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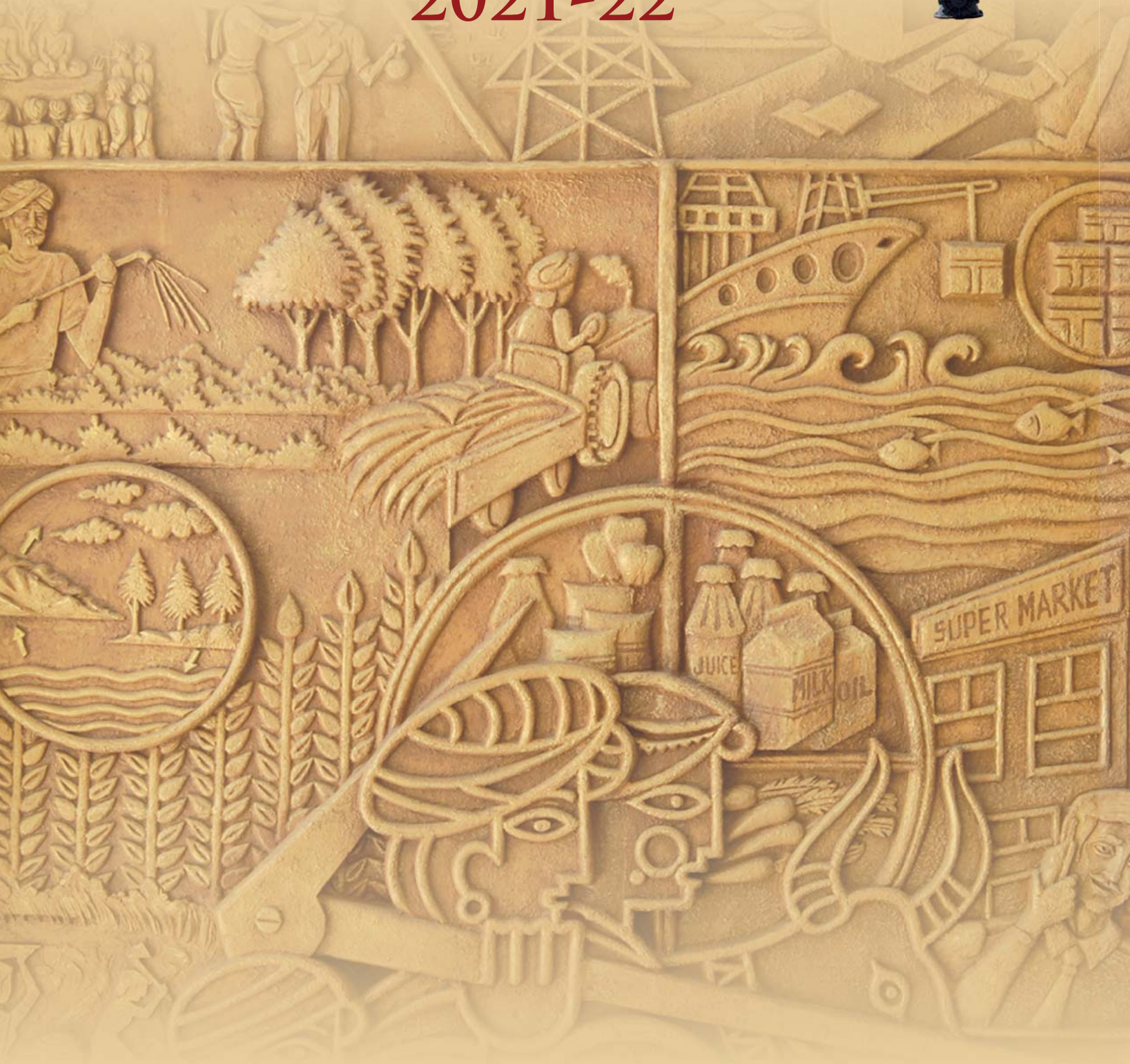

भाकृअनुप – राष्ट्रीय कृषि आर्थिकी एवं नीति अनुसंधान संस्थान

ICAR - National Institute of Agricultural Economics and Policy Research

(Indian Council of Agricultural Research)

Annual Report
2021-22

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Preface

India's agri-food system is experiencing a transformation from plate to plough. Through its creditable empirical research, the ICAR-National Institute of Agricultural Economics and Policy Research (NIAP) has provided inputs to research administrators and policymakers to make informed decisions on several technological and institutional issues to facilitate the process of transformation. Besides, the Institute is mandated to improve the quality of human resources in the National Agricultural Research System (NARS) through capacity-building programs.

This report provides a synoptic view of the research and capacity-building activities undertaken by the Institute during 2021-22. It is heartening to note that despite the Covid-19 pandemic threat, the ICAR-NIAP has made significant contributions in different thematic areas of Agricultural Growth and Development, Technology and Sustainable Agriculture and Agricultural Markets and Trade. The main contributions include the projections of agricultural growth, prospects of agricultural exports, price transmission across value chains of pulses and oilseeds, strategies for reducing import dependence in edible oils, the impact of Covid-19 induced lockdown on demand for food and farm inputs, benefits of adoption of crop insurance vis-à-vis other risk management measures, contribution of formal and informal credit to agricultural productivity and its resilience, prospects of organic agriculture in North Eastern Hill region, contribution of technological change to agricultural productivity growth, impact of farm mechanization on crop yields, groundwater-energy nexus and management of groundwater resources, and spillover effects of climatic shocks on agricultural productivity.

The Institute was actively engaged in policy discourse on agriculture and rural development with several departments of the central and state governments. The ICAR-NIAP is a knowledge partner of the Ministry of Agriculture and Farmers' Welfare for the Doubling Farmers' Income initiative. It has functional linkages and partnerships with NITI Ayog, Ministry of Finance, CGIAR centres, and many State Agricultural Universities and ICAR Institutes. On the capacity-building front, the Institute conducted an orientation training for the probationers of the Indian Economic Services and several workshops and symposia in advanced quantitative techniques for impact assessment and policy analysis.

The Institute received exceptional support from the Council. I sincerely thank Dr. Trilochan Mohapatra, Secretary, Department of Agricultural Research and Education & Director General, Indian Council of Agricultural Research, and Dr. R.C. Agrawal, Deputy Director General (Education), ICAR, for their guidance and support. My thanks are due to the Research Advisory Committee and Institute Management Committee members for their suggestions for improving the research and administrative activities. I thank my colleagues Dr. Khem Chand, Dr. Dinesh Chand Meena, Dr. Kingsly I.T. and Mrs. Sonia Chauhan for their efforts in compiling, collating and editing the information needed for this report. A word of appreciation for Mrs. Umeeta Ahuja and Mr Deepak Tanwar for processing and type setting that helped brings this report into its present shape.

Date : July 11, 2022

Pratap Singh Birthal
Director (Acting)

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List of Acronyms

AERA	Agricultural Economics Research Association
AKMU	Agricultural Knowledge Management Unit
APART	Assam Agribusiness & Rural Transformation Project
ARMS	Agricultural Research Management System
ASAE	Asia Society of Agricultural Economist
ASI	Annual Survey of Industries
BAAG	Bangladesh Academy of Agriculture
CACP	Commission for Agricultural Costs and Prices
CAS	Current Awareness Service
CBIP	Central Board of Irrigation and Power
CGE	Computable General Equilibrium
CGWA	Central Ground Water Authority
CGWB	Central Ground Water Board
CoC	Cost of Cultivation
CWPRS	Central Water and Power Research Station
DAC&FW	Department of Agriculture Cooperation and Farmers' Welfare
DDS	Document Delivery Service
DSR	Direct Seeded Rice
EPI	Export Potential Indicator
EPW	Economic and Political Weekly
ERP	Enterprise Resource Planning
FPOs	Farmer Producers Organizations
FT	Friedman test
GIDS	Giri Institute of Development Studies
GP	Gram Panchayat
GVA	Gross Value Added
GWR	Ground Water Recharge
HH	Herfindahl-Hirschman
HHC	High spread, High yield & Critical
HHS	High spread, High yield & Safe
HLC	High spread, Low yield & Critical
HLO	High spread, Low yield & Over-exploited
IAAG	India Agriculture Advancement Group
ICAE	International Conference of Agricultural Economists
ICAR	Indian Council of Agricultural Research
IDEA	India Digital Ecosystem of Agriculture
IES	Indian Economic Service

IGP	Indo-Gangetic Plains
IIWM	Indian Institute of Water Management
ILRI	International Livestock Research Institute
ILSP	Integrated Livelihood Support Project
IMC	Institute Management Committee
INM	Integrated Nutrient Management
INSAIT	Indian Society of Agricultural Information Technology
IO	Input-Output
IRC	Institute Research Council
ISOPOM	Integrated Scheme of Oilseeds, Pulses, Oil Palm and Maize
ITC	International Trade Centre
JSC	Joint Staff Council
KCC	Kisan Credit Card
KSY	Kisan SAMPADA Yojana
LDPE	Low Density Polyethylene
LHS	Low spread, High yield & Safe
LLO	Low spread, Low yield & Over-exploited
LOPs	List of Points
mbgl	meters below ground level
MI	Market Intelligence
MI	Micro-irrigation
MIS	Management Information System
MK	Mann-Kendall
MoFPI	Ministry of Food Processing Industries
MoWR	Ministry of Water Resource
MPI	Malmquist Productivity Index
NARS	National Agricultural Research System
NCAER	National Council of Applied Economic Research
NER	North Eastern Region
NGOs	Non-Governmental Organizations
NIAP	National Institute of Agricultural Economics and Policy Research
NIH	National Institute of Hydrology
NITI	National Institute for Transforming India
NMEO-OP	National Mission on Edible Oils – Oil Palm
NMOOP	National Mission on Oilseeds and Oil Palm
NSSO	National Sample Survey Office
NWB	National Water Board
NWDA	National Water Development Agency
NWIC	National Water Informatics Centre
NWRC	National Water Resource Council

OPAE	Oil Palm Area Expansion
OPDP	Oil Palm Development Program
OPP	Oilseeds Production Program
PME	Priority Setting, Monitoring and Evaluation
PMFBY	Pradhan Mantri Fasal Bima Yojna
PMKSY	Pradhan Mantri Krishi Sinchayee Yojana
PRC	Project Review Committee
PWDs	Public Works Departments
QS	QS test
RAC	Research Advisory Committee
RCA	Revealed Comparative Advantage
RCP	Real Cost of Production
RD&GR	River Development & Ganga Rejuvenation
RGNGWTRI	Rajiv Gandhi National Ground Water Training & Research Institute
RIDF	Rural Infrastructure Development Fund
RKVY	Rashtriya Krishi Vikas Yojana
RSCA	Revealed Symmetric Comparative Advantage
SAARC	South Asian Association for Regional Cooperation
SAM	Social Accounting Matrix
SAPB	State Agricultural Prices Board
SAPs	Sustainable Agricultural Practices
SDGs	Sustainable Development Goals
SHGs	Self Help Groups
STI	Science Technology and Innovation
TBI	Trade Balance Index
TE	Technical Efficiency
TFP	Total Factor Productivity
ULB	Urban Local Bodies
UNFSS	United Nations Food System Summit
USDA	U.S. Department of Agriculture
VGF	Viability Gap Funding
WALMI	Water and Land Management Institute
WAPCOS	Water and Power Consultancy Service
WAR	Water Allotment Right
WDRA	Warehousing Development and Regulatory Authority
WFP	World Food Program
WPR	Worker Population Ratio
WUAs	Water User Associations
WUE	Water Use Efficiency

विशिष्ट सारांश

भा.कृ.अ.प.–राष्ट्रीय कृषि आर्थिकी एवं नीति अनुसंधान संस्थान (एनआईएपी) कृषि विज्ञान संबंधी नीतियों के लिए भारतीय कृषि अनुसंधान परिषद (भा.कृ.अ.प.) के 'प्रबुद्ध मंडल' के रूप में कार्य करता है। यह संस्थान समकालीन कृषि विकास संबंधी मुद्दों पर कार्य करता है तथा क्षमता निर्माण संबंधी कार्यक्रम आयोजित करके राष्ट्रीय कृषि अनुसंधान प्रणाली (नार्स) में कृषि अर्थशास्त्र एवं नीति अनुसंधान को सबल बनाने की दिशा में निरंतर प्रयासरत है। यह कृषि–खाद्य प्रणालियों के रूपांतरण की प्रक्रिया में उभरती हुई चुनौतियों एवं अवसरों के संबंध में योगदान देते हुए नीति–निर्माताओं को भी अवगत कराता है।

यह संस्थान तीन मुख्य विषयों के अंतर्गत अनुसंधान करता है: (i) कृषि वृद्धि एवं विकास, (ii) प्रौद्योगिकी एवं टिकाऊ कृषि तथा (iii) कृषि विपणन एवं व्यापार। वर्ष 2021–22 के दौरान संस्थान की अनुसंधान उपलब्धियों तथा अन्य गतिविधियों का संक्षिप्त ब्योरा निम्नानुसार है:

अनुसंधान उपलब्धियाँ

कृषि वृद्धि एवं विकास

कोविड–19 महामारी के कारण अभूतपूर्व आर्थिक संकट उत्पन्न हुआ, जोकि संभवतः 1930 के दशक के दौरान आने वाली विश्वव्यापी मंदी के पश्चात् सर्वाधिक कष्टकारी था। यद्यपि लॉकडाउन के कारण रोग के प्रसार को रोका गया तथा हजारों जीवन बचाए गए। तथापि, लॉकडाउन की अवधि के दौरान आर्थिक गतिविधियों के पूरी तरह रुक जाने तथा आपूर्ति–श्रृंखलाओं एवं प्रचालन तंत्र (लॉजिस्टिक्स) की आपूर्ति में आने वाले बार–बार के व्यवधान के कारण आर्थिक असंतुलन पैदा हुआ। कृषि एकमात्र वह क्षेत्र था जिस पर लॉकडाउन का कोई विशेष प्रभाव नहीं पड़ा। कोविड–19 महामारी के प्रभाव के एक मूल्याँकन में यह प्रदर्शित हुआ कि चावल, गेहूँ, मोटे अनाजों, दलहनों और तिलहनों की माँग की तुलना में फलों, सब्जियों, दूध, अण्डों, कुक्कुट एवं अन्य मांस तथा मछलियों की माँग में अपेक्षाकृत अधिक गिरावट (6–26 प्रतिशत) आई। उर्वरकों, जीवनाशी, यंत्रों तथा फार्म उपकरणों जैसे उपक्षेत्रों में निवेश की मांग में अधिक गिरावट नहीं हुई।

खाद्य उपलब्धता में उल्लेखनीय सुधार के बावजूद देश में कुपोषण निरंतर बना हुआ है। यद्यपि राष्ट्रीय परिवार स्वास्थ्य सर्वेक्षणों (एनएफएचएस) में पोषण के परिणाम संकेतकों जैसे बच्चों की वृद्धि रुक जाने तथा उनका भार कम बने रहने के मामले में 1998–99 और 2015–16 के बीच गिरावट की प्रवृत्ति देखी गई। तथापि, कुपोषण अब भी उच्च स्तर पर विद्यमान है। इसके अतिरिक्त पिछले कुछ वर्षों के दौरान बच्चों में अपक्षय तथा विशेष रूप से वयस्क महिलाओं में मोटापा बना हुआ है। अतः देश में चल रहे पोषण–विशिष्ट और पोषण संवेदी नीति हस्तक्षेपों या प्रयासों को अधिक प्रभावी एवं सबल बनाने की आवश्यकता है।

