ANNUAL REPORT
2020-21

भाकृअनुप - राष्ट्रीय कृषि आर्थिकी एवं नीति अनुसंधान संस्थान
ICAR – National Institute of Agricultural Economics and Policy Research
(Indian Council of Agricultural Research)

Annual Report
2020-21

ICAR – National Institute of Agricultural Economics and Policy Research

(Indian Council of Agricultural Research)

ICAR-NIAP Annual Report 2020-21

Published

July, 2021

Editorial Team

Dr. Suresh Pal

Dr. Khem Chand

Dr. S. K. Srivastava

Dr. Kingsly Immanuelraj

Dr. Dinesh Chand Meena

Dr. Vikas Kumar

Dr. Sant Kumar (Hindi)

Technical Assistance

Ms. Sonia Chauhan

Mr. Prem Narayan (Hindi)

Published by

Dr. Suresh Pal

Director

ICAR-NIAP, New Delhi- 110 012

Printed at

National Printers, B-56, Naraina Industrial Area, Phase II, New Delhi-110028
Phone No.: 011-42138030, 09811220790

Preface

The ICAR-National Institute of Agricultural Economics and Policy Research (NIAP) was established by ICAR to strengthen agricultural economics and policy research within the National Agricultural Research System (NARS). The Institute has made significant contributions to the mandated activities during the year under report. Despite COVID-19 lockdowns and restrictions, engagements of scientists in research, capacity building and policy communications were maintained with the use of information and communication technology. The capacity building programs of ICAR-NIAP through online mode have helped thousands of researchers, academicians and students in understanding new developments in data analysis and policy research. Besides, the Institute's collaboration with sister institutes of ICAR, state agricultural universities and development institutions of national importance were strengthened during the year under report.

The significant research contributions of the Institute pertain to the area of agricultural growth and transformation, impacts of COVID-19 on agriculture, achieving five trillion dollar economy, doubling farmers' income, development of aspirational districts, impact of climate change on agriculture and adaptation strategies, impact of ICAR technologies, water management, market integration, price transmission and extension advisory services. ICAR-NIAP was also actively engaged in policy dialogue with the departments of MoA&FW for doubling farmers' income, management issues in crop insurance, agricultural diversification and price forecasting of agricultural commodies. The Institute also provided input on in-situ management of crop residue in the North-West Plains. The Institute organised more than 10 workshops and trainings, including a sponsored orientation program for the officers of the Indian Economic Service. A twenty day Webinar series on "Quantitative Methods for Social Sciences" was also organised for the NASS faculty and students. The Institute has published first Agricultural Development Report in this year. The Institute's linkages with NITI Ayog, MoA&FW, CG Centres, office of Principal Scientific Advisor to the Government of India and other reputed organizations were strengthened.

I sincerely thank Dr. Trilochan Mohapatra, Secretary, DARE and Director General, ICAR and Shri Sanjay K. Singh, Additional Secretary, DARE and Secretary, ICAR for their guidance and continuous support. I am also thankful to Dr. R.C. Agarwal, Deputy Director General (Education) for his constant support in undertaking various activities of the Institute. The valuable guidance provided by the members of the Institute Management Committee and Research Advisory Committee is acknowledged with grateful thanks. I sincerely thank all my colleagues for their cooperation, particularly Dr. Khem Chand, Dr. S.K. Srivastava, Dr. Kingsly I., Ms. Jaya Jumrani, Dr. Balaji S.J., Dr. Vikas Kumar and Dr. D.C. Meena for compilation and editing of the Annual Report, and to Dr. Sant Kumar for Hindi version of the Report. Special thanks to Ms. Sonia Chauhan for her help in the compilation and presentation of the material. A word of appreciation goes to Mrs. Umeeta Ahuja and Mr. Deepak Tanwar for their word processing skills and information compilation.

(Suresh Pal)
Director
ICAR- National Institute of Agricultural
Economics and Policy Research

July 31, 2021

Contents

List of Tables

List of Figures

List of Acronyms

3SLS	Three-Stage Least Squares
ACZ	Agro-Climatic Zones
ADI	Agro ecosystem Diversity Index
AERA	Agricultural Economics Research Association
AESSRA	Agricultural Economics and Social Science Research Association
AI	Artificial Intelligence
AIF	Agricultural Infrastructure Fund
AKMU	Agricultural Knowledge Management Unit
ARCH	Autoregressive Conditional Heteroscedasticity
ARIMA	Autoregressive Integrated Moving Average
CAS	Current Awareness Service
CCHAU	Chaudhary Charan Singh Haryana Agricultural University
CEO	Chief Executive Officer
CFH	Cochin Fisheries Harbor
CGWB	Central Groundwater Board
CIAS	Composite Index of Agricultural Sustainability
CIFE	Central Institute of Fisheries Education
CIMMYT	International Maize and Wheat Improvement Center
CMA	Centre for Management in Agriculture
CMIE	Centre for Monitoring Indian Economy
CPH	Central Plateau & Hills
CPRI	Central Potato Research Institute
CRA	Climate Resilient Agriculture Index
CSWRI	Central Sheep and Wool Research Institute
DAC&FW	Department of Agriculture, Cooperation and Farmers' Welfare
DARE	Department of Agricultural Research and Education
DDG	Deputy Director General
DDS	Document Delivery Service
DES	Directorate of Economics and Statistics
DFI	Doubling Farmers' Income
DG	Director General
DoCA	Department of Consumer Affairs
DW	Data warehouse
ECH	Eastern Coast Plains & Hills
EHR	Eastern Himalayan Region
e-NAM	National Agriculture Market
EPH	Eastern Plateau & Hills
ERNET	Education and Research Network
ERP	Enterprise Resource Planning
ES	Ecosystem Services
EYC	Eastern Yamuna Canal
FPOs	Farmer Producer Organizations
FPTC	Farmers' Produce Trade and Commerce Act
GA	Genetic Algorithm
GARCH	Generalized Autoregressive Conditional Heteroscedasticity
GDP	Gross Domestic Product
GPH	Gujarat Plains & Hills
GrAMs	Gramin Agriculture Markets
GVA	Gross Value Added
HYVs	High-yielding varieties
HPC	High Performance Computing
ICRIER	Indian Council for Research on International Economic Relations
IAAE	International Association of Agricultural Economists
IARI	Indian Agricultural Research Institute
ICAR	Indian Council of Agricultural Research
ICMLBDA	International Conference on Machine Learning and Big Data Analytics
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ICT	Information and Communication Technologies
IDEA	India Digital Ecosystem of Agriculture
IES	Indian Economic Service

IFPRI	International Food Policy Research Institute
IGP	Indo-Gangetic Plain
ILRI	International Livestock Research Institute
IMC	Institute Management Committee
IPWRA	Inverse Probability Weighted Regression Adjustment
IRC	Institute Research Council
IRR	Internal Rate of Return
IRRI	International Rice Research Institute
IWMI	International Water Management Institute
JSC	Joint Staff Council
KCC	Kisan Credit Card
KVK	Krishi Vigyan Kendra
LGP	Lower-Gangetic Plains
LOA	Length Overall
LP	Linear Programming
LR	Likelihood Ratio
MAE	Mean Absolute Error
MAPE	Mean Absolute Percentage Error
MGMG	Mera Gaon Mera Gaurav
MGNREGA	Mahatma Gandhi National Rural Employment Act
MGP	Middle Gangetic Plains
MIS	Management Information system
MNAIS	Modified National Agricultural Insurance scheme
MoA& FW	Ministry of Agriculture & Farmers Welfare
MTAR	Momentum Threshold Auto Regressive models
NAAS	National Academy of Agricultural Sciences
NAIS	National Agricultural Insurance Scheme
NARES	National Agricultural Research and Education System
NARS	National Agricultural Research System
NGOs	Non-Government Organizations
NIAP	National Institute of Agricultural Economics and Policy Research
NPV	Net Present Value
NRAA	National Rainfed Area Authority
NRM	Natural Resource Management
NSSO	National Sample Survey Office
NSSO-EUS	National Sample Survey Office-Employment Unemployment Survey
OLS	Ordinary Least Squares
OSFVs	Offshore Fishing Vessels
PAU	Punjab Agricultural University
PLFS	Periodic Labour Force Survey
PMFBY	Pradhan Mantri Fasal Bima Yojana
PPFC	Public-Private-Farmer Cooperation
PSO	Particle Swarm Optimization
QRT	Quinquennial Review Team
RA	Regression Adjustment
RAC	Research Advisory Committee
RCA	Revealed Comparative Advantage
RNFE	Rural Non-Farm Employment
RNFS	Rural Non-Farm Sector
SAPB	State Agricultural Prices Board
SAUs	State Agricultural Universities
SCSP	Scheduled Caste Sub-Plan
SDGs	Sustainable Development Goals
SOC	Soil Organic Carbon
SPH	Southern Plateau & Hills
SVPA & T	Sardar Vallabhbhai Patel University of Agriculture & Technology
TAR	Threshold Autoregressive
TGP	Trans - Gangetic Plains
TOP	Tomato, Onion and Potato
UGP	Upper-Gangetic Plains
VAR	Vector Autoregressive
VDSA	Village Dynamics in South Asia
VEC	Vector Error Correction
WCG	Western Coast Plains & Ghats
WDR	Western Dry Region
WDRA	Warehousing Development and Regulatory Authority
WESs	Watershed Ecosystem Services
WHR	Western Himalayan Region
WPH	Western Plateau & Hills

कार्यकारी सारांश

भाकृअनुप – राष्ट्रीय कृषि आर्थिकी एवम् नीति अनुसंधान संस्थान, नई दिल्ली, कृषि नीतियों के बारे में विचार करने हेतु, भारतीय कृषि अनुसंधान परिषद् के लिए विषेशज्ञ समूह (थिंक टैंक) के रूप में कार्य करता है और कृषि अर्थशास्त्र एवं नीति अनुसंधान को मजबूती प्रदान करने में लगातार प्रयत्नशील है। संस्थान नियमित अंतराल पर क्षमता निर्माण एवं प्रशिक्षण कार्यक्रमों का आयोजन करता है। संस्थान कृषि विकास की चुनौतियों के समाधान हेतु नीति–निर्माताओं एवं सरकार को अनुसंधान आधारित साक्ष्य प्रदान करता है एवं उन्हें अवगत कराता है। संस्थान में अनुसंधान कार्य तीन व्यापक क्षेत्रों जैसे कि कृषि वृद्धि एवं विकास, प्रौद्योगिकी एवं टिकाऊ कृषि, और कृषि विपणन एवं व्यापार के अन्तर्गत किये जाते हैं। प्रतिवदेन वर्षावधि 2020–21 में संस्थान द्वारा हासिल की गयी अनुसंधान उपलब्धियों एवं संचालित अन्य गतिविधियों की एक झलक प्रस्तुत है।

अनुसंधान उपलब्धियाँ

कृषि वृद्धि एवं विकास

इस विषय के अन्तर्गत किये गये अध्ययनों में प्रमुख रूप से कृषि में वृद्धि एवं रूपांतरण के स्रोत एवं कारक, गैर–कृषि रोजगार, प्रणाली विविधीकरण, कोविड–19 महामारी का कृषि पर प्रभाव, पचास खरब डालर आकारवाली अर्थव्यवस्था के लक्ष्यों की प्राप्ति, किसानों की आय दोगुना करना एवं आकांक्षी जिलों को चिन्हित करना शामिल हैं।

किसानों की आय दोगुना करने के एक अध्ययन में कृषि में वृद्धि के स्रोत्रों की पहचान की गयी है। जिनमें प्रमुख रूप से फसल एवं पशुपालन उत्पादकता में सुधार, कारक उपयोग दक्षता में वृद्धि, फसल सघनता में वृद्धि, अधिक मूल्य वाली फसलों की ओर विविधीकरण, वास्तविक कृषि मूल्यों में सुधार और श्रमिकों का कृषि से गैर–कृषि व्यवस्याओं की तरफ स्थानान्तरण शामिल हैं। किसानों के सामाजिक–आर्थिक आयामों की समझ हेतु आकांक्षी जिलों में एक आधारीय विश्लेषण किया गया। अध्ययन दर्शाता है कि किसान परिवारों की आय का प्रमुख साधन खेती है और खेती से पशुपालन की ओर स्थानान्तरण में भूजोत आकार का नकारात्मक प्रभाव है। किसानों की आय बढ़ानें में कृषि ऋण, सामुदायिक संस्थाओं में भागीदारी एव गैर–कृषि आय सहायक हैं। आकांक्षी जिलों के वृद्धि एवं विकास हेतु मिशन मोड दृष्टिकोण, इलेक्ट्रॉनिक शासन (सरकारी सेवाएं प्रदान करने हेतु सूचना एवं संचार प्रौद्योगिकी का उपयोग), कौशल विकास, आंकड़ों पर आधारित निर्णय एवं निजी निवेश प्रमुख हैं।

राष्ट्रीय प्रतिदर्श सर्वेक्षण कार्यालय के क्रमिक सर्वेक्षणों में पिछले 24 वर्षों के दौरान भारतीय कृषि में श्रमिकों की संख्या में लगातार गिरावट आयी है। जबकि दूसरी तरफ, खेतिहर किसानों की गिरावट की दर धीमी रही है। वास्तव में वर्षावधि 2011–12 से 2017–18 के बीच में पुरूष काश्तकारों की संख्या में बढ़ोत्तरी हुई है। इस प्रकार की प्रवृत्ति गैर–कृषि क्षेत्रों में श्रमिकों की कम अवशोषण क्षमता अथवा कृषि क्षेत्र में हो रहे सुधारों से इसके अधिक लाभकारी होने की संभावना के कारण हो सकता है।

व्यवसाय–वार रोजगार आंकलन से पता चला है कि ग्रामीण भारत में गैर–कृषि रोजगार वर्ष 2011–12 में 31.78 प्रतिशत से बढ़कर वर्ष 2017–18 में 41.33 प्रतिशत हो गया। कोविड–19 बंदी के परिणामस्वरूप देश के राज्यों में बेरोजगारी एवं विपरीत प्रवासन में वृद्धि हुई है। विपरीत प्रवासन से मूल प्रवासी राज्यों में श्रमिकों की उपलब्धता बढ़ी है। एक त्वरित अध्ययन से पता चला है कि पंजाब में कोविड–19 महामारी (पहली लहर) के दौरान गेहूँ की कटाई एवं धान की रोपाई के लिए श्रम लागत में क्रमशः 15 तथा 40 प्रतिशत की वृद्धि हुई है इससे उपरोक्त फसलों की उत्पादन लागत (A_1+पारिवारिक श्रम लागत) में क्रमशः 1.1 प्रतिशत तथा 4.6 प्रतिशत का सकरात्मक बदलाव आया। इसके बावजूद विपरीत प्रवासन से बिहार में श्रम लागत में कमी का प्रभाव नहीं दिखाई दिया।

कोरोना वायरस के संक्रमण को रोकने के लिए राष्ट्रव्यापी बंदी के कारण वर्ष 2020–21 में प्रति–व्यक्ति प्रतिमाह खाद्य एवं गैर–खाद्य मदों के खर्चों में क्रमशः 4.98–21. 24 प्रतिशत तथा 7.69–39.79 प्रतिशत की कमी आने की संभावना है। खाद्य वस्तुओं के तहत, अनाजों की खपत में सबसे कम कमी (2.32–9.89 प्रतिशत), जबकि फलों, मांसाहारी खाद्य वस्तुओं और दूध में अधिक गिरावट की संभावना है। सरकार एवं नागरिक समाज संगठनों के प्रयासों से कोविड बंदी के दौरान खपत पर नकारात्मक प्रभाव में कमी आने की संभावना है।

वर्ष 2024–25 तक भारतीय अर्थव्यवस्था के पचास खरब डॉलर आकार के लक्ष्यों की प्राप्ति हेतु कृषि क्षेत्र के मौजूदा उत्पादन स्तर 3.9 खरब डालर (2018–19) से 10 खरब डालर के स्तर तक पहुँचना होगा। इस लक्ष्य की प्राप्ति में कृषि क्षेत्र में दहाई अंकों की विकास दर, अधिक मूल्य वाली फसलों की तरफ विविधीकरण, बाजार एवं सिंचाई के आधारभूत ढ़ाचें में निवेश, भूमि सुधार, कृषि उद्योगों को बढ़ावा देना, निर्यात को बढ़ावा देने के लिए अच्छी कृषि पद्धतियों का अंगीकरण, आपूर्ति–श्रंखलाओं का आधुनिकीकरण, एवं उत्पादन कारकों को उचित मूल्य पर मुहैया कराना, आदि प्रमुख आवश्यकताएं हैं।

कृषि श्रमिक बाजार के एक अध्ययन में वर्षावधि 2011–12 से 2017–18 के दौरान कृषि श्रमिकों की संख्या (37 मिलियन तक) में अप्रत्याशित कमी देखी गई है। ऐसा प्रमुख रूप से काश्तकारों एवं श्रमिकों, विशेष रूप से महिला श्रमिकों, के खेती से बाहर आने के कारण हो सकता है। इससे मजदूरी की दर में वृद्धि हुई है, जिसके परिणामस्वरूप खेती में श्रम लागत की हिस्सेदारी बढ़ी है। इसके बावजूद, बढ़ते मशीनीकरण तथा अन्य तकनीकी नवाचारों के प्रयोग से कृषि क्षेत्र ने मजदूरी में वृद्धि के प्रभाव को आंशिक रूप में बेअसर सिद्ध कर दिया है।

दीर्घावधि में भारत में कैलोरी अन्तर्ग्रहण में गिरावट की प्रवृत्ति का साक्ष्य मिला है। राष्ट्रीय सर्वेक्षण कार्यालय के एक अध्ययन से पता चला है कि घरेलू खपत सर्वेक्षण में 'घर से बाहर भोजन' पर संकलित आंकड़ों में संशोधन के रूझान का सकारात्मक प्रभाव दिखा। आंकड़ा संग्रहण में माप त्रुटियों में सुधार करने से आहार को समझने एवं सामाजिक कल्याण के कार्यक्रमों को डिजाइन करने में सहायता मिलती है। वर्षावधि 1993–94 तथा 2011–12 के दौरान बड़े पैमाने पर एकत्रित आंकड़ों से पारिवारिक स्तर पर पोषण माँग का विश्लेशण दर्शाता है कि लोग अपने आहार की थाली में अनाजों की अपेक्षा, विशेष रूप से डेयरी एवं पशु उत्पादों को शामिल कर रहे हैं। इसके अतिरिक्त, तेल एवं वसा, और विविध खाद्य एवं पेय पदार्थ, जिन्हें अस्वास्थ्यकर भोजन माना जाता है, विशेष रूप से ग्रामीण क्षेत्रों में इनकी माँग में वृद्धि देखी गयी है।

प्रौद्योगिकी एवं टिकाऊ कृषि

इस विषय के अन्तर्गत किये गये अध्ययनों में कृषि पर जलवायु परिवर्तन का प्रभाव एवं अनुकूलन रणनीतियाँ, भा.कृ.अनु.प. की प्रौद्योगिकियों के आर्थिक प्रभाव का आंकलन, कृषि में टिकाऊपन का मूल्याँकन, कृषि पारिस्थितिकी तंत्र विविधता एवं सेवाएं, कृषि में जल प्रबंधन, कुशल जल उपयोग प्रौद्योगिकियाँ, कृषि में कृत्रिम बुद्धिमत्ता का उपयोग एवं सलाह सेवाओं का प्रसार शामिल हैं।

भा.कृ.अनु.प.की प्रौद्योगिकियों के आर्थिक प्रभाव आकलन पर किये गये एक अध्ययन में पता चला है कि इन प्रौद्योगिकियों के अंगीकरण से खाद्य सुरक्षा, कृषि में टिकाऊपन एवं गरीबी निवारण में बड़ी सफलता मिली है। कृषि की छः प्रौद्योगिकियों ने 9.6–14.7 हजार करोड़ रूपये के बीच वार्षिक लाभ दिया। विगत वर्षों में कृषि अनुसंधान में निवेश (1980–2008) पर आंतरिक वापसी की माध्यिका दर 58.5 प्रतिशत थी, जोकि पूर्वी क्षेत्र के लिए 34.9 प्रतिशत तथा उत्तरी क्षेत्र के लिए 80.5 प्रतिशत पायी गयी। इस्ट्रस सिनक्रोनाईजेशन तकनीक के अंगीकरण की दर एक प्रतिशत रहने पर इससे वार्षिक शुद्ध लाभ 506.74 लाख रूपये तथा 27 प्रतिशत की दर से आंतरिक लाभ की संभावना है। कृषि प्रसार एवं सलाहकार प्रणालियों के प्रभाव से संबंधित एक अध्ययन में पता चला है कि युवा किसान कृषि संबंधी जानकारी प्राप्त करने के लिए एक से अधिक सूचना तकनीक माध्यमों का प्रयोग करते हैं। जिन किसानों ने कम से कम एक औपचारिक स्रोत से सूचना प्राप्त की उनकी उत्पादकता में 11 प्रतिशत की सार्थक वृद्धि दर्ज हुई।

कृषि उत्पादकता पर जलवायु संबंधी दुष्प्रभावों के एक अध्ययन में इस बात का पता चला कि सिंचाई, कृषि विविधीकरण एवं उत्पादन कारकों के युक्तिसंगत प्रयोग से जलवायु दुष्प्रभावों के नकारात्मक प्रभाव को एक सीमा तक कम किया जा सकता है। फसल पद्धतियों पर जलवायु परिवर्तन, विशेष रूप से तापमान में वृद्धि के प्रभाव, का विश्लेषण दर्शाता है कि उच्च तापमान, फसलों की पैदावार पर नकारात्मक प्रभाव डालता है और भविष्य में यह प्रभाव विभिन्न जलवायु परिदृश्यों में अधिक नुकसानदायक साबित हो सकता है। उत्सर्जन परिदृश्य के तहत जलवायु क्षेत्र 4.5 में, मध्यम अवधि (2041–2060) में फसलोत्पादकता में 1.8–6.6 प्रतिशत तथा लम्बी अवधि (2061–2080) में 7.2–23.6 प्रतिशत तक की कमी आ सकती है।

भारत के विभिन्न कृषि जलवायु क्षेत्रों में जलवायु लचीलापन की जाँच के लिए एक कृषि जलवायु लचीलापन सूचकाँक

(क्लाइमेट रेजीलिएन्ट एग्रीकल्चर इन्डेक्स) तैयार किया गया। एक तरफ देश के पश्चिमी तट के मैदानों और घाटों, गंगापार के मैदानों, गुजरात के मैदानों एवं पहाड़ी क्षेत्रों में जलवायु में अधिक लचीलापन मिला। जबकि दूसरी ओर, बिहार एवं उत्तर प्रदेश के कुछ हिस्सों और छत्तीसगढ़, झारखंड तथा ओडिशा में जलवायु तनावों से निबटनें में कम लचीलापन दिखा। इसके अतिरिक्त एक ही कृषि जलवायु क्षेत्र के विभिन्न जिलों में व्यापक विविधताएं मिली। जलवायु परिवर्तन अनुकूलन हेतु योजनाओं को मजबूती प्रदान करने के लिए स्थानिक आवश्यकताओं के अनुरूप विशेष उपायों एवं नीतियों को विकसित करने की आवश्यकता है जोकि कृषि प्रणाली में लचीलेपन को बढ़ावा देते हैं।

लगातार बढ़ रही आबादी की खाद्य–सुरक्षा को बनाये रखने के लिए कृषि में कुशल जल प्रबंधन महत्वपूर्ण है। पानी की कमी, सूखे की स्थिति, शहरीकरण एवं जनभागीदारी की कमी, पानी की खराब गुणवत्ता, अधिक तापमान तथा जलवायु विविधता, आदि पानी के प्रबंधन में प्रमुख बाधक तत्व हैं। राजस्थान में छिड़काव (स्पिंकलर) सिंचाई प्रणाली का अंगीकरण करने वालों में मध्यम किसानों की भागीदारी सर्वाधिक (29 प्रतिशत) थी, इसके बाद छोटे एवं मझोले किसान (24.5 प्रतिशत, प्रत्येक) एवं शेष सीमांत एवं बड़े किसान (11 प्रतिशत, प्रत्येक) थे। सृजित सूक्ष्म सिंचाई सुविधा का उपयोग अपेक्षाकृत अधिक लाभ प्रदान करने वाली फसलों में सार्थक रूप से लाभकारी पाया गया। बुंदेलखंड क्षेत्र में किये गये एक अध्ययन में मिला कि बूँद–बूँद सिंचाई प्रणाली को विभिन्न फसलों में अपनाने से 40–130 प्रतिशत तक उपज वृद्धि मिलती है, तथा जल उपयोग दक्षता 65 प्रतिशत तक सुनिश्चित होती है।

संकुल कृषि स्थिरता सूचकांक से संकेत मिला है कि राजस्थान में कृषि सबसे कम टिकाऊ है जबकि मिजोरम प्रान्त में सबसे अधिक टिकाऊ हैं। गंगा के मैदानी भागों में कृषि टिकाऊपन में उत्तरोत्तर वृद्धि वाले राज्य उत्तर प्रदेश, पंजाब, बिहार एवं हरियाणा आते हैं। इसके अतिरिक्त अन्य राज्यों जैसे कि मणिपुर, आंध्र प्रदेश, मध्य प्रदेश तथा केरल में भी कृषि टिकाऊपन में उत्तरोत्तर वृद्धि दिखी ।

जलोत्सारण क्षेत्र (वाटरशेड) द्वारा विकसित पारिस्थितिकीय सेवाओं के मूल्याँकन संबंधी अधिविश्लेषण (मेटा–एनालाइसिस) से पता चला है कि जलविभाजक प्रतिवर्ष लगभग 11.54 टन/है. मिट्टी प्रतिधारण, 1.94 मीटर भूजल पुनर्भरण, और 337 किग्रा/है. कार्बन अधिग्रहण सेवाएं प्रदान करते हैं। भारत में वाटरशेड द्वारा प्रदान की जाने वाली उपरोक्त सभी पारिस्थितिकीय सेवाओं का मौद्रिक मूल्य अधिक है। जिन जगहों पर जनभागीदारी अधिक होती है वहाँ वाटरशेड द्वारा उपार्जित पारिस्थितिकीय सेवाओं की स्थिति अच्छी पायी गयी है। कृषि पारिस्थितिकी तंत्र में मौजूद विविधता, खाद्य सुरक्षा, जलवायु परिवर्तन, बढ़ती जनसंख्या एवं कृषि के टिकाऊपन को बनाये रखने तथा चुनौतियों का समाधान करने की क्षमता है। कृषि पारिस्थितिकी विविधता सूचकांक से पता चला है कि गंगा पार के मैदानी भागों में विशिष्ट खेती के अपनाये जाने से इसकी जैविक एवं अजैविक झटकों के प्रति संवेदनशीलता घटी है।

बुंदेलखंड क्षेत्र में टिकाऊ कृषि उत्पादन के लिए उपलब्ध संसाधनों के इष्टतम उपयोग का पता लगाने के लिए विकसित फसल उपयुक्तता सूचकांक से संकेत मिला है कि किसान खेती करते समय उपलब्ध जैव–भौतिक तथा सिंचाई मानदंडो (टिकाऊपन संकेतक) को ध्यान में रखने के बजाय उसके सामाजिक–आर्थिक पक्षों को महत्व देते हैं। इस प्रकार, जैवभौतिक संसाधनों के अनुरूप खेती करने तथा रणनीतिक मूल्य नीति को लागू करने के लिए किसानों को जागरूक करने की आवश्यकता है। बुंदेलखंड क्षेत्र के जिलों में टिकाऊ कृषि हेतु एक या अन्य दूसरे महत्वपूर्ण बुनियादी सुविधाओं की कमी है, इसलिए इस क्षेत्र में कृषि के बुनियादी ढ़ांचे में सुधार की आवश्यकता है।

विपणन एवं व्यापार

कृषि विपणन एवं व्यापार विषय के अन्तर्गत किये गये प्रमुख अनुसंधान अन्तर्राष्ट्रीय व्यापार, विभिन्न खाद्य वस्तुओं की आपूर्ति–श्रंखला विश्लेषण, मूल्य अस्थिरता और प्रसार, बाजार एकीकरण और कृषि वस्तुओं की दृष्टिकोण माँडलिंग पर केन्द्रित हैं।

पिछले कुछ वर्षों में भारतीय कृषि निर्यात के स्तर, संरचना एवं विविधीकरण में महत्वपूर्ण परिवर्तन हुए हैं। निर्यात प्रदर्शन सूचकांक से संकेत मिला है कि चावल, फ्रोजन मांस, सूती धागे, कच्चा कपास, अदरक, काली मिर्च एवं मसालों के बीज अत्यधिक प्रतिस्पर्धी वस्तुओं के रूप में बने रहे। वर्ष 2015–18 के दौरान क्रस्टेशियंस अत्यधिक प्रतिस्पर्धी वस्तु के रूप में उभरा। क्रस्टेशियाई जलजीवों के

व्यापार में भारत सबसे बड़ा निर्यातक देश बनकर उभरा है इसके बाद अन्य प्रमुख निर्यातक देशों के रूप में इक्वाडोर, कनाडा और संयुक्त राज्य अमेरिका का स्थान आता है। प्रतिस्पर्धा में सुधार करने से भारतीय निर्यात में तेजी से सुधार होगा तथा इसकी वैश्विक उपस्थिति और मजबूत होगी। अध्ययन दर्शाता है कि अनुसंधान एवं विकास में निवेश तथा नवीनतम प्रौद्योगिकियों के प्रयोग से गुणवत्ता में सुधार, भारत को दीर्घावधि में प्रतिस्पर्धी बनाये रखने में महत्वपूर्ण हैं।

दिल्ली में प्रमुख दालों की मूल्य–श्रंखला और कीमत संचरण से पुष्टि होती है कि दीर्घावधि में अधिप्रवाह (अपस्ट्रीम) कीमतें अनुप्रवाह (डाउनस्ट्रीम) कीमतों पर हावी रहती हैं। जबकि अल्पावधि में, अपस्ट्रीम एवं डाउनस्ट्रीम दोनों कीमतें साथ–साथ निर्धारित होती हैं। यह घटना उर्ध्वाधर बाजारों में कीमतों की खोज में मददगार होती हैं। डेयरी मूल्य–श्रंखलाओं से पता चला है कि एकीकृत उत्पादन एवं प्रसंस्करण प्रणाली, अन्य प्रणालियों की तुलना में सबसे अधिक लाभदायी है जो पूरी तरह से उत्पादन या वितरण पर निर्भर करती हैं। इस प्रणाली की सफलता मुख्य रूप से दूध मूल्य–श्रंखला के विभिन्न चरणों के उध वार्धर एकीकरण के लिए जिम्मेदार है। प्रत्येक चरण में आसान ट्रेसिंग के कारण दूध में संदूषण के जोखिम को कम किया जा सकता है।

मछली मूल्य–श्रंखला के विश्लेषण से पता चला है कि बड़े पैमाने पर मछली पकड़ने की गतिविधि धीरे–धीरे गहरे समुद्र में मछली पकड़ने की ओर स्थानांतरित हो गयी है। हालांकि, समुद्र तट से दूरी तथा गहराई बढ़ने के साथ–साथ, मछली पकड़ने की उत्पादकता में कमी आती है। केरल राज्य के मछुआरों के समुद्र में मछली पकड़ने के कारकों को चिहिन्त किया गया है जिसमें (1) मछली पकड़ने में अधिक यात्रा लागत, (2) कम मछली पकड़ने की दक्षता, (3) सीमित मछली धारण क्षमता, (4) पूरे ट्रिप में बर्फ ले जाने की आवश्यकता, और (5) मछुआरों की अनौपचारिक ऋण स्रोतों पर अधिक निर्भरता, आदि प्रमुख हैं।

कोविड–19 बंदी के परिणामस्वरूप कृषि वस्तुओं की कीमत, आवक एवं इनके अन्तर्राष्ट्रीय व्यापार पर प्रभाव पड़ा है। कोविड–19 बंदी के दौरान कई आवश्यक कृषि वस्तुओं की आवक एवं कीमत दोनों में, एक संक्षित अवधि के लिए गिरावट आयी, जिससे किसानों को उनके उत्पादों के कम मूल्य मिले। कोविड बंदी के दौरान सब्जियों की आवक सबसे अधिक प्रभावित हुई तथा इसमें 60 प्रतिशत तक गिरावट आयी। प्याज एवं आलू की आवक में भी भारी गिरावट आयी। कृषि उत्पादों का निर्यात मार्च 2020 में कुछ हद तक, जबकि अप्रैल 2020 में काफी हद तक प्रभावित हुआ। हालांकि अप्रैल 2020 में गैर–बासमती चावल, खाद्यान्न तथा चीनी के निर्यात में वृद्धि हुई है। मई–जून 2020 के महीनों में कृषि निर्यात में भारी उछाल आया और पिछले वर्ष की तुलना में इन महीनों में निर्यात में वृद्धि हुई। कोविड–19 बंदी की पहली लहर के दौरान विभिन्न रबी फसलों के बाजार मूल्यों में काफी स्थिरता देखी गयी और अनुमान के अनुरूप मूल्य में बढ़ोत्तरी हुई।

प्रमुख अनाजों के दृष्टिकोण मॉडलिंग के एक अध्ययन में चावल उत्पादन का अनुमान वर्ष 2020–21 में 118.5 मिलियन टन से बढ़कर वर्ष 2030–31 में 138.9 मिलियन टन लगाया गया है, इसमें पूर्वी एवं उत्तरी क्षेत्रों का प्रमुख योगदान होगा। राष्ट्रीय स्तर पर चावल की कुल अनुमानित माँग (जिसमें भोजन, चूनी तथा औद्योगिक माँग शामिल हैं) वर्ष 2020–21 में 103.88 मिलियन टन से बढ़कर वर्ष 2030–31 में 122.0 मिलियन टन होने की संभावना है। उत्पादन दर अनुमानित माँग दर से थोड़ा ज्यादा है। इसलिए आगामी वर्षों में शुद्ध व्यापार क्षमता 13.9 मिलियन टन से बढ़कर 17 मिलियन टन होने की संभावना है।

अन्य गतिविधियाँ

प्रतिवेदन अवधि के दौरान संस्थान के प्रकाशनों की संख्या में महत्वपूर्ण सुधार हुआ है, जिसमें 61 समीक्षित अनुसंधान पत्र, 5 नीति पत्र एवं नीति संक्षेप, 5 पुस्तकें और विशेष रिर्पोट और 19 पुस्तक अध्याय शामिल हैं। इसके अतिरिक्त, कई लोकप्रिय लेख, कार्य पत्र/चर्चा पत्र और समाचार पत्रों में लेख प्रकाशित किये गये तथा सम्मेलन प्रस्तुतियाँ दी गयी। संस्थान में कृषि विकास रिर्पोट का नियमित प्रकाशन शुरू किया गया है।

अनुसंधान के अतिरिक्त, संस्थान ने विभिन्न विषयों पर अन्तर्मंत्रालयी समितियों जैसे कि किसानों की आय दोगुनी करने, बाजार सूचना तथा वस्तुओं की कीमत स्थिर रखने, आदि को नीति संबंधी तकनीकी जानकारी मुहैया करायी है। फसल बीमा, सूक्ष्म सिंचाई, उत्पादन कारकों की कीमतों, तथा अनुसंधान एवं विकास प्रयोगशालाओं के आकलन पर

नीतिगत जानकारी सुलभ करायी है। संस्थान ने पंजाब, हरियाणा, उत्तर प्रदेश एवं दिल्ली राज्यों में फसल अवशेषों के प्रबंधन संबंधी जानकारी मुहैया करायी है। इसके अतिरिक्त संस्थान ने रसायन एवं उर्वरक मंत्रालय को भारतीय उर्वरक कम्पनियों द्वारा कच्चे माल की प्राप्ति के लिए नीति निर्धारण एवं विचार–विमर्श में सहयोग किया।

भा.कृ.अनु.प.–निआप कृषि एवं किसान कल्याण विभाग का एक ज्ञानपरक साझीदार है और इसके द्वारा देश में बाजार सूचना एवं मूल्य पूर्वानुमान प्रणाली के विकास हेतु संस्थागत प्रयास किया जा रहा है। संस्थान द्वारा कृषि एवं किसान कल्याण विभाग के तहत कार्यान्वित कृषि आर्थिकी अध्ययन केन्द्रों की समीक्षा की एवं परिषद् की परिणाम समीक्षा समिति को सहयोग एवं सुविधा प्रदान की गयी।

संस्थान ने प्रतिवेदन वर्षावधि 2020–21 में समसामयिक मुद्दो पर कार्यशालाएं/प्रशिक्षण कार्यक्रमों के आयोजन के साथ–साथ क्षमता निर्माण में सहयोग प्रदान किया। संस्थान द्वारा 'भारतीय आर्थिक सेवा' के अधिकारियों हेतु एक विशेष अभिविन्यासी कार्यक्रम (ओरिएन्टेशन प्रोग्राम) का आयोजन किया। प्रतिवेदन वर्षावधि के दौरान संस्थान की अन्य महत्वपूर्ण गतिविधियों में वार्षिक दिवस, हिन्दी पखवाड़ा, अन्तर्राष्ट्रीय योग दिवस, सर्तकता जागरूकता सप्ताह, अन्तर्राष्ट्रीय महिला दिवस, अम्बडेकर जयंती, महात्मा गांधी की 150वीं वर्षगांठ, संविधान दिवस, स्वच्छता पखवाड़ा, किसान दिवस और कृषि विकास रिर्पोट 2020–21 पर वेबिनार के आयोजन शामिल हैं।

Executive Summary

The ICAR-National Institute of Agricultural Economics and Policy Research (NIAP) acts as a think tank of the Indian Council of Agricultural Research (ICAR) for agricultural policies. The ICAR-NIAP undertakes policy studies on contemporary agricultural development issues and makes persistent efforts in strengthening agricultural economics and policy research through capacity building programmes. The Institute also sensitizes and provides inputs to policy planners and the government about the strategy to address the challenges of agricultural development. The research is conducted under the three major themes:(i) Agricultural Growth and Development, (ii) Technology and Sustainable Agriculture, and (iii) Agricultural Markets and Trade. A brief account of research achievements and other activities undertaken by the Institute during the year 2020-21 is presented here.

Research Achievements

Agricultural Growth and Development

Under this theme focus was on sources and drivers of agricultural growth and transformation, non-farm employment, system diversification, impacts of COVID-19 on agriculture, target of achieving five trillion dollar economy, doubling farmers' income, and development of aspirational districts.

A study on Doubling Farmers' Income (DFI) has identified important sources of growth as improvement in crop and livestock productivity, resource use efficiency, increase in cropping intensity, diversification towards high value crops, improvement in real farm prices, and shift workers from farm to non-farm occupations. A baseline analysis of the Aspirational Districts was done to understand the socio-economic dimensions of farmers. The study found that cultivation was the principal source of income and landholding size had significant negative impact on shifting a farmer from cultivation to livestock. The farmers' income has increased due to credit support, participation in community organisations and non-farm income. The "mission mode" approach, e-governance, skill development, data based decisions and private investment are necessary for the growth and development of these districts.

Successive NSSO surveys during the last 24 years have revealed a consistent decline in agriculture labours in India. On the other hand, declining trend in cultivators is slowing down over time. Infact, number of male cultivators has increased between 2011-12 and 2017-18. This could be either due to limited capacity of non-farm sectors to absorb incoming workforce or effect of ongoing agricultural reforms raising their expectation about remunerative returns. The decline in the absolute number of agricultural workers (by 37 million) during the period 2011-12 to 2017-18 resulted in wage rise, which in turn, led to an upswing in the share of labour cost in cultivation. Nevertheless, with increasing mechanization and other technological innovations, agricultural sector has partly negated the effect of wage rise by reducing the labour use.

The assessment of occupation-wise employment revealed that non-farm employment in rural India has increased from 31.78 percent in 2011-12 to 41.33 percent in 2017-18. COVID-19 lockdown has resulted in a rise in unemployment and reverse migration across the states of India. The reverse migration has led to higher labour availability in migrant origin states. A quick study showed that during lockdown (first wave), labour cost for wheat harvesting and paddy transplanting in Punjab increased by 15 and 40 percent, respectively. It led to 1.1 percent and 4.6 percent change in the cost of production (A_1+FL) of wheat and paddy, respectively. Reverse migration did not affect labour wages in Bihar.

Due to the nation-wide lockdown to curb virus infection, per capita monthly food and non-food expenditures in 2020-21 are likely to decline by 4.98 to 21.24 percent and 7.69 to 32.79 percent, respectively depending on the pace of recovery in the economy. Within the food basket, cereals are likely to witness the lowest decline in consumption (2.32 percent to 9.89 percent), while higher decline is expected in fruits, non-veg items and milk. The interventions of government and civil society organisations are likely to reduce negative impact of lockdown on the consumption.

For achieving the target of five trillion dollar economy by the year 2024-25, agricultural output has to reach the level of one trillion dollar from the existing level of 0.39 trillion dollar (2018-19). The pre-requisites to achieve this target are: double digit growth rate in agriculture sector, diversification towards high value crops, investment in market and irrigation infrastructures, land reforms, promotion of agro- industries, adoption of Good Agricultural Practices for boosting exports, modernisation of supply chains, and ensuring inputs at affordable rates.

The evidences have revealed a reversal in the long run declining trend in calories intake in India. The study revealed that refinement in data collection on "Food Away From Home" in NSSO's household consumption survey has a positive effect on the trend reversal. Correcting for measurement errors in data collection have definite implications to understand diets and to design social welfare programmes. The nutrient demand analysis based on large-scale household-level data from 1993-94 to 2011-12, showed that people are shifting their dietary basket from staple foods towards other foods, particularly to dairy and animal-based foods. In addition, oils & fats, and miscellaneous foods and beverages, which are considered as unhealthy food, have witnessed a higher growth, particularly in rural areas over time.

Technology and Sustainable Agriculture

Studies under this theme focussed on impact of climate change on agriculture and adaptation strategies, impact of ICAR technologies, agricultural sustainability assessment, agroecosystem diversity and services, water management, efficient water use technologies, artificial intelligence in agriculture, and extension advisory services.

A study on "Impact of ICAR Technology" revealed significant contributions of the National Agricultural Research System to food security, sustainability and poverty reduction. Six ICAR technologies generated annual benefits ranging from Rs. 9.6 to 14.7 thousand crore and eleven technologies generated the annual benefits ranging from Rs. 1.2 to 4.7 thousand crore. The median rate of return on the past investments was 58.5 percent and it varied from 34.9 percent in the Eastern region to 80.5 percent in the Northern region during 1980-2008. The technology of estrus synchronization with one percent level of adoption can generate a net benefit of Rs. 506.74 lakhs annually, with an internal rate of return (IRR) of 27 percent. The study on impact of agricultural extension and advisory systems revealed that the young farmers used more IT tools to obtain information related to agriculture. Farmers, who are accessing information from at least one formal source, achieved significantly higher yield (11 percent).

A study on impact of climatic hazards on agricultural productivity highlighted that the negative impacts of climatic hazards can be mitigated to an extent through adaptation measures like irrigation, agricultural diversification, and rationalization of input use. The study on effects of climate change, especially effect of temperature rise, on cropping patterns showed that higher temperature negatively impacts crop yields, and the impact is larger in the plausible future climate scenarios. Under the representative concentration pathway (RCP) 4.5 emission scenario, crop yields may decline in the range of 1.8 percent to 6.6 percent in the medium term (2041–2060) and 7.2 percent to 23.6 percent in the long term (2061–2080).

The Climate Resilient Agriculture Index (CRA) was prepared to investigate climate resilience

across agro-climatic zones of India. High climate resilience was found in Western Coast Plains & Ghats (WCG), Trans- Gangetic Plains (TGP), Gujarat Plains & Hills (GPH), and Eastern Coast Plains & Hills (ECH). On the other hand, Bihar and parts of Uttar Pradesh (MGP) and Chhattisgarh, Jharkhand, and Odisha (EPH) were the least resilient to manage climatic stresses. Further, within the agro-climatic zones, wide variations were observed among the districts. To bring robustness in climate change adaptation planning, there is a need to develop suitable location-need-context specific interventions and policies that build the resilience of the agricultural system.

Efficient water management in agriculture is crucial for sustaining food security of ever-growing population. The prime causes of conflicts in water management are water scarcity, drought conditions, urbanizations, lack of peoples' participation, poor quality of water, high temperature and climate variability. Adoption of sprinkler irrigation systems in Rajasthan showed that among the adopters, medium farmers were the largest beneficiaries (29 percent), followed by small and semi-medium farmers (24 percent each). The micro-irrigation facility created was found to be utilized effectively in supplying critical irrigation to crops providing relatively better returns. A study conducted in the Bundelkhand region showed that drip irrigation system can increase yield by 40-130 percent in different crops, while ensuring water efficiency up to 65 percent.

The Composite Index of Agricultural Sustainability (CIAS) indicated that the Rajasthan is the least sustainable state followed by Indo-Gangetic Plain (IGP) states like Uttar Pradesh, Punjab, Bihar, and Haryana. The north-eastern state of Mizoram was the most sustainable followed by Manipur, Andhra Pradesh, Madhya Pradesh and Kerala. Agro-ecosystem diversity has the potential to address major challenges of ensuring food security, climate change, increasing population and sustaining agriculture. Agro-ecosystem diversity index revealed that Trans-Gangetic Plains of India has become highly specialized, making agriculture more vulnerable to numerous biotic and abiotic shocks.

A meta-analysis on the valuation of ecosystem services generated by watersheds showed that watersheds provide ecosystem services of about 11.54 t/ha/year soil retention, 1.94 meters of groundwater recharge, and 337 kg/ha/year carbon sequestration. The monetary value of all these ecosystem services provided by the watersheds in India is considerable. The watershed ecosystem services are found significantly better where people's participation is high.

The crop suitability index developed to explore optimum utilization of the available resources for sustainable agricultural production in the Bundelkhand region indicated that the farmers are not cultivating the crops based on suitability of biophysical and irrigation parameters (indicator of sustainability) rather based on socio-economic parameters. Thus, there is a need for creating awareness among the farming community and also implementing strategic price policy to expand the area under crops based on biophysical suitability. As districts of Bundelkhand are lacking one or the other crucial infrastructure for sustainable agriculture, there is a need to upgrade the same in the region.

Agricultural Markets and Trade

The theme of Agricultural Markets and Trade focused on the issues of international trade, value chain analysis of different food commodities, price volatility and transmissions, market integration and outlook modelling.

Agricultural exports from India have undergone significant change in terms of level and composition and diversification over the years. The export performance index indicated that rice, frozen bovine meat, cotton yarn, raw cotton, ginger, pepper and seed spices remained as highly competitive commodities. Crustaceans emerged as highly competitive during 2015-18. India became the largest

crustacean exporter in the world followed by Ecuador and Canada with USA emerging as single major export destination. Improving the competitiveness shall help in accelerating the Indian exports and strengthen its global presence. The study suggests that investment in R&D and use of innovative technologies are crucial to quality improvement and sustaining India's competitiveness in the long run.

Price transmission along the value chain of major pulses in Delhi confirmed that the upstream prices often dominated the downstream prices in the long-run. While in the short-run, both upstream and downstream prices are determined simultaneously. This phenomenon shall help in discovering prices in the vertical markets. The analysis on dairy value chains revealed that integrated production and processing system is the most profitable over the other systems which solely depend on either production or distribution. The success of this system is largely attributed to the vertical integration of different stages of milk value chain. The risk of contamination in milk could be minimised with ease of traceability at each stage.

The study on fish value chain showed that the industrial scalefishing (intense fishing) at large extent has been gradually shifted towards deep sea fishing. However, the productivity of oceans generally decreases with distance from the shore as well as water depth. The identified factors for declining performance of deep sea fishing for fishermen from Kerala are (i) high costs incurred in a fishing trip, (ii) lower fishing efficiency, (iii) limited fish hold capacity, (iv) the need to carry ice throughout the trip, (v) lack of on-board fish handling skills, (vi) under-pricing of landed fish, and (vii) high dependence of fishermen on informal credit sources.

The impact of COVID-19 lockdown on prices, market arrivals and international trade of agricultural commodities was analysed. In many essential commodities, both the arrivals and prices declined for a brief period during the lockdown, causing farmers to suffer from the reduced product monetization. Vegetable arrivals were affected the most during the lockdown and it declined up to 60 percent. Arrivals of onion and potato also declined drastically. The export of agricultural products got impacted to some extent in March 2020 and severely in the month of April (lockdown period in most of the countries), although export of non-basmati rice, foodgrains and sugar has increased in April. Agricultural exports rebounded in May and June months and were even higher than in the corresponding months of previous year for many of the commodities. The market prices of different Rabi crops prevailed during the first wave of COVID-19 lockdown period showed a fair amount of stability, and behaved consistently with the projected price.

The Outlook model for major cereals projected that rice production would be 118.5 million tonnes (Mt) and 138.9 Mt in 2020–21, and 2030-31, respectively, with the largest share of the eastern and northern regions. At the national level, the total demand for rice including food, feed and industrial demand is projected to grow from 103.88 Mt in 2020-21 to 122.0 Mt by 2030-31; the growth rate being slightly lower than the production growth. Hence,the net trade potential shall likely to increase from 13.9 Mt to 17 Mt during this period.

Other Activities

During the period under report, the Institute showed significant improvement in the number of publications, which included 62 peer reviewed research articles, 5 policy papers and briefs, 4 books and special reports, and 20 book chapters. Beside this, a number of popular articles, working/ discussion papers, and newspaper articles were published and conference presentations were made. The Institute also started publication of Agricultural Development Report on a regular basis.

