.05-0.08), oilseeds (0.04-0.08), and the lowest for cereals (0.03-0.05). Amongst vegetables, tomato prices are highly volatile, and turmeric prices are the most volatile among spices. The lowest price volatility is for cereals because of the assured procurement of wheat and rice at minimum support price (MSP). Food commodities with higher income elasticity of demand and limited storage and processing facilities exhibit higher price volatility. The price volatility has increased for almost all commodities (Figure 2.30).

Price volatility peaks during the pre-harvest and harvest periods. For vegetables, seasonality in production is the most significant cause of price volatility, accounting for 14-26% of total price volatility. Vegetables, turmeric, groundnut, soybean, mustard, gram, and maize have higher seasonal gaps. The frequent changes in trade policy and stocking limits for vegetables (onion), pulses, and edible oils also contribute to food price volatility. Non-competitive trade practices, inefficient supply chains, inadequate infrastructure, and asymmetrical information are other causes of price volatility.

Strengthening post-harvest value chains, particularly at storage and processing levels, can help to reduce seasonal price fluctuations. Further, market intelligence can aid in managing price volatility.

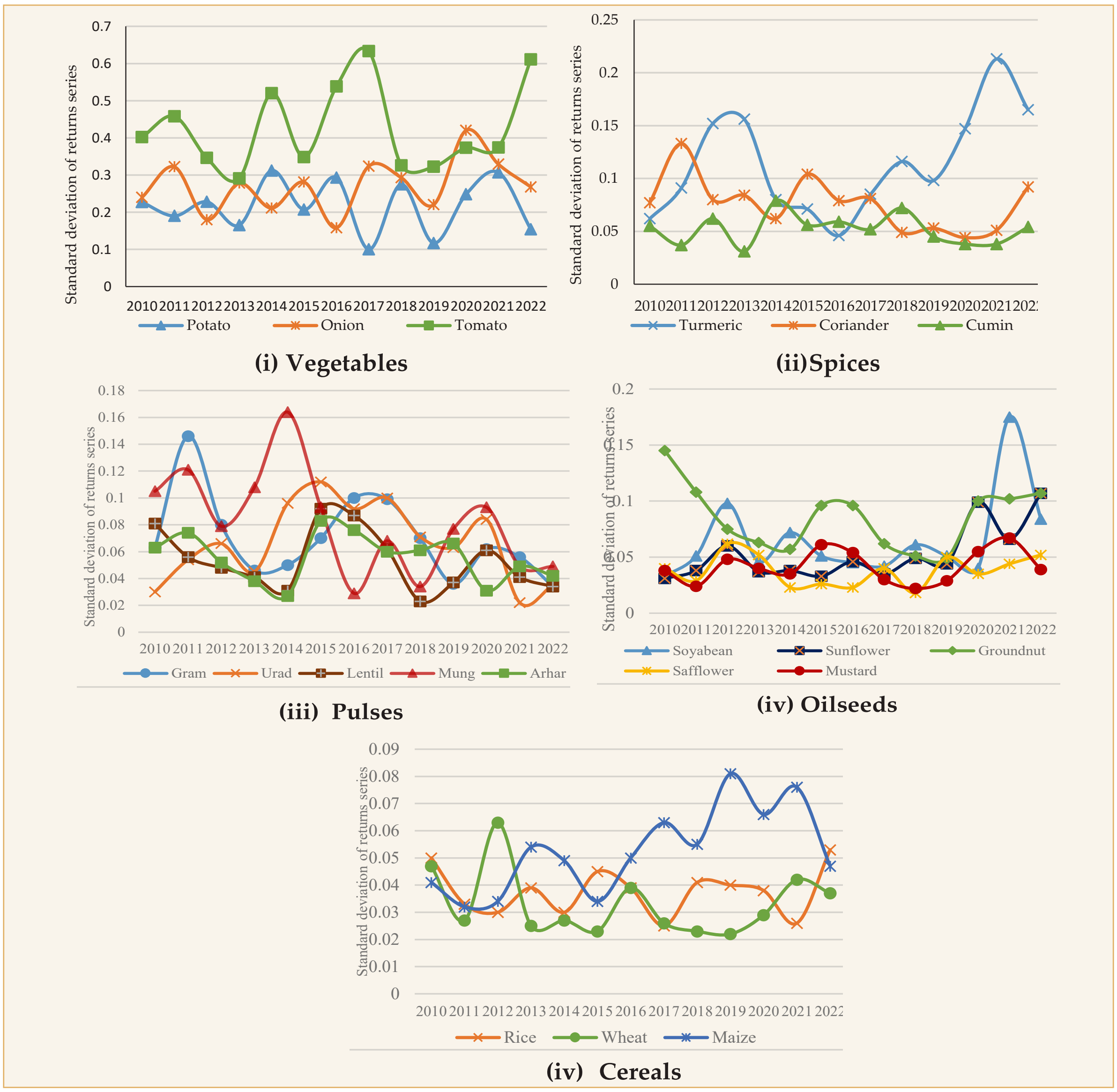



**Figure 2.30: Trends in price volatility in food commodities**

## Food price inflation: Determinants and their asymmetric impact

*Purushottam Sharma, D. C. Meena and Md. Ejaz Anwer*

The study examines the asymmetric dynamic relationship between food price inflation and its drivers in the short and long run. The Autoregressive Distributed Lag (ARDL) and the Non-linear Autoregressive Distributed Lag (NARDL) models have been applied to explore the dynamics of food inflation and its determinants using monthly data from January 2011 to December 2022. Findings from ARDL confirm that international food prices, wage rates, agricultural GDP, and call money rates are major contributors to food inflation in the long run. The NARDL results reveal significant asymmetric effects of money supply, wage rate, crude oil prices, international food prices, real effective exchange rate, and call money rate on food inflation in the long run (Figure 2.31). These findings will help policymakers and agricultural stakeholders take policy measures to control food price inflation.

## Productivity growth and technical change in Indian meat processing industry

*Shiv Kumar and Abdulla*

Using unit-level panel data (at 4-digit level) from the Annual Survey of Industries (ASI) and employing a stochastic frontier production (SFP)

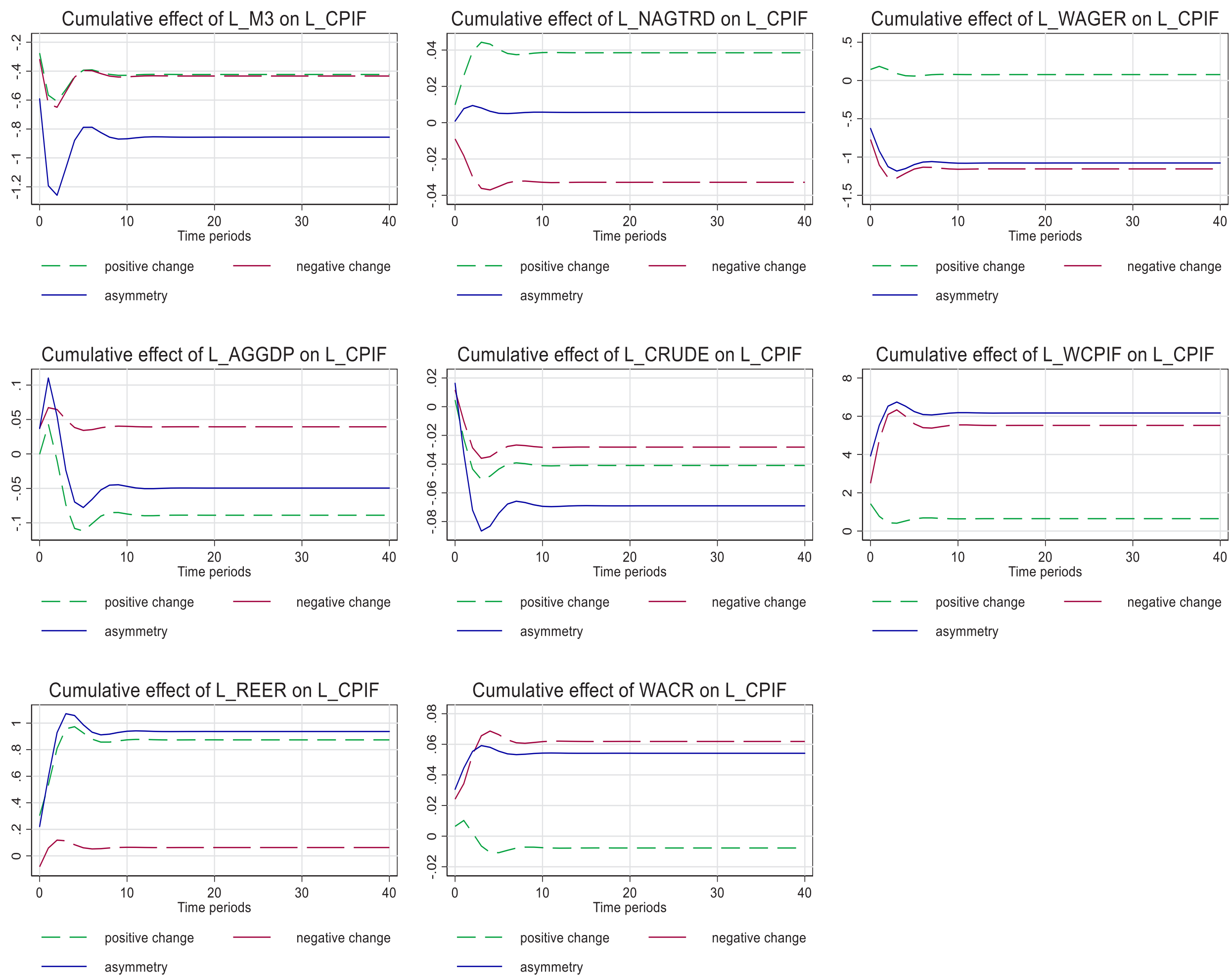



**Figure 2.31: Dynamic multipliers effect of determinants on food prices**

model, this study investigates the technological change and productivity of the Indian meat industry from 2002 to 2016.

The results from the half-normal translog SFP show that the first-order coefficient of labor is positive and significant at 1%, while the energy coefficient is negative and statistically significant (Table 2.18). However, the coefficient of capital is negative and insignificant. Notwithstanding, labor and capital, when interacting with time, appear negative and insignificant. The negative coefficient on the interaction of time trend is expected as the input supplies vary over time. Furthermore, coefficients on interactions of these inputs among themselves are either positive or negative, suggesting the possibilities of input substitution or complementarity. Contrary to our expectation, the first-order coefficient on the time trend is positive. This can happen as, in the beginning, policies to restructure the industry may retard technical progress due to changes in relative prices that may adversely affect the choice of factor inputs.

However, the second-order coefficient on time trend is negative, indicating no acceleration in technical progress in the long run. Also, the interaction of time trend with labor is negative and insignificant, suggesting that the non-neutral part of technical progress tends to offset the adverse effects of the neutral part of the technical change. The coefficient of time is statistically insignificant.

The state-wise analysis of TFP growth decomposition in Figure 2.32 shows higher TFP growth in Punjab, Haryana, Rajasthan, West Bengal, Madhya Pradesh, Bihar Assam, Telangana, and Andhra Pradesh. Uttar Pradesh, Maharashtra, Karnataka, Kerala, and West Bengal have moderate TFP growth. In contrast, Jammu and Kashmir, Himachal Pradesh, Delhi, Jharkhand, Orissa, Tamil Nadu, Pondicherry and Manipur have lower TFP growth.

**Table 2.18: Estimates of half-normal stochastic production frontier model**

| Variables | Coefficients |
|---|---|
| log(Labour) | 1.864***<br>(-7.58) |
| log(Capital) | -0.106<br>(-0.63) |
| log(Energy) | -0.461*<br>(-2.31) |
| log(Labour)^2 | -0.106***<br>(-4.30) |
| log(Capital)^2 | 0.00479<br>(-0.91) |
| log(Energy)^2 | -0.0496**<br>(-2.92) |
| log(Labour)*log(Capital) | -0.0259*<br>(-2.12) |
| log(Labour)*log(Energy) | 0.0498**<br>(-2.75) |
| log(Capital)*log(Energy) | 0.0404***<br>(-3.59) |
| Time trend | 0.173<br>(-1.66) |
| Time trend^2 | -0.00843***<br>(-3.89) |
| Time*log( Labour) | -0.0124<br>(-1.52) |
| Time*log(Capital) | 0.000381<br>(-0.06) |
| Time*log(Energy) | 0.0182**<br>(-2.79) |
| Constant | -0.0554<br>(-0.03) |
| $\sigma_u$ | |
| Time | -0.0316<br>(-1.33) |
| Constant | 0.683*<br>(-2.5) |
| $\sigma_v$ | |
| Constant | -0.444***<br>(-4.87) |
| N | 2305 |

Note: t-statistics in parentheses. * p<0.05, ** p<0.01, *** p<0.001.

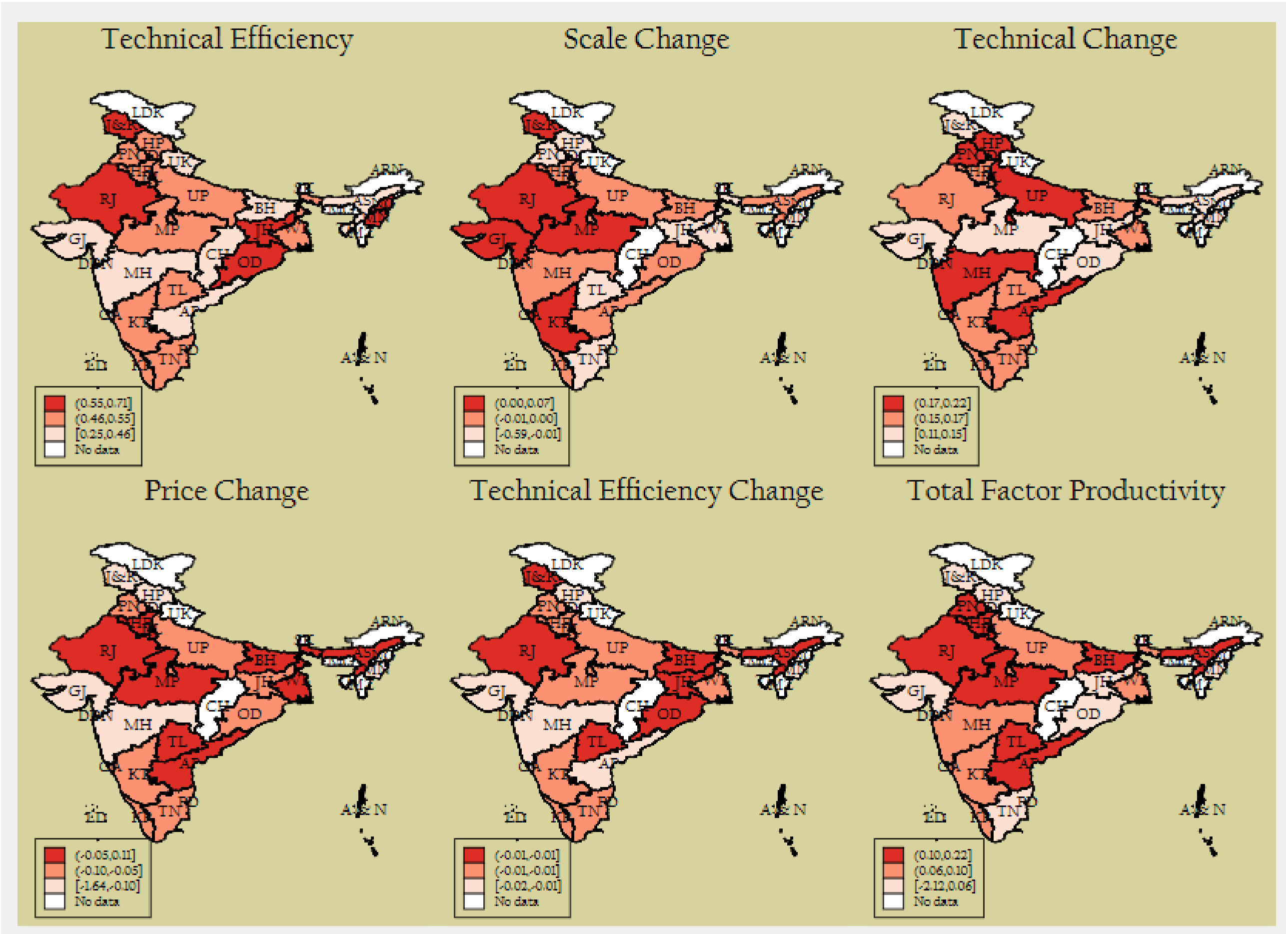



**Figure 2.32: Spatial total factor productivity and technical change**

The sub-group specific TFP of the meat processing industry (Table 2.19) shows that poultry slaughtering and beef slaughtering firms have the highest TFP growth.

**Table 2.19: Sub-group specific average TFP**

| Industry | Scale change | Technical change | Technical efficiency change | Price change | TFP |
|---|---|---|---|---|---|
| Mutton-slaughtering, preparation | -2.2% | 17.0% | -1.5% | -13.2% | 0.2% |
| Beef-slaughtering, preparation | -0.9% | 18.9% | -1.4% | -5.1% | 11.5% |
| Pork-slaughtering, preparation | -0.3% | 17.4% | -1.5% | -6.8% | 8.8% |
| Poultry and other slaughtering, preparation | 0.5% | 19.2% | -1.5% | -2.3% | 15.9% |
| Preservation, processing and canning of meat | -0.9% | 17.0% | -1.5% | -7.7% | 6.8% |
| Production of hides and skins originating from slaughterhouses | 2.1% | 26.9% | -1.6% | -17.9% | 9.6% |
| Production and processing of animal offal | -0.1% | 14.6% | -1.4% | -4.9% | 8.1% |
| Production, processing and preserving of other meat and meat product | -0.8% | 16.4% | -1.5% | -8.2% | 6.0% |
| Total | -0.6% | 17.8% | -1.5% | -7.8% | 7.9% |

Improving technical efficiency and productivity in the meat processing and preservation industry is critical for realizing the potential of meat production. There is a need to transform the meat processing industry with changing socioeconomic and legal frameworks.