पिछले दशक में कृषि से होने वाले सकल मूल्य वर्धन (जीवीए) में 3.5 प्रतिशत की वार्षिक दर से वृद्धि हुई है। यह वृद्धि प्रमुख रूप से पशुधन और मात्स्यिकी क्षेत्रों में वृद्धि के कारण हुई हैं जिनमें क्रमशः 7.6 प्रतिशत और 9 प्रतिशत वार्षिक वृद्धि हुई है। यह मानते हुए कि सार्वजनिक तथा निजी निवेश की वृद्धि में कोई भी परिवर्तन नहीं होता है, पूर्वानुमान लगाया गया है कि वर्ष 2021–37 के दौरान कृषि के क्षेत्र में 4 प्रतिशत वार्षिक वृद्धि होगी।

किसानों की आय बढ़ाना नीति संबंधी चिंता का प्रमुख विषय बना हुआ है। कृषि परिवारों के स्थिति मूल्याँकन सर्वेक्षणों से प्राप्त परिणाम यह प्रदर्शित करते हैं कि वर्ष 2012–13 और 2018–19 के बीच कृषि परिवारों की आय में नाममात्र 1.6 गुना वृद्धि हुई। पारिवारिक आय के संघटन में भी परिवर्तन हुआ है; फसलों की आय का हिस्सा कम हुआ है, जबकि मजदूरी व पशुपालन में वृद्धि हुई है। इससे किसानों की आय बढ़ाने में विविधीकरण की महत्वपूर्ण भूमिका का सुझाव मिलता है। स्थिति मूल्याँकन सर्वेक्षण, 2018–19 पर आधारित एक अन्य अध्ययन में यह प्रदर्शित हुआ है कि छोटी जोत वाले किसान पशुधन और कुक्कुट पर अधिक निवेश करते हैं, जबकि बड़ी जोत वाले किसान फार्म यंत्रीकरण पर अधिक निवेश करते हैं। छोटे किसानों द्वारा पशुधन और कुक्कुट पर किया जाने वाला निवेश यह दर्शाता है कि इन गतिविधियों में विविधीकरण कृषि वृद्धि को और बढ़ाने, निर्धनता को कम करने व पोषणिक सुरक्षा को सुधारने की दृष्टि से महत्वपूर्ण हो सकता है। राज्यों के बीच किसानों द्वारा किया जाने वाला निवेश तेलंगाना, केरल, पंजाब व हरियाणा में 2,000 रुपये से 3,030 रुपये के बीच

अलग–अलग रहा है। दूसरी ओर झारखंड, असम, बिहार तथा ओडिशा और उत्तर पूर्वी राज्यों में किसानों द्वारा किए जाने वाला निवेश का स्तर अपेक्षाकृत कम रहा है। खेती संबंधी निवेश में राज्यों के बीच यह भिन्नता औपचारिक तथा अनौपचारिक वित्तीय संस्थाओं से उपलब्ध होने वाले ऋण से सकारात्मक रूप से सह–संबंधित है।

कृषि, ग्रामीण कार्य बल को सबसे अधिक रोजगार देने वाला क्षेत्र है। यहाँ पुरुषों और महिलाओं दोनों को सर्वाधिक रोजगार मिलता है। वर्ष 2004–05 और 2011–12 के बीच कृषि कार्य बल (खेतिहर तथा श्रमिक दोनों) में कमी आई। तथापि, खेतिहरों के बीच गिरावट की प्रवृत्ति 2011–12 और 2017–18 के बीच देखी गई तथा केवल महिला खेतिहरों के मामले में यह प्रतिबंधित रहा। खेतिहरों की संख्या में गिरावट का कारण सरकार द्वारा किसानों की आय सुधारने और/अथवा गैर कृषि क्षेत्रों की सीमित क्षमता माना जा सकता है जिससे भावी कर्मियों को उत्पादक रोजगार के अवसर प्राप्त होते है।

कृषि विकास के मामले में अत्यधिक क्षेत्रीय विषमताएं हैं। देश के 9 राज्यों के 117 महत्वाकांक्षी जिलों में किए गए एक अध्ययन से यह सुझाव मिलता है कि कृषि इन जिलों के सकल विकास में उल्लेखनीय भूमिका निभा सकती है। इसमें यह तर्क दिया जाता है कि परती भूमि को खेती के अंतर्गत लाया जाए, बारानी क्षेत्रों में जल संभरों में किया जाने वाला निवेश बढ़ाया जाए, भू–जल प्रबंधन की विधियों को अपनाने में सुधार हो तथा अपघटित भूमि को सुधारा जाए ताकि कृषि वृद्धि में तेजी लाई जा सके।

गैर–सरकारी संगठन (एनजीओ) कृषि एवं ग्रामीण विकास में उत्प्रेरक की भूमिका निभाते हैं। भारत में ग्रामीण क्षेत्रों में अनेक एनजीओ कार्य कर रहे हैं जो कृषि तथा कृषि व्यापार से संबंधित विभिन्न गतिविधियों को बढ़ावा दे रहे हैं। राष्ट्रीय सूचना केन्द्र के एनजीओ–दर्पण मॉड्यूल के अनुसार 1.20 लाख पंजीकृत एनजीओ में से 28,452 कृषि क्षेत्र में, 20,211 पशुपालन क्षेत्र में तथा 16,389 खाद्य प्रसंस्करण क्षेत्र में सक्रिय हैं। ये एनजीओ प्रौद्योगिकियों तथा सूचना के प्रचार–प्रसार के अतिरिक्त मूल्य–श्रृंखलाओं को स्थापित करके बाजार से सम्पर्क विकसित करने की सुविधा प्रदान करते हैं, छोटी जोत वाले किसानों की मोल–तोल की शक्ति को बढ़ाते हैं तथा बाजार बुद्धिमत्ता उपलब्ध कराते हैं।

कृषि उत्पादकता में वृद्धि करने तथा जलवायु संबंधी आघातों को सहने के लिए समुत्थानशीलता लाने में ऋण उत्प्रेरक की भूमिका निभाते हैं। उत्पादकता पर कृषि ऋण के पड़ने वाले प्रभावों तथा कृषि की समुत्थानशीलता पर किए गए एक अध्ययन से यह प्रदर्शित होता है कि ऋण से कृषि उत्पादकता में वृद्धि होती है तथा किसानों के खेती से संबंधित जोखिम कम हो जाते हैं। इस अध्ययन में जोखिम से निपटने के उपाय तथा संस्थागत ऋण में कमी करने के लिए ऋण के प्रवाह में वृद्धि का तर्क दिया जाता है।

प्रधानमंत्री फसल बीमा योजना (पीएमएफबीवाई) के अंतर्गत उल्लेखनीय नीतिगत सहायता के बावजूद फसल बीमा को कम अपनाया जाना एक पहेली बनी हुई है। केवल एक तिहाई किसान ही फसल बीमा करा रहे हैं। अनेक कारकों जैसे खेत का आकार, संस्थागत ऋण तक पहुँच, खाद्य सुरक्षा के लिए सूचना एवं सामाजिक सुरक्षा के संजाल तथा रोजगार और जलवायु संबंधी आपदाओं में निरंतर वृद्धि किसानों के फसल बीमा संबंधी निर्णय को प्रभावित करते हैं। फसल बीमा बनाम अन्य अपनाए जाने वाले उपायों के तुलनात्मक लाभों पर किए गए अध्ययन से यह प्रदर्शित हुआ है कि उत्पादकता तथा किसानों के परंपरागत जोखिम प्रबंधन की कार्यनीतियों जैसे सिंचाई से होने वाले लाभ फसल बीमा से होने वाले लाभ की तुलना में बेहतर हैं। तथापि, जब ये दोनों ही उपाय एक साथ अपनाए जाते हैं तो उत्पादकता और जोखिम संबंधी लाभ, दोनों ही बढ़ जाते हैं। इस अध्ययन से यह सुझाव मिलता है कि किसानों द्वारा स्वयं जोखिम संबंधी उपायों को अपनाकर होने वाले लाभों को ध्यान में रखते हुए यह कहा जा सकता है कि यह बीमे की किस्त के संबंध में निर्णय लेने का एक प्रमुख कारण सिद्ध हो सकता है।

प्रौद्योगिकी एवं टिकाऊ कृषि

भारतीय कृषि में अनुसंधान एवं विकास पर किए जाने वाले निवेश से संबंधित एक अध्ययन में यह प्रदर्शित हुआ है कि कृषि अनुसंधान की गहनता अर्थात कृषि डीजीपी में कृषि अनुसंधान एवं विकास के हिस्से में त्रिवार्षिकी 1983–84 के दौरान 0.42 प्रतिशत से त्रिवार्षिकी 2019–20 के दौरान 0.60 प्रतिशत की वृद्धि हुई है। तथापि, इसमें क्षेत्रीय असमानताएं हैं। दक्षिणी अर्धशुष्क उष्णकटिबंधीय क्षेत्र में कृषि अनुसंधान एवं विकास में सर्वाधिक निवेश हुआ है जबकि पंजाब, हरियाणा तथा उत्तर प्रदेश जैसे प्रौद्योगिकीय दृष्टि से उन्नत राज्यों में कृषि अनुसंधान एवं विकास पर अपेक्षाकृत कम निवेश हुआ है।

प्रौद्योगिकीय परिवर्तन कृषि वृद्धि की कुंजी है। गेहूँ के वृद्धि निष्पादन में प्रौद्योगिकी परिवर्तन के योगदान पर किए

गए एक अध्ययन में यह प्रदर्शित हुआ है कि कुल कारक उत्पादकता (टीएफपी) में 0.89 प्रतिशत वृद्धि हुई जबकि पंजाब में यह सबसे कम 0.65 प्रतिशत और मध्य प्रदेश में सबसे अधिक 1.38 प्रतिशत थी। प्रौद्योगिकी परिवर्तन से न केवल गेहूँ के उत्पादन में वृद्धि हुई है बल्कि इससे उत्पादन की वास्तविक लागत में भी कमी आई है। इस अध्ययन में उपज अंतराल का भी मूल्याँकन किया गया। उपज अंतराल बिहार में सर्वाधिक था, उसके पश्चात् क्रमशः हिमाचल प्रदेश, मध्य प्रदेश और उत्तर–पश्चिमी राज्यों का स्थान था। उपज अंतराल को कम करने से देश में गेहूँ के उत्पादन में उल्लेखनीय वृद्धि हो सकती है।

जल की बचत के लिए फसल नियोजन अनिवार्य है। टिकाऊ कृषि के गहनीकरण पर किए गए अध्ययन से यह संकेत मिला है कि मुख्यतः उत्तर–पश्चिमी व पश्चिमी राज्यों में चावल के क्षेत्र में 1.93 मिलियन हैक्टर क्षेत्रफल को कम सिंचाई चाहने वाली फसलों की तरफ परिवर्तन करने से फसलों द्वारा सिंचाई जल के उपभोग में कमी आई है। पूर्वी तथा उत्तर–पूर्वी राज्यों में चावल की खेती वाले क्षेत्र के लगभग 43 प्रतिशत भाग में और अधिक गहनीकरण की क्षमता है। गेहूँ के मामले में विशेषरूप से राजस्थान में लगभग 0.65 मिलियन हैक्टर क्षेत्रफल कृषि के टिकाऊपन की दृष्टि से जोखिमपूर्ण है। मुख्यतः उत्तर प्रदेश और तमिलनाडु में गन्ने की खेती के अंतर्गत लगभग 13,543 हैक्टर क्षेत्रफल के कारण भू–जल के स्तर में गिरावट आ रही है।

पंजाब में प्रोत्साहन–अभिमुख आयतनात्मक सिंचाई जल की बचत की नीति तथा फसल क्रम, जल उपयोग और किसानों की आय पर इसके प्रभाव की व्यवहारिकता संबंधी एक अध्ययन से यह प्रदर्शित हुआ है कि भू–जल निकाले जाने की वर्तमान दर से राज्य में कृषि के और अधिक गहनीकरण को नहीं बनाए रखा जा सकता है। यद्यपि संसाधनों के आबंटनों को इष्टतम बनाकर जल बचाने की क्षमता में 8 प्रतिशत की वृद्धि जा सकती है, लेकिन केवल चावल–गेहूँ की एकल फसलन पद्धति को ऐसा करके समाप्त करना असंभव है। अध्ययन से यह सुझाव मिलता है कि भूजल में आने वाली गिरावट को रोकने के लिए विभेदनशील जल मूल्य निर्धारण किया जाए।

पारिस्थितिक प्रणाली संबंधी सेवाएं कृषि के टिकाऊ विकास के लिए अनिवार्य हैं। टिकाऊ कृषि विधियों (एसएपी) जैसे समेकित पोषक तत्व प्रबंधन (आईएनएम), जैविक सुधार, शून्य/न्यूनतम जुताई, फसल क्रम, अवशिष्ट को बनाए रखना, अंतरफसलन और जैव काष्ठ कोयला की कार्बन प्रच्छादन क्षमता का एक अध्ययन के अंतर्गत मात्रात्मक निर्धारण किया गया। जैव काष्ठ कोयला कार्बन प्रच्छादन का सर्वाधिक प्रभावी उपाय है तथा फसल क्रम में सबसे कम कार्बन प्रच्छादन क्षमता होती है। इसके अतिरिक्त अर्धशुष्क पर्यावरणों में एसएपी की कार्बन प्रच्छादन क्षमता अधिक है। एसएपी की कार्बन प्रच्छादन गतिकी से यह संकेत मिलता है कि 40 वर्षों के लिए अतिरिक्त कार्बन प्रच्छादित किया जा सकता है (2.62 tonnes/ha) जिसके पश्चात इसमें कमी आनी आरंभ हो जाती है। एक आर्थिक मूल्याँकन से ये प्रदर्शित हुआ है कि सापेक्ष मृदा कार्बन लाभ 3,400 रुपये से 70,236 रुपये/हैक्टर/वर्ष का कार्बन क्रेडिट प्राप्त होता है तथा इससे होने वाला शुद्ध आर्थिक लाभ 3,254 रुपये से 67,220 रुपये/हैक्टर/वर्ष है। जलसंभरों की पारिस्थितिक प्रणाली संबंधी सेवाओं पर किए गए एक अध्ययन में यह प्रदर्शित हुआ है कि पारिस्थितिक प्रणाली संबंधी सेवाएं देश के विभिन्न कृषि–जलवायु अंचलों में उल्लेखनीय रूप से भिन्न हैं। वृहत जलसंभर सूक्ष्म जलसंभरों की तुलना में बेहतर हैं तथा नियोजन, कार्यान्वयन और प्रबंधन से पारिस्थितिक प्रणाली सेवाओं में अत्यधिक वृद्धि होती है। इसके अतिरिक्त जलसंभरों के कारण जलोढ़ भूमियों में मृदा के बने रहने की मात्रा उल्लेखनीय रूप से अधिक होती है।

फसल विविधीकरण से न केवल कृषि उत्पादकता को सुधारने में सहायता मिलती है बल्कि यह जलवायु संबंधी आघातों को सहने की क्षमता भी प्रदान करता है। तथापि, इसके उत्पादकता संबंधी लाभ जोखिम लाभों की तुलना में अधिक पाए गए हैं। फसल विविधीकरण की जोखिम कम करने की भूमिका शुष्क क्षेत्र में प्रमुख रूप से अधिक है, जबकि अन्य क्षेत्रों में यह अधिक नहीं है। एक अध्ययन से फसल विविधीकरण के लाभों, कृषि सूचना व वित्तीय संस्थानों तक किसानों की पहुँच को सुधारने और कृषि–मौसम संबंधी परामर्शों के संदर्भ व विषय–वस्तु को सुधारने में सहायता मिलती है इसके अतिरिक्त किसानों तक समय पर पहुँचाने के लाभों के बारे में जागरूकता सृजित करने की आवश्यकता का सुझाव मिलता है, ताकि किसान सूचना के आधार पर जोखिम प्रबंधन संबंधी निर्णय समय पर ले सकें।