Apart from research, ICAR-NIAP provided significant policy and technical inputs to Inter-Ministerial Committee of Doubling Farmers' Income, market intelligence and stabilization of commodity prices. Policy input was also provided on crop insurance, micro-irrigation,

input prices and assessment of R&D labs. ICAR-NIAP also provided input on in-situ management of crop residue in states of Punjab, Haryana, Uttar Pradesh, and Delhi. The Institute facilitated Ministry of Chemicals and Fertilizers in framing policy for overseas acquisition of raw material by the Indian fertilizer companies.

The Institute is a knowledge partner of Department of Agriculture, Cooperation and Farmers Welfare (DAC&FW) and undertaking a major programme to institutionalize the capacity for development of market information and price forecasting system in the country. ICAR-NIAP also conducted external review of the Agro-Economic Research Scheme of DAC&FW, and also facilitated outcome review of ICAR.

The Institute contributed to capacity building by organising more than 10 workshops and trainings on the topical issues in 2020-21. A special orientation program was conducted for the officers of the Indian Economic Service. Organization of 29th Foundation Day on 29th October 2020, celebration of Hindi Pakhwara, International Yoga Day, Vigilance Awareness Week, International Women Day, Ambedkar Jayanti Celebration, 150th Birth Anniversary of Mahatma Gandhi Ji, Constitution Day, Swachhta Pakhwara, Kisan Divas, and a webinar on Agricultural Development Report 2020-21 were some other important activities of the Institute during 2020-21.

CHAPTER 1

ICAR-NIAP: An Overview

Significant Research Achievements

Capacity Building

Policy Interactions

Research Outputs

Awards and Recognitions

Participation in Scientific Activities

Management Committee Meetings

Other Institute Activities

Personnel and Budget

ICAR-NIAP

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

The Indian Council of Agricultural Research (ICAR) has established the National Institute (formerly Centre) of Agricultural Economics and Policy Research (NIAP) in 1991. It is an institute of national repute committed to provide a leadership role in strengthening agricultural economics and policy research within the National Agricultural Research System (NARS). It is efficiently discharging the role of a think tank of ICAR in the area of agricultural economics and policy research, and provides credible research-based inputs to the Council to actively participate in policy debates and decisions. The Institute also provides regular technical and policy inputs to NITI Aayog, various ministries at the Centre and States and to other stakeholders to facilitate their policy decisions related to food and agriculture.

In last three decades, its contribution to growth of the discipline of agricultural economics in the country is significant. Expertise and research studies of the institute have made remarkable contributions in understanding contemporary issues and the challenges of Indian agriculture. It has ably guided the Council in prioritization of its research agenda to improve efficiency and equity in agricultural research. Specifically, the Institute has made notable contributions in the areas like the assessment of agricultural R&D, investment and subsidies, technological change, agricultural sustainability, diversification, domestic market reforms, international trade, institutional innovations, market intelligence, commodity outlook, prices, and demand forecasts. It strives to foster partnership to tackle common research problems and directs trajectory of agricultural growth through policy-oriented research and communications. Its vision and mandate are addressed through agricultural policy research, training and policy interface programs focusing 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, market and trade
2. Strengthening agricultural economics and policy research
    - Capacity development by facilitation, networking and dissemination of information
    - Enhancing ICAR participation in policy decisions through policy dialogue and institutional linkages.

Institute Activities

Research activities

The research activities of ICAR-NIAP are broadly covered under the following three major themes: (1) Agricultural Growth and Development; (2) Technology and Sustainable Agriculture, and (3) Agricultural Markets and Trade.

The theme Agricultural Growth and Development comprise structural transformation of agriculture, disparities in development, agricultural diversification, drivers of growth, farm and non-farm linkages for enhancing farmers' income, property rights, gender mainstreaming, and agriculture-nutrition-health linkages. Technology and Sustainable Agriculture theme includes policy studies on climate change, natural resources management and environment, risk in agriculture, valuation of environmental services, agro-climatic zonal planning, resource use efficiency, impact of agricultural technology, and performance evaluation of agricultural extension system. Agricultural Markets and Trade theme focuses on policy studies on market reforms, infrastructure development, mapping value chains, market intelligence, marketing efficiency, commodity outlook, price forecasts, price transmission, food quality and food safety, innovations in input markets, credits and farm services, agricultural trade pattern and international agreements. These themes are effectively addressed not only by its in-house research projects but also through

network projects involving interdisciplinary teams encompassing scientists of applied and basic sciences.

Capacity building

The Institute plays a pivotal role in strengthening capacity and human resources development in agricultural economics and policy research. Formal linkages among the institutions within and outside NARS are established through network projects. Besides these projects, it helps to exchange modern concepts and advanced analytical skills among the researchers on contemporary issues in agricultural economics and policy research. Capacity building workshops and trainings are regularly organized to keep pace with the new developments in the discipline.

Policy interface activities and communication

Faculty of ICAR-NIAP contributes to the policy formulation by participating in policy dialogues, debates and several committees of Central and State Governments. The Institute regularly publishes futuristic Policy Papers, Discussion Papers, and Policy Briefs on contemporary policy issues, which serve as a medium for constructive suggestions to research community and policy makers.

Organization and Management

The Director of ICAR-NIAP is advised and assisted by different committees and cells to manage research and other programmes of the institute.

Research Advisory Committee (RAC) comprising eminent professionals outside the ICAR system, ICAR officials and farmers' representatives, guides the institute in planning research thrusts and strategies. Besides, RAC also guides the institute in human resource development, approaches to improve policy dialogues and evaluation. Dr. H.K. Bhanwala, former Chairman, NABARD, is the Chairman of the present RAC which is constituted by the Council for three years (2020-2023). The functioning of the institute is supervised by the Institute Management Committee (IMC). Besides RAC and IMC, several internal committees and cells, including those mandated by ICAR, are operating for an efficient and decentralized management

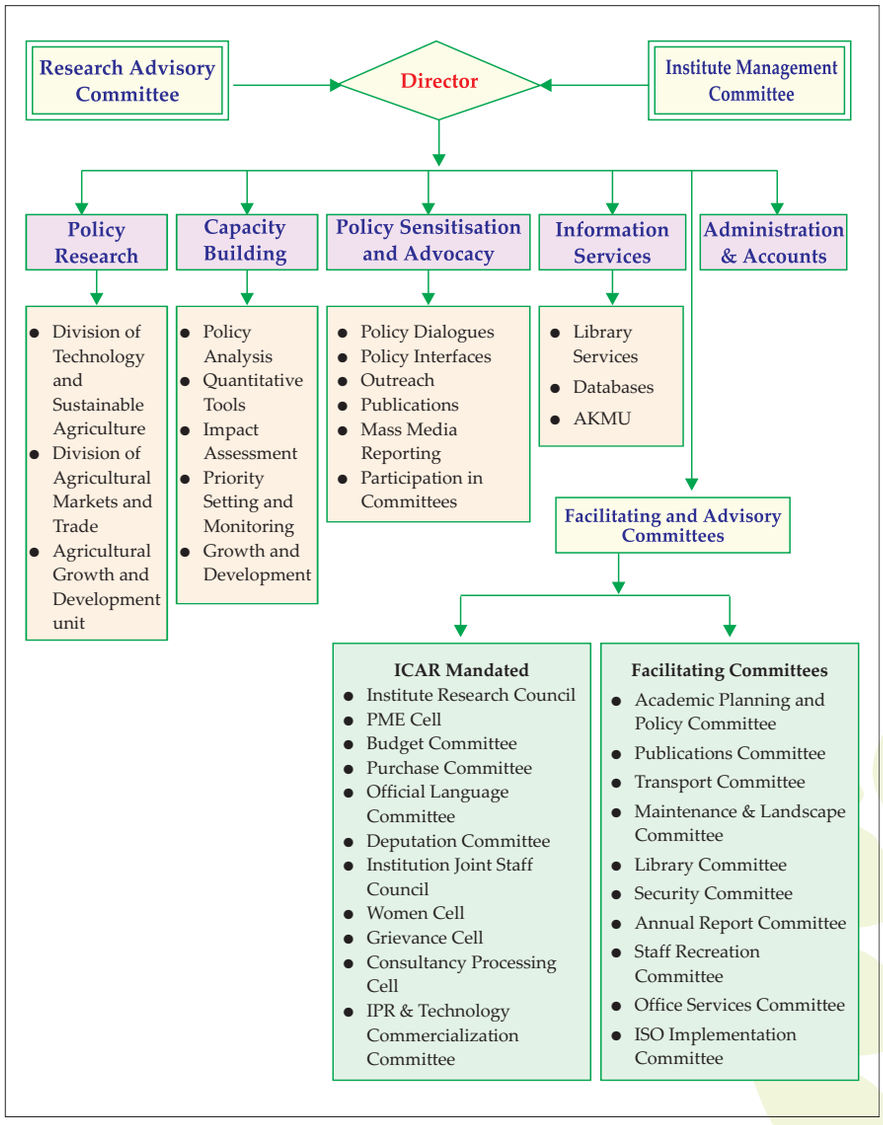


Figure 1.1. Organogram of ICAR-NIAP

of the Institute. The Joint Staff Council (JSC) enables consultatative decisions on promoting the interests of the staff. The Director conducts regular meetings with staff, mostly every month, to discuss scientific and management issues to elicit suggestions for the cordial functioning of the Institute. The organogram of the Institute is given in Figure 1.1.

Information, Data and Facilitating Services

Agricultural Knowledge Management Unit (AKMU)

Management of research information and products is done by AKMU. It also provides research related information through electronic and web modes. Its goal is to strengthen information management using modern technologies. The unit is also helping in implementation of IT reforms and management systems.

Library

ICAR-NIAP has a specialized collection of print, electronic and digital resources. Presently, the library subscribes Economic and Political Weekly (EPW) digital archives and data base www.indiastat.com. Library is conducting an innovative information literacy programme of J-Gate and Consortium for e-Resources in Agriculture for scientific fraternity. The library has 7,856 publications including books, journals, bulletins, CD ROMs, database publications, reports and 16 national journals. Institute's library has reserved a separate section for books of the official language (Hindi). The Library also acquired 21 gift publications. Library is playing an active role in timely dissemination of scientific and technical information for research via Document Delivery Service (DDS), Current Awareness Service (CAS), Newspaper Clipping Service, Resource Sharing Activities in other sister institute's libraries like IARI, IASRI. Inter-Library Loan facility on reciprocal basis from the CGIAR Centres like IFPRI, IWMI, CIMMYT, IRRI, ILRI is available at the Institute.

ICAR-NIAP website

The Institute website (www.niap.icar.gov.in) in English and Hindi, showcases the latest information and activities, particularly about its staff, infrastructure, research projects, publications, employment, tenders, RTI

Home page of ICAR-NIAP website (www.niap.icar.gov.in)

information and linkages. The website is hosted by Education and Research Network (ERNET), New Delhi, and is updated regularly. All publications, viz. Policy Papers, Policy Briefs, Working Papers, PME Notes, Workshop Proceedings, etc. of ICAR-NIAP are available on the website. More than 94,000 visitors from 145 countries across the world have visited the website.

AKMU is well equipped with the latest computers, servers, higher-end internet security firewall (Fort iGATE 301e), centralized antivirus server and analytical software like SPSS, STATA, LIMDEP, GIS, GAMS, Stella, E-Views and SAS. SQL server and Visual Studio facilities available with AKMU facilitate data management and in-house software development. NKN leased line of 100 mbps has been upgraded to 1000 MBPS to enhance quality and timeliness of network connectivity. All staff members of the Institute have been provided with the latest computers and software, LAN, internet and other required computational facilities. ICAR email system is being fully used by ICAR-NIAP staff for all official communications. AKMU maintains a video conferencing facility at the Institute. The management information system (MIS) modules developed by the Council like FMS, PERMISNET, PIMS, HYPM, etc are fully functional and maintained by AKMU.

Exhibition-cum-record room

Research and other accomplishments of the Institute are displayed and documented in Exhibition-cum-record room. It displays all research documents, ICAR-NIAP publications, annual reports and publications of scientists, recognitions and awards received by the Institute and the scientists. The memories of all important events organized by the Institute are displayed in photo gallery.

Agricultural Knowledge Management Unit at ICAR-NIAP

Management Information System (MIS)

A Centralized Enterprise Resource Planning (ERP) system solution developed for the entire ICAR is fully functional at ICAR-NIAP. The system includes solutions for financial management, project management, material management, human resource management and payroll. Various functionalities provided by these modules are as follows:

a) **Financial management:** Solutions for General ledger, Account Payable, Account Receivable, Cash Management, Fixed Assets Management, Budget Management and grants.

b) **Project management:** Scope for Project Information, Costing, Project Documents, and Contract Management and Collaboration of Project documents.

c) **Material management:** Solutions for Purchase and Inventory Management.

d) **Human resource:** Employees Information, HR Policies, Leave Management, Performance and Appraisal System.

Snapshot of MIS and FMS in ICAR

e) Payroll system: Salary, GPF, Pension Payment, Retirement Benefit Calculation and Income Tax Calculation Solutions for all the employees.

Human Resources

The staff position at ICAR-NIAP during the year 2020-21 is given in Table 1.1.The scientific cadre strength has been increased to 30 and two positions of heads of the division have been created.

Table 1.1. Staff position at ICAR-NIAP during 2020-21

Name of the Post	Sanctioned strength	In position	Vacant
R.M.P	1	1	0
Heads of Division	2	0	2
Scientific	28	28	0
Technical	5	5	0
Administrative and Supporting Staff	14	10	4
Total	**50**	**44**	**6**

ISO 9001:2015 Certification

ICAR-NIAP operates a quality management system, which complies with the requirements of ISO 9001:2015. ISO 9001:2015 certifies the Institute's ability to provide research and policy inputs on economic aspects of agriculture to the stakeholders and capacity development on agricultural economics and policy research.

CHAPTER 2

ICAR-NIAP: An Overview

Significant Research Achievements

Capacity Building

Policy Interactions

Research Outputs

Awards and Recognitions

Participation in Scientific Activities

Management Committee Meetings

Other Institute Activities

Personnel and Budget

Network projects	**: 03**
Externally funded projects	**: 05**
Institute funded projects	**: 18**
Consultancy/Contract projects	**: 04**
Agricultural Growth and Development	**: 13 studies**
Technology and Sustainable Agriculture	**: 20 studies**
Agricultural Markets and Trade	**: 14 studies**

Theme I

AGRICULTURAL GROWTH AND DEVELOPMENT

Excerpts

- Indian agriculture is diversifying steadily. The share of livestock in total agricultural output has risen from 22% to 29%, and within the crop sector, the share of horticulture has increased from 32% to 36% between 2011-12 and 2019-20.

- Higher public and private investments in agriculture and an allied sector-oriented growth strategy have enhanced agricultural productivity. The impact of private investment on agricultural productivity has been relatively higher than public investment because of its higher multiplier effect.

- For achieving the target of 5 trillion dollar economy by 2024-25, agriculture sector should grow at around 10%. Diversification towards high value crops, development of rural infrastructure and risk management, land reforms and irrigation development, investment in market infrastructure, agro-industries, adoption of Good Agricultural Practices in agriculture for boosting exports, modernisation of supply chain, flow of technology and inputs at affordable prices are necessary.

- To double the farmers' income, capital channelization has increased in agriculture and emphasis has been given to farmers' credit needs and productivity gains in crops like pulses, oilseeds and nutri-cereals and agricultural export promotion.

- Transforming aspirational districts is important for sustainable and inclusive growth. A 'mission mode' approach is required for meeting the requisite growth and development, and promoting private investment will be critical in these districts. Integrated efforts of diverse stakeholders and institutions would be the key to address the local needs and synergising the development initiatives.

- Modellig of consumer behaviour revealed that due to COVID-19 led lockdown, the non-food household expenditure may decline by 7.69% and 32.79%, whereas food expenditure may shrink by 4.98% to 21.24% during 2020-21 (over the base year 2019-20) depending upon the speed of recovery in the economy. Within the food basket, decline in consumption shall be the lowest for cereals (2.32% to 9.89%).

- The study on nutrient use across food categories using nationally representative large-scale household-level data from 1993-94 to 2011-12, found that the shares of cereals and fruits and vegetables have declined, while the shares of pulses, meat, milk and oils & fats have increased. Unhealthy food categories such as oils & fats, and miscellaneous foods & beverages have witnessed a higher growth in rural areas than urban areas over time.

- The evidences have revealed a reversal of the long-run declining trend in caloires intake in India. Refinement in data collection on food consumed away from home (FAFH) is found to have a positive effect on the trend reversal. The finding shall have implications on designing social welfare programs.

- The number of farmers insured under PMFBY has increased from 562.7 lakhs in 2016-17 to 590.2 lakhs in 2020-21. The farmers benefitted are about 31.4 percent of total insured farmers. The risk intensity (variability) in crop yields is lower in the states with assured irrigation and better infrastructure facility.

Agricultural Growth and Transformation: Sources and Drivers

Suresh Pal, Balaji S.J. and Subash S.P.

Sources of agricultural growth

The agriculture sector grew at annual Indian agriculture is rapidly transforming. The agricultural productivity is consistently rising, and the contribution of high-value commodities is increasing faster. In less than a decade (2011-12 to 2019-20), the share of livestock sector in total agricultural GVA has risen from 22% to 29%, and within the crop sector, the share of horticulture has increased from 32% to 36%. The livestock and fisheries sectors have grown by 7.6% and 9% a year respectively, during this period. The crop sector grew only by 1.3%, and horticulture, especially the fruits and vegetables, and pulses have been the major sources of growth in this sector. Among the states, Madhya Pradesh, Tamil Nadu, Rajasthan, and Andhra Pradesh have contributed significantly to the growth of livestock sector. In fisheries sector, the contribution of Andhra Pradesh, Madhya Pradesh, and Odisha has been substantial.

Crop sector growth has been more than 3% a year in Madhya Pradesh, Andhra Pradesh, and West Bengal, and between 2-3% in Assam, Chhattisgarh, Karnataka, Uttar Pradesh, and Gujarat during 2012-20. To some extent, the spread of technologies such as micro-irrigation has played a crucial role in ensuring growth in this sector. More than 12 million hectares of land is under micro-irrigation in the country. Five states, namely Rajasthan, Andhra Pradesh, Maharashtra, Karnataka, and Gujarat cover 75% of drip irrigation and 69% of sprinkler irrigation and make a substantial contribution to the crop sector. At the national level, investment (public & private) in agriculture has grown by 6-8% a year during 2018-20 and a positive growth is expected in the coming years, which shall further enhance farmers' investment in improved technologies and high-value agriculture. Improvement in institutional lending shall support the private investment. With the recovering economic growth and household income, market-driven growth of high-value agriculture shall increase.

Drivers of agricultural transformation

Structural change theories describe relative decline of agricultural output and employment as a common feature of development in a nation. The Indian agriculture has transformed in a similar fashion but with notable differences among the states. The rate of transformation had been dissimilar, conditioned by a set of factors specific to states or regions with similar development patterns. To understand major sources of transformation in agriculture, a simultaneous equations model was developed using panel data covering 20 major states for the period 2005-2019 and solved with the three-stage least squares (3SLS) method. A number of alternative systems were specified and tested for robustness. The results show that the factors of relative wage differential, terms of trade, capital intensity, and technology have expedited structural transformation during the study period. Higher public and private investments in agriculture and an allied sector-oriented growth strategy have enhanced agricultural productivity in the states. The impact of private investment on agricultural productivity has been relatively higher because of its higher multiplier effects. This signifies the need for enhancing on-farm capital assets in agriculture, for which access to institutional credit is essential. Improvements in governance have increased institutional credit access, and its impact was reflected by a significant and positive impact of law and order on on-farm capital investment.

Despite lower returns, public investment acts as a precursor for private investment. A rise in public investment was found to increase the private investment, necessitating the need for raising the Government's capital expenditure in agriculture for inclusive growth. Interestingly, the extent to which such capital shall be met out was found to be affected not by the expenditure incurred on farm subsidies but to be determined with the states' total revenues from both tax and non-tax sources, for which development in nonfarm sector is necessary. Favorable terms of trade in agriculture was the other factor

to enhance the Government's investment in agriculture.

Rural Non-Farm Sector in India : Trends, Structural Changes, Farm Sector Growth and Poverty Linkages

Subash, S.P., Md. Ejaz Anwer, Prem Chand and Balaji, S.J.

The study assessed the impact of the shift of households to rural non-farm sector on reduction in poverty. The study compared the poverty-level of households employed in different occupations; self-employed in agriculture, self-employed in non-agriculture, wage and salaried employment, casual labour in agriculture, casual labour in non-agriculture and other employment. The comparison of poverty-level across these households provides insights on the status of the employment pattern in the development process. The study used National Sample Survey Office - Employment and Unemployment Survey (NSSO-EUS) 2011-12 and Periodic Labour Force Survey (PLFS) 2017-18 to estimate the employment rates of the households. The estimates from the two rounds of data have shown that the extent of non-farm employment as principal status in rural India has increased from 37.18 percent in 2011-12 to 41.33 percent in 2017-18 (Figure 2.1).

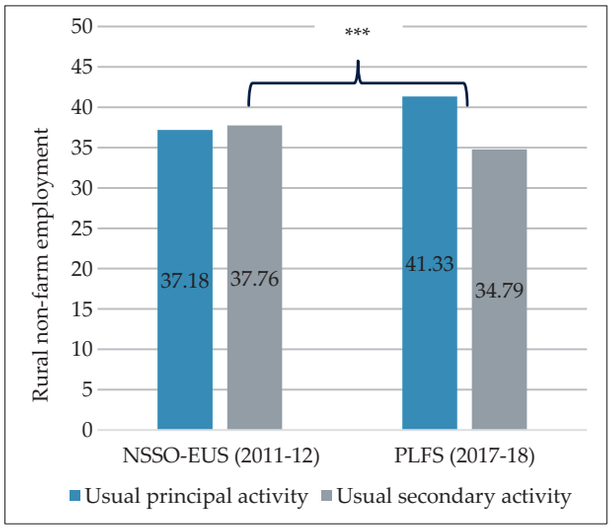


Figure 2.1. Rural non-farm employment by occupational status

Note: *** Significant at 1% level.

Source: Calculated using NSSO 2011-12 Employment and Unemployment Survey and PLFS 2017-18 data.

The study showed that the poor may be pushed into casual non-farm activities rather than being pulled into other high return non-farm sectors due to lack of opportunities in the agricultural sector. Comparing the households across employment types after controlling for other factors using treatment effect models {Regression Adjustment (RA), Inverse Probability Weighted (IPW), and Inverse Probability Weighted Regression Adjustment (IPWRA)} shows that compared to households self-employed in agriculture, self-employed in non-agriculture and regular wages are better off, while the households employed as casual labour in agriculture and non-agriculture are worse off (Table 2.1). The results implied that the increase in non-farm employment could be distress-driven. For the development of rural sector, policymakers must stimulate rural economies with robust investment in capacity building. Along with the poverty reduction programmes, targeted efforts should be made to pull the casual workforce out of poverty.

Table 2.1. Impact of household employment on poverty

Comparison	Poverty (ATE score)$		
	RA	IPW	IPWRA
Self-employed Non-Agri vs Self-employed Agri	-0.100***	-0.094***	-0.093***
	(0.006)	(0.006)	(0.006)
Regular Wage vs Self-employed Agri	-0.116***	-0.104***	-0.105***
	(0.006)	(0.006)	(0.006)
Casual Labour Agri vs Self-employed Agri	0.111***	0.124***	0.131***
	(0.009)	(0.011)	(0.011)
Casual Labour Non-Agri vs Self-employed Agri	0.022***	0.021***	0.024***
	(0.007)	(0.008)	(0.008)
Others vs Self-employed Agri	-0.030*	-0.184***	-0.126**
	(0.017)	(0.058)	(0.055)

Note: Figures in parentheses are robust standard errors; ***,**, and * indicate significance at 1%, 5 %, and 10% levels respectively; $Average Treatment Effect on the Treated (ATE) is the mean difference between the comparison groups.

Source: Estimated by the authors based on PLFS 2017-18 data

Changing Agricultural Labour Market and its Effect on Farm Economy in India

S.K. Srivastava, J. Singh, N.R. Kumar, N. P. Singh and N. Ahmad

Long-run trends in estimated agricultural workforce and labour use in crop cultivation

Table 2.2 presents changes in the estimated agricultural workforce during 1993-94 to 2017-18. The sub-period 1993-94 to 2004-05 witnessed an increase in agricultural workforce (usual status) by 25 million at annual growth rate of about one per cent. The size of agricultural labour did not increase and incremental agricultural workforce during this period was only due to increase in the cultivators. The subsequent period till 2011-12 witnessed an unprecedented decline in the absolute number of agricultural workers by 37 million at annual growth rate of 2.09 per cent. The decline in agricultural workforce was due to withdrawal of both cultivators and labours, particularly female workers. The annual rate of withdrawal of female workers was more than 4 per cent in both cultivator and labour categories.

During the recent period 2011-12 to 2017-18, withdrawal from agriculture accelerated and another 30 million agricultural workers left agriculture. The withdrawal from agriculture sector during the recent years was primarily led by agricultural labours, while the withdrawal by cultivators decelerated. The growth rate in the decline in the female agricultural workers accelerated to 5.04 per cent during recent period as compared to 4.35 per cent during previous period. Interestingly, male agricultural labours declined at historically highest rate of 7.21 per cent per annum during the latest period. Thus, successive NSSO surveys during the last 24 years have revealed consistent declining trend in agricultural labours in the country. On the other hand, declining trend in cultivators is slowing down over time. In fact, the number of male cultivators has increased between 2011-12 and 2017-18. This could be either due to limited capacity of non-farm sectors to absorb incoming workforce or effect of ongoing agricultural reforms raising their expectations about remunerative returns.

Table 2.2. Changes in agricultural workforce (usual status) in India during 1993-94 to 2017-18

Period	Cultivators			Agricultural Labours			Agricultural Workers		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
Absolute numbers (million)									
1993-94	90	56	146	58	40	97	148	96	244
2004-05	101	72	172	57	40	96	157	112	269
2011-12	99	52	151	51	29	80	150	82	232
2017-18	109	39	148	33	21	54	142	60	202
Compound growth rate (%)									
1994-2005	1.10	2.49	1.64	-0.17	0.00	-0.12	0.62	1.52	0.97
2005-2012	-0.29	-4.44	-1.88	-1.43	-4.38	-2.56	-0.68	-4.35	-2.09
2012-2018	1.75	-4.92	-0.38	-7.21	-5.02	-6.43	-0.90	-5.04	-2.29

Data source: Authors' estimates based on NSSO estimates on activity-wise distribution of workers and census population

Effect of withdrawal of agricultural labours on farm economy

A perusal of Table 2.3 reveals that average labour use in crop cultivation declined by 8 per cent between 1993-94 and 2004-05. But despite reduction in labour use, labour cost at real prices increased by 14 per cent on account of 33 per cent rise in real wages. Incremental labour cost contributed 26 per cent of the total increase in Cost A_1+FL during this period. Nevertheless,

the share of labour in Cost A_1+FL reduced from 41.3 per cent in 1993-94 to 38.4 per cent in 2004-05 due to relatively higher increase in cost of other factors of production. The subsequent period till 2011-12 witnessed significant rise in real labour wages which resulted in 45 per cent increase in labour cost (despite decline in labour use). This inflated real cost A_1+FL by 82 per cent and the share of labour in cost increased to 46 per cent by the year 2011-12. Interestingly, decline in the labour use accelerated during the latest period 2011-12 to 2016-17 which negated the effect of rising wages on labour cost.

Table 2.3. Changes in average labour use and cost of cultivation of major crops during 1993-94 to 2016-17

Year	Average labour use (Hrs/ha)			Average real labour cost (Rs/ha)	Average real labour wages (Rs/hr)	Average real cost A1+FL (Rs/ha)	Share of labour cost in cost A1+FL*
	Male	Female	Total				
Absolute numbers							
1993-94	455	246	701	4367	6.2	10585	41.3
2004-05	419	223	642	4971	7.7	12938	38.4
2011-12	412	220	632	7205	11.4	15651	46.0
2016-17	366	189	555	7218	13.0	15705	46.0
Growth rate (%)							
1994-2005	-0.89	-1.13	-0.97	1.30	2.10	2.03	-
2005 -2012	-0.26	-0.15	-0.22	5.45	5.82	2.76	-
2012-2017	-2.34	-2.99	-2.56	0.04	2.67	0.07	-

*at current prices

These evidences indicate that despite the reduction in labour use in crop cultivation, labour cost could not be reduced during the past 24 years. This phenomenon is explained by the inelastic nature of demand of labour in crop cultivation. The estimated price elasticity of labour demand was negative and less than one in all the selected crops with the average value of -0.21. This implies that in the situation of wage rise, labour use in crop cultivation reduces less than proportionately resulting in rising labour cost. As the magnitude of reduction in labour use is insufficient to negate the wage-push cost inflation, it is necessary to promote farm mechanization and improve its economic access to farmers through institutional innovations (eg. custom hiring centres).

Doubling Farmers' Income in India

Suresh Pal, Raka Saxena, Balaji S.J., and Ranjit K. Paul

The Government of India is committed to double the farmers' income by 2022 and a number of strategies are currently employed to realize the target. The Government is considering 2015-16 as the base year for tracking farmers' income. Seven sources of growth, viz. improvement in crop and livestock productivity, resource use efficiency, increase in cropping intensity, diversification towards high-value crops, improvement in real prices received by farmers, and shift from farm to non-farm occupations have been identified. ICAR-NIAP is the knowledge partner of the Department of Agriculture, Cooperation and Farmers Welfare and has worked closely in formulating the DFI strategic framework and facilitated the implementation of the strategies.

The Government has made serious efforts to double the farmers' income. Capital channelization into the agriculture sector is picking up as evident from higher budgetary allocation, mobilization of non-budgetary resources, enhancement in institutional credit and incentivizing corporate investments. Special credit needs of the smallholders are given due emphasis. It's evident that the disbursal of farm credit has exceeded the targets in recent years.

The Government has announced Rs. one lakh crore to finance agricultural infrastructure projects. This will help in creating affordable and financially viable post-harvest management infrastructure at the farm gate and aggregation points. Further, Rs. 500 crore has been allocated to extend the Operation Greens scheme to cover all fruits and vegetables, which currently covers three most price volatile commodities, namely tomato, onion, and potato (TOP).

Strong emphasis is given on productivity-based gains with specific focus on crops like pulses, oilseeds, and nutri-cereals. Technological innovations coupled with favourable policy environment have already resulted in a substantial increase in pulses production in the country. A roadmap for oilseeds for bridging the deficit in domestic edible oil production is also underway. Oilseeds production of 27.5 million tonnes and the productivity of 1,075 kg/ha (2014-15) has increased to 32.3 million tonnes and 1,265 kg/ha, respectively (2018-19). Edible oil production has increased from 9.8 million tonnes (2014-15) to 12.9 million tonnes (2018-19). The area under horticulture crops has increased under the Mission on Integrated Development of Horticulture. Diversification towards high-value crops is producing encouraging results. There has also been an increase in cropping intensity. For effective risk management, Pradhan Mantri Fasal Bima Yojana (PMFBY) was launched in 2016 providing insurance cover for all stages of the crop cycle, including the post-harvest risks in specified instances.

There had been a positive impact of micro-irrigation on crop productivity, water conservation, resource use efficiency, and cost reduction; and of soil health card and neem coated urea on the productivity and cost reduction. Funds are allocated to strengthen e-NAM (National Agriculture Market) and GrAMs (Gramin Agriculture Markets). A separate Agricultural Infrastructure Fund (AIF) has been created to build agri-logistics. Several market reforms have been rolled out for strengthening backward and forward linkages and ensuring remunerative prices to the farmers. Recent reforms include a) The Farmers Produce Trade and Commerce (Promotion & Facilitation) Act, 2020; b) The Farmers (Empowerment & Protection) Agreement on Price Assurance and Farm Services Act, 2020; and c) amendments to the Essential Commodities Act, 1955. Enhancing agricultural exports also remains a thrust agenda and the Agri-Export Policy targets to double the agricultural exports by 2022. This envisages an export to the tune of USD 60 billion by 2022. The exports have increased significantly during 2020 despite the pandemic-related restrictions and impacts. These aim at enhancing farmers' income through improved price realization, reducing price risk, and strengthening agricultural supply chains.

ICAR-NIAP is continuously providing support in preparing the index of "Ease of Doing Agriculture" to DAC&FW. In light of the new policy aiming to increase India's agricultural exports to USD 60 billion by 2022 and USD 100 billion in the next few years with a stable trade policy regime, ICAR-NIAP is working on potential agricultural commodities for enhancing incomes. Sectoral analysis is also underway to tap the agri-export potential. Further, the development strategies for transforming 'aspirational districts' are also being studied for prioritization and effective implementation of DFI strategies.

Transforming Aspirational Districts

Suresh Pal, Raka Saxena, Balaji S.J. and Vinita Kanwal

The Government of India has undertaken 'Transformation of Aspirational District' program to expeditiously improve the socio-economic status of 117 districts across 29 states and seven Union Territories of India. These districts are identified based on six broad parameters i.e. health and nutrition, education, agriculture and water, financial inclusion, skill development, and basic infrastructure. The study developed a baseline ranking of 117 districts and attempted to understand socio-economic dimensions of farmers in these districts related to asset holding, productivity, governance, institutions, and markets. Notably, the role of agricultural diversification was studied and the importance of off-farm income was analysed. As the household income varies

significantly across the aspirational districts, the study delineated (two) homogenous zones based on various parameters such as irrigation intensity, cropping intensity, rural literacy, credit availability and rainfall distribution etc.

Multiple attributes govern the households' choice to shift away from traditional cultivation to various allied and non-farm occupations: the factors that affect the relative return and risk of agricultural production and others, determine the capacity to participate in various non-farm activities. A farmer with a large land size is expected to engage in cultivation and reap the benefits of economies of scale while the small landholders looking for alternate income sources. The results showed more than 80% of the households having access to subsidised food in both the regions. A majority of them engaged in cultivation as the principal source of income. The landholding size had significant negative impact on the probability of shifting from cultivation to livestock in both the typologies implying that the households with large land tend to have cultivation as the primary income source. Non-farm business enterprises offer vast scope in income enhancements.

Transforming the aspirational districts is important for the country's sustainable and inclusive growth. A 'mission mode' approach is required for the requisite growth and development of these regions. Promoting private investment will be critical in developing the aspirational districts. Integrated efforts of diverse stakeholders and institutions would be the key to address the local needs and synergising the development agenda. Governance and institutions should continue to reduce crime, poverty, and unemployment. E-governance and data-based decisions would be critical in improving the system's capacity to participate in overall economic development. Formal training in agriculture may incentivise the farm households to remain in cultivation and create impacts in the long run. Skill development in agriculture needs to be given strong emphasis through an effective extension system and making use of various government schemes.

Agriculture and Food Policy for the Five Trillion Dollar Economy

Suresh Pal, S.K. Srivastava and Balaji S.J.

On August 15, 2019, Hon'ble Prime Minister of India shared the vision of making India the third-largest economy in the world by achieving the target of 5 trillion dollar economy by the year 2024-25. To achieve this target, agricultural output has to reach USD one trillion from the existing level of USD 0.39 trillion (2018-19). Agriculture, being a predominant employer (44.5% of the total workforce) and contributor to the economy (17.5%), assumes a critical role in meeting the target. Indian agriculture is heading towards commercialization which strengthens various direct and indirect linkages between the farm and non-farm sectors. Such linkages offer various income and employment opportunities in and around the agricultural sector and provide a fillip to overall economic growth. The development of agro-based industries is the expected pattern of structural transformation accelerating the process of commercialization. Value-added and processed food products, textiles, apparels, and leather products constitute 22.7 percent share in Gross Value Added from manufacturing (2016-17). Agriculture, as a supplier of raw-material, immensely contributes to the growth in agro-based industrial products in the country. There exists huge potential for value-addition and processing of farm products and therefore opportunities for investment (both domestic and foreign investment) and capitalizing its spill-over impacts on the overall economy. Similarly, rising use of purchased inputs (fertilizer, pesticides, farm machinery, and farm services) in agriculture provides an attractive market for the agro-input industry. Unleashing the potential of agriculture assumes priority in realizing the ambitious target of a 5 trillion dollar economy. The important requirements for realizing the target are doubling the agriculture sector growth through higher investments, diversification towards high-value crops, development of rural infrastructure and risk management, land reforms and irrigation development, investment in market infrastructure, agro-industries, adoption of

Good Agricultural Practices in agriculture for boosting exports, modernisation of supply chain, facilitating flow of technology and inputs at affordable rates and higher participation of women in decision making.

Conceptualizing Public - Private-Farmer Cooperation for Fostering Investment for Sustainable Agricultural Development

S.K. Srivastava and Suresh Pal

During the past six decades, agricultural productivity has improved significantly, leading to 2.4 times increase in per capita food production. Agriculture has also become more resilient and stable in the current decade. However, agriculture is relatively less remunerative as compared to non-farm sectors primarily due to the dominance of the crop sub-sector. Diversification towards livestock, fisheries, and commercial crops offers ample scope to raise returns from agriculture. Although Indian agriculture is gradually diversifying, its pace is slow due to several impediments.

During the past four decades, investment in productive assets in agriculture has increased at an annual growth rate of 5.39 percent. The value of gross fixed capital formation in agriculture at current prices was USD 49797 million in 2017-18. On a per hectare basis, it turns out to be low at USD 355. About three-fourth of the total investment is contributed by farmers. Recently, investment in agriculture by farmers has started declining which has led to stagnation in total investment in agriculture. Private corporations have recently started entering agriculture, but their share in capital investment is low (2%). The investment in agriculture is primarily absorbed in the crop sub-sector and it is desirable to diversify the investment portfolio towards other sub-sectors such as livestock, fisheries, etc.

Farmers, public and private entities have synergistic relationships. The approach of public-private-farmer cooperation (PPFC) recognizes the specific roles and unique expertise of these stakeholders in identifying emerging challenges and addressing them together. The priority areas to foster investment through PPFC include agricultural efficiency and productivity improvement, value chain development, market infrastructure development, climate risk, and natural resources management, and knowledge management in agriculture. PPFC recognizes the integration of R&D and extension systems to effectively disseminate technological innovations to the end-user.

Income Induced Effects on Food Consumption Pattern of Indian Households in the Context of COVID-19

S.K. Srivastava and N. Sivaramane

The study modeled consumer behaviour to simulate likely effect of income shocks on consumption pattern in the context of COVID-19 The estimated expenditure elasticities of food groups and non-food items are presented in Table 2.4. The elasticities varied across different commodities, implying a differential response of change in income on consumption. Among the food groups, cereals exhibited a positive but lowest expenditure elasticity (0.37). Thus, with the change in income, consumption of cereals will change but only marginally. Edible oils, pulses, and vegetables were relatively more elastic than cereals, but in case of change in income, consumption of these commodities will change less proportionately. For milk and non-vegetarian products, elasticity values were closer to one. Fruits and other foods exhibited higher expenditure elasticities implying that a change in income of the households will change the consumption of these commodities proportionately more. Overall, the average weighted (expenditure) elasticity of food is 0.80 (inelastic), implying food is a necessary item for the consumers. The expenditure elasticity is 1.23 for the non-food commodities.

Using these expenditure elasticities, the likely

Table 2.4. Likely change in income induced (due to COVID-19) consumption expenditure during 2020-21

Particulars	Expenditure elasticity	Pre-COVID consumption expenditure (2019-20): Rs/ capita/month	Change in consumption expenditure during 2020-21 (%)		
			Scenario 1	Scenario 2	Scenario 3
Cereals	0.37	238	-9.89	-4.65	-2.32
Pulses	0.53	67	-14.05	-6.60	-3.30
Milk	0.89	202	-23.62	-11.10	-5.54
Edible oils	0.42	78	-11.32	-5.32	-2.66
Non-veg	0.96	77	-25.56	-12.02	-6.00
Vegetables	0.58	100	-15.42	-7.25	-3.62
Fruits	1.25	32	-33.43	-15.71	-7.84
Other foods	1.29	256	-34.30	-16.12	-8.05
Food total	0.80	1048	-21.24	-9.99	-4.98
Non-food	1.23	1318	-32.79	-15.41	-7.69

Note: **Scenario 1:** With the same decline in PFCE observed during April-June; Scenario 2: With a gradual recovery in remaining quarters; Scenario 3: With a 100% recovery in remaining quarters

Source: Authors' estimates

effect of COVID-19 led decline in income on consumption was simulated for the year 2020-21 under three scenarios. Average per capita monthly consumption expenditure of Rs. 1,599/- was allocated among various food and non-food items in the year 2011-12. Between 2011-12 and 2019-20, general price level (CPI) in the country increased by 48 percent, which inflated consumption expenditure to Rs. 2,366/- for maintaining the same level (2011-12) of consumption in the year 2019-20. This was taken as the consumption expenditure in the baseline (pre-COVID) year 2019-20 and was allocated to food and non-food items based on the 2011-12 consumption expenditure pattern.

The overall decline in total consumption expenditure for the year 2020-21 is estimated to be 26.68 percent, 12.54 percent, and 6.36 percent under the first, second, and third scenarios, respectively. The decline in the non-food expenditure is estimated to range between 7.69 percent and 32.79 percent, whereas food expenditure is expected to squeeze by 4.98 percent to 21.24 percent during 2020-21 (Table 2.4). In absolute terms, per capita monthly non-food expenditure in 2020-21 will be Rs. 101 to Rs. 432 less than in the year 2019-20. The decline in absolute per capita monthly food expenditure is expected to range between Rs. 52 to Rs. 223. Within the food basket, cereals will witness the lowest decline in consumption (2.32% to 9.89%) as compared to the other food commodities. The decline in the consumption of high-value food commodities such as milk, non-vegetarian products, fruits, and other food products (beverages, dry fruits, processed food, etc.) will be comparatively higher than the staple foods such as like cereals, pulses, and edible oils.

The results suggest that the households will reallocate expenditure from non-essential to essential items. The share of non-food expenditure will decline, whereas on essential items like food will gain in their share in total expenditure. Within the food basket, commodities having inelastic demand will witness an increase in their share in the food budget. The interventions of governments (Central and State) and civil society organizations through various schemes, supplementary income and welfare measures are expected to reduce the COVID-19 led income-induced impacts in the economy. Overall strategy to revive the economy shall include demand push measures.

Impact of COVID-19 Pandemic on Employment and Migration in Rural India

Subash, S.P. and Jaya Jumrani

The study looked into the effect of COVID-19 pandemic on employment in India using the employment data provided by Centre for Monitoring Indian Economy (CMIE-Consumer Pyramids Survey) and migration data from the population census. The unemployment rates increased from 8.75% in March 2020 to 23.42% in April, which continued in May 2020 (23.48%). These two months coincide with the lockdown period. The unemployment rates declined later in June to the levels in the pre-lockdown period. As a result of the lockdown, there were reverse migrations. The study tracked the migration based on the total migration data provided by the Census. The study looked into the inter-state migrants (for less than one year) as it could be a proxy to capture the seasonal migration. The census data shows that out of the total rural to urban migration, 23.7% migrate for work, 29.6% for marriage, and 36.2% for house.

The study plotted the inter-state migration in major states using the Census 2011 data on migration (Figure 2.2). The major states (>70,000 migrants) by migrant origin are Uttar Pradesh, Bihar, Karnataka, Andhra Pradesh, Madhya Pradesh, Rajasthan and Gujarat. The major migrant destinations states are Maharashtra, NCT of Delhi, Gujarat, Haryana, Karnataka, Jharkhand, Uttarakhand, West Bengal, and Punjab. This reverse migration could have an effect on labour supply in

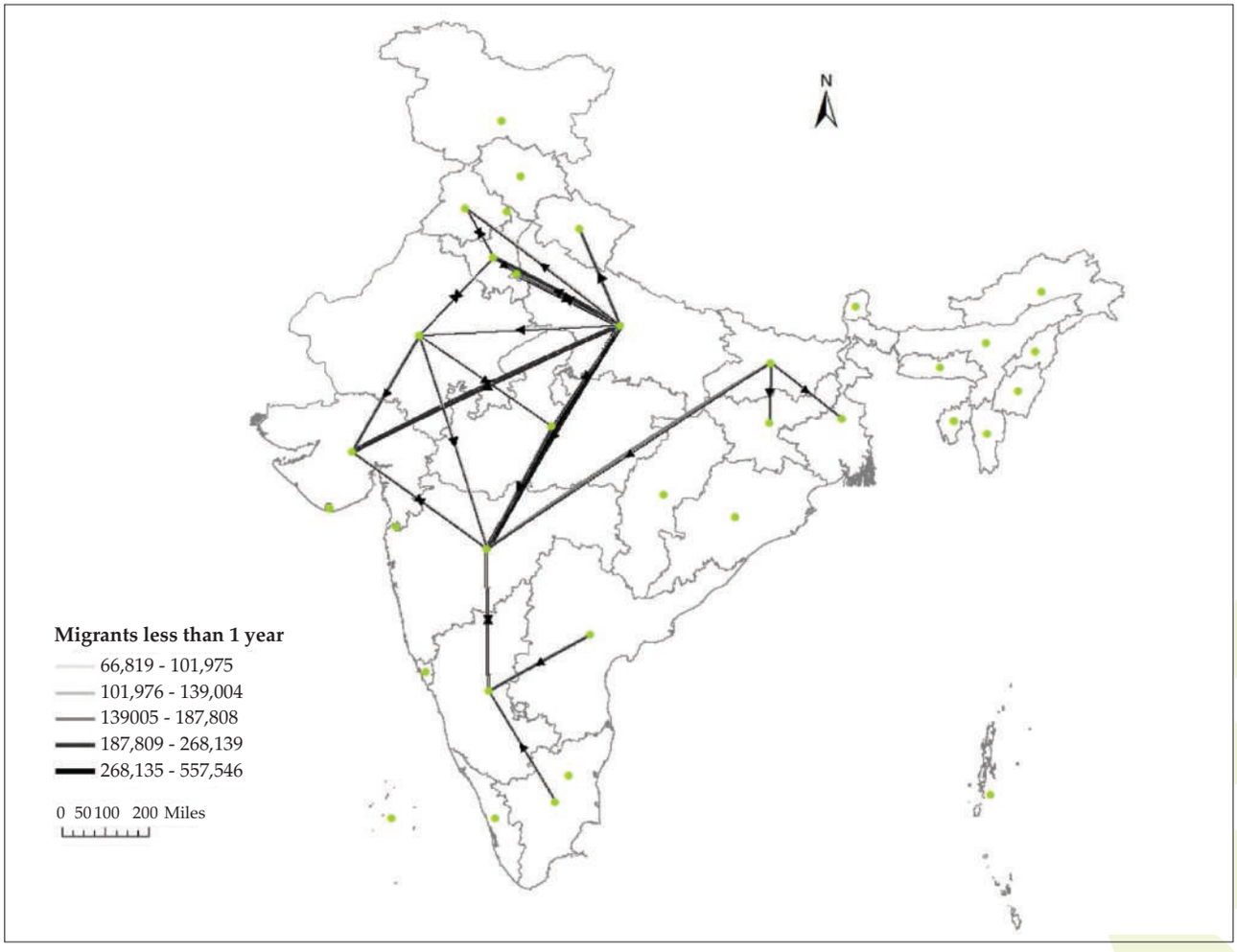


Figure 2.2. Inter-state migration among migrants less than 1 year (major states- migrants > 70, 000 migrants)

Source: Census data, 2011.

states like Haryana and Punjab. Farmers in these states have resorted to direct sowing of rice or two other crops such as cotton which requires lesser labour during sowing season. On the other hand, the migrant origin states are predominantly agriculture and the reverse migration coinciding with the agricultural season has led to higher labour availability, which is reflected as increased sowing area as reported by Ministry of Agriculture and Farmers Welfare. Unlike urban areas, rural areas were covered under the social protection mechanism for employment; Mahatma Gandhi National Rural Employment Act (MGNREGA) has reduced effect in rural unemployment due to migration.

Effect of COVID-19 Pandemic on Labour Supply and Farm Economy

S.K. Srivastava , J. Singh, N.R. Kumar, N.P. Singh and N. Ahmad

After the first case of COVID-19 was confirmed on January 30, 2020 in Kerala, the Indian Government announced a nationwide lockdown on March 24, 2020, for 21 days. Owing to the rising number of cases, the lockdown was further extended till May 3, 2020. As the period of lockdown coincided with rabi harvesting and kharif sowing seasons, agricultural activities (along with selected other essential services) were permitted with social distancing provisions. The labour-deficit states like Punjab where farmers primarily depend on contractual labour from outside the state for wheat harvesting and paddy transplanting faced labour shortages to carry out these operations due to inter-state movement restrictions. The farm-level observations revealed that labour scarcity resulted in 24.4 and 46.6 percent increase in wages for wheat harvesting and paddy transplanting in 2020 over the previous year. The effect of such wage rise on cost was ascertained using estimated price elasticity of labour and share of these operations in cost A_1+FL.

A perusal of Table 2.5 reveals that due to the wage rise, estimated labour cost for harvesting of wheat and transplanting of paddy increased by 15.62 and 40.54 percent, respectively, in Punjab. Multiplication of change in labour cost with its share in cost A_1+FL provides likely effect of COVID-19 led change in labour supply on cost of cultivation. The results show 1.1 per cent and 4.6 per cent change in cost A_1+FL for wheat and paddy, respectively. In absolute terms, it is Rs. 287 per hectare for wheat and Rs. 1,668 per hectare for paddy at 2016-17 prices. In case of Bihar, it was expected that reverse migration would positively contribute to farm economy by pushing wages downwards due to an increase in labour supply. However, farm-level observations revealed no change in wages as immigrating labour did not work at farms and preferred to work in public work programmes like Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS). Also, most of the labourers started coming back to urban centres as soon as lockdown was relaxed. Thus, disequilibrium in labour market created due to reverse migration did not show any effect on cost of cultivation in Bihar.