## Sustaining long-term agricultural exports from India

*Raka Saxena, Devesh Kumar Pant, Purushottam Sharma and Ranjit Kumar Paul*

This study analyzed the trend, composition, and dynamics of India's comparative advantage in

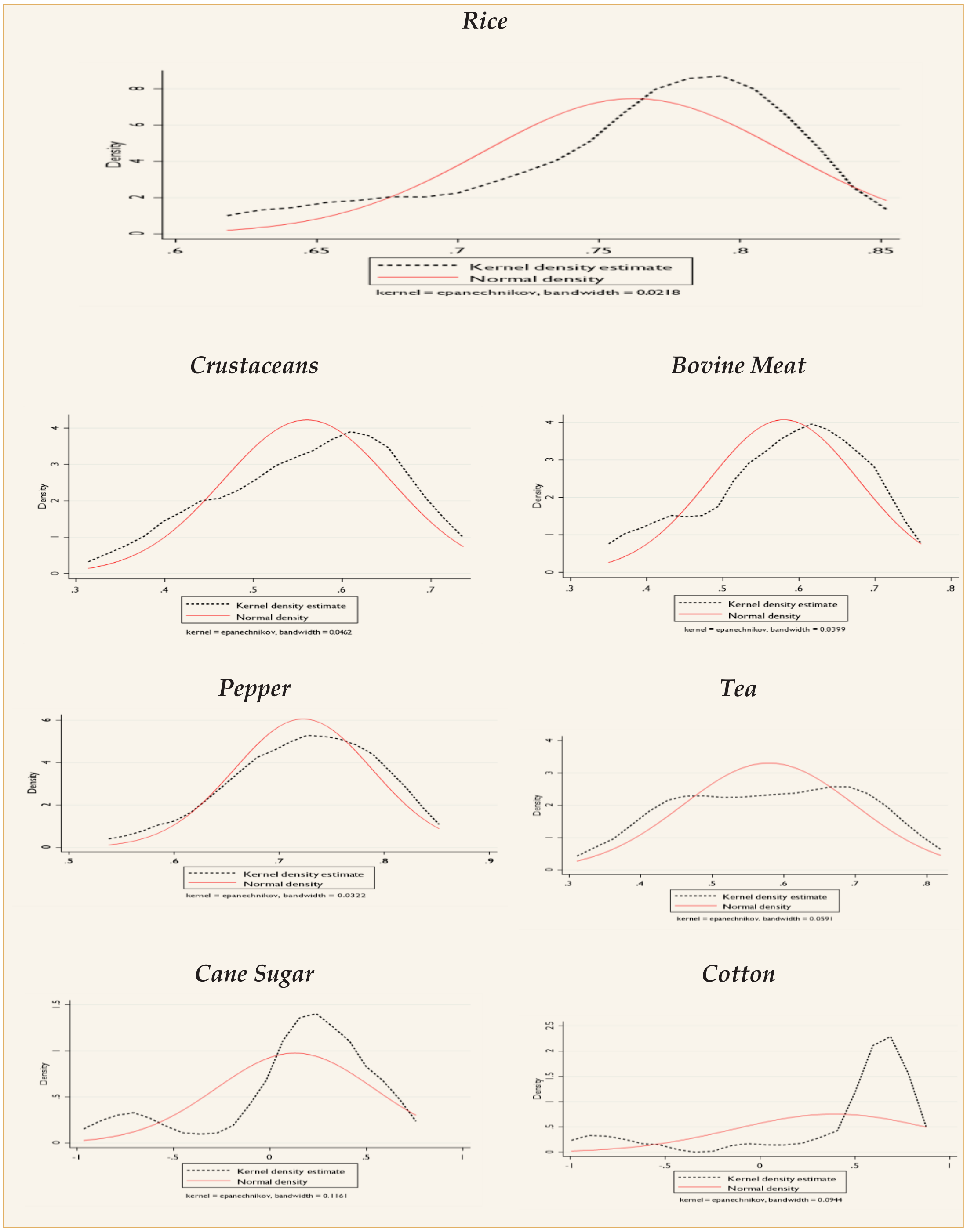



**Figure 2.33: Kernel density distributions of Revealed Symmetric Comparative Advantage (RSCA) indices for selected commodities**

agricultural exports from 2001 to 2021 for seven agricultural commodities: rice, crustaceans, bovine meat, cotton, pepper, cane sugar, and tea. Agricultural exports have gradually improved their share in agricultural gross value added (GVA). Rice has the highest comparative advantage, followed by pepper and tea, whereas crustaceans and bovine meat have a low comparative advantage (Figure 2.33). The COVID-19 pandemic disrupted supply chain networks, leading bovine meat and tea exports to fall.

## Regional patterns and factors affecting area allocation under millets

*Prem Chand*

Despite having better nutritional attributes and climate resilience characteristics, the cultivation of millets in India is experiencing a decline. Using panel data from Indian states and employing a random-effects model, this paper investigates spatiotemporal changes in millet cultivation and explores factors influencing their area allocation. Findings reveal that although the overall area under millets has decreased, there is a rise in their production mainly due to increased yields. The area of sorghum declined in Maharashtra and of small millets in Madhya Pradesh and Andhra Pradesh. Madhya Pradesh, Andhra Pradesh, and Gujarat have the potential for increased millets production (Figure 2.34). Similarly, Tamil Nadu holds significant potential for increasing millet production, given the higher yield of finger millet (>3 tons/ha), pearl millet (2.5 tons/ha), and small millets (1.4 tons/ha).

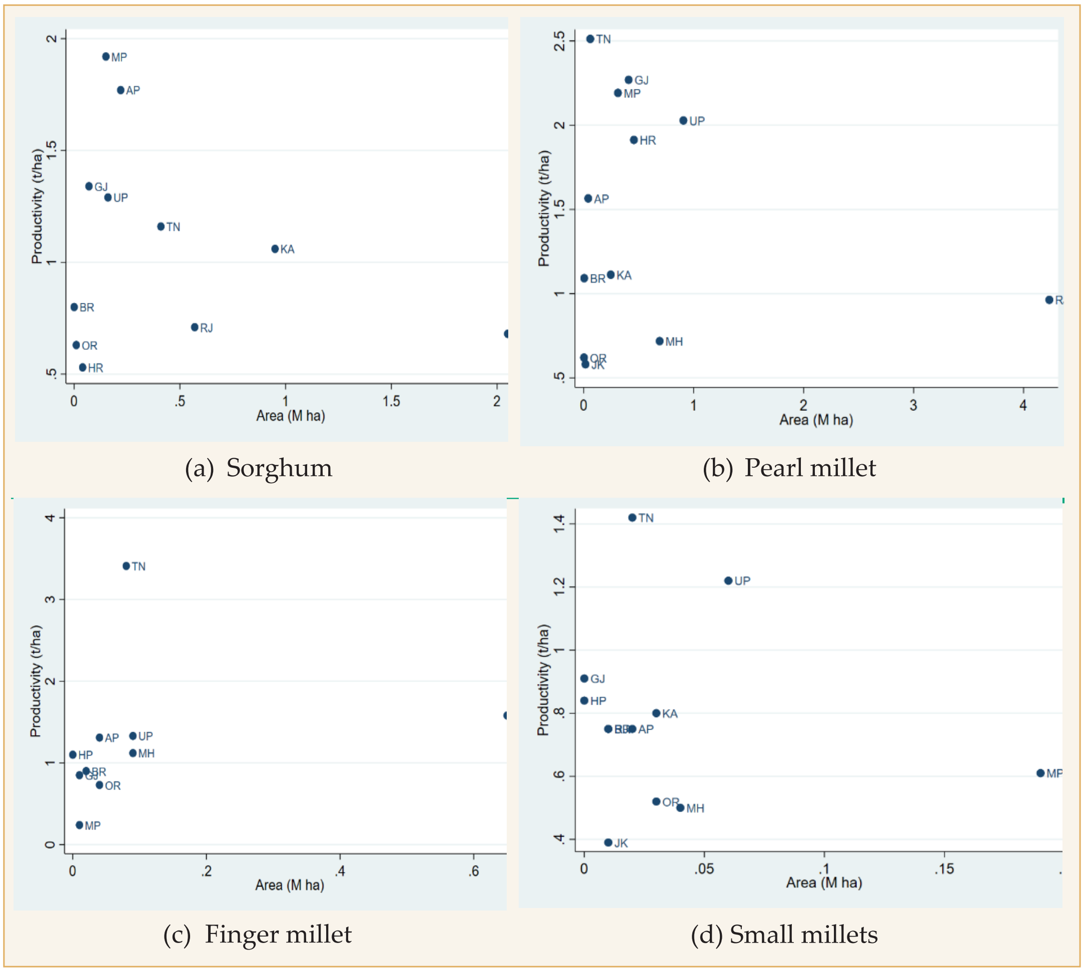



**Figure 2.34: Area and yield of millets in major producing states of India, TE 2020/21**

The returns from competing crops, like rice or maize, influence area allocation to millets. A crop-neutral price policy is advocated to foster a fair environment for millets. Although there has been a commendable increase in minimum support prices of millets, their procurement remains a concern.

## Impact of Farmer Producer Organizations

*Vinayak R. Nikam, Haripriya Veesam, Kiran Kumara T. M. and Prem Chand*

A meta-analysis was undertaken to assess the impact of FPOs at the farm level. The findings show that FPOs significantly positively impact agricultural productivity and farm income. The mean effect size is estimated at 3.59% for crop yields and 18.23% for milk yield (Figure 2.35). The effect is higher for income, indicating their important role in marketing and price realization.

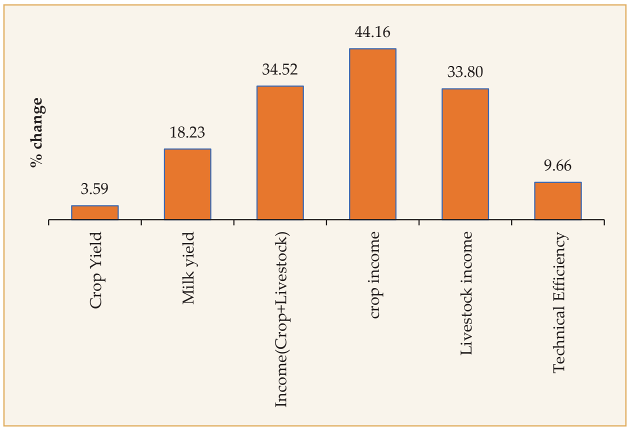



**Figure 2.35: Impact of FPOs on yield, income, and technical efficiency**

## Impact of attitude on purchase intent in organic food consumption

*Satish Chandra Pant, Raka Saxena and Devesh Kumar Pant*

This study delved into the dynamics of organic food consumption behavior dynamics. The research explored how various factors influence consumers' decisions by analyzing the interplay between attitude and purchase intention (PI). Findings underscore the mediating roles of perceived quality (PQ), perceived value (PV), and perceived price (PP) in the relationship between attitude and purchase intention, shedding light on the nuanced pathways guiding consumer behavior. Moreover, the study contributed novel insights by unveiling serial mediation effects. This sequential mediation analysis, considering pathways through PP and PQ, PQ and PV, PP and PV, and finally through PP, PQ, and PV, offers a comprehensive understanding of the intricate mechanisms shaping consumers' intentions towards organic food products. Perceived price and quality are important mediators. Given the growing significance of organic food consumption amidst global ecological, environmental, and health concerns, the research findings hold substantial implications. These provide a clear roadmap for practitioners to design effective marketing strategies by emphasizing the importance of perceived price and quality.

## Impact of COVID-19 and Russia-Ukraine conflict on India's agricultural trade

*Purushottam Sharma, Devesh Kumar Pant and Raka Saxena*

The impacts of COVID-19 and the Russia-Ukraine war on India's agricultural trade were studied using monthly commodity level exports and imports data. The study employed interrupted time series analysis to examine the pre-and post-intervention levels and trend changes in exports and imports of major agricultural commodities. The COVID-19 pandemic caused an immediate decline in agricultural exports and imports, but it also created opportunities to boost India's agricultural exports through proactive policy interventions. The Russia-Ukraine war opened up new markets for Basmati rice and oil meals, while imports of most major agricultural products surged dramatically, except pulses. The proactive measures initiated by the Government after the pandemic and the Russia-Ukraine conflict served to reduce the impact of both these crises.

## Dried fish economy of India: Organization, impacts and policies

*Suresh A., Rajni Jain and Vinayak R Nikam*

A deeper analysis of the dried fish value chain was undertaken using data collected from 25 dried fish firms in Visakhapatnam (Andhra Pradesh), Veraval (Gujarat), Cochin (Kerala), and Mumbai (Maharashtra). Of the total fish production in India, about 67% is consumed as fresh, 16% is utilized for processing and drying, 6% is converted into fishmeal, and only 1% is canned. The broader trend is that dried fish production is declining. A detailed analysis of export of dried fish from India is provided in Figure 2.36.

The analysis of informal sector enterprises relied on data from Unincorporated Non-Agricultural Enterprises Survey rounds 67$^{th}$ (2010-11) and 73$^{rd}$ (2015-16) conducted by the National Sample Survey Office (NSSO). For formal sector industries, data were taken from the Annual Survey of Industries (ASI) from 2009-10 to 2019-20. Sun drying remains the predominant fish drying method, with a significant increase in enterprises from 2010-11 to 2015-16 (Table 2.20).

**Table 2.20: Estimated number of dried fish-related enterprises in India**

| | Sun-drying of fish | | Artificial dehydration of fish and seafood | |
|---|---|---|---|---|
| | **2010-11** | **2015-16** | **2010-11** | **2015-16** |
| Rural | 3540 | 7576 | 0 | 10 |
| Urban | 529 | 6439 | 9 | 0 |
| **Total** | **4069** | **14015** | **9** | **10** |

Overall, all the respondents followed the sun drying method - 4% used solar dryers, and another 4% used electric dryers. Women owned 52% of dried fish units. The mean capacity utilization is 71%. The existence of idle production capacity is a result of several factors, including the availability of raw materials, markets, and processing facilities. Developing quality assurance systems in dried fish is required for further market capture. The major policy gaps and suggestions for addressing these are given in Table 2.21.

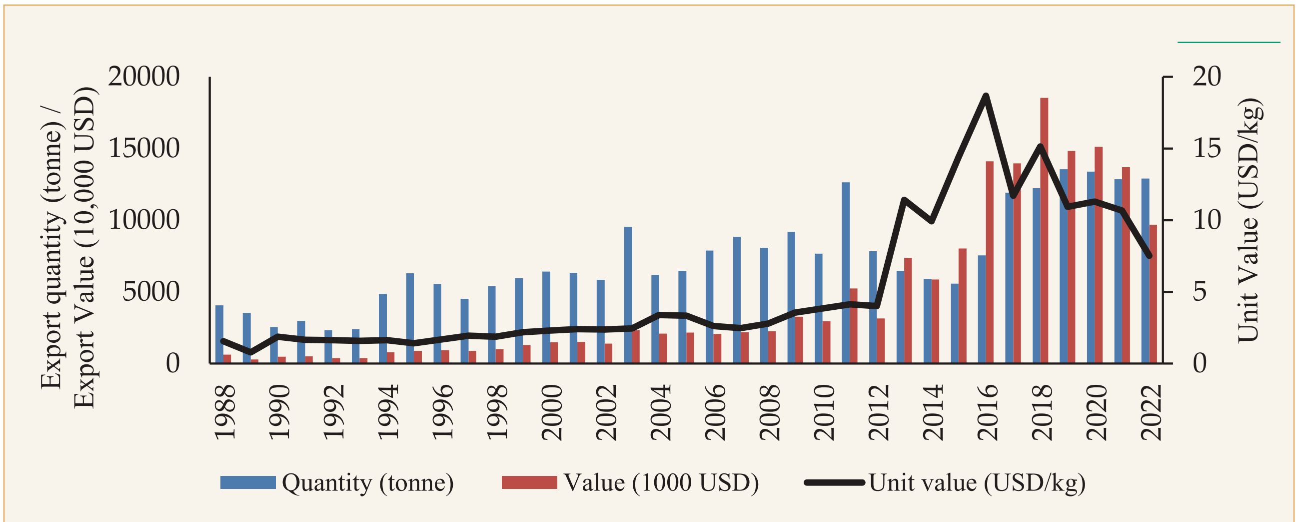



**Figure 2.36: Export of dried fish from India, 1988-2022**

**Table 2.21: Policy gaps identified and corresponding suggestions for improving dried fish economy in India**

| S. No. | Policy gaps | Suggestions |
|---|---|---|
| 1 | Technology and Practices | 1. Technology penetration<br>2. Promotion of good drying practices<br>3. Technology for advanced product preparation |
| 2 | Support and Development | 1. Formation and support of producer collectives<br>2. Institutional support for entrepreneurship development<br>3. Capacity development through extension services and training programmes |
| 3 | Regulation and Framework | 1. Development of a regulatory framework<br>2. Improving statistical systems and market intelligence |
| 4 | Market and Material Availability | 1. Increasing the availability of fish for drying<br>2. Ensuring the availability of raw materials<br>3. Developing market linkages |
| 5 | Social and Infrastructure Support | 1. Providing social protection<br>2. Enhancing infrastructure<br>3. Addressing informality and marginality<br>4. Promoting livelihood diversification<br>5. Gender and ecological concerns |

## Bibliometric analysis of agri-food systems and nutritional security

*Raka Saxena, Devesh Kumar Pant and Satish Chandra Pant*

This study has examined the evolution of research on linkages between agri-food systems and nutritional security globally using bibliometric analysis of 1,057 documents listed in the SCOPUS database from 1984 to 2023. The systematic study used the PRISMA approach to screen the document for clarity. The study identified significant keywords in the literature, such as food security, India, nutrition, and climate change, establishing their significance in the field. The analysis of co-occurrence networks identified a prominent cluster named "sustainable agri-food systems for achieving food and nutritional security," emphasizing sustainable approaches in agriculture and food systems to ensure both food and nutritional security.

The analysis of historical developments in the 'agri-food systems and nutritional security' research domain begins with a comprehensive examination of thematic evolution (Figure 2.37), which utilizes authors' keywords and an inclusion index weighted by word occurrence. The evolution of themes in the 21$^{st}$ century was analyzed over three time spans. During 2000-10, there was a global emphasis on food security focusing on Asian and African countries; nutritional security received little attention during this span. The second time slice (2011-19) witnessed the emergence of research on nutritional security, which included a variety of topics such as gender, dietary diversity, breeding and food security. The third time slice (2020-23) was primarily concerned with establishing measures for mitigating climatic change, abiotic stresses, and the impacts of the COVID-19 pandemic on nutritional security.