कृषि की भूजल पर निर्भरता बढ़ती जा रही है। पिछले 10 वर्षों (2008–19) के दौरान सीजीडब्ल्यूबी के 65–70

प्रतिशत पर्यवेक्षणों में कूपों में भूजल के स्तर में कोई उल्लेखनीय प्रवृत्ति नहीं देखी गई है। तथापि, मानसून के पूर्व की अवधि में 24 प्रतिशत कूपों तथा मानसून के पश्चात् की अवधि में 18 प्रतिशत कूपों में भूजल के स्तर में गिरावट की प्रवृत्ति पाई गई। इसलिए भूजल में आने वाली कमी को रोकने के लिए प्रौद्योगिकी एवं नीति संबंधी उपायों की आवश्यकता है। बिहार में किए गए एक अध्ययन से यह प्रदर्शित हुआ है कि बिजली संबंधी बुनियादी ढांचे को सुधारकर बिजली की दिशा में ऊर्जा स्रोतों के विविधीकरण की बहुत संभावना है। यह स्पष्ट किया गया है कि पम्प उपयोग के निर्धारित स्तर पर समान दर प्रभार प्रणाली के अंतर्गत भू–जल को निकालने की प्रति आयतन ऊर्जा की लागत 'प्रो रेटा' आधारित शुल्क की तुलना में 6.75 गुना अधिक होगा। प्रो रेटा शुल्क प्रणाली के अंतर्गत ऊर्जा की कम लागत से भूजल को पम्प द्वारा निकालने के लिए बिजली के मीटर लगाने हेतु आर्थिक औचित्य उपलब्ध होता है।

सूक्ष्म सिंचाई प्रणाली को अपनाना जल बचत के महत्वपूर्ण उपायों में से एक है तथा इससे उत्पादकता में कोई कमी नहीं आती है। पिछले कुछ वर्षों के दौरान सूक्ष्म सिंचाई के अंतर्गत आने वाले क्षेत्र में उल्लेखनीय वृद्धि हुई है। यह वर्ष 2005–06 में सूक्ष्म सिंचाई के अन्तर्गत 3.1 मिलियन हैक्टर क्षेत्रफल था जोकि 2020–21 में बढ़कर 12.91 मिलियन हैक्टर हो गया है। प्रमाणों से यह स्पष्ट हुआ है कि सूक्ष्म सिंचाई के कारण जल व पोषक तत्वों के उपयोग दक्षता तथा फसलोत्पादकता में वृद्धि हुई है और उत्पादन की लागत में कमी आई है। तथापि, अब भी सूक्ष्म सिंचाई की क्षमता का पर्याप्त उपयोग नहीं हुआ है तथा सूक्ष्म सिंचाई को अपनाने की क्रिया में तेजी लाकर इस क्षमता का भरपूर उपयोग किया जा सकता है।

जैविक खेती भारत में जड़ पकड़ रही है। भारत के उत्तर–पूर्वी क्षेत्र में अदरक की जैविक खेती पर किए गए एक अध्ययन में मेघालय व मिजोरम की तुलना में विशेष रूप से सिक्किम (एक जैविक खेती वाला राज्य) में इसकी उत्पादकता अधिक पाई गई है। इससे यह दृष्टिकोण खण्डित होता है कि जैविक खेती के परिणामस्वरूप उपज में कमी आती है।

यंत्रीकरण को कृषि उत्पादकता बढ़ाने तथा श्रम की लागत को कम करने की दृष्टि से अनिवार्य माना गया है। सिंधु–गंगा के मैदानों (आईजीपी) में धान की खेती करने वाले प्रमुख राज्यों के लिए तैयार किए गए यंत्रीकरण सूचकांक से यह प्रदर्शित हुआ है कि पंजाब में कृषि संबंधी कार्यों के यंत्रीकरण का स्तर उच्चतर है, जिसके पश्चात् इस मामले में हरियाणा, बिहार, उत्तर प्रदेश और पश्चिम बंगाल का स्थान है। फार्म यंत्रीकरण फसल उपज तथा शुद्ध लाभ की दृष्टि से सकारात्मक पाया गया है।

यदि विस्तार प्रणाली अल्पविकसित रहती है तो अनुसंधान एवं विकास पर होने वाले निवेश से पूरा–पूरा लाभ प्राप्त नहीं किया जा सकता है। कपास की खेती करने वाले किसानों के सूचना खोज संबंधी व्यवहार पर किए गए एक अध्ययन में यह पाया गया है कि विशेष रूप से युवा किसान सूचना के साधनों की अधिक खोज करते हैं और उनकी पहुँच भी अधिक है। भूमि जोत तथा ग्रामीण संगठनों की सदस्यता किसानों के सूचना खोज संबंधी व्यवहार से सकारात्मक रूप से संबंधित हैं। सूचना तक पहुँच होने से खेती की लागत में कमी आती है और फसल की उपज व शुद्ध लाभ में वृद्धि होती है।

कृषि विपणन एवं व्यापार

वर्ष 2021–22 के दौरान भारत का कृषि निर्यात 50 बिलियन अमेरिकी डालर से अधिक रहा है। मांस, खाद्य मांस अवशिष्ट तथा मछलियों व झींगों–केकड़ों का निर्यात निष्पादन पर्याप्त प्रभावशाली रहा है। भारत मछलियों, झींगों, जलजीवों आदि के सबसे बड़े निर्यातक के रूप में उभरा है तथा इनका निर्यात सबसे अधिक अमेरिका में किया जाता है। दीर्घावधि में इसे प्रतिस्पर्धी बनाए रखने की दृष्टि से गुणवत्ता में सुधार के लिए अनुसंधान एवं विकास में निवेश तथा नवोन्मेषी प्रौद्योगिकियों के उपयोग की सशक्त आवश्यकता है।

भारत फलों व सब्जियों का सबसे बड़ा उत्पादक देश है और हमारे यहाँ इन जिंसों के निर्यात की पर्याप्त क्षमता है जिसका अभी तक दोहन नहीं हुआ है। उत्पाद मानचित्रण से यह प्रदर्शित होता है कि खीरे और छोटे खीरे (घेरकिन) के निर्यात का भारत को तुलनात्मक लाभ प्राप्त है। भले ही मौसम सीमित हो, लेकिन फलों व सब्जियों का निर्यात देश को लाभ प्रदान करने में महत्वपूर्ण भूमिका निभाता है। अतः यह महत्वपूर्ण है कि किस मौसम में किस फल या सब्जी का निर्यात किया जाए, इसकी पहचान की जाए तथा तुलनात्मक लाभ से युक्त जिंसों के निर्यात को बढ़ावा दिया जाए।

घरेलू माँग को पूरा करने के मामले में भारत खाद्य तेलों के आयात पर बहुत अधिक निर्भर है। यद्यपि सरकार की

पहल से तिलहन उत्पादन को बढ़ाने में सहायता मिली है, तथापि खाद्य तेलों की घरेलू माँग अब भी इसकी आपूर्ति की तुलना में अधिक है। तिलहनों के उच्चतर घरेलू मूल्यों से किसानों को उपज बढ़ाने वाली प्रौद्योगिकियों को अपनाने में प्रोत्साहन मिलेगा। इस क्षेत्र में शुल्क एक प्रभावी कारक सिद्ध हो सकता है। उच्च शुल्क के संभावित परिदृश्य के अंतर्गत किसानों को तिलहनों से होने वाला मूल्य लाभ अनुमानतः 2.4 प्रतिशत से 6 प्रतिशत के बीच है और उत्पादन से होने वाला लाभ लगभग 2 प्रतिशत है। तिलहनों में कुल कारक उत्पादकता (टीएफपी) वृद्धि की वर्तमान दरें देश को तिलहन के मामले में आत्मनिर्भर बनाने की दृष्टि से अपर्याप्त हैं, अतः प्रौद्योगिकी परिवर्तन के द्वारा उत्पादन को बढ़ाने की बहुत आवश्यकता है।

उत्पादकों और इसके साथ–साथ उपभोक्ताओं को बाजार लेन–देन से लाभ उठाने की दृष्टि से बाजार संबंधी सुधार आवश्यक हैं। दलहनों और तिलहनों की मूल्य श्रृंखलाओं में आए मूल्य परिवर्तन के प्रमाणों से यह प्रदर्शित हुआ है कि मूल्य परिवर्तन में असमानता विद्यमान है, जिससे यह संकेत मिलता है कि वर्तमान में बाजार संबंधी लेन–देनों से न तो उत्पादकों को लाभ हो रहा है और न ही उपभोक्ताओं को। संभवतः इसका कारण मूल्य श्रृंखला के संबंधित पक्षों में सूचना का सटीक प्रवाह न होना है। अध्ययन से यह सुझाव मिला है कि बाजार में आने वाले उतार–चढ़ावों को न्यूनतम करने के लिए बाजार बुद्धिमत्ता की प्रणाली विकसित किए जाने की आवश्यकता है।

निचली धारा से ऊपरी धारा तक विभिन्न पक्षों के बीच मूल्यवर्धन में लाभ की भागीदारी के लिए प्रभावी तथा सकल मूल्य श्रृखलाओं का विकास किया जाना अनिवार्य है। उत्तर–पूर्वी भारत में जैविक इलायची की मूल्य श्रृंखला से संबंधित प्राप्त किए गए अनुभवी प्रमाणों से यह पाया गया है कि किसान अपनी अधिकांश उपज बेच देते हैं तथा बहुत थोड़ा भाग अपने घरेलू उपभोग के लिए रखते हैं, जिसे वे अपने मित्रों व संबंधियों को उपहार के रूप में देते हैं। आपूर्ति श्रृख्ंला के क्रम में उपज उत्पादक से प्राथमिक थोक विक्रेताओं से होती हुई द्वितीयक थोक विक्रेताओं/व्यापारियों के माध्यम से फुटकर विक्रेताओं के द्वारा उपभोक्ताओं तक पहुँचती है। किसानों द्वारा इस आपूर्ति श्रृख्ंला को सर्वाधिक पसंद किया जाता है। बड़ी मात्रा में विपणन योग्य अतिरिक्त माल के बचे रहने से यह सुझाव मिलता है कि गांवों के क्लस्टर के लिए इलायची की बड़ी–बड़ी मंडियां स्थापित की जाएं।

निवेश बाजारों पर बहुत कम अध्ययन हुआ है। राष्ट्रीय प्रतिनिधित्व करने वाले फार्म सर्वेक्षण के आंकड़ों के विश्लेषण से यह प्रदर्शित होता है कि किसान बीज संबंधी अपनी आवश्यकता के लिए स्थानीय व्यापारियों पर अधिक निर्भर रहते हैं। अन्य निवेशों के मामले में वे स्थानीय व्यापारियों के अलावा निवेश डीलरों, सहकारी समितियों तथा सरकारी एजेंसियों के अलावा महत्वपूर्ण बाजार प्रणालियों पर भी निर्भर रहते हैं।

अन्य गतिविधियाँ

प्रतिवेदन वर्षावधि के दौरान संस्थान के वैज्ञानिकों ने समीक्षित राष्ट्रीय एवं अंतरराष्ट्रीय जर्नलों में 57 शोध पत्र, एक नीति पत्र, पाँच कार्यशील/चर्चा–पत्र तथा 4 पुस्तक अध्याय प्रकाशित किए। इसके अतिरिक्त विभिन्न पत्रिकाओं व समाचार–पत्रों में अनेक लेख प्रकाशित हुए तथा सम्मेलनों, सेमिनार व कार्यशालाओं में प्रस्तुत किए गए।

भा.कृ.अ.प.–निआप ने किसानों की आय दुगुनी करने की अंतर–मंत्रालयी समिति को नीति व तकनीकी सहयोग उपलब्ध कराने के साथ प्रधानमंत्री किसान संपदा योजना, मोटे अनाजों/मिलेट्स की खरीद तथा वितरण और बीटी कपास के बीज के न्यूनतम समर्थन मूल्य (एमएसपी) पर भी नीति एवं तकनीकी सहयोग उपलब्ध कराए। संस्थान ने फार्म उपज के विपणन के लिए सकल रूप से संस्थाओं को सबल बनाने के लिए उत्तराखण्ड सरकार को भी महत्वपूर्ण सुझाव उपलब्ध कराए। संस्थान ने डेयरी मास्टर प्लान के लिए एक संकल्पनात्मक बुनियादा ढांचा विकसित करने हेतु अंतरराष्ट्रीय पशुधन अनुसंधान संस्थान (आईएलआरआई) को सहयोग उपलब्ध कराया। इस संस्थान ने कृषि में त्वरित वृद्धि लाने के लिए नीतिपरक कार्य योजनाओं के कार्यान्वयन हेतु क्रियाविधियाँ विकसित करने व क्षमता निर्माण के लिए असम सरकार के असम कृषि व्यापार एवं ग्रामीण रूपांतरण परियोजना (एपीएआरटी) को तकनीकी सहायता उपलब्ध कराई।

संस्थान ने दस से अधिक कार्यशालाएं और प्रशिक्षण कार्यक्रम आयोजित करके 'नार्स' की क्षमता निर्माण में अपना योगदान दिया। भारतीय आर्थिक सेवा के अधिकारी–प्रशिक्षणार्थियों के लिए एक विशेष अभिमुखन कार्यक्रम भी आयोजित किया गया।

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 its agricultural science policy. It undertakes research on contemporary agricultural development issues and makes persistent efforts toward strengthening the agricultural economics and policy research in the National Agricultural Research System (NARS) by organizing capacity-building programs. It also sensitizes policymakers and provides inputs to them on the emerging challenges and opportunities in the process of transformation of agri-food systems.

The Institute conducts research under three broad themes: (i) Agricultural Growth and Development, (ii) Technology and Sustainable Agriculture, and (iii) Agricultural Markets and Trade. Below is a brief account of the research achievements, and other activities undertaken during 2021-22.

Research Achievements

Agricultural Growth and Development

The COVID-19 pandemic triggered an unprecedented economic crisis, perhaps the most severe after the Great Depression of the 1930s. Although the lockdown imposed to contain the spread of disease saved thousands of lives, the complete cessation of the economic activities and frequent interruptions in the supply chains and logistics during the lockdown had created an economic disequilibrium. Agriculture was the only sector that was not affected by the lockdown. An assessment of the effect of Covid-19 shows a more significant decline in demand for perishable commodities such as fruits, vegetables, milk, eggs, poultry and other meats, and fish (6-26%) than in demand for staple foods such as rice, wheat, coarse cereals, pulses, and edible oils. The demand for inputs like fertilisers, pesticides, machines and farm implements did not fall much.

Despite significant improvement in food availability, malnutrition continues to exist in the country. Although National Family Health Surveys (NFHS) show a declining trend in the prevalence of nutritional indicators such as stunting and underweight between 1998-99 and 2015-16, malnutrition is still at a high level. Moreover, the prevalence of wasting among children and obesity, particularly among adult women, has been rising over the year. This necessitates strengthening ongoing nutrition-specific and nutrition-sensitive policy interventions in the country.