Table 2.5. Effect of COVID-19 on farm economy of Punjab and Bihar

State	Crop	Price elasticity of labour demand	Change in wages in 2020 (April-June) over 2019 (April-June) (%)	Change in labour cost (%)	Share of transplanting/ harvesting labour cost in costA_1+FL (%)	Change in costA_1+FL due to change in wages (%)
Punjab	Paddy	-0.13	46.6	40.54	11.4	4.6
	Wheat	-0.36	24.4	15.62	6.8	1.1
Bihar	Paddy	-0.18	Nil		13.9	-
	Wheat	-0.25	Nil		14.5	-

Source: Authors' estimation

Impact of COVID-19 Lockdown on Poverty

Jaya Jumrani and Subash S.P.

The rapid spread of coronavirus (COVID-19) pandemic around the globe has led to an unprecedented halting of almost all economic activities. The share of households and the incidence of poverty in rural and urban India as per different employment categories are provided in Table 2.6. Given that the latest poverty estimates are not available, the estimates for 2011-12 from the Consumer Expenditure Survey of the National Sample Survey Office (NSSO) have been used. About 13% rural and 12% urban households are employed as casual labour in the non-farm sector in 2011-12. In addition, there are 21% of households working as casual labour in agriculture in 2011-12, which reduced to 12% in 2017-18. The immediate short-run impacts of the lockdown were expected to be felt most among these casual workers. Here it may be noted that some small and marginal farmers and casual agricultural labour also work in the rural non-farm sector, and these may also be affected to the extent of employment lost. The incidence of poverty is high among these casual workers in rural and urban areas, which may further deteriorate if income loss is not compensated.

The study evaluated the impact on poverty (headcount ratios) due to the contractions in income, i.e. monthly per capita consumption expenditure (MPCE) under certain assumptions. Three scenarios have been assessed – low risk (5% contraction in consumption), medium risk (10% contraction), and high risk (20% contraction). In rural India, there are about 792 million people, of which 201 million reside below the poverty line. It is expected that there

Table 2.6. Employment categories and the incidence of poverty in India

Household Type	Share of households (%)		Poverty headcount ratio (%), 2011-12	5% hit - Poverty headcount ratio (%)	10% hit - Poverty headcount ratio (%)	20% hit - Poverty headcount ratio (%)
	2011-12	2017-18				
Rural						
Self-employed in agriculture	34.3	37.8	22	26	32	44
Self-employed in non-agriculture	15.5	14.3	19	23	28	40
Regular wage/ salary earning	9.6	12.7	11	13	16	24
Casual labour in agriculture	21.0	12.1	40	46	53	65
Casual labour in non-agriculture	13.5	12.9	33	38	44	57
Others	6.1	10.1	18	22	27	34
Overall	100	100	25	30	35	47
Urban						
Self-employed	35.3	32.4	15	18	21	28
Regular wage/ salary earning	41.7	41.4	7	8	10	15
Casual labour	11.8	11.8	33	36	40	54
Others	11.2	14.4	8	9	11	13
Overall	100	100	14	16	18	25

Note: State-level poverty line estimated using Tendulkar methodology for 2011-12 (GoI 2014).
Source: Authors' estimates based on Consumer Expenditure Survey data, 2011-12, PLFS data 2017-18.

will be an addition of around 37 million to 172 million poor people ranging across low-risk and high-risk scenarios. This might translate into an increase of headcount poverty ratio ranging from 30% to 47% across these scenarios. As expected, the proportion of people below the poverty line is lower among urban areas. About 43 million are found to be poor out of the total 317 million urban population. There will be an addition of around 7 million to 37 million urban poor people ranging across low-risk and high-risk scenarios. This might translate to an increase of headcount poverty ratio ranging from 16% to 25% in these three risk scenarios in urban India.

This increase in the incidence of poverty is subject to the condition of no income transfer or usual public distribution by the government. The Government, however, has taken several steps to support the agricultural and allied sector by exempting the sector from the lockdown restrictions, undertaking public distribution of foodgrains and direct cash transfers. The poverty impacts may thus act as a temporary shock and long-term impacts may occur through a lower rate of growth in other sectors. These poverty impacts shall have strong implications on the food and nutritional security of the population, particularly among the vulnerable sections such as children and women. One of the ramifications of the COVID-19 lockdown has been on the closure of schools that has led to the suspension of mid-day meals and supplementary nutrition programmes such as the Integrated Child Development Services Scheme.

Nutrient Demand Responsiveness in India

Jaya Jumrani

This study examined the patterns and trends in nutrient use across food categories and evaluated the demand responsiveness of nutrient intakes to changes in household income. Using the nationally representative large-scale household-level survey data on consumption expenditure from 1993-94 to 2011-12, the analysis found that the shares of cereals and fruits and vegetables have declined significantly, while the shares of pulses, meat, milk, and oils and fats have considerably increased during the period 1993-94 and 2011-12. This decline in cereals and horticultural products highlights that people are shifting their dietary basket from staple foods towards other foods, particularly dairy and animal-based foods. Unhealthy food categories such as oils & fats, and miscellaneous foods & beverages have witnessed a higher growth in rural areas than urban areas over time.

The estimates of parametric (Ordinary Least Squares (OLS) regression presented in Table 2.7 below suggest that the income elasticities for all three nutrients considered i.e. calories, protein and fats have declined for both rural and urban areas, and are marginally higher than the estimates obtained from other studies. Dairy products, meat, eggs & fish, and miscellaneous food products & beverages have elastic caloric demand with respect to household expenditure. Besides parametric OLS regression, parametric (Instrumental Variables (IV) regression and semi-parametric regression data analysis have also been undertaken. The parametric IV regression estimates are not presented here for the sake of brevity. The parametric (IV) elasticity estimates have also witnessed a decline over time, and are lower than the OLS estimates, except for fats.

Given the concerns with non-parametric estimation, a semi-parametric estimation strategy was employed as semi-parametric models allow for the incorporation of confounding variables in a parametric way, and are considered as an ideal approach to reveal the complex relationships between well-being and nutrition. Semi-parametric Engel curves are steeper as compared to non-parametric Engel curves in both the sectors. The non-augmented elasticity curves highlight that the functional form that best represents the relationship between demand for nutrients and income is indeed non-linear and non-monotonic. The augmented semi-parametric elasticity curves also have the same basic shape as that of non-augmented curves in rural India (Figure 2.3).

Table 2.7. Nutrient-income elasticities - OLS estimation

Particulars	Log per capita daily calorie intake			Log per capita daily protein intake			Log per capita daily fat intake		
Rural	**1993-94**	**2004-05**	**2011-12**	**1993-94**	**2004-05**	**2011-12**	**1993-94**	**2004-05**	**2011-12**
Log of real MPCE	0.582*** (0.015)	0.539*** (0.008)	0.463*** (0.009)	0.596*** (0.022)	0.581*** (0.015)	0.514*** (0.011)	1.011*** (0.028)	0.937*** (0.022)	0.800*** (0.02)
R^2	0.7060	0.6891	0.6124	0.6972	0.7199	0.6819	0.7928	0.8217	0.8022
Observations	66862	75551	57105	66862	75551	57105	66862	75551	57105
Urban	**1993-94**	**2004-05**	**2011-12**	**1993-94**	**2004-05**	**2011-12**	**1993-94**	**2004-05**	**2011-12**
Log of real MPCE	0.513*** (0.028)	0.476*** (0.015)	0.424*** (0.013)	0.502*** (0.036)	0.479*** (0.024)	0.443*** (0.017)	0.834*** (0.043)	0.756*** (0.032)	0.642*** (0.03)
R^2	0.7040	0.6822	0.6356	0.6288	0.6439	0.6248	0.8076	0.7875	0.7654
Observations	44547	43384	40263	44547	43384	40263	44547	43384	40263

Note: Standard errors clustered by state are in parentheses; *** p<0.01, ** p<0.05, * p<0.1.
Source: Author's estimations using National Sample Survey Office's Consumer Expenditure Survey (CES) data

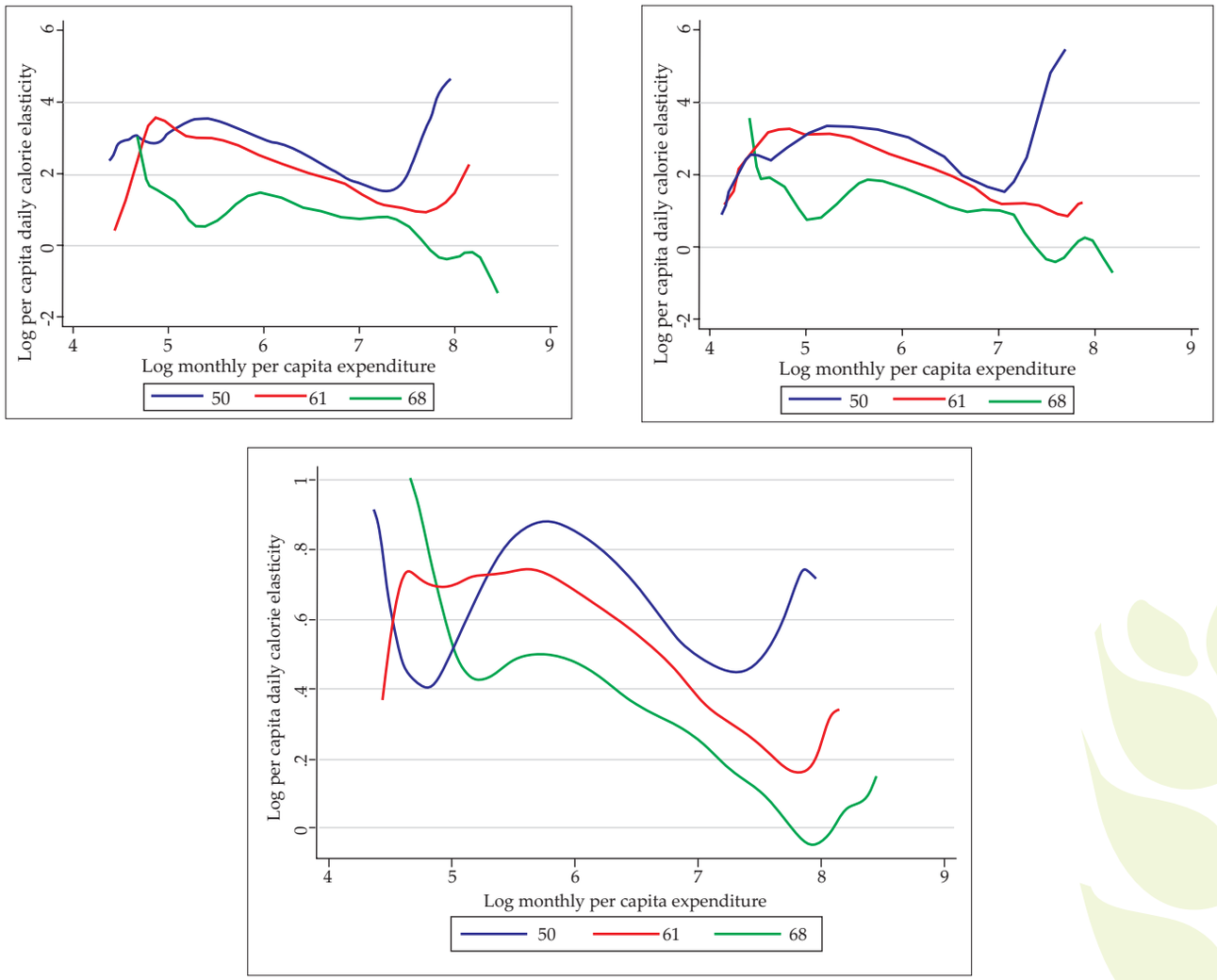


Figure 2.3. Augmented semi-parametric elasticity estimates for rural India

In the current landscape of India's nutrition economy, the study highlighted that it is imperative to evaluate the effect of income over the entire nutrient intake distribution and not just at the means. The findings from this analysis would be useful for designing appropriate interventions and government policies that aim to mitigate and even eliminate diseases caused by undernourishment or excessive intake of unhealthy foods.

Food Away From Home and the Reversal of the Calorie Intake Decline in India

Deepthi E. Kolady, S.K. Srivastava, David Just and Jaspal Singh

Calorie intake is considered as a direct measurement of satisfaction of basic food needs and is often used to measure poverty and welfare. Due to the positive relationship between food consumption and welfare, as income increases, the under-nourishment level is expected to decrease. India experienced a consumption puzzle since the 1970s, where households' calorie intake declined over time, despite significant economic growth. This declining trend in calorie intake (consumption puzzle) reversed for the first time in 2011–12.

The study brings new insights to this calorie consumption puzzle and investigates the effect of refinement in data collection of food consumed away from home (FAFH) on the first-time reversal in the declining trend of calorie intake. Findings show that refinement in data collection on FAFH has a positive effect on the first time reversal of the declining trend in calorie intake in India. Incorrect estimates of calorie intake will have negative implications on the effectiveness of social welfare programs developed based on the calorie intake estimates. Results showed that correcting for measurement error will improve calorie intake estimate have implications not only for India but also for other countries that use household-level consumption data to understand diets and to design social welfare programs. Nutrient content of a given food item also depends on the form and manner in which it has been cooked and served. The data collected through household consumption expenditure surveys (HCES) do not have information on qualitative aspects of foods consumed and hence our analyses do not account for this. While we recognize the challenges of using nationally representative surveys to collect qualitative and quantitative information on food consumption at household level in a country such as India, availability of such data will further improve the efficiency of calorie and nutrient intake estimations using HCES.

Pradhan Mantri Fasal Bima Yojana

Vikas Kumar, Khem Chand and Jaya Jumrani

Pradhan Mantri Fasal Bima Yojana (PMFBY)-an area-based insurance scheme was started in Kharif-2016 to provide insurance cover to farmers suffering from crop losses due to any natural calamities and other kinds of risks. It works as a hedging mechanism against various kinds of risks involved in the process of crop production till the threshing operations are over. This study examined the performance of this scheme and analysed the crop yield variability in different states of India. There has been about 6 percent increase in the number of farmers insured in the last 5 years (Figure 2.4). The study showed comparatively higher insurance uptake in the Kharif season (69.25 percent), which may largely be due to higher production risk in this season. During the same period, the scheme could insure 244.6 million hectares, with a higher proportion (64.47%) in the Kharif season. The average claim paid to farmers as a proportion of the gross premium collected was 86.2 percent during last five years. About 31.35 percent of the insured farmer got benefitted from the scheme during 2016-2020. The share of claims paid against the gross premium collected showed a mixed trend in different seasons (Figure 2.5).

Crop yield is affected by various kinds of fluctuations in weather and a variety of physical inputs used. The instability analysis captures the risk involved in crops production in a particular period. The study analysed the risk intensity (variability) in crop yields during

the past 20 years (1999-2000 to 2018-19). The instability index for various crops and states are provided in Table 2.8. The findings indicate that the states with assured irrigation, better infrastructural facilities and cultivating crops suitable to that agro-climatic situation have lower instability index. Crops with higher instability index and harsh agro-climatic conditions could be discouraged by charging comparatively higher insurance premium.

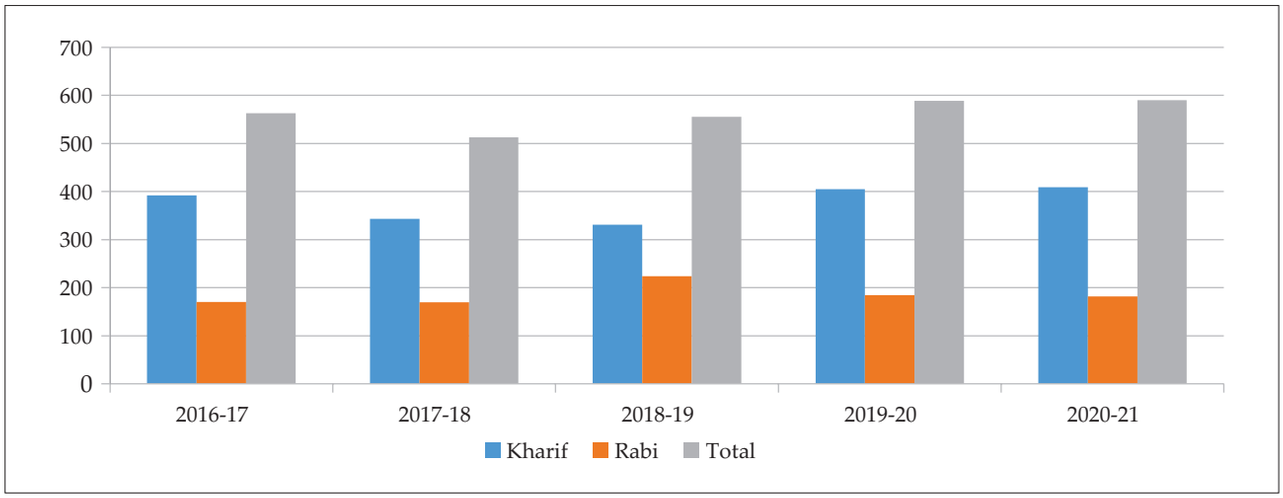


Figure 2.4. Number of farmers registered under PMFBY during 2016-17 to 2020-21 (in lakhs)

Table 2.8. State wise yield instability index of important crops

States	Paddy	Wheat	Pearl millet	Tur	Chick pea	Rapeseed and Mustard	Ground-nut	Soy-bean	Cotton	Sugar-cane
Bihar	13.86	8.89								7.51
Madhya Pradesh	9.07	8.19	5.46	18.34	4.65	5.71	8.55	9.41	15.00	
Tamil Nadu	8.61		11.01				7.18		20.46	4.11
Jharkhand	8.17			19.77		4.78				
Chhattisgarh	7.69				10.70					
Karnataka	7.61		10.02	10.74	9.42		9.2		12.80	6.34
Assam	6.27					4.29				
Orissa	5.41			5.04						
Maharashtra	4.82		10.92	19.81	8.52		4.44	13.10	12.44	6.48
Uttar Pradesh	4.67	5.71	4.18	13.28	12.23	5.12				5.39
Andhra Pradesh	4.43		15.05	17.75	11.56		28.05		13.57	4.00
Haryana	4.36	4.02	7.65			8.29			20.14	2.29
Punjab	2.77	3.60							15.76	6.70
West Bengal	1.31					4.08				
Rajasthan		2.23	10.11		9.91	5.12	11.5	15.39	12.87	
Gujrat			25.17	11.06	8.25	4.10	22.81		20.79	4.70
Uttrakhand										4.45
All India	1.87	3.33	5.27	5.06	3.77	3.87	4.81	10.33	12.92	2.87

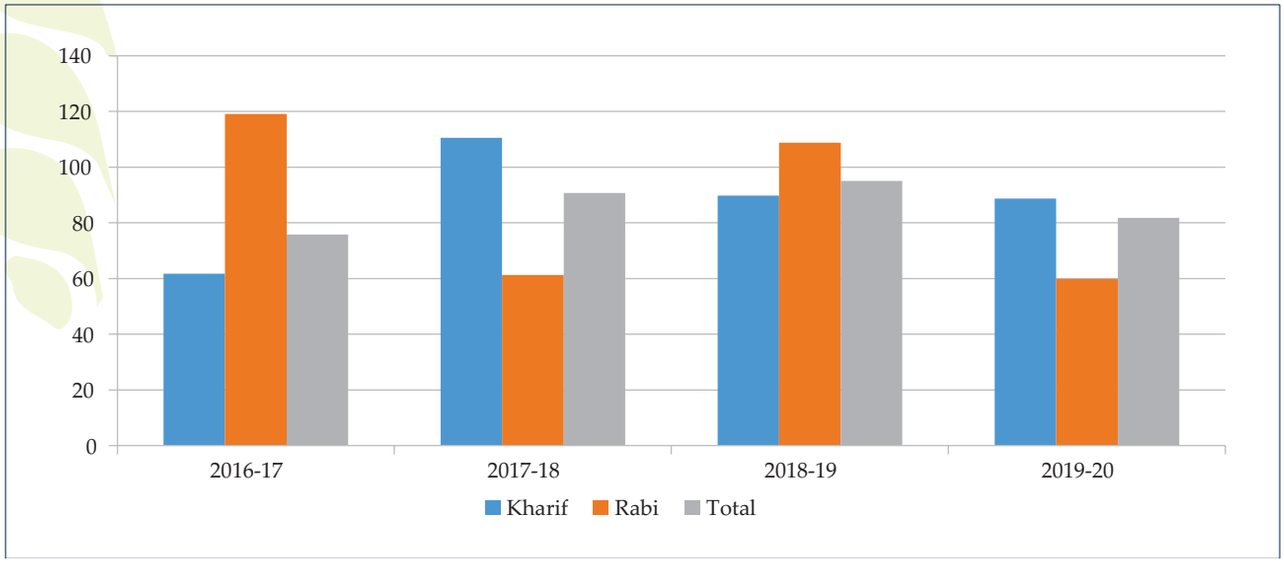


Figure 2.5. Insurance claims paid as a ratio of gross premium collected in PMFBY (percent)

Source: Department of Agriculture, Cooperation & Farmers Welfare, Ministry of Agriculture and Farmers Welfare, Government of India

Theme II

TECHNOLOGY AND SUSTAINABLE AGRICULTURE

Excerpts

- Median rate of return to the investments made during 1980 to 2008 in agricultural R&D was 58.5 percent, and it varied from 34.9 percent in the eastern region to 80.5 percent in the northern region. Some of the ICAR technologies generated the annual gross economic benefits (surplus) as high as Rs. 14.7 thousand crore in 2017-18.

- The Composite Index of Agricultural Sustainability (CIAS) for 24 Indian states revealed a moderate level of agricultural sustainability in India. The Rajasthan state was the least sustainable, while the North-Eastern state of Mizoram was the most agriculturally sustainable followed by Manipur, Andhra Pradesh, Madhya Pradesh and Kerala.

- Climate Resilient Agriculture Index (CRA) revealed a high resilience in the Western Coast Plains & Ghats, Trans-Gangetic Plains, Gujarat Plains & Hills, and Eastern Coast Plains & Hills regions, whereas the resilience was lowest in the Middle Gangetic Plains (Bihar and parts of Uttar Pradesh) and Eastern Plateau & Hills (Chhattisgarh, Jharkhand, and Odisha). Climatic hazards has negatively affected agricultural productivity which can be mitigated through adaptation measures like irrigation, agricultural diversification, and by rationalisation of input use.

- Drip irrigation system in Bundelkhand region increased yield by 40-130 percent while ensuring water use efficiency up to 65 percent. The micro-irrigation facility created in Rajasthan was found to be utilized effectively, resulting in better returns. The farmers perceived the factors such as water scarcity, drought conditions, urbanization, lack of people's participation, poor water quality, high temperature, and climate variability as critical in irrigation water management.

- Agroecosystem Diversity Index (ADI) for Trans-Gangetic Plains of India showed that agroecosystem in the region has become highly specialized, making agriculture more sensitive to numerous biotic and abiotic shocks. Monetary value of ecosystem services (considering soil retention, water augmentation, and carbon sequestration) delivered by the watershed project has been estimated to Rs. 34,113 per hectare.

- Crop suitability index analysis in the Bundelkhand region showed that farmers are not cultivating the crops based on suitability of biophysical and irrigation parameters but based on suitability of socio-economic parameters. Districts of the Bundelkhand region are lacking one or the other infrastructure for agriculture.

- The economic assessment of estrus synchronization technology (AVIKASIL-S) revealed that the break-even point of the technology could be achieved even at an adoption level of 0.02%. Farmers with access to information from at least one formal source had significantly higher yield (11%) than the farmers who did not access to information.

Strategic Research Component of National Innovations on Climate Resilient Agriculture

N.P. Singh, B. Anand and S.K. Srivastava

Climate resilience across agro-climatic zones of India

Using a multi-scalar and multi-indicator assessment framework, 14 Agro-climatic zones (excluding island region) in India have been profiled by constructing a Climate Resilient Agriculture (CRA) Index. A total of 26 indicators, relating to the environment, technology, socio-economic, and infrastructure & institution dimensions were employed to purport inter and intra Agro-Climatic Zones (ACZ) differentials in the level of resilience using district level information.

Inter-ACZ resilience

Table 2.9 shows the inter-ACZ resilience to climate change. Environmental resilience was found to be the lowest in the TGP comprising states of Haryana and Punjab and WDR (parts of Rajasthan). Indo-Gangetic plains exhibited high technological resilience among the zones. The level of socio-economic resilience was found to be highest in WCG and TGP. Among the zones, WCG, GPH, SPH, and TGP were grouped under the high level of resilience under the institutional & infrastructural index. Based on the relative performance of ACZs across different dimensions of resilience, the CRA index was prepared. In the order of ranking, high climate resilience was found in WCG, TGP, GPH, and ECH. On the other hand, MGP (Bihar and parts of Uttar Pradesh) and EPH (primarily comprising Chhattisgarh, Jharkhand, and Odisha) were rated the lowest in terms of CRA index. Other zones, namely WDR, EHR, and UGP were also categorized under the lower degree of resilience to climate change.

Intra-ACZ: District level resilience

Most districts falling within the Gangetic Plains region and WDR, had a very low level of environmental resilience. Out of 89 districts in the EHR, about 67 percent had very high environmental resilience. Among the districts with very low to low level of technological resilience, about 54 percent were concentrated in the EHR and EPH. Districts located in the SPH had medium level of socio-economic resilience. In WCG, Raigarh, Sindhudurg, Thane, Dakshina Kannada, Kodagu, Udupi, Theni, Kanniyakumari, and all districts within Goa and Kerala had very high level of socio-economic resilience. Southern India

Table 2.9. Categorization of ACZs across different levels of climatic resilience

Indices of Resilience	High Resilience	Medium Resilience	Low Resilience
Environmental Index	CPH, EHR, EPH, WCG	ECH, GPH, UGP, WHR, WPH	LGP, MGP, SPH, TGP, WDR
Technology Index	LGP, MGP, TGP, UGP	CPH, ECH, SPH, GPH, WPH	EHR, EPH, ECG, WDR, CPH
Socio-Economic Index	ECH, TGP, WCG, WDR	EHR, GPH, SPH, WHR, WPH	CPH, EPH, LGP, MGP, UGP,
Institutional & Infrastructural Index	GPH, SPH, TGP, WCG	ECH, EPH, LGP, WHR, WPH	CPH, EHR, MGP, UGP, WDR
CRA Index	ECH, GPH, TGP, WCG	CPH, LGP, SPH, WHR, WPH	EHR, EPH, MGP, UGP, WDR

Note: Western Himalayan Region (WHR), Eastern Himalayan Region (EHR), Lower Gangetic Plains (LGP), Middle Gangetic Plains (MGP), Upper Gangetic Plains (UGP), Trans- Gangetic Plains (TGP), Eastern Plateau & Hills (EPH), Central Plateau & Hills (CPH), Western Plateau & Hills (WPH), Southern Plateau & Hills (SPH), Eastern Coast Plains & Hills (ECH), Western Coast Plains & Ghats (WCG), Gujarat Plains & Hills (GPH), Western Dry Region (WDR)

districts, particularly those falling in Kerala state and within GPH and TGP, showed better institutional and infrastructural foundation.

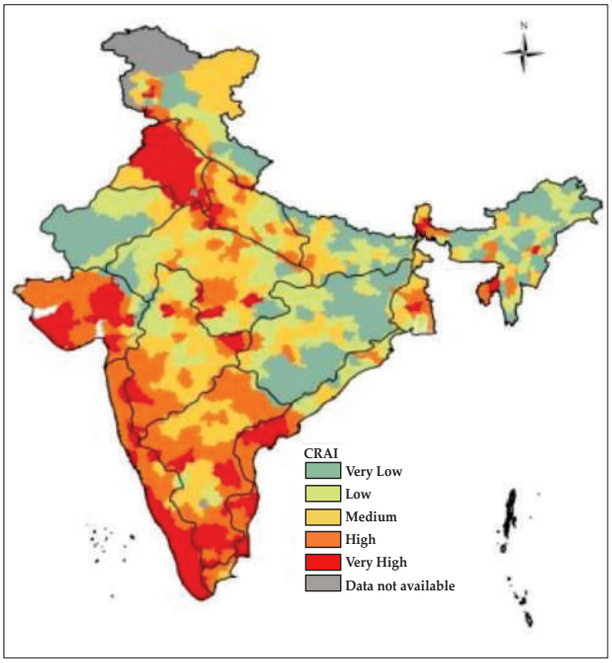


Figure 2.6. District level resilience in terms of CRA index (ACZ demarcation is shown with black boundary line)

Based on CRA index, a total of 247 districts were placed at the bottom of the resilience pyramid. Among 247 districts, 124 had a very low level of resilience with 66 districts primarily falling under north-eastern states forming part of EHR, 40 districts from EPH with maximum concentration from the state of Jharkhand, and Chhattisgarh and 25 districts from MGP particularly from the state of Bihar. As shown in Figure 2.6, most of the districts in TGP and WCG showed very high resilience to manage climate risks. Overall, the study observed that the southern states forming parts of WCG, ECH, and SPH, had a greater strength to respond to the climatic-related risks. On the other hand, MGP and EPH recorded the least resilience to manage climatic stresses. Even within the ACZs, wide variations were observed among the districts. The analysis indicates that special policy attention must be given to the north-eastern region, western dry region, and eastern parts of the country.

To bring robustness in climate change adaptation planning, there is a need to develop suitable location-need-context specific interventions and policy that builds the resilience of the agricultural system. Moreover, devising action plans with emphasis on awareness, conservation of natural resources, diversification, building physical infrastructure, strengthening of grass-root institutions, and mainstreaming climate adaptation in the developmental policy is crucial for climate-resilient pathways.

Research Priorities and Policies for Climate Resilient Agriculture

Impact of climatic hazards on agricultural productivity growth

Pratap S. Birthal, Jaweriah Hazrana and Digvijay Negi

Using a panel of state-level data for the period 1970-2018, the study assessed the impacts of different climatic hazards such as droughts, floods, heat waves, and cold waves on agricultural productivity growth, and evaluated the potential of a few important adaptation measures in offsetting their adverse effects. The results highlight that (i) the frequency of all types of climatic hazards has increased over time, (ii) all hazards have a negative effect on agricultural growth, but droughts and heat waves have a larger effect, (iii) the negative growth effect of climatic hazards has increased over time, and (iv) the poor and agrarian states are more affected by climatic hazards. Irrigation and diversification are efficient in reducing the negative effect.

Nevertheless, the results also demonstrate that the negative impacts of climatic hazards can be mitigated to an extent through adaptation measures like irrigation, agricultural diversification, and manipulation of input use. Irrigation and crop diversification provide more adaptation benefits against the droughts and heat waves, but their adaptation benefits slowdown in case of their rising frequency. The adaptation benefits of animal husbandry and fertilizer use are comparatively small

but sustainable against the frequent climatic hazards.

Effect of delayed monsoon on major crops and its implications for crop insurance

Hardeep Singh, Digvijay S. Negi and Pratap S. Birthal

This study using a district-level panel dataset for the last 50 years investigated three inter-related issues that are critical for managing the weather-induced agricultural risks: (i) it examines the impact of timing of monsoon on crop yields, (ii) it quantifies adaptation benefits of irrigation against delayed monsoon, and (iii) utilizing results of (i) and (ii) it simulates actuarially fair premium rates for an area yield insurance under varying levels of irrigation.

The results show that in the last 50 years the arrival of monsoon has shifted forward for about a day from its normal arrival date, and also the probability of its shift has increased. In general, there appears an inverted U-shape relationship between crop yields and the timing of monsoon, meaning that an early as well as delayed monsoon leads to suboptimal outcomes not only for the rainy season crops but also for the crops grown in the post-rainy season. A 10-day delay in the onset of monsoon can reduce the yield of Kharif crops ranging from 1.1% for maize to 4.2% for pearl millet. Its effect on rabi crops, however, is relatively weak. Further, it demonstrates that irrigation, apart from contributing to yield improvements, also acts as a buffer against delayed monsoon. This finding has an important implication for the pricing of the yield-based crop insurance contracts. The demand for index-based insurance products is highly price-sensitive, and a higher premium is one of the reasons for the low uptake of crop insurance in developing countries. These findings, however, show that insurance premium rate varies across crops and spatially along the irrigation landscape, and failing to account for this in deciding insurance premium results in over-pricing of insurance products for the regions where irrigation or any other adaption measure provides partial insurance against climatic shocks implicitly.

Climate change and land use in Indian agriculture

Pratap S. Birthal, Jaweriah Hazrana and Digvijay S. Negi

Using a panel of district-level data from India, this study investigated the effects of climate change, especially of temperature rise, on land use in agriculture or cropping patterns, presupposing that climate change influences acreage allocations via its effects on crops' comparative advantage. The findings show that excess temperature negatively impacts crop yields, and the impact is larger in the plausible future climate scenarios. Under the RCP 4.5 emission scenario, the crop yields decline in the range of 1.8% to 6.6% in the medium term (2041–2060) and 7.2% to 23.6% in the long term (2061–2080). This heterogeneity in the crops' yield response to temperature, however, does cause significant change in the land use. The area share of crops declined by 0.1 to 0.4 percentage points in the medium term and 0.4 to 1.3 percentage points in the long term. These results indicate limited prospects for adaptation to climate change through adjustments in land use. To manage climate risks, the recourse has to be with other adaptation strategies, including crop breeding for stress-tolerance, higher yields and resource-use efficiency, optimum use of natural resources, and adoption of climate-smart agronomic practices and formal insurance.

Resource use Planning for Sustainable Agriculture

Rajni Jain and Prem Chand

Crop suitability index in Bundelkhand region

The study proposed a framework for crop suitability index using various attributes like soil, climate, topography, socio-economic factors and infrastructural facilities. In the proposed

framework all attributes and parameters were standardized and matched with the thresholds applicable for each crop. The suitability indices of main parameters are presented in Figure 2.7 for the major crops in Bundelkhand region.

The suitability indices ranged from 0.456 to 1, 0.547 to 0.842, 0.153 to 0.955, 0.111 and 0.225 for soil physical, chemical, climatic and topographical factors, respectively. The most limiting factor is slope which has effectively constrained all the crops except sorghum and pearl millet. In case of climatic factors, length of growing period is found limiting factor for sugarcane cultivation in all the districts, and temperature is a limiting in all zones other than the Vindhyan Plateau (Damoh and Sagar) for crops like pearl millet, chick-pea, maize, soybean, wheat, sorghum, mustard and

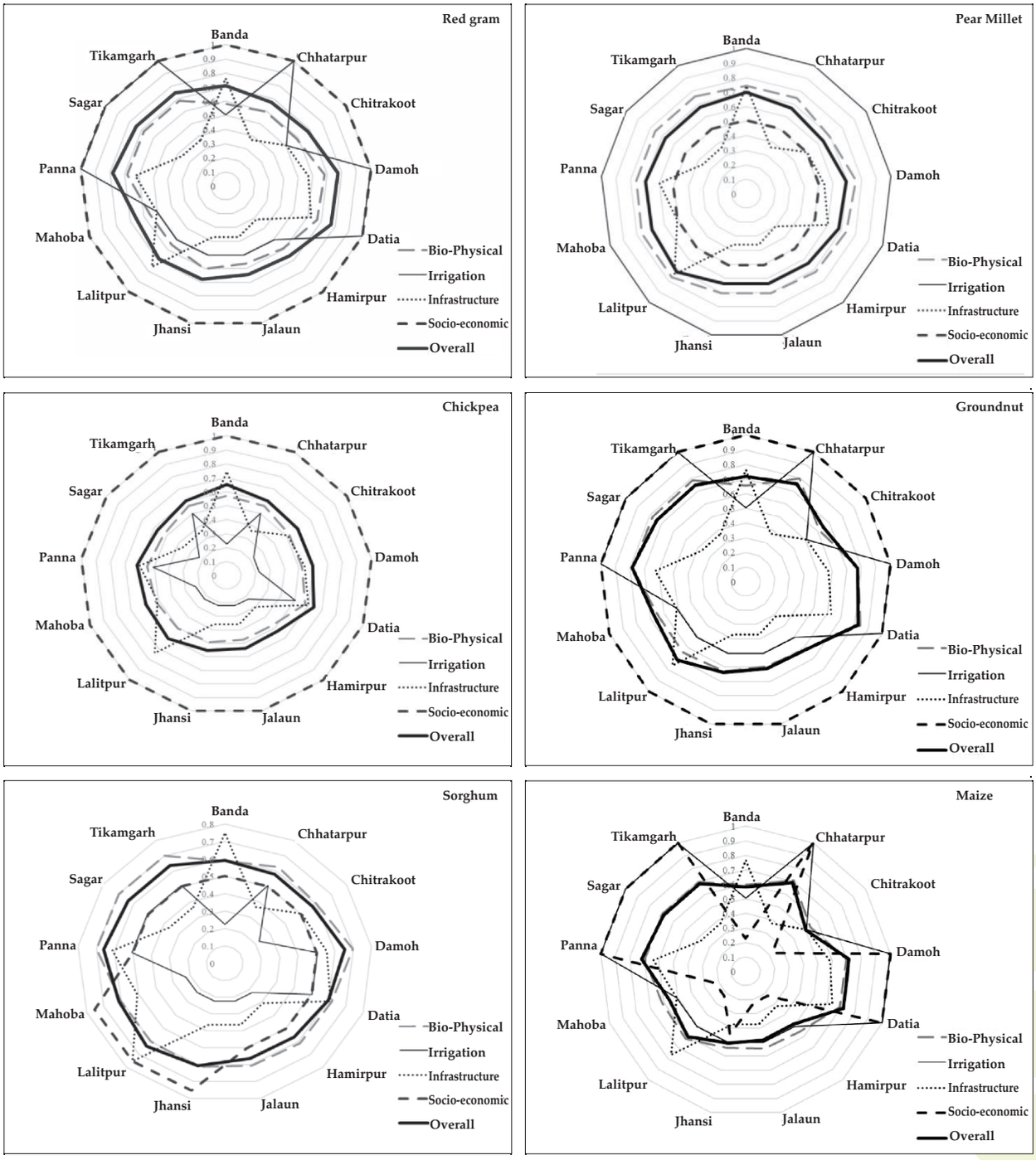


Figure 2.7. Crop suitability index based on biophysical, irrigation, infrastructure and socio-economic parameters

rapeseed, groundnut, paddy and sesamum. Rainfall is a striking constraint in case of wheat and sugarcane, which are high water consuming crops. Infrastructural parameter, road density, is also observed as a limiting factor for cultivation of major crops in the districts of Damoh and Hamirpur.

Analytical Hierarchy Process was used to assign weights for each criterion, combining them and reaching an overall suitability index for each crop in the region. The results revealed that most of the existing crops are either moderately or marginally suitable for cultivation. However, some crops like pigeon

pea in Damoh, Datia and Panna; groundnut in Chattarpur, Damoh, Datia and Panna; sesamum in Banda, Lalitpur and Mahoba, soybean in Banda and Lalitpur are highly suitable. Further analysis highlighted that farmers are not cultivating the crops based on suitability of biophysical and irrigation parameters (indicator of sustainability) but based on suitability of socio-economic parameters. Thus, there is a need for creating awareness among farming community, and also revising price policy so as to improve socio-economic suitability of

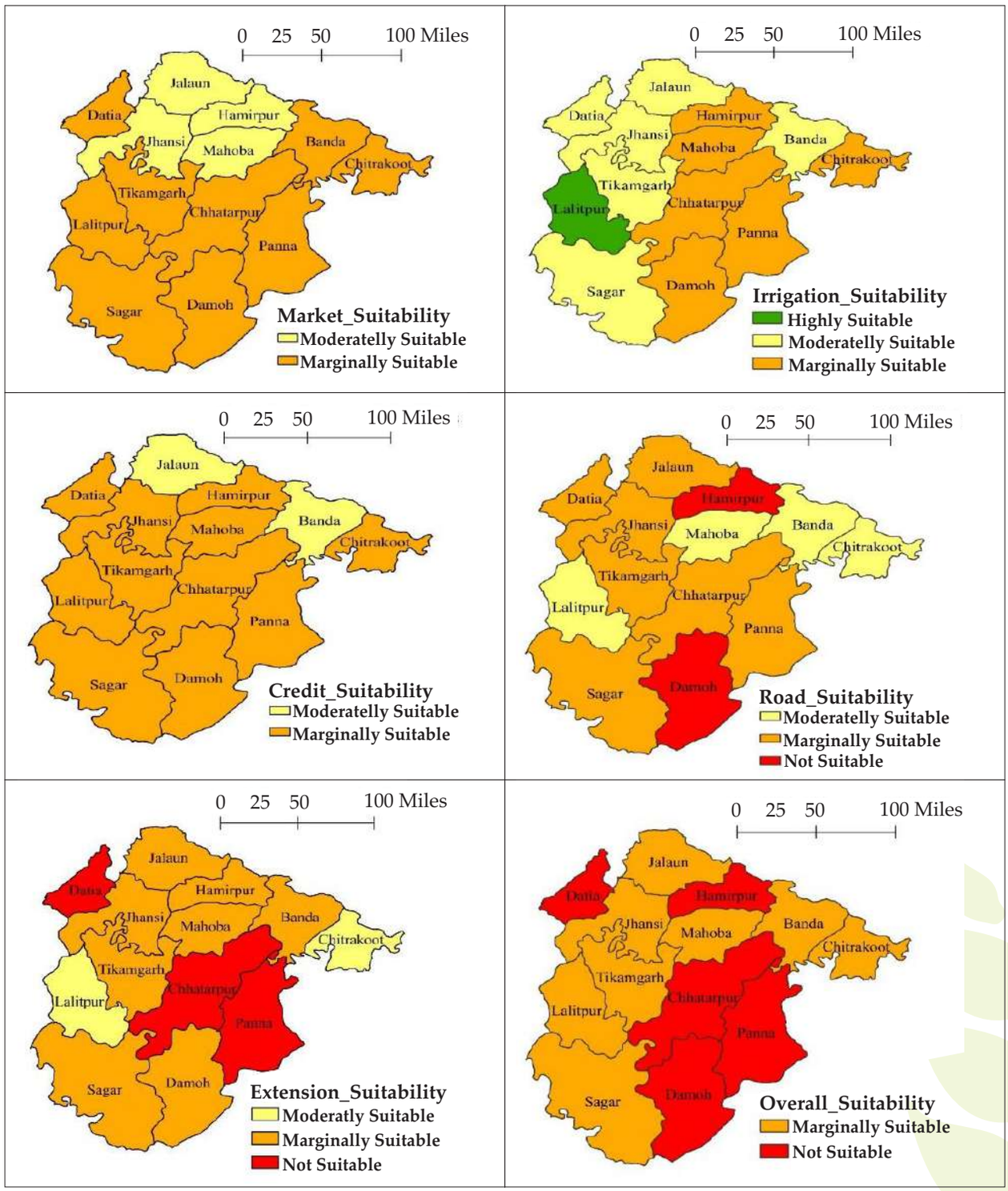
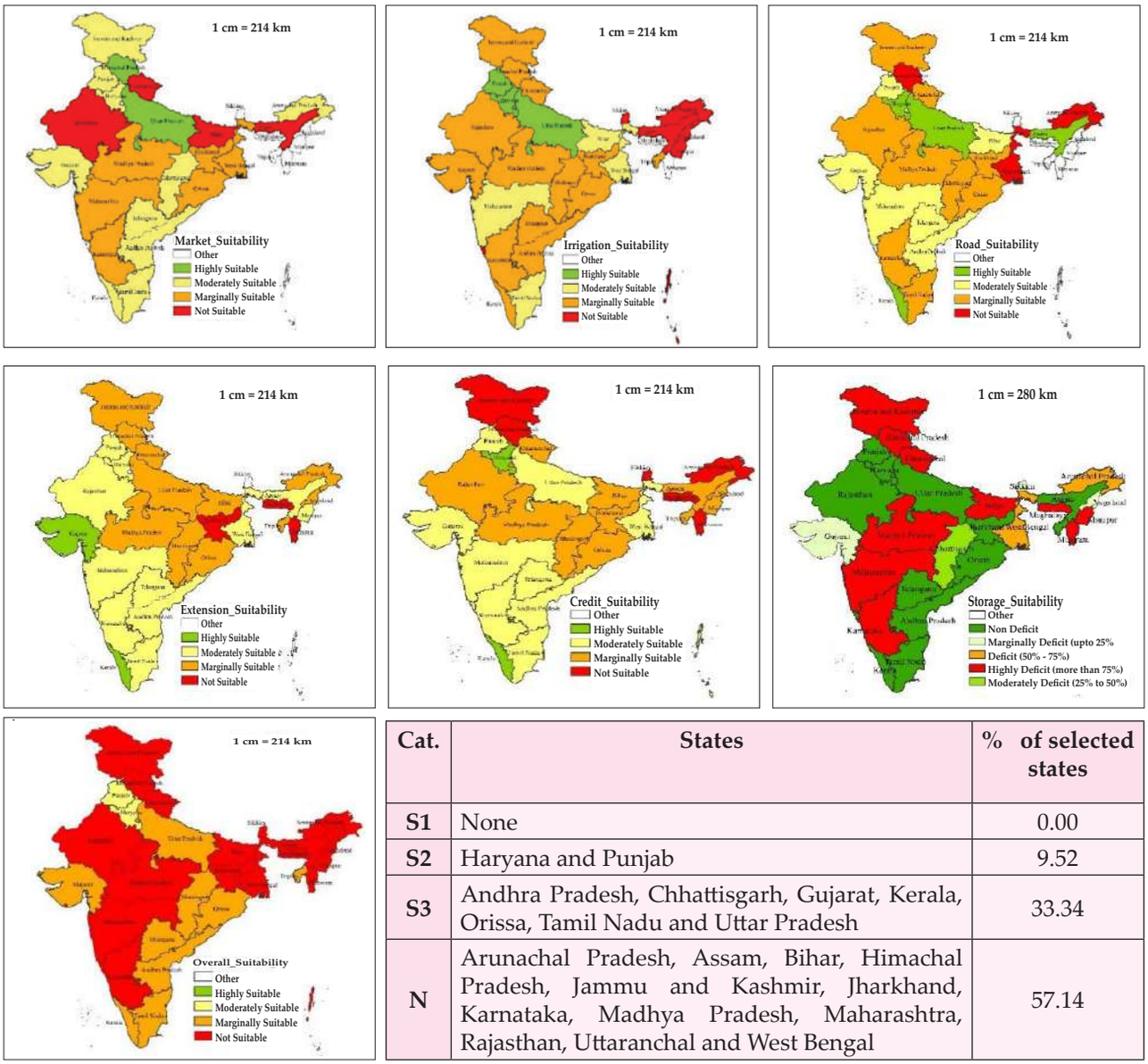


Figure 2.8. Agricultural infrastructural adequacy in Bundelkhand region

crops in favour of biophysically suitable crops. Development of such indices across the country will further aid in adoption of suitable crops.

Examining agricultural infrastructural adequacy for Bundelkhand region

Adequacy of agricultural infrastructure was determined based on the availability of markets, irrigation, credit, roads, KVK and communication infrastructures. It is observed that each district of Bundelkhand is lacking one or the other infrastructure for agriculture (Figure 2.8). About 75 percent of districts are not having bare minimum marketing infrastructure, and hence requires investment. Except Lalitpur district, irrigation infrastructure is not adequate in any other district of Bundelkhand. Out of 13, 50 % districts are under marginal category and 25% districts are having moderate adequacy of road infrastructure. Extension and banking system requires improvement in 90% of the districts. Thus, there is a need for substantial increase in public investment to upgrade the agricultural infrastructure in Bundelkhand region.



Cat.	States	% of selected states
S1	None	0.00
S2	Haryana and Punjab	9.52
S3	Andhra Pradesh, Chhattisgarh, Gujarat, Kerala, Orissa, Tamil Nadu and Uttar Pradesh	33.34
N	Arunachal Pradesh, Assam, Bihar, Himachal Pradesh, Jammu and Kashmir, Jharkhand, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan, Uttaranchal and West Bengal	57.14

Figure 2.9. Mapping of state-level agricultural infrastructural adequacy

Examining infrastructural adequacy at state level

An index of agricultural infrastructural adequacy for the states is presented in Figure 2.9. Key policies implications of the study are: (i) Only 2.25 percent of states are identified as adequate in road infrastructure while 60 percent states are under marginally adequate or inadequate category. Thus, there is a need for developing and maintaining roads infrastructure in the country. (ii) There is a need to provide internet facilities for better participation of farmers in innovative and promising schemes of the Government. (iii) Inadequate credit facilities indicate demand for the development of financial institutions within reachable access to the farmers to restrict informal credit disbursement.

Agricultural Sustainability in India: A Parametric Study

Prem Chand, Kiran Kumara T.M. and Suresh Pal

Measuring agricultural sustainability of Indian states

Agriculture is the common thread holding 17 Sustainable Development Goals (SDGs) together. Any threat to agricultural sustainability shall weaken this thread and jeopardize the overall achievement of SDGs. Despite the increased number of studies, significant gaps remain in the assessment of agricultural sustainability. Agricultural sustainability of 24 Indian states has been assessed employing 51 indicators across four dimensions: soil, water, environmental and socio-economic factors by constructing a Composite Index of Agricultural Sustainability (CIAS). Overall, agricultural sustainability was found to be at moderate level with wide inter-state variations. The arid western state of Rajasthan was the least sustainable (CIAS 0.41) state, while the north-eastern state of Mizoram was the most sustainable followed by Manipur, Andhra Pradesh, Madhya Pradesh, and Kerala (Figure 2.10). The CIAS scores were below the half mark for more than half of the states. The bottom rank state- Rajasthan, was followed by states in Indo-Gangetic Plain (IGP) like Uttar Pradesh, Punjab, Bihar, and Haryana. Besides IGP, rice-dominated states of Jharkhand and Assam also performed poorly in terms of agricultural sustainability. Much of India's food grains supply particularly staple foods as wheat and rice comes from these states, and any sustainability threats in this region have serious implications on the country's overall sustainability performance.