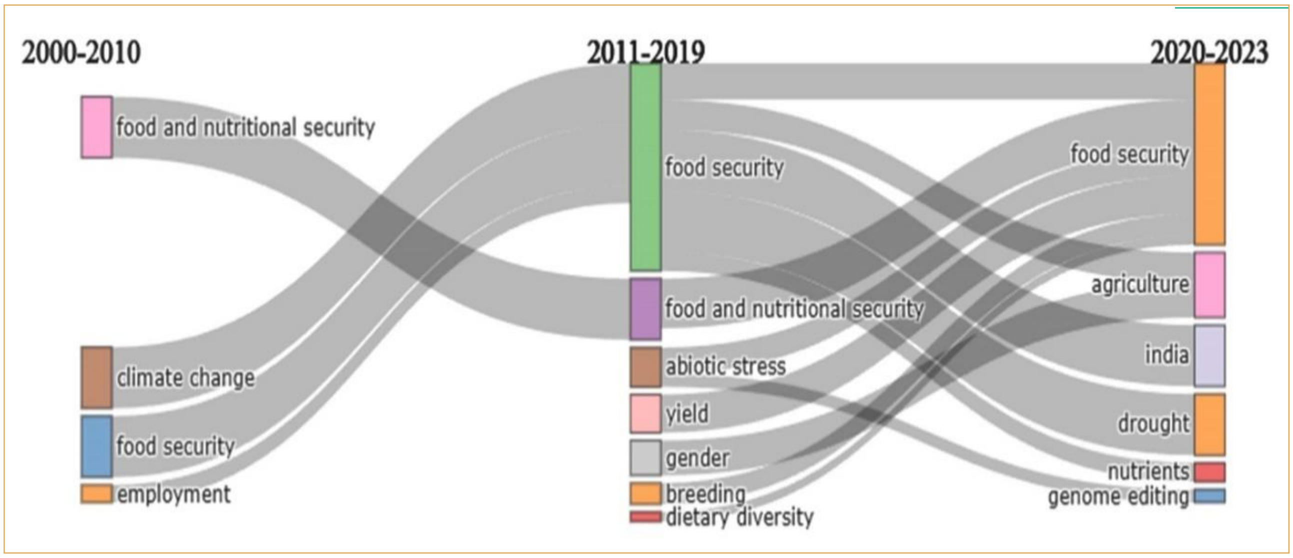



**Figure 2.37: Thematic evolution in the area of nutritional security**

## List of Research Projects

**Table 2.22: Completed and ongoing research projects**

| Title | Theme | Project duration | Project team | Project status |
|---|---|---|---|---|
| Network Project (Ecosystems, agribusiness and institutions) | | | | |
| Component I: Inclusive agricultural development (Hill and arid agriculture) | Technology and Sustainable Agriculture | April 2021-March 2026 | Prem Chand, Khem Chand and Kiran Kumara T.M. | Ongoing |
| Component II: Impact of agricultural technology | Technology and Sustainable Agriculture | April 2021-March 2026 | Rajni Jain, Ankita Kandpal and Vinayak R. Nikam | Ongoing |
| Component III: Agricultural market intelligence and commodity outlook | Agricultural Market and Trade | April 2021-March 2026 | Purushottam Sharma, D. C. Meena and Kingsly Immanuelraj T. | Ongoing |
| Component-IV: Farmers' income, governance impacts and agricultural trade | Agricultural Growth and Development | April 2021-March 2026 | Raka Saxena and Balaji S.J. | Ongoing |
| **Externally funded projects** | | | | |
| Doubling farmers' income in India by 2021-22: Estimating farm income and preparation of strategic framework | Agricultural Growth and Development | April 2017-December 2023 | Raka Saxena, Balaji S.J. and R. K. Paul | Completed |
| Strategic research component of National Innovations on Climate Resilient Agriculture (NICRA) | Technology and Sustainable Agriculture | April 2017-Contd. | Nalini Ranjan Kumar, S. K. Srivastava and N. P. Singh | Ongoing |
| Trees outside forests in India | Technology and Sustainable Agriculture | November 2021-October 2026 | Prem Chand, Kiran Kumara T.M. and Vinayak R. Nikam | Ongoing |
| Improving groundwater sustainability through analysing groundwater-energy nexus | Technology and Sustainable Agriculture | April 2021-March 2026 | S. K. Srivastava, Subhash Chand, Prabhat Kishore, Ranu Rani Sethi and Ankhila R.H. | Ongoing |
| Management and impact assessment of farmer FIRST | Technology and Sustainable Agriculture | February 2017- March 2024 | Shiv Kumar, Rajni Jain, Vinayak R. Nikam, Ankita Kandpal and Kingsly Immanuelraj T. | Ongoing |

| Title | Theme | Project duration | Project team | Project status |
|---|---|---|---|---|
| The South Asia agriculture adaptation atlas: interconnections between climate risks, practices, technologies, and policies | Technology and Sustainable Agriculture | April 2023-August 2025 | Prem Chand and Prabhat Kishore | Ongoing |
| R & D investment and innovation outcomes in Indian agriculture | Technology and Sustainable Agriculture | August 2020-March 2025 | Ankita Kandpal and P. S. Birthal | Ongoing |
| **Institute funded projects** | | | | |
| Re-examining farm size – productivity relationships in Indian agriculture | Agricultural Growth and Development | December 2023 – November 2025 | Balaji S. J., Jaya Jumrani and P. S. Birthal | Ongoing |
| Database development for agricultural rural households with special focus on weaker sections | Technology and Sustainable Agriculture | April 2020-March 2025 | Subhash Chand, Rajni Jain, Vikas Kumar, Dilip Kumar, D. C. Meena, K. R. Chaudhary and M. S. Chauhan | Ongoing |
| Farm mechanization-the role of custom hire services and rural labour market | Technology and Sustainable Agriculture | April 2020-March 2024 | Nalini Ranjan Kumar and S. K. Srivastava | Completed |
| Sustainable intensification of agriculture | Technology and Sustainable Agriculture | April 2020-March 2024 | Prem Chand, Kiran Kumara T. M. and D. C. Meena | Ongoing |
| Institutions and technology for agricultural water management | Technology and Sustainable Agriculture | April 2021-March 2024 | S. K. Srivastava, Subhash Chand and Prabhat Kishore | Ongoing |
| Performance and Impact of Farmer Producer Organizations (FPOs) | Technology and Sustainable Agriculture | April 2021-March 2024 | Vinayak R .Nikam and Prem Chand | Ongoing |
| Economic valuation of ecosystem service from sustainable agricultural practices in India | Technology and Sustainable Agriculture | July 2022-June 2023 | Kiran Kumara T. M., D. C. Meena and P. S. Birthal | Ongoing |
| AI and machine learning for supply forecasts | Technology and Sustainable Agriculture | April 2021-March 2026 | Rajni Jain, Dilip Kumar, Anshu Bharadwaj and Sapna Nigam | Ongoing |

| Title | Theme | Project duration | Project team | Project status |
|---|---|---|---|---|
| Regional disparity in use of fertilizers in India: causes and impacts | Technology and Sustainable Agriculture | September 2022-August 2024 | Sant Kumar and Kingsly I.T. | Ongoing |
| Appraisal of dairy services: Access, preferences and impacts | Technology and Sustainable Agriculture | January 2023-December 2024 | Arathy Ashok, Vikas Kumar and Vinayak R. Nikam | Ongoing |
| Value chain study on non-bovine milk in India | Technology and Sustainable Agriculture | November 2023-October 2025 | Khem Chand | Ongoing |
| Impact analysis of farmers' Innovations on agro-economic development in rural areas | Technology and Sustainable Agriculture | July 2022-December 2024 | Vikas Kumar, Arathy Ashok and Dilip Kumar | Ongoing |
| Digital innovations in agriculture | Technology and Sustainable Agriculture | January 2023-March 2025 | Rajni Jain, Vikas Kumar and Arathy Ashok | Ongoing |
| Research priorities in Indian agriculture | Technology and Sustainable Agriculture | July, 2022 to June, 2024 | S V Bangararaju Tatipudi, Raka Saxena and P. S. Birthal | Ongoing |
| Economic valuation of impact of bio stimulants on agricultural ecosystem services | Technology and Sustainable Agriculture | January, 2024-December, 2025 | D. C. Meena Kiran Kumara T. M. and P. S. Birthal | Ongoing |
| Agricultural price analysis and forecasting | Agricultural Market and Trade | April 2020-March 2025 | Purushottam Sharma, D.C. Meena, Kingsly Immanuelraj T. and Shiv Kumar | Ongoing |
| Welfare gains to the farm households with access to minimum support price and its effect on groundwater depletion | Agricultural Market and Trade | April 2022-March 2024 | Prabhat Kishore, P. S. Birthal and S. K. Srivastava | Ongoing |
| Untangling India's dual malnutrition burden: Analyzing spatial and socio-demographic patterns under changing climatic conditions | Agricultural Market and Trade | December 2023 to December 2026 | Jaya Jumrani and Prem Chand | Ongoing |

**Table 2.23: Consultancy and contract research projects**

| Area of consultancy/ contract research | Funding agency | Scientists involved |
|---|---|---|
| Economic valuation of ecosystem services from agriculture in India | IFPRI, South Asia, New Delhi | Kiran Kumara T.M., D. C. Meena and P. S. Birthal |
| Unpacking social and gender dynamics of seed systems for sustainable intensification of agriculture | International Rice Research Institute (IRRI) | Raka Saxena, P. S. Birthal, Shiv Kumar, Prabhat Kumar and S.V. Bangara Raju Tatipudi |
| Foresight and metrics to accelerate food, land, and water systems transformation (Foresight) | Bioversity International | Balaji S.J., Purushottam Sharma, S.K.Srivastava and Kingsly I.T. |
| Assessing benefits of solar-powered micro-irrigation in India | International Copper Association (India) | S. K Srivastava, Prabhat Kishore and P. S. Birthal |
| Indian food systems for improved nutrition: Policy support research facility | University of Sheffield, UK | Shiv Kumar, P. S. Birthal, Jaya Jumrani and Kiran Kumara T.M. |
| In-Depth analysis of implementation challenges and potential opportunities for digitalization | Nanyang Technological University (NTU), Singapore | Rajni Jain and Arathy Ashok |

# 3 Capacity Building

## Seminars, Workshops, Training and Lectures Organized

### ICAR-NIAP Policy Lecture Series

ICAR-NIAP organized the following lectures as a part of the policy lecture series initiated in January 2023.

- India's Agricultural GIs: Unlocking Economic Potential by Mr. Abhijit Das, former Professor and Head, Centre for WTO Studies, New Delhi, April 28, 2023.
- Paradigm Shift in Agriculture: Bio-economy, Circular Economy and Secondary Agriculture by Dr. Ashok Dalwai, Chairman, Empowered Body, Doubling Farmers Income, Ministry of Agriculture & Farmers' Welfare, New Delhi, July 7, 2023.
- Over Optimism in Public Policy: Implications for Support to Agricultural Development by Dr. Nick Maddock, Agriculture and Rural Development Economist, October 26, 2023.

### Winter School

ICAR-NIAP organized a 21-day ICAR-sponsored Winter School on "Quantitative Techniques for Agricultural Policy Analysis" during March 8-28, 2024. A total 24 participants from the National Agricultural Research System attended the training programme. The programme was coordinated by Dr. Prem Chand (Course Director), Dr. Vinayak Nikam, and Dr. Kiran Kumara T.M. Dr. R. C. Agrawal, Deputy Director General (Education), ICAR, New Delhi, inaugurated the training programme. Participants were exposed to various econometric and policy analysis techniques during training. Shri Siraj Hussain, Former Secretary, Agriculture, Government of India was the Chief Guest in the valedictory ceremony.

**Winter School on "Quantitative Techniques for Agricultural Policy Analysis"**

### Workshop on IPR-related Issues in Agriculture

ICAR-NIAP organized a workshop on IPR related Issues in agriculture on the occasion of World Intellectual Property (IPR) Day on April 26, 2023. Dr. Neeru Bhooshan, ADG (IPTM&PME), ICAR, talked about the relevance of a strong IP system in agriculture.

**Workshop on "IPR Related Issues in Agriculture"**

### Brainstorming Workshop on Upscaling Digital Innovations in Agricultural Supply Chain

ICAR-NIAP organized a brainstorming workshop on "Upscaling Digital Innovations in Agricultural Supply Chain" on July 31, 2023. Representatives from AgriTech firms participated and discussed their digital innovations, major challenges faced in their upscaling, and policy needs. Mr. Deepak Pareek, Chief Growth Officer, Suumaya Industries Limited, and Dr. P. S. Birthal, Director, ICAR-NIAP, co-chaired the session.

**Brainstorming workshop on "Upscaling Digital Innovations in Agricultural Supply Chain"**

## Stakeholders' Consultation on Policies and Strategies for Expansion of Trees outside Forests in Arid Region of India

ICAR-NIAP and Sri Karan Narendra Agriculture University (SKNAU), Jobner, jointly organized a consultation on "Policies and Strategies for the Expansion of Trees Outside Forests in the Arid Region of India" on September 8, 2023, at the Zonal Agricultural Research Station, Fatehpur, Sikar, Rajasthan. Dr. Balraj Singh, Vice-Chancellor of SKNAU Jobner, was the chief guest, and Dr. P. S. Birthal, Director of ICAR-NIAP, chaired the programme. Dr. Singh emphasized the need for careful selection of indigenous, multi-purpose, and climate-resilient tree species like *Moringa oleifera, Azadirachta indica,* and multiple harvest species like *Syzygium cumini, Capparis decidua, and Ailanthus sp.* He highlighted the need to revive community-level seed collection, incentivize communities to expand indigenous trees and address the threat of *Prosopis juliflora* to indigenous vegetation due to its allelopathic effects. Dr. Birthal stressed strengthening the carbon credit market and emphasized Geographical Indications for indigenous products. He also emphasized improving timber traceability using blockchain technology.

**Stakeholders' Consultation on "Policies and Strategies for Expansion of Trees outside Forests in Arid Region of India"**

## Workshops on Gender Dynamics of Seed Systems in Telangana and Bihar

ICAR-NIAP organized a workshop on 'gender dynamics of seed systems' in Telangana on October 4, 2023. This workshop included representatives from Telangana Seed Corporation, National Seed Corporation, Professor Jayashankar Telangana State Agricultural University, KVKs, FPOs, and the seed industry. Subsequently, a farmers' meet was organized at Nilayigudi village on October 5, 2023, to discuss the farmers' perspectives on issues, challenges, and constraints in the existing seed production system.

A similar workshop was organized in Patna, Bihar, on November 7, 2023. It was attended by farmers, representatives of farmer's collectives, and research organizations, including Dr. Rajendra Prasad Central Agricultural University, ICAR Research Complex for Eastern Region, Bihar Seed Certification Agency, National Seed Corporation, State Seed Corporation, and private companies.

**Workshops on "Gender Dynamics of Seed Systems in Telangana and Bihar"**

## Progress Review Meeting of Network Project

An online meeting was organized to review the progress of partner institutes in the network project ‘Ecosystem, Agribusiness and Institutions’ on January 25, 2024, under the chairmanship of Dr. P. S. Birthal, Director ICAR-NIAP. He emphasized the importance of this network project for Agricultural Economists and highlighted its long-term benefits.

## Workshop on Impact of Agricultural Technologies

A workshop to harmonize methodologies for impact assessment was organized on August 8, 2023. Dr. P. S. Birthal, Director, ICAR-NIAP, urged partners to identify crop varieties for impact assessment.

Another workshop to review the progress of partner institutes was organized on September 18, 2023. The necessity of creating a well-structured impact assessment framework that encompasses essential data, the approach, and critical parameters like demand and supply elasticities was emphasized.

**Workshop on “Impact of Agricultural Technologies”**

## Brainstorming Workshop on Protecting Equine Biodiversity

ICAR-NIAP and ICAR-National Research Centre on Equines (NRCE) jointly organized a brainstorming workshop on “Protecting equine biodiversity” at NRCE, Hisar, on November 26, 2023. More than 40 participants from Rajasthan, Gujarat, Punjab, Haryana, and Himachal Pradesh attended the brainstorming session.

**Brainstorming workshop on “Protecting Equine Biodiversity” NRCE, Hisar**

## Workshop on Impact of Pradhan Mantri Fasal Bima Yojana

A workshop on “Impact of Pradhan Mantri Fasal Bima Yojana on the Socio-Economic Development of Farmers” was jointly organized by Symbiosis School of Economics and ICAR-NIAP, New Delhi at Pune, Maharashtra on December 28, 2023. The workshop brought together a diverse array of stakeholders, including farmers, ICAR scientists, representatives from insurance companies, common service centers, state agriculture departments, commercial banks, and academic institutions.

**Workshop on “Impact of Pradhan Mantri Fasal Bima Yojana”, Pune, Maharashtra**

### Training on Decoding STATA for Agricultural Economics and Policy Research

International Food Policy Research Institute (IFPRI), in collaboration with ICAR-NIAP, organized a training and experience sharing workshop on "Decoding STATA for Agricultural Economics and Policy Research" at ICAR-NIAP during November 7-8, 2023.