In the past decade, agriculture's gross value added (GVA) grew at an annual rate of 3.5%. The growth was primarily driven by the livestock and fisheries sectors which grew at an annual growth of 7.6% and 9%, respectively. Assuming no change in the growth of public and private investments, the agricultural sector is predicted to grow at 4% annual growth during 2021 to 2037.

Enhancing farmers' incomes remains a key policy concern. The pieces of evidence from Situation Assessment Surveys of Agricultural Households show a 1.6 times increase in the nominal income of agricultural households between 2012-13 and 2018-19. The composition of household income also changed; the income share of crops declined, while that of wages and animal farming increased, suggesting the critical role of diversification in enhancing farmers' incomes. Another study based on the Situation Assessment Survey, 2018-19 shows that small farm households invest more in livestock and poultry while large farm households invest more in farm mechanisation. Investment in livestock and poultry by small farmers suggests

that diversification into these activities can be an instrument to promote agricultural growth, reduce poverty and improve nutritional security. Among states, the level of annual investment by a farm household varies between Rs 2,000 and Rs 3,030 in Telangana, Kerala, Punjab and Haryana. On the other hand, the level of investment in Jharkhand, Assam, Bihar, Odisha and north-eastern states is on the lower side. The inter-state variation in farm investment is positively correlated with credit availability from formal and informal financial institutions.

Agriculture is the largest employer of rural workforce, both male and female. The agricultural workforce (both cultivator and labour) declined between 2004-05 and 2011-12. But the declining trends in cultivators decelerated between 2011-12 and 2017-18, and the withdrawal was restricted to only female cultivators. The deceleration in decline in the cultivators could be attributed to the Government's emphasis on improving farmers' income and/or the limited capacity of the non-agricultural sectors to provide productive employment to the incoming workers.

There are considerable regional disparities in agricultural development. A study on 117 aspirational districts across nine states suggests that agriculture can play a significant role in the overall development of these districts. It argues for bringing fallow lands under cultivation, augmenting investment in watersheds in rainfed areas, improving adoption of groundwater management practices and reclaiming degraded lands for accelerating agricultural growth.

Non-governmental organisations (NGOs) act as a catalyst in agricultural and rural development. In India, many NGOs have been functioning in the rural areas, promoting various agricultural and agribusiness activities. According to the NGO-DARPAN module of the National Informatics Centre, out of 1.20 lakh registered NGOs, 28,452 are active in agriculture, 20,211 in animal husbandry and 16,389 in food processing sectors. Besides the dissemination of technologies and information, these NGOs also facilitate evolving market linkages through establishing value chains, enhancing bargaining power of smallholders, and providing market intelligence.

Credit plays a catalytic role in enhancing agricultural productivity and resilience to climatic shocks. A study on farm credit's effects shows that farm credit improves agricultural productivity and reduces farmers' exposure to downside risk. The study argues for an increase in credit flow for adopting risk-mitigating measures and reducing bias in institutional lending.

Despite significant policy support under the Pradhan Mantri Fasal Bima Yojana (PMFBY), the low adoption of crop insurance remains a puzzle. Only one-third of the farmers subscribe to crop insurance. Several factors, including the farm size, access to institutional credit, information and social safety nets for food security and employment, and the historical exposure to climatic shocks, influence farmers' decision to adopt crop insurance. A study on the comparative benefits of crop insurance vis-à-vis other adaptation measures shows that the productivity and risk benefits of farmers' traditional risk management strategies, like irrigation, outweigh that of crop insurance. Nevertheless, the productivity and risk benefits are augmented when both the adaptation measures are used in conjunction. The study suggests considering the benefits of farmers' self-risk management measures while deciding on the insurance premium rates.

Technology and Sustainable Agriculture

A study on R&D investment in Indian agriculture shows an increase in agricultural research intensity, i.e., the share of agricultural R&D in agricultural GDP, from 0.42% during TE 1983-84 to 0.60% during TE 2019-20. However, there

are regional disparities. The southern semi-arid tropical region accounts for the highest investment in agricultural R&D, whereas the technologically advanced states, viz. Punjab, Haryana, and Uttar Pradesh invest comparatively lesser in agricultural R&D.

Technological change is key to agricultural growth. A study on the contribution of technological change to the growth performance of wheat shows a TFP growth of 0.89 %, but ranging from 0.65 % in Punjab to 1.38 % in Madhya Pradesh. Technological change has increased wheat output and reduced its real cost of production. This study also assessed the yield gap. The yield gap is the highest in Bihar, followed by Himachal Pradesh, Madhya Pradesh and north-western states. Reducing the yield gap can significantly enhance the wheat output in the country.

Crop planning is essential for saving water. A study on sustainable intensification of agriculture indicates shifting 1.93 million hectares of rice area, mainly in the north-western and western states, to the less water-consuming crops. Nearly 43% of the rice area in the eastern and north-eastern states has potential for further intensification. In the case of wheat, around 0.65 million hectares of area, mainly in Rajasthan, is critical for the sustainability of agriculture. About 13543 hectares of sugarcane, mainly in the western Uttar Pradesh and Tamil Nadu, is causing deterioration of groundwater resources.

Another study on the feasibility of an incentive-oriented volumetric irrigation water-saving policy and its effect on cropping patterns, water use, and farmers' income in Punjab shows that the current rate of groundwater withdrawal may not sustain further intensification of agriculture in the state. Although optimisation of resource allocation has the potential of saving water by 8%, it alone is unlikely to break the rice-wheat mono-cropping pattern. The study suggests differentiated water pricing for arresting groundwater depletion.

Ecosystem services are essential for the sustainable development of agriculture. A study quantified the carbon sequestration potential of sustainable agricultural practices (SAPs) such as integrated nutrient management (INM), organic amendment, zero/minimum tillage, crop rotation, residue retention, intercropping and biochar. Biochar is the most effective means of carbon sequestration, and crop rotation has the least carbon sequestration potential. Further, carbon sequestration of SAPs is higher in semi-arid environments. The dynamics of carbon sequestration of SAPs indicate that the additional carbon can be sequestrated for 40 years (2.62 tonnes/ha), and afterwards, it declines. An economic assessment shows that the relative soil carbon gains represent carbon credit of Rs 3400 to Rs 70236 $ha^{-1}year^{-1}$. Another study on ecosystem services of watersheds has shown significant differences in these across agro-climatic zones. Macro watersheds are better than micro watersheds, and people's participation in planning, implementation and management greatly enhance the ecosystem services. Further, soil retention is higher in alluvial soils.

Crop diversification helps improve agricultural productivity and acts as a buffer against climatic shocks. Its productivity benefits, however, are found to outweigh the risk benefits. The risk-reducing role of crop diversification is more prominent in the arid zone and not much in other zones. The study suggests the need to create awareness about the benefits of crop diversification, improve farmers' access to agricultural information and financial institutions, and improve the contexts and contents of agro-met advisories and their timely delivery to farmers to enable them to make informed risk management decisions.

Agriculture's reliance on groundwater is increasing. During the last ten years (2008-2019), 65-70% of the observation wells of CGWB witnessed no significant trend in groundwater level. But about 24% of wells in the pre-monsoon and 18% in the post-monsoon experienced a declining trend in groundwater level. This necessitates technological and policy interventions in arresting the groundwater decline. Another study in Bihar has shown ample scope for diversifying energy sources toward electricity by improving power infrastructure. It highlights that at the given level of pump utilisation, the energy cost per unit volume of groundwater extraction under a flat-rate tariff system would be 6.75 times higher than a pro-rata-based tariff. The lower energy cost under the pro-rata tariff system provides an economic rationale for installing electricity meters for pumping the groundwater.

Adoption of micro-irrigation system is an essential means of saving water without any productivity trade-off. Over time, there has been a significant increase in the area under micro-irrigation, from 3.1 million hectares in 2005-06 to 12.91 million hectares in 2020-21. Evidence shows higher water and nutrient use efficiency and crop yields and a reduction in the cost of production due to micro-irrigation. However, there remains the vast unexploited potential of micro-irrigation, which can be tapped by accelerating the adoption of micro-irrigation.

Organic agriculture is gaining ground in India. A study on organic ginger cultivation in the North Eastern Region of India shows its higher productivity, especially in Sikkim (an organic state), compared to Meghalaya and Mizoram. It contradicts the observation that organic agriculture results in lower yields.

Mechanisation is considered essential for improving agricultural productivity and reducing labour costs. A mechanisation index constructed for major paddy growing states in the Indo-Gangetic Plains (IGP) shows a higher level of mechanisation of agricultural operations in Punjab, followed by Haryana, Bihar, Uttar Pradesh and West Bengal. Farm mechanisation is positively associated with crop yield and net returns.

The returns on investment in R&D may not be fully realised if the extension system remains under-developed. A study on the information search behaviour of cotton farmers shows that high searchers, especially younger farmers access more sources of information. Landholding and membership in village organisations are positively associated with the farmers' information search behaviour. Access to information lowers the cost of cultivation and enhances the crop yield and net profit.

Agricultural Markets and Trade

India's agricultural exports during 2021-22 crossed US$ 50 billion. The export performance of meat and edible meat offal and fish and crustacean has been quite impressive. India has emerged as the largest exporter of fish and crustaceans, with the US being the single largest export destination. There is a strong need to foster investment in R&D and the application of innovative technologies for improving quality to maintain competitiveness in the long run.

India is the second largest producer of fruits and vegetables, and these commodities have vast untapped export potential. A product mapping shows India's comparative advantage in exports of cucumber and gherkins. Seasonality, however, plays a role in exporting fruits and vegetables. Hence, it is important to identify seasonal trade windows and promote exports of commodities having a comparative advantage.

India depends heavily on imports of edible oils to meet its domestic demand. Although the Government's initiatives have helped increase oilseeds production, domestic demand still outstrips the supply of edible oils. The higher

domestic prices for oilseeds should encourage farmers to adopt yield-enhancing technologies. On this front, tariffs can be an effective instrument. Under the plausible scenario of high tariff, the price gains to oilseeds farmers are estimated at 2.4% to 6% and production gains by about 2%. The current rates of TFP growth in oilseeds are inadequate to move oilseeds towards self-sufficiency; hence there is a need for raising production frontiers through technological change.

Market reforms are essential for enabling producers as well as consumers to benefit from market transactions. Evidence on price transmission in value chains of pulses and oilseeds shows the presence of asymmetric price transmission, indicating that neither producers nor the consumers benefit from market transactions, possibly due to a lack of perfect flow of information across the value chain actors. The study suggests the need to evolve a market intelligence system to minimise market distortions.

Developing efficient and inclusive value chains is essential for sharing the benefits of value addition among different actors from downstream to upstream. Empirical evidence on the value chain of organic cardamom in North Eastern India finds that farmers sell most of the produce, retaining only a small proportion for home consumption and in-kind gift to friends and relatives. The produce is transferred from producer to primary wholesalers to secondary wholesalers/traders to retailer to consumers. This is the most preferred channel by the farmers. The availability of a substantial marketable surplus suggests opening market yards for cardamom in a cluster of villages.

Input markets are less studied. An analysis of the data from the nationally representative farm survey shows excessive reliance of farmers for their seed requirement on the local traders. Besides the local traders, the input dealers, cooperatives and government agencies are also important market channels for inputs other than seed.

Other Activities

During the period under report, the faculty of the Institute published 57 research articles in peer-reviewed national and international journals, one policy paper, five working/discussion papers and four book chapters. Besides, many articles were published in magazines and newspapers and presented at conferences, seminars and workshops.

ICAR-NIAP provided policy and technical inputs to the Inter-Ministerial Committee of Doubling Farmers' Income on Pradhan Mantri Kisan SAMPADA Yojna, Procurement and Distribution of Coarse Grains/Millets, and Minimum Support Price (MSP) of Bt Cotton Seed. The Institute also provided inputs to the Government of Uttarakhand to strengthen collective institutions for marketing farm produce and out-scaling successful development interventions. The Institute provided inputs to the International Livestock Research Institute (ILRI) to develop a conceptual framework for the Dairy Master Plan. It also provided technical support to the Assam Agribusiness & Rural Transformation Project (APART), the Government of Assam, in developing the mechanisms and building capacity to implement the strategic action plans for fostering rapid growth in agriculture.

The Institute contributed to the capacity building of NARS by organising more than ten workshops and training program. A special orientation program was conducted for the officer-trainees of the Indian Economic Service.

1 ICAR-NIAP: An Overview

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) established the National Institute (formerly Centre) of Agricultural Economics and Policy Research (NIAP) in 1991. It is an institute of national repute committed to play a leadership role in strengthening agricultural economics and policy research within the National Agricultural Research System (NARS). It efficiently discharges the role of a think tank of ICAR by providing credible research-based inputs to the Council to participate in policy debates and decisions actively. The Institute also offers regular technical and policy inputs to NITI Aayog, various ministries of the Central and State governments and other stakeholders tofacilitate their policy decisions related to food and agriculture.

In the last three decades, the ICAR-NIAP has significantly contributed to the growth of the agricultural economics discipline. The expertise and research studies of the Institute have made remarkable contributions to understanding contemporary issues and challenges in Indian agriculture. It has guided the Council in prioritizing its research agenda to improve the efficiency, sustainability and equity of agricultural investments. The Institute has made notable contributions in the areas such as the assessment of the impacts of agricultural R&D, returns on investment versus subsidies, total factor productivity, climate change impacts and adaptations, sustainability of agri-food systems, management of groundwater resources, agricultural diversification, structural change in agriculture, doubling farmers' income, international trade in agriculture, institutional innovations, crop insurance, impact of COVID-19 on agriculture, market intelligence, commodity outlook, value chains of food commodities, price volatility and transmissions, market integration and demand forecasts. It strives to foster partnerships with the national and international organizations for research on common economic and social problems and directs the trajectory of agricultural growth through policy-oriented research and communication. Its vision and mandate 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
    - Enhance ICAR participation in policy decisions through policy dialogues and institutional linkages.

Institute Activities

Research activities

The research activities of the ICAR-NIAP are broadly classified under 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* encompasses studies on structural transformation, disparities in development, agricultural diversification, drivers of agricultural growth, farm and non-farm linkages, property rights, gender mainstreaming, agriculture-nutrition-health linkages and agricultural insurance. The *Technology and Sustainable Agriculture* theme includes the studies on climate change and risk management, natural resource management, valuation of ecosystem services, land use planning, resource use efficiency, the impact of agricultural technology, groundwater sustainability, common property resources, and performance of agricultural extension system. The theme *Agricultural Markets and Trade* focuses on studies on market reforms, infrastructure, value chains, market intelligence, marketing efficiency, commodity outlook, price forecasts, price transmission, food quality and safety, innovations in input markets, credit and farm services, and agricultural trade and international agreements. These issues are addressed through in-house research projects and network projects involving interdisciplinary teams.

Capacity building

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

Policy interface activities and communication

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

Organization and Management

As per the guidelines of the ICAR, the Director of ICAR-NIAP is advised and assisted by several committees to manage research and other programs.

The Research Advisory Committee (RAC), comprising eminent professionals from outside the ICAR system, ICAR officials and farmers' representatives, guides the Institute in planning research thrusts and strategies. Besides, the RAC also guides the Institute in human resource development, policy dialogues and research evaluation. Dr. H.K. Bhanwala, former Chairman, NABARD, is the Chairman of the present RAC (2020-2023). The Institute

Management Committee (IMC) supervises the functioning of the Institute. Besides the RAC and IMC, several internal committees and cells, including those mandated by the ICAR, assist the Director in the efficient management of the Institute. The Joint Staff Council (JSC) enables consultative decisions on safeguarding and promoting the interests of the staff. The Director conducts regular meetings with staff, mostly every month, to discuss scientific and management issues and elicit suggestions for the Institute's smooth functioning. Figure 1.1 presents the organogram of the Institute.