Though the performance was consistently moderate across all the dimensions, water and socio-economic dimensions were the major concerns. High input subsidies were associated with large areas under unfavorable soil pH, deficiency of soil organic carbon, groundwater overexploitation, and less area under natural and organic farming. A trade-off between socio-economic and environmental was observed

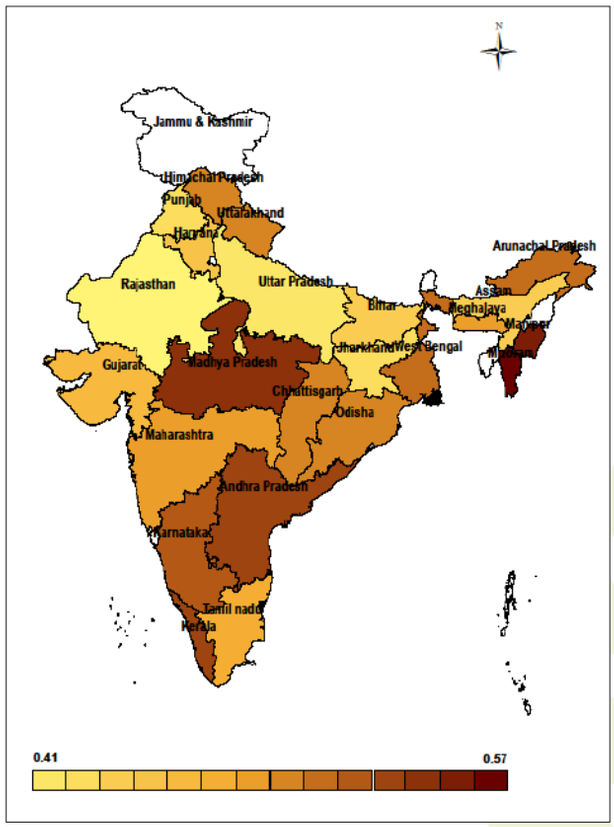


Figure 2.10. Composite index of agricultural sustainability in Indian states

while environmental and water dimensions having week synergies.

Eastern states of Bihar, Jharkhand, Assam, and Chhattisgarh were laggards mainly because of poor economic efficiency indicators. Besides, soil health dimension was equally poor in these states mainly due to problematic soils (acidic soils). In the eastern and north-eastern regions of the country, improving crops and cropping systems by strengthening infrastructure, particularly improving irrigation potential, improving productivity, small farm mechanization, developing stress-tolerant varieties are to be prioritized for sustainable intensification. Given the strong linkages between the core agriculture sector and other areas of the rural economy, the policy focus should be on comprehensive rural development, which could also enable a much stronger revival of the agriculture sector in the region. Crop and enterprise diversification was found to be the major resilient instruments in arid and semi-arid regions like Rajasthan, Gujarat, Karnataka, Maharashtra, and Tamil Nadu. The scores of indicators like the productivity of livestock, crop diversification, etc. were quite satisfactory in most of these states. Agricultural support services particularly livestock support services and revival of the traditional system of common property resources (common pasture and grazing lands, community water storage structure) shall be extremely important in the arid and semi-arid region to support the diversified production system and livelihoods of farmers. The promotion of an agroforestry-based production system will further strengthen crop-livestock linkages in these states.

Modelling agroecosystem diversity: Moving beyond taxonomic diversity

Chhabilendra Roul, Prem Chand, Suresh Pal and Kalu Naik

Agroecosystem diversity has the potential to address major challenges of ensuring food security, climate change, increasing population, and sustaining agriculture. A system-based and holistic approach is required towards achieving biodiversity targets defined by international treaties and conventions at national as well as international levels, especially of Conventions on Biodiversity and Sustainable Development Goals. Going beyond the taxonomic level of diversity, an Agroecosystem Diversity Index (ADI) has been proposed to assess the diversity of agroecosystems using 20 indicators grouped under four major themes: landscape and ecosystem diversity, genetic and species diversity, agrobiodiversity threats, and societal response. The application of ADI in the Trans-Gangetic Plains of India revealed that agroecosystem in the region has become highly specialized making agriculture more sensitive to numerous biotic and abiotic shocks. Though there was no much inter-district variability in the ADI, the districts falling in Shivalik hills and piedmont spread across the Panchkula, Yamunanagar and Ambala districts of Haryana and Gurdaspur, Hoshiarpur, SBS Nagar and Rupnagar districts of Punjab were relatively better as compared to the central plains. Southern districts, namely Mahendragarh, Rewari, and Gurugram also had comparatively better diversity. These districts have offshoots of the Aravali slope and are dominated by dry mixed deciduous forests. Major concerning dimensions were increasing threats to agrobiodiversity and inadequate response to reverse the agrobiodiversity losses. The average normalized values of indicators depicted in Figure 2.11 show that the performance of the region was consistently low across the indicators except a very few. For most of the indicators, the actual values were not up to the mark in respect to the identified diversity benchmarks. Though, efforts are being made for ex-situ conservation of germplasm, conserving the plant genetic resources under its native environment is much more practical, particularly for crop wild relatives.

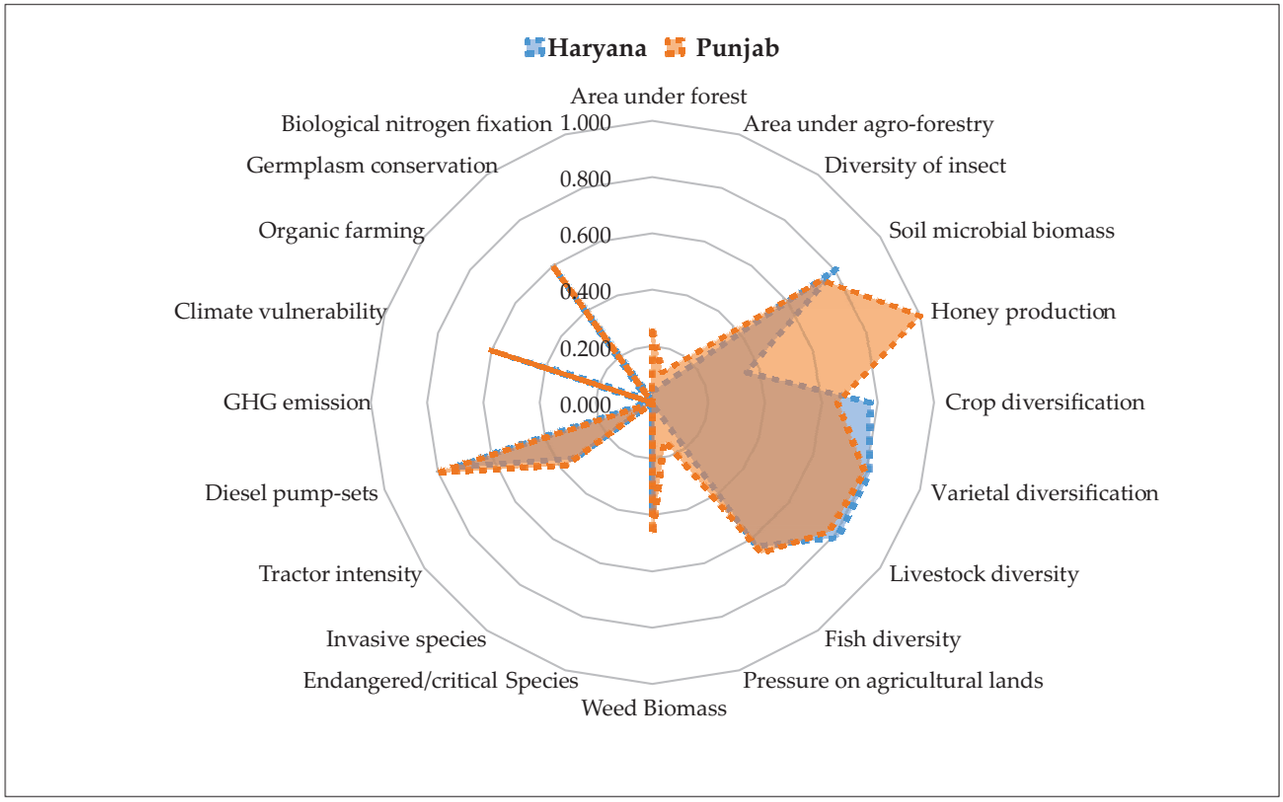


Figure 2.11. Average normalized values of agrobiodiversity indicators

Institutions and Technology for Agricultural Water Management

S.K. Srivastava and Subhash Chand

Meta-analysis on agricultural water management

Historically, irrigation has played a crucial role in agricultural growth and development and it will continue to be an important factor due to its direct as well indirect positive impact on the rural economy. With the massive public and private investment in irrigation, irrigation potential has increased from 22 million hectare (Mha) during pre-plan period to 126 Mha upto 2018 making India as the world leader in the irrigation sector. However, positive impacts of irrigation accompany unsustainable use of water resources in irrigation in several parts of the country. Presently, irrigation uses 85 per cent of the total water use. It is projected that per capita demand for water (for various uses) will outpace utilizable supply and cause to rise inter-sectoral competition that will reduce the share of irrigation in total water use to 74 per cent by the year 2050. Rising water scarcity poses a threat to the stability in food production system and warrants improvement in water use efficiency and its sustainable management in agriculture.

Over the years, groundwater has emerged as a predominant source of irrigation in India due to its reliable and assured supply over canal water. This is reflected from the increase in its share in net irrigated area from 30.36 per cent in 1964-65 to 64.10 per cent in 2015-16. However, in several parts of the country existing cropping pattern is not aligned with the utilizable water resources availability. Cultivation of paddy in Punjab and sugarcane in Maharashtra are glaring examples of distorted cropping pattern. The excessive rate of withdrawal of groundwater over and above the replenishable rate of recharge, and other demand and supply side factors are leading to depletion of groundwater resources. On the other hand, in eastern region there exists a vast

potential to utilize groundwater and harness its positive association with agricultural income. Central Groundwater Board (CGWB) has categorized 17.2 per cent of the assessment units (Blocks/Mandal/Talukas) as over-exploited. As agriculture is the predominant user of groundwater resources (89%), its efficient management in agriculture is crucial to sustain food security of ever growing population. In this context, reliable information on contribution of different crops in total irrigation water withdrawal in the areas witnessing depleting groundwater level is essential for realigning existing cropping pattern with the regional water availability. Presently, no official estimate is available on withdrawal of groundwater for irrigating different crops except the aggregate level periodic assessment by CGWB on groundwater use in irrigation sector.

Apart from sub-optimum cropping pattern, existing level of water use efficiency at every stage of water distribution from its source to farmers' field is very less. Even in groundwater irrigation system, there is a great scope to improve irrigation efficiency to large extent. According to latest Minor Irrigation Census, about 43 per cent of total groundwater extraction pumps in India use unlined/kutcha open water channels to convey water. In over-exploited state like Punjab this share is 88 per cent. The inefficient water distribution infrastructure compels farmers to extract excess groundwater over the actual water requirement by the crops. The availability of subsidized/free electricity and subsidized credit for installing and energizing pumps further contribute negatively in using water judiciously. Using the representative cost of cultivation data, it was observed that about 80 per cent of the total water requirement of paddy (including basmati) is met by groundwater and farmers extract 52 per cent higher groundwater over the economic optima. Given a lower yield of basmati, its groundwater footprints are almost double (3557 lit/kg) as compared to common paddy (1846 lit/kg). Thus, on account of environmental rationality, odds turn against basmati which otherwise fetches a premium price and annually provides foreign revenue of about Rs. 27,000 crore. In this context, it is essential to quantify the extent of over-use of water resources (over actual crop water requirement) and externally validate the evidences on wasteful use of fresh water by the farmers so that appropriate communication strategies can be developed to check such practices at farmers' fields.

Out of several direct and indirect demand-side management and supply-side augmentation approaches, regulation of energy supply and pricing have often been suggested as an effective indirect approach for sustainable groundwater development. it is estimated that de-subsidization of electricity in Punjab can lead to 29-82 per cent saving in groundwater extraction in different crops. Although subsidy removal can bring substantial efficiency improvement, its decision depends on various geo-political factors. Conducive energy policy therefore can play a crucial role in sustainable management of groundwater resources.

Causes of conflicts in irrigation water management

The causes of conflicts in irrigation water management have been analysed using primary survey of 299 farm households conducted during 2019-2020 in the Eastern Yamuna Canal (EYC) covering three districts of Uttar Pradesh (Saharanpur, Bagpat, and Ghaziabad). Figure 2.12 presents the causes of conflicts encountered by the farmers (as per their perception) based on the Likert scale. The prime causes of water conflicts are water scarcity, drought conditions, urbanizations and lack of peoples' participation,

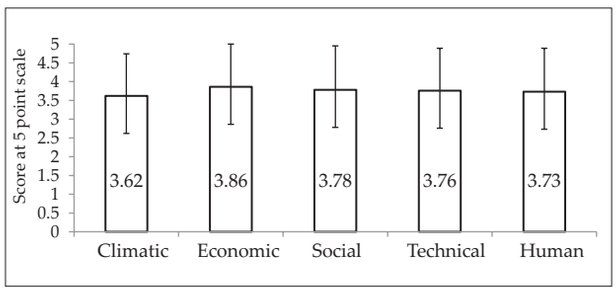


Figure 2.12. Causes of conflicts in water management

poor quality of water, high temperature, and climate variability.

A binary logistic model was used to find the determinants of water management conflict in the canal command area. The response of the farmer to the question of being a part of the conflict (yes or no) was taken as the dependent variable. The education, family size, landholding size, management of water, regulation of water distribution, unemployment, and overuse of water were taken as independent variables. The variables landholding size, drought, and increased water use were found to be positively associated with the conflicts in water management (Table 2.10). On the other hand, education level, family size, poor water management, and unemployment were found to be negatively associated with the conflicts.

Table 2.10. Determinants of conflicts in irrigation water management

Conflicts (Y=1,N=0)	Coefficient	Standard error
Education (Yrs)	-0.03681	0.03270
Family Size	-0.35104**	0.12295
Landholding ha.	0.24993**	0.10517
Drought	0.26752**	0.13574
Poor water management	-0.37500*	0.18496
Lack of local water management	-0.37500*	0.18496
Unemployment	-0.24092	0.16140
Increased water uses	0.37285 *	0.16716
Constant	-0.13035	1.6916
Number of observations	295	

Note: ** and* are significant at 1 and 5% of probabilities, respectively.

Assessment of Ecosystem Services of Watershed Development

D.C. Meena and Suresh Pal

The development of rain-fed agriculture is one of the priorities of the Government of India as these areas are the hot spots of poverty, water scarcity, and land degradation. Waterhsed development is considered as an effective approach to address these issues. Usually the provisioning services of the watershed are evaluated in monetary terms, whereas other ecosystem services (regulating, supporting, and cultural) remain unaccounted in monetary terms. This study analyzed the ecosystem services particularly soil retention, carbon sequestration, and water augmentation delivered by watershed projects. The effects of peoples' participation on ecosystem services were also assessed. The results of the meta-analysis of watersheds are presented in Table 2.11. The watersheds provided ecosystem services of about 11.54 t/ha/yr soil retention, 1.94 meters of water augmentation (groundwater recharge), and 337 kg/ha/yr carbon sequestration. About 34% of watersheds retained soil loss below 5 t/ha/yr, whereas about 17% of watersheds retained the soil loss of more than 20 t/ha/yr. Similarly, about 65% of watersheds provided groundwater recharge below 2 meters and only 8% of watersheds provided groundwater recharge more than 4 meters.

It is indicated from Table 2.12 that Watershed Ecosystem Services (WESs) are higher in watersheds where people's participation was more as compared to the watershed with low level of participation. These evidences indicated that greater people's participation in watershed activities provides higher benefits from the watershed project.

Table 2.11. Summary of watershed ecosystem services from the meta-analysis

Particulars	Unit	No. of Studies	Mean	Mode	Median	Min.	Max.	't' stat
Soil retention	t/ha/yr	28	11.54	9.70	7.65	1.00	55.30	4.97
Carbon Sequestration	kg/ha/yr	25	337	NA	181	33	722	3.10
Ground water recharge	Meter (m)	148	1.97	1.50	1.50	0.10	10.00	15.38

Source: Derived from various studies

Table 2.12. Summary of ecosystem services from the watershed studies according to people's participation

Ecosystem services	Unit	People's participation		
		High	Medium	Low
Soil retention	t/ha/yr	13.81 (3.74)	10.71 (3.83)	8.93 (3.93)
Carbon Sequestration	kg/ha/yr	335 (2.96)	211 (1.27)	367 (7.74)
Ground water recharge	meters	2.79 (10.63)	1.88 (9.98)	0.76 (4.76)

Note: Figures in parentheses are the t-values

Economic values of WESs are presented in Table 2.13. The economic value of nutrients conserved, due to soil erosion control with the adoption of the watershed, was estimated using the replacement cost principle. Three major chemical fertilizers (Urea, DAP, and MOP) were considered for the valuation of soil retention. The economic prices including a subsidy of the fertilizers were used to calculate the monetary value of conserved nutrients. It is estimated that about Rs. 6,923/ha was saved by the watershed otherwise it would be spent to replace the lost macro-nutrients through inorganic fertilizers alone. The value of soil organic carbon (SOC) retention was estimated by using the social cost of CO_2 and is estimated Rs. 7394/ha in the watershed. The market price method was employed for the valuation of water augmentation. The value of water augmented was estimated using a purchase price of irrigation water Rs. 1.02/m^3. The economic value of this ecosystem service from the watershed is estimated Rs. 19796/ha. The economic value of ecosystem services (considering soil retention, water augmentation and carbon sequestration) per hectare delivered by the watersheds in India was estimated Rs. 34,113.

Table 2.13. Economic value of ecosystem services from watersheds, India

Parameters	Quantity	Value (Rs/ha)
Soil conservation		
Soil retention (t/ha)	11.54	
N content in soil retention (kg/t)	7.09	2493
P content in soil retention (kg/t)	1.31	1884
K content in soil retention (kg/t)	5.41	2546
Value of soil retention (Rs./ha)		6,923
SOC retention		
SOC retained in CO_2 equivalent (t/ha/yr)		1.23
Social cost of CO_2 (US $/t)		86
Value of SOC retention (Rs./ha)		7394
Water augmentation		
Mean of GW recharged (m)		1.94
Value of water augmentation (Rs./ha)		19,796
Total economic value of WESs (Rs./ha)		34,113

Source: Derived from existing studies

Economic Impact of ICAR Research

Sant Kumar and Suresh Pal

The technical change induced agricultural growth has helped in increasing food availability to poor people at an affordable price. The ICAR provides a leadership role in steering these contributions. To document the impact of past spending and agricultural technologies, a study on "Impact of ICAR technology" was undertaken by ICAR-NIAP in collaboration with selected ICAR institutes. A total of 29 ICAR technologies belonging to crops, horticulture, animal sciences, fisheries, agricultural engineering and natural resource management were selected for the impact assessment. The selected technologies were improved varieties and planting materials of field and horticultural crops, animal health management techniques, improved aquaculture practices, and farm machinery.

The median rate of return on the past investments in research was 58.5 percent varying from 34.9 percent in the eastern region to 80.5 percent in the northern region during 1980-2008. The rate of return was 38.8 percent from the technological interventions in the rice-wheat system during the last two decades. The analysis has shown that some of the technologies

of ICAR generated the annual gross economic benefits (surplus) as high as Rs. 14.7 thousand crore in 2017-18. The annual benefits were in the range of Rs. 9.6 to 14.7 thousand crore each for six technologies. Further, eleven technologies generated annual benefits in the range of Rs. 1.2 to 4.7 thousand crore each. The environmental and social impacts are likely to be equally impressive. Technologies for salt affected soils, conservation agriculture, crop residue management and soil testing kits are notable contributions to promote sustainability of Indian agriculture. The benefits of animal health management, machinery for seeding and weeding of paddy crop, and improvement in fish trawl nets have contributed directly to the welfare of resource poor farmers and landless workers. These technological interventions have made significant economic impact on the farmers' fields and also benefitted the consumers.

Assessing Impact of Soil and Water Conservation Technologies

Sant Kumar, Pramod Kumar and M. Awais

Adoption of sprinkler irrigation in Rajasthan

The adoption of sprinkler systems among sample farmers of the Bikaner and Sikar districts of Rajasthan was studied based on the parimary survey. Tha analysis showed that sample farmers in Rajasthan had started adopting sprinkler irrigation technology in the early 1980s, and there was a marked inter-year variation in the adoption of sprinkler irrigation (Figure 2.13). This implies that farmers of the study area were aware of the importance of sprinkler irrigation systems even before the initiation of government schemes. However, the intensive adoption started in the early 1990s and continued till the introduction of PMKSY. Among the sample farms, about 52% had sprinkler irrigation and about 62.6% of the total cultivated area was irrigated.

The adoption pattern of sprinkler system in Rajasthan was analyzed in terms of farm size and preference given to crop irrigated first time after installation. The results presented in Table 2.14 show that among the adopters, medium farmers constituted the largest share (29%) in the total number of beneficiaries followed by small (24.2%) and semi-medium (23.7%).

In terms of the utilization of micro-irrigation to grow crops, the analysis revealed that about one-third of the sprinkler adopting sample farmers (35.4%) first-time irrigated wheat crop (Table 2.15). About 55% of beneficiary farmers used sprinkler water first time to irrigate cash crops like gram, groundnut, rapeseed & mustard, and onion. About 5% of farmers irrigated guar which requires less water and is highly profitable cash crop. The farm level

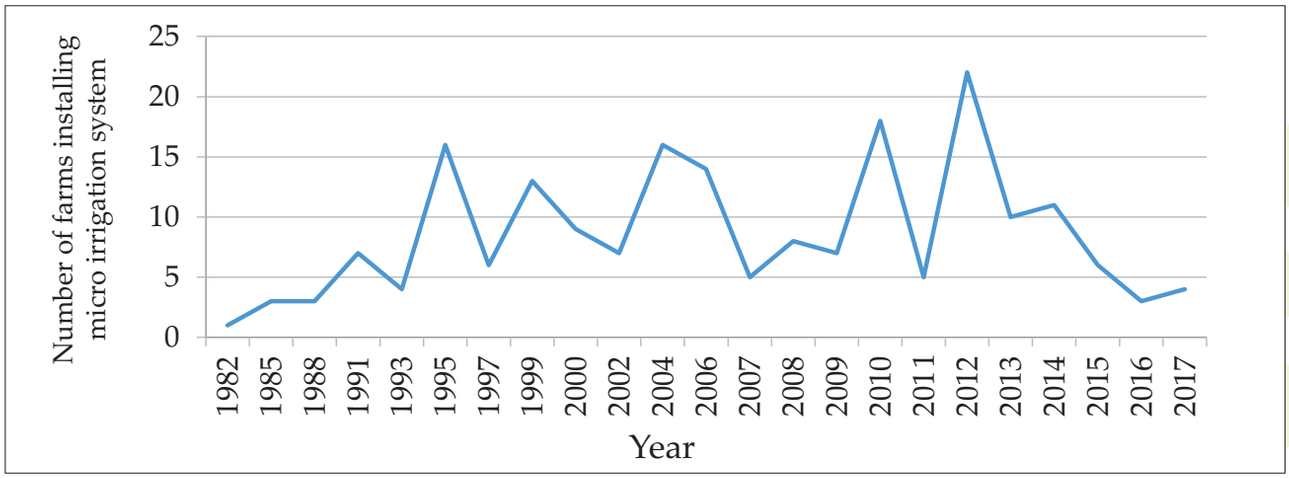


Figure 2.13. Adoption of sprinklers system on sample farms in Rajasthan

Source: Authors' estimate using field survey data

evidences revealed that the irrigation facility created was utilized effectively in irrigating crops providing relatively better returns over the rainfed condition.

Table 2.14. Adoption of sprinkler irrigation system by farm size

Farm size	Number of farms with sprinkler irrigation	Per cent
Marginal (<1.0 ha)	23	11.6
Small (1-2 ha)	48	24.2
Semi-medium (2-4 ha)	47	23.7
Medium (4-10 ha)	58	29.3
Large (10 ha and above)	22	11.1
Total	198	100.0

Source: Authors' estimate using field data

Table 2.15. Sample farms irrigated first crop after installation of sprinkler irrigation

Crop	Number of farms	Per cent
Wheat	70	35.4
Gram	36	18.2
Groundnut	23	11.6
Mustard	23	11.6
Onion	20	10.1
Guar	11	5.6
Bajra	5	2.5
Methi	4	2.0
Barley	3	1.5
Others	3	1.5
Total	198	100.0

Source: Authors' estimate using field data

Factors influencing adoption of sprinkler irrigation

The adoption of micro-irrigation technology is viewed as the most efficient system to expand irrigation facilities and bring more area under cultivation. The study has identified key factors influencing the adoption of sprinkler system in Rajasthan. About 52% of sample households adopted sprinkler systems on their farms. The coefficient of age of the household head indicated a negative and significant association with the adoption of sprinkler system (Table 2.16). The evidences showed that younger farmers are better at availing government subsidies for the adoption of the sprinkler. The adoption of sprinkler leads to an increase in cultivated land thereby cropping intensity and profits from the farming.

The coefficient for education (measured as years of schooling) was found positive but statistically insignificant. Although knowledge about the adoption of the sprinkler system is important, the adoption of sprinklers in Rajasthan is taking place for the past several years and this technology is considered no more a new technology. Possession of Kisan Credit Card has emerged as an important factor significantly affecting the adoption of sprinkler irrigation in Rajasthan. Irrigated area (owned land) has appeared the most important determinant for the adoption of sprinkler systems, as possession of irrigation source is viewed as one of the essential eligibility criteria for availing subsidy benefits. Farmers with own tube well have better access to water supply which increases the probability of adoption.

Table 2.16. Factors determining adoption of sprinkler irrigation in Rajasthan

Variable	Co-efficient	Standard Error
Farm household age (years)	-0.0191*	0.0114
Household education level (years)	0.0052	0.0338
Household category (SC/ST= 0; GN+OBC=1)	0.4678	0.4864
Family labour (number)	0.1784**	0.0752
Farmers having KCC (yes=1, otherwise 0)	0.6146**	0.2747
Owned irrigated land	0.7441***	0.1028
Constant	-1.5622*	0.8307
Number of observations	379	

Note : ***, ** and* are significant at 1, 5 and 10% of probabilities, respectively

Source: Authors' estimate

Role of institutions in adoption of micro-irrigation

Knowledge about handling the micro-irrigation system is important for its progressive adoption in field conditions. This study has analyzed institutions providing training to farmers on micro irritation in the Sikar and Bikaner districts of Rajasthan. The analysis has revealed that about 55% of sample farmers received training from public sector institutions (comprising SAUs/KVKs, and state departments), followed by private firms (43%), and NGOs (2%). Regarding general awareness about micro-irrigation, about 93% of farmers opined, it is very essential in dealing with the new system (Table 2.17). About dealing with agronomic practices, the majority of farmers (97%) told training is essential to operate sprinkler irrigation systems efficiently. Considering knowledge about suitability of crop using sprinkler, 37% farmers perceived it as very essential. Regarding irrigation management, all the farmers opined it is essential because of increasing water scarcity and the rising cost of irrigation. Training of micro-irrigation system was also viewed essentially by the majority of farmers (81%) in managing pests.

Table 2.17. Farmers' response about components of training on micro irrigation

Components of training	Response of adopted farmers (%)		
	Very essential	Essential	No opinion
General awareness	45.5	46.5	8.1
Agronomic practices	48.5	48.5	3.0
Repair & maintenance	11.6	53.0	35.4
Suitability of crops	36.9	59.6	3.5
Irrigation management	69.7	30.3	0.0
Plant protection	23.2	58.1	18.7

Source: Authors' estimate using field data

Gains From Improved Technology Adoption in Bundelkhand Region

Raka Saxena, Vinita Kanwal and Mohd Arshad Khan

Bundelkhand has been a priority region for the country and special policy packages have been announced to support agricultural production strategies, investment in infrastructure and research & extension. The study examined the status and determinants of technology adoption in one of the most vulnerable regions of India. Adoption of three major technologies, i.e. high yielding variety, micro-irrigation and mechanization were studied based on primary survey conducted using multi-stage random sampling method. In this study, binary logistic regression model is used to determine the factors that significantly affect the adoption of these technologies.

One of the biggest contributors to crop productivity, viz. water is under stress in the region. Adoption of micro-irrigation is very less in the study region. The study found that drip irrigation system increases yields 40-130 per cent while ensuring water efficiency up to 65 per cent. Sprinkler system is more effective in close spacing crops, whereas drip irrigation system is suitable in wide spacing crops. The study showed that adoption of sprinkler irrigation lead to better yield and water use efficiency as compared to traditional irrigation method. The yield of groundnut grown with sprinkler system was found to be 40 per cent higher than that grown with conventional irrigation (Table 2.18). The study showed that socio-economic factors have important effect on the technology adoption in this region. Farmers who shifted to improved crop varieties during the last five years reported significant improvement in crop productivity. Adoption of sprinkler irrigation led to enhanced yield and water use efficiency in comparison to conventional irrigation method of canal, well and tanks. Water use efficiency under micro-irrigation enhanced by 55-65 per cent. Age of the household head was found to have a negative association with the adoption of high yielding varieties for cultivation. This indicates the bending and favouritism

Table 2.18. Crop-wise adoption and impacts of micro-irrigation

Crop	Farmers cultivating (%)	Farmers adopting micro-irrigation (%)	Yield (q/acre)			Water use efficiency (q/acre/cm)		
			Sprinkler irrigation method	Conventional irrigation method	% yield gains	Sprinkler irrigation method	Conventional irrigation method	% Gains
Groundnut	7.87	0.79	10.00	5.96	40.40	0.15	0.07	57.43
Gram	11.81	0.79	10.25	9.12	11.02	1.31	0.51	60.87
Lentil	7.09	0.79	5.25	4.41	16.00	0.67	0.25	63.06
Pea	23.62	7.09	12.42	9.12	26.55	1.30	0.47	64.18
Wheat	7.87	1.57	17.75	14.92	15.94	1.22	0.43	65.13

*Q=Quintal (=100 kg)

Table 2.19. Determinants of adoption of improved agricultural varieties, micro-irrigation and farm mechanisation

Variables	Improved agricultural varieties and micro-irrigation		Farm Mechanisation	
	Coefficient	Marginal Effect	Coefficient	Marginal Effect
Age	-0.062**(0.012)	-0.012	0.027 (0.362)	0.002
Education	0.942(0.297)	0.151	0.179 (0.860)	0.012
Household size	0.018(0.838)	0.003	0.106 (0.378)	0.007
Working members	-0.096 (0.677)	-0.018	-0.177 (0.471)	-0.011
Ration card	1.347*(0.063)	0.204	-1.334 (0.135)	-0.061
Operated land	-0.078 (0.103)	-0.015	0.535*** (0.001)	0.034
Cultivation income	0.000**(0.029)	0.000	0.000 (0.318)	0.000
Livestock income	0.000(0.626)	0.000	0.000 (0.712)	0.000
Non-agricultural Income	0.000(0.228)	0.000	0.000 **(0.022)	0.000
Regular salary earning	0.000**(0.055)	0.000	0.000 (0.133)	0.000
MGNREGA	3.237***(0.006)	0.647	-0.600 (0.548)	-0.042
Herd size	0.058 (0.011)	0.011	-0.019 (0.925)	-0.001
Kisan credit card	0.041 (0.947)	0.008	1.867** (0.032)	0.168
Outstanding amount	0.000**(0.037)	0.000	0.000 (0.459)	0.000
Membership	1.124*(0.075)	0.245	0.131 (0.878)	0.008
Constant	-0.808 (0.594)		-6.456 (0.002)	
LR chi2(15)	43.91		96.98	
Pseudo R2	0.272		0.558	
Observations	126		126	

Note : *, **, *** and represents 10 percent, 5 percent and 1 percent level of significance, respectively. Figures in parentheses indicate the standard errors.

of relatively young generation towards new technologies. Additionally, owning a job card is positive and highly significant in the adoption of advanced varieties. This could be viewed in light of additional source of income and affordability to cost of technology adoption. As job card ensures additional income to farmers, which in turn ensures the additional cost of technology adoption can be met by farmers. Confirming to this, the study established

affirmative and significant effect of household income from cultivation on adoption of improved crop varieties. On the other hand, gross income from regular salary earnings has also significant positive impact on technology adoption. Credit (outstanding loan amount) created an affirmative and important influence on the adoption of HYVs in agriculture. Participation in community organizations and trainings enhanced earnings of households positively and significantly (Table 2.19).

KCC emerged as an important determinant of farm mechanization in the region besides land and income from non-agricultural occupations. Regarding the adoption of farm mechanization, non-agricultural income was positively and significantly linked, revealing that increase in income from non-agricultural sources will increase the amount of money available with the farm households to invest in farm machinery. There should be quick spread of seeds of new, high yielding, stress tolerant & climate resilient varieties to the farmers. Productivity enhancement needs to be coupled with efficient and effective market linkage along with risk mitigation. Effective extension systems hold the key to success in terms of disseminating advanced technological information.

Farm Mechanization : The Role of Custom Hire Services and Rural Labour Market

Nalini Ranjan Kumar and S.K. Srivastava

Mechanization pattern across farm-size categories in wheat growing IGP states

To assess the extent of mechanization in the major wheat growing states of IGP across farm size categories, the mechanization index was estimated for the year 2016-17 using the cost of cultivation (CoC) survey data of the Directorate of Economics and Statistics. A perusal of state-wise mechanization index in Table 2.20 revealed that the level of farm mechanisation was highest in Punjab (0.61) followed by Haryana (0.51), Bihar (0.41) and Uttar Pradesh (0.38). Further, level of farm mechanization was higher on large-size farms in comparison to smaller-size farms in Punjab. A similar trend was observed in other states except in Bihar. For IGP as a whole, the mechanization index varied from the lowest level (0.43) at marginal farms to the highest level (0.49) at large farms indicating high level of mechanization at large farms.

Table 2.20. Mechanization index of wheat farms across farm size categories in major wheat producing IGP states in 2016-17

States	Marginal	Small	Medium	Large	Overall
Punjab	0.60	0.62	0.62	0.61	0.61
Haryana	0.45	0.50	0.49	0.52	0.51
Uttar Pradesh	0.39	0.40	0.41	0.42	0.41
Bihar	0.40	0.41	0.38	0.31	0.38
IGP	0.43	0.44	0.44	0.49	0.45

The sample farmers were also classified into three groups based on the estimated values of mechanization index (Table 2.21). The results showed a wide inter-state variation in farm machinery adoption pattern. Most of the farmers in Punjab and Haryana belonged to high adopter category, whereas in Uttar Pradesh and Bihar, majority of the farmers were medium adopter.

Table 2.21. Distribution of sample farms across major wheat growing states of IGP according to machine adopter categories

Per cent

State	Low adopter (≤ 0.25)	Medium adopter (0.25 to 0.50)	High adopter (> 0.5)	Overall (number)
Punjab	3	12	85	607
Haryana	12	37	51	350
Uttar Pradesh	14	69	17	1173
Bihar	14	80	6	1124
IGP	12	59	30	3254

Impact of mechanization on technical efficiency in wheat production

To quantify the impact of farm mechanization on efficiency in wheat production, technical, efficiency was estimated in IGP states across the machinery adoption categories using Data

Envelopment Analysis (DEA) approach. A perusal of the Table 2.22 revealed that farmers belonging to low adopter category had the highest technical efficiency (TE) in the highly mechanised states of Punjab (0.97) and Haryana (0.93) as well as in IGP as a whole (0.85) which declined with an increase in mechanization level. On the other hand, in moderately mechanized states of Bihar and Uttar Pradesh, technical efficiency increased with an increase in mechanization level.

Table 2.22. Technical efficiency in wheat production across machine adoption category farms and major states of IGP

State	Low adopters	Medium Adopters	High adopters
Punjab	0.97	0.90	0.83
Haryana	0.93	0.86	0.84
Uttar Pradesh	0.82	0.71	0.84
Bihar	0.86	0.75	0.87
IGP	0.85	0.75	0.84

Out of total 3254 sample wheat farms in IGP, 5.4 percent were found to be technically the most efficient; 17.3 percent were less efficient; 57.0 percent were moderately efficient and 20.3 percent were inefficient. As majority of the farms were less than efficient, there exists an ample opportunity for improvement in technical efficiency. Among several measures, acceleration in farm mechanization can play a catalytic role in improving technical efficiency. In highly mechanized states like Punjab and Haryana, judicious use of farm machinery can lead to further improvement in technical efficiency in wheat production. In the case of moderately mechanized states of Uttar Pradesh and Bihar, improved adoption of farm machinery can lead to higher technical efficiency in wheat production.

Impact of mechanization on productivity and profitability of wheat in IGP

The productivity and returns from wheat crop across machine adopter categories in IGP states is presented in the Table 2.23.

Table 2.23. Productivity and profitability of wheat in IGP states in 2016-17

(Rs./ha)

State	Yield (Kg/ ha)	Gross Return	Returns over		
			Cost A1	Cost A2+FL	Cost C2
Punjab					
Low adopter	50.5	97520	62286	55264	27917
Medium adopter	50.5	93284	65371	52804	25219
High adopter	49.6	89363	64172	55208	27110
Overall	49.7	89811	64218	55038	26992
Haryana					
Low adopter	47.9	100896	63769	54328	25292
Medium adopter	47.9	93212	61107	51871	22954
High adopter	49.9	93408	66592	62431	29816
Overall	49.1	93948	64760	58691	27444
Uttar Pradesh					
Low adopter	39.1	76174	47235	37763	18056
Medium adopter	38.1	73887	41422	34803	13036
High adopter	37.0	62106	32960	29381	12221
Overall	38.1	71917	40670	34199	13673
Bihar					
Low adopter	30.7	57474	32663	28834	13217
Medium adopter	31.2	58623	31363	27234	11989
High adopter	34.9	59768	36206	34175	26141
Overall	31.5	58579	32002	28116	13515
IGP					
Low adopter	37.2	72275	43828	36751	17335
Medium adopter	36.0	68725	38909	33066	13672
High adopter	46.0	82438	56251	49769	24493
Overall	39.2	73017	44660	38619	17584

Results revealed that the wheat yield was the highest at 50.5 q/ ha on low adopter farms in the Punjab and a similar trend was observed in the state of Uttar Pradesh. On the other hand, the yield was the lowest (30.7 q/ha) on low adopter farms and highest on high adopter farms (34.9 q/ha) in the Bihar. A similar trend was observed in the Haryana. Overall at the IGP level, the yield of wheat varied from 36.0 q/ha at medium adopter farm to 46.0 q/ ha at high adopter farms. This indicates that the adoption of farm machinery had helped in achieving higher yields in the IGP, though with inter-state variation.

Table 2.24. Estimates of regression adjustment model using Treatment effect for assessing the impact of mechanization on wheat yield

States	Mechan-ization level	Co-efficient (Mean yield)	Robust standard error
Punjab	Low mechanised	51.19**	1.37
	Increase on medium over low	-4.48**	1.68
	Increase on high over low	-2.26	1.43
Haryana	Low mechanised	44.26**	1.50
	Increase on medium over low	3.99**	1.52
	Increase on high over low	3.59*	1.59
Uttar Pradesh	Low mechanised	39.18**	0.57
	Increase on medium over low	-1.25*	0.60
	Increase on high over low	1.21	1.24
Bihar	Low mechanised	30.47**	0.36
	Increase on medium over low	1.15**	0.38
	Increase on high over low	6.98**	1.21

Note: ** and* are significant at 1and 5% of probabilities, respectively

The gross returns were estimated at Rs. 73017 per hectare in IGP which varied from Rs. 68725/ ha at medium adopter farms to Rs. 82438/ha at high adopter farms. The average returns over cost A_2+FL was Rs. 38619/ha in IGP which varied from Rs. 33066/ha at medium adopter farms to Rs. 49769/ha at high adopter farms. Thus, both the productivity and profitability in wheat cultivation has a positive relationship with mechanization level.

A regression adjustment model was fitted to assess the impact of mechanization on wheat yield. In Bihar, the estimated coefficient revealed 1.15 q/ha higher yield at medium adopter farms as compared to low adopter farms (Table 2.24). Further, significant coefficient of 6.9 for the interaction between low adopter and high adopter indicate that the yield will further increase by 6.98 q/ha when mechanization level increases from medium adopter to high adopter level. Similarly, in Haryana, average wheat yield at the farms with low adoption of farm machinery (44.26 q/ha) increased by 3.99 q/ha and 3.59 q/ha under medium and high adoption scenario over the base level, respectively. These evidences establish a positive impact of the farm mechanization on wheat yield in Bihar and Haryana.

However in the state of Punjab and Uttar Pradesh, coefficient of the Average Treatment Effect on Treated (ATET) is negative and significant at medium adoption level and negative but insignificant at high adoption level which indicates that the average yield of wheat will go down with the increase in mechanization level from low to medium adopter farms by 4.48 q/ha in Punjab and by 1.25 q/ha in UP from respective yield at low adoption level. Since the coefficient are significant for interaction between low adopter categories and high categories in both the state there will be no change in wheat yield when there will be an improvement in mechanization from medium adopter categories to high adoption categories. This may be due to more use of machinery and other inputs at high adopter categories of farms in Punjab. Thus it can be concluded that the mechanization level has a significant and positive impact on wheat yield in all the states excepting Punjab and Uttar Pradesh where improvement in mechanization leads to a reduction in yield and hence farmers of these

states require skilling on optimum use of scarce resources including farm machinery in wheat production.

Technology Foresight in Agriculture

Subash, S.P., Md. Ejaz Anwer, Arathy Ashok and Suresh Pal

Bibliometric analysis of artificial intelligence in agriculture in India

The objective of the study was to carry out a bibliometric analysis of studies on artificial intelligence in agriculture. Web of science database and keyword search were used to extract bibliometric data and the extracted data was visualized using VoS viewer. Artificial Intelligence (AI) is an umbrella term for multiple computer science technologies and a vital tool for many businesses which can be combined in different ways to perform capabilities normally

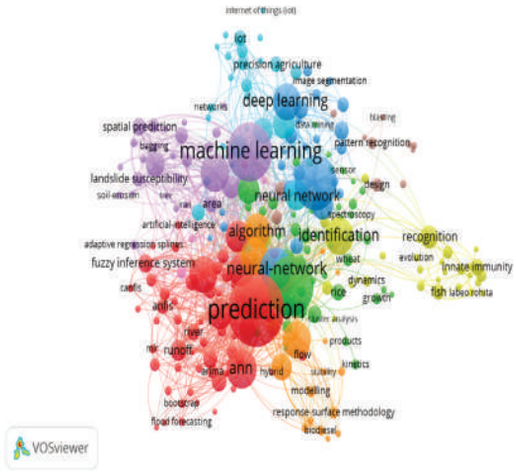


Figure 2.14. Co-occurrence data of AI techniques

requiring human intelligence. Keyword co-occurrence data was analyzed to get a landscape of different AI techniques used in agriculture (Figure 2.14). The analysis showed the application of these techniques in different areas of agriculture. The study also looked into the co-authorship network by institutions (Figure 2.15). The co-authorship network is used as a proxy to understand the collaboration between different institutions working on AI in agriculture in India. The analysis shows that

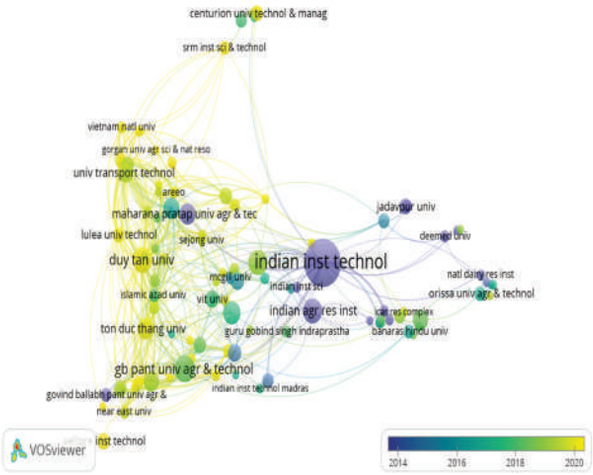


Figure 2.15. Co-authorship network to see collaboration

IITs, ICAR institutes, Deemed Universities are closely collaborating, while SAUs and other private research institutions are farther in from these networks. Among ICAR institutes, the Indian Agriculture Research Institute (IARI), and among SAUs, G. B. Pant Agricultural University are key collaborating universities. This analysis provides insights on developing new collaboration among institutes in the National Agricultural Research and Education System (NARES) in India.

Recent Developments in the Herbicide Research Domain: A Bibliometric Assessment

Jamaludheen A., Praveen K.V. and Prem Chand

Herbicides continue to be an integral part of weed control in global agriculture and hence the researches related to herbicides have paramount importance. A bibliometric analysis of herbicide research was undertaken during the period from 2011 to 2020. For this, the bibliometric data on published literature was collected from the ISI Web of science core collection database in March 2021. A combination of search strings was used to obtain the appropriate data on herbicide research. The web of science inbuilt "Analyze result" option is used for the preliminary analysis of the data and VOS viewer software is used for network analysis and visualization. The results indicated

that there are 9,980 published articles on herbicide research with an average citation per article of 9.94 during this period. The volume of publications exhibited an increasing trend over the years. Further, the leading countries involved in the herbicide research domain are the USA, China, and Brazil. With the help of co-occurrence analysis of author keywords (Figure

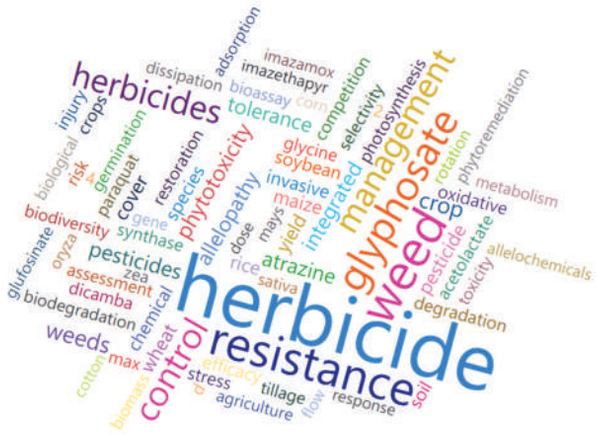


Figure 2.16. A cloud view of author 'keywords' used in research publications during 2011-2020

2.16), the study found that herbicide resistance was the most preferred domain chosen by the researchers. Co-authors' network showed that the USA showed the highest link strength and hence it was connected to many countries but closely to China and Canada (Figure 2.17). The second and third highest link strength was observed for China and Canada, respectively.

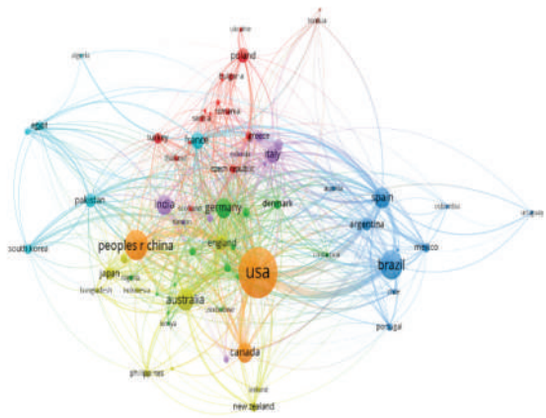


Figure 2.17. Co-authorship network of top countries in herbicide research

Management and Impact Assessment of Farmer FIRST Project

Vinayak Nikam, Shiv Kumar, Kingsly I.T., S.J. Balaji, Abimanyu Jhajhria, Raj Kumar and Davendra Kumar

Economic potential of AVIKASIL-S technology for estrus synchronization in sheep

The ICAR-Central Sheep and Wool Research Institute, (ICAR-CSWRI), Avikanagar (Rajasthan) has developed an estrus synchronization technology called AVIKASIL-S. Though this technology has been developed quite earlier still it is in a nascent stage of adoption. The study quantified the expected economic surplus generated by the technology if adopted by farmers at varying levels using an economic surplus model. The break-even point of the technology could be achieved even at an adoption level of 0.02% in 2011–12. The technology when adopted by 0.02% of the farmers in the state would start generating economic surplus in the society. The study projected the economic benefits till 2030, where at a one percent level of adoption, this technology would generate net benefit of Rs. 506.74 lakh, with an internal rate of return (IRR) of 27% and the Net Present Value (NPV) of Rs. 1,048.59 lakh. A sensitivity analysis was performed for a range of values of adoption rate at 5%, 10%, 20%, and 30 %. With the increase in the adoption rate to 5%, IRR would be 33%, and the total gain would be Rs. 4,645 lakh. At 30% level of adoption, NPV would be Rs. 28,059 lakh, a total surplus of Rs. 5,952 lakh, and an IRR of 42%. The economic appraisal parameters of technology decipher that if efforts are made to increase the adoption of the technology at a larger scale, society would be immensely benefited. The technology has potential but at present adoption is minuscule. To reap the more benefits of technology, the adoption rate needs to increase. Wider dissemination and adoption over a time horizon would help shepherds to get enhanced income as well as consumers to get meat at an economic rate.

Performance and Impact Assessment of Agricultural Extension and Advisory Systems

Arathy Ashok, Vinayak Nikam and Suresh Pal

Access and impact of information on cotton yield in Jalgaon, Maharashtra

Determinants of access to information from different sources and impact of information on cotton output in irrigated agro-ecosystem of Jalgaon district of Maharashtra were studied by conducting primary survey of 292 cotton farmers. Probit model was fitted to identify determinants of access to information from a particular source.