### Trainings under SC Sub Plan Programmes

The following training programmes on tailoring for the empowerment of women belonging to the SC community were organized:

**Table 3.1: Details of tailoring training**

| S. No. | Venue | Duration of training | No. of participants |
|---|---|---|---|
| 1. | Village Rakshada, Samalkha block, Panipat, Haryana | February 23 to March 23, 2023 | 29 |
| 2. | Village Basada, Samalkha block, Panipat, Haryana | February 23 to March 23, 2023 | 26 |
| 3. | Village Rakshada, Samalkha block, Panipat, Haryana | August 25 to September 24, 2023 | 24 |
| 4. | Village Rakshada, Samalkha block, Panipat, Haryana | October 11 to November 11, 2023 | 26 |
| 5. | Village Rakshada, Samalkha block, Panipat, Haryana | December 28, 2022 to January 27, 2023 | 25 |
| 6. | Village Dhamravali, Bulandshar, Uttar Pradesh | February 27 to March 28, 2023 | 24 |
| 7. | Village Dhamrawali, Bulandshar, Uttar Pradesh | July 25 to August 24, 2023 | 27 |
| 8. | Village Raipurtalab, Bulandshar, Uttar Pradesh | September 4 to October 3, 2023 | 25 |
| 9. | Village Raipurtalab, Bulandshar, Uttar Pradesh | January 3, 2024 to January 2, 2024 | 24 |
| 10. | Village Narsinghpura, Jaipur, Rajasthan | August 18 to September 17, 2023 | 23 |
| 11. | Village Narsinghpura, Jaipur, Rajasthan | November 4 to December 3, 2024 | 25 |



घरेलू कामगार महिलाओं का सिलाई प्रशिक्षण शुरू

कालाडेरा. नृसिंहपुरा में सिलाई प्रशिक्षण के शुभारम्भ पर मौजूद महिलाएं।

कालाडेरा. ग्राम नृसिंहपुरा में भारतीय कृषि अनुसंधान परिषद के राष्ट्रीय कृषि आर्थिकी एवं नीति अनुसंधान संस्थान नई दिल्ली के तत्वावधान में घरेलू कामगार महिलाओं का एक माह का सिलाई प्रशिक्षण शिविर शुक्रवार से शुरू हुआ। संस्थान के निदेशक प्रताप सिंह बिरथल ने कहा कि महिलाओं को स्वरोजगार से जोड़ने के लिए सिलाई का प्रशिक्षण दिया जा रहा है। नोडल ऑफिसर ख्यालीराम चौधरी ने कहा कि ऐसे छोटे-छोटे प्रयासों से ही गांव की महिलाएं आर्थिक रूप से सशक्त हो पाएंगी। शिविर में 25 महिलाओं को प्रशिक्षण दिया जा रहा है। इस मौके पर सिलाई का प्रशिक्षण लेनी वाली विभिन्न गांव की महिलाएं भी मौजूद थी।(निसं.)

राजस्थान केंद्रीय

नैक द्वारा ग्रेड A

विज्ञापन : आर/एफ.150/भर्ती/2023/1

महिला कृषकों को सब्जी के मिनिकिट वितरित

नृसिंहपुरा में आयोजित कृषक गोष्ठी में मिनिकिट वितरित करते हुए।

कालाडेरा. ग्राम पंचायत नृसिंहपुरा में गुरुवार को भारतीय कृषि अनुसंधान परिषद के तत्वावधान में आजादी का अमृत महोत्सव के तहत कृषक गोष्ठी का आयोजन किया। नोडल अधिकारी डॉ. ख्यालीराम चौधरी व योजना प्रभारी डॉ. आरसी मीणा ने महिला कृषकों को घर वाटिका के लिए सब्जी बीजों के मिनिकिट वितरित किए। गोष्ठी में मनोज अटल, सहायक कृषि अधिकारी उद्यान चौमूं जगदीश प्रसाद नील आदि भी मौजूद थे। (नि.सं.)

**Human Resource Development activities under SC SP programmes**

## Teaching and student guidance

**Table 3.2: Teaching activities undertaken by ICAR-NIAP Scientists**

| Name of the scientist | Course Name | Credit hours | Role (Course Leader/ Associate) | Division |
|---|---|---|---|---|
| N.R. Kumar | Macroeconomics and Policy (AgEcon 504) | 2+0 | Course Associate | Agricultural Economics, ICAR-IARI, New Delhi |
| | Advanced Macroeconomics (AgEcon 602) | 2+0 | Course Associate | Agricultural Economics, ICAR-IARI, New Delhi |

| Name of the scientist | Course Name | Credit hours | Role (Course Leader/ Associate) | Division |
|---|---|---|---|---|
| Rajni Jain | Spatial Informatics, GIS and Remote Sensing | 2+0 | Course Associate | Computer Applications and IT, ICAR-IASRI, New Delhi |
| | AI and Machine Learning | 3+0 | Course Leader | Computer Applications and IT,ICAR-IASRI, New Delhi |
| Purushottam Sharma | Commodity Trading and Future Markets (PGDM 714) | 2+0 | Course leader | Post Graduate Diploma in Management (Agribusiness Management), ICAR-NAARM, Hyderabad |
| Kingsly I. T. | Operation Research (AgEcon 605-2021) | 1+ 1 | Course Leader | Agricultural Economics, ICAR-IARI, New Delhi |
| Vinayak R. Nikam | Nutrition Policy and Agriculture | 2+0 | Course Leader | Agricultural Extension, ICAR-IARI, New Delhi |
| | Policy Engagement and Extension | 2+1 | Course Associate | Agricultural Extension, ICAR-IARI, New Delhi |
| | Organisational Behaviour | 2+1 | Course Associate | Agricultural Extension, ICAR-IARI, New Delhi |
| Dilip Kumar | Digital Image Processing | 2+1 | Course Associate | AKMU- ICAR-IARI, New Delhi |
| | Software Engineering | 2+0 | Course Associate | Computer Application, ICAR-IASRI, New Delhi |

**Table 3.3: Student guidance as chairperson of the advisory committee**

| Name of scientist | Name of student | Degree | Division | Thesis Topic |
|---|---|---|---|---|
| N.R. Kumar | Rohith S. | Ph.D | Agricultural Economics, ICAR-IARI, New Delhi | Evaluation of Some Innovative Custom Hiring Models of Farm machinery |
| | Raj Rattan Pandey | Ph.D | Agricultural Economics, ICAR-IARI, New Delhi | Climate Challenges and Adaptive Solutions: A Comprehensive Study of Flood-Prone Areas in Bihar |
| | Soumya Cheela | Ph.D | Agricultural Economics, ICAR-IARI, New Delhi | Impact Assessment of National Rural Livelihood Mission (NRLM) on Mitigation of Climate Change-Induced Risk |

| Name of scientist | Name of student | Degree | Division | Thesis Topic |
|---|---|---|---|---|
| | Md. Jamaludheen A | Ph.D | Agricultural Economics, ICAR-IARI, New Delhi | Climate Change and Food Security of Farm Households: A Case Study of the Kuttanad Region of Kerala |
| Rajni Jain | Sapna Nigam | Ph.D | Computer Applications and IT, PG School, ICAR- IARI, New Delhi | Development of Deep Learning Model for Identification of Major Wheat Diseases |
| S.K. Srivastava | Sneha S. B. | M.Sc | Agricultural Economics, ICAR-IARI, New Delhi | Changing Rural Employment Pattern and its Implications on Farm Economy |
| Kingsly I. T. | Hitashree | M.Sc | Agricultural Economics, ICAR- IARI, New Delhi | Competitiveness, Concentration and Capacity Utilization of Oilseeds Processing Industry |
| | Seema Arya | Ph. D | Agricultural Economics, ICAR- IARI, New Delhi | Pass Through Effects of Energy Prices on Prices of Agricultural Commodities |
| Vinayak R. Nikam | Veesam Haripriya | PhD | Agricultural Extension, ICAR-IARI, New Delhi | Credit Access Behavior of Indian Farmers: Determinants and Impact on Farm Income |
| | Suresh Kumar Bishnoi | MSc | Agricultural Extension, ICAR-IARI, New Delhi | A Study of Social Networks and Stakeholders in Farmer Producer Organisations |

# 4 Policy Interactions

- Provided evidence-based inputs for Doubling Farmers' Income' as a knowledge partner to the Ministry of Agriculture & Farmers' Welfare, Government of India, and participated in the concluding meeting held at the Prime Minister's Office to charter the path ahead.
- Provided inputs to the Committee on Minimum Support Price (MSP) and Crop Diversification, constituted by the Government of India.
- Generated demand and supply forecasts of various agricultural commodities for the NITI Aayog, Government of India.
- Provided inputs on the Effect of the Cotton Seed Price Control (CSPC) Order- 2015 on the economic viability of cotton farming in India.
- Provided inputs on the Price Policy of Crops to the Ministry of Agriculture & Farmers' Welfare, Government of India.
- Provided inputs on the Export Policy of Agricultural Produce to the Government of Uttar Pradesh.
- Provided inputs to the Core Team of Agricultural and Processed Food Products Export Development Authority to monitor SPS and TBT Notifications issued by other countries in WTO.
- Institute provided inputs on methodology for Agri-business Company for Impact Assessment of Weedicide to the Ministry of Forests, Climate Change, and Environment, Government of India.
- Participated in ICAR Regional Committees and provided policy inputs to state governments.
- Provided inputs to Expert Consultation on COP 28: Preparedness for Indian Agriculture organized by the National Academy of Agricultural Sciences.
- Interaction with the team led by the Secretary, Ministry of Agriculture & Farmers' Welfare, Government of India on India's agricultural policy needs.

# 5 Research Outputs

## Policy Papers

1. Nikam, V., Veesam, H., Kiran Kumara, T.M., and Chand, P. (2023). Farmer Producer Organisations in India: Challenges and Prospects. Policy Paper 40, ICAR-National Institute of Agricultural Economics and Policy Research, New Delhi.
2. Birthal, P.S., Hazrana, J., Roy, D., and Satyasai, K.J.S. (2024). Can Finance Mitigate Climate Risks in Agriculture? Farm-level Evidence from India. Policy Paper 41, ICAR-National Institute of Agricultural Economics and Policy Research, New Delhi.
3. Chand, P., Kiran Kumara, T.M., Pal, S., and Naik, K. (2024). A Spatial Assessment of Sustainability in Indian Agriculture. Policy Paper 42, ICAR-National Institute of Agricultural Economics and Policy Research, New Delhi.
4. Kishore, P., Roy, D., Birthal, P.S., and Srivastava, S.K. (2024). Regulation and Policy Response to Groundwater Preservation in India. Policy Paper 43, ICAR-National Institute of Agricultural Economics and Policy Research, New Delhi.
5. Kandpal, A., Birthal, P.S., and Mishra, S. (2024). From Research to Impact: Payoffs to Investment in Agricultural Research and Extension in India. Policy Paper 44, ICAR-National Institute of Agricultural Economics and Policy Research, New Delhi.

## Policy Briefs

1. Sharma, P., Pal, D.B., and Birthal, P.S. (2023). Technology and Policy Options for Sustaining Pulses Revolution. Policy Brief 53, ICAR-National Institute of Agricultural Economics and Policy Research, New Delhi.
2. Kumar, S., Birthal, P.S., Chand, P., and Kingsly, I.T. (2024). Technology and Policy Options for Efficient Use of Fertilizers in Indian Agriculture. Policy Brief 54, ICAR-National Institute of Agricultural Economics and Policy Research, New Delhi.
3. Srivastava, S.K., Kishore, P., Birthal, P.S., and Shirsath, P.B. (2024). Enabling Policies for Solar-powered Micro-irrigation. Policy Brief 55, ICAR-National Institute of Agricultural Economics and Policy Research, New Delhi.
4. Mandal,S., Kumar, S., Singh,J., Jain, R., and Kandpal ,A. (2024) Policy Brief 56, ICAR-National Institute of Agricultural Economics and Policy Research, New Delhi.
5. Chand,K., Birthal,P.S., and Kachhawaha, S. (2024). Policy Brief 57, ICAR-National Institute of Agricultural Economics and Policy Research, New Delhi.

## Research Papers

1. Anwer, Md. E., Subash, S.P., and Kandpal, A. (2023). Trends and patterns of patent in agriculture and allied sector. *Journal of Intellectual Property Rights*, 28(6): 529-543.
2. Athare, P.G., Singh, D.R., Kumar, N.R., Jha, G.K., Venkatesh, P., and Chakrabarti, B. (2023). Spatio-temporal analysis of rainfall and temperature trends in Maharashtra. *International Journal of Environment and Climate Change,* 13(9): 552-561.
3. Balaji, S.J. and Gopinath, M. (2023). Spatial growth and convergence in Indian

agriculture. *Agricultural Economics*, 54(6): 761-777.

4. Bijla, S., Birthal, P.S., Dixit, A.K., Sankhla, G., Maiti S., Singh, P. (2024). Livestock and transitional poverty in rural India. *Agricultural Economics Research Review*, 32:155-168.

5. Birthal, P.S. (2023). Enhancing agriculture resilience to climate change: Technological, institutional and policy requirements. *Indian Journal of Agricultural Marketing*, 37:30-46.

6. Chand, K., Kumar, R.V., Meena, S.S., Biradar, N., Choudhary, B.B., Ghosh, A., Palsaniya, D.R., Mahanta, S.K., Nagar, R.P., Meena, H.S., and Kishore, P. (2023). Financial and environmental impact analysis of developing common pasturelands. *Range Management and Agroforestry*, 44(1):183-191. https://doi.org/10.59515/ rma.2023.v44.i1.22.

7. Chand, S., Kumar, A., and Chaudhary, K.R. (2023). Livestock insurance policy in India: Insights from ground level study in India. *Research Journal of Extension Education*, 23(3): 108-115.

8. Das, M.M., Singh, S., Singh, K.K., Sharma, P., and Chand, K. (2023). Nutrient utilization, milk yield and economics of production in crossbred cows fed berseem hay meal supplemented diet. *Indian Journal of Animal Nutrition*, 40(2): 109-115. https://doi.org/10.5958/2231-6744.2023.00014.2.

9. Jain, R., Pavithra S., Ashok, A., Bharadwaj, A., Sachan, R., and Paul, R.K. (2023). Digitalization of agricultural education in northern India: Accessibility, use and effectiveness. *Journal of the Indian Society of Agricultural Statistics*, 77(3): 305-316.

10. Joshi, K., Kandpal, A., Roy, M.L., Mukharjee, A., Pattanayak, A., Meena, V.S., and Pandey, S.C. (2023). Farmers' perception of climate change and management strategies in the mid-Himalaya. *Current Science*, 124(10): 1201-1210. https://doi.org/10.18520/cs/v124/i10/1201-1210.

11. Jumrani, J. and Meenakshi, J.V. (2023). How effective is a fat subsidy? Evidence from edible oil consumption in India. *Journal of Agricultural Economics*, 74(2): 327-348. https://doi.org/10.1111/1477-9552.12510.

12. Kandpal, A., Kiran Kumara, T.M., and Pal, S. (2023). Does conservation agriculture promote sustainable intensification in the rice–wheat system of the Indo-gangetic plains in India? Empirical evidences from on-farm studies. *Current Science*, 124(10): 1188-1193. https://doi.org/10.18520/cs/v124/i10/1188-1193.

13. Kiran Kumara, T.M., Pal, S., Chand, P., and Kandpal, A. (2023). Carbon sequestration potential of agroforestry systems in Indian agricultural landscape: A meta-analysis. *Ecosystem Services*, 62: 1-12. https://doi.org/10.1016/j.ecoser.2023.101537.

14. Kishore, P. and Birthal, P.S. (2023). The Impact of direct benefit transfers for micro-irrigation on farm performance: Evidence from India. *Environment, Development and Sustainability*. https://doi.org/10.1007/s10668-023-03374-y.

15. Kumar, N.R. (2023). Impact of farm mechanization on productivity and profitability of wheat in Indo-Gangetic plains of India. *Indian Journal of Economic Development*, 19(3): 499-506.

16. Kumar, R. and Kumar, N.R. (2023). Comparative economics of various management regimes of *chaur* fisheries in koshi- gandak river basin of Bihar. *Fishery Technology*, 60: 212-220.

17. Kumar, S., Bisht, B., Rajput, H., Mishra, J., Kiran Kumara, T.M., and Brahmanand, P.S. (2023). Reference evapotranspiration

prediction using machine learning models: An empirical study from minimal climate data. *Agronomy Journal.* 116(3): 956-972. https://doi.org/10.1002/ agj2.21504.

18. Kumar, V., Kumar, A., Yadav, A.L., and Singh, C. (2024). Organic farming in India: Challenges and policy support. *Plant Archives*, 24(1):1345-1349.

19. Kumar, V., Satyapriya, Bisnoi, S., Singh, R., Kumar, D., and Roy, S.K. (2024). Nourishing the future: Assessing progress, challenges, and policy initiatives for millet revival in India. *Agricultural Mechanisation in Asia, Africa and Latin America,* 55(4): 17561-17572.

20. Meena, D.C. and Chand, P. (2023). Does people's participation enhance the success of watersheds? A comprehensive assessment. *Journal of Soil and Water Conservation*, 22(2):169-177. https://doi.org/10.5958/2455-7145.2023.00023.1.

21. Meena, D.C., Kiran Kumara, T.M., and Kumar, A. (2023). Harnessing potential of legumes for sustainable intensification of Indian agriculture. *Agricultural Economics Research Review*, 36 (2): 201-212. https://doi.org/10.5958/0974-0279.2023.00033.2.

22. Meena, D.C., Sharma, P., and Anwer, M.E. (2024). Did Covid-19 impact market arrivals and prices of major food commodities in India: Evidence from extended time series analysis. *Agricultural Research*. 13: 340-351. https://doi.org/10.1007/ s40003-023-00695-2.

23. Meena, M., Jangir, C.K., Meena, S.S., and Meena, D.C. (2023). Direction and determinants of Indian seed spices export: A case of cumin. *Indian Journal of Economics and Development*, 19(3): 491-498. https://doi.org/10.35716/ijed-23005.

24. Navghan, M., Kumar, N.R., Rami, V., Singh, K., Hoilenting, and Saiyad, S. (2023). An empirical analysis of fish consumption pattern in Gujarat. *International Journal of Oceans and Oceanography*, 17(1): 1-16.

25. Negi, D. S., Kumar, A., Birthal, P. S., and Tripathi, G. (2023). Adoption and impact of hybrid rice in India: evidence from a large-scale field survey. *Journal of Agribusiness in Developing and Emerging Economies.* https://doi.org/10.1108/JADEE-05-2023-0118.

26. Nuthalapati, C. S., Kumar, A., Birthal, P. S., and Sonkar, V. K. (2024). Demand-side and supply-side factors for accelerating varietal turnover in smallholder soybean farms. *Journal of Cleaner Production*, 447: 141372. https://doi.org/10.1016/j.jclepro.2024.141372.

27. Palsania, D.R., Kumar, S., Das, M.M., Rai, S.K., Kiran Kumar, T., Chaudhary, M., Chand, Khem, Ahmed, A., Sahay, C.S., and Kumar, P. (2023). Rain water harvesting, agroforestry and goat based intensification for livelihood resilience in drought prone rainfed smallholder farming system – a case for semi-arid tropics. *Agroforestry Systems*. https://doi.org/10.21203/rs.3.rs-2450169/v1

28. Pandey, N.K., Kharumnuid, P., Kumar, S., Chakrabarti, S.K., and Bhardwaj, V. (2024). Economic impact of early bulking and drought-tolerant potato cultivar Kufri Pukhraj in India. *Potato Research*. https://doi.org/10.1007/s11540-024-09690-8.