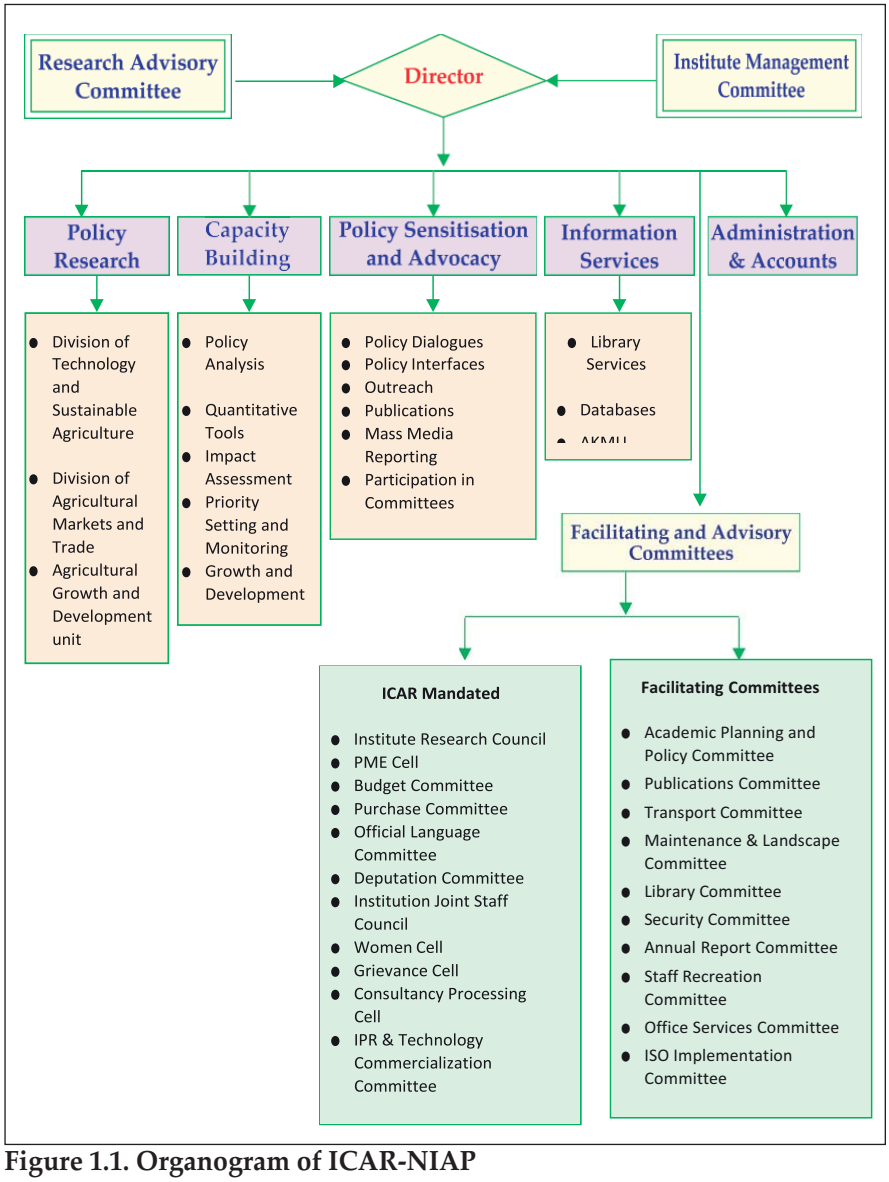


Figure 1.1. Organogram of ICAR-NIAP

Information, Data and Facilitating Services

Agricultural Knowledge Management Unit (AKMU)

The AKMU manages research information and products. Its function is to support data management using modern technologies. It provides data for research through electronic modes. It also helps in the application of IT for efficient office management. It is well equipped with the latest computers, servers, higher-end internet security firewall (Fort iGATE 301e), centralized antivirus server and statistical and analytical software, including SPSS, STATA, LIMDEP, GIS, GAMS, Stella, E-Views and SAS. SQL Server and Visual Studio facilitate data management and in-house software development. The Institute has procured ENVI 5.5 for image processing and simulation. The Institute uses a 1000 MBPS internet leased line provided by the Government of India under the National Knowledge Network.

All staff members of the Institute have been provided with the latest computers and software, LAN connectivity, internet and other required computational facilities. ICAR email system is fully functional at the Institute for all official communications. The AKMU maintains an online conferencing facility, and the Institute uses the ICAR e-office system for administrative activities. It also implements the Management Information System (MIS) like

FMS, PERMISNET, PIMS, ARMS and HYPM developed by the Council.

ICAR-NIAP Website

The Institute website (www.niap.icar.gov.in) in English and Hindi displays the latest information and activities, particularly about its staff, infrastructure, research projects, publications, employment, tenders, RTI information and internal and external linkages. The website is also accessible through the earlier URLs, namely https://niap.res.in and https://ncap.res.in. The website is hosted by the ICAR Data Centre, New Delhi, and is updated regularly. All publications, viz. Policy Papers, Policy Briefs, Working Papers, books and Workshop Proceedings of the Institute are available on the website. On average, 52 visitors from more than 150 countries visit the Institute's website daily, and the share of visitors from other countries is 14% (Figure 1).

Library

ICAR-NIAP has a specialized collection of print, electronic and digital resources. Presently, the library subscribes the Economic and Political Weekly (EPW) digital archives, databases www.indiastat.com and www.indiastatdistricts.com. The library operates an innovative information literacy program of J-Gate and Consortium for e-Resources in Agriculture for the scientific fraternity. The library has books, journals,

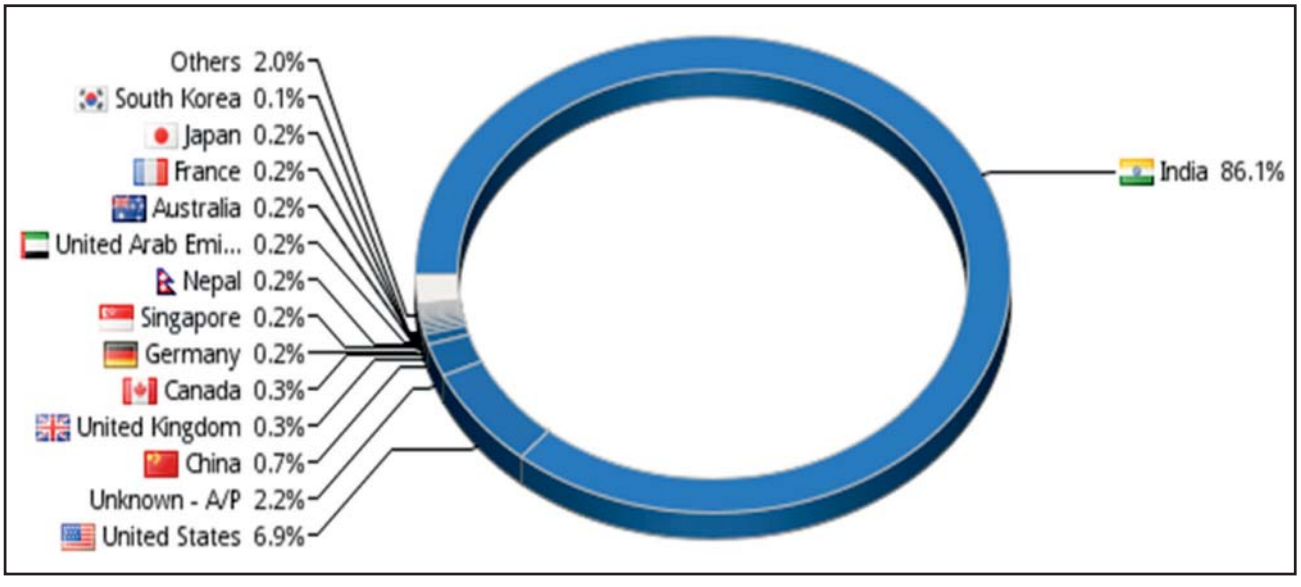


Figure 1.2: Distribution of the viewers of the Institute website

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

Library at ICAR-NIAP

bulletins, CD ROMs, database publications, reports, and national and foreign journals. Institute's library has reserved a separate section for books in the official language (Hindi). The library plays an active role in the 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 libraries of the sister Institutes like IARI, IASRI. Inter-library Loan facility from the CGIAR Centres is also available on a reciprocal basis.

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, recognitions and awards. The memories of all important events organized by the Institute are displayed in the photo gallery.

Management Information System (MIS)

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

- **Financial management:** Solutions for General ledger, Account Payable, Account Receivable, Cash Management, Fixed Assets Management, Budget Management and Grants.
- **Project management:** Scope for Project Information, Costing, Project Documents, Contract Management and Collaboration of Project documents.
- **Material management:** Solutions for Purchase and Inventory Management.
- **Human resource:** Employees Information, HR Policies, Leave Management, Performance and Appraisal System.
- **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 2021-22 is shown in Table 1.1.

Table 1.1. Staff position at ICAR-NIAP during 2021-22

Name of the Posts	Sanctioned strength	In position
RMP	1	1
Head of Division	2	0
Scientific	28	27
Technical	5	5
Administrative and Supporting Staff	15	11
Total	**51**	**44**

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

2 Research Achievements

AGRICULTURAL GROWTH AND DEVELOPMENT

COVID-led Changes in Agricultural Sector and Food Consumption

Balaji S. J. and P. S. Birthal

The coronavirus (COVID-19) pandemic triggered an unprecedented economic crisis, perhaps the most severe after the Great Depression of the 1930s. India imposed a lockdown to contain the spread of the disease. The lockdown affected almost all economic activities, except agriculture. The beginning of the lockdown coincided with the harvest of winter or *Rabi* crops. Given the critical role of agriculture in the livelihoods of farming communities and the nation's food security, the agriculture-related activities, including the routine farm operations (i.e., sowing, ploughing, harvesting, etc.), supply of inputs and services, and marketing of produce, were exempted from the strict provisions of the lockdown.

This study assessed the impact of the pandemic on selected agricultural commodities, food processing industries, and agro-input demand. The input-output (IO) Table for 2015-16 was the base for estimating the impact. The IO Table was forecasted for 2020-21. The impact of the lockdown was quantified by introducing income shocks in the vector of final demand through the income elasticities. The change in demand was estimated under two scenarios: (i) due to loss in workers' income, and (ii) due to loss to firms and industries plus loss in wages.

The predicted impact of lockdown on the demand is more significant in the case of perishable food commodities such as fruits, vegetables, milk, eggs, poultry, meat and fish than for staple foods such as paddy and wheat, coarse cereals,

Table 2.1: Impact on final demand for primary and processed foods, and agro-inputs

(%, 2020-21)

Item	Scenario 1 (loss in workers' incomes)	Scenario-2 (Scenario 1 + loss in firms' income)
Primary food commodities		
Paddy	-0.61	-1.67
Wheat	-0.58	-1.57
Jowar	-0.54	-1.46
Bajra	-0.54	-1.46
Maize	-0.54	-1.46
Gram	-0.17	-0.45
Other pulses	-0.67	-1.84
Groundnut	-0.25	-0.67
Coconut	-0.31	-0.84
Other oilseeds	-0.18	-0.50
Fruits	-7.83	-21.31
Vegetables	-6.28	-17.08
Dairy products	-9.70	-26.39
Poultry and eggs	-5.67	-15.43
Meat	-8.18	-22.27
Fish	-5.87	-15.97
Processed food commodities		
Sugar	-2.27	-6.18
Edible oil	-2.94	-8.01
Tea and coffee	-0.26	-0.71
Miscellaneous foods	-3.97	-10.81
Grain mill products	-9.82	-26.73
Beverages	-0.81	-2.21
Tobacco	-3.56	-9.68
Agro-inputs		
Fertilizers	-0.04	-0.11
Pesticides	-0.11	-0.30
Tractors and implements	-0.19	-0.52

pulses and edible oils. The second-order impacts are more demand-suppressing. Accounting for firms' loss, the decline in demand is 2.7 times larger, and more pronounced in the case of perishables. Among the processed foods, the grain mill products recorded the highest decline and the essential food commodities like edible oil and sugar a moderate decline. Demand for agro-inputs like fertilizers, pesticides, machines, and farm implements was not affected much.

The implications of a decline in demand due to income shocks are for both the consumers and the producers. For consumers, reduction in the consumption of non-staple nutrient-rich food commodities may adversely affect their nutritional outcomes; and the consequences could be severe for the poor consumers. On the supply side, although there was no impact on production, the decline in demand for high-value food commodities may adversely affect farmers' incomes, especially the smallholders who are more engaged in their production.

Socio-demographic and Geographical Inequalities in Under-nutrition and Over-nutrition

Jaya Jumrani

Preliminary evidence reveals a decline in the proportion of stunted and underweight children between 1998-99 and 2015-16. However, the proportion of the children suffering from wasting has increased, and it currently stands at 21%. Obesity among adult women, i.e., those with BMI above 25, increased from 11% to 21%. The double burden of malnutrition is a widely acknowledged public health phenomenon. It exists not just at the population but also the household and individual levels. The household-level double burden of malnutrition is a consequence of unequal economic development.

Forecasting Growth in Indian Agriculture

Raka Saxena and Balaji S. J.

Between 1991 and 2021, the agricultural sector's gross value added (GVA) more than doubled, from Rs 787 thousand crores to Rs 1817 thousand crores at constant 2011-12 prices. The share of agriculture in GDP declined, but the momentum of growth picked up. In the most recent decade, the agricultural sector grew at an annual rate of 3.5%, and the growth was driven by livestock and fisheries, which respectively registered a growth of 7.64% and 8.99%. Further, the performance of agriculture was found better in 1983-84, 1988-89, 1996-1997, 2003-04, and 2010-11.

This study forecasts agricultural GDP using its quarterly series from Q1: FY 1996-97 to Q2 FY 2020-21 using ARIMA as the baseline and its version SARIMA to adjust for the seasonality. For forecasting agricultural growth in a business-as-usual scenario and with specific interventions in key macroeconomic indicators, the relationship was modelled to result from the public and private investments. The extent of the public investment in agriculture is presumed to be influenced by farm subsidy expenditure. Private investment is modelled as an outcome of credit supply (short-term and long-term), availability of labour and agriculture' terms of trade. Further, the agricultural labour supply was modelled to result from the wage differentials between farm and non-farm sectors.

The growth was forecasted for 2036-37. The estimated coefficients were used to simulate the impacts of interventions. The agricultural sector is predicted to grow at the most 4% a year at the given rates of growth in public and private investment. Note that private investment currently accounts for more than 80% of the total investment, and the estimated model assumes its GDP multiplier is roughly four times the public investment. Hence, a 5% growth in private capital will need substantial efforts – conducive policy support, inclusivity of the financial sector and a shift towards lending credit for capital assets, and a preference for investment over short-term farm expenses.