Age, education, irrigated area, innovativeness, and social category of the farmers were found to be important determinants of access to information from government sources (Table 2.25). More experienced farmers were more likely to access government sources for the information. The education level of the farmers positively influenced their access to mass media and ICT and other sources. Farmers with better educated level were likely to give more value to extension advice than their counterparts. Landholding of the farmers was an important determinant of access to information from mass media, while land type and social category of the farmers affected negatively and significantly. Access to information from FPOs was determined by age, education, and membership in village organizations. The age of the farmers was negatively related to access to information from ICTs, indicating more use of ICT by the younger farmers. Farmers with more landholding and irrigated areas would use more ICT to obtain information.

The impact assessment analysis revealed that farmers accessing information from at least one formal source had significantly higher yield (11%) than the farmers who did not access any formal source. Source-wise impact of information revealed that access to government sources resulted in 3.5 percent higher yield to the farmers as compared to their counterparts who did not receive information from government sources. Farmers receiving information from the mass media had significant yield advantage of 9.8 percent. Notwithstanding most of the contribution to the mass media like TV, Radio, and Newspaper largely comes from the public extension or research personnel, showing their indirect impact on the output of the farmers. Because of the large number of vacancies and overburden of administrative work, the contribution of public extension functionaries was less, however, through mass media, they are reaching a large number of farmers and helping in increasing their output and income. The evidences suggest increasing use of mass media by government sources, devising effective extension models for FPOs, enhancing efforts to increase the trustworthiness of ICT, etc.

Table 2.25. Determinants of obtaining information from different sources

Particulars	Government sources	Mass media	FPOs	ICT	More than two formal source
Age	0.013**	0.009	0.019**	-0.03***	0.018**
Education	0.049**	0.076**	0.032	0.089***	0.099***
Landholding	0.015	0.027*	-0.006	0.034**	0.02*
Membership	0.253	0.71**	0.288	0.19	0.567**
Irrigated area	-0.002	0.002	0.002	0.008**	0.003
Land type	0.093	-0.243 **	0.054	0.006	0.152
Innovativeness	-0.119 *	-0.031	-0.224 **	-0.061	0.017
Social category	-0.615 **	-0.168	-0.343	-0.189	-0.299
Intercept	-0.404	0.116	-1.702**	-0.562	-1.214*
Likelihood ratio test	-189.84**	-136.31***	-123.47**	-147.63***	-166.42***

Note: ***, ** and * represent significance levels at 1%, 5% and 10%, respectively.

Database Development for Agricultural Rural Households with Special Focus on Weaker Sections

Subhash Chand, Rajni Jain, Vikas Kumar, Dilip Kumar, Khyali Ram Chaudhary and M.S. Chauhan

Decadal change in cropping pattern

Farmers in Bulandshahar, cultivate crops, viz. wheat, rice, sugarcane, maize, onion, rapeseed and mustard, potato, fruits and vegetables, and fodder crops. It was observed that there is an increase in area under rice, sugarcane, fruits and vegetable, and potato during 1990 to 2017. The compound decadal growth rate for these crops was positive in rice (112%), fruits and vegetables (10%), sugarcane (3%), and potatoes (3%). This change in cropping pattern was due to assured irrigation, subsidized inputs, pest and disease control, high yielding and resistant varieties, and assured procurement by government and private agencies. However, during 1990s, the farmer used to cultivate minor millets and other crops due to deficit water availability and other inputs. Over the years, the area under pearl millet (8%), sorghum (100%), rapeseed and mustard (45%), oilseeds (48%), and barley (75%) and sesamum (97%) has declined (Figure 2.18). Assured irrigation and accessibility to market services contributed to crop diversification in the district.

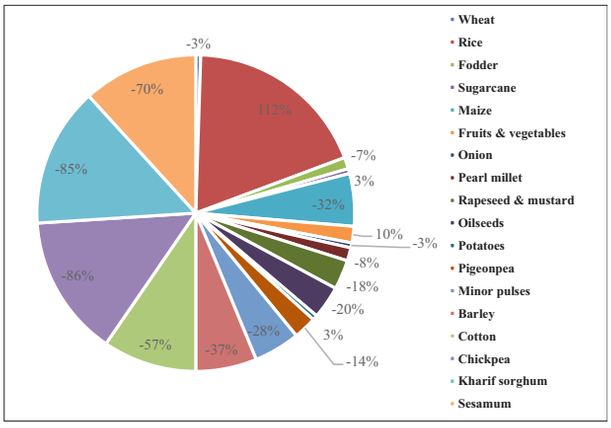


Figure 2.18. Decadal growth rate of area under different crops.
Source: District wise data, ICRISAT, 2020 and https://dacnet.nic.in

Data Warehousing for Open Data Sharing in Agriculture

G.V. Anupama, Rajni Jain, Thomas Falk, Uttam Deb and Cynthia Bantilan

Data warehouse (DW) approaches have the potential to facilitate accessibility and analytical explorations of agricultural big data and steer forward the open data charter. The study aimed to document and share information about the successful DW project and elaborate the process followed in the project, challenges faced and actions taken to overcome the challenges. Figure 2.19 shows the architecture for DW development for VDSA (Village Dynamics in South Asia) household data.

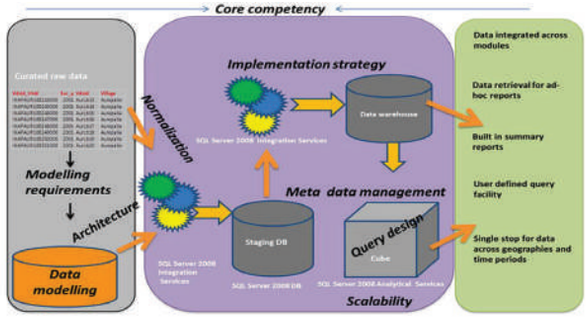


Figure 2.19. Architecture for DW development for VDSA household data

The VDSA-DW has greatly facilitated harmonization and user-friendly access of longitudinal data collected at different scales, geographies, and across a wide range of domains of agricultural systems (Figure 2.20). This created an opportunity for a global community of scientists to study South Asian agricultural systems across geographies over almost half a century. The DW substantially reduced the time and effort to generate reports and extract data for more in-depth analysis.

DW development process provided a framework for better data management. The source data was in a variety of formats but the DW structure forced the data owners to clean and harmonize the data. This removed important constraints in using the dataset. Earlier, cleaning and harmonization used to be performed individually by each data user.

The probability of data being used substantially increases if potential users are provided with tools to quickly understand the data, orient themselves to its structure, intuitively merge module data into data formats fitting to their research interests and analyze the data for immediate adaptive and dynamic decision support. This is of special importance given that the DW for agricultural data targets more diverse users than most private-sector DWs.

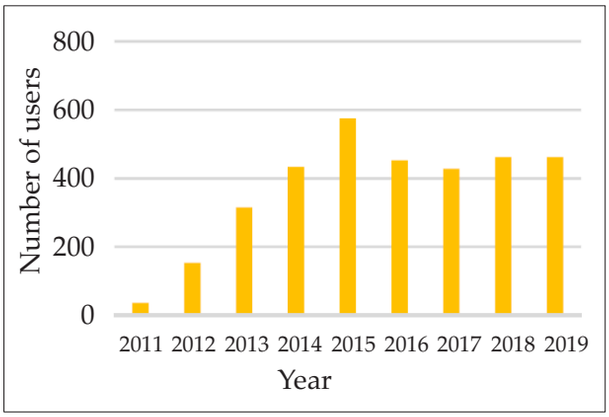


Figure 2.20. VDSA data access by users across the world
Source: http://vdsa.icrisat.ac.in/

The need for continuous interactions between the technical team and scientists is a key lesson learned from the VDSA-DW process. Only such an inclusive, teamwork approach ensures that the DW product fits the data and the needs of the users and fulfils its envisioned function. This study has documented how developments in information technology can be innovatively used to promote open data and enhance the impacts of research funded by governments, foundations, and philanthropists. The study stimulates interest among researchers and donors in building DW for better management and use of data.

Identification of Optimal Crop Plan using Nature Inspired Metaheuristic Algorithms

Kamalika Nath and Rajni Jain

The study aimed to explore three nature-inspired metaheuristics algorithms, namely Differential Evolution (DE), Genetic Algorithm (GA), and Particle Swarm Optimization (PSO) for developing optimal crop plans with the objective of improving the net benefits from the farming activities in Punjab. Resource constraints considered for the study are maximum available land area, groundwater availability, and cropped area for different crops. The results were compared with an LP-based plan from LINGO software (Figure 2.21). The results revealed the net benefit per ha derived using DE, PSO, GA, and LINGO as Rs. 73842, Rs. 73439, Rs. 70556, and Rs. 73842 for Kharif crops and Rs. 20185, Rs. 20173, Rs. 19861, and Rs. 20185 for rabi crops, respectively. It is observed that PSO and DE performed better in contrast to GA and comparable to LP. For the adoption of these techniques by academicians and policy researchers, a multi-pronged strategy is needed. Efforts should be directed towards (i) multi-disciplinary research including evolutionary computation experts, (ii) easy-to-use functions and modules for DE, PSO, GA, and LP, (iii) extending the functionality for crop planning, and (iv) capacity building.

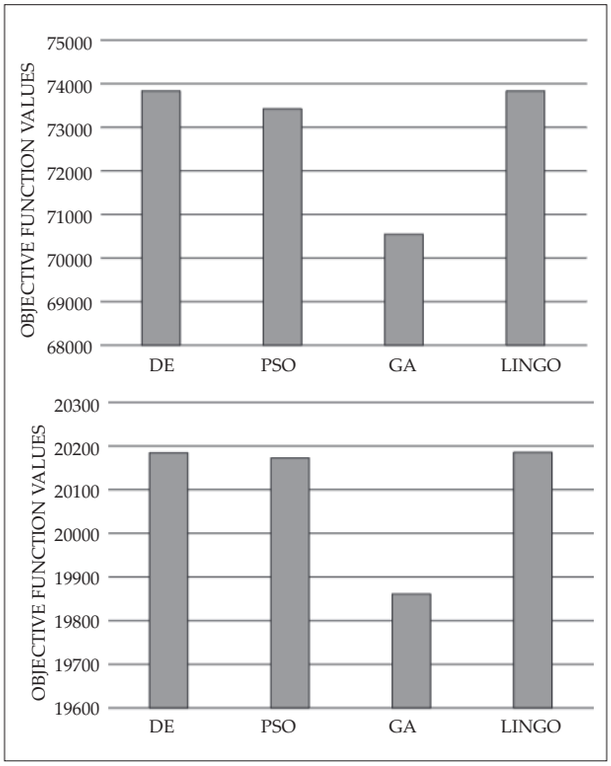


Figure 2.21. Comparison of evolutionary computation techniques for crop planning for Kharif and Rabi crops

AI Model for Disease Identification

Sapna Nigam, Rajni Jain, Sudeep Marwaha and Alka Arora

Automated image-based tools are required for the identification of plant diseases when human assessment is inappropriate, unreliable, or unavailable. Artificial Intelligence (AI) applications have achieved exponential growth leading to the development of novel methodologies and models. This study demonstrated the use of deep learning, an AI-based technique, to identify wheat leaf diseases. The study was based on 4000 images of which 50 percent were infected with rust (Figure 2.22).

The study used the Keras - an open-source deep-learning library and PyCharm - python IDE for programming and AI model for disease identification. The objective was to develop and evaluate the predictive performance of the AI model on unseen data of yellow rust infected leaves. It was observed that with the increase in the number of images used for training the model, the predictive accuracy improves to the extent of 97.4% (Table 2.19). There is a need to bring the AI revolution in agriculture by developing databases of images, availability of High-Performance Computing (HPC) infrastructure on the cloud, and enhancement of expertise. The findings can be further extended to automate the process of wheat disease identification using the mobile app.

No. of images	Accuracy (%)
100	76.0
200	77.5
500	83.3
1000	90.2
1500	93.6
2000	97.4

Figure 2.22 . Healthy and infected leaf image of wheat plant and accuracy of images.

Theme III

AGRICULTURAL MARKETS AND TRADE

Excerpts

- The outlook model for cereals projected that rice production would increase to 128.5 million tonnes by 2025 and 138.9 million tonnes by 2030, and the net export potential would increase from 10 to 17 million tonnes during this period.
- India has immense potential and comparative advantage to export castor oil to China, Netherlands and USA, and is competitive than France, Japan, Thailand and Germany. The other competitive commodities are onion, chillies and pepper.
- Rice, frozen bovine meat, cotton yarn, raw cotton, ginger, pepper and seed spices remained highly competitive commodities during 2011-18. Crustaceans emerged as highly competitive during 2015-18. The revealed comparative advantage of India, Ecuador and Canada has increased over time. India has exported USD 4,640 million worth of crustacean in TE 2019.
- Marine products, the single largest export item hold as large as 47 to 85 percent of untapped export potential that can be made available through effective supply chain management and policy interventions.
- The study of offshore fishing indicated that many commercially important fish stocks along the coastal waters have been overfished and hence deep sea fishing is the other alternative. There is immense scope to enhance the economic efficiency and viability of deep sea fishing through cutting costs, efficient gear operations, scientific on-board fish handling, and better value chain linkages.
- An integrated system of milk production and processing is more profitable over other systems that work as either milk collection centre or vendor system alone. For leveraging milk value chain, three important key interventions are crucial (1) Training in milk handling, (2) Packing and processing; efficient transportation and processing technology; and (3) Efficient design of procurement systems.
- Instability in onion production can be reduced by reducing regional concentration of onion production. The geographical diversification and redistribution of the crop to newer pockets shall help in minimising the impact of production uncertainties on price volatility.
- In fruits, dry fruits and other plantation crops, more than 80 to 85 percent forecasts accuracy has been achieved in price forecasts. However, in vegetable crops, forecast precision is observed to be low.
- The impact of COVID-19 lockdown has been worked out on prices, arrivals and international trade of agricultural commodities. In many essential commodities, both arrivals and prices have declined temporarily during the lockdown, reducing the product monetisation. However, these were restored after opening of transport of agricultural commodities.

Role of Exports to Growth and Income

Balaji S.J. and Subash S.P.

The Government of India announced Agricultural Export Policy (AEP) in 2018 aiming to double the agricultural exports to the tune of USD 60 billion by the year 2022. The policy identifies a number of commodities and their target markets abroad, but there is a need to understand the relative competitiveness of India's competitors exporting the same commodities to the countries where India's major exports are dealt. In this direction, a sub-set of commodities identified in the AEP was chosen. The countries that compete with India in the same export markets were identified using the Revealed Comparative Advantage (RCA) for the TE 2019. The results showed that India has tremendous potential to export castor oil to China (mainland), Netherlands, and the USA and is competitive than France, Japan, Thailand, and Germany who are the key exporters to these countries. Onion and chillies are the other competitive commodities with higher RCA indices (5.69 and 5.15, respectively), followed by pepper (after Indonesia). The indices are relatively lower for grapes, cardamom, tea, banana, potatoes, and oranges. It stands that while attempts are being made to promote clusters aiming to improve exports, attention shall be paid on product quality differences and other concerns with respect to the products originating from our competitors.

Structure, Performance and Competitiveness of Indian Agricultural Exports

Raka Saxena, Priyanka Agarwal, Rohit Kumar and Raman M.S.

Trade in agricultural commodities can play a significant role in stabilizing supply conditions and agricultural prices besides ensuring food security. Diverse agro-climatic conditions in India facilitate the production and trade of various agricultural commodities. Agricultural exports from India have undergone significant change in terms of trends, composition, and diversification (Figure 2.23). We examined trends in exports of agricultural commodities, export performance, commodity and geographical diversification, and established the trade-growth linkages. Export performance was examined through a comparative export performance index. Since 2001, cotton and cereals, especially rice have been major contributors to agricultural exports. Also, the share of meat and edible meat offals has consistently increased from 2001 to 2018. An analysis of export performance categorized various commodity groups into highly competitive, competitive, weakly competitive and uncompetitive commodities during the periods from 2011-14 and 2015-18. During 2011-18, rice, frozen bovine meat, cotton yarn, raw cotton, ginger, pepper and seed spices remained as highly competitive commodities. Crustaceans emerged as highly competitive during 2015-18. Granger causality established bidirectional causality in tea, coffee & spices and fish exports, while export-led growth hypothesis was confirmed in the case of cotton.

The results indicate no change in export performance of the cereals during the study period and they remained competitive throughout. Although, the within-commodity group scenario is interesting, as rice (HS 1006) is the only commodity that is highly competitive for India; while maize (HS 1005), wheat and meslin (HS 1001) are uncompetitive as indicated by the negative value of Symmetric Comparative Export Performance (SCEP) Index. Meat is dominated by the exports of frozen bovine meat, and India enjoys competitiveness in its exports (Table 2.26). The performance of the other two products, i.e. edible meat offals (HS 0206) and sheep and goat meat (HS 0204) improved during 2015-18; however, they remained uncompetitive. The export performance of the fish and crustaceans, molluscs and other aquatic invertebrates (HS 03) remained weakly competitive throughout. India has emerged in the competitiveness of crustaceans (HS 0306), as their status changed from competitive during 2011-14 to highly competitive during 2015-18. Pepper (HS 0904), ginger (HS 0910), and seeds of anis, badian, fennel etc. (HS 0909) remained highly competitive. India remained competitive in case of tea (HS 0902), but is uncompetitive for coffee (HS 0901).

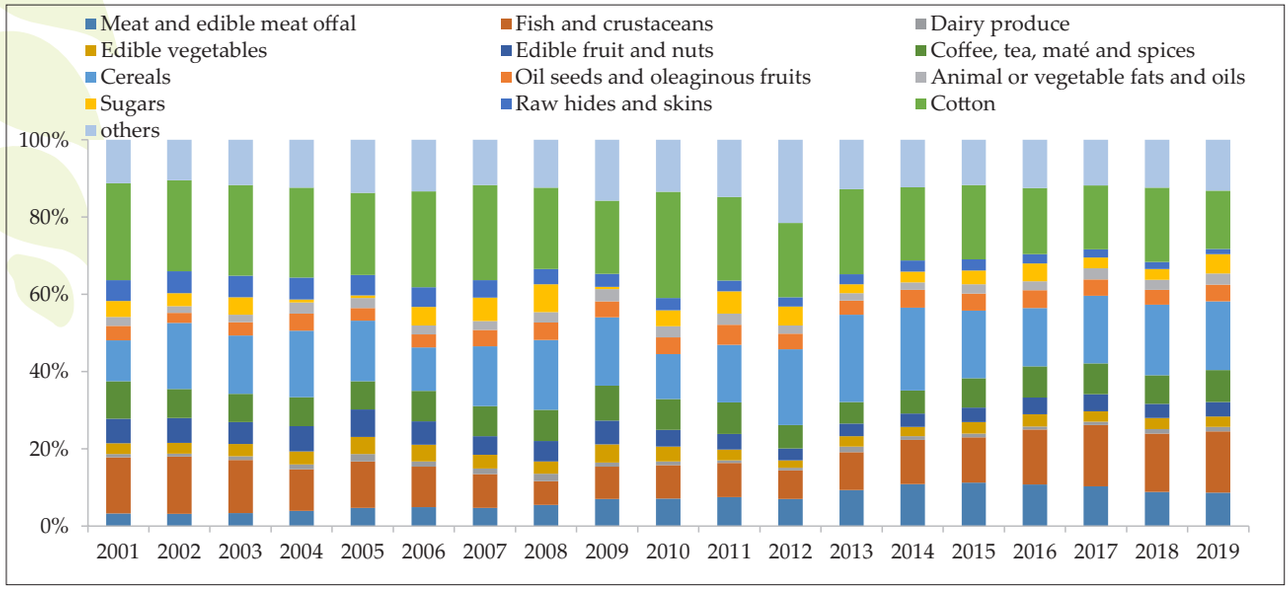


Figure 2.23. Composition and trends in agricultural exports from India

Table 2.26. Classification of the selected products based on SCEP (2015-18)

Highly competitive	Competitive	Weakly Competitive	Uncompetitive
1006 Rice 0202 Meat of bovine frozen 0306 Crustaceans, whether in shell or not 0904 Pepper of the genus Piper 0909 Seeds of anis, badian, fennel etc. 0910 Ginger, saffron, turmeric "curcuma", thyme 5205 Cotton yarn 5201 Cotton neither carded nor combed	0307 Molluscs, fit for human consumption 0902 Tea, whether or not flavoured 5208 Woven fabrics of cotton 5209 Woven fabrics of cotton	Nil	1005 Maize 1001 Wheat and meslin 0206 Edible offals of bovine animals, swine etc. 0204 Meat of sheep or goats 0303 Frozen fish 0901 Coffee

In assessing the status of export diversification of agricultural commodities, Herfindahl-Hirschman Index was used. Figure 2.24 portrays the commodity diversification in India's exports of selected commodities. The commodity diversification was worked out at four-digit Harmonized System (HS). Meat turns out to be the least diversified commodity group as it is dominated by the exports of frozen bovine meat. Also, the commodity diversification index for cereals has remained quite low and declined over time, as the category consists of predominantly rice exports. Commodity diversification within cotton category has almost remained stable during the recent decade.

Dynamics in Global Crustaceans' Exports and Competitiveness: Scanning from Indian Perspective

Raka Saxena, Ranjit K. Paul, Ritambhara Singh and Rohit Kumar

The prominent role of the fisheries sector in economic development and livelihood security is unquestionable. India, exporting USD 4,640 million in TE 2019, is the largest crustaceans'

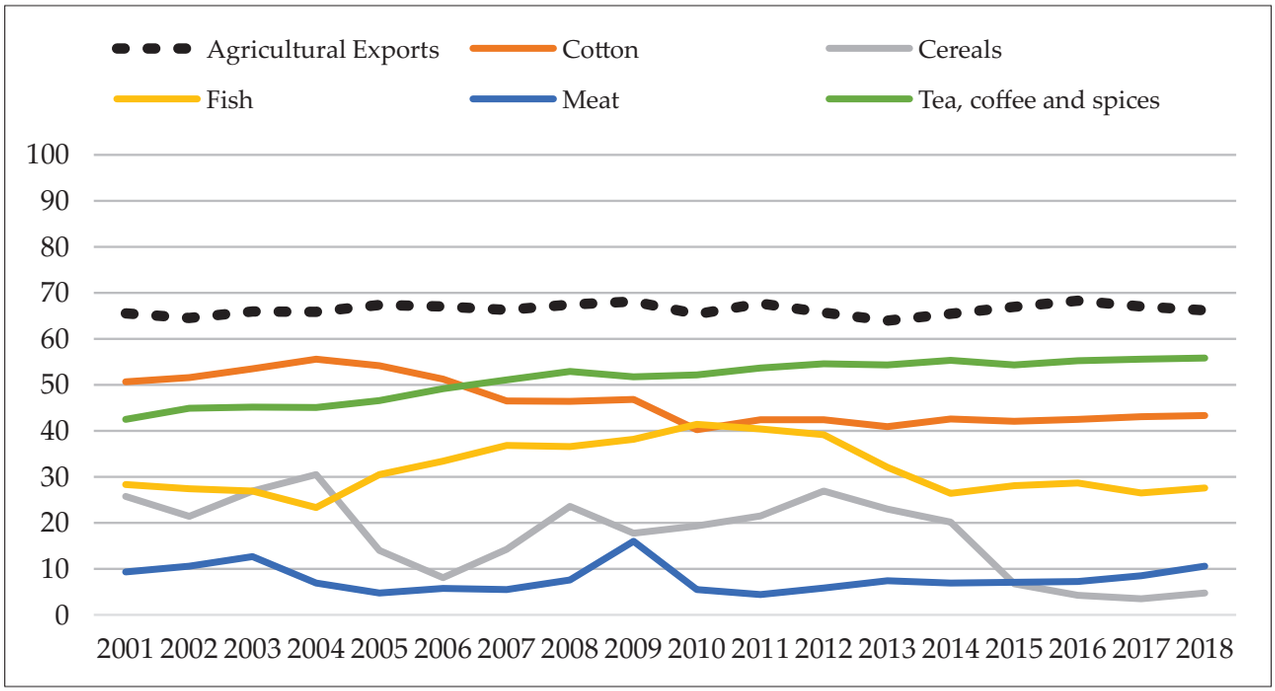


Figure 2.24. Commodity diversification index of agricultural products in India

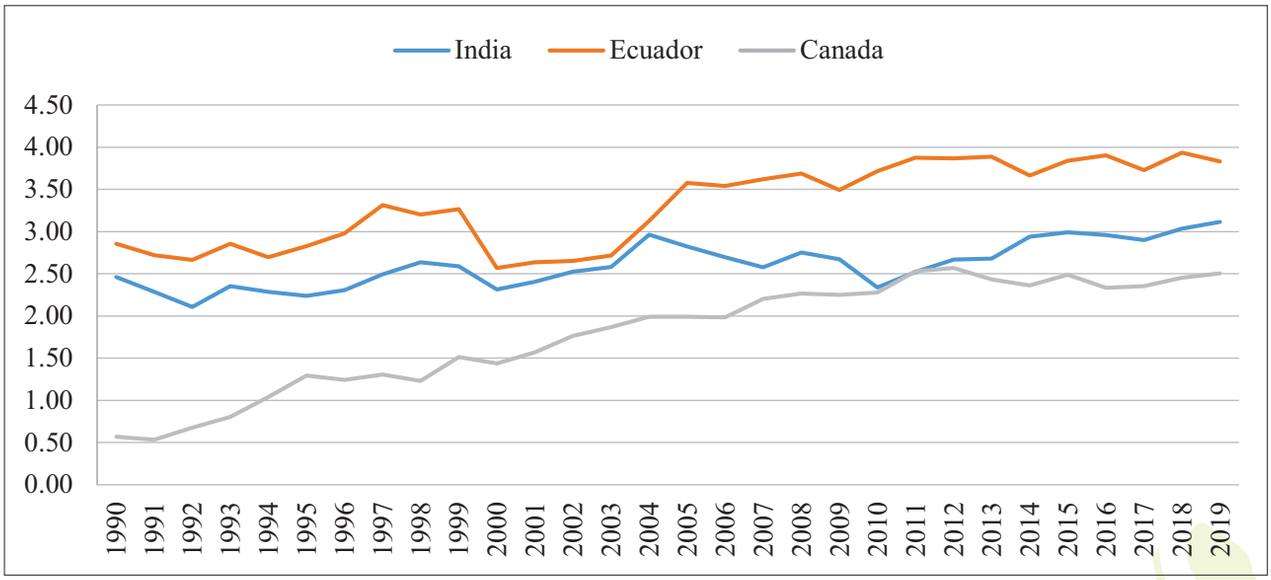


Figure 2.25. Trends in RCA for major crustacean exporters

exporter in the world followed by Ecuador and Canada with the USA emerging as a single major export destination for India (Figure 2.25). The revealed comparative advantage (RCA) of India, Ecuador and Canada have increased over time. Interesting global linkages in crustacean competitiveness were made evident with the detection of unidirectional causality flows from Canada to India's RCA and Canada to Ecuador's RCA. An unidirectional causality from crustacean export to India's RCA was also confirmed. Hence, to reap further gains, enhancing competitiveness and strengthening market intelligence on international markets are need to be promoted.

First equation in the Vector Error Correction model (Table 2.27) revealed that if there are any

Table 2.27. Estimtaed parameters of vector error correction model

Error Correction:	lnRCA India	lnICEX	lnIUVR	lnRCA Canada	lnRCA Ecuador
Coint Eq1	-0.97 (-5.66)	-0.83 (-1.14)	0.26 (0.44)	0.30 (0.82)	-0.47 (-1.58)
D (lnRCA India (-1))	0.30 (1.98)	-0.19 (-0.30)	-0.53 (-0.99)	-0.20 (-0.61)	0.17 (0.65)
D (lnICEX (-1))	-0.18 (-2.41)	0.05 (0.17)	0.08 (0.33)	0.18 (1.12)	-0.14 (-1.12)
D (lnIUVR (-1))	0.23 (2.72)	-0.08 (-0.22)	-0.13 (-0.44)	-0.14 (-0.76)	0.04 (0.28)
D (lnRCA Canada (-1))	-0.11 (-1.21)	-0.27 (-0.67)	-0.05 (-0.14)	0.24 (1.16)	-0.15 (-0.90)
D (lnRCA Ecuador (-1)	0.28 (2.01)	1.06 (1.81)	0.55 (1.15)	-0.46 (-1.55)	0.05 (0.20)
C	0.02 (2.11)	0.08 (1.74)	0.01 (0.18)	0.04 (1.47)	0.03 (1.50)
R-squared	0.64	0.16	0.10	0.19	0.13
Log likelihood	51.81	11.43	17.09	30.37	36.36
AIC	-3.20	-0.32	-0.72	-1.67	-2.10

Note: Figure in parentheses represent t-statistics

shocks in the independent variables, RCA of India will move towards equilibrium quickly, as 97 percent of error is being corrected within the year itself. The export of crustacean products holds tremendous importance as the country is a prime exporter in the world in this category. Improving competitiveness in this category would further help to enhance Indian exports and strengthen its global presence. India should keep investing in R&D and use innovative technologies for quality improvement and sustaining its RCA in the long run.

Impact of COVID-19 Lockdown on Agricultural Markets

P. Sharma, A. Jhajhria and Kingsly I.T.

Agricultural markets and commodity prices

Impact on prices

The wholesale and retail prices of foodgrains and edible oils in the four metro cities increased moderately (less than 10%) during the fortnight ending in the first phase of lockdown over the pre-lockdown fortnight, except for gram dal in Mumbai and Tur dal in Chennai (Table 2.28). Prices of pulses continued to increase even during the second phase of lockdown. This was partly because of the supply disruptions due to the closure of dal mills due to non-availability of labour and lockdown restrictions and change in consumer preferences from animal protein to vegetable protein. The prices of vegetables rose significantly (15-50%) during the first phase of lockdown mainly due to disruptions in the supply chains and a large part of the price change was because of the lean season for vegetables. The government efforts towards easing lockdown restrictions on agricultural and marketing activities resulted in the easing of prices of essential food commodities during subsequent phases of lockdown, except for the off-season perishable commodities.

Impact on market arrivals

End of March and April months are peak harvesting periods for rabi crops and a significant proportion of crop produce arrives at the market. Mostly, marginal and small farmers sell their produce immediately after

Table 2.28. Changes (%) in wholesale and retail prices of essential food items in metro cities during different phases of the lockdown and unlocking periods

Prices	Centres	Lock1	Lock2	Lock3	Lock4	Lock5	June2F	Jul.1F	Jul.2F	Aug.1F
Wheat wholesale	Delhi	0.0	-1.6	-6.6	-2.4	0.3	-1.1	0.8	-1.1	-2.3
	Mumbai	-4.6	0.5	0.0	0.2	0.7	-2.4	-4.3	0.0	0.0
	Chennai	2.6	7.2	1.2	1.8	0.0	0.0	0.0	3.8	1.2
Wheat retail	Delhi	0.0	0.0	-3.0	-1.2	0.0	-8.7	0.0	-2.7	-2.1
	Mumbai	-0.3	5.3	1.1	0.0	0.0	-2.3	-3.5	0.0	0.0
	Chennai	3.2	8.2	2.1	3.3	0.0	0.0	0.0	0.0	0.0
Gram dal wholesale	Delhi	0.4	2.0	0.4	-0.7	-0.7	-3.3	0.9	-1.3	-1.3
	Mumbai	14.3	2.1	0.0	-1.0	-7.0	1.3	2.2	-0.6	-2.8
	Kolkata	9.0	15.6	4.6	-16.1	-2.7	-4.0	0.2	-0.6	-0.4
	Chennai	5.2	6.8	-2.5	0.0	0.0	-3.2	0.0	1.0	-0.7
Gram dal retail	Delhi	7.5	12.2	-1.5	-9.3	-1.1	-5.3	2.0	-2.2	-1.2
	Mumbai	12.1	8.6	-0.4	-1.0	-3.6	1.0	1.4	-0.3	-2.1
	Kolkata	7.6	13.3	4.0	-14.8	-2.9	-1.9	0.2	-0.5	-0.4
	Chennai	6.6	9.2	3.2	-0.9	-1.5	-5.5	1.5	0.0	0.0
Tur dal wholesale	Delhi	1.1	6.5	-0.2	-2.1	-1.9	-2.0	3.2	-2.0	-1.3
	Mumbai	7.6	4.9	0.0	-0.8	-5.5	-0.8	-1.4	-0.6	-2.9
	Kolkata	3.3	5.9	0.0	0.0	0.0	-0.8	0.7	0.2	-1.7
	Chennai	6.1	14.9	-4.3	-0.6	-6.7	-2.0	-0.2	0.0	-1.7
Tur dal retail	Delhi	5.7	4.4	3.3	-2.5	-2.3	-5.0	0.6	0.0	0.2
	Mumbai	7.2	11.5	1.3	-0.9	-3.4	-0.7	-1.1	-0.3	-2.4
	Kolkata	3.2	5.2	0.0	0.0	0.0	-0.7	0.6	0.2	-1.5
	Chennai	13.1	10.3	-0.6	-1.3	-3.0	-1.6	-0.1	0.0	-1.6
Groundnut oil wholesale	Delhi	-0.1	1.9	1.8	6.1	1.7	2.2	0.6	-1.7	-2.2
	Mumbai	2.8	5.2	-0.1	6.1	-0.3	-4.0	-1.0	-5.0	-2.2
	Kolkata	1.4	1.4	2.3	0.1	1.3	-1.9	7.1	6.4	-4.5
	Chennai	4.8	0.0	1.3	4.5	0.4	3.0	-0.3	0.4	-1.1
Groundnut oil retail	Delhi	4.5	2.6	2.5	0.6	0.0	0.0	0.0	0.0	0.0
	Mumbai	4.0	1.6	1.3	3.6	-0.2	-2.9	-0.5	-4.5	-1.7
	Kolkata	1.3	1.3	2.2	0.1	1.2	-1.8	6.7	6.0	-4.2
	Chennai	4.1	2.7	-0.1	6.7	0.5	-0.5	0.5	0.0	0.3
Onion wholesale	Delhi	-22.3	-23.5	-18.5	-12.8	-8.4	34.9	4.7	14.0	2.8
	Mumbai	-10.4	-35.4	4.7	-13.0	-15.8	9.7	-4.5	-3.0	4.6
	Kolkata	0.0	-2.9	-13.6	2.2	-12.6	24.9	-8.9	10.6	-2.9
	Chennai	7.4	-31.9	1.8	-16.9	-9.6	33.8	-1.2	-7.1	8.4
Onion retail	Delhi	3.1	-15.2	-10.0	-19.3	-9.0	19.0	-6.1	-7.8	-1.6
	Mumbai	6.9	-16.2	-4.6	-7.2	2.4	1.6	-1.2	-1.8	-0.8
	Kolkata	0.0	-9.6	-20.9	2.3	-8.8	18.7	-5.1	6.5	0.0
	Chennai	12.8	-24.9	32.6	-37.1	-8.9	22.1	-9.1	-3.5	0.5

Contd...

Table 2.28 Contd...

Potato wholesale	Delhi	16.8	-8.6	5.9	-5.2	6.4	2.3	3.0	14.2	12.1
	Mumbai	12.2	-9.1	-2.5	0.0	0.0	4.7	6.1	3.9	2.3
	Kolkata	33.2	8.1	-5.0	5.4	9.9	2.7	10.2	10.0	-0.4
	Chennai	27.3	-1.8	-4.9	-6.2	11.4	11.7	-2.4	6.0	3.3
Potato retail	Delhi	24.9	-13.6	4.8	0.0	0.0	0.0	6.2	3.6	1.7
	Mumbai	15.8	5.7	6.2	1.8	-0.2	3.0	3.8	2.1	1.0
	Kolkata	27.9	7.1	-4.4	4.7	8.8	2.4	9.2	9.0	-0.3
	Chennai	24.7	-4.3	20.0	-28.6	11.1	15.2	2.3	18.7	-6.9

Note: The change denotes the percentage change in fortnightly average prices over the pre-lockdown/previous lockdown phase/ unlock period ending fortnight. Lock1- lockdown 1, Lock2- lockdown 2, Lock3- lockdown 3, Lock4- lockdown 4, Lock5- lockdown 5, June.2F- June second fortnight, July.1F- July first fortnight, July.2F- July second fortnight and Aug.1F- August first fortnight.

Table 2.29. Market arrivals for major commodities ('000' tonnes)

Period	Commodities	March	April	May	June	July
TE 2019	Wheat	1546.3	15566.5	5970.9	1407.7	982.7
	Paddy Common	912.3	885.0	1209.7	1050.4	709.9
	Mustard	688.2	631.0	377.4	211.8	123.6
	Bengal Gram	426.1	618.6	720.6	340.7	188.1
	Lentil	79.8	85.7	98.1	54.8	50.8
	Potato	1530.9	923.7	894.0	856.2	893.9
	Onion	1093.9	1115.4	1309.8	1483.0	1061.8
	Tomato	232.7	239.9	278.8	281.6	292.5
2020	Wheat	1035.1	3725.4	7349.9	2302.2	791.1
	Paddy Common	726.5	712.7	1307.6	1051.5	515.2
	Mustard	330.1	255.6	390.3	316.5	142.8
	Bengal Gram	215.2	151.0	304.4	334.4	146.3
	Lentil	88.8	71.0	97.9	61.1	25.4
	Potato	729.2	475.5	511.9	517.0	440.7
	Onion	900.6	459.8	604.9	655.9	481.0
	Tomato	199.0	169.1	219.9	283.4	263.8
% Change	Wheat	-33.06	-76.07	23.10	63.55	-19.50
	Paddy Common	-20.37	-19.46	8.09	0.10	-27.43
	Mustard	-52.03	-59.49	3.40	49.43	15.49
	Bengal Gram	-49.49	-75.59	-57.75	-1.84	-22.21
	Lentil	11.21	-17.20	-0.24	11.32	-49.98
	Potato	-52.37	-48.52	-42.75	-39.62	-50.70
	Onion	-17.67	-58.78	-53.82	-55.77	-54.70
	Tomato	-14.48	-29.51	-21.12	0.64	-9.80

Source: AGMARKNET (http://www.agmarknet.gov.in/)

harvest leading to a spurt in arrivals in the mandis. With the lockdown initiated on March 25, 2020, trade activities in the agricultural markets halted and agricultural supply chains were disrupted. The impact of COVID-19 on agricultural markets reveals that the market

arrivals declined significantly from March to August 2020. As this period is dominated by the arrival of rabi crops (especially wheat), wheat arrivals declined drastically compared to the previous year's monthly arrivals. The highest decline in wheat was observed in April 2020 (Table 2.29). Arrivals of most of the pulses also declined during the period, a prominent decline was noted in the arrivals of Bengal Gram. With the decline upto 60%, vegetables arrivals were the most affected during the lockdown period. Arrivals of onion and potato also declined drastically. Market arrivals of foodgrains and oilseeds have increased in May and June 2020, while it continued to be low for vegetables in the lean season.

Impact on agricultural exports

Export of agricultural products (in value terms) in 2019-20 was comparable to that in 2018-19 (Figure 2.26) even with the occurance of COVID-19 in March 2020. The exports were however lower for rice (basmati and other than

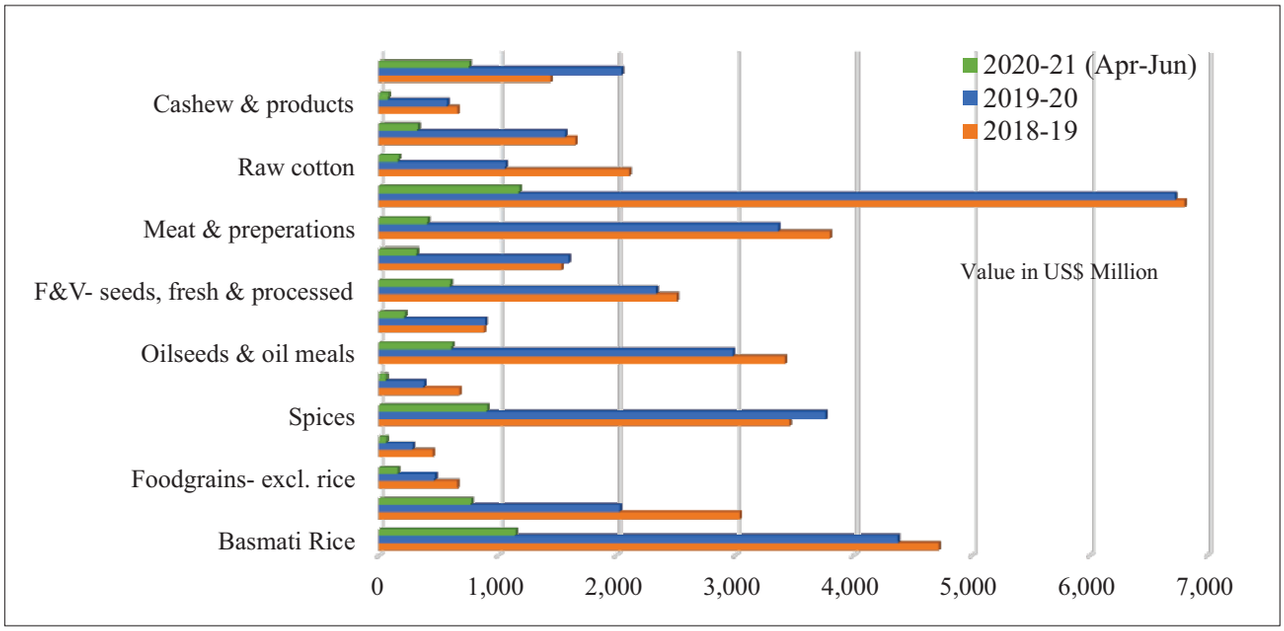


Figure 2.26. Value of agricultural exports from India

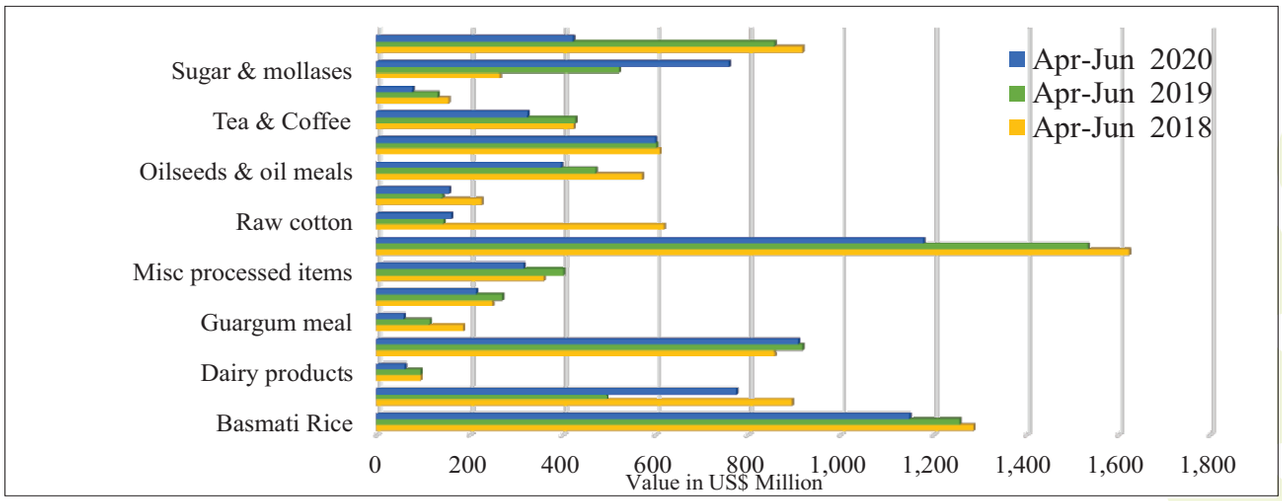


Figure 2.27. Value of agricultural exports from India during COVID-19 period

basmati), marine products, oilseeds, and meat and its products. During the first three months of 2020-21, export of agricultural products such as fresh and processed fruits and vegetables, foodgrains including rice, spices, sugar & molasses, and cotton were comparable or even higher than the corresponding period in 2019-20. Exports have however decreased for animal & marine products segment, tea & coffee, oilseeds & oil meals, and other processed items.

Monthly exports data indicated that export of agricultural products got impacted to some extent in March 2020 and largely in April 2020 (lockdown period in most countries), although export of non-basmati rice, foodgrains and sugar increased in April (Figure 2.27). Agricultural exports rebounded in May and June and were even higher than in the corresponding month in the previous year for many of the commodities. Continuous export activities have also helped improve the market sentiment and thus commodity prices were not much affected.

Agricultural Price Analysis and Forecasting

P. Sharma, A. Jhajhria, Kingsly I.T. and Shiv Kumar

Crop price forecasting

Commodity prices in major wholesale markets of wheat, grams, rapeseed and mustard, potato and onion were projected for two periods, viz. lockdown phase (3rd week of April, 2020) and unlock phase (3rd week of August, 2020) to examine the stability in prices. The daily prices of aforesaid commodities were compiled from Agricultural Marketing Information Network AGMARKNET from 2009 onwards and were converted into weekly price series. The time series forecasting models, viz. Autoregressive Integrated Moving Average (ARIMA), Hybrid ARIMA-GARCH (Generalised AutoRegressive Conditional Heteroskedasticity) were applied and best-fitted models were used for forecasts. The length of the projection was six weeks for each period.

The observed prices during the lockdown period are compared against the projected prices. The trends in prices were fairly stable during the lockdown period, even with a week delay in market arrivals of rabi crops, and shutdown of many mandis for fifteen days from last week of March to the first week of April. The projected price series in the unlock phase showed that prices were stable with a moderately increasing trend possibly due to the end of arrivals of rabi crops and improved normalcy attained from the phased unlock.

Price Transmission in Pulses Markets

P. Sharma, A. Jhajhria and Kingsly I.T.

Reliable price signals are essential for ensuring efficiency in the exchange of agri-commodities. Price signals may differ with rising/falling prices in the marketing chain and also there may be delayed transmission in the price signals along the value chain. The analysis of price transmission provides an insight into the structure of the supply chain and conduct of the market participants at different stages. This study analysed the direction and extent of price transmission along the value chain of major pulses in Delhi. Monthly data collected from Directorate of Economics & Statistics and Department of Consumer Affairs for the period January 2009 to December 2019 for grains wholesale, pulses (dal) wholesale, and pulses (dal) retail were used in the analysis.

Cointegration and causality

Johansen cointegration analysis for gram/tur value chains (chain-I: gram/tur wholesale- dal wholesale; chain-II: dal wholesale- dal retail; and chain-III: gram/tur wholesale- dal retail) indicated one cointegrating vector between dal wholesale and gram/tur wholesale (chain-I), and dal retail and gram/arhar wholesale (chain-III) prices, implying that these price pairs are cointegrated and move together in the long run. The null hypothesis of no cointegration was rejected at 1% level of significance (Table 2.30). However, the results indicated no cointegration in chain-II for both the pulses.

Table 2.30. Tests of Hypothesis: Cointegration

Channel	Tests	Hypothesis	Gram		Tur	
			Test Statistic	Critical Values	Test Statistic	Critical Values
Chain-I (GdW-GrW)	λtrace	r = 0 vs r ≥ 1 r = 1 vs r ≥ 2	22.192*** (3.661)	15.495 (3.841)	21.71** (4.70)	19.96 (9.24)
	λmax	r = 0 vs r ≥ 1 r = 1 vs r ≥ 2	18.530*** (3.661)	14.265 (3.841)	17.01** (4.70)	15.67 (9.24)
Chain-II (GdR-GdW)	λtrace	r = 0 vs r ≥ 1 r = 1 vs r ≥ 2	13.750 (3.227)	15.495 (3.841)	14.77 (5.00)	19.96 (9.24)
	λmax	r = 0 vs r ≥ 1 r = 1 vs r ≥ 2	10.523 (3.227)	14.265 (3.841)	9.77 (5.00)	15.67 (9.24)
Chain-III (GdR-GrW)	λtrace	r = 0 vs r ≥ 1 r = 1 vs r ≥ 2	17.981*** (3.433)	15.495 (3.841)	21.38** (4.72)	19.96 (9.24)
	λmax	r = 0 vs r ≥ 1 r = 1 vs r ≥ 2	14.548*** (3.433)	14.265 (3.841)	16.66** (4.72)	15.67 (9.24)

Note: ***, ** and * indicate significance at 1, 5 and 10 percent level, respectively.
Figures in parenthesis indicate 't' values-

The causality (long-term, short-run and strong exogeneity) tests were performed based on the estimated VECM models in the Johansen cointegration framework. The results of the Wald test indicated that in chain-I of the gram value chain, wholesale prices of dal granger cause gram wholesale price but not vice-versa (Table 2.31). Similarly, in chain-III, retail price of dal granger causes gram wholesale price but not vice-versa. This implied that the upstream prices dominate the downstream prices and thus play a price discovery role in the vertical markets. However, the short-run causality and strong exogeneity results indicated the bidirectional causality in chain-I and chain-III of gram value chain and suggested that prices are simultaneously determined. In case of tur, the Wald test for causality results (long-run, short-run and strong exogeneity) indicated that the wholesale price of dal granger causes tur wholesale price in chain-I. However, in chain-III, long-run and strong exogeneity tests supported the bidirectional causality that exists between the retail price of dal and the wholesale price of tur.

Asymmetric adjustment to shocks

Threshold cointegrations such as Threshold AutoRegressive Model vs Momentum -AutoRegressive models (TAR, MTAR and their consistent counterpart) and test of long-run asymmetry in the speed of adjustment were estimated for both the pulses for chain-I and chain-III. Threshold values for consistent TAR and MTAR models were selected following Chen (1993). The consistent MTAR model has the best threshold value with the lowest sum of squared errors estimated for both the supply chains of gram (I and III). A presence of cointegration and assymetric price transmission were verified by the significance of Fstatistics.