29. Pant, S.C., Saxena, R., Gupta, N.K., Yadav, H., Kumar, S. Ad., and Pant, D.K. (2024). The organic odyssey: Navigating the influence of attitude on purchase intent, mediated by perceived value, quality, and price in India. *Journal of Retailing and Consumer Services,* 79:103801. https://doi.org/10.1016/j.jretconser.2024.103801.

30. Pasupuleti, S., Nikam, V., Bishnoi, S., and Kumbhare, N.V. (2024). Mapping the mango value chain of Farmer Producer

Organizations in Andhra Pradesh and Telangana state of India. *Indian Research Journal of Extension Education*, 24(1): 75-77.

31. Patel, R. M., Sharma, P., Bunkar, K., Ramesh, A., and Khandekar, N. (2023). Decadal cropping pattern and expansion dynamics of soybean in Madhya Pradesh, India. *Soybean Research*, 21(1); 110-123.

32. Prakash, P., Kumar, P., and Kishore, P. (2023). Economic feasibility of polyhouse establishment with and without government subsidy support: A case of bell pepper (capsicum annuum l.) cultivation in Maharashtra, India. *European Journal of Horticultural Science*, 88(2):1-7. https://doi.org/10.17660/ eJHS.2023/015.

33. Raghavendra, K.J., Kumar, S., Kar, A., Kumar, P., Singh, R., Arya, P., and Kiran Kumara, T.M. (2023). Awareness and determinants of farmers' participation in e-marketing of agricultural commodities in India. *Indian Journal of Extension Education*, 59(4): 161-164. https://doi.org/10.48165/ijee.2023.59433.

34. Rani, S.U., Kumar, P., Singh, N.P., Srivastava, S.K., Paul, R.K., Padaria, R.N., Tadigiri, S., Naik, B.N., Rani, N., and Kishore, M.R. (2023). Farmer's perception and efficacy of adaptation strategies to climate change in north eastern transition zone of Karnataka state in India. *International Journal of Environment and Climate Change*, 13(12): 545-558. https://doi.org/10.9734/ijecc/2023/v13i123712.

35. Rath, S., Das, A., Kiran Kumara, T.M., and Sarangi, K.K. (2023). Mapping, temporal dynamics and assessment of agricultural ecosystem services: Evidence from eastern India. *Frontiers in Sustainable Food Systems*, 7:1-12. https://doi.org/10.3389/fsufs.2023.1151205.

36. Reddy, K.V., Paramesha, V., Ravikumar, K.N., Asci, S., Kingsly, I.T., Madhav, M.S., Sendhil, R., Konduru, S., Rao, K.P., and Ramasundaram, P. (2024). Econometric modelling of tobacco exports in the milieu of changing global and national policy regimes repercussions on the Indian tobacco. *Frontier in Environmental Economics*, 2:1-13. https://doi.org/10.3389/frevc.2023.1216153.

37. Saxena, R., Pant, D.K., Pant, S.C., and Singh, R. (2023). Mapping the global research landscape: Bibliometric analysis of agri-food systems and nutritional security. *Indian Journal of Agricultural Economics*, 78 (3): 328-342.

38. Saxena, R., Pant, D.K., Pant, S.C., Joshi, L., Paul, R.K. and Singh, R. (2023). Artificial intelligence-led innovations for agricultural transformation. *Agricultural Economics Research Review*, 36(2): 1-18.

39. Saxena, R., Pant, D.K., Sharma, P., Paul, R. K., and Kumar, R. (2023). Sustaining long-term agricultural exports from India. *Current Science*, 125 (10): 1109-1115. https://doi.org/10.18520/cs/v125/i10/1109-1115.

40. Saxena, R., Raman, M.S., Srivastava, S.K., Khan, M.A., and Kumar, R. (2023). Does India need a different rice ecosystem to harness the export advantages and manage the virtual water exports? *Current Science*, 124(4): 407-413.

41. Sharma, P., Meena, D.C., and Anwer, M.E. (2024). Asymmetric price transmission in perishable crops value chain: A NARDL approach. *Agribusiness*. https://doi.org/10.1002/agr.21904.

42. Singh, J.M., Sachdeva, J., Chand, P., Singh, J., and Kaur, B. (2023). Resource conservation technologies for sustainable development of agriculture: A case study in Indian Punjab. *Agricultural Economics Research Review*,

36(1): 1-11. https://doi.org/10.5958/0974-0279.2023.00001.0.

43. Singh, P.P., Kumar, V., Jain, R., and Neeraj (2024). Production performance, income and employment generation through broiler business: revelations in Morena district of Madhya Pradesh. *Indian Journal of Animal Research*. https://doi.org/10.18805/IJAR.B-5247.

44. Subash, S.P. and Ohja, J. (2023). Beyond the number games: Understanding the farmer producer companies in India and way forward. *Journal of Asian and African Studies*. 1-16. https://doi.org/10.1177/00219096231192332.

45. Subash, S.P., Aditya, K.S., Trivedi, P., and Srinivas, K. (2023). Women self-help groups and intra-household decision-making in agriculture. *Annals of Public and Co-operative Economics*, 1-20. https://doi.org/10.1111/apce.12442.

46. Thakur, A. and Birthal P.S. (2023). Sexed semen technology for cattle breeding: An interpretative review on its performance, and implications for India's dairy economy. *Agricultural Economics Research Review*, 36(1): 53-64.

47. Upreti, P., Singh, D.R., Kumar, N.R., Venkatesh, P., Nain, M.S., Jha, G.K., and Kumar, S. (2023). Feasibility analysis of solar-powered tube wells in arid and sub-humid regions of Rajasthan. *Indian Journal of Extension Education*, 59 (3): 126-131.

48. Veesam, H., Nikam, V., Sangeetha, V., Kumar, P., Ray, M., Mahra, G.S., and Mahapatra, A. (2024). Constraints faced by members of FPOs in Telangana and Andhra Pradesh. *Journal of Community Mobilization and Sustainable Development*, 19(1): 1-6.

49. Yadav, A.L., Babu, S., Krishnan, P., Kaur, B., Bana, R.S., Chakraborty, D., Kumar, V., Joshi, B., and Lal, S. K. (2024). Zinc oxide (ZnO) and ferric oxide ($Fe_2O_3$) nanoparticles combination increases the plant growth, yield, and quality of soybean (Glycine max L.) under semiarid climate. *Chemosphere*. 352:141432. https://doi.org/10.1016/j.chemosphere.2024.141432.

50. Yeasin, M., Sharma, P., Paul, R. K., Meena, D. C., and Anwer, M. E. (2023). Understanding price volatility and seasonality in agricultural commodities in India. *Agricultural Economics Research Review*, 36(2): 177-188.

## Book Chapters

1. Balaji, S.J., and Suresh C. Babu. (2024). Approaches to population estimations and their use in food policy analysis in urban settings. In: Handbook on Public Policy and Food Security (Eds., Sheryl L. Hendriks and Suresh C. Babu). Edward Elgar Publishing, United Kingdom. 276-283.

2. Birthal, P.S., Sharma, P., and Chand, P. (2023). Transforming food systems for higher, sustainable, and inclusive agricultural growth: Role of policies and institutions. In: Transformation of Agri-food Systems (Eds., K.C. Bansal, W.S. Lakra, and H. Pathak). Springer, Singapore. https://doi.org/10.1007/978-981-99-8014-7_2. 9-18.

3. Das, A., Saha, S., Layek, J., Babu, S., Saxena, R., and Ramkrushna, G.I. (2023). Agricultural technologies. In: Trajectory of 75 Years of Indian Agriculture After Independence (Eds., P.K. Ghosh, A. Das, R. Saxena, K. Banerjee, G. Kar, and D. Vijay). Springer Nature, Singapore. 57-78.

4. Hazrana J. and Birthal, P. S. (2023). Cropping system diversification for higher productivity and resilience of agriculture: Evidence from India. In: Managing Risk in Agriculture (Eds., Ashok K. Mishra, Subal

C. Kumbhakar and Gudbrand Lien). CAB International. 264-281.

5. Kiran Kumara, T.M., Chikkathimme Gowda, H.R., Raghavendra, K.J., Kandpal, A., Amrutha, T., and Kumar, B. (2023). Production, trade, and future prospects of organic agriculture in India. In: Futuristic Trends in Agriculture Engineering & Food Sciences (Eds., A. Kumar, Sonali Ghosh, and B. Mohapatra). IIP series.

6. Kumar, D., Kumar, V., Yeasin, Md., Pradhan, A.K., Samal, I., Murmu, S., and Chaurasia, H. (2024). Digital data collection tools for cost-effective agricultural survey. In: Agriculture Technologies for Sustainable Development. (Eds., S. Dwivedi, V. Kumar and Neer Somakka). New Delhi Publishers, New Delhi. 97-110.

7. Kumar, D. et. al. (2024). Remote sensing in precision agriculture: Current status and applications. In: Artificial Intelligence and Smart Agriculture. Advances in Geographical and Environmental Sciences. (Eds., K. Pandey, N.L. Kushwaha, C.B. Pande, K.G Singh). Springer, Singapore.

8. Kumar, R., Raman, M.S., and Chauhan, S. (2023). Agricultural reforms in India. In: Trajectory of 75 years of Indian Agriculture After Independence (Eds., P.K. Ghosh, A. Das, R. Saxena, K. Banerjee, G. Kar, and D. Vijay). Springer Nature, Singapore. 775-790. https://doi.org/10.1007/978-981-19-7997-2_30

9. Kumar, V., Kumar, D., Narain, S., Awais, Md., Ritika, and Dwivedi, S. (2024). Smart agriculture through laser-guided levelling for the saving of inputs and enhancement of yield. In: Agriculture Technologies for Sustainable Development. (Eds., S. Dwivedi, V. Kumar and Neer Somakka). New Delhi Publishers. 1-17.

10. Nikam V. (2023). Economic theories of entrepreneurship. In: Entrepreneurship Development: Theory and Practice (Eds. J.S. Manhas, P. Slathia, and R. Kumar). Narendra Publishing house, ISBN: 978-93-92851-47-6. 34-40.

11. Nikam V., Veesam H., Chand P., and Kumar K. (2024). Farmer producer organizations: Global perspective. In: Agri-business Ecosystem of Farmer Producer Organizations (Eds., R.B. Kale, S.S. Gadge, P. Kanak Durga, R. Bhat, K. Khandagale and V. Mahajan). National Institute of Agricultural Extension Management (MANAGE) and ICAR-Directorate of Onion and Garlic Research, Pune. 1-9.

12. Nityashree, M.L. and Saxena, R. (2023). Food processing industry. In: Trajectory of 75 years of Indian Agriculture After Independence (Eds., P. K. Ghosh, A. Das, R. Saxena, K. Banerjee, G. Kar, and D. Vijay). Springer Nature, Singapore. 745-759.

13. Pradhan, A.K., Kumar, D., Chaurasia, H., Murmu, S., Samal, I., Bhoi, T.K., Kumar G. A. K., and Mondal, B. (2024). Crop monitoring system integrating with Internet of Things and Artificial Intelligence. In: Artificial Intelligence and Smart Agriculture. Advances in Geographical and Environmental Sciences (Eds., K. Pandey, N.L. Kushwaha, C.B. Pande, and K.G. Singh) Springer, Singapore.

14. Ritika, Kumar, A.A., and Kumar, D. (2023). Internet of things: future of agriculture. In: Current Trends in Agriculture & Allied Sciences (Vol-1) (Eds., R. Almoselhy, R. Chandran, and A. J. Mary). S. P. Publishing, Bhubaneswar, Odisha.

15. Saxena, R., Chauhan, S., Ghosh, D.K., Kumar, R., Kumar, D., and Das, A. (2023). Trends and trajectory of Indian agriculture

In: Trajectory of 75 years of Indian Agriculture After Independence (Eds., P.K. Ghosh, A. Das, R. Saxena, K. Banerjee, G. Kar, and D. Vijay). Springer Nature, Singapore. 3-32.

16. Saxena, R., Singh, R., Agarwal, P., Kumar, R., and Raman, M.S. (2023). Structure, performance and competitiveness in Indian agricultural exports. In: Sustainable Food Value Chain Development (Eds., S. A. Narula and S.P. Raj). Springer Nature, Singapore. 295-317.

17. Saxena, R., Srivastava, S.K., Joshi, N., Kumar, R., and Raman, M.S. (2023). Trajectory of market reforms. In: Trajectory of 75 years of Indian Agriculture After Independence (Eds., P.K. Ghosh, A. Das, R. Saxena, K. Banerjee, G. Kar, and D. Vijay). Springer Nature, Singapore. 707-723.

18. Sendhil, R., Kiran Kumara, T.M., Kandpal, A., Kumari, B., and Mohapatra, S. (2023). Wheat production, trade, consumption, and stocks: Global trends and prospects. In: Wheat Science, (Eds., O.P. Gupta, S. Kumar, A. Pandey, M.K. Khan, S.K. Singh and G.P. Singh). CRC Press.

19. Srivastava, S.K., Singh, J., and Saxena, R. (2023). Changing structure of rural employment. In: Trajectory of 75 years of Indian Agriculture After Independence (Eds., P.K. Ghosh, A. Das, R. Saxena, K. Banerjee, G. Kar, and D. Vijay). Springer Nature, Singapore. https://doi.org/10.1007/978-981-19-7997-2_3. 47-56.

20. Veesam H. and Nikam V. (2024). Reinvigorating primary agricultural credit societies into multi-service societies: An instigators case of T. Narsapuram society from Andhra Pradesh. In: Agri-business Ecosystem of Farmer Producer Organizations (Eds., R.B. Kale, S.S. Gadge, P. Kanak Durga, R. Bhat, K. Khandagale, and V. Mahajan). National Institute of Agricultural Extension Management (MANAGE) and ICAR-Directorate of Onion and Garlic Research, Pune. 121-139.

21. Veesam H., Mahapatra A., and Nikam V. (2024). Formation and functioning of farmer producer organizations for inclusive extension and advisory services. In: Agri-business Ecosystem of Farmer Producer Organizations (Eds., R.B. Kale, S.S. Gadge, P. Kanak Durga, R. Bhat, K. Khandagale, and V. Mahajan). National Institute of Agricultural Extension Management (MANAGE) and ICAR-Directorate of Onion and Garlic Research, Pune. 10-26.

22. रजनी जैन और शबाना बेगम (2023)। दाल मिल - भूसी निकालने और बंटवारे की मशीन, ग्रामीण महिलाओ हेतु श्रम दक्ष तकनिकियां, संपादक कीर्तिमणि त्रिपाठी, लक्ष्मीकांत, साधना पांडे, शांतनु कुमार दुबे, पृष्ठ संख्या 253, बायोटेक बुक्स।

23. शबाना बेगम और रजनी जैन (2023)। टी प्लकर सीज़र टाइप -चाय कटाई हेतु उपकरण, ग्रामीण महिलाओ हेतु श्रम दक्ष तकनिकियां, संपादक कीर्तिमणि त्रिपाठी, लक्ष्मीकांत, साधना पांडे, शांतनु कुमार दुबे, पृष्ठ संख्या 261, बायोटेक बुक्स।

24. सपना निगम, रजनी जैन और दिलीप कुमार (2023)। कृषि श्रम को कम करने के लिए कृत्रिम बुद्धिमत्ता का योगदान, ग्रामीण महिलाओ हेतु श्रम दक्ष तकनिकियां, संपादक कीर्तिमणि त्रिपाठी, लक्ष्मीकांत, साधना पांडे, शांतनु कुमा।

## Edited Books

1. Dwivedi, S., Kumar, V., and Somakka, N.A.N. (2024). Agriculture Technologies for Sustainable Development. New Delhi Publishers. Delhi. ISBN no. 978-81-19006-67-0.

2. Gathiye, G.S., Kumar, V., Kumar, D., and Pradhan, A. K. (2023.) Recent Trend

in Agricultural Science. Elphinstone publications. ISBN no 9788119778027.

3. Ghosh P.K., Das, A., Saxena, R., Banerjee, K., Kar, G., and Vijay, D. (2023). Trajectory of 75 Years of Indian Agriculture After Independence. Springer Nature, Singapore. ISBN no. 978-9811979965

4. Kumar, R., Kumar, V., Srivastava, S.C., and Chandel, L.P.N. (2023). Advances in Macro Economics. Elphinstone publications. ISBN no. 9788119778423.

## Popular Articles

1. Avilés-Irahola, D. and Subash, S.P. (2023). A would-be match made in heaven: Activists and academics for women's land rights. Part 1. https://blog.zef.de/?p=8586.

2. Beck, L. and Subash, S.P. (2024). Blog 212-Can we generate spaces for the transformation of gender norms through extension services? https://www.aesanetwork.org/blog-212-can-we-generate-spaces-for-the-transformation-of-gender-norms-through-extension-services.

3. Chand, P, Kiran Kumara, T.M., and Bal, D. (2023). The Forest Conservation (Amendment) Bill 2023: What it means to tree growers. *Agriculture Today*, 26(9):52-53.

4. Chand, P., Birthal, P.S., and Kiran Kumara, T.M. (2023). India's farmers need financial motivation to check indiscriminate use of groundwater for irrigation. *Down to Earth.* https://www.downtoearth.org.in/blog/water/india-s-farmers-need-financial-motivation-to-check-indiscriminate-use-of-groundwater-for-irrigation-90702.

5. Kumar, D., Kumar, V., Pradhan, A.K., Samal, I., Murmu, S., and Acharya, L.K. (2023). Bhartiya krishi main drone: Paridrishy Evam Mahatv. *Ankur Magazine*, 3: 26-31.

6. Kumar, V., Kumar, D., Yadav, A.S., and Berro, S.K. (2023). Pradhan Mantri Fasal Bima Yojna: Krishi Main Jokhim Ko Kam Karne Ke Liye Ek Mahatvpoorn Yojna. *Ankur Magazine*, 3: 13-16.

7. Kumar, V. and Pal, S. (2023). Bharat Ki G20 Adhyakshta Aur Vaishvik Khag Samasya Tatha Prathmik Swasth Ka Samadhan. Anuvanshiki Pravah, 24-28.

8. Meena, D.C. and Kumari, M. (2024). Prioritization of low food grains productivity districts for rural development planning in India. *Indian Farming*, 74 (01): 22-24.