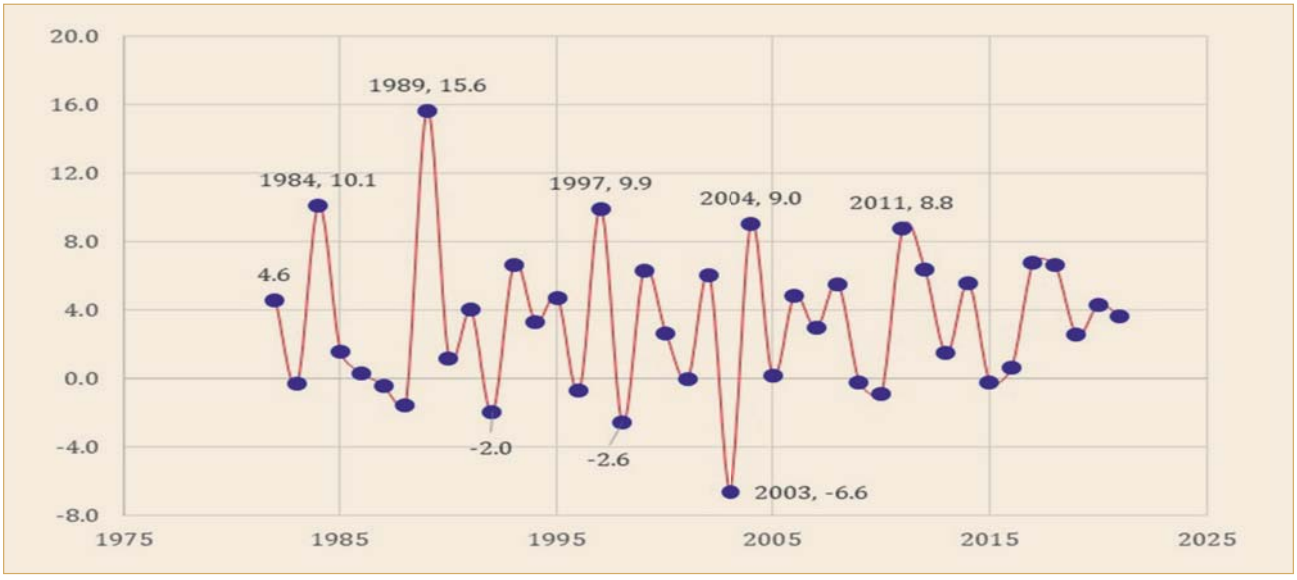


Figure 2.1: The best and the worst years of agricultural performance

Dynamics of Farmers' Income in India

Raka Saxena, Suresh Pal, Balaji S. J. and Mohd. Arshad Khan

This study makes a comparative assessment of farmers' income across three rounds of the Situation Assessment Survey of Agricultural Households for 2002-03, 2012-13, and 2018-19. The income levels of agricultural households from different sources, in nominal and real terms, are presented in Table 2.2. In nominal terms, their average monthly income in 2018-19 was Rs 10,218, compared to Rs 6426 in 2012-13 and Rs 2115 in 2002-03. The share from crops declined in real terms. Much of the increase in income resulted from increase in wages and income from animal farming.

Table 2.2: Average monthly income of agricultural households (Rs/household/month)

Particulars	Year	Wages	Crop production	Farming of animals	Leasing out of land	Non-farm business	Total income
Nominal income	2002-03	819 (39)	969 (46)	91 (4)		236 (11)	2115 (100)
	2012-13	2071 (32)	3081 (48)	763 (12)		512 (8)	6426 (100)
	2018-19	4063 (40)	3798 (37)	1582 (15)	134 (1)	641 (6)	10218 (100)
Real income with CPIAL, 2018-19 prices	2002-03	2340 (39)	2769 (46)	260 (4)		674 (11)	6043 (100)
	2012-13	2749 (32)	4090 (48)	1013 (12)		680 (8)	8532 (100)
	2018-19	4063 (40)	3798 (37)	1582 (15)	134 (1)	641 (6)	10218 (100)
Real income with GDP deflator, 2018-19 prices	2002-03	2836 (39)	3355 (46)	315 (4)		817 (11)	7323 (100)
	2012-13	3011 (32)	4480 (48)	1109 (12)		745 (8)	9344 (100)
	2018-19	4063 (40)	3798 (37)	1582 (15)	134 (1)	641 (6)	10218 (100)
Growth in real income across sources with GDP deflator	2002-03 to 2012-13	0.60	2.93	13.41		-0.93	2.47
	2012-13 to 2018-19	5.12	-2.72	6.09		-2.46	1.50

Figures in parenthesis indicate % share

Between 2002-03 and 2012-13, the farmers' real income grew by 2.47% a year. The income growth, however, decelerated to 1.5% between 2012-13 and 2018-19. The income from the farming of animals has grown at an accelerated rate.

Providing remunerative prices remain a major concern. Marketing reforms and price support are needed to enhance farmers' income. Furthermore, linking agro-processing with production via efficient value chains and contract farming are necessary to enhance farmers' income. The promotion of innovative technologies for increasing productivity and reducing cost should be given priority. Finally, fostering rural non-farm economy will have a multiplier income effect on farmers' income by creating opportunities in auxiliary enterprises.

Changing Structure of Rural Employment

S.K. Srivastava, Jaspal Singh and Raka Saxena

The study has examined the long-run changes in the rural employment through a gender and occupation lens. The workforce in rural areas increased from 191 million in 1972-73 to 361 million in 2019-20 (Table 2.3). But, the growth in workforce remained less than the growth in population, which is indicated in the declining worker-population ratio (WPR). Rural workforce constituted 84% of the total workforce in 1972-73. The rural share in the total employment declined due to relatively higher growth in the urban workforce. Despite this, the rural sector engages 70% of the workforce.

Almost all agricultural workers and about half of the non-agricultural workers belong to the rural sector. In 2011-12, about 49% of the total non-agricultural workforce engaged in the rural sector produced 35% of the total non-agricultural output, meaning that rural economic activities are more labour-intensive but with lower labour productivity.

Male workers' participation rate is higher, making them a dominant force in the rural labour market. Over time, the female participation rate declined, reaching 18% in 2017-18; and consequently, the share of females in the rural workforce fell to 24% in 2017-18 from 36% in 1972-73. The withdrawal of female workers also contributed to the decline in the absolute number of the rural workforce between 2004-05 and 2017-18. However, since 2018-19, the declining trend of female participation has reversed.

Table 2.3: Worker population ratio (WPR) and rural share in the total workforce in India (%)

Year	Rural workforce (million)	WPR	Rural share in total workforce		
			Agriculture	Non-agriculture	Total
1972-73	191	46	97	47	84
1983	226	45	96	48	81
1993-94	293	44	96	47	78
2004-05	343	44	96	47	75
2011-12	336	40	96	49	71
2017-18	316	35	96	49	69
2018-19	327	36	96	51	70
2019-20	361	39	96	49	70

Cultivators comprised 60% of the total agricultural workforce in 1993-94 (Table 2.4). Between 1993-94 and 2004-05, the number of cultivators increased by 22 million at an annual growth rate of 1.47%. On the other hand, the agricultural labour experienced a marginal decline. The subsequent period between 2004-05 and 2011-12 witnessed a decline in the number of cultivators at an annual growth rate of 1.83%. The decline in the absolute number of cultivators occurred first time since Independence. The decline in agricultural labour also accelerated during this period. The decline in the agricultural workforce and the simultaneous increase in the non-agricultural workforce implies prospects for employment diversification in favour of more productive non-agricultural activities.

There was a deceleration in the withdrawal of cultivators between 2011-12 and 2017-18. The number of male cultivators rather increased, and the withdrawal was restricted to female cultivators. While, agricultural labour continued to withdraw.

Transforming Aspirational Districts

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

The study analyses the potential of agriculture in the economic development of aspirational districts. All the 117 aspirational districts were classified into three homogenous typologies based on parameters such as irrigation intensity, cropping intensity, rural literacy, credit availability, and rainfall distribution and using K means clustering technique. Typology I has 40 districts, Typology II 22 districts, and Typology III rest of the districts. These typologies differ significantly in their attributes. The distribution of the districts

Table 2.4: Changes in the agricultural workforce in rural India

Year	Cultivator			Agricultural labour			Agricultural workers		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
Number (million)									
1993-94	85	53	138	54	37	91	139	90	229
2004-05	93	67	160	53	37	89	146	103	249
2011-12	91	49	140	48	27	75	139	76	215
2017-18	101	37	138	30	20	50	131	56	187
2018-19	100	41	140	29	19	49	129	60	188
2019-20	108	58	165	33	24	57	141	81	222
Growth rate (%)									
1993-94 to 2004-05	0.89	2.32	1.47	-0.27	-0.18	-0.23	0.45	1.35	0.82
2004-05 to 2011-12	-0.24	-4.32	-1.83	-1.41	-4.34	-2.56	-0.64	-4.26	-2.06
2011-12 to 2017-18	1.76	-4.75	-0.30	-7.54	-5.07	-6.56	-0.96	-4.94	-2.29
2017-18 to 2019-20	3.06	25.50	9.47	5.05	10.10	6.94	3.47	20.33	8.80

in these typologies is shown in Figure 2.2. About 93% of farmers in Typology I are small and marginal farmers, much higher than in Typology II. Corresponding to this, the average landholding size in Typology I is 0.71 ha; however, the irrigation and cropping intensity is much higher.

Agriculture has a tremendous role in achieving the development goal of aspirational districts.

The additional effort must be put into enhancing irrigation and cropping intensity in Typology II. Also, a considerable part of the geographical area in Typology I (approximately 20%) is marked as fallow land, which can be used for agriculture. Lower productivity is one of the most significant

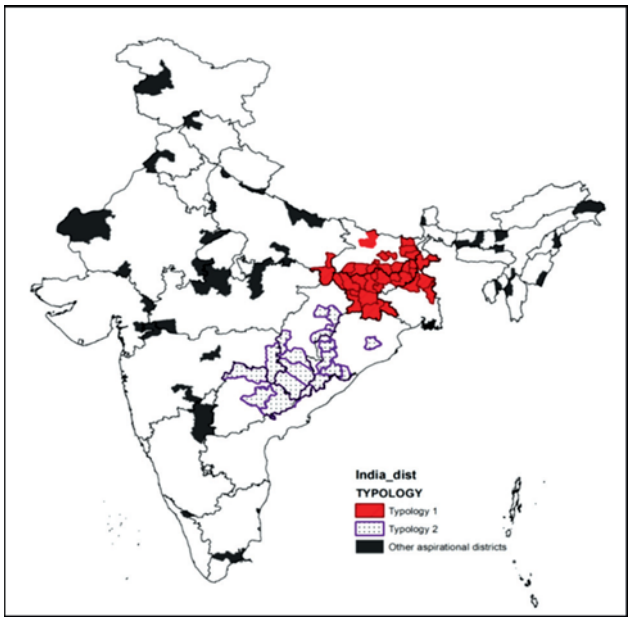


Figure 2.2: Delineation of broad typologies

Table 2.5: Agriculture development indicators in aspirational districts

Particulars	Operational variable	Typology I	Typology II	All Districts	All India
Land use and cropping Systems	Operational holdings (No. in million)	9.6	2.3	21.6	138.3
	Smallholders (%)	92.84	81.42	86.17	85.01
	Size of holding (ha)	0.71	1.44	1.10	1.15
	Irrigation intensity (%)	162.0	131.7	132.0	141.1
	Cropping Intensity (%)	162.0	114.9	146.8	141.6
Degraded and wastelands	Barren & unculturable land (%)	5.25	5.54	5.55	5.17
	Fallow land (%)	19.51	5.61	9.53	7.96
	Forests (%)	21.88	27.20	20.16	21.84
Crop yield	Rice (tonnes/ha)	2.07	2.78	2.33	2.58
	Wheat (tonnes/ha)	2.93	1.64	2.6	3.37
Climate	Rainfall, mm	907	1493	1076	1074
	Kharif rainfall (%)	82.67	86.95	81.21	78.69
	Highly vulnerable districts	7	0	26	150
Markets	Regulated markets (area per mandi, ha)	191071	112130	112784	11741
	e-mandies	550284	1976288	832608	561961
Livestock	Indigenous female (in milk+dry, %, 2019)	44.88	52.24	47.53	49.43
	Crossbreed female (in milk+dry, %, 2019)	47.18	55.35	50.61	54.68
Milk yield (kg/day)	Indigenous	3.65	1.47	2.59	2.50
	Crossbreed	4.94	5.58	5.97	6.78
	Buffalo	4.75	3.74	4.30	4.91

constraints in both the typologies. Despite the dominance of rice and wheat crops, agricultural productivity remains low. Interventions are required to increase productivity of rice and wheat. In the case of Typology II, wheat yield is considerably low. Efforts are needed to adopt sustainable agricultural practices such as soil reclamation and improved groundwater management. Typology I is more exposed to climatic shocks. The average annual rainfall is lower in Typology I. Market infrastructure is poor in Typology II.

The pattern of investment in aspirational districts is displayed in Figure 2.3. Household-level investments in productive farm assets were extracted from the Situation Assessment Survey for marginal and small landholders and other categories of households. There is huge variation across districts. Interestingly, the marginal and small farmers invest relatively more (per hectare). The high correlation between investment and income signals that in aspirational districts, the investment will likely push agriculture on a higher and sustainable growth path.

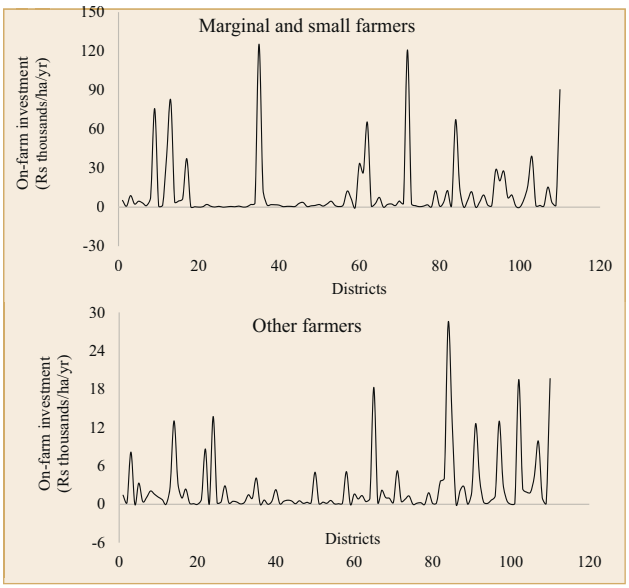


Figure 2.3: Farm household investments in aspirational districts, 2012-13

Non-Governmental Organizations (NGOs) in Transforming the Agri-Business

Raka Saxena, Ritambhara Singh and Raman M. S.

The National Informatics Centre developed a module called 'NGO-DARPAN', which is managed by the NITI Aayog. By August 15, 2021, around 1.20 lakh NGOs have signed up for the module. Of these, 28,452 NGOs are active in agriculture, 20,211 in animal husbandry, 16,389 in food processing, and others in related activities (Figure 2.4). They perform a number of functions—create backend linkages for quality inputs and farm services, facilitate technology dissemination, facilitate product value addition and processing, and support market linkages. Some prominent NGOs in India in the agribusiness sector are PRADAN, SRIJAN, DHAN, AGHA KHAN Foundation, and JEEVIKA. A large number of NGOs are functioning in rural areas and performing several agribusiness activities. NGOs may also contribute to improving market linkages by integrating the value chains, increasing market access, and enabling smallholders to attract and negotiate with larger buyers, access certifications, and grow their businesses. Many NGOs provide information, required market infrastructure, credit, and extension education to farmers. NGOs may **strengthen global connectivity and expand global linkages. Effective global market intelligence would help analyse the new markets and tap the untapped potential, especially of export-oriented supply chains.** Facilitating certification for smallholders through a third party can help them realize better prices in local and international markets.