The point estimates for the price adjustment in gram value chain I were -0.456 for negative shocks and -0.189 for positive shocks (Figure 2.28). These values imply that the negative deviations from the long-run equilibrium resulting by an increase in dal wholesale price or decrease in gram wholesale price ($\Delta\xi t\text{-}1 >= 0.01$) are eliminated faster at 45.6% per month, however, the negative shocks are eliminated at 19% per month. The positive deviations take about 2 months while negative deviations take nearly 5 months to converge. In case of gram value chain III, the positive shocks adjusted faster (takes 4 months) than the negative shocks (6 months) in the long-run equilibrium. In the case of tur chain-I, negative deviations took about 3 months, whereas positive deviations took 6 months to adjust. In the case of Chain-III, positive deviations in prices adjusted faster (in about 2 months) than the negative deviations (in about 6 months).

Table 2.31. Wald test for causality in Gram and Tur value chain

Vertical chains	Causations	Hypothesis	Gram		Tur	
			χ2-test stat	Causality	χ2-test stat	Causality
Chain-I: GrWP-dWP	Long-term causality	α1=0 vs α1≠0 α2=0 vs α2≠0	10.345*** (0.0013) 1.482 (0.223)	Unidirectional (DalWP-GrWP)	13.346*** (0.0003) 1.214 (0.2704)	Unidirectional (DalWP-TurWP)
	Short-run causality	∑βi=0 vs ∑βi≠0 ∑βj=0 vs ∑βj≠0	18.173*** (0.001) 41.264*** (0.000)	Bidirectional	12.306*** (0.0021) 0.761 (0.684)	Unidirectional (DalWP-TurWP)
	Strong exogeneity	∑βi=0, α1=0 vs ∑βi≠0, α1≠0 ∑βj=0, α2=0 vs ∑βj≠0, α2≠0	21.910*** (0.0005) 49549*** (0.000)	Bidirectional	40.462*** (0.000) 2.976 (0.424)	Unidirectional (DalWP-TurWP)
Chain-III: GrWP-dRP	Long-term causality	α1=0 vs α1≠0 α2=0 vs α2≠0	8.545*** (0.0035) 1.051 (0.305)	Unidirectional (DalRP-GrWP)	5.630** (0.0177) 4.101** (0.043)	Bidirectional
	Short-run causality	∑βi=0 vs ∑βi≠0 ∑βj=0 vs ∑βj≠0	17.458*** (0.0016) 40.510*** (0.000)	Bidirectional	1.147 (0.284) 7.662*** (0.006)	Unidirectional (TurWP-DalRP)
	Strong exogeneity	∑βi=0, α1=0 vs ∑βi≠0, α1≠0 ∑βj=0, α2=0 vs ∑βj≠0, α2≠0	19.522*** (0.0015) 52.386*** (0.000)	Bidirectional	8.942** (0.0114) 13.950*** (0.0009)	Bidirectional

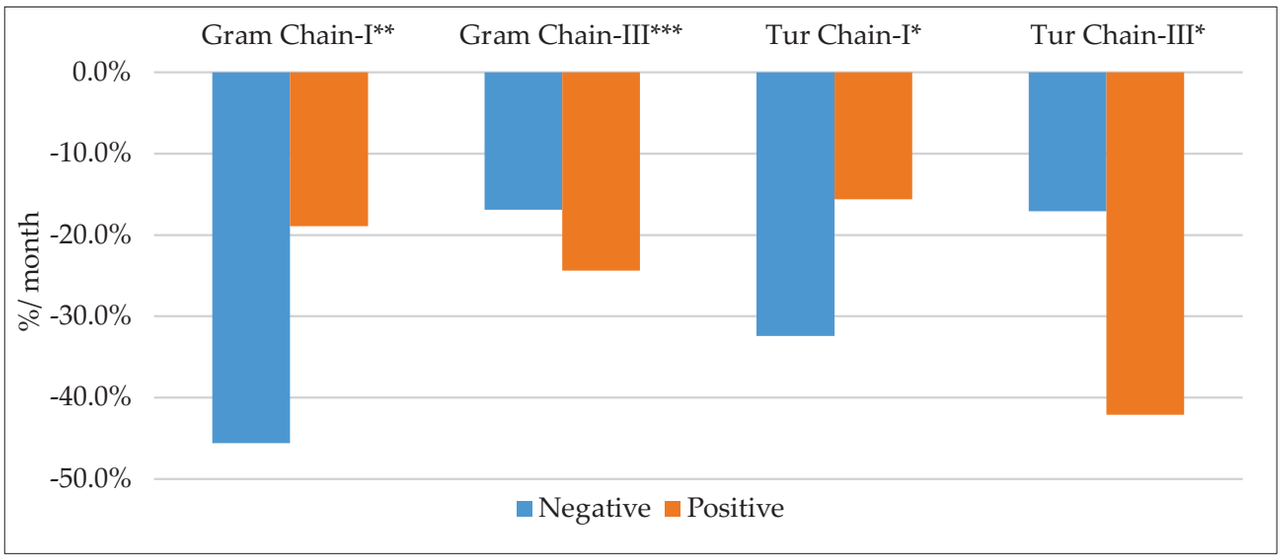


Figure 2.28. Speed of adjustment for upward and downward changes in pulses value chain

Note: *** denotes rejection of symmetry at 1% significance, ** denotes rejection at 5%, * denotes rejection at 10%.

Seasonality and Price Transmission Linkages in Onion

Raka Saxena and Rohit Kumar

Seasonality in onion prices was visually examined to identify the price peak and low price months for onion in different markets. Figure 2.29 illustrates the seasonality in onion prices. After the seasonality check, price transmission links across different domestic markets was identified. The market behaviour was analysed using weekly data on onion arrivals and prices in Azadpur market in Delhi, Lasalgaon and Pimpalgaon markets in Maharashtra, and Bengaluru market in Karnataka. There was strong seasonality in onion wholesale and retail prices. The prices remain lower from March to August, the situation aggravated from September onwards and the prices escalate following shortages in the supply. Pimpalgaon has emerged as the largest market for rabi onion in terms of rabi arrivals, and Bengaluru continued to dominate the kharif arrivals.

Price transmissions exists across major markets (Table 2.32). The Granger causality test was applied to test the pair-wise linkages between the markets. Figure 2.29 revealed that almost

Table 2.32. Granger causality in major markets

Sample: 1 476		
Lags: 2		
Null Hypothesis:	**F-Statistic**	**Prob.**
DELHI does not Granger Cause BANGALORE	3.81192	0.02
BANGALORE does not Granger Cause DELHI	45.9022	0.00
LASALGAON does not Granger Cause BANGALORE	24.0292	0.00
BANGALORE does not Granger Cause LASALGAON	5.3529	0.01
PIMPALGAON does not Granger Cause BANGALORE	16.0556	0.00
BANGALORE does not Granger Cause PIMPALGAON	9.18932	0.00
LASALGAON does not Granger Cause DELHI	84.0963	0.00
DELHI does not Granger Cause LASALGAON	2.9964	0.05
PIMPALGAON does not Granger Cause DELHI	56.6256	0.00
DELHI does not Granger Cause PIMPALGAON	0.89938	0.41
PIMPALGAON does not Granger Cause LASALGAON	0.60165	0.55
LASALGAON does not Granger Cause PIMPALGAON	17.1907	0.00

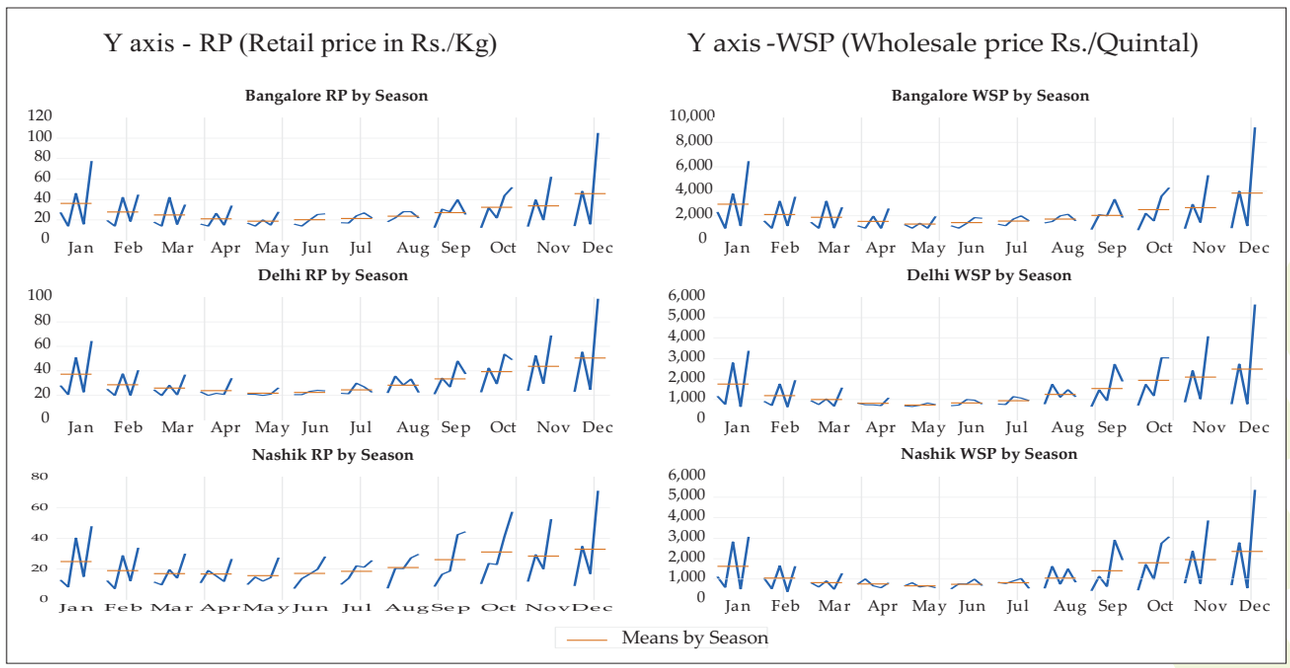


Figure 2.29. Seasonality in onion prices in major markets

bi-directional causality existed in all the selected markets. It is interesting to note that Lasalgaon, the largest onion market, Granger caused Pimpalgaon prices, indicating the lead role of former. The prices of Lasalgaon and Bengaluru markets found to affect the prices in all the markets.

Commodity Outlook Model for Rice

Kingsly I. T., Shiv Kumar and Shinoj P.

The Outlook model for rice developed previously at ICAR-NIAP was revised for two purposes. First, to extend the projections of economic variables up to 2030, and second, to reduce the dependence on excel-based computation which is not suitable for large data and is prone to human error. In addition, this revision would aid to create a simulation environment based on a standard programming language. This revised model was worked out based on dynamic as well as spatial partial equilibrium modelling framework. A system of simultaneous equations was employed to effectively depict the linkages between various economic variables corresponding to the food balance sheets of major foodgrains in India.

The Outlook model consists of different sub-models that include commodity and regions based production models and price linkage models, besides commodity-based consumption models, export and import models, and open and close stock models. The coefficients of the different models were partly compiled and partly calibrated. Finally, all the models were linked to simultaneously estimate the equilibrium values of the targeted variables. All the sub-models were linked in a way that are consistent with the economic theory, unites various economic activities such as production, consumption, trade, and stocking related to commodities of interest across regions over time.

To judge the accuracy of the forecasted values, validation activity was carried out. Validation is a crucial exercise in any projection, without which reliability of the forecast is at stake. It is carried out by generating projections for all the targeted variables from 2016 to 2019 using the base data, and the degree of accuracy is obtained by matching these values with respective observed values. The span of the base dataset is from 1995 to 2015, and outlook's projections are generated for the period 2020 to 2030. Mainly, two statistical measures such as the mean absolute error (MAE) and the mean absolute percent error (MAPE) were used for the validation (Table 2.33). The MAE values for the different variables were found to be within acceptable levels. The percent error, a better measure to judge the accuracy, stood below 10 per cent for all variables, except for stocks and net trade, irrespective of crops. The higher error in ending stocks and net trade could be because of the high levels of variability generally observed in the stocks, exports and imports of cereals in India. In general, it can be concluded that the model has good predictive power, as the level of error was 8 per cent.

Table 2.33. Validation of Rice Outlook (2016-17 to 2019-20)

Region	Production	
	MAPE (%)	MAE (MT)
East	3.50	0.57
West	3.90	0.33
North	1.23	0.13
South	8.16	0.58
Hilly	6.73	0.02
North East	2.01	0.02
India	1.14	1.33

The projections for rice production were 109.6 million tonnes(mt) by 2016–17, 116.32 mt by 2020–21, 128.5 mt by 2025–26 and 138.9 mt by 2030.

The corresponding region-wise projections for the area, yield and production are provided in Table 2.34. The highest share of production would be from the eastern and northern regions. Yield improvements are expected in all the regions, but with the highest gains in the northern and southern regions. The demand for rice is likely to increase with the rising population and changes in dietary habits. At the national level, total demand for rice including food, feed and industrial demand is

Table 2.34. Outlook for Rice in India: 2016–17 to 2030–31

Region	Variable	2016-17	2019-20	2020-21	2025-26	2030-31
All India	Production	109.62	116.32	118.22	128.56	138.93
	Yield	2.49	2.73	2.78	2.94	3.18
	Area	44.00	42.65	42.75	43.29	44.05
	Food use	90.50	93.65	95.20	104.20	112.80
	Feed use	0	0	0	0	0
	Total use (including other uses)	97.94	102.13	103.88	113.77	122.02
	Net Trade	10.60	13.30	13.90	15.05	17.27
East	Area	16.80	17.22	17.41	17.80	18.56
	Production	41.50	43.91	45.27	50.55	56.61
	Yield	2.47	2.55	2.60	2.84	3.05
West	Area	8.68	7.73	7.61	7.56	7.50
	Production	17.36	15.61	15.37	16.10	17.18
	Yield	2.00	2.02	2.02	2.13	2.29
North	Area	10.53	10.73	10.78	11.04	11.20
	Production	30.33	35.52	36.22	39.96	42.78
	Yield	2.88	3.31	3.36	3.62	3.82
South	Area	6.62	5.65	5.62	5.52	5.40
	Production	17.61	18.19	18.21	18.49	18.63
	Yield	2.66	3.22	3.24	3.35	3.45
Hills	Area	0.36	0.31	0.31	0.32	0.33
	Production	0.65	0.61	0.61	0.63	0.67
	Yield	1.80	1.96	1.97	1.98	2.03
North-East	Area	1.01	1.01	1.02	1.05	1.06
	Production	2.18	2.47	2.54	2.81	3.06
	Yield	2.16	2.45	2.49	2.68	2.89

Note: Area in million ha, Yield in t/ha and other variables in million tonnes

projected to grow from 97.9 mt in 2016–17 to 122.0 mt by 2030, the rate being slightly lower than the production growth. Accordingly, net trade potential of rice would increase from 10 mt to 17 mt during this period

Effectiveness of Market Intelligence for Non-MSP Horticultural Crops in India

Raka Saxena, Ranjit Kumar Paul and Rohit Kumar

Price forecasts for horticultural commodities were developed and disseminated through various means to the farmers before sowing and during harvests to facilitate informed and intelligent decisions. Horticultural commodities, particularly onion and potato, remained highly volatile in recent years resulting in lower forecast accuracy. The study used Autoregressive Conditional Heteroscedasticity (ARCH)/Generalized Autoregressive Conditional Heteroscedasticity (GARCH) to forecast prices. Prices of few commodities were also forecasted using Vector Autoregressive (VAR) model recursively in some cases.

The forecasts were validated based on the Mean Absolute Percentage Error (MAPE) for the hold-

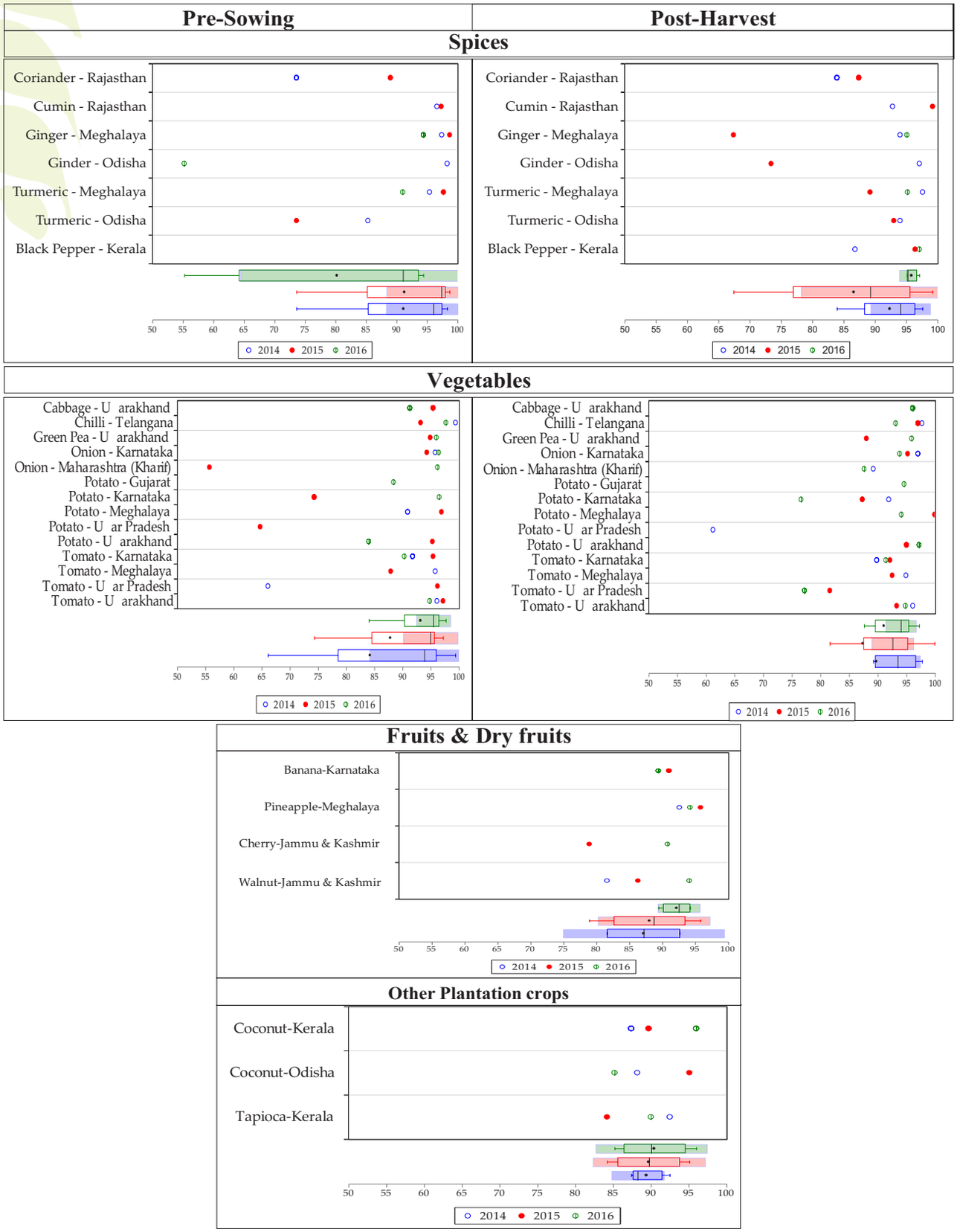


Figure 2.30. Forecast accuracy for horticultural crops across selected states

Note: Figures on the x-axis represent the forecast accuracy (%)

out data as it is a scale-independent measure. The final forecasts were validated using statistical criteria along with the qualitative information collated from traders'/farmers' survey in the respective locations/markets. Forecast accuracy was derived from the MAPE for the selected crops for three consecutive years, i.e. 2014 to 2016. The prices of horticultural commodities, especially vegetables, were most volatile during the study period. Emphasis was on the use of statistically advanced and non-linear models which could capture the volatility in prices and render more efficient forecast values. Extremely high seasonal and irregular variations were observed in the case of onion. However, seasonal variations were the main reason for potato price fluctuations. The study recommends the need to develop a sound market intelligence system in the country with wide coverage in terms of regionally important commodities. Market intelligence efforts need to be institutionalized over time and supported by market infrastructure and other logistics.

In general, pre-harvest (PH) forecasts were more precise as compared to pre-sowing (PS) forecasts due to limited scope to consider climatic or market uncertainty due to proximity in time of forecasts. The lowest forecast precision was noted for vegetable crops for three consecutive years. Though the forecast accuracy was more than 90 percent for cabbage, chilli and green pea, however, extreme fluctuations were observed in prices of onion, potato and tomato crops, resulting in lower accuracy in price forecasts for vegetable crops as a whole. Extremely high seasonal and irregular variations from June 2013 to December 2015 also affected the forecast accuracy. PH forecast accuracy for 2014 was 89.2 percent in Maharashtra that declined to 38.8 per cent in 2015 and further increased to 87.6 per cent in 2016, the same observed in PS forecasts of onion. Potato price fluctuations were also observed mainly due to seasonal variations. In potato, Uttarakhand, Meghalaya and Karnataka displayed higher forecast accuracy, while the markets of Uttar Pradesh (UP) displayed very low forecast accuracy, i.e. PS forecast accuracy was 37.6 per cent in 2014 and 64.7 per cent in 2015. Tomato forecast accuracy was more than 85 per cent, except for Uttar Pradesh (Figure 2.29).

In case of fruits, dry fruits and other plantation crops, more than 80 and 85 per cent forecast accuracy was achieved. Banana, pineapple forecast accuracy was observed to be more than 85 per cent, and it was less than 85 per cent for walnut and cherry in 2014 and 2015, respectively (Figure 2.30). In the plantation crops category, coconut and tapioca were selected for price forecasting. The price forecast accuracy for spices was generally more than 85 per cent, except PS accuracy in coriander for Rajasthan in 2014 and turmeric and ginger for Odisha market during 2015 and 2016, respectively. In case of PH price forecast accuracy in ginger in Odisha and Meghalaya was lower than 80 per cent.

Price Spread and Marketing Reforms

Raka Saxena, S.K. Srivastava and Priyanka Agarwal

A meta-analysis of several studies conducted at the regional/state level provides evidence on the temporal and spatial variation on price realization across various commodities and regions (Figure 2.31). The new Farm Acts shall be effective in improving the marketing efficiency by increasing competition, improvising marketing channels and thereby leading to better price realization by the farmers. Many innovative marketing arrangements have shown that farmers' share can be enhanced and marketing costs and margins of the chain can

Table 2.35. Current status of agricultural exports (value in million dollars) and untapped potential (%) for major commodities

Major exportable items	TE 2019-20	Untapped potential
Rice (HS 1006)	499.0	17-60
Cotton (HS 52)	470.5	6-85
Tea (HS 0902)	53.2	51-64
Coffee (HS 0901)	37.2	32-87
Fish and crustaceans (HS 03)	438.8	47-85
Meat and offal (HS 02)	254.4	49-51
Onion (HS 0703)	31.5	56-58
Potato (HS 0701)	4.9	58-68
Grapes (HS 0806)	24.2	64-71

Source: INTRACEN

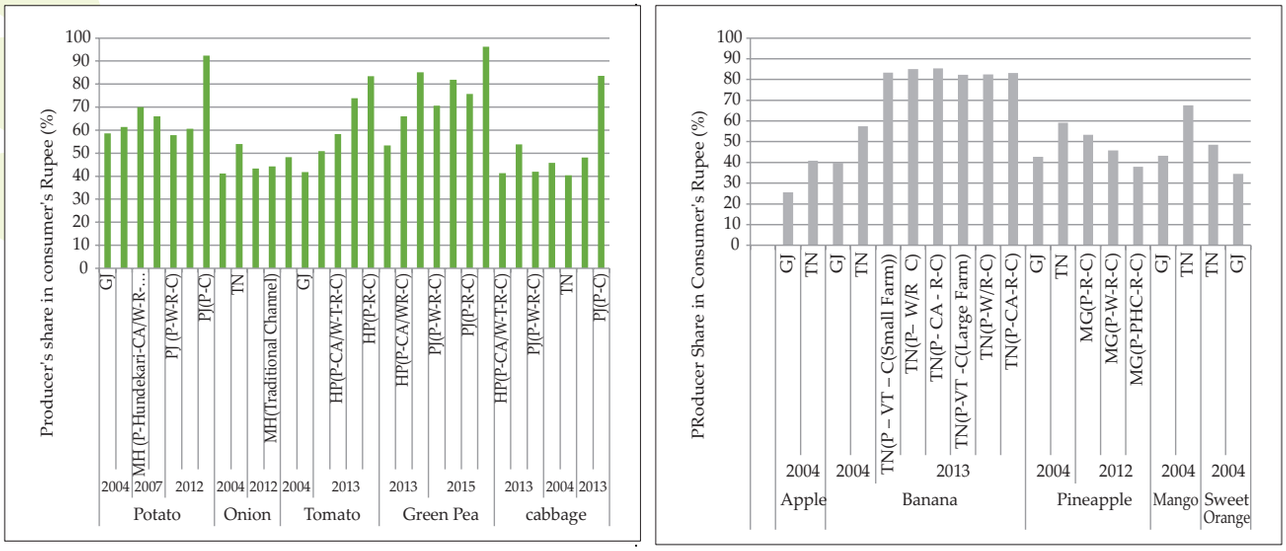


Figure 2.31. Producer's share in prices of major horticultural commodities

be managed efficiently through appropriate interventions.

Agricultural export is emerging as an important avenue for the disposition of surplus output. Export promotion and enhancement remains as one of the major agendas under the new agricultural export policy, which aims to double the agricultural exports from US$ 30+ billion to US$ 60+ billion in the next five years. The policy also aims to diversify the export basket, providing an institutional mechanism for pursuing market access, tackling barriers and deal with sanitary and phytosanitary issues and enable the farmers to get the benefit of export opportunities in overseas markets. Effective agri-logistics and efficient supply chains must result in the desired quality as per the international standards. Marine products are in the country's single largest export category and as large as 47-85 per cent potential can be tapped through effective supply chain management and policy interventions (Table 2.35).

Artisanal Fishers in Harnessing the Potential of Offshore and Distant Waters

Shinoj P. and Shiv Kumar

Being the sixth largest producer of capture fish in the world, India has high stakes in the global marine fishery sector. Recent literature deciphers that many of the commercially important fish stocks along the coastal waters of India are overfished and deep-sea fishing (fishing from the water column or sea bottom beyond 200 metres of depth) remains bountiful.

Much of industrial-scale fishing (intense fishing) has been gradually shifted towards deep fishing into the oceans. The literature reveals that productivity of oceans generally decreases with distance from shore as well as depth. In the study, primary data was collected with the help of a structured questionnaire from two groups of respondents: (1) from purposively selected fifty boat owners /skippers pertaining to the cost and earnings (trip-wise), socio-economic profile, level of involvement in offshore fishing activities, technical stipulations of the vessels and gears, types of fishing techniques practiced and (2) from artisanal fishermen hailing from the fishing villages of Thoottoor who operate mainly from Thengapattanam fishing harbor, Thoottoor, or Cochin Fisheries Harbor (CFH), Kochi, regarding marketing practices followed. These sample data were collected from December 2018 to February 2019. Besides, several rounds of focused group discussions were organized with major value chain players.

Costs and earnings from artisanal offshore fishing

The analysis revealed that about 66 per cent of units used in deep-sea fishing called offshore fishing vessels (OSFVs) were sole-owned,

the rest were owned jointly by multiple share-holders. The main components of the operational cost of a trip of offshore fishing consist of expenditures on fuel (33%) and crew share (31%), which together account for nearly two-thirds of the total expenditure. Cost and return structure revealed, on average, a fishing trip cost was Rs. 5,29,168 for the sample fishermen. Out of this, variables costs incurred on fuel, crew remunerations, ice, food, commission charges, and other miscellaneous expenditures together accounted for Rs. 4,36,038. On the earnings side, the average value of gross revenue per fishing trip was Rs. 5,75,500, which fetched a net revenue of Rs. 46,332 per fishing trip of an average duration of 23.4 days. On a daily basis, this works out to be Rs. 1,980 accrued to the owner of the vessel. The average crew income per trip is estimated to be Rs. 13,261 which renders an average income of Rs. 568 to the crew on a per-day basis.

Figure 2.32 shows the landing pattern of sample vessels in terms of the relative distribution of gross earnings realized across fishing trips. The earnings are classified into six categories based on their magnitude, measured in million rupees (0-0.2; 0.2-0.4; 0.4-0.6; 0.6-0.8; 0.8-1 and >1) and presented separately across four categories of vessels, categorized based on their LOA measured in metres (<13, 13-15, 15-17 and >17). In the case of the lowest size category of vessels (<13 m), nearly 90 per cent of fishing trips returned gross revenue less than Rs. 0.6 million. As expected, the share of fishing trips with greater gross revenue per trip increased on moving towards larger vessel groups. For vessels with LOA greater than 17 m, nearly 40 per cent of fishing trips returned catches worth over Rs. 0.6 million. Out of these, about 14 per cent returned landings over Rs. one million.

Figure 2.34 presents the distribution of average net operating income accrued by OSFVs of various length categories during the period under study. The estimates were found to vary between Rs. 0.12 million and Rs. 0.16 million and showed a generally rising trend with the length of the vessel. On an average, the net operating income stood at Rs. 0.14 million per trip. Figure 2.33 presents the distribution of

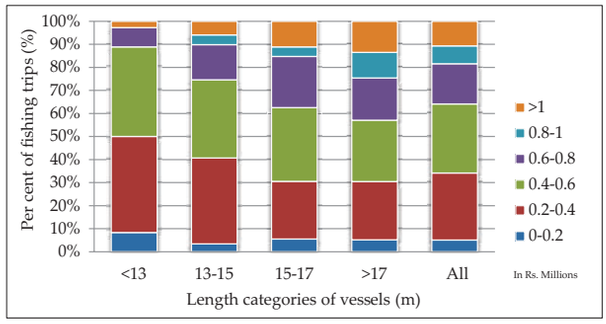


Figure 2.32. Distribution of landings value by sample OSFVs by type, 2018

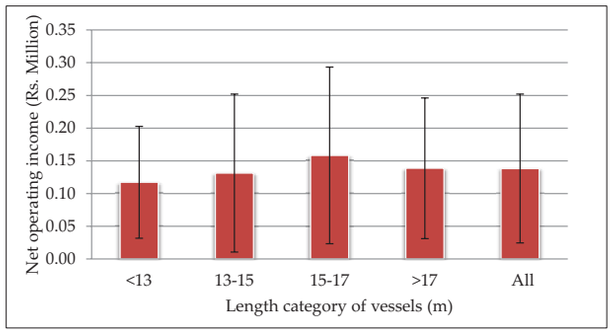


Figure 2.33. Average net operating income realized by sample OSFVs by type, 2018

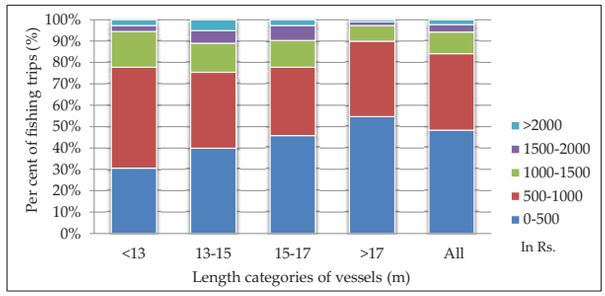


Figure 2.34. Distribution of income (per person per working day) realized by OSFVs crew across fishing trips, 2018

income per crew per working day across the length categories of OSFVs over the fishing trips undertaken by them. It is interesting to note that, the share of fishing trips with per day income lower than Rs. 500 was the highest for the topmost category (>17 m). This share declined progressively towards vessels of lower length categories. Fishing trips with an average daily income between Rs. 500 and Rs.100 varied from 32 to 47 per cent across the vessel categories, the latter corresponding to the lowermost length category. Only less than 10 per cent of fishing trips made by all vessels fetched an average income of Rs. 1500 and above for the crew.

The economic analysis concluded that, despite engaging in strenuous and risky activity at far away distances from the shore, the earnings of the Thoothoor fishermen are quite modest. While the average wage earned by a rural worker in India stood at Rs. 350 presently, the crew of OSFVs with an average daily income of Rs. 568, did not earn any significantly higher. The average owner's shares of Rs. 1,980 per day also appears to be quite modest. For Thoottoor fishermen, distant water fishing is an avenue for livelihood to support their families and more, a way of life, which needs to be protected and supported.

Options for strengthening livelihood of Thoothoor fishermen

There is an immense scope to enhance the economic efficiency and viability of such fishing through cutting costs, efficient gear operations, scientific onboard fish handling protocols, and better value chain linkages. A set of technological and policy options could aid in upgrading the AOSF (Artisanal Offshore fishing) fishing for enhanced utilization of the deep sea and offshore fish stocks. The major domains identified for devising interventions include (i) standard operating procedures for offshore fishing, (ii) technical readiness of the fleet, (iii) disaster preparedness and risk proofing, (iv) onboard processing and storage, and (v) value chain augmentation. The findings reaffirm that offshore fishing would become economically viable and rewarding only if supported by an efficient fishing fleet equipped with modern facilities for gear operations, navigation, fish finding, onboard fish handling and nearshore areas are almost fully utilized. However, such seaward expansion of fishing should be both sustainable and economically viable, so that the long-term interests of the sector are well taken care of. In a nutshell, the research discerns that harnessing the fishing prowess of traditional fishing communities and strengthening their capacity through economic, technical and logistical support could go a long way in furthering sustainable exploration of India's offshore fishery potential.

Value Chain Analysis of Informal Dairy Processing Units in Haryana (India): A System Dynamic Approach

Amit Thakur, A.K. Dixit, G. Bhandari, Shiv Kumar and A. Jhajhria

The study examined the value chains of liquid milk handled by the informal sector based on the procurement system adopted by dairy processing units. Product flow and core actors involved in milk value chains were mapped. Three main routes of milk procurement by processing units for supply of raw milk to the processing units were identified, namely (i) collection centres, (ii) integrated production and processing units, (iii) private vendor systems. To arrive at value addition and profit, chain-wise cost incurred at each unit operation level was computed in a simulation model Vensim PLE x32 package. The study revealed that the cost of milk procurement was the least in the collection centre (Model-I). The integrated production and processing system (Model-II) could attain higher profits (Rs. 9.56/Litres (L)) compared to Model-I (Rs. 2.65/L) and vendor system, i.e. Model-III (Rs. 1.78/L). Integrated production and processing units system (Model-II) was found to be the most profitable system. The success of the Model-II is largely attributed to the producer approach which follows vertical integration of different stages of the milk value chain. The profitability is found to be linked with the system approach—integrating production with processing and efficient distribution of milk in appropriate packets, while maintaining the quality throughout the chain. The fully vertically integrated value chain operates completely under control and command of management. The sources of risk and entry points of risks at each stage in value chain could be easily traced and identified, thus helping in bringing risk of contamination of milk at zero level. Hence, the compliance as per standards for maintaining quality of milk at each stage has become core point for success of the model. Besides, three important identified key interventions, viz. training in milk handling, packing and processing; efficient transportation and processing technology; and efficient design of procurement systems need to be renewed and realigned periodically as per emergent business environment for leveraging the milk value chain.

List of Research Projects

Table 2.36. Completed and ongoing research projects

Title of the project	Project area	Project period	Project team
Network Projects (Completed)			
Structural transformation, regional disparity and institutional reforms in agriculture	Agricultural Growth and Development	October 2017-March 2021	Suresh Pal Balaji S.J. Pavithra S. Subash S.P. Nalini Ranjan Kumar
Resource use planning for sustainable agriculture	Technology and Sustainable Agriculture	October 2017-March 2021	Prem Chand Rajni Jain Subhash Chand Prabhat Kishore
Policy imperatives for promoting value chain of agricultural commodities in India	Agricultural Markets and Trade	November 2017-March 2021	Shiv Kumar Abimanyu Jhajhria T.K. Immanuelraj
Externally Funded Projects (Completed)			
Agricultural sustainability in India – A parametric study	Technology and Sustainable Agriculture	June 2018- March 2021	Suresh Pal Chhabilendra Roul S. K. Chaudhari Prem Chand Kiran Kumar
Investments in ICAR leadership in agricultural higher education	Technology and Sustainable Agriculture	February 2019-March 2021	Rajni Jain
Institute Funded Projects (Completed)			
Farm mechanization on small and marginal farms in India- Trends and drivers	Technology and Sustainable Agriculture	April 2017- March 2020	Nalini Ranjan Kumar S.V. Bangaraju T.
Rural non-farm sector (RNFS) in India: Trends, structural changes, farm sector growth and poverty linkages	Agricultural Growth and Development	October 2017-March 2020	Subash S.P. Prem Chand Balaji S.J.
Nutrient demand and the effect of women empowerment in improving nutritional outcomes in India	Agricultural Growth and Development	March 2018-March 2020	Jaya Jumrani Usha Rani Ahuja
Performance and impact assessment of agricultural extension and advisory systems	Technology and Sustainable Agriculture	April 2017- March 2021	Arathy Ashok Vinayak R. Nikam (PI from July 2019)
Technology foresight in agriculture	Technology and Sustainable Agriculture	October 2017-March 2021	Subash S.P. Arathy Ashok Suresh Pal
Direct benefit transfers for micro-irrigation: Impact on farm performance	Technology and Sustainable Agriculture	October 2017-March 2020	Prabhat Kishore P. S. Birthal
Institutional mechanisms in irrigation water management system and water markets in northern India	Technology and Sustainable Agriculture	October 2017-March 2020	Subhash Chand Prabhat Kishore Hubba Lal Singh

Contd...

Table 2.36 Contd...

Assessing impact of soil and water conservation schemes and innovative agricultural technology	Technology and Sustainable Agriculture	November 2017-March 2020	Sant Kumar Pramod Kumar
Marketing reform and infrastructure	Agricultural Markets and Trade	October 2017-March 2020	Raka Saxena Abimanyu Jhajhria
Market integration and price transmission in agricultural commodities	Agricultural Markets and Trade	April 2017- March 2020	T. K. Immanuelraj Abimanyu Jhajhria Shiv Kumar
Network Project (Proposed)			
Farmers' income, governance impacts and agricultural trade	Agricultural Growth and Development	2021-2025	Suresh Pal Raka Saxena Balaji S.J.
Impact of technology on agriculture	Technology and Sustainable Agriculture	2021-2025	Vinayak Nikam, Ankita Kandpal Kiran Kumar
Inclusive agricultural development (hill and arid agriculture)	Technology and Sustainable Agriculture	2021-2025	Prem Chand Khem Chand
Agriculture markets intelligence and commodity outlook	Agricultural Markets and Trade	2021-2025	Purushottam Sharma Abimanyu Jhajhria T.K. Immanuelraj Shiv Kumar
Externally Funded Projects (Ongoing)			
Research priorities and policies for climate resilient agriculture	National Professor Scheme	Feb 2017-Feb 2022	P.S. Birthal Prabhat Kishore
Doubling farmers' income in India by 2021-22: Estimating farm income and preparation of strategic framework	Agricultural Growth and Development	April 2017- March 2022	Suresh Pal Raka Saxena Naveen P. Singh Balaji S.J. Ranjit Kumar Paul
Strategic research component of national innovations on climate resilient agriculture	Technology and Sustainable Agriculture	April 2017-September 2021	N.R. Kumar S.K. Srivastava N.P. Singh
Agricultural innovations and technology management	Technology and Sustainable Agriculture	November 2017-Contd.	Sant Kumar Ankita Kandpal (PI from August 2020)
Management and Impact assessment of farmers FIRST Project	Technology and Sustainable Agriculture	February 2017-March, 2021	Shiv Kumar Rajni Jain Vinayak R. Nikam T.K. Immanuelraj Abimanyu Jhajhria
Institute Funded Projects (Ongoing)			
Crop insurance in India: Progress, farmers' willingness to pay and role of information	Agricultural Growth and Development	October 2017-October 2021	Jaya Jumrani Vikas Kumar (PI from 20.12.2019) Khem Chand (from 26.8.2020)

Contd...

Table 2.36 Contd...

Sustainable intensification of agriculture	Technology and Sustainable Development	April 2021-March 2025	Prem Chand Kiran Kumar D.C. Meena
Institutions and technology for agricultural water management	Technology and Sustainable Development	April 2020-March 2025	S.K. Srivastava Subhash Chand
Farm mechanization- the role of custom hire services and rural labour market	Technology and Sustainable Development	April 2020-March 2025	Nalini Ranjan Kumar S.K. Srivastava
Performance and impact of Farmer Producer Organisation	Technology and Sustainable Development	April 2021-March 2024	Vinayak Nikam
Impact assessment of agricultural technology	Technology and Sustainable Development	April 2021-March 2024	Sant Kumar
Database development for agricultural rural households with special focus on weaker sections	Technology and Sustainable Development	April 2020-March 2025	Subhash Chand Rajni Jain Vikas Kumar Dilip Kumar Khyali Ram Chaudhary M.S. Chauhan
Agricultural price analysis and forecasting	Agricultural Markets and Trade	April 2020-March 2025	Purushottam Sharma Abimanyu Jhajhria T.K. Immanuelraj Shiv Kumar
Innovations and technology foresight in agriculture	Technology and Sustainable Development	April 2021-March 2025	Rajni Jain Dilip Kumar Ankita Kandpal
Agricultural commodity value chains and exports	Agricultural Markets and Trade	April 2021-March 2025	Shiv Kumar Abimanyu Jhajhria P. Sharma

Table 2.37. Consultancy and contract research projects

Name of the scientist	Institution to which consultancy provided	Area of consultancy/contract research
Pratap S. Birthal	International Food Policy Research Institute, Washington DC	Transformation, and sources of growth in Southeast Asian agriculture
Suresh Pal, Abimanyu Jhajhria, Subash S.P.	Department of Fertilizer, Ministry of Chemicals and Fertilizers	Framing policies for overseas acquisition of raw material by Indian fertilizer companies and role of Government in India
Shiv Kumar, Raka Saxena, Kingsly I.T., Abimanyu Jhajhria	Directorate of Marketing & Inspection, Faridabad	Research studies on post-harvest profiles of 10 selected commodities
S. K. Srivastava	International Food Policy Research Institute	Analysis on sustainability issues in groundwater irrigation in eastern genetic plains (Bihar and West Bengal)

CHAPTER 3

Seminars/Workshops/ Brainstorming sessions organized	**: 5**
Trainings organized	**: 3**
Lectures organised	**: 3**
Scientists trained /participated	**: 4256**

Seminar/Workshop/ Brainstorming Sessions Organized

Sustainable Agriculture

One-day national seminar on sustainable agriculture was inaugurated by Dr. Trilochan Mohapatra, Secretary, DARE and DG, ICAR on March 6, 2020. Assesment of agricultural sustainability, agricultural technologies, practices, policies and institutions were discussed in the seminar. On this occasion, NIAP Policy Brief 46 entitled "Agricultural Sustainability in the Indo-Gangetic Plains of India" co-authored by Chhabilendra Roul, Prem Chand and Suresh Pal, was released.

Release of Policy Brief 46 by Dr. Trilochan Mohapatra, Secretary, DARE and DG, ICAR

Agriculture Development Lecture Series

ICAR-NIAP started a lecture series on "Agricultural Development" focusing on various aspects of agricultural development. A lecture was delivered by Dr. Suresh Pal, Director, ICAR-NIAP on "Agriculture during Covid-19: Economic Package and Reforms" on June 16, 2020. Dr. Ramesh Chand, Member, NITI Aayog and Dr. H K Bhanwala, Former Chairman, NABARD, also delivered lectures on June 24, 2020. It covered various aspects related to policies and finance in agriculture. These videos are available on Facebook page of ICAR-NIAP. So far, 9759 visitors have viewed these videos.

Agriculture and Food Policy

NAAS and ICAR-NIAP jointly organized a Brainstorming Session on "Agriculture and Food Policy for Five Trillion Dollar Economy in the Post COVID Scenario" on October 14, 2020. The session was co-chaired by Dr. Ramesh Chand, Member, NITI Ayog and Dr. Trilochan Mohapatra, Secretary, DARE and DG, ICAR. Dr Suresh Pal, Director, Dr S.K. Srivastava, Scientist and Dr Balaji S.J. Scientist, ICAR-NIAP were co-convenors of the session. Eminent panelists from India and abroad participated and provided inputs for achieving the target.

Brainstorming Session on "Agriculture and Food Policy for Five Trillion Dollar Economy in the Post COVID Scenario"

Agricultural Market Reforms

ICAR-NIAP and NAAS organised a Brainstorming Session on "Recent Agricultural Marketing Reforms 2020" on December 18, 2020. The discussion was chaired by Prof. R B Singh, Chancellor, Central Agricultural University, Imphal and moderated by Dr. Trilochan Mohapatra, Secretary, DARE and Director General, ICAR, and President, NAAS. The discussion hovered around issues related to agricultural market reforms and its long-term benefits to the farming community. The session was attended by eminent agricultural experts, agricultural economists, policymakers, and farmers' representatives. The session critically examined recent agricultural marketing reforms and suggested road map for furthering the reforms process.

Webinar on Mahatma Gandhi's Vision of Village and Agro-Industries

Prof. Vasant Gandhi, Professor, IIM, Ahmedabad delivered a lecture on "Gandhi's vision for agriculture and agro-industries in development" on 150th Birth anniversary on October 2, 2020. The webinar was live through zoom and Facebook. He covered the issues of village swaraj, Panchayati Raj system, village cleanliness, revival of village craft and agro-processing industries and development of small-scale industries in villages,etc.

Trainings

Indian Economic Services (IES) Training

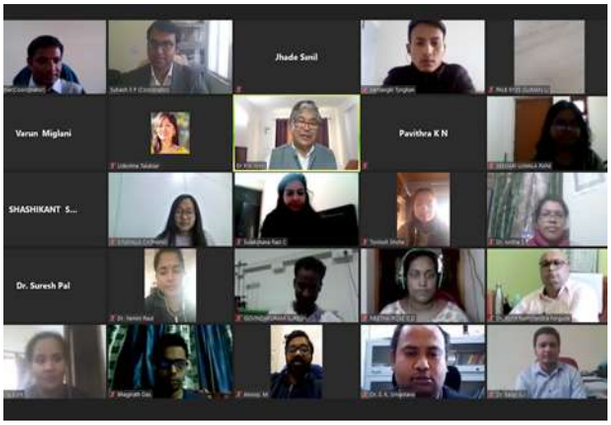
ICAR-NIAP conducted training program for Officer Trainees of IES-2019 batch during February 17-21, 2020 on 'Core Issues Related to Agricultural Sector'. The purpose was to familiarize the officers with emerging issues in India's agricultural and rural economy. The training focused on the issues such as R&D policy, food security, water management, value chains, market reforms and farm income, etc.

Agricultural Policy Research Training under SCSP

ICAR-NIAP conducted one-week short capacity-building training course under Scheduled Caste Sub-Plan (SCSP) on "Agricultural Policy Research'' during December 3-9, 2020 through online mode. Dr. Kiran Kumar and Subash, S.P., Scientists, ICAR-NIAP were the coordinators of the training programme. About 56 participants, mostly from social sciences disciplines in the

Training of IES officers on "Core issues in Agricultural sector"

cadre of assistant professors, young scientists and Ph.D. scholars attended the training programme. Experts from the domain of Agricultural Economics, Agricultural Statistics, and Agricultural Extension from various ICAR institutes provided hand-on training to the participants. A total of 12 lectures on analytical methods and research communication skills were delivered with practical demonstration. The training was inaugurated by Dr. P.K. Joshi, Ex South-Asia Director, International Food Policy Research Institute (IFPRI).



Capacity building training course under SCSP

Quantitative Methods for Social Sciences

ICAR-NIAP organized 20-days Webinar series on "Quantitative Methods for Social Sciences" from June 2 to June 20, 2020. About 4215 researchers and students registered for the series. Lectures covered theoretical as well as practical aspects of various quantitative methods for social scientists. Zoom platform was used and simultaneously it was live-streamed on the Facebook page of NIAP. Recorded lectures are freely available on the Facebook page (https://www.facebook.com/ICARNIAP) and YouTube channel(https://www.youtube.com/channel/UCfYSwK1skn9IXBP4IvljP4w?viewas=subscriber) of the Institute. More than 51000 researchers have viewed the videos on Facebook. .

Lectures Organised

Smallholder Agriculture, Productivity Growth and Sustainable Healthy Food Consumption

Dr. Uma Lele, President-Elect, International Association of Agricultural Economists (IAAE) delivered a Dr. D. Jha memorial lecture on "Smallholder agriculture, productivity growth and sustainable healthy food consumption"on October 29, 2020 on the occasion of Foundation Day.

Hi-Tech Horticulture

Dr. Brahma Singh, NAAS Fellow delivered a lecture on Hi-Tech Horticulture on December 23, 2020 on the celebration of Kisan Divas at ICAR-NIAP. He shared his research experiences on new developments in the horticulture sector for different regions of India.

Women Day Lecture

Prof. Neetha N., Centre for Women's Development Studies, Indian Council of Social Science Research, New Delhi delivered a lecture on March 8, 2021. She highlighted various issues in gender studies, women in agriculture, challenges and opportunities for women during lock-down.