9. Meena, D.C. and Sharma, P. (2023). Fair market access and remunerative prices through e-NAM. *Intensive Agriculture*, 57(3): 27-31.

10. Meena, D.C., Kumar, V., Chand, S., and Meena, R.B. (2023). Dairy cooperatives movement in India: Characteristics, status and challenges. *Indian farming*, 73 (10): 8-10.

11. Rajasekar, S., Subash, S.P., Koreleva, M., and Avilés-Irahola, D. (2023). World Environment Day: Bridging the gap between gender and the environment. https://blog.zef.de/?p=8263.

12. Singh, P. and Kumar, V. (2023). Rajbhasha Anusandhan Aaur Pragati. *Rajbhasha pravah*, 78-82, NBPGR, New Delhi.

## Newspaper Articles

1. Saxena, R. and Joshi, L. (2024). The digital harvest: Unlocking AI's promise in revolutionizing agriculture, Qurius. https://www.ncaer.org/news/the-digital-harvest-unlocking-ais-promise-in-revolutionizing-agriculture.

2. Kiran Kumara, T.M. and Birthal, P.S. (2023). Green credits for sustainable development of Agriculture. The Hindu Business Line, July 22, 2023. https://www. thehindubusinessline.com/economy/agri-business/green-credits-

forsustainable developmentofagriculture/article67108999.ece#:~:text=The%20Green%20Credit% 20Programmesme%20provides%20a%20basic%20framework%20for%20harnessing,But%20it%20also%20offers%20solutions.

3. Choudhary, B.B. and Chand, P. (2023). Act fast address farm sector's vulnerabilities. Opinion Article, *The Tribune*, July 3, 2023. https://epaper.tribuneindia.com/c/72838732.

## Technologies/Products Developed

**Table 5.1: Technologies/ products certified by ICAR**

| SI No. | Type of Innovations/ Developments | Title of Innovations/ Developments | Name of Scientist(s) |
|---|---|---|---|
| 1. | Index for measuring heat stress (Heat Index-HI) | Methodology | Pratap S. Birthal, Jaweriah Hazrana, Digvijay S. Negi, Ghanshyam Pandey |
| 2. | Sustainability mapping for rice cultivation | Methodology | Raka Saxena and Shivendra K. Srivastava |
| 3. | Agroecosystem Diversity Index | Methodology | Chhabilendra Roul, Prem Chand, Suresh Pal and Kalu Naik |
| 4. | Composite Index of Agricultural Sustainability | Methodology | Prem Chand, Suresh Pal, Chhabilendra Roul and Kiran Kumara T.M. |
| 5. | Composite Effectiveness Index for the extension and advisory services of FPOs | Methodology | Haripriya Veesam and Vinayak R. Nikam |

# 6 Awards and Recognitions

## Awards

### Balaji S.J.

- Fulbright Nehru Postdoctoral Research Fellowship

### Subhash Chand

- Lifetime Achievement Award, Agricultural Economics, Pragati International Scientific Foundation, Meerut, India & Andaman Science Association (ASA), Port Blair

### S.K. Pandey

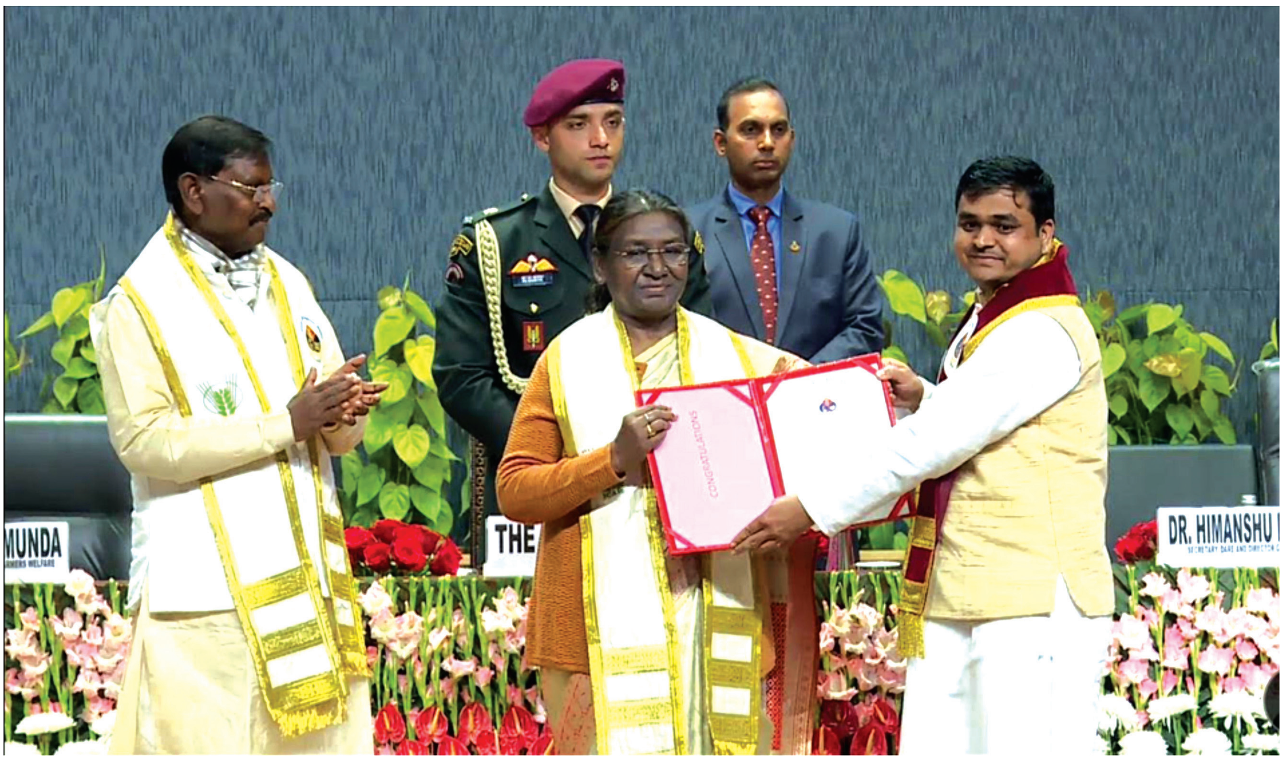
- Best paper award by the Indian Potato Association for "Returns to potato research in India: A case of Kufri Pukhraj", P*otato Journal*, 49(2): 141-148

### Prem Chand and Rajni Jain

- R.S. Deshpande Award by the Institute of Economics and Social Change, Bengaluru for the paper "Irrigation water policies for sustainable groundwater management in irrigated north-western plains of India"

### Vinayak R. Nikam

- NABARD Researcher of the Year Award, from the ICAR-Indian Agricultural Research Institute, New Delhi.
- Young Scientist Award by the Society for Community Mobilisation and Sustainable Development, IARI, New Delhi.




**Dr. Vinayak Nikam receiving NABARD Researcher of the Year Award from Honourable President of India**

### Kiran Kumara T.M.

- Uma Lele AERA India/AAEA Mentorship Programmes Award, 2024

## Recognitions

### P.S. Birthal

- Chairman, Working Group on Crop Husbandry, Agriculture Inputs, Demand and Supply, NITI Aayog, Government of India
- Member, Quinquennial Review Team (QRT), ICAR-Central Institute for Research on Cattle (CICR), Meerut
- Member, Research Advisory Committee (RAC), ICAR-National Dairy Research Institute (NDRI), Karnal
- Member, Research Advisory Committee (RAC), ICAR-Indian Veterinary Research Institute (IVRI), Izatnagar
- G. Parthasarthy Memorial Lecture of Indian Society of Agricultural Marketing (ISAM), TNAU, Coimbatore
- L.S. Venkataram Memorial Lecture, ISEC, Bengaluru
- Chief Editor, Agricultural Economics Research Review, New Delhi
- Member, Organizing Committee, International Conference of Agricultural Economists 2024
- Member Scientific Committee, International Conference on From Research to Impact: Towards Just and Resilient Agri-Food Systems

### Raka Saxena

- Associate Editor, Agricultural Economics Research Review
- Vice-President, Indian Society of Agricultural Economics

### S.K. Srivastava

- Member, Working Group on Crop Husbandry, Agriculture Inputs, Demand and Supply, NITI Aayog, Government of India

### Khem Chand

- Member, Quinquennial Review Team (QRT), ICAR-NBAGR, Karnal
- Member, Technical Committee on 21st Livestock Census, DAHD, New Delhi
- Member, Committee for Formulation of Rangeland/ Grassland Policy for India, ICAR-IGFRI, Jhansi

### Subhash Chand

- Member, Institute Management Committee, ICAR-IISWC, Dehradun

### Rajni Jain

- Member, Executive Committee, Indian Society of Agriculture and Information Technology (INSAIT) for the year 2023-24

### S.K. Pandey

- Member, Research Advisory Committee, ICAR-National Research Centre for Integrated Pest Management, New Delhi

### Prem Chand

- Member, Research Programmes Committee, Indian Society of Agricultural Economics, Mumbai
- Joint Secretary, Agricultural Economics Research Association, New Delhi
- Member, Institute Management Committee, ATARI, Pune

### Balaji S.J.

- Visiting Fellow, International Food Policy Research Institute, Washington DC.

# 7 Participation in Scientific Activities

**Table 7.1: Lectures delivered by ICAR-NIAP scientists**

| Name of the scientist | Topic | Venue and date |
|---|---|---|
| P. S. Birthal | G. Parthasarathy Memorial Lecture at 37th Annual Conference of Indian Society of Agricultural Marketing (ISAM) | Centre for Agricultural and Rural Development Studies (CARDS), September 14, 2023 |
| | 18th Prof. L.S. Venkataramanan Memorial Lecture | Agriculture Development and Rural Transformation Centre (ADRTC), Institute for Social and Economic Change (ISEC), Karnataka, January 23, 2024 |
| Khem Chand | Enhancing fodder production under climate change scenario in India | MANAGE, Hyderabad, March 18, 2024 |
| Rajni Jain | Big data analysis and AI: Quantitative techniques for agricultural policy analysis *in* Winter School on Quantitative Methods for Social Sciences | ICAR-NIAP, New Delhi, March 14, 2024 |
| | कृषि में कृत्रिम बुद्धिमत्ता | ICAR-NIAP, New Delhi, June 30, 2023 |
| | Impact assessment of agricultural technologies | ICAR-NIAP, New Delhi, August 8 and September 18, 2023 |
| | Decision trees and random forests using R | ICAR-IASRI, New Delhi, September 6, 2023 |
| | Bridging horizons: Integrating IT innovations across disciplines | Department of Computer Science & Applications, in collaboration with the UGC-Malaviya Mission Teacher Training Centre (MM-TTC), October 31, 2023 |
| | डिजिटल इंडिया कार्यक्रम के अंतर्गत ई-ऑफिस द्वारा प्रभावी एवं पारदर्शी प्रबंधन | ICAR-NIAP, New Delhi, December 15, 2023 |
| | Digital innovations in agriculture | Navsari, Agricultural University, Navsari, Gujarat, February 2-4, 2024 |
| | AI-Driven digital initiatives revolutionizing agriculture: A comprehensive overview | Banasthali Vidyapith, Banasthali, Rajasthan, February 28, 2024 |
| Subhash Chand | Importance of millets for nutritional security in rural areas | ICAR-NIAP, New Delhi, September 5 and November 21, 2023 |
| Purushottam Sharma | Agri start-ups ecosystem support and networking economic dimensions of the growing start-up ecosystem | SKN Agricultural University, Jobner, Jaipur, Rajasthan, December 3, 2023 |
| | Start-ups in agricultural marketing: Ecosystem in India | Agricultural University, Kota, Rajasthan, January 9, 2024 |

| Name of the scientist | Topic | Venue and date |
|---|---|---|
| Prem Chand | Measuring agrobiodiversity and sustainability index | Centre for Advanced Faculty Training, ICAR-IARI, New Delhi, January 10, 2024 |
| | Measuring agrobiodiversity and sustainability using index approach | Division of Agricultural Economics, ICAR-IARI, New Delhi, August 9, 2023 |
| Vikas Kumar | Market access to smallholder's farmers: Challenges and prospects | Rani Lakshmi Bai Central Agricultural University, Jhansi, June 12, 2023 |
| Kingsly I. T. | The commodity outlook for rice and wheat | ICAR-IARI, New Delhi, January 22, 2024 |
| D.C. Meena | Knowledge on government schemes in the agriculture sector | ICAR-NIAP, New Delhi, November 8, 2023 |
| | Agriculture marketing in India: Institutions, progress and digitalization | KVK, Kota, January 10, 2024 |
| Jaya Jumrani | Food and nutritional security in India: Empirical evidence from CES data | ICAR-NIAP, New Delhi, March 11, 2024 |
| Arathy Ashok | Choice modelling | ICAR-NIAP, New Delhi, March 26, 2024 |
| Pavithra S. | Implications of WTO for Trade in Fisheries presented *in* National Webinar on Indian Fisheries in the Context of WTO Guidelines | Fisheries College and Research Institute, Tamil Nadu Dr.J.Jayalalithaa Fisheries University, Thoothukudi, March 28, 2024 |
| Vinayak Nikam | Farmer Producer Organization: Status and policy support | ICAR- Directorate Of Onion And Garlic Research, Pune, May 1, 2023 |
| | Farmer Producer Organization: Need, functioning and guidelines | Extension Education Institute, Nilokheri, May 16, 2023 |
| | Business opportunities and value chain efficiency through FPOs | College of Forestry, Ponnampet - Kodagu district, Karnataka, October 12, 2023 |
| Prabhat Kishore | Synthetic Control Method for impact assessment | ICAR-IARI, New Delhi, August 10, 2023 |
| | Synthetic Difference in Difference Method for impact assessment | ICAR-IARI, New Delhi, January 15, 2024 |
| | Regulation and responses to policies for checking groundwater depletion in India | ICAR-Indian Institute of Water Management, Bhubaneswar, Odisha, February 13, 2024 |
| Ankita Kandpal | Economic surplus model | ICAR-NIAP, New Delhi, March 26, 2024 |
| | Total factor productivity: Measurement and approach | Navsari Agricultural University, Navsari, February 24, 2024 |
| Kiran Kumara T. M. | Approaches for estimating ecosystem services | ICAR-IARI, New Delhi, August 18, 2023 |
| | A framework and approaches for valuation of agro-ecosystem services | ICAR-IARI, New Delhi, January 16, 2024 |

| Name of the scientist | Topic | Venue and date |
|---|---|---|
| | Meta-analysis in agricultural research | ICAR- NIAP, New Delhi, March 19, 2024, and Navsari Agricultural University, Navsari, February 24, 2024 |
| Dilip Kumar | GIS and mapping of bioinformatics data on ArcGIS | AKMU, ICAR-IARI, New Delhi, September 15, 2023 |
| | आधुनिक कृषि द्वारा किसानों का सशक्तिकरण | ICAR-NIAP, New Delhi, November 8, 2023 |

**Table 7.2: Training attended**

| Name of the scientist | Name of the event | Venue and duration |
|---|---|---|
| P. S. Birthal | Executive Development Programmes on Leadership Development | ICAR-NAARM, Hyderabad, May 22-27, 2023 |
| Rajni Jain | Unit level data collection methodology, data processing and applications | Goa Institute of Management, October 6-10, 2023 |
| Prem Chand | Climate risk management: Policy and governance | Lal Bahadur Shastri National Academy of Administration, Mussoorie, September 11-15, 2023 |
| Arathy Ashok, Pavithra S., Jaya Jumrani, Prabhat Kishore, S.V. Bangararaju, Dilip Kumar | Data science in agriculture | ICAR-Indian Agricultural Statistical Research Institute (IASRI), New Delhi, September 4-15, 2023 |
| Sonia Chauhan | Digital competency, new tools and software for efficient computer applications | ICAR-IASRI, New Delhi, January 3-9, 2024 |