To address the issues related to the small and marginal landholdings, the Government of India announced the formation of the 10,000 Farmer Producer Organizations (FPOs) by 2024-25. FPOs are considered to enhance both forward and backward linkages of agriculture.

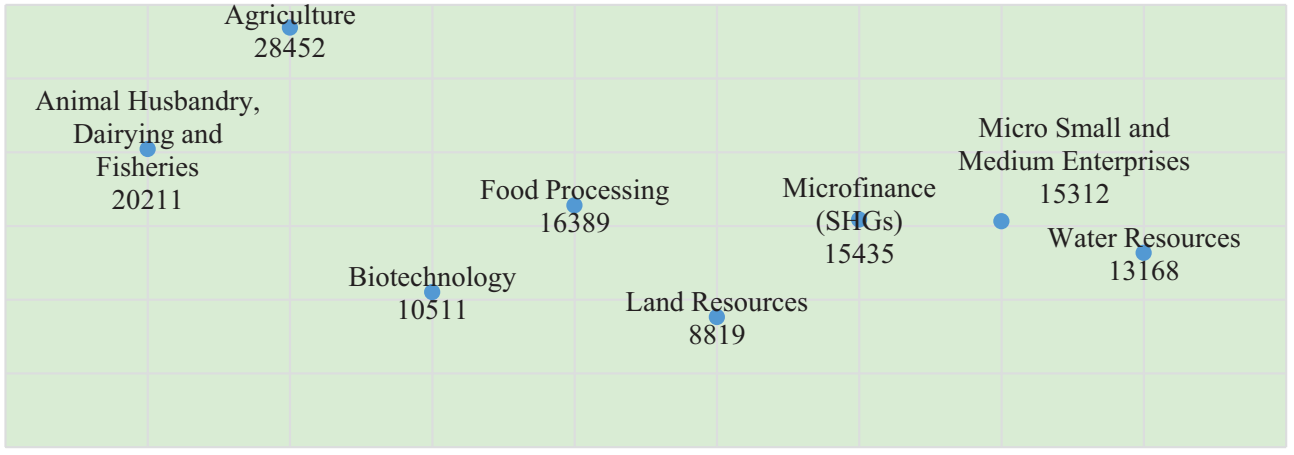


Figure 2.4: Details of NGOs working in agriculture and related sectors in India (No.)

RECENT POLICY SUPPORT

- Ministry of Food Processing Industries (MoFPI) has re-structured its schemes under a new Central Sector Scheme called "Kisan SAMPADA Yojana" (KSY) as of May 2017, which is a comprehensive package to give renewed thrust to agro-marine processing and the development of agro-processing clusters in the country. The scheme focusses on mega food parks, integrated cold chain and value addition infrastructure, creation/expansion of food processing & preservation capacities (new), infrastructure for agro-processing clusters (new), creation of backward and forward linkages (new) and food safety and quality assurance infrastructure (on going). The beneficiaries can include individuals, group of entrepreneurs, cooperative societies, Self Help Groups (SHGs), Farmer Producer's Organizations (FPOs), NGOs, Central/State PSUs, etc., subject to fulfilment of scheme guidelines.
- Centrally sponsored capital assistance for development of fish processing, preservation and storage infrastructure, with 100 per cent grant to Govt undertakings; 75 per cent grant-in-aid to Cooperatives/NGOs/SHGs in NE region, Hilly/Tribal areas, Women SHGs, Fisher SHG/ Cooperative, SHGs of SC/ST in all areas; and 50 per cent to NGO/Cooperatives other than above and Private organisations owned by SC/STs and fishermen in all areas.
- Rashtriya Krishi Vikas Yojana (RKVY) is a scheme to incentivize states to draw up plans for their agriculture sector more comprehensively, taking agro-climatic conditions, natural resource issues and technology into account, and integrating livestock, poultry and fisheries. The scheme was recently modified to allocate 50 per cent of the annual outlay for infrastructure and assets, split in a ratio of 60:40 for post-production and production related infrastructure. The subsidy for infrastructure projects is capped at 50 per cent for private individuals/NGOs, etc. As a number of infrastructure items are covered under Rural Infrastructure Development Fund (RIDF) and Viability Gap Funding (VGF), etc., RKVY is intended to supplement these other sources and not replace them.

Source: GoI (2018)

Effects of Farm Credit on the Productivity and Resilience of Agriculture in India

P.S. Birthal, Jaweriah Hazrana, D.S. Negi and Jaya Jumrani

Using a cross-section dataset from a nationally representative survey of farm households and applying the multinomial endogenous switching regression technique, this study has assessed the contribution of farm credit to farm productivity and its resilience against production risks. Contrary to the evidence of a muted response of agricultural output to credit, study findings show that credit is an important catalyst in agricultural development; it enhances productivity and reduces downside risk exposure. Nevertheless, there is a source effect — the institutional credit has a more significant impact on both productivity and downside risk exposure. Further, although there is no significant difference in the productivity effects of long-term credit and short-term credit, their combined effect is significantly higher. The findings also demonstrate a bias in institutional lending; the socially and economically disadvantaged households are also at a disadvantage in the formal credit market. These findings have some important implications for agricultural credit policy. Given that many farm households are deprived of the benefits of expanding outreach of the financial institutions, the need for improving the inclusiveness of credit programs cannot be undermined. There is a lending bias against socially and economically disadvantaged households. Nearly 70% of the farm households possess landholdings of size not exceeding one hectare. Their credit requirements are small, but the financial institutions are reluctant to lend them because of the higher transaction costs and risks associated with small loans. Therefore, the financial institutions should deliberate on their lending criteria and innovate mechanisms that emphasize intangible collateral, such as criss-cross guarantees, group lending, and trade and value chain finance. Two, the financial institutions should revisit their credit portfolio emphasizing climate finance for the adoption of mitigation and adaptation strategies compatible with natural resource management principles. Third, for farmers to benefit more from the institutional finance, there is a need to improve the synergy between long-term credit for capital formation and short-term credit meant to purchase inputs and other operational expenses.

Farmers' Investment and Access to Credit

Balaji S.J., Raka Saxena and Suresh Pal

The farmers' investment behaviour in agriculture was studied using the data from Situation Assessment Surveys 2012-13 and 2018-19. Investment levels have remained low. Large farmers invest 25 times more that those having land holdings of less than 0.4 hectares (Table 2.6).

The households with limited landholdings invest more in animal husbandry and non-farm activities. On the other hand, large farmers invest more in farm mechanization. Table 2.6 shows a consistent decline in investment shares of animal husbandry, by more than 43% in the lowest farm class and by 21% in the highest farm class. Similar is the case in the non-farm investment. More than 70% of the investment on large farms is on farm machinery and implements.

In 2018-19, Haryana invested the most, an average of Rs 3,030 per households (Figure 2.5). Investment varies between Rs 2,000 and Rs 3,000 in Telangana, Kerala, and Punjab, and between Rs 1,000 and Rs 2,000 in Andhra Pradesh, Himachal Pradesh, and Rajasthan. The households in Tamil Nadu, Maharashtra, Madhya Pradesh, Uttarakhand, and Karnataka have invested between Rs 800 and Rs 1,000. States like Jharkhand, Assam, Bihar, and Odisha have invested the least.

Table 2.6: Investment and its composition in agriculture (All-India, 2018-19)

Land class (ha)	Investment (Rs/agriculture household/ month)	Investment shares in different components (%)				
		Livestock & poultry	Agricultural machinery & implements	Other productive assets*	Non-farm	Total
0.01 – 0.40	279	43.4	23.7	21.1	11.5	100
0.41 – 1.00	545	25.1	25.1	40.9	8.6	100
1.01 – 2.00	848	21.9	41.4	30.1	6.7	100
2.01 – 4.00	2,109	10.6	47.6	37.8	3.9	100
4.01 – 10.00	3,816	13.1	45.5	35.7	5.7	100
> 10.00	7,088	11.4	70.9	17.6	0.1	100
All	806	20.7	38.8	33.9	6.6	100

*include land for farm business, building for farm business and fish tank used for farm business

The variation in investment is correlated with the extent of credit availability from formal and informal financial institutions, signalling that investment might have come at the cost of indebtedness. This is true when a comparison is made among the agricultural households across different landholding categories. The earlier observation of a positive association between investment and farm size is complemented by a consistent rise in the indebtedness. The share of indebted agricultural households has almost doubled in the case of large farmers. It was only the marginal farmers whose level of indebtedness stood below the national average.

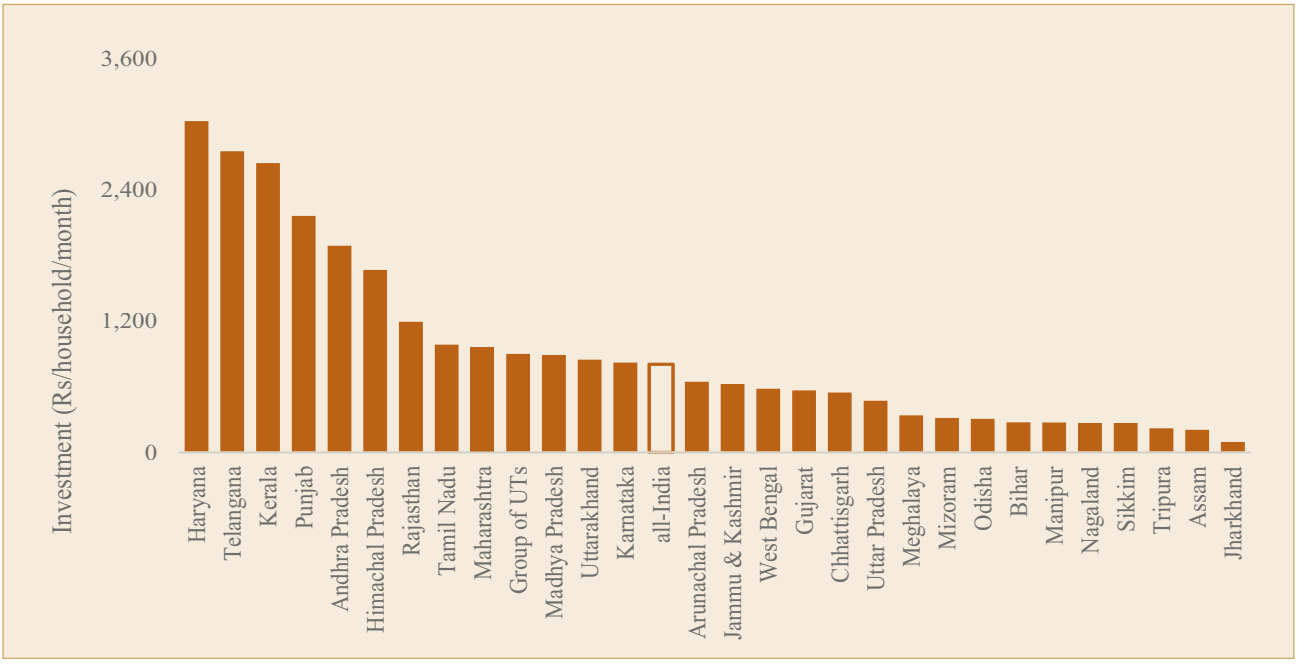


Figure 2.5: Investment of agricultural households across states (2018-19, Rs/household/ month)

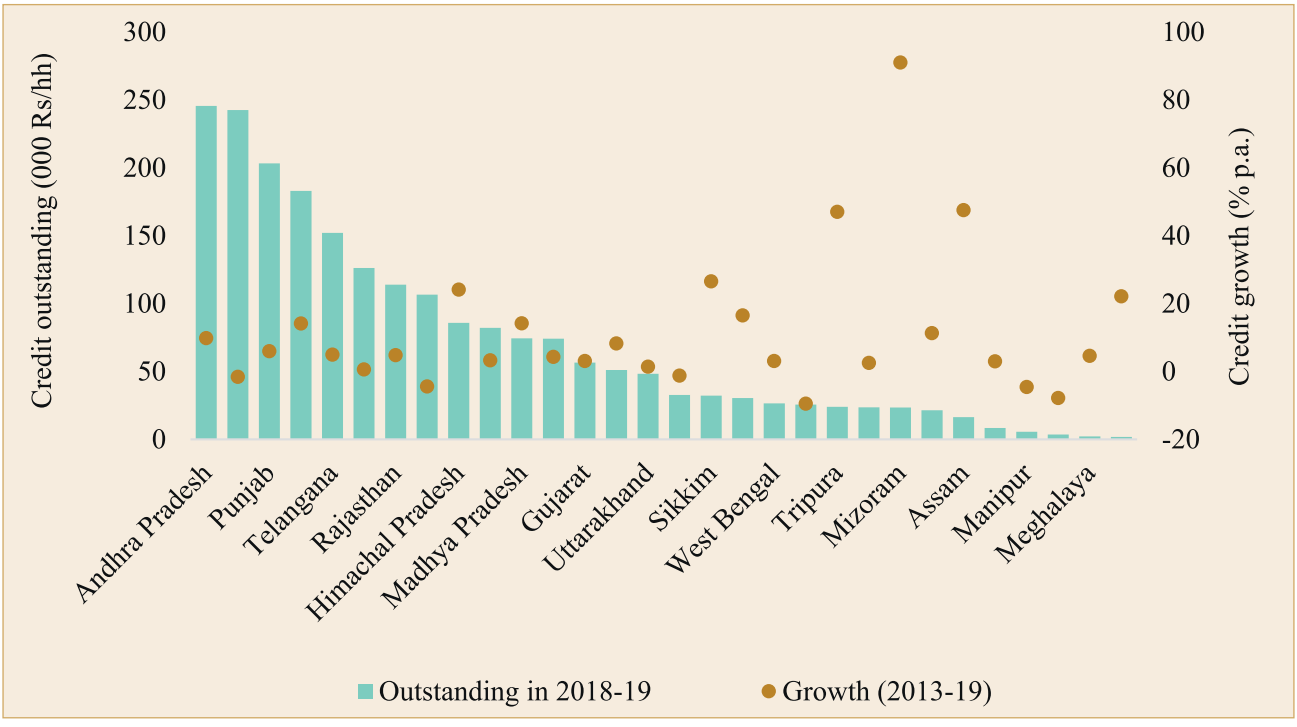


Figure 2.6: Credit outstanding and growth during 2012-13 to 2018-19 at 2011-12 prices

More investment in animal husbandry by marginal and small farmers is an opportunity to promote its contribution to agriculture. The role of formal credit institutions assumes critical importance in this. Having observed that a limited share of investment credit, extending medium-term credit to smallholders for livestock activities could be a potential strategy to raise farmers' incomes.

Crop Insurance in India: Progress, Willingness to Pay and Role of Information

Vikas Kumar and Khem Chand

The Pradhan Mantri Fasal Bima Yojna (PMFBY) scheme covers 34.27% of the farmers. Since its inception in 2016-17, the share of non-loanee farmers increased to 35.66% in 2020-21 from 23.99%. The participation of marginal and small farmers has also increased, resulting in the reduction of area insured per farmer from 0.98 hectares to 0.72 hectares, an increase in the sum insured from Rs 35096.79 to Rs 43510.92, and reduction in premium from Rs 646.48 to Rs 611.20. The claim ratio has increased from 4.15 to 5.84, and the claim received from Rs 2683.21 to Rs 3810.46 per farmer.

However, from farmers' perception (UP and Rajasthan), it is noticed that 25.6% of the farmers have not heard of the PMFBY and 90.8% do not know the procedure to avail its benefits. 78.4% of the non-beneficiaries and 57.2% of the beneficiaries indicated promotional efforts for the scheme. Close to 37% of the beneficiaries have responded that payment of claims is given in 3-4 months, and 44.8% received it in 4-5 months. Further discussions with stakeholders have bought many issues regarding the implementation of PMFBY. These include (i) lack of promotion of scheme at the grassroots level, (ii) errors in registration by banks and delays in submission of registration data to implementing agency, (iii) poor linkage among different stakeholders at the district level, (iv) delay in disbursement of premium subsidy, (v) lack of weather stations at panchayat level for

more precise information and trust generation among farmers, and (vi) delays in the estimation of loss through crop cutting experiments

Adaptation Benefits of Crop Insurance vis-à-vis Irrigation

P.S. Birthal, Jaweria Hazrana, D.S. Negi and Ashok Mishra

This study has assessed the impact of crop insurance vis-à-vis irrigation on farm income and its higher-order moments. It uses farm survey data and applies the multinomial endogenous switching regression technique to estimate their productivity and risk benefits. Four key findings have emerged from this study. First, farmers' decisions on risk management are influenced by their landholding size, access to institutional credit and agricultural information, and social safety nets for food security and employment, besides the historical exposure to climatic shocks. Second, both crop insurance and irrigation are effective at improving farm income and reducing farmers' exposure to downside risk. However, irrigation is relatively more effective. Third, the income and risk benefits augment when both measures are used in conjunction. Fourth, there is considerable spatial variation in the benefits payoffs from these measures — crop insurance is relatively more effective at higher levels of rainfall, while the converse is true for irrigation. The key implications are: (i) crop insurance can be an efficient substitute for irrigation or any other adaptation measures, provided the insurance premium is linked to the adaptation benefits of the alternative risk management measures like irrigation; (ii) One size does not fit all. The adaptation measures are quite heterogeneous in their impacts across the space. Hence, the contemporary risk management strategies should consider the agro-ecological and socio-economic environments that differentiate farmers' adoption decisions and their effects on farm income and risk exposure; and (iii) Relaxing the liquidity and information constraints by expanding the outreach of financial institutions and information dissemination systems will facilitate greater uptake of the risk-mitigating measures in general and the crop insurance in particular.

Game-Changing Policies for India's Food System

Ashok Dalwai, Pawanexh Kohli, Shobha Nagnur, Raka Saxena and Ritambhara Singh

This study discusses the game-changing policies, actions and initiatives of the Government of India that have impacted the country's food system. The food system is " *the complex web of activities involving the production, processing, transport, and consumption of food.*" One of the objectives of this study is to share India's course of actions that evolved over definitive phases and brought in a more comprehensive food system and facilitate other countries at various stages of development to replicate some of these as appropriate to their context. Corrective changes are also informed, which may aid fast-tracking of interventions and engender local and global partnerships, besides elevating public discussion for greater awareness, steep forward, scale-up, and system-based monitoring. A panoply of policies, programs, and schemes, related to overall agricultural development and growth and the food system, are implemented in India and they provided incremental gains in their course. The paper intended to narrate the evolution of the food system in the country and the direction taken for sustaining the pathway well beyond 2030.

The post-independence phase saw the initial restructuring and organizing of the food production systems-both crops and animal husbandry – along more equitable lines. Hundreds of millions of cultivators came to benefit from access to agricultural land, while a mechanism to protect producers from existing market monopolies was rolled out. With the establishment of the agricultural market network that regulated and managed the distribution of commodities, steps were also taken to ensure

The United Nations Food System Summit (UNFSS) aims to document and discuss food related initiatives taken across the world and to disseminate and progress a more systemic & standardised approach for greater equitability in nutritional security, sustainability and dependability of the Food System worldwide.

UNFSS Outcomes

- **Document significant initiatives and measurable progress** towards the 2030 Agenda for Sustainable Development.
- **Raise awareness and elevate public discussion** about how diversifying and reforming our agri-food systems can help us all to achieve the SDGs by implementing reforms that are good for people and planet.
- **Develop principles to guide governments and other stakeholders** looking to leverage their agri-food systems to support the SDGs.
- **Create a system of follow-up and review** to ensure that the Summit's outcomes continue to drive new actions and progress.

that the consumers are not artificially denied access to essential food items. These initial policies set the framework to revamp food producers' production, post-production, and livelihood status. They positioned India and her farmers to quickly step into the next phase of game-changing actions, which has come to be recognised as the Green Revolution.

In the first week after independence, India named the Ministry of Food on 29 August 1947. In February 1951 it was combined with the Ministry of Agriculture to constitute the Ministry of Food & Agriculture. Various iterations followed and currently India has a Ministry of Agriculture & Farmers Welfare, the Ministry of Cooperation, the Ministry of Fisheries, Dairying & Animal Husbandry, the Ministry of Consumer Affairs, Food and Public Distribution, and the Ministry of Food Processing Industries, all of which are the front-line agencies related to the food system. However, the food system closely involves other ministries such as rural development, education, health & family welfare, women & child development, tribal welfare, water resources, transport, skill development, environment, forestry and climate change, power, and others. Numerous specific and important initiatives were taken up by various ministries and departments, and; a quick review of which indicated more than 320 schemes are in operation. This must be seen in juxtaposition to several state-specific initiatives as their stand-alone or supplementary to central initiatives.

The Government's procurement mechanism for basic food commodities greatly incentivized the output and led to the country becoming food secure, and imparted the ability to build strategic food buffers. Reforms and initiatives in the banking system eased the availability of credit to the food system. The country developed a large education and extension system, besides ensuring the geographic spread of agriculture research centers. Laying appropriate emphasis on financial inclusion, the Government of India set forth the long-term facilitation mechanism for the key stakeholders of the food system, not only to ease their access to credit to support basic operations but also for modernization and diversification.

Much of the aforesaid initiatives were rooted in fears of past food insecurity and were focused on enhancing productivity and production. When production gains were visible, especially in high-value foods, the general mantra was to target better-priced export markets. India's food system was primarily focused on the high-value production. These actions have a direct impact on

improving post-harvest management, minimizing food loss, and strengthening smallholders to mitigate risks. They also contribute to advancing livelihood and livelihood opportunities across the food system. Relating to the supply chain, these also ensure benefits that cut across various action tracks. Several other policies and actions also have an impact on agriculture and allied sectors such as adopting the WTO agreement, committing to SDGs, international cooperation through Joint Agricultural Working Groups, region-specific initiatives, localized sector-specific programs, solarised applications like irrigation pumps, employment guarantee program, income support programs, digitalization of agriculture, funds to support agricultural tools, infrastructure and R&D, interventions to facilitate railway, waterway, and airway connectivity etc. Being an agrarian society, many of India's socio-economic development and welfare activities inherently converge on the associated stakeholders including the food system.

TECHNOLOGY AND SUSTAINABLE AGRICULTURE

R&D Investment and Innovation Outcomes in Indian Agriculture

Ankita Kandpal

Agricultural research intensity, i.e., the share of agricultural R&D in agricultural GDP, has gradually increased from 0.42% in TE 1983-84 to 0.60% in TE 2019-20. The hilly region has a higher research intensity (1.06%) followed by the southern semi-arid tropical region (1.01%). In other regions it lies between 0.38 and 0.43%.

The annual indices of TFP growth were estimated from 1960 to 2018 at the national level as the value-share weighted growth of outputs less the value-share weighted growth of inputs. India's average annual agricultural TFP growth rate was estimated 2.16%.

R&D outcome in terms of agricultural patents was measured during 2005 to 2020. The total number of active patents was 923 in agriculture, the highest patents being in agrochemicals (67.6%), followed by livestock & fisheries (9%), agricultural machinery (8.1%) and tissue culture techniques (6.6%). Of these patents, the majority (79%) were granted to private companies, 12.7% to public organizations and 8.3% to individuals

Technological Change and Growth Performance of Wheat in India

Sant Kumar and Kingsly I. T.

TFP growth in wheat production has been estimated for the states of Uttar Pradesh, Madhya Pradesh, Punjab, Haryana, and Rajasthan for four decades (i.e. 1979-2018) using the cost of cultivation data from the CACP reports. The

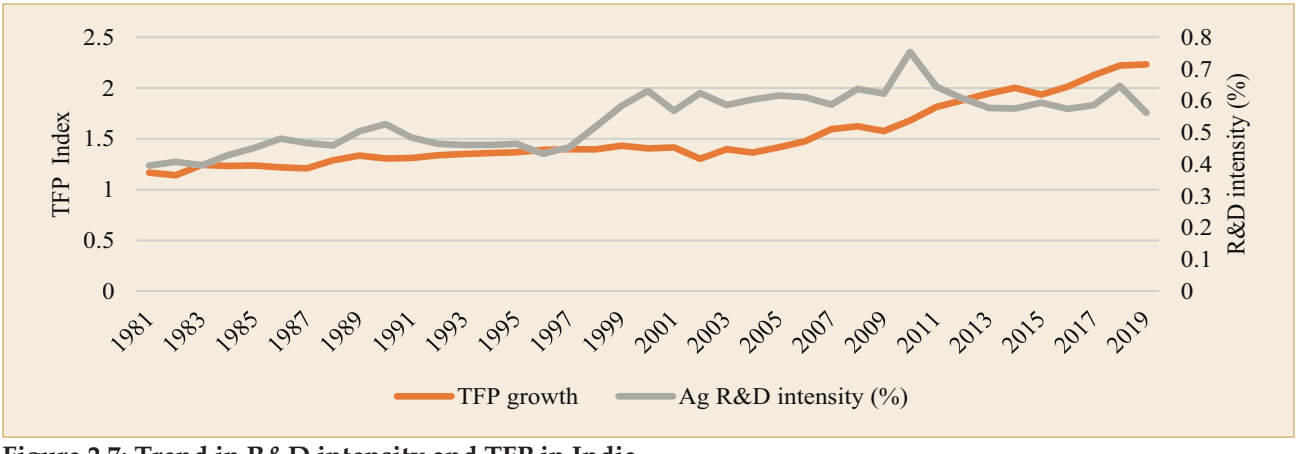


Figure 2.7: Trend in R&D intensity and TFP in India

annual growth in Input, Output, TFP, and real cost of production (RCP) is presented in Table 2.7. Input growth was less than 1 %, but negative in Uttar Pradesh and Rajasthan. Similarly, the annual growth in output was 0.81 %, ranging from 0.67 % in Uttar Pradesh to 1.67 % in Madhya Pradesh. The output growth in other states was about 1 %. The increase in input use and the adoption of improved technologies and practices have helped TFP grow. Overall TFP growth was positive (0.89 %), ranging from 0.65 % in Punjab to 1.38 % in Madhya Pradesh. Technological change has not only increased the output but has also brought a significant reduction in the RCP.

Table 2.7: Annual growth in input, output, TFP and RCP for wheat production, 1979-2018 (%)

State	Input growth	Output growth	TFP growth	RCP growth	TFP share in output growth
Haryana	0.659	1.192	0.723	-0.113	60.7
Punjab	0.435	0.991	0.649	-0.438	65.6
Madhya Pradesh	0.568	1.669	1.383	0.928	82.8
Rajasthan	-0.229	1.113	1.255	-0.389	88.7
Uttar Pradesh	-0.015	0.672	0.665	-0.221	98.9
Overall	0.167	0.807	0.886	-0.107	79.3

Potential to Raise Supply of Wheat in India

Kingsly I.T. and Sant Kumar

Improving technical efficiency (TE) is an important pathway to increasing crop production. This becomes critical when the natural resources like land and water are scarce and have competing demands. This study has estimated TE scores of wheat by applying the stochastic meta-frontier production function and using the plot-level cost of cultivation data for 2000- to 2016. The overall TE score is 0.73, ranging from 0.60 in Himachal Pradesh to 0.95 in Haryana (Table 2.8). A comparison of the TE scores with observed yields shows a positive

Table 2.8: Technical efficiency and possible additional production of wheat in India

State	TE score	Yield (tonnes/ha)			Attainable production (000 tonnes)	% share
		Average	Potential	Gap		
Haryana	0.95	4.30	4.54	0.24	628.5	2.8
Punjab	0.94	4.52	4.79	0.27	956.4	4.2
Rajasthan	0.93	3.10	3.33	0.23	704.5	3.1
Gujarat	0.82	2.80	3.40	0.60	594.4	2.6
Uttar Pradesh	0.75	2.78	3.70	0.92	8986.6	39.5
Madhya Pradesh	0.70	2.94	4.19	1.25	7481.2	32.9
Bihar	0.62	2.21	3.58	1.37	2916.6	12.8
Himachal Pradesh	0.60	1.99	3.33	1.34	454.8	2.0
Overall (India)	0.73	2.99	4.12	1.13	22722.9	100

relationship, implying that states with higher yields have higher technical efficiency.

TE scores have been used to compute the potential yield and production at existing level of technology. Bihar has the highest yield gap (13.7 q), followed by Himachal Pradesh (13.4 q), Madhya Pradesh (12.5 q), and below 2.5 q in the western states. The overall yield gap is 11 q/ha. Bridging the yield gap can produce an additional output of 22.7 million tonnes. 85 % of the attainable production can come from Uttar Pradesh, Madhya Pradesh and Bihar.

Cross-border Effects of Climatic Shocks on Agricultural Productivity

Jaweriah Hazrana, D.S. Negi and P.S. Birthal

Although enormous empirical evidence exists on the adverse effects of climate change on agriculture, our understanding of its cross-border effects is limited. Using a long panel of district-level data from India and applying spatial econometric techniques, this study first looked into spatial dependence in climate and then assessed its cross-border effects on agriculture. The findings reveal a spatial dependence in climatic shocks, influencing the performance of agriculture beyond spatial boundaries. However, the cross-border effects of different climatic shocks are different. The deficit rains in the rainy season have a significant cross-border effects than the excess rains. Similarly, the excess temperature in the post-rainy season produces significant cross-border effects. The key implication of these results is that ignoring spatial dependence in climate in empirical analysis leads to underestimating the impacts of climate change on agriculture, and, an incomplete understanding of the climate change impacts may engender imperfections in the risk management strategies and targeting thereof.

Sustainable Intensification of Rice, Wheat and Sugarcane in India

Prem Chand, Sulakshana Rao, Priyanka Agarwal and Rajni Jain

Based on the district-level data on area, productivity and level of groundwater extraction, this study identifies the critical and potential areas for the cultivation of three water-intensive crops, i.e., rice, wheat and sugarcane. Based on (i) relative spread index- the ratio of the district and national proportions of the area under crop in relation to the gross cropped area (ii) relative yield index- the ratio of the district and national yield of the crop, and (iii) the stage of groundwater extraction, the districts which are either over-exploited or critical in groundwater extraction combined with low yield are categorised as 'critical areas' irrespective of the extent of area spread. The rationale behind this is that the additional groundwater use is less efficient and leads to the depletion of natural resources. Theoretically, this category denotes the third stage of the classical production function. Contrary to this, the districts with high yield potential with a safe or critical level of groundwater extraction are categorised as 'potential areas' being efficient in production within permissible level of groundwater extraction. These areas have the potential for sustainable intensification.

Findings show that 1.93 million hectares of rice, mainly in the north-western and western India, need to be gradually shifted to other crops (Table 2.9). Nearly 43% of the rice area in the eastern and north-eastern states of West Bengal, Odisha, Chhattisgarh and Assam has the potential for further intensification. In the case of wheat, around 0.65 million hectares, mainly in Rajasthan, is critical in terms of sustainability. Livestock is an integral part of agriculture in Rajasthan, and hence diversification of wheat may require a mixed strategy of shifting to

alternative dual-purpose crops and its cultivation