CHAPTER 4

Number of Policy Interface of National Importance: 14

Policy Interactions

- **Doubling Farmers' Income:** As a knowledge partner of DAC&FW, ICAR-NIAP provided policy and technical inputs in designing the framework for DFI strategies and implementation. The Institute also facilitated the finalization of framework for 'ease of doing agribusiness' across states. Presently, the implementation phase of DFI strategies is in progress. For effective implementation of DFI strategies, the Institute worked out mid-term income estimates of farmers' income. Director, ICAR-NIAP was a member of DFI Committee, and presently a member of Empowered Body for implementation of DFI strategies.
- **Fertilizer Trade and Investment Policies:** ICAR-NIAP has analysed and suggested a policy framework to the Department of Fertilizer for encouraging international co-operation in acquisition of raw material and the role of the Government in ensuring the availability of fertilizers to the farmers at a reasonable price.
- **Market Intelligence:** To strength and institutionalize the capacity for the development of market information and price forecasting system, ICAR-NIAP is assisting DAC&FW in developing the mechanism and methods for price forecasting and development of Artificial Intelligence platform.
- **Rating and Ranking of R&D Labs:** The NITI Aayog has undertaken an exercise to develop a framework for the rating and ranking of R&D labs. ICAR-NIAP represented ICAR and contributed to the development of the framework, particularly on the assessment of socio-economic impacts. This framework is being implemented by the Office of Principal Scientific Advisor to the Government of India.
- **Outcome Review of ICAR:** The outcome review of ICAR was facilitated by ICAR-NIAP. Information on significant research outputs and their outcomes were compiled by ICAR-NIAP and submitted to the committee for the finalization of the report. The report has been submitted to the Government
- **Establishment of New KVKs:** The Institute participated in a meeting on "Approach and indicators for channelling the Finance Commission Grants to States". ICAR-NIAP also participated in a meeting on the establishment of KVKs in newly created districts. The Institute also participated in a meeting on "Formation and Promotion of 10,000 FPOs" organised by MoA&FW, New Delhi.
- **Technical expert for reforms in Pradhan Mantri Fasal Bima Yojna (PMFBY):** A committee of experts was constituted by National Rainfed Area Authority (NRAA), MoA&FW to study the operational issues in the implementation of PMFBY. The ICAR-NIAP is leading a sub group to the work on "management and institutional recommendations for bringing reforms in PMFBY". The researchers of the Institute have deliberated with the stakeholders for implementation of PMFBY on the issues of insurance premium, risk in production of various crops and management issues of the scheme.
- As a representative of DARE/ICAR, NIAP scientist participated and provided inputs to Inter-Ministerial Committee (IMC) constituted by the Department of Consumers Affairs, Ministry of Consumers Affairs, Food and Public Distribution to review prices of essential commodities and agricultural scenario in the country. The Committee comprised of representatives of Consumers Affairs and other departments of different ministries besides special invitees, viz. FCI, SFAC, Food and supply department of Delhi, NAFED, Mother Dairy, etc.
- ICAR-NIAP scientists participated in the policy meeting of Task Force 3 (Economic Analysis) conducted by NITI Aayog. The meeting was in line with Inter-

Ministerial Meeting to seek inputs on studies to be commissioned under India Energy Modelling Forum (IEMF). ICAR-NIAP scientists provided feedback on energy issues in agriculture activities, especially in the micro-irrigation sector. For streghneting Prime Minister Krishi Sinchai Yojna (PMKSY), ICAR-NIAP provided technical and policy inputs.

- As a member of the Committee constituted by the Secretary, DARE and DG, ICAR, ICAR-NIAP carried out an economic analysis of the alternative /ex-situ options of the crop residue management. The Committee made several deliberations and made specific recommendations on economic use of crop residues to solve environmental pollution problems that arise due to its burning by the farmers.
- ICAR-NIAP has devised a methodology to estimate State/UT wise population ratio to be covered under the National Food Security Act (NFSA), 2013 based on the income data as available in the Periodic Labour Force Survey conducted in 2017-18 and 2018-19 by the National Sample Survey Office (NSSO). Existing estimates use consumption expenditure as the base variable rather than income for the year 2011-12.
- ICAR-NIAP participated and provided inputs in the meeting of the committee to recommend maximum sale prices of Btcotton for the year 2021 under Cotton Seeds Prices (Control) Order-2015. The meeting was chaired by Joint Secretary, Seeds and participated by ADG (CC), ICAR; CMD, NSC; representative of Principal Secretary, Department of Agriculture, Govt. of Telangana and Gujarat; Member Secretary, CACP and a farmer representative.
- Development of Indian Seed Sector: ICAR-NIAP scientists participated in a policy interaction meeting on the issue of the development of Indian seed sector for betterment of farming community. The interaction meet was organised by the Trust for Advancement of Agricultural Sciences (TAAS) in collaboration with the Indian Society of Seed Technology (ISST), New Delhi.
- ICAR-NIAP provided inputs on economic issues in a stakeholders' dialogue on "Strategies for Safe and Sustainable Weed Management" organized by TAAS, ICAR, Directorate of Weed Research (DWR) and Indian Society of Weed Science (ISWS).

CHAPTER 5

Books/Reports	**: 5**
Edited books/ Training manuals	**: 2**
Policy Papers/Policy Briefs	**: 5**
Peer reviewed research articles	**: 60**
Book chapters	**: 19**
Popular articles	**: 14**
Working Papers/Discussion Papers	**: 3**
Abstracts/Conference proceedings	**: 3**
Newspaper article	**: 1**
Methodological development	**: 5**

Reports

1. Agricultural Development Report 2020-21, ICAR-National Institute of Agricultural Economics and Policy Research, New Delhi.
2. COVID-19 Lockdown and Indian Agriculture: Options to Reduce the Impact (2020), ICAR-National Institute of Agricultural Economics and Policy Research, New Delhi.
3. Economic Impact of ICAR Research (2020), ICAR-National Institute of Agricultural Economics and Policy Research, New Delhi.
4. Outcome Review 2012-13 to 2019-20, Report, Indian Council of Agricultural Research, December 2020.
5. Efficiency of micro-irrigation in economizing water use in India: learning from potential and under-explored state, ICAR-National Institute of Agricultural Economics and Policy Research & NITI Aayog, New Delhi.

Edited Book

1. Pathak, H., Pal, Suresh. and Mohapatra, T. (2020), Mahatma Gandhi's Vision of Agriculture Achievements of ICAR, Indian Council of Agricultural Research, New Delhi. ISBN: 9788171642069

Training Manual

1. Khatadkar, A., Sah, R.P., Deb, R., Kumar, G.M.S., Basak, S., Yadav, S. Jumrani, J. and Singh, A. (2019). Participatory Rural Appraisal: A Case Study, Approach and Implementation. Satish Serial Publishing House. ISBN: 9789386200877.

Policy Papers

1. Chand, S., Kishore, P., Kumar, S. and Srivastava, S.K. (2020). Potential, Adoption and Impact of Micro Irrigation Technology in Indian Agriculture, Policy Paper 36, ICAR-National Institute of Agricultural Economics and Policy Research, New Delhi.
2. Singh, N.P., Anand, B. and Singh, S. (2020). Impact of Climate Change on Agriculture in India: Assessment for Agro-climatic Zones, Policy Paper 35, ICAR-National Institute of Agricultural Economics and Policy Research, New Delhi.
3. Subash, S.P., Jhajhria, A. and Suresh Pal, (2020). Trade and Investment Policy for Overseas Acquisition of Fertilizers and Raw Materials: Role of the Government. Policy Paper 37, ICAR-National Institute of Agricultural Economics and Policy Research, New Delhi.

Policy Briefs

1. Pal, Suresh, Saxena, R. and Balaji, S.J. (2020). Market and Innovation-led Agricultural Transformation. Policy Brief 45, ICAR-National Institute of Agricultural Economics and Policy Research, New Delhi.
2. Roul C., Chand, P. and Suresh Pal (2020). Developing Agricultural Sustainability Index for the Indo-Gangetic Plains of India. Policy Brief 46, ICAR-National Institute of Agricultural Economics and Policy Research, New Delhi.

Research Papers in Peer Reviewed Journals

1. Anupama, G.V., Jain, R., Falk, T., Deb, U. and Bantilan, C. (2020). Data warehousing for open data sharing and decision support in agriculture: A case study of the VDSA knowledge bank and its development process, *International Journal of Information Technology*,12: 923–931.
2. Balaji, S.J., Kumar, S., Nikam, V., Kingsly, I.T., Jumrani, J., Joshi, V. and Kumar A. (2020). Impact of direct seeded rice technology adoption on farm income in Punjab, *Indian Journal of Agricultural Sciences*, 90(3): 625–628.
3. Bardhan, D., Kumar, S., Kumar, S., Singh, R.P. and Hosmani, M. (2020). Cost-benefit analysis of vaccination against goat pox. *Indian Journal of Animal Sciences*, 90 (4): 515–520.

4. Billore, S.D., Dupare, B.U., Sharma, P., Verma, R.K. and Raghvendra, M. (2020). Performance of soybean varieties under frontline demonstrations. *Soybean Research*, 18(1): 77-86.

5. Billore, S.D., Sharma, P. and Dupare, B.U. (2020). Break-even Yield and Cost of Cultivation of Different Soybean Varieties – An Analysis. *Soybean Research*, 18(1): 60-68.

6. Birthal, P.S., Jaweriah, H. and Negi, D.S. (2020). Impact of climatic hazards on India's agricultural growth. *Climate and Development,* https:// DOI: 10.1080/17565529.2020.1867045.

7. Chand, K., Choudhary, B.B., Kumar, S. and Tewari, P. (2020). Examining intended consequences of MGNREGP Intervention on women empowerment: Evidences from block level study in Jodhpur district of Rajasthan, *Indian Journal of Extension Education*, 56 (2): 93-96.

8. Chand, K., Kumar, S., Suresh, A. and Dastagiri, M.B. (2020). Marketing efficiency of vegetables in developing economies: Evidences for critical intervention from Rajasthan, India, *The Indian Journal of Agricultural Sciences*,90 (8): 1419–27.

9. Chand, P., Jain, R., Chand, S., Kishore, P., Malangmeih, L. and Rao, S. (2020). Estimating water balance and identifying crops for sustainable water resources in Bundelkhand region of India. *Transactions of American Society of Agricultural Engineers*, 63(1): 117-124.

10. Chand, P., Rao, S., Jain, R. and Suresh Pal, (2020). Identifying sustainable rice cultivation zones in India: Implications of the crop water footprint. *Agricultural Economics Research Review*, 33(2): 147-160.

11. Chand, S. and Kishore, P. (2021). Whether source of irrigation make difference in technical efficiency of wheat growers canal command areas? A stochastic frontier approach. *Indian Journal of Agricultural Economics*, 76(1): 165-178.

12. Darekar, A., Nikam, V. and Mahapatra, A. (2021). Consumer awareness, sentiments and behavioural changes related to food items during COVID-19 pandemic. *International Journal of Extension Education*, 15: 48-53.

13. Das, A., Raju, R. and Kiran Kumara T.M. (2020). Performance and determinants of exports of coffee from India: A post-WTO scenario. *Indian Journal of Agricultural Economics*, 75(4): 546-559.

14. Dupare, B.U, Sharma, P., Billore, S.D. and Verma, S.K. (2020). Changes in agricultural scenario of Madhya Pradesh with special reference to soybean in changed climatic scenario: A study on farmers' perception. *Journal of Oilseeds Research*, 37(4): 299-308.

15. Dupare, B.U., Sharma, P., Billore, S.D. and Verma, S.K. (2020). Impact of climate change on soybean cultivation in Malwa and Nimar region of Madhya Pradesh: Farmers' perspective. *Soybean Research*, 18(1): 87-97.

16. Dupare, B.U., Sharma, P., Billore, S.D. and Verma, S.K. (2020). Farmers' perception on climate change and its impact: A case of soybean growers in Central India. *Soybean Research*, 18(2): 40-59.

17. Gupta, M., Gerad, M., Subash, S.P. and Sastry, K.R. (2020). Trends of CRISPR technology development and deployment into agricultural production-consumption systems. *World Patent Information,* 60: 101944.

18. Jain, R., Chand, P., Rao, S.C. and Agarwal, P. (2020). Crop and soil suitability analysis using multi-criteria decision making in drought-prone semi-arid tropics in India. *Journal of Soil and Water Conservation*, 19(3): 271-283.

19. Jhajhria, A. and Kumar, S. (2019). Price transmission in major cumin markets of India. *Indian Journal of Extension Education,* 55(4): 110-115.

20. Kanwal, V., Sirohi, S. and Chand, P. (2020). Effect of drought on livestock enterprise: evidence from Rajasthan. *Indian Journal of Animal Sciences,* 90(01): 94-98.

21. Khadatkar, A., Deb, R., Sah, R.P., Basak, S., Sandeep, G.M., Kumar, S. and Jumrani, J. (2020). Application of indigenous knowledge for control of insects-pests in field crop and diseases in livestock. *Indian Journal of Extension Education*, 56(3): 181-184.

22. Kishore, P., Singh, D.R., Chand, P. and Prakash, P. (2020). What determines groundwater depletion in India? A meso level panel analysis, *Journal of Soil and Water Conservation*, 19(4): 388-397.

23. Kolady, D.E., Srivastava, S.K., Just, D. and Singh, J. (2020). Food away from home and the reversal of the calorie intake decline in India. *Food Security*,13: 369-384.

24. Kumar, A., Deka, N., Batla, S., Saroj, S. and Srivastava, S.K. (2020). Rural non-farm employment in eastern India: Implications for economic well-being. *The Indian Journal of Labour Economics*, 63: 657–676.

25. Kumar, A., Hazrana, J., Negi, D.S., Birthal, P.S. and Tripathi, G. (2020). Understanding the geographic pattern of diffusion of modern crop varieties in India: A multilevel modelling approach. *Food Security*, https://doi.org/10.1007/s12571-020-01114-y

26. Kumar, S. and Abdulla (2020). Dynamics of technical efficiency of sugar mills in India: Stochastic Frontier Approach. *Indian Journal of Agricultural Sciences*, 90(8): 1532–7.

27. Kumar, S., Abdulla and Singh, C. (2020). Productivity growth in India's bakery manufacturing industry. *Journal of Agribusiness in Developing and Emerging Economies*, 1-10. DOI 10.1108/JADEE-12-2019-0204 https://www.emerald.com/insight/2044-0839.htm

28. Kumar, S., Anwer, Md. E., Immanuelraj, T. K., Kumar, S., Singh, H.P., Mishra, S.N. and Sarkar, S.K. (2020). Trends and determinants of agricultural wages in India. *Agricultural Economics Research Review*, 33(1): 71-79.

29. Kumar, S., Kumar, S., Joshi, D., Kumar, S. and Singh, U. (2020). Impact of rural infrastructure on performance of livestock sector in Uttar Pradesh, *Indian Journal of Animal Sciences*, 90 (4): 647–654.

30. Kumar, S., Singh, D.R., Jha, G.K., Singh, N.P. and Kingsly, I.T. (2020). Impact of natural resource management technologies on technical efficiency in sorghum cultivation: application of meta-frontier and endogenous switching regression model, *Agricultural Economics Research Review*, 33 (Conference Number): 85-98.

31. Kumara, K.T.M., Kandpal, Ankita and Pal, Suresh (2020). A meta-analysis of economic and environmental benefits of conservation agriculture in South Asia. *Journal of Environmental Management*, 269:110773. DOI: 10.1016/j.jenvman.2020.110773.

32. Kumara, K.T.M., Kumar, S., Aditya, K.S., Singh, D.R., Immanuelraj, T.K., Kallega, H.K. and Singh, P.L. (2020). Economic impact of tank rehabilitation in rainfed region of India. *Indian Journal of Agricultural Sciences*, 90 (3): 138-141.

33. Misra, T., Arora, A., Marwaha, S., Chinnusamy, V., Rao A.R., Jain, R., Sahoo, R. N., Ray, M., Kumar, S., Dhandapani R., Jha, R.R., Nigam, A. and Goel, S. (2020). Spike SegNet-a deep learning approach utilizing encoder-decoder network with hourglass for spike segmentation and counting in wheat plant from visual imaging. *Plant Methods*, 16, 40.

34. Nath, K., Jain, R., Marwaha, S., Arora, A. and Roy, H.S. (2020). Identification of optimal crop plan using nature inspired metaheuristic algorithms, *Indian Journal of Agricultural Sciences*, 90(8): 1587-92.

35. Negi, D.S., Birthal, P., Kumar, A. and Tripathi, G. (2020). Farmers' social networks and the diffusion of modern crop varieties in India. *International Journal of Emerging Markets*, https://doi.org/10.1108/IJOEM-04-2020-0407.

36. Nikam, V., Kumar, S. and Kingsly, I.T. (2021). Social network factors affecting adoption of Mobile app by farmers. *Indian Journal of Agricultural Sciences*, 91(2): 13-17.

37. Nikam, V., Kumar, S., Kingsly, I.T. and Ray, M. (2020). Farmers mobile use pattern, information sources and perception about mobile app for grapes. *Indian Journal of Extension Education,* 56(1): 77-83.

38. Nithyashree, M.L. and Pal, Suresh (2020). Rising capital intensity and employment potential of Indian food processing industry, *Indian Journal of Agricultural Economics,* 75(4): 518-533.

39. Pal, Suresh, (2021). Institutions, supply chains and resource management for agricultural development, *Indian Journal of Agricultural Economics,* 76(1): 78-91.

40. Parappurathu, S., Ramachandran, C., Menon, M., Baiju, K.K., Rohit, P., Kumar, P.N., Padua, H. and Kumar, S. (2020). Harnessing artisanal prowess in offshore fisheries: The case of Thoothoor Fishers from India. *Marine Policy,* 121: 01-08.

41. Praveen, K.V., Singh, A., Kumar, P., Jha, G.K. and Kingsly, I.T. (2000). Advancing with fertilizers in Indian agriculture: Trends, challenges, and research priorities. *Agricultural Economics Research Review,* 33 (Conference Number): 49-60.

42. Rai, M., Chand, P., Kalvaniya, K.C., Jat, H.S., Agarwal, T., Sharma, P.C. and Jat, M.L. (2020). How profitable climate smart agricultural practices are? Voice of farmers from rice-wheat ecologies. *Indian Journal of Agricultural Sciences,* 90(7): 1271-1276.

43. Ravi, K.N., Bharat, S. Sontaki, Shimray, P.W., Mukhtar, S., Mansuri, Verma, S., Kumar, T.M.K., Gurjar, B., Naik, V. and Tegelli, R. (2020). Field experience training: pragmatic multidisciplinary approach for developing comprehensive village development action plan. *Indian Research Journal of Extension Education,* 20(1): 21-26.

44. Roul, C., Chaudhari, S.K., Chand, P., Jayaraman, S., Sukla, N.B., Ramawat, N., Pal Suresh, and Karad, G. (2021). Agricultural sustainability in context of Indian agriculture: A parametric approach from Punjab and Haryana. *Journal of the Indian Society of Soil Science,* 68(3): 253-274.

45. Sabu, S.S., Kuruvila, A. and Subash, S.P. (2020). Price volatility of black pepper in Kerala: Could institutional mechanism such as contract agreement be a solution? *Indian Journal of Agricultural Economics,* 75(2): 166-185.

46. Sam, A.S., Subash, S.P., Kächele, H., Kumar, R. and Müller, K. (2020). Climate change, drought and rural communities: Understanding people's perceptions and adaptations in rural eastern India. *International Journal of Disaster Risk Reduction,* 44: 101436.

47. Sendhil, R., Kumara, K.T.M., Ramasundaram, P., Sinha, M. and Kharkwal, S. (2020). Nutrition status in India: Dynamics and determinants. *Global Food Security,* 26, 100455.

48. Singh, N.P., Anand, B., Singh, S., Srivastava, S.K., Rao, C.S., Rao, K.V. and Bal, S.K. (2021). Synergies and trade-offs for climate-resilient agriculture in India: An agro-climatic zone assessment. *Climatic Change,* 164: 11.

49. Singh, N.P., Anand, B., Srivastava, S.K., Rao, K.V., Bal, S.K. and Prabhakar, M. (2020). Assessing the impacts of climate change on crop yields in different agro-climatic zones of India. *Journal of Atmospheric Science Research,* 3(4): 16-27.

50. Singh, N.P., Anand, B., Srivastava, S.K., Sharma, S. and Kumar, N.R. (2021). Grassroots farmers' perceptions on climate change and adaptation in arid region of Rajasthan. *Indian Journal of Traditional Knowledge,* 20(2).

51. Singh, R., Dympep, A., Passah, S., Feroze, S.M., Choudhury, A., Kumar, S. and Jhajhria, A. (2020). Value chain analysis of Lakadong turmeric in Meghalaya: A micro-level study. *Agricultural Economics Research Review,* 33(2): 239-249.

52. Singh, R., Feroze, S.M. and Kumar, S.

(2020). Production of turmeric in North East Hill region of India: A value chain analysis. *Indian Journal of Agricultural Economics*, 7(04): 359-37.

53. Srivastava, S.K. and Saxena, R. (2021). New farm acts, 2020: Rationale and challenges. *Current Science*, 120(6): 981-988.

54. Srivastava, S.K., Singh, J., Kumar, N.R., Singh, N.P. and Ahmad, N. (2020). Changing agricultural labour market and its effects on farm economy in India. *Indian Journal of Agricultural Economics*, 75(4): 469-480.

55. Srivastava, S.K. and Sivaramane, N. (2020). Income-induced effects of COVID-19 on the food consumption pattern of Indian households. *Agricultural Economics Research Review*, 33(Conference number): 15-24.

56. Subash, S.P. (2020). Intellectual property, competition, and regulatory policies: A case of Bt cotton seed industry in India. *CCI Journal on Competition Law and Policy*, 1: 79-101.

57. Subash, S.P., Balaji S.J., and Pal, Suresh (2020). Agricultural input markets in India – Recent policy reforms and way forward: A review. *Indian Journal of Agricultural Sciences*, 90(6): 1047–53.

58. Umanath, M., Paramasivam, R., Felix, K.T. and Balaji, S.J. (2020). Simultaneous equation model for Indian sugar sector. *Journal of Social and Economic Development* 22: 113-141.

59. Venkatesh, P., Pal, B.D., Dubey, S.K., Sangeetha, V., Balasubramanian, M., Renjini, V.R., Singh, D.R., Kar, A., Balaji, S.J. and Pal, Suresh. (2020). Structural transformation, export promotion policy options, and their impact on the Indian economy: A social accounting matrix (SAM) approach. *Agricultural Economics Research Review*, 33(1): 9-21.

60. Vinayak, R.N., Kumar, S., Kingsly, I.T., Balaji, S.J., Jhajhria, A., Kumar, R. and Kumar, D. (2020). Economic potential of AVIKASIL-S technology for estrus synchronization in sheep. *Indian Journal of Animal Sciences*, 90(3): 383-387.

Book Chapters

1. Badal, P.S., Choudhary, H., Agarwal, P. and Chand, P. (2020). Rice fallow in eastern India: prospects, constraints and possible strategies. In: Natural Resource Use Planning for Sustainable Agriculture (Eds. Chand, P., Jain, R., Kumar, S.D., Singh, J.M., Badal, P.S.) ICAR-National Institute of Agricultural Economics and Policy Research, New Delhi. 129-143.

2. Balasubramanian, M., Singh, D.R., Devi, S.S.A., Jha, G.K., Aditya, K.S., Chand, P., Anbukkani, P., Kishore, P. and Jain, R. (2020). Impact of tank rehabilitation on agriculture in Warangal district of Telangana. In: Natural Resource Use Planning for Sustainable Agriculture. (Eds: Chand, P., Jain, R., Kumar, S.D., Singh, J.M., Badal, P.S.), ICAR-National Institute of Agricultural Economics and Policy Research, New Delhi, 94-106.

3. Birthal, P.S., Joshi, P.K. and Hazrana, J. (2020). Financing agricultural value chains. In: Transforming Agriculture in South Asia. Routledge (Eds. Mishra, A.K., Kumar, A., Joshi, P.K.).

4. Birthal, P.S. and Pandey, G. (2020). Sources of agricultural growth in South Asia. In: Transforming Agriculture in South Asia. Routledge (Eds. Mishra, A.K., Kumar, A., Joshi, P.K.).

5. Chand, K., Chand, S. and Kumar, V. (2021). Flagship programmes of the government. In: Agricultural Development Report 2021 (Eds. Saxena, R., Chand, P., Balaji, S.J., Pal, Suresh), ICAR-National Institute of Agricultural Economics and Policy Research, New Delhi. 21-30.

6. Chand, P., Jain, R., Pal, S., Rao, S.C. and Agarwal, P. (2020). Resource use planning for sustainable agriculture: synthesis of issues. In: Natural Resource Use Planning for Sustainable Agriculture. (Eds: Chand, P., Jain, R., Kumar, S.D., Singh, J.M., Badal, P.S.),

ICAR-National Institute of Agricultural Economics and Policy Research, New Delhi,1-16.

7. Chand, S., Ravishankar, N., Kumar, S., Bhattrai, M., Srivastava, R.C. and Kumar, D. (2020). Institutional innovations in canal irrigation management system in India: Constraints and way forward (Eds: Bhatt, .P, Pandey V.C.), Managing land degradation for enhancing farm productivity, ICAR-ISWC, RC, Vasad, Gujarat. 305-319.

8. Jumrani, J., Joshi, V. and Shah, S.A. (2020). Vital elements for a successful enterprise in Subsidiary enterprises to empower women and rural youths.(Eds: Toppo, S., Borah, T.R, Haque, N.,Mitra, A.), Today & Tomorrow's Printers and Publishers, 1-11.

9. Jumrani, J. and Rai, V.N. (2020). The unacceptable status quo: malnutrition challenges of the developed and developing world in Wheat and Barley Grain Biofortification. (Eds: Gupta, O.P., Pandey, V., Narwal, S., Sharma, P., Ram, S., Singh, G.P.), Woodhead Publishing, 1-25.

10. Kandpal, A., Balaji, S.J., Meena, D.C., Kumar, S., Kumar, D. and Chauhan, S. (2021). Agricultural Development Indicators. In: Agricultural Development Report 2021 (Eds. RakaSaxena, Prem Chand, Balaji SJ and Suresh Pal), ICAR-National Institute of Agricultural Economics and Policy Research, New Delhi. 53-58.

11. Nigam, S., Jain, R., Marwaha, S. and Arora, A. (2021). Wheat rust disease identification using deep learning. In: Internet of Things and Machine Learning in Agriculture - Technological Impacts and Challenges. (Eds: Chatterjee, J.M, Kumar, A., Rathore, P.S., Jain, V., De Gruyter), Frontiers in Computational Intelligence, 8, De Gruyter, Germany, 239-250.

12. Saxena, R., Sharma, P., Jhajhria, A. and Subash S.P. (2021). Agricultural Policy Reforms. In: Agricultural Development Report 2020-21, ICAR-National Institute of Agricultural Economics and Policy Research, New Delhi. 13-20.

13. Sharma, P., Jumrani, J., Srivastava, S.K. (2021). Impact of Covid-19 on Indian Agriculture, In: Agricultural Development Report 2021. ICAR-National Institute of Agricultural Economics and Policy Research, New Delhi. 5-12.

14. Sharma, P., Subhash, S.P., Kingsly, I.T. and Kumar, N.R. (2021). Prospects for 2021-22. In: Agricultural Development Report 2021. ICAR-National Institute of Agricultural Economics and Policy Research, New Delhi. 43-48.

15. Singh, J.M., Singh, J., Kumar, H., Singh, S., Sachdeva, J., Kaur, B., Chopra, S. and Chand, P. (2020). Economics of paddy straw management technologies for wheat cultivation in Punjab. In: Natural Resource Use Planning for Sustainable Agriculture. (Eds: Chand, P., Jain, R., Kumar, S.D., Singh, J.M., Badal, P.S.), ICAR-National Institute of Agricultural Economics and Policy Research, New Delhi, 79-92.

16. Singh, P., Reddy, M.N., Dixit, S. and Nikam, V. (2021). Management of Agricultural Extension Organisation. Handbook of Agricultural Extension, Extension Division, Indian Council of Agricultural Research, New Delhi.

17. Srivastava, S.K. and Pal, S. (2020). Fostering investment for sustainable agricultural development in India: Public-Private-Farmer Cooperation (PPFC). In: Fostering Responsible Investment for Sustainable Agriculture and Food Systems in South Asia (Eds: Shrestha, R.B., Ali, Y., Hassan, M.S.), SAARC Agriculture Center, Bangladesh, ActionAid, Bangladesh, Ministry of Agriculture, Sri Lanka. 211.

18. Talukdar, U., Taye, N., Hazarika, J., Deka, N., Agarwal, P., Chand, P. and Jain, R. (2020). Flood damage management in Assam: A case study. In: Natural Resource Use Planning for Sustainable Agriculture. (Eds: Chand, P., Jain, R., Kumar, S.D., Singh, J.M., Badal, P.S.), ICAR-National

Institute of Agricultural Economics and Policy Research, New Delhi, 107-116.

19. Mohapatra T., Singh, S. and Pal, S. (2020). Realizing Gandhiji's vision for agriculture and rural development: Role of ICAR innovations, In: Mahatma Gandhi's Vision of Agriculture Achievements of ICAR, Indian Council of Agricultural Research, New Delhi, 1-13.

Book Review

Subash, S.P. (2020) Wall Street View of Rural India: A Banker's Diary of a Decade of Road Trips. https://www.aesanetwork.org/a-wall-street-view-of-rural-india-a-bankers-diary-of-a-decade-of-road-trips/

Popular Articles

1. अबिमन्यु झाझरिया, शिवकुमार एवं विनायक निकम. (2020). बाजार और सूचनातंत्र मे कृत्रिम बुद्धिमत्ता की भूमिका। सांखिकी विमर्श, 2019–20, भाकृअप–भारतीय कृषि सांखिकी अनुसंधान संस्थान, नई दिल्ली।

2. Aditya, K.S., Subash, S.P. and Bhuvana, N. (2020). Getting smart with surveys: using computers, tablets or smart phones for household surveys. https://www.aesanetwork.org/blog-106-getting-smart-with-surveys-using-computers-tablets-or-smart-phones-for-household-surveys/

3. Balaji, S.J. and Babu, S.C. (2020). Agriculture: can it revive the economy? *The Global Analyst*, 9(9): 19-21.

4. Balaji, S.J., Babu, S.C. and Inbasekar, K. (2021). Smart agriculture: myth or reality? *The Global Analyst*, 10(1): 46-48.

5. Chand, S. and Kishore, P. (2020). Demining Warabandi water management system in India? A case study of saharanpur district of Uttar Pradesh, *Soil and Water Conservation Bulletin*, (5): 1-3.

6. Jain, R., Chauhan, S. and Chauhan, M.S. (2020). *Prakartik Sansadhan Niyojan: Krashak Aay Badhotarimai Sahayak, Krishi Chetna*, ICAR-IIMR, 3, 66-67.

7. Kumar, A., Srivastava, S.K. and Awais, M. (2020). Bharat me sahjan (drumstick) kiupyogita ayumvipransambandhit chunautiyan (hindi article). *Sankhyiki Vimarsh*, 2019-20

8. Kumar, S., Kumar, P. and Awais, Md. (2020). *Bhartiya Krishi Mein Sooksham Sinchyaee Ki Sarthakata: Pragtievam Prabhav Vishleshan, Jal Chetna,* National Institute of Hydrology, Roorkee, 9(1): 6-10.

9. Nikam, V. and Kale, R. (2020). Unshackling farmer producer organisations from Covid-19 lockdown. *Agriculture Extension in South Asia* (AESA) Blog 110, April 2020.

10. Nikam, V. and Singh, D. (2020). Straw Burning: Issues and Prevention Strategies, *Indian Farming*, 70 (2).

11. Kumar, V. (2020). Performance analysis of National Agricultural Insurance Scheme (NAIS) and Pradhan Mantri Fasal Bima Yojna (PMFBY). *Agro Economist*, 7(2): 145-152

12. Kumar, V., and Chand, K. (2020). Pradhan Mantri Fasal Bima Yojna (PMFBY) for reduction of farmers' risk in agriculture: Status and progress. *Progressive Research*, 15 (4): 274-276.

13. Kumar, V., Meena, D.C. and Chand, K. (2020). Comparative economics of pulses and wheat production in Uttar Pradesh. *Agro Economist*, 7(2): 89-94.

14. Jain, R., Chauhan, M.S. and Chauhan, S. (2020). *Krishi Vishavavidyalya main Suchanaavam Prasar Taknikoka Upyog*: AkAkalan. *RashtriyaKrishi*, 15(1): 27-29.

Working /Discussion Papers

1. Balaji, S.J. and Babu, S.C. (2020).Agricultural productivity, inter-sectoral labour shift, and economic growth in India. IFPRI Discussion Paper 01943, Director General's Office, International Food Policy Research Institute, Washington DC, June.

2. Balaji, S.J., Babu, S.C. and Pal, Suresh (2020). Research-policy linkages: empirical evidence

from agroeconomic research in India, IFPRI Discussion Paper 01970, Director General's Office, International Food Policy Research Institute (IFPRI), Washington DC, November.

3. Singh, H., Negi, D.S. and Birthal, P.S. (2020). Uncertain Monsoon, Irrigation and Crop Yields: Implications for Pricing of Insurance Products. Working Paper. Indira Gandhi Institute of Development Research, Mumbai.

Proceedings of Conferences, Workshops, Symposia

1. Chand, P., Jain, R., Kumar, S.D., Singh, J.M. and Badal, P.S. (2020). Natural resource use planning for sustainable agriculture. ICAR-National Institute of Agricultural Economics and Policy Research, New Delhi.

2. Chand, P., Rao, S. and Agarwal, P. (2019). Cross-sectoral diversification for sustainable intensification: Addressing groundwater resource imbalance in India. In: Water cooperation: Coping with 21st Century challenges, Proceedings of 6th Water Week, New Delhi September, 24-28, 2019.

3. Singh, S.S., R., Feroze, S.M. and Kumar, S. (2021). Production of turmeric in North East hill region of India: A value chain analysis. 80th Annual Conference of the (Indian Society of Agricultural Economics, Tamil Nadu Agricultural University, Coimbatore (Tamil Nadu), February10-12, 2021.

Newspaper Article

1. Jumrani, J., Opinion article on 'Nudging health: an apt time to relook at our dietary choices', *The Financial Express*, November 5, 2020.

Others

1. E-Diary NIAP, July, 2020, Eds. Rajni Jain, Mangal Singh Chauhan, Sonia Chauhan, E-published by ICAR-NIAP, available at https://niap.icar.gov.in/Niap_Dairy.html.

2. E-Diary NIAP, January, 2021. Eds. Rajni Jain, Mangal Singh Chauhan, Sonia Chauhan, E-published by ICAR-NIAP, available at https://niap.icar.gov.in/Niap_Dairy.html.

3. Sendhil, R., Ramasundaram, P., Subash, S.P., Ram, S., Kumar, A., Singh, S. and Singh, G.P. (2020). Policy Imperatives for Wheat Procurement. Policy Paper 1. ICAR-Indian Institute of Wheat and Barley Research, Karnal.

4. Umanath, M., Felix, K.T., Paramasivam, R. and Balaji, S.J. (2020). How Can We Meet the Growing Demand for Sugar? Research Brief 1, Madras Institute of Development Studies, Chennai.

Methodological development

Composite Index of Agricultural Sustainability

Suresh Pal, Prem Chand, Chhabilendra Roul and Trilochan Mohapatra

Incorporating socio-economic, water, soil and ecological dimensions, a composite index of agricultural sustainability (CIAS) was developed using indicator framework. The identification of the sustainability indicators was based on the review of literature followed by their revalidation by the experts based on the criteria of relevance and objectivity. In total, 79 indicators relating to soil, water, agro-biodiversity and productivity were selected, representing the status of the sustainability, pressures on it, and policy response to address the concerns. The robustness of the sustainability index was checked by employing various normalization methods and weighting schemes. The results showed that the benchmark method of normalization representing a desirable range of the indicators, was found to be superior as it is useful in spatio-temporal comparison of the sustainability index. The framework was applied to assess the sustainability at meso and macro level in India and has wider applicability in developing countries.

Agroecosystem Diversity Index

Chhabilendra Roul, Prem Chand, Suresh Pal and Kalu Naik

The Institute has developed the Agroecosystem Diversity Index (ADI) which encompasses three broad aspects, viz. diversity status at multi-levels (ecosystem, landscape, species and genetic), drivers of agrobiodiversity threats/ losses, and societal response to reverse these losses. The ADI is the first of its kind to measure the diversity of agro-ecosystems at a regional level and it helps understand policymakers the opportunities to improve agrobiodiversity. The proposed index can also be used to identify agrobiodiversity hotspots and monitor agrobiodiversity targets at global, national and ecosystem levels. The model was validated with a case study of the Indo-Gangetic Plains of India.

Climate Resilient Agriculture Index

N.P. Singh and S.K. Srivastava

A Climate Resilient Agriculture Index (CRA) has been constructed to assess and profile resilience across 14 Agro-climatic zones (excluding island region) in India. A total of 26 indicators, relating to environment, technology, socio-economic and infrastructure & institutional dimensions were employed to purport inter and intra Agro-Climatic Zones (ACZ) differentials in the level of resilience using district level information. The results revealed wide inter-zonal and intra-zonal variation in resilience to the climatic changes.

Market Intelligence

Shiv Kumar, Sharma P., Immanuelraj T.K., Jhajhria, A., G.K. Jha, Prawin Arya, R.K. Paul and Raka Saxena

Forecasts are generated based on modelling framework along with the consideration of qualitative expectations of farmers and traders. All possible forecasting techniques viz. statistical, econometric, machine learning, Internet of things (IoTs), AI tools are embedded in the platform to auto-find the best fit according to nature of data. For reliable forecasting, standard forecasting steps like training, validation and forecasting are followed.

Commodity Outlook

Immanuelraj T.K, Shiv Kumar and Shinoj P.

This Outlook model consists of different sub-models that includes commodity and regions based production models and price linkage models besides, commodity based consumption models, export and import models, and open and close stock models. The coefficients of the different models were partly compiled and partly calibrated. Finally, all the models are linked to simultaneously estimate the equilibrium values of the target variables. All the sub-models are linked in a way that is consistent with economic theory, unites various economic activities such as production, consumption, trade and stocking related to commodity across regions over time.

CHAPTER 6

ICAR Award and NAAS Fellow	**: 2**
Membership in committees	**: 7**
Working groups of national importance	**: 15**
Young Scientist Award	**: 2**

Awards

S.No.	Name of Awards	Recipient
1	Rafi Ahmed Kidwai Award	Suresh Pal
2	Elected Fellow of NAAS	N.P. Singh
3	Young Scientist Award (Social Sciences) of NAAS for the Biennium 2019-20	S.K. Srivastava
4	Uma Lele AERA India Mentorship Award	Subash S.P.
5	Young Agricultural Economist Awards of AERA	Balaji S.J

Recognitions

Suresh Pal

- Member of the Committee to facilitate all activities related to `Ease of doing business' under the Chairmanship of Addl. Secretary (D) and Secretary, ICAR.
- Member of the Committee for providing specific views/Memorandum on all issues related to DARE/ICAR to the Fifteenth Finance Commission constituted by Secretary DARE & DG, ICAR under the Chairmanship of Dr. A.K. Singh, DDG (Ag. Extension).
- Member of Technical Committee on Market Intelligence (Supply Management, Price and Demand Forecasting) under the Chairmanship of CEO-NRAA.
- Member of Editorial Board of the Indian Journal of Agricultural Sciences from October 1, 2018.
- Member Secretary to undertake an Outcome Review of various Schemes of ICAR for XIIth Plan Period. Committee constituted by Hon'ble Agriculture Minister, MoA& FW, Government of India, New Delhi
- Member of the Inter-Ministerial Committee for recommending strategy for Doubling Farmers' Income, DAC&FW.
- Member of the committee to examine the issues relating to considering of KVKs in newly created districts of the country under the Chairmanship of Dr. Panjab Singh, Former Secretary, DARE & DG, ICAR.
- Member of the Board, State Agricultural Prices Board (SAPB), Thiruvananthapuram, Kerala, February 06, 2021.
- Member of the Core-Committee to prepare Policy Document on Futuristic Crop Planning for 2030/2050 under the chairmanship of Deputy Director General (NRM).
- Member of a Committee of Department of Agriculture Cooperation and Farmers' Welfare (DAC&FW) and Warehousing Development and Regulatory Authority (WDRA) on the need for convergence to strengthen post-harvest and marketing infrastructure, Department of Agriculture Cooperation and Farmers' Welfare.
- Member of the Committee to recommend the maximum sale price of Bt. Cotton seed Secretary, Agricultural Economics Research Review.
- Organizing Secretary, 32st International Conference of Agricultural Economists (ICAE)
- Delivered Keynote Speech, 80thISAE annual conference held at TNAU, Coimbatore

P. S. Birthal

- Chairman, NSSO Working Group on Situational Analysis of Farm Households, Indebtedness and Livestock holdings, Ministry of Statistics and Program Implementation, Government of India.
- Member- Sub-group on Agricultural Commodities for Revision of Wholesale Price Index, Ministry of Agriculture and Farmers Welfare, Government of India.
- Member, Committee for Evaluation of Marketing System, Govt of Punjab.

- Member, Research Advisory Committee, IVRI, 2017- 2020.
- Member, Research Advisory Committee, CPRI, Shimla.
- Member- Quinquennial Review Team, Indian Institute of Rice Research, Hyderabad.
- Chief Editor, Agricultural Economics Research Review.
- Editor, NAAS.

N. R. Kumar

- Member, Editorial Board, Potato Journal, a journal of Indian Potato Association, ICAR-CPRI, Shimla.
- Member, Board of School of Agricultural Sciences & Rural Development, Nagaland University for 2 years.

Khem Chand

- Member, Editorial Board, Agro Economist, an international refereed research journal published by Association of Agricultural Economics and Agri-Business Management (AAEBM), New Delhi, India

Rajni Jain

- External Member, 69th IMC, IASRI, New Delhi
- Content creator, E-learning course MCA-561, Unit 1 on Programming Fundamentals using International Conference on Machine Learning and Big Data Analytics (ICMLBDA) 2021 for 6 research papers.

Subhash Chand

- Nominated assubject matter expert for agricultural economics professors application screening under CAS, at Dr.Rajeder Prasad, Central Agricultural University, Samastipur, Bihar, during March 19-21, 2021.
- Nominated assubject matter expert for agricultural economics associateprofessor application screening at Dr.Rajender Prasad, Central Agricultural University, Samastipur, Bihar during October 2020.
- Nominated as an expert by the VC SVPA & T, University at Modipuram, Meerut on February 03, 2020, and a member in interview board to select the guest faculty for Agricultural Economics and Agribusiness management division.

S.K. Pandey

- Member, Executive Committee, Indian Society of Agricultural Economics, Mumbai. Reviewer for Agricultural Economics Research Review.

Raka Saxena

- Member, Task force for inter alia, creating a framework and implementation plan for India Digital Ecosystem of Agriculture (IDEA), created by Ministry of Agriculture & Farmers Welfare, Government of India.
- Chaired a session on Rural Economy; Challenges & Opportunities in "Global conference on Emerging Agricultural Research to Endure the Predicament of COVID-19 Pandemic" held on December 12-13, 2020 at Triveni Devi Bhalotia College, KaziNarul University, PaschimBardhaman, West Bengal.
- Keynote Lecture delivered on Containing covid-19 Impact on Rural Economy; Challenges & Opportunities in "Global conference on Emerging Agricultural Research to Endure the Predicament of COVID-19 Pandemic" held on December 12-13, 2020 at Triveni Devi Bhalotia College, KaziNarul University, PaschimBardhaman, West Bengal.

Prem Chand

- Member, Executive Committee, Indian Society of Agricultural Economics, Mumbai.

S. K. Srivastava

- Young Scientist Award (Social Sciences) for

the Biennium 2019-20 of National Academy of Agricultural Sciences, New Delhi

- Expert by SAARC Agriculture Centre, Dhaka, Bangladesh to contribute a country paper on "Fostering investment for sustainable agricultural development for SAARC member countries: Public-Private-Farmer Partnership (PPFC).
- Review Editor on the Editorial Board of Insect Economics (specialty section of Frontiers in Insect Science).
- Member of the Editorial board of "Agriculture letters", A monthly e-newsletter for agri-allied sciences.

D. C. Meena

- Associate-editor for "International Journal of Agriculture Sciences": Publisher- Bioinfo Publications

Prabhat Kishore

- Best Oral Paper Presentation Award in Global Conference on 'Emerging Agricultural Research to Endure the Predicament of COVID-19 Pandemic' organised by Agricultural Economics and Social Science Research Association (AESSRA), New Delhi, India held on December 12-13, 2020.

CHAPTER 7

Table 7.1. Lectures delivered by ICAR-NIAP Scientists

Name of the Scientist	Topic	Venue and date
Suresh Pal	Global Summit 2020: Mission 5 Trillion – Sector Specific CMA Cryogenic Roles	Institute of Cost Accountants of India, Lodhi Road, New Delhi, January 11, 2020
	State of farm productivity in India	India Habitat Centre, Lodhi Road, New Delhi, February 28, 2020
Subhash Chand	Integrated Farming System promotion through convergence of schemes and FPOs in Customized training programmesfor NABARD officers	ICAR-IIFSR, Modipuram, January 27, 2021
Rajni Jain	Introduction to data science and basic probability to participants of Faculty Development Programme (FDP) on data science	Dr. Hari Singh Gour University, Sagar, Madhya Pradesh, May 9, 2020
	Statistical inference to participants of FDP on data science	Dr. Hari Singh Gour University, Sagar, Madhya Pradesh, May 9, 2020
	Tools for data analysis (SPSS) to participants of FDP on data science	Dr. Hari Singh Gour University, Sagar, Madhya Pradesh, May 10, 2020
	Machine learning to participants of FDP on data science	Dr. Hari Singh Gour University, Sagar, Madhya Pradesh, May 13, 2020
	Evaluation measures for Comparing AI algorithm to participants of FDP on artificial intelligence	Dr. Hari Singh Gour University, Sagar, Madhya Pradesh, May 25, 2020
	Targets and achievements under the theme technology policy in RAC meeting, ICAR-NIAP	ICAR-NIAP, New Delhi, May 25, 2020
	Basics of Weka for AI to participants of FDP on artificial intelligence	Dr. Hari Singh Gour University, Sagar, Madhya Pradesh, May 27, 2020
	Classification using Weka to participants of FDP on artificial intelligence	Dr. Hari Singh Gour University, Sagar, Madhya Pradesh, May 28, 2020
	Artificial intelligence and big data R to the participants of webinar series on "Quantitative Methods for Social Sciences"	ICAR-NIAP, New Delhi, June 20, 2020
	Classification by decision trees using R to the participants of the training on Data Science in Agriculture using R	ICAR-IASRI, New Delhi, September 9, 2020
	Machine learning algorithms to participants of seminar	Turing Society, Acharya Narender Dev College,Delhi University, Delhi, November 3, 2020

	Evolutionary computing for optimum cop Planning in conference on Visionary Innovations in Statistical Theory and Applications (VISTA-2021)	ICAR-NAARM, Hyderabad, February 28, 2021
Raka Saxena	Decoding farm bill in the National Webinar	ICAR-NDRI, Karnal, January 13, 2021
	Marketing and trade of high value crops in the National Webinar	ICAR-NDRI, Karnal, January 14, 2021
	Role of market intelligence (MI) in agriculture marketing- concept & process of MI, models of MI in India in online training programme for NABARD officers	National Bank Staff College, Lucknow, February 24, 2021
	Price volatility & market intelligence in webinar on "Agricultural Market Reforms and Market Intelligence	Anand Agricultural University, Gujarat, July 8, 2020
	Advanced Statistical method and forecasting for agriculture produce in a online training programme	CCS National Institute of Agricultural Marketing (NIAM), Jaipur, August 19, 2020
	Role of market intelligence (MI) in agriculture marketing- concept & process of MI, Models of MI in India in online training programme for NABARD officers	National Bank Staff College, Lucknow, October 10, 2020
	Market intelligence and price volatility in context to the horticulture crops in the National Webinar on Market Intelligence & Export Potential in Horticulture Sector	College of Horticulture, SardarkrushinagarDantiwada Agriculture University, Jagudan, Gujarat, October 14, 2020
	Examining the trade competitiveness and assessing the trade potential- methodologies issues in webinar on International trade in agricultural commodities	Anand Agricultural University, Anand, Gujarat, October 23, 2020
	Promoting agricultural trade from India: trends, methodological issues and Covid-19 impacts in a web-talk	Department of Economics, Aligarh Muslim University, Aligarh, December 16, 2020
	Global opportunities for Indian agribusiness to the students of MBA Sustainable Development and Management	Nalanda University, February 25, 2021
	Market intelligence (MI) in agriculture and doubling farmers' income marketing- concept & process of MI, Models of MI in India	National Bank Staff College, Lucknow, March 10, 2021

Purushottam Sharma	Agricultural marketing reforms 2020: future prospects in awareness programme on recent agriculture marketing reforms	KVK, Indore and ATMA, Indore, November 11, 2020
	Development of agriculture over years in Training program on 'Agriculture for Economic Development: Policy Planning, Policy Analysis and Techniques of Economic Analysis'	MANAGE, Hyderabad February 25, 2021
	Importance of marketing in agriculture in Training program on 'Agriculture for Economic Development: Policy Planning, Policy Analysis and Techniques of Economic Analysis'	MANAGE, Hyderabad, February 25, 2021
Prem Chand	Basic of diversification for high income generating enterprises in webinar on Extension strategy for diversification towards high income generating enterprises	Extension Education Institute, Nilokheri, Haryana, October 12, 2020
Balaji S.J.	Advanced econometrics models (IV & 2SLS) in short-term capacity building programme on 'Agricultural Policy Research'	ICAR-NIAP, New Delhi, December 5, 2020
	Young agricultural economist award 2020 lecture at 28th Annual AERA Conference	UAS, Bangalore, December 18, 2020
	Time series methods in National Online Workshop on Application of Research Methods and Statistical Tools in Management Studies and Social Sciences	Satyabhama Institute of Science and Technology, Chennai, February 13, 2021
Vinayak Nikam	Farmers producers organisation: Role in linking farmers to market and current situation in training programme on "Linking farmers to market and processing industries"	Extension Education Institute, Nilokheri, Haryana, January 21, 2021
	Functioning of farmer producer organization and new guidelines for farmer producer organizationin training programme on Extension strategy for promoting FPO, FPC and SHG"	Extension Education Institute, Nilokheri, Haryana, December 23, 2020

	Farmer producer organization: means to overcome the risks in agriculture & allied sectorsin training programme on Risk management in agriculture and allied sector"	Extension Education Institute, Nilokheri, Haryana September 9, 2020
Jaya Jumrani	Policy advocacy and communication, capacity building training course on Agricultural Policy Researchprogramme	ICAR-NIAP, New Delhi, December 9, 2020
Subash S.P.	Building basic econometric models in Webinar series on Quantitative Methods in Social Sciences	ICAR- NIAP, New Delhi, December 3, 2020
	Behavioral insights for agricultural economics in Lecture Series "Being Farmer"	Christ University, Bangalore, November 6, 2020
	Using discontinuity as natural experiment- Regression discontinuity design in National Higher Education Programme (NAHEP)-Center for Advanced Agricultural Science and Technology (CAAST)	NAHEP-CAAST ICAR-IARI, New Delhi, March 25, 2021
	Contribution of behavioral & welfare economics in public policy in Lecture Series	Central University of Rajasthan, January 18, 2021
	What economists do? in NCR Lecture Series	Christ University, NCR, July 27, 2020
Abimanyu Jhajhria	Agricultural value chains and policy imperatives inIndian Economic Service (IES) Training programme	ICAR- NIAP, New Delhi, February 21, 2020
Kingsly I.T.	Grain Outlook Model in IES training	ICAR-NIAP, New Delhi, November 11, 2020
	Introduction to R in Summer School	ICAR-NIAP, New Delhi, December 3, 2020
	Common errors in application of econometrics and Linear Programming a partial alternative in Webinar on Diagnostics and Remedial Measures for Common Error in Application of Statistics	Navsari Agricultural University, Navsari, Gujarat, October 21, 2020

Table 7.2. Training attended

Name of the Scientist	Name of the event	Venue and duration
Rajni Jain	Online Training on leveraging big data analytics to drive business outcomes	Academic Staff College, Hyderabad, September 28-30, 2020
	Online Training on MDP on PME	ICAR-NAARM, Hyderabad, October 12-17, 2020
	Online Training on Geo-informatics in agriculture using open-source data and analysis platforms	ICAR-IARI, New Delhi, March 1-5, 2021
	Online Training oncyber-security	Ministry of Electronics and Information Technology, Government of India, January 5, 2021
	Online Training on data analytics and machine learning for productivity	Asian Productivity Organization, December 16-18, 2020
Purushottam Sharma, Abimanyu Jhajhria, D. C. Meena	Online Training on time series data analysis	ICAR-NAARM, Hyderabad, January 04-09, 2021

Table 7.3. Seminar/Conference/Webinar- Paper Presented

Name of the scientist	Name of the event	Venue& duration
Suresh Pal	Keynote speaker in 5th Uttar Pradesh Agricultural Science Congress - Production, consumption and marketing linkages for remunerative farming	Banaras Hindu University, Varanasi, February 24, 2020
	ISCA Webinar on Coastal Agriculture: Transforming Coastal Zone for Sustainable Food and Income Security	SCAR in collaboration with ICAR-CSSRI, Karnal, Haryana, March 16-19, 2021
	Paper presented in Brainstorming Session on 'Role of agriculture for a five trillion economy in the Post COVID Scenario	NAAS, New Delhi, October 14, 2020
	Paper presented in the Conference on "Technological Innovations for Sustainable Food Systems" on biotechnology for agriculture and food from the Indian perspective	Global Sustainable Technology & Innovation Community (G.STIC), Brussel, Belgium October 28, 2020
	Paper presented in India International Science Festival on the topic "The Challenges of making India self reliant in agriculture"	IITM, New Delhi, December 22-25, 2020

	Delivered keynote address at the annual conference of Indian Society of Agricultural Economics	TNAU, Coimbatore, February 11, 2021
	Keynote speaker in 1st Indian Rice Congress – 2020, Rice Research and Development for Achieving Sustainable Development Goals on the theme area of the congress as "agricultural research & development policy: reforms & policy options"	ICAR-National Rice Research Institute, Cuttack, December 8-9, 2020
	Lead speaker in the session "Crop Scenario and Policy Perspectives" during national webinar (WebCon 2021) on "sustaining pulse production for self sufficiency and nutritional security"	ICAR-IIPR, Kanpur, UP, February 9, 2021
	Presented a paper in ISCA Webinar-International Symposium on "Coastal Agriculture: Transforming Coastal Zone for Sustainable Food and Income Security	ISCAR and ICAR-CSSRI, Karnal, March 16-19, 2021
P. S. Birthal	Presented a paper on, Valuation of soil carbon' in the brainstorming session on "Strategies for enhancing soil organic carbon (SOC) for food security and climate action"	NAAS, New Delhi, August 21, 2020.
	Presented a paper on 'sources of agricultural growth in India' in the brainstorming session Agriculture and Food Policy for Five Trillion Economy	NAAS, New Delhi, October 14, 2020
	Presented a lead paper on farmers' risk management strategies' in the International Workshop on Climate-Smart Agriculture	TISS, Hyderabad and NITK, Suarthkal, October 23-27, 2020
	Presented a paper on 'political economy of agrarian reforms' in the 'International Webinar on New Agriculture Acts, 2020: A Multidimensional Approach	The School of Humanities, KIIT University, Bhubaneswar November 28, 2020
Khem Chand	Paper presented in E-Conference on Technology, Innovation and Management for Sustainable Development	ITM University Gwalior, Madhya Pradesh, February 18-20, 2021
Vikas Kumar	Paper presented in 9th International E-Conference on Technology, Innovation and Management for Sustainable Development	ITM University Gwalior, Madhya Pradesh, February 18-20, 2021

S. K. Srivastava	Speaker in the session on "decoding new farm laws" in the Webinar on "marketing of agricultural commodities: challenges and opportunities"	ICAR- NDRI, Karnal, Haryana, January 12-14, 2021
	Speaker in the brainstorming session on "agriculture and food policy for the five trillion dollar economy"	NAAS, New Delhi, October 14, 2020
	Keynote speaker in the session "Agricultural Reforms-Road Ahead" in 103rd Annual Conference of Indian Economic Association	University of Rajasthan, Jaipur, December 27-28, 2020
Jaya Jumrani	Presented a paper 'Intra-household food distribution' at the Micronutrient Forum, CONNECTED 2020, 5th Global Conference	Micronutrient Forum, Washington, DC USA November 6-13, 2020

Table 7.4: Seminar/Conference/Webinar - Attended

Name of the scientist	Name of the event	Venue& duration
Suresh Pal	Dialogue: Way Forward for the Indian Seed Sector	Trust for Advancement of Agricultural Sciences (TAAS) in collaboration with Indian Society of Seed Technology (ISST), New Delhi, February 22, 2020
	Xi National KVK Conference – 2020 on Empowering Youth for Technology Led Farming	NASC Complex, New Delhi, February 28, 2020
	Webinar on Valuing Nature for Sustainability in the Agriculture and Food Sector of India	The Economics of Ecosystems and Biodiversity (TEEB), June 19, 2020
	Web Seminar on Scope for Action on STI for SDGs: Focus on Frontier Technologies	Research and Information System for Developing Countries (RIS), June 23, 2020
	Virtual Launch Of 2020 Global Food Policy Report on Building Inclusive Food Systems	IFPRI, South Asia, Indian Council of Agricultural Research (ICAR) and Trust for Advancement of Agricultural Sciences (TAAS), July 6, 2020
	Inception Workshop on TEEB Implementation: Promoting a Sustainable Agriculture and Food Sector	UNEP, India, July 13, 2020
	92nd Foundation Day and Award Ceremony of the Indian Council of Agricultural Research	ICAR, New Delhi, July 16, 2020

	Thirty-fifth Session of the FAO Regional Conference for Asia and The Pacific. Senior Officers Meeting	FAO, Thimphu, Bhutan, September 1-4, 2020
	Conference on Biotechnology for agriculture and food from the Indian perspective	G-STIC 2020, Brussel, Belgium, October 28, 2020
	भाकृअप वार्षिक राजभाषा समारोह 2020	Director (OL), ICAR, New Delhi, November 26, 2020
	Stakeholders Dialogue on Strategies for Safe and Sustainable Weed Management- A Way forward	TAAS, ICAR, DWR, ISWS. December 9, 2020
	Pre-Conference Day Workshops-28th National Conference Of Agricultural Economics Research Association	University of Agricultural Sciences- Bengaluru, December, 16-18, 2020
	Ongoing activities with India focus as well as future plans. Meeting With Representatives of the Consultative Group on International Agricultural Research (CGIAR)	International Agricultural Research (CGIAR), February 3, 2021
	Stakeholders Dialogue On Enabling Policies for Harnessing the Potential of Genome Editing in Crop Improvement (TAAS)	TAAS in collaboration with ICAR, NAAS, BCIL, TIGS, NABI and BIRAC, March 17, 2021
	National Conference on Institutionalizing M&E Practices for Sustainable Impact	NITI Ayog, March 18-19, 2021
	National Webinar on Sustainable Livelihood and Nutritional Security under Changing Climate in the North-Western Himalayan Region: Issues, Challenges and Strategies	VPKAS, Almora, March 20, 2021
Suresh Pal, Khem Chand, N. R. Kumar, Vikas Kumar, Abimanyu Jhajhria	Brainstorming Session on Contract Farming for Transforming Agriculture in India: Challenges and Way Forward	IFPRI & NAAS, New Delhi, March 10, 2021
Khem Chand	Workshop on Intellectual Property Management	ICAR- IIAB, Ranchi, Jharkhand, November 28, 2020
Khem Chand, S. K. Pandey, Raka Saxena, Vikas Kumar, D.C. Meena	World Food Day and 75th Anniversary of FAO	FAO, Washington DC, USA. October 16, 2020
Khem Chand, Vikas Kumar	Webinar on Know your Milk Food: Facts and Myths of A1 and A2 Milk	ICAR-NDRI, Karnal January 23, 2021

Khem Chand, D.C.Meena, S.K. Srivastava, Purushottam Sharma, Abhimanyu Jhajhria, Vikas Kumar	Webinar on Marketing of Agricultural Commodities-Challenges and Opportunities	ICAR-NDRI, Karnal January 12-14, 2021
N. R. Kumar	Webinar on Challenges and Opportunities in Post Covid Era for Human and Shrimp Industry	CIFE, Mumbai, May 20, 2020
	Webinar on COVID-19 and South Asia: A Conversation with Purvi Mehta, Arvind Panagariya, and Hossain Zillur Rahman	IFPRI, New Delhi, May 7, 2020
	Webinar on Combating post-COVID-19 challenges in sugarcane sector: Appropriate Technologies and approaches.	ICAR-SBI, Coimbatore, June 25, 2020
	Workshop on Economics Research in India (SERI)	IEG and CDE, DSE, July 7-10, 2020
	Webinar on Impact of COVID-19 on Small-Holder Farmers in India and the Way Forward	IFPRI, New Delhi, August 28, 2020
	Webinar on Farm Bills 2020: Understanding the Implications	IARI, New Delhi, September 28, 2020
	Webinar on Who owns my property? Prindex: Measuring property rights globally–what can India learn	NCAER, New Delhi, October 12, 2020
	Webinar on Navigating the Impact of COVID-19 on Agriculture Supply Chain in India	IGC, ADRI, Patna, October 19, 2020
	Webinar on Profit Drivers: Trends in the Asian Aquaculture Sector and New Strategies to Improve Productivity	Informal Markets, October 27-29, 2020
	Webinar on Land Policy Initiative India Land Forum 2020- Data-driven Research & Evidence for Land Policy in India	NCAER, New Delhi, November 24-27, 2020
N. R. Kumar, Balaji S.J., S.K. Pandey	Virtual Launch of Global Food Policy Report, 2020 Virtual Launch	IFPRI, New Delhi, July 06, 2020
N. R. Kumar, Purushottam Sharma, Prem Chand, S.K. Pandey, Balaji S.J., D.C. Meena, Abhimanyu Jhajhria	Webinar on National Dialogue – Indian Agriculture Towards 2030	FAO, India, January 19-22, 2021

N. R. Kumar, Rajni Jain, Purushottam Sharma, D.C. Meena, Abhimanyu Jhajhria	Panel Discussion on Agricultural Market Reforms: Problems and Prospects	IEG, New Delhi, September 29, 2020
N. R. Kumar, Subhash Chand, S. K. Pandey Balaji SJ, Prabhat Kishore, Purushottam Sharma	Conference of Indian Society of Agricultural Economics	CARDS, TNAU, Coimbatore, February 10-12, 2021
Subhash Chand	Workshop on Land policy reforms for agriculture transformation in India	NRMC Centre for Land Governance Online, April 23, 2020
	Online workshop on HRD Nodal and Co-Nodal officers	ICAR, HRD Division, Krishi Bhavan, New Delhi, May 8, 2020
	National Water Mission -Online Talk on Water digest	NSM, DoWR, New Delhi, August 8, 2020, September 18, 2020, November 6, 2020
	Online Conference on 12th Annual international conference G-20	Indian Council for Research on International Economic Relations (ICRIER), October 5-8, 2020
Subhash Chand, Purushottam Sharma, Balaji S.J.	Online AERA Annual Conference on Agriculture new law	University of Agricultural Sciences, G.K.V.K., Bengaluru, December, 16-18, 2020
Rajni Jain	Online Panel Discussion on Performance Evaluation of Schemes	ICAR Agricultural Education Division, ICAR, New Delhi, November 2, 2020
	Online Webinar on Role of AI and Data Sciences	BPIT, New Delhi, June 15, 2020
Purushottam Sharma	International Economic Forum on Asia on Digitalisation and Development: Reflections from Asia' and OECD Outlook for Southeast Asia, China and India 2021	Research and Information System for Developing Countries, New Delhi, March 5, 2021
	International Economic Forum on Asia on Revisiting Economic Cooperation in BIMSTEC in Post COVID	Research and Information System for Developing Countries, New Delhi, June 30, 2020
	Webinar on WTO@25	Research and Information System for Developing Countries, New Delhi, October 22, 2020
Purushottam Sharma, Abimanyu Jhajhria	Symposium on TEEB Agri-Food Asia	UNEP, March 24-26, 2021
	Conference on India Agricultural Outlook Forum 2020	Ministry of Agriculture & Farmers Welfare, GOI, New Delhi, October 15-16, 2020
Prem Chand	Online workshop on Sustainable Productivity Models in Agriculture	National Productivity Organization, Bangladesh, November 16-18, 2020

	Rajasthan Water Summit on Harnessing water resource for a better tomorrow	Federation of Indian Chambers of Commerce and Industry, Jaipur March 17, 2021
Vikas Kumar	Webinar on Intellectual Property and Technology Commercialization: Pivotal for successful business	Dr. Y.S.R. Horticultural University, Andhra Pradesh, October 12, 2020
	Webinar on Sustaining Agriculture through Collectives, Cooperatives and Farmer Producer Organization	VAMNICOM, Pune, September, 08, 2020
D.C. Meena	Webinar on Galvanizing South and South-East Asia Transport Connectivity post-COVID19	ICRIER and UNESCAP South and South-West Asia, January 22, 2021
Abimanyu Jhajhria	Conference on Indian Farmer in a $5 Trillion Economy	India International Centre, New Delhi, January 9, 2020
	Global Summit on Responsible AI for Social Empowerment (RAISE 2020)	Govt. of India, New Delhi, October 5-9, 2020
	Seminar on Inter linked transactions in credit-output markets in Indian agriculture: Testing an old model with new data	IEG, New Delhi, October 9, 2020
	Round table on Promotion of R&D Services Exports	Principal Scientific Adviser and the Department of Commerce, New Delhi, January 19, 2021
Balaji S.J.	23rd Annual Conference on Global Economic Analysis	Virtual Purdue University, USA June 17-19, 2020
	34th National Conference on Indian Society of Agricultural Marketing	B.B. Ambedkar University, Lucknow, March 16-18, 2021
	Conference on The Impacts of the COVID-19 Pandemic and its Policy Implications	Asian Development Bank, December, 1-2, 2020
	Session on COVID-19: Wakeup Call for Better Cooperation. December 11, 2020 between Science and Policy-making	UNDP Seoul Policy Centre (USPC) and Research and Information System for Developing Countries (RIS), December 11, 2020
	Webinar on Strengthening Agricultural Innovation Systems (AIS) in the context of sustainable agricultural development and food security	FAO-Agrinatura, December 1, 2020
	Webinar on C.D. Deshmukh Lecture 2021	NCAER, New Delhi, January 28, 2021
	Session on Agricultural Development: New Perspectives in a Changing World (Book launch)	IFPRI, Washington DC, February 4, 2021
	Seminar on A Brief History of Equality: Lessons from "Capital and Ideology" and the World Inequality Database.	World Bank Group, February 10, 2021

	Webinar on Quarterly Review of the Economy, 2020:1Q in Coronavirus times	NCAER, New Delhi, May 15, 2020
	Webinar on Quarterly Review of the Economy, 2020:1Q in Coronavirus times	NCAER, New Delhi, May 15, 2020
	Virtual launch of Food, Agriculture, and Nutrition in India 2020: Leveraging Agriculture to Achieve Zero Hunger	Tata-Cornell Institute, August 4, 2020
Balaji S.J., Abimanyu Jhajhria	Webinar on Transforming the Agriculture Sector - Union Budget 2021	Policy Division, DoAC&FW, March 1, 2021
Prabhat Kishore	National Conference on Agricultural Resource Management for Atmanirbhar Bharat	Central Agricultural University, Imphal, July 17-19, 2020.
	Global Conference on Emerging Agricultural Research to Endure the Predicament of COVID-19 Pandemic	Agricultural Economics and Social Science Research Association (AESSRA), New Delhi, India December 12-13, 2020

Participation in other Scientific Events

Suresh Pal

- Participated in 91st Annual General Meeting of the ICAR Society NASC Complex, New Delhi, February 27, 2020.
- Participated in meeting on Strategies and Approaches for Large Scale Technology Application for Doubling Farmer Income. NASC Complex, New Delhi, February 29, 2020.
- Participation in meeting on Assessment of human resource requirements in Agriculture and allied sciences to meet the emerging challenge. NAHEP on June 25, 2020.
- Panelist in a webinar on "Transformation of Fertilizer subsidy in India" organized by Indian Institute of Public Administration on July 8, 2020.
- Participation in meeting on approach and indicators for channeling the Finance Commission Grants to States to KVKs and SAUs. July 9, 2020.
- Participation in meeting on Prime Minister's Science, Technology & Innovation Advisory Council (PM-STIAC). July 24, 2020.
- Participation in meeting onFormation and Promotion of 10,000 FPO's. November 9, 2020, MoA&FW.
- Participation in XXVI meeting of ICAR Regional Committee-V comprising the States of Haryana, Punjab and Delhi. December 7, 2020.
- Expert in India International Science Festival with theme "Science for Self Reliant India and Global welfare" during 22-25 December 2020 in virtual mode on the topic "The Challenges of Making India Self Reliant in Agriculture".
- Participation in meeting on Establishment of KVKs in newly created districts. January 5 & 14, 2021.
- Meeting under the Chairmanship of Vice Chairman, NITI Ayog on "Production & Price Prediction through application of Advance Techniques, February 22, 2021.
- Participation in meeting on Agricultural Prices Board (SAPB). Thiruvananthapuram, Kerala, February 6, 2021.
- Participation in XXVI Meeting of ICAR Regional Committee No. V comprising the states of Rajasthan, Gujarat, UT of Dadra & Nagar Haveli & Daman & Diu. March 13, 2021.
- Participation in meeting on Promotion of Agriculture Mechanization for In-Situ Management of Crop Residue in the States of Punjab, Haryana, Uttar Pradesh and NCT of Delhi. March 24, 2021.

P. S. Birthal

- Panelist in the brainstorming session on "One World One Health" organized by NAAS, New Delhi. September 19, 2020.
- Panelist in the webinar on "Farm Sector Bills/Acts and their Implications for Punjab Agriculture" organized by the Department of Economics and Sociology, PAU, Ludhiana on October 7, 2020.
- Panelist in the round of deliberations on 'Reorienting Education and Research at PAU' organized by Government of Punjab. January 15, 2021.

Rajni Jain

- Presented progress of NAHEP project regarding feedback on responses from agricultural universities to the Advisory committee meeting, NAHEP, Component 2 held on September 26, 2020, Chaired by Dr. R C Aggarwal, DDG Education.
- Attended online meeting of 69th IMC, IASRI, December 31, 2020.

S. K. Pandey

- Brainstorming on Impact of Agricultural Engineering Technology, organised by ICAR, New Delhi & CIAE, Bhopal on July 22, 2020.
- Which Women Own land in India-Inter Gender and Intra Gender Gaps, organised by IEG, New Delhi on December 11, 2020.
- Policy Discourse on India Achieving Zero Hunger by 2030, organised by TCI and BAIF on December 17, 2020.
- Virtual Roadshow for Prarambh start-up India International summit 2021-Himachal Pradesh, organised by NDRI, Karnal on January 05, 2021.
- Demographic Shocks and Women's Labour Market Participation: Evidence from the 1918 Influenza Pandemic in India, organised by IEG, New Delhi on January 12-14, 2021.
- Indian Agriculture at a Crucial Stage: Change and Transformation for Bright Future, organised by TNAU, Coimbatore on February 10, 2021.
- Executive Committee Meeting of ISAE, organised by ISAE, Mumbai on February 11, 2021.

Raka Saxena

- Invited as a team member in meeting on review the progress of Doubling Farmers Income (DFI) by Hon'ble Agriculture Minister, Government of India on August 14, 2020.
- Panelist in the Group discussion on policy communication and advocacy in the Short-term training under SCSP on ''Capacity Building for Agricultural Policy Research" December 03- 09, 2020.

Vinayak Nikam

- Attended the virtual program on Publishing Agricultural Development Research in Social Science Journals, organised by IFPRI on November 30, 2020.
- Attended the lecture on Assessing the impact of agro-ecological farms, organized by Erasmus on January 27, 2021.
- Attended a lecture on visioning the next level of growth for FPOs organized by National Association of Farmer Producer Organizations on November 03 2020.

Subash S. P.

- Participated in Online Meeting onWorld Environment day. IARI, New Delhi. May 5, 2020.

Participation in TV/Radio talk

Suresh Pal

- DD News, Jan 21, Jan 27, 2020.
- IMB Forecast and Agriculture; HMA Guidelines for Lockdown and Agriculture, DD News, April 15, 2020.
- Agriculture in the Lockdown, DD News, April 28, 2020.
- Agriculture Performance, DD News, April 30, 2020.
- *Khas Mulakat, Krishi Darshan*, DD Kisan, May 11, 2020.
- Package of the Government for Farmers and Rural Workers, DD News, May 14, 2020.
- Ordinance for agriculture reforms, DD News, June 3, 2020.
- Startups in agriculture, DD News, June 15, 2020.
- विशेष कार्यक्रमः कृषि क्षेत्र – सकारात्मक सन्देश, DD News, 10 July, 2020.
- विशेष कार्यक्रमः कृषि क्षेत्र – सकारात्मक सन्देश, DD News, July 19, 2020.
- विशेष कार्यक्रमः कृषि क्षेत्र – सकारात्मक सन्देश,

Agriculture Infrastructure Fund, DD Kisan, August 9, 2020.

- Independence Day Special Program,DD News, August 15, 2020.
- *Monsoon Par Najar*, DD News, September 7, 2020.
- *Sewa Me 6 Varsh*, DD News, September 19, 2020.
- Farm Bills, DD News, September 21, 2020.
- *Krishi Kanoon, Badlav and Dayara*, Rajya Sabha TV, September 24, 2020.
- Farm Bills, DD News, September 28, 2020.
- फार्मिंग बिल एक्ट 2020, "Hello Kisan", Doordarshan Kisan, October 20, 2020.
- Agricultural Reforms, DD News, November 30, 2020.
- English special show "Reset India" on Transforming Rural Economy, Rajya Sabha TV, January 12, 2021.

P. S. Birthal

- Discussant Rajya Sabha TV in Desh Deshantra: Climate Change: Impact on Agriculture. October 1, 2020.

N. R. Kumar

- Krishi Utpadan Vyaparaur Vanijya Act, 2020, "Hello Kisan", DD Kisan, October 22, 2020.
- Krishi Utpadan Vyaparaur Vanijya Act, 2020, "Hello Kisan", DD Kisan, November 22, 2020.
- Farming Act, 2020, "Hello Kisan", DD Kisan, December 08, 2020.
- बजट 2021-22 गाँव और किसान, "Hello Kisan", DD Kisan, February 01, 2021.
- बजट 2021-22 और कृषि अवसंरचना का विकास, FM Gold, February 04, 2021.
- *Nyuntam Smarthan Mulya Ka Nirdharan*, 'Kisan Ki Baat'', FM Gold, September, 26, 2020.

Khem Chand

- Contact farming under Farmers produce Trade and commerce (Promotion & Facilitation) Act, 2020, "Hello Kisan'', DD Kisan,November 10, 2020 (YouTube link: https://youtu.be//AeekmGInALM).
- Farmers produce Trade and commerce (Promotion & Facilitation) Act, 2020, "Hello Kisan'', DD Kisan, November 19, 2020 (youtube link: https://youtu.be//ArLhQ8zD-7w).
- Contact farming under Farmers produce Trade and commerce (Promotion & Facilitation) Act, 2020, "Hello Kisan'', DD Kisan, December 01, 2020 (YouTube link: https://www.youtube.com/watch?v=GbFbJkUpRhA).
- Farmers produce Trade and commerce (Promotion & Facilitation) Act, 2020, "Hello Kisan", DD Kisan, December 22, 2020 (YouTube link: https://youtu.be//5f5zWXBJUi8).
- Farmers produce Trade and commerce (Promotion & Facilitation) Act, 2020, "Hello Kisan", DD Kisan,December 29, 2020 (YouTube link: https://www.youtube.com/embed/bhnRq2JIua8).
- चारा फसलों का प्रबंधन, "Hello Kisan'',DD Kisan, January 26, 2021 (YouTube link: https://youtu.be/bpwDruYsQT0).
- Budget 2021 Special (Gaon Avam Kisan) "Hello Kisan",DD Kisan, February 01, 2021 (youtube link: https://youtu.be/6nLa-weNDLg).
- कृषि ऋण पर परिचर्चा, Radio talk (All India Radio), February 16, 2021.

Raka Saxena

- New Farm Laws in India, "Hello Kisan" DD Kisan, December 24, 2020.

Shiv Kumar

- New Farm Laws in India, "Hello Kisan", DD Kisan, March 31, 2020.

S. K. Srivastava

- Budget of Hope 2021-22", RajyaSabha TV, January 20, 2021.

Vinayak Nikam

- कृषि उत्पाद व्यापार और वाणिज्य अधिनियम 2020P "Hello Kisan", DD Kisan, December 18, 2020.

Purushotam Sharma

- Agricultural marketing reforms 2020, "Hello Kisan", DD Kisan, December 15, 2020 (YouTube link: https://www.youtube.com/watch?v=t8mdGaxxV60).
- COVID-19: Impact on Food Supply Chains in Asia. APO productivity talk, Asian Productivity Organisation, Japan, June 4, 2020.

Vikas Kumar

- Union Budget 2021-22 evam Rastriy khadya Suraksha mission (NFSM), Radio talk (All India Radio), February16, 2021.

CHAPTER 8

Quinquennial Review Team (QRT)

The IVth QRT constituted for a five-year review of the progress of research and evaluation of constraints, potentials and strategies to achieve the mission and goal of the Institute concluded in January 2020. The composition of QRT is given in Table 8.1.

Table 8.1. Fourth Quinquennial Review Team of ICAR-NIAP

Prof. S. Mahendra Dev Director and Vice-Chancellor Indira Gandhi Institute of Development Research, Mumbai	Chairman
Dr. Devendra Verma Former Director General, Central Statistics Office Ministry of Statistics and Programme Implementation	Member
Dr. Vasant Gandhi Professor Indian Institute of Management, Ahmedabad	Member
Dr. R. S. Sindhu Registrar Punjab Agricultural University, Ludhiana	Member
Dr. J. P. Mishra Former Additional Director General Indian Council of Agricultural Research	Member
Dr. Naveen P Singh Principal Scientist ICAR-National Institute of Agricultural Economics and Policy Research	Member-Secretary

The QRT assessed the overall performance of the Institute on two accounts, namely achievement made on realizing the mandate, and in overall institutional management. The Team lauded the work and professional contributions of the Institute as it had performed well in terms of addressing the issues raised by the Council and the Ministry in particular. QRT feels that, despite several constraints, the Institute has performed exceedingly well in fulfilling the needs of the scientific community and ICAR. Their contributions to the research and policy inputs in recent times have enhanced the role of ICAR in policy circles and agricultural policy-related discussions. The team also recognized the role of the institute in grooming agricultural economists within the NARS. The QRT also made several analysis-based suggestions/ recommendations.

Research Advisory Committee (RAC)

The virtual meeting of RAC was convened on 26th May 2020 to review the research progress and future programs (2020-24), under the chairmanship of Professor Abhijit Sen,Former Member, Planning Commission, New Delhi. Action taken report on recommendations from the previous meeting of RAC was presented to the committee. Work progress of the ongoing research programs was reviewed by the committee during the meeting under all the themes. RAC members provided valuable suggestions and recommendations for improving the research agenda of the institute for the

new EFC. ICAR has also approved a new RAC for the next three years (20.8.2020 to 19.8.2023) and details of the chairman and members are given in Table 8.2.

Table 8.2. Research Advisory Committee of ICAR-NIAP

Dr. Harsh K. Bhanwala Former Chairman, National Bank for Agriculture and Rural Development Mumbai	Chairman
Dr. Ajit Mishra, Director Institute of Economic Growth University of Delhi (North Campus)	Member
Dr. Shashanka Bhide, Senior Advisor National Council of Applied Economic Research (NCAER), New Delhi	Member
Dr. A.K Singh Former Director, Giri Institute of Development Studies (GIDS), Lucknow	Member
Dr. S.A. Wani, HoD, SKAUT, Srinagar	Member
Dr. P. Kumar, Former Head Division of Agricultural Economics, IARI New Delhi,	Member
Dr. J.V. Meenakshi, DSE, ND Advisor National Council of Applied Economic Research (NCAER) \ New Delhi	Member
Dr. B. Ramaswamy, ISI, ND Advisor National Council of Applied Economic Research (NCAER), New Delhi	Member
Dr. Suresh Pal Director ICAR-National Institute of Agricultural Economics and Policy Research (NIAP), New Delhi	Member
Dr. G. Venkateshwarlu ADG (EQA&R) Indian Council of Agricultural Research, Krishi Anusandhan Bhawan– II, New Delhi	Member
Sh. Harbir Singh Harbir nursery, Kurukshetra	Member (Ex-officio)
Sh. Rajpal Rana Mukhamelpur, Delhi	Member (Ex-officio)
Dr. Khem Chand Principal Scientist (Ag. Economics), ICAR-NIAP, New Delhi	Member Secretary

Institute Management Committee (IMC)

29th Institute Management Committee meeting of ICAR-NIAP was held on October 9, 2020. Director NIAP presented various activities of the institute in this meeting. IMC members appreciated the progress made by the institute and its popularity among stakeholders.

Table 8.3. Institute Management Committee (IMC) of ICAR-NIAP

Dr. Suresh Pal Director ICAR-NIAP, New Delhi	Chairman
Director Directorate of Economics & Statistics, Delhi	Member
Director (Economics & Statistics) Department of Planning, Yojana Bhawan, Lucknow	Member
Dr. D. P. Malik, Head, Department of Agricultural Economics CCS Haryana Agricultural University, Haryana	Member
Sh. Harbir Singh Harbir nursery, Kurukshetra, Haryana	Member
Sh. Rajpal Rana Mukhamela, Delhi	Member
Dr. G.K. Jha Principal Scientist ICAR-IARI, New Delhi	Member
Dr. S. K. Soam Principal Scientist ICAR-NAARM, Rajendranagar, Hyderabad	Member
Dr. T.M. Gajanana Principal Scientist ICAR- IIHR, Bengaluru	Member
Dr. Mahesh Chander Principal Scientist ICAR-IVRI, Izatnagar, UttarPradesh	Member
Dr. G.Venkateshwarlu ADG (EQA&R) Education Division, ICAR, New Delhi	Member
Sr. Finance and Accounts Officer ICAR-National Bureau of Plant Genetic Resources, Pusa, New Delhi	Member
Administrative Officer ICAR-NIAP, New Delhi	Member Secretary

Institute Research Council (IRC)

The annual meeting of IRC of ICAR-NIAP washeld on July 24-25, 2020. The IRC meetingwas chaired by Dr. Suresh Pal, Director, ICAR-NIAP., Dr. R. C. Agarwal, Deputy Director General (Education), and Dr. G Venkateshwarlu, ADG (EQA&R) attended IRC as special guests. Dr. Parmod Kumar, Professor, Institute for Social and Economic Change, Bengaluru, and Dr. Vijay Laxmi Pandey, Indira Gandhi Institute of Development Research, Mumbai attended as external experts. The experts appreciated the quality research work conducted at this institute and provided valuable suggestions for each project.

CHAPTER 9

ICAR-NIAP Annual Day 2020

ICAR-NIAP celebrated its 29th Annual Day on 29th October 2020. The 13th Prof Dayanatha Jha Memorial Lecture was delivered by Uma Lele, President-Elect, International Association of Agricultural Economists (IAAE) on "Smallholder agriculture, productivity growth and sustainable healthy food consumption". The foundation day award for the year 2020 was presented to Dr. Shalander Kumar, ICRISAT for his outstanding contribution in the field of agricultural economics and policy research.

29th Foundation Day and Prof DayanathaJha Memorial Lecture by Dr. Uma Lele, President-Elect, IAAE

International Women Day

ICAR-NIAP celebrated International Women's Day on March 8, 2021. Prof. Neetha N, Centre for Women's Development Studies, Indian Council of Social Science Research, New Delhi, delivered a lecture on this occasion. She highlighted various issues in gender studies, women in agriculture, challenges and opportunities for women during the lock-down period. Dr. Suresh Pal, Director, NIAP emphasized the need for more gender-oriented research in academic institutions and more gender-inclusive decisions from the administrative side.

Ambedkar Jayanti Celebration

ICAR-NIAP staff celebrated Ambedkar Jayanti on April 14, 2020, using virtual means during the lockdown. All colleagues read the preamble of the constitution of India and constitution duties from their homes due to lockdown. Dr. Suresh Pal, Director, ICAR-NIAP chaired the meeting.

International Yoga Day

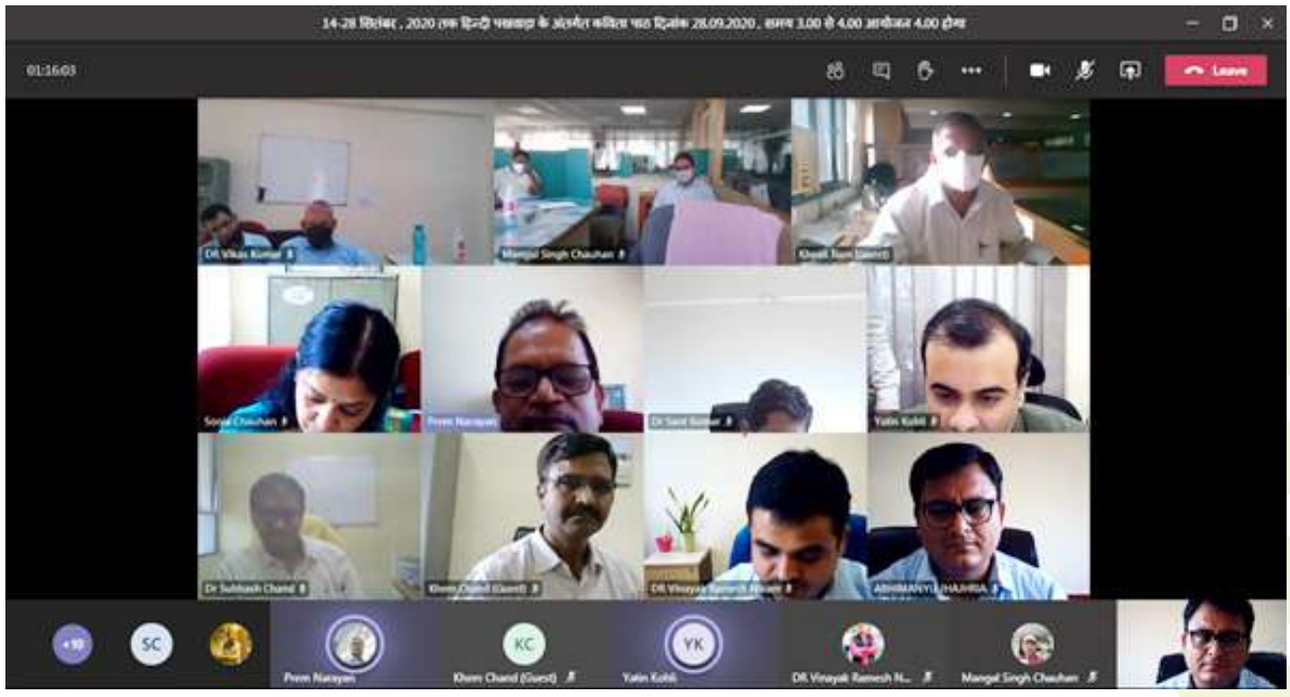
As per the directives of the ICAR, International Yoga Day was celebrated on June 21, 2020. An online Yoga session was organized under the guidance of an eminent yoga trainer, Mrs. Shikha Chakraborty from Mumbai.

Promotion of Official Language 2020-21

For the implementation and extensive use of Rajbhasha among the staff of the Institute, a committee on Rajbhasha official language has been established by Central Rajbhasha Department. The committee monitors the progress of various actions being taken and suggests measures for implementation of the official language. It coordinates and helps in executing the Council orders and circulars of Central Rajbhasha Department and Annual program guidelines. Institute Rajbhasha committee submitted the quarterly progress reports online as well hard copy timely to Central Rajbhasha Department and ICAR headquarter respectively and half-yearly progress report to Nagar Rajbhasha Karyanvyan Samiti. The Institute's Rajbhasha Karyanvyan Samiti has organized the quarterly meeting of Rajbhasha and Hindi workshop regularly.

The Institute Rajbhasha Samiti implemented all the guidelines, circulars and instructions issued by ICAR and Central Rajbhasha Department, Government of India. The Institute has bilingual facilities in all computers through Hindi fonts and Unicode for Hindi typing. The Institute organized timely Hindi workshops for better awareness of Hindi.

The Official language committee of ICRA-NIAP organized a series of events to celebrate "Hindi Pakhawada" during September 14-18, 2020 to create more awareness among the staff to obtain fluency in Hindi. The activities which were organized during the "Hindi Pakhawada" program were debate in Hindi on वैश्विक कोरोना महामारी के कारण आर्थिक मंदी एवं बेरोजगारी की समस्या, live discussion and essay competition to develop creative writing skills on topics i.e. "कृषि में टिड्डी दल के आक्रमण से नुकसान की समस्या". Other activities include dictations of the administrative word in Hindi, नोटिंग ड्राफ्टिंग/पत्रलेखन in Hindi. Besides extempore activities were also organized to improve the vocabulary in Hindi and English. The participation and competitions in these events were overwhelmingly more than ninety percent. Hindi Phakhwada ended with poem recitation competition on 28.09.2020. Shri Anil Sharma, Rajbhasha Expert, from Bangalore delievered a lecture and distributed prizes to the winners of



हिंदी पखवाड़ा के अंतर्गत कविता पाठ

various competitive events organizaed during Hindi Pakhawada.

150th Birth Anniversary of Mahatma Gandhi Ji

A week-long program was organised to celebrate 150th Birth Anniversary of Mahatma Gandhi Ji. An online poster competition on Gandhiji and Swachhta was organised for the children of NIAP staff on September 28, 2020. On September 29, 2020, Swachhta Abhiyan, sanitization and cleanliness drive was conducted following the guidelines on Covid-19. Shri Anil Joshi, Vice President, Indian Hindi Institute also expressed his views on the philosophy of Gandhi Ji and Swachhta Abhiyan.

Constitution Day

ICAR-NIAP celebrated on 26th November as Constitution Day to commemorate the adoption of the Constitution of India. All staff participated in reading the Preamble with the Hon'ble Prime Minister.

Kisan Divas

ICAR-NIAP celebrated Kisan Divas on December 23, 2020. Dr. Brahma Singh, NAAS Fellow delivered a lecture on Hi-Tech Horticulture. The lecture was well received and followed by a lively discussion with farmers.

Organised poster competition during Vigilance awareness week celebration

Vigilance Awareness Week

Vigilance Awareness Week was celebrated from October 27 2020. On the first day i.e. October 27, 2020, The Integrity Pledge Administering ceremony was observed. Poster competitions and essay writing competitions were also organized to spread awareness about the efforts for fighting against corruption.

Ekta Pledge

To promote harmony among staff, the Ekta pledge was taken by institute staff on October 31, 2020.

Prime Minister's Address to Farmers

ICAR-NIAP staff attended a web-telecast of the Hon'ble Prime Minister's address to the farmers on December 25, 2020. (https://pmevents.ncog.gov.in)

Mera Gaon Mera Gaurav (MGMG)

Mera Gaon Mera Gaurav (MGMG) scheme of the government aims at fulfilling the dream of the Lab to Land by regular contact of the scientist with the farmers in the village. Under this scheme, three teams have been formed in the institute and selected 15 villages from

Online lecture on Hi-Tech Horticulture by Dr. Brahma Singh, NAAS Fellow

Rohtak, Palwal and Mewat district of Haryana state. Because of restricted mobility during Covid-19 and subsequent measures, scientists mostly contacted farmers from MGMG villages through WhatsApp, mobile messages, phone calls, video calls, etc. Scientists guided the farmers about care and hygiene during Covid-19 for agricultural operations. Guidance was provided regarding crop planning because of the reduced demand in the market for certain crops and vegetables. Information about the protection of crops from the Locust attack was also given to the selected farmers and they were urged to disseminate the information to other farmers in the village. Besides this awareness about the government schemes like PMFBY was also done among the farmers. Advisories related to animal husbandry were also given to the farmers.

Distinguished Visitors / Online Interactions

Dr. Ramesh Chand
Member
NITI Aayog

Dr. Trilochan Mohapatra
Secretary, DARE and Director General
ICAR

Dr. A.K. Srivastava
Member
Agricultural Scientists Recruitment Board

Dr. Ashok Dalwai
Chief Executive Officer
National Rainfed Area Authority

Sh. Chhabilendra Roul
Secretary,
Department of Fertilizers, Ministry of Chemicals & Fertilizers

Dr. S. Mahendra Dev
Director and Vice-Chancellor
Indira Gandhi Institute of Development Research, Mumbai

Dr. Joy krushna Jena
Deputy Director-General, Fisheries,
ICAR

Dr. K Alagusundaram
Deputy Director-General, Agricultural Engineering ICAR

Dr. A. K. Singh
Deputy Director-General, Extension
ICAR

Dr. A. K. Singh
Deputy Director General, Horticulture
ICAR

Dr. Abhijit Sen
Former Member
Planning Commission

Dr. P.K. Joshi
Former Director-South Asia,
IFPRI, New Delhi

Dr. C. Ramasamy
Former Vice-Chancellor
TNAU

Dr. Mruthyunjaya
Former Director,
ICAR-NAIP

Dr. DevendraVerma
Former Director-General
Central Statistical Office

Dr. Manoj Panda
RBI Chair Professor
Institute of Economic Growth

Dr. Vasant Gandhi
Professor
Indian Institute of Management, Ahmedabad

Dr. Ajit Mishra
Director
Institute of Economic Growth

Dr. A.K. Padhee
Director, Country Relations,
ICRISAT

Dr. Uma Lele
President
International Association of Agricultural Economists (IAAE)

Dr. Shahidur Rashid
Director-South Asia
IFPRI

Dr. Tomio Shichiri
FAO Representative, New Delhi

CHAPTER 10

Personnel

Scientific

S.No.	Name	Designation
1.	Dr. Suresh Pal	Director
2.	Dr. Pratap Singh Birthal	National Professor
3.	Dr. Nalini Ranjan Kumar	Principal Scientist
4.	Dr. Khem Chand	Principal Scientist
5.	Dr. Rajni Jain	Principal Scientist
6.	Dr. Subhash Chand	Principal Scientist
7.	Dr. Naveen Prakash Singh (on deputation)	Principal Scientist
8.	Dr. Sant Kumar	Principal Scientist
9.	Dr. Shiv Kumar	Principal Scientist
10.	Dr. Raka Saxena	Principal Scientist
11.	Dr. Purushottam Sharma	Principal Scientist
12.	Dr. Prem Chand	Senior Scientist
13.	Dr. Vikas Kumar	Senior Scientist
14.	Dr. Shivendra Kumar Srivastava	Scientist (SS)
15.	Dr. Dinesh Chand Meena	Scientist (SS)
16.	Mrs. Arathy Ashok (Study leave)	Scientist (SS)
17.	Dr. Kingsly Immanuelraj T.	Scientist (SS)
18.	Mrs. Pavithra Srinivasamurthy (Study leave)	Scientist (SS)
19.	Dr. Vinayak Ramesh Nikam	Scientist (SS)
20.	Ms. Jaya Jumrani	Scientist (SS)
21.	Mr. Subash S. P.	Scientist
22.	Dr. S. J.Balaji	Scientist
23.	Dr. Abimanyu Jhajhria	Scientist
24.	Mr. S. V. Bangararaju	Scientist
25.	Mr. Prabhat Kishore (Study leave)	Scientist
26.	Dr. Ankita Kandpal	Scientist
27.	Dr. Kiran Kumara T. M.	Scientist
28.	Mr. Dilip Kumar	Scientist

Technical

S.No.	Name	Designation
1.	Mr. Prem Narayan	Chief Technical Officer
2.	Mr. Khyali Ram Chaudhary	Assistant Chief Technical Officer
3.	Mr. Mangal Singh Chauhan	Assistant Chief Technical Officer
4.	Mrs. Sonia Chauhan	Assistant Chief Technical Officer
5.	Mr. Satender Singh	Technical Officer (Driver)

Administrative

S.No.	Name	Designation
1.	Mrs. Neha Agarwal	Administrative Officer (up to 18.7.2020)
2.	Mr. Chander Vallabh	Administrative Officer (22.7.2020 onwards)
3.	Mr. Mohammad Irfan	Assistant Finance & Accounts Officer
4.	Mr. Inderjeet Sachdeva	Assistant Administrative Officer
5.	Mrs. Umeeta Ahuja	Personal Secretary
6.	Mr. Yatin Kohli	Assistant
7.	Mr. Harish Vats	Assistant
8.	Mr. Deepak Tanwar	Stenographer Gr.D
9.	Mr. Ajay Tanwar	UDC
10.	Mr. Mahesh Kumar	LDC

Skilled Supporting Staff

S.No.	Name	Designation
	Mr. Mahesh Pal	Skilled Supporting Staff

Promotions & Transfer

S.No.	Name
1.	Dr. Purushottam Sharma (Promoted to the next higher grade of Principal Scientist from Senior Scientist under CAS w.e.f. 25.07.2018)
2.	Dr. Prem Chand (Promoted to the next higher grade of Senior Scientist from Scientist under CAS w.e.f. 21.04.2018)
3.	Mrs. Neha Agarwal, Administrative Officer (Promoted to the post of Under Secretary, ICAR) and relieved on 18.07.2020
4.	Mr. Mahesh Kumar (Promoted to the post of Lower Division Clerk from SSS w.e.f. 20.10.2020)

New Joining

S.No.	Name& Designation	Joined on
1.	Dr. Khem Chand, Principal Scientist	26.08.2020
2.	Dr. Dinesh Chand Meena, Scientist (SS)	10.08.2020
3.	Mr. Dilip Kumar, Scientist	04.04.2020
4.	Mr. Chander Vallabh, Administrative Officer	22.07.2020

Retirement

S.No.	Name & Designation	Relieved on
1.	Dr. Mahendra Singh, Principal Scientist	30.09.2020

Budget

Table 10.1. ICAR-NIAP expenditure (2020-21)

(Rs. in Lakhs)

Head	Grant Expenditure
Grants for Creation of Capital Assets (Capital)	
Equipment	1.05
Information Technology	4.24
Library Books and Journals	9.15
Furniture & Fixtures	3.74
Others	3.27
Total Capital Expenditure	**21.45**
Grant in Aid-Salaries (Revenue)	**697.47**
Total Establishment Expenses (Salaries)	**697.47**
Grant in Aid-General	
Research and Operational Expenses	106.73
Administrative Expenses	231.12
Others	92.98
Total Expenditure Grant in Aid-General	**430.83**
Grand Total	**1149.75**
Revenue Receipt	**15.75**
Budget of Externally-funded projects	**107.38**

ICAR - National Institute of Agricultural Economics and Policy Research
(Indian Council of Agricultural Research)

Dev Prakash Shastri Marg, Pusa, New Delhi - 110 012, INDIA
Ph: +91(11) 2584 7628, 25848731 Fax: +91 (11) 2594 2684
Email : director.niap@icar.gov.in, Website : www.niap.res.in

ICAR–NIAP