**Table 7.3: Presentations in Seminar/Conference/Webinar**

| Name of the scientist | Name of the topic/event | Venue and duration |
|---|---|---|
| P. S. Birthal | Keynote lecture on Policies and institutions for transforming high-value food commodities, *in* XVI Agricultural Science Congress 2023 | Hotel Le Meridian, Kochi, Kerala, October 12, 2023 |
| | Keynote lecture on Policies for food system transformation under climate change, *in* Conference on Achieving Sustainable Development Goal in Challenged Agro-ecosystems (ASDGCAE-24) | ICAR-Central Arid Zone Research Institute, Jodhpur, Rajasthan, March 3, 2024 |
| Raka Saxena | Enhancing export of agricultural products *in* Chintan Shivir | NASC complex, New Delhi, July 7, 2023 |

| Name of the scientist | Name of the topic/event | Venue and duration |
|---|---|---|
| | Artificial intelligence-led innovations for agricultural transformation: A scoping study *in* 31st Annual Conference of Agricultural Economics Research Association | Dr. Rajendra Prasad Central Agricultural University, Bihar, December 7, 2023 |
| | Mapping the global research landscape: Bibliometric analysis of agri-food systems and nutritional security *in* 83rd Annual Conference of the Indian Society of Agricultural Economics | Odisha University of Agriculture and Technology, Odisha, December 18, 2023 |
| | Regional food trade *in* Regional conference on agriculture trade in BIMSTEC: Opportunities, option and way forward | Research & Information System for Developing Countries (RIS), New Delhi, August 17, 2023 |
| | Facilitating India's long-term exports from horticulture: Key takeaways *in* 10th Indian Horticulture Congress, 2023 | Assam Agricultural University, Assam, November 6-9, 2023 |
| | Mastering market dynamics: The role of market intelligence *in* International Conference on Frontiers in Tobacco and Commercial Agriculture Towards Preparedness for Future Farming | ICAR-Central Tobacco Research Institute, Rajahmundry, December 15, 2023 |
| | Strategy to make wheat production globally competitive *in* Dialogue on India to Emerge a Global Wheat Player organized by the Trust for Advancement in Agricultural Sciences (TAAS), ICAR, and Indian Institute of Wheat and Barley Research (IIWBR), Karnal | NASC Complex, New Delhi, March 22, 2024 |
| Subhash Chand | Meeting the future water demand: Potential and prospects of expanding micro irrigation in India *in* International Conference on Prospects and Challenges of Environmental Biological Sciences in Food Production System for Livelihood Security of Farmers (ICFPLS-2023) | Pragati International Scientific Research Foundation (PISRF), Meerut, & Andaman Science Association (ASA), Port Blair, September 18-20, 2023 |

| Name of the scientist | Name of the topic/event | Venue and duration |
|---|---|---|
| | Impact of natural resource conservation *in* International Conference on Sustainable Natural Resource Management under Global Climate Change | Soil Water Conservation Society India, NASC Complex, New Delhi, November 7-10, 2023 |
| Prem Chand,<br>Sant Kumar, Kingsly I. T. | Enabling policies for sustainable use of fertilizers *in* Stakeholders Dialogue on Enhancing Fertilizer Use Efficiency for Sustainable Soil Health | NASC Complex, New Delhi, September 28-29, 2023 |
| Prem Chand | Sustainable agricultural development priorities of Indian states *in* International Conference on Rejuvenating Salt Affected Ecologies for Land Degradation Neutrality under Changing Climate | ICAR- Central Soil Salinity Research Institute, Karnal, February 15, 2024 |
| | Socio-economic aspects of soil, restoration and improvement of soil health *in* Brainstorming Session on Restoration and Improvement of Soil Health | National Academy of Agricultural Sciences, New Delhi, October 28, 2023 |
| | Prioritizing adaptation options based on cost-benefits analysis *in* Annual Project Review and Planning Meeting of project *Atlas of Climate Adaptation in South Asian Agriculture (ACASA)* | Kathmandu, Nepal, December 13, 2023 |
| Vikas Kumar | Enhancement of millets production in India through increase in exports of millets *in* National Seminar on Sustainable Emerging Approach in Agri-business Development | Department of Agricultural Economics, Nagaland University, Nagaland, November 1-3, 2023. |
| | International trade in millets for enhancing economic growth and ensuring global food security *in* National seminar on Recent approaches for production and value addition of millets ( Sri Anna) in changing climate scenario | Integral University, Lucknow, September 29, 2023. |
| | Government schemes for promotion of organic and natural farming in India and way forward *in* International Agriculture Conference on Natural Vs Organic Farming: In Context to Bharatiya Agriculture | Gujarat Natural Farming Science University, Anand IIMT University Meerut, Hindustan Agricultural Research Welfare Society, December 24-26, 2023 |

| Name of the scientist | Name of the topic/event | Venue and duration |
|---|---|---|
| Arathy Ashok | ICT mediated agro-advisory services: Gendered access and impacts *in* ISEE National Seminar on Evolving extension science towards secondary agriculture for sustainable development | University of Agricultural Sciences (UAS), Bengaluru, June 22-24, 2023 |
| Prabhat Kishore | Regulation and responses to policies for checking groundwater depletion in India: Evaluation using Synthetic Difference-in-Difference approach *in* 18th Annual Conference on Economic Growth and Development | Indian Statistical Institute, New Delhi, December 18-20, 2023 |
| Balaji S. J. | Spatial growth and convergence in Indian agriculture *in* Agricultural & Applied Economics Association (AAEA) Annual Meeting 2023 | Washington DC, USA, July 25, 2023 |
| | A machine learning approach to insurance choice and crop revenue risk reduction *in* National Seminar on Indian Agriculture @ 75 – Achievements, Challenges, and Way Forward | Department of Economics, Pondicherry University, July 21, 2023 |
| Kiran Kumara T. M. | The value of ecosystem services from sustainable agricultural practices in India: Implications for re-purposing agricultural subsidies *in* International Conferences on Sustainable Natural Resource Management under Global Climate Change organized by the Soil Conservation Society of India | New Delhi, November 7-10, 2023 |
| Dilip Kumar | Drone application for cost effective production in natural farming *in* 1st International Agriculture Conference on Natural vs Organic Farming in Context to Bharratiya Agriculture | Gujarat Natural Farming Science University, Anand IIMT University Meerut, Hindustan Agricultural Research Welfare Society, December 24-26, 2023 |

**Table 7.4: Seminar/Conference/Webinar/Workshop/Panel Discussion attended**

| Name of the scientist | Name of the event | Venue and duration |
|---|---|---|
| P. S. Birthal | Panel discussion on Road Map for Indian Agricultural Research, Education and Extension for Amrit Kaal 2047 *in* Foundation Day Programme of National Academy of Agricultural Sciences | A.P. Shinde Symposium Hall, NASC Complex, June 4, 2023 |

| Name of the scientist | Name of the event | Venue and duration |
|---|---|---|
| | Workshop on Preparation for The Next Phase of World Bank Funded Project of Senior Officials | KAB-II, Pusa Campus, June 14, 2023 |
| | Review-Cum-Workshop of ITMUs/ ZTMCs/ABIs in the Discipline of Agricultural Education Under the ZTMC ICAR-NAARM, Hyderabad | ICAR IP&TM Unit, KAB I, New Delhi, June 28, 2023 |
| | Agricultural Exports | Department of Agriculture and Farmers Welfare, ICAR, July 7, 2023 |
| | Workshop on Agriculture Climate Transition | The World Bank, HT Building, New Delhi, August 2, 2023 |
| | Mid-Term Review of ICAR-IFPRI Work Plan | NASC Complex, New Delhi, August 4, 2023 |
| | Brainstorming workshop on Roadmap for Increasing Targeted Milk Production in India during Amrit Kal | ICAR-National Dairy Research Institute, Karnal, August 24, 2023 |
| | Expert consultation on COP 28: Preparedness for Indian agriculture | NAAS, New Delhi, September 25, 2023 |
| | 5th International Conference on Sustainable Natural Resource Management Under Global Climate Change | Soil Conservation Society of India (SCSI), NASC, New Delhi, November 7-10, 2023 |
| | 19th Foundation Day of Protection of Plant Varieties' and Farmers Rights Authority (PPV&FRA) | NASC Complex, New Delhi, November 17, 2023 |
| | Golden Jubilee National Conference on India's Growth Trajectory During Amrit Kaal | The Department of Finance and Business Economics, University of Delhi, South Campus, November 17, 2023 |
| P.S. Birthal, Sant Kumar, D.C. Meena | Foundation Day Programme of the National Academy of Agricultural Sciences | A.P. Shinde Symposium Hall, NASC Complex, June 5, 2023 |
| | Stakeholder Dialogue on Enhancing Fertilizer Use Efficiency for Sustainable Soil Health | TAAS, NASC Complex, New Delhi, September 28-29, 2023 |
| P.S. Birthal, Khem Chand, S. K. Srivastava, Prabhat Kishore, Sant Kumar | Stakeholder Consultation Assessing Benefits of Solar Based Micro Irrigation | ICAR-NIAP, New Delhi March, 18, 2024 |
| P. S. Birthal, Prem Chand | Workshop on Policies and Strategies for Expansion of Trees Outside Forests in Arid Region of India | Agricultural Research Station, Sri Karan Narendra Agriculture University, Sikar, Rajasthan, September 8, 2023 |
| P. S. Birthal, N.R. Kumar | 95th Foundation Day/ Technology day of the ICAR Society | ICAR, NASC Complex, July 16, 2023 |

| Name of the scientist | Name of the event | Venue and duration |
|---|---|---|
| P.S. Birthal, Vikas Kumar | नगर राजभाषा कार्यान्वयन समिति, उत्तरी दिल्ली की 10वी छमाही बैठक | ए. पी. शिंदे सभागारा, एन.ए.एस.सी परिसर, November 16, 2023 |
| P.S. Birthal, N.R. Kumar, Prem Chand | 31st Annual Conference of the Agricultural Economics Research Association (AERA) | DRPCAU, Samastipur, Bihar, December 7-9, 2023 |
| P. S. Birthal, Raka Saxena, Khem Chand, N.R. Kumar, Prem Chand, Purushottam Sharma, Prabhat Kishore S.V. Bangararaju | Regulations & Governance Issues in Indian Seed Sector | IFPRI, ICAR Lecture Hall, NASC Complex, Pusa, September 26-27, 2023 |
| N.R. Kumar | The Future Food System Summit organized by Department of Sustainable Use of Natural Resources, University of Hohenheim, Germany and ICAR-IARI, New Delhi | ICAR-IARI, New Delhi, February 21-22, 2024 |
| N.R. Kumar, Balaji S.J. | South Asia Regional Workshop on Climate Change and Economy-Wide Modelling, Centre for Agricultural and Rural Development Studies (CARDS) | Tamil Nadu Agricultural University, Coimbatore (T.N.), February 20-23, 2024 |
| N.R. Kumar, Khem Chand | First Global Symposium on Farmers Rights | FAO Rome & Ministry of Agriculture and Farmers Welfare, Government of India, NAAS Complex, New Delhi, September 12-15, 2023 |
| Khem Chand | Workshop on Pastoralism in Jammu and Kashmir-Issues, Challenges and Way Forward | Sher-i-Kashmir International Conference Centre, Srinagar, July 31-August 1, 2023 |
| | Global Dialogue on Sustainable Mobility: Embracing Pastoralist Lifestyle | August 17, 2023 (Online) |
| | Workshop on Grassland Policy Issues | ICAR-IGFRI, Jhansi, August 16, 2023 |
| | National Conference on Enhancing Agricultural Productivity: Integration of Improved Inputs, Technology & Mechanization | ASSOCHAM, Hotel Taj Mansingh, New Delhi, October 26, 2023 |
| | Investment for Advancing Climate Resilient Agri-Food Systems | FAO, NITI AYOG and MoA&FW, India International Centre, New Delhi, January 18-19, 2024 |
| | Maru Manthan, Jaisalmer, Rajasthan | Desert Resource Centre, Bikaner, Rajasthan, February 9-10, 2024 |

| Name of the scientist | Name of the event | Venue and duration |
|---|---|---|
| | The Moral Economy of Camel Milk Marketing | Institute of Development Studies, University of Nairobi, March 21, 2024 |
| | Challenges and Opportunities in Pastoral Territories of Life in Asia | Indigenous Peoples' and Community Conserved Areas and Territories (ICCAs) Consortium, Asia and Pacific mega region, March 22, 2024 |
| | National Lunch of India Employment Report 2024: Youth Employment, Education and Skills | The Institute for Human Development and ILO, Kamaladevi Complex of India International Centre, New Delhi, March 26, 2024 |
| P.S. Birthal<br>Rajni Jain | Knowledge Exchange Event: Scaling Digitalization for Sustainable and Climate Smart Agriculture in India and Southeast Asia | Hotel Jaypee Continental, Vasant Vihar, New Delhi, November 9, 2023 |
| Rajni Jain | Artificial Intelligence (AI) and Internet of Things (IoT) for Digital Agriculture (FG-AI4A) | ITU/FAO Focus Group, May 22-24, 2023 |
| | National Conference on Generative AI in Practice for Empowering Agricultural Research Productivity | ICAR-National Research Centre for Grapes, Pune, September 11-12, 2023 |
| | Enhancing The Adoption of Digital Technologies in Agriculture | Intellicap, Delhi, Bengaluru, September 13, 2023 |
| | 26th Annual Conference of the Society of Statistics and Computer Application | Banashthali Vidyapith, Banasthali, Rajasthan, February 26-28, 2024 |
| | Cultivating Tomorrow: Advancing Digital Agriculture Through IoT and AI | ICAR and Department of Telecommunications, Ministry of Communications, Government of India, NASC Complex, New Delhi, March 18-19, 2024 |
| | Digital Agriculture for Internal Discussion and Deliberation | NASC Complex, New Delhi, March 20, 2024 |
| Purushottam Sharma | Workshop on True Value and Cost Accounting in Organic Agriculture | Mongolian Productivity Organization and APO, Tokyo, October 10-12, 2023 |
| | Virtual Conference on Linking Farmers to Markets: Barriers, Solutions, and Policy Options | Asian Development Bank Institute (ADBI), August 16-18, 2023 |
| | Technical Brainstorming Session on "Agriexcellence" | C-DAC, Delhi, September 13, 2023 |

| Name of the scientist | Name of the event | Venue and duration |
|---|---|---|
| Prem Chand | ACASA Heuristics Model Workshop on Analytic Hierarchy (AHP) for Multi-Criteria Decision Making in Adaptation Technology Selection: Suitability and Socio-Economic Barriers | BISA, New Delhi, March 28, 2024 |
| Prem Chand, Vikas Kumar, Arathy Ashok, Prabhat Kishore Kiran Kumara T.M. Ankita Kandpal | International Conference on From Research to Impact: Towards Just and Resilient Agri-Food Systems | NASC Complex, New Delhi, October 9-12, 2023 |
| Prem Chand, Kiran Kumar T.M. | Bio-Resources Circularity for Agro-Ecological Transformation in India | World Agroforestry ICRAF and GIZ, South Asia, New Delhi, June 22-23, 2023 |
| Vikas Kumar | Annual Hindi conference | Pune, September 14-15, 2023 |
| | Rajbhasha Chhamahi Baithak | AP Shinde Hall, NASC, New Delhi, November 16, 2023 |
| D.C. Meena | ADBI Virtual Conference Linking Farmers to Markets: Barriers, Solutions, and Policy Options | Asian Development Bank Institute (ADBI), August 16-18, 2023 |
| | CGIAR Policy Seminar Series on Payments for Ecosystem Services: Win-Win Solutions? | International Food Policy Research Institute (IFPRI), South Asia Regional Office, New Delhi, September 21, 2023 |
| Vinayak R. Nikam | International Extension Education Congress – 2023 on Rural Transformation and Sustainable Agri-Food System through Community Based Organisation (CBO) Oriented Extension Strategy | Rajasthan Agricultural Research Institute, Jaipur, Rajasthan, December 18-20, 2023 |
| | 11th National Seminar on Transformative Agriculture and Sustainable Development: Rethinking Agriculture for a Changing World | Maharana Pratap University of Agriculture and Technology (MPUAT), Udaipur, March 5-7, 2024 |
| Balaji S. J. | Spring 2023 Chicago Fulbright Scholar Enrichment Seminar | Chicago, Illinois, April 12-15, 2023 |
| | Unleashing Africa's Trade in Services Through Progressive Liberalization | World Bank, Washington DC, June 1, 2023 |
| S.V. Bangararaju Prabhat Kishore, D.C. Meena Kiran Kumara T. M. | Workshop on Advances in Difference in Differences | IFPRI, SAO, New Delhi, July 27, 2023 |

| Name of the scientist | Name of the event | Venue and duration |
|---|---|---|
| Kiran Kumara T. M. | Workshop on Economic Valuation of Ecosystem Services by MI-INSEE | Mongabay-India, in collaboration with the Indian Society for Ecological Economics (INSEE), July 19, 2023. |
| Ankita Kandpal | Workshop on SRIJAN: Empowering ZTMCs & ITMUs | NASC Complex, New Delhi, January 17-19, 2024 |

## Meetings attended by the scientists

### P. S. Birthal

- ICAR Regional Committee No. V , NASC Complex, April 27, 2023
- ICAR-Regional Committee No. VII, ICAR-CIAE, Bhopal, Madhya Pradesh, August 18, 2023
- ICAR Regional Committee No. VI, ICAR-CSWRI, Avikanagar, Rajasthan, November 3, 2023
- ICAR-Regional Committee No. III, NASC Complex, New Delhi, December 1, 2023
- ICAR Regional Committee No. VIII, ICAR-CIBA, Chennai, February 15-17, 2024
- QRT Meeting of ICAR-Central Institute for Research on Cattle, Meerut, CIRC, Meerut, May 30, 2023
- QRT Meeting of ICAR-Central Institute for Research on Cattle, Meerut, ICAR-CIRC, Meerut, October 6, 2023
- Research Advisory Committee (RAC) meeting of NDRI, Karnal, June 27-28, 2023
- RAC meeting of ICAR-NDRI, Karnal, Haryana, March 21, 2024
- Working Group on Demand and Supply Projections, NITI Aayog, August 7 &11, 2023.
- Research Advisory Committee (RAC) meeting of ICAR-Indian Institute of Wheat & Barley Research (IIWBR), Karnal, October 27, 2023
- Review meeting of the CG Centres, NASC Complex, February 6, 2024
- Directors and VC meeting, NASC Complex, February 26-27, 2024
- Expert Consultation on "Smart Animal Farming: Perspective Planning Towards 5 Trillion Economy" NAAS, New Delhi, March 22, 2024

### Khem Chand

- Development of Annual Capacity Building Plan (ACBP) of ICAR/DARE for 2023-24, KAB-II, ICAR, New Delhi, May 10, 2023
- QRT Meeting, ICAR-National Bureau of Animal Genetics Resources (NBAGR), Karnal, Haryana, October 30-31, 2023

### Rajni Jain

- Review meeting for eHRMS implementation, ICAR, New Delhi April 12 &April 25, 2023
- Working group meeting on IoT and 5G Use Cases in Agriculture, April 10, 2023
- National working group 20 corresponding to ITU-T SG-20 , Ministry of Communications, Government of India, June 5, 2023

### Sant Kumar

- Research Advisory Committee meeting of ICAR-NCIPM, New Delhi, October 6-7, 2023

### Prem Chand

- TOFI Review, Planning and Target Setting Meeting, Goa, February 27-28, 2024

### Vikas Kumar

- Scientific Advisory Committee meeting of KVK, Bhind, MP, June 10, 2023

### D.C. Meena

- Monitoring of SPS and TBT measures organized by Ministry of Commerce and Industry, Vanijya Bhawan, December 22, 2023

### S.V. Bangararaju

- Expert committee meeting of Genetic Engineering Appraisal Committee (GEAC), Ministry of Environment Forests & Climate Change, New Delhi, February 19, 2024

## Participation in mass media

### P.S. Birthal

- Discussion on Doubling Farmers Income , Sansad TV, June 2, 2023
- Discussion on Mandi.com show, DD Kisan, July 1, 2023
- Discussion on Mandi.com show, DD Kisan, July 30, 2023
- Discussion on Budget 2024, DD Kisan, February 01, 2024

### Khem Chand

- Hello Kisan: Agricultural Budget, DD Kisan, February 2, 2024

### N.R. Kumar

- "Sach ke Saath" (सच के साथ) programme, DD Kisan, February 27, 2024

- Radio talk on Kisan kee baat: Krishi me shiksha evam rojgaar ke awsar" (किसान की बातः विषय–कृषि में शिक्षा एवं रोज़गार के अवसर), December 2, 2023

### Purushottam Sharma

- Hello Kisan: Agricultural Budget, DD Kisan, February 2, 2024

### Prem Chand

- FPO बनाकर सरकारी योजनाओं का लाभ कैसे ले, All India Radio, April 6, 2023
- किसान की बातरू श्री अन्न उत्पादन का आमदनी स्वास्थ्य और आजीविका में महत्त्व, All India Radio, FM Gold, January 11, 2024
- किसान की बातः अंतरिम बजट 2024–25 में कृषि एवं पशुपालन, All India Radio, FM Gold, February 1, 2024
- Choudhary B.B. and Chand P. 2023. Act fast address farm sector's vulnerabilities. Opinion Article, The Tribune, July 3, 2023, https://epaper.tribuneindia.com/c/72838732

### Vikas Kumar

- Hello Kisan: Kisan Utpadak Samuha, DD Kisan, May 26, 2023

### Balaji S.J.

- Outreach interview, UGA Today. "Meet UGA's International Fulbright Visiting Scholars", March 29, 2023. https://news.uga.edu/meet-ugas-international-fulbright-visiting-scholars/

# 8 Management Committee Meetings

## Research Advisory Committee (RAC)

ICAR-NIAP successfully conducted the final meeting of the X RAC on August 21, 2023, under the chairmanship of Dr. Harsh K. Bhanwala, Former Chairman, National Bank for Agriculture and Rural Development (NABARD). RAC members reviewed the progress of the ongoing research programmes under all the themes and provided valuable suggestions and recommendations for improving future research agendas. The following members attended the meeting (Table 8.1).

**Table 8.1: Research Advisory Committee**

| | |
|---|---|
| Dr. Harsh K. Bhanwala<br>Former Chairman,<br>National Bank for Agriculture and Rural Development, Mumbai | Chairman |
| Dr. Shashanka Bhide<br>Senior Advisor,<br>National Council of Applied Economic Research, New Delhi | Member |
| Dr. S.A. Wani,<br>Dean, Faculty of Horticulture,<br>SKUAST, Srinagar | Member |
| Prof. J.V. Meenakshi<br>Indraprastha Institute of Information Technology,<br>New Delhi | Member |
| Dr. P. Kumar<br>Former Head,<br>Division of Agricultural Economics, ICAR-IARI,<br>New Delhi | Member |
| Dr. P. S. Birthal<br>Director, ICAR-NIAP,<br>New Delhi | Member |
| Dr. Khem Chand<br>Principal Scientist (Ag. Economics), ICAR-NIAP,<br>New Delhi | Member Secretary |

## Institute Management Committee (IMC)

The newly constituted IMC is as follows:

**Table 8.2: Institute Management Committee**

| | |
|---|---|
| Dr. P.S. Birthal<br>Director, ICAR-NIAP,<br>New Delhi | Chairman |
| Director (Animal Husbandry)<br>Animal Husbandry Development Department, GNCTD of Delhi, Zorawar Singh Marg, Near Pul Mithai, Tis Hazari,<br>Delhi- 110 054 | Member |
| Director of Agriculture<br>Department of Agriculture,<br>Punjab Kheti Bhawan,<br>Institutional Site No 204,<br>Phase-6<br>Mohali, Punjab | Member |
| Vice Chancellor<br>Maharana Pratap University of Horticulture, Anjanthali,<br>Karnal, Haryana – 125 004 | Member |
| Dr. Birpal Singh<br>RZ-35, Hans Park, West Sagarpur,<br>New Delhi- 110 046 | Member (non-official) |
| Dr. Tarun Kumar Gupta<br>RZ-17, Maruti Gali,<br>Surakhpur Road, Gopal Nagar, Najafgarh,<br>New Delhi- 110043 | Member (non-official) |

| | |
|---|---|
| Dr. Prawin Arya<br>Head (A), Forecasting & Agricultural Systems Modelling, ICAR-IASRI, Pusa,<br>New Delhi -110 012 | Member |
| Dr. Alka Singh<br>Head, Division of Agricultural Economics, ICAR-IARI, Pusa,<br>New Delhi- 110 012 | Member |
| Dr. Ranjit Kumar<br>Principal Scientist, Agribusiness Management Division,<br>ICAR-NAARM,<br>Rajendranagar,<br>Hyderabad 500 030,<br>Telangana | Member |
| Dr. A.K. Dixit,<br>Principal Scientist, Dairy Economic, Statistics and Management Division,<br>ICAR-National Dairy Research Institute,<br>Karnal-132 001, Haryana | Member |
| ADG (EQA&R)<br>ICAR, Krishi Anusandhan Bhawan-II,<br>Pusa, New Delhi-110 012 | Member |
| Sh. K.K. Sharma<br>CF&AO, ICAR-Indian Agricultural, Statistical Research Institute (IASRI),<br>Pusa, New Delhi-110 012 | Member |
| Sh. Navdeep Kumar Sharma<br>Administrative Officer,<br>ICAR-NIAP,<br>New Delhi- 110 012 | Member Secretary |

## Institute Research Council (IRC)

The annual Institute Research Committee (IRC) meeting of the Institute was held on January 19, 2024, under the chairmanship of the Director, ICAR-NIAP. Dr. R.S. Siddhu, Former Registrar Punjab Agricultural University, Ludhiana, was the external expert. The Chairman briefed the experts about the agenda of the IRC meeting and introduced the research themes. All the scientists presented the progress of their research projects during 2022-23 and research plans for the following year.

# 9 Other Institute Activities

## Annual Day

The ICAR-NIAP celebrated its 32nd Annual Day on May 2, 2023. On this occasion, Dr. P. K. Joshi, Former Director, IFPRI, South Asia, delivered Professor Dayanatha Jha memorial lecture on *Innovation-Policy Connect for Inclusive and Sustainable Agriculture*. A Panel Discussion on ChatGPT and Generative Artificial Intelligence was also organized.

**Releasing of publications by dignitaries on 32nd Annual Day**

## Har Ghar Tiranga and Meri Maati Mera Desh Campaign

ICAR-NIAP celebrated *Har Ghar Tiranaga* and *Meri Maati Mera Desh* Campaign on August 14, 2023. All staff participated enthusiastically in these events.

**Har Ghar Tiranaga and Meri Maati Mera Desh Campaign**

## Swachhata Pakhwada Phase – I

ICAR-NIAP celebrated Swachhata Pakhwada from 15 September to 02 October 2023. Several activities were organized to keep institute premises clean. A special Swachhta drive was organized by the NIAP team to keep NH-8 and tourist places clean. Lectures were also organized to motivate school children and villagers to keep their surroundings clean. A poster competition on clean India was also organized at the institute.


**Glimpse of the posters prepared by NIAP staff during Swachhata Pakhwada**

## World Soil Day

ICAR-NIAP celebrated World Soil Day on December 7, 2023.

## Swachhata Pakhwada Phase – II

As a part of Swachhata Pakhwada, ICAR-NIAP conducted different activities from December 16 to 31, 2023. Activities included the Swachhata Pledge, cleaning office premises, and cleanliness drive in adopted villages and public places by organizing competitions related to cleanliness, hygiene, and plastic waste management.


**Swachhata Pakhwada activities, December 16-31, 2023**

## ICAR Zonal Sports Tournament (Central Zone) – 2023

ICAR-NIAP contingents participated in the ICAR Zonal Sports Tournament (Central Zone) – 2023 at the Sports Ground of Tatya Tope Stadium, Bhopal during December 18-21, 2023. The Institute team participated in Volleyball (Shooting), Table Tennis, Badminton, Cricket and other individual athletic and game events. Ms. Sonia Chauhan, Technical Officer, ICAR-NIAP, secured Silver Medal in chess competition.

**ICAR Zonal Sports Tournament 2023**

## Interaction Meeting

Shri Manoj Ahuja, Secretary, Ministry of Agriculture & Farmers Welfare visited the Institute on January 10, 2024, to interact with the faculty.

## Foreign Delegation Visit

Dr. Seth Meyer, Chief Economist, United States Department of Agriculture (USDA), visited ICAR-NIAP on January 29, 2024.

**Interaction meeting with Dr. Seth Meyer, USDA**

## Release of Working Group Report

Report of the NITI Aayog Working Group on “Crop Husbandry, Agriculture Inputs, Demand and Supply” prepared under the chairmanship of Dr. P.S. Birthal, Director, ICAR-NIAP was released on February 21, 2024.

## Official Language Implementation

### हिन्दी पखवाड़ा

संस्थान में हिन्दी के प्रसार एवं अधिकाधिक कार्य कुशलता बढ़ाने के लिए, निदेशक निआप एवं अध्यक्ष राजभाषा के निर्देशन में 14-29 सितंबर, 2023 तक हिन्दी पखवाड़ा का आयोजन किया गया। हिंदी पखवाड़े का उद्घाटन, राष्ट्रीय स्तर पर, 14 सितम्बर 2023 को प्रातः10 बजे गृह एवं सहकारिता मंत्री माननीय श्री अमित शाह जी द्वारा श्री शिव छत्रपति स्पोर्ट्स काम्प्लेक्स, पुणे (महाराष्ट्र) से किया गया। संस्थान मे हिन्दी पखवाड़ा के अंतर्गत हिंदी भाषा क्विज, कार्यालयों में हिंदी का और अधिक प्रयोग बढ़ने के उपाय पर निबंध लेखन, नोटिंग ड्राफ्टिंग एवं पत्र लेखन तथा "क्या बढ़ती कीमतों को सरकार ही नियंत्रित कर सकती है" पर वाद- विवाद प्रतियोगिता का आयोजन किया गया। पखवाड़े का समापन कविता पाठ एवं पुरुस्कार वितरण से किया गया।

### वर्ष 2023-24 में आयोजित राजभाषा कार्यशालाए

पहली तिमाही: 30 जून 2023 में हिंदी कार्यशाला विषय : कृत्रिम बुद्धिमत्ता का कृषि में उपयोग पर डॉ. रजनी जैन, (प्रधान वैज्ञानिक) ने विस्तार से वक्तव्य दिया।

दूसरी तिमाही : 11 सितम्बर 2023 को हिन्दी कार्यशाला विषय : R सॉफ्टवेयर द्वारा कार्यालय और शोध में आंकड़ो का विश्लेषण पर डॉ रंजीत कुमार पॉल, वरिष्ठ वैज्ञानिक, IASRI, नई दिल्ली ने व्याख्यान दिया।

तीसरी तिमाही : 15 दिसम्बर 2023 को डिजिटल इंडिया कार्यक्रम के अंतर्गत ई-ऑफिस द्वारा प्रभावी एवं पारदर्शी प्रबंधन विषय पर राजभाषा कार्यशाला का आयोजन किया गया। । इस अवसर पर कंप्यूटर अनुपयोग के विशेषज्ञ डॉ रजनी जैन, (प्रधान वैज्ञानिक) एवं श्री दिलीप कुमार (वैज्ञानिक) ने कार्यालयों में सरल, प्रभावी एवं पारदर्शी ई-ऑफिस प्रणाली के बारे में विस्तार से जानकारी दी एवं ऑनलाइन ई-ऑफिस के कार्य करने का प्रदर्शन भी बताया। साथ ही बताया कि ई-ऑफिस में भी हिंदी में भी प्रविष्टियाँ भरी जा सकती है और टिप्पणी लिखी जा सकती है।

चौथी तिमाही : 14 फरवरी 2024 को राजभाषा कार्यशाला अनाधिकृत गतिविधि या फ्रॉड; जागरूकता, सतर्कता एवं सुरक्षा पर विशेषज्ञ श्री प्रशांत खुराना- एरिया मैनेजर- इन्वेस्टीगेसंस, एवं श्री रमण सिंह कँवर – लोकेशन मैनेजर- इन्वेस्टीगेसंस, Department of Credit Intelligence and Control-HDFC Bank द्वारा विशेष जानकारी दी गयी।

# 10 Personnel and Budget

## Personnel

### Scientific

| S. No. | Name | Designation |
|---|---|---|
| 1. | Dr. Pratap Singh Birthal | Director |
| 2. | Dr. Shiv Kumar | Head, Division of Agricultural Market and Trade |
| 3. | Dr. Raka Saxena | Head, Division of Technology and Sustainable Agriculture |
| 4. | Dr. Nalini Ranjan Kumar | Principal Scientist (Ag. Economics) |
| 5. | Dr. Khem Chand | Principal Scientist (Ag. Economics) |
| 6. | Dr. I. Sekar | Principal Scientist (Ag. Economics) |
| 7. | Dr. Rajni Jain | Principal Scientist (Computer Application in Agriculture) |
| 8. | Dr. Subhash Chand | Principal Scientist (Ag. Economics) |
| 9. | Dr. Naveen Prakash Singh* | Principal Scientist (Ag. Economics) |
| 10. | Dr. Sant Kumar | Principal Scientist (Ag. Economics) |
| 11. | Dr. Anil Kumar | Principal Scientist (LPM) |
| 12. | Dr. Purushottam Sharma | Principal Scientist (Ag. Economics) |
| 13. | Dr. Prem Chand | Senior Scientist (Ag. Economics) |
| 14. | Dr. Vikas Kumar | Senior Scientist (Ag. Economics) |
| 15. | Dr. Shivendra Kumar Srivastava | Senior Scientist (Ag. Economics) |
| 16. | Dr. Kingsly Immanuelraj T. | Senior Scientist (Ag. Economics) |
| 17. | Dr. Dinesh Chand Meena | Senior Scientist (Ag. Economics) |
| 18. | Dr. Vinayak Ramesh Nikam | Senior Scientist (Ag. Extension) |
| 19. | Dr. Jaya Jumrani | Senior Scientist (Ag. Economics) |
| 20. | Dr. Arathy Ashok | Scientist (Ag. Extension) |
| 21. | Dr. Pavithra Srinivasamurthy | Scientist (Ag. Economics) |
| 22. | Mr. Subash S. P.** | Scientist (Ag. Economics) |
| 23. | Dr. Balaji S. J. | Scientist (Ag. Economics) |
| 24. | Mr. S. V. Bangararaju | Scientist (Ag. Economics) |
| 25. | Dr. Prabhat Kishore | Scientist (Ag. Economics) |
| 26. | Dr. Ankita Kandpal | Scientist (Ag. Economics) |
| 27. | Dr. Kiran Kumara T. M. | Scientist (Ag. Economics) |
| 28. | Mr. Dilip Kumar | Scientist (Computer Application and IT) |

*On deputation to Commission on Agricultural Costs and Prices, Ministry of Agriculture and Farmers Welfare, Government of India, New Delhi.

** On study leave

## Technical

| S. No. | Name | Designation |
|---|---|---|
| 1. | Mr. Khyali Ram Chaudhary | Chief Technical Officer |
| 2. | Mr. Mangal Singh Chauhan | Chief Technical Officer |
| 3. | Mrs. Sonia Chauhan | Chief Technical Officer |
| 4. | Mr. Satender Singh | Technical Officer |

## Administrative

| S. No. | Name | Designation |
|---|---|---|
| 1. | Mr. Navdeep Kumar Sharma | Administrative Officer |
| 2. | Mr. Bijender Singh Tewthia | Principal Private Secretary |
| 3. | Mr. Mohammad Irfan | Assistant Finance & Accounts Officer |
| 4. | Mr. Inderjeet Sachdeva | Assistant Administrative Officer |
| 5. | Mr. Yatin Kohli | Assistant |
| 6. | Mr. Harish Vats | Assistant |
| 7. | Mr. Ajay Tanwar | Assistant |
| 8. | Mr. Deepak Tanwar | Personal Assistant |
| 9. | Mr. Mahesh Kumar | Lower Division Clerk |
| 10. | Mrs. Kanika Arora | Lower Division Clerk |

## Skilled Supporting Staff

| S. No. | Name | Designation |
|---|---|---|
| 1. | Mr. Mahesh Pal | Skilled Supporting Staff |

## Promotions & Transfers

| S. No. | Name and Designation |
|---|---|
| 1. | Mrs. Pavithra Srinivasamurthy, Scientist, promoted in the next higher grade from Level 11 to Level 12 under C.A.S w.e.f. 15.09.2021 |
| 2. | Dr. Jaya Jumrani, Scientist, promoted in the next higher grade from Level 11 to Level 12 under C.A.S w.e.f. 15.09.2022 and re-designated as Senior Scientist w.e.f. 08.05.2023 |

## New Joining

| S. No. | Name and Designation | Joined on |
|---|---|---|
| 1. | Dr. Shiv Kumar, Head, Division of Agricultural Market and Trade | 17.07.2023 |
| 2. | Dr. Raka Saxena, Head, Division of Technology and Sustainable Agriculture | 17.07.2023 |
| 3. | Dr. Anil Kumar, Principal Scientist (LPM) | 11.12.2023 |
| 4. | Mr. Bijender Singh Tewthia, Principal Private Secretary | 02.11.2023 |

## Study Leave

| S. No. | Name and Designation | Study Leave Period |
|---|---|---|
| 1. | Mr. Subash S.P., Scientist | 20.07.2021 to 19.07.2024 |

## Budget

**Table 10.1: ICAR-NIAP Expenditure, 2023-24 (Rs. in Lakhs)**

| Head | Expenditure |
|---|---|
| **Grants for Creation of Capital Assets (Capital)** | |
| Works | 6.31 |
| Equipment | 7.62 |
| Information Technology | 28.63 |
| Library Books and Journals | 19.02 |
| Furniture & Fixtures | 5.42 |
| Others | 0.00 |
| **Total Capital Expenditure (A)** | **67.00** |
| **Grant in Aid-Salaries (Revenue)** | **989.82** |
| **Pension and other Retirements Benefits** | **40.65** |
| **Total Establishment Expenses (B)** | **1030.47** |
| **Grant in Aid-General** | |
| Travelling Allowance | 8.68 |
| Research and Operational Expenses | 208.07 |
| Administrative Expenses | 247.28 |
| Others | 0.97 |
| **Total Expenditure Grant in Aid-General (C )** | **465.00** |
| **Grand Total (A+B+C)** | **1562.47** |
| **SCSP Grant in Aid Capital** | **19.98** |
| **SCSP Grant in Aid General** | **20.00** |
| **Total Expenditure SCSP (D)** | **39.98** |
| **Total Expenditure including SCSP (A+B+C+D)** | **1602.45** |
| Revenue Receipt | 20.54 |
| Budget of Externally Funded Projects (Expenditure) | 119.12 |

भाकृअनुप – राष्ट्रीय कृषि आर्थिकी एवं नीति अनुसंधान संस्थान

**ICAR - National Institute of Agricultural Economics and Policy Research**

(Indian Council of Agricultural Research)

New Delhi 110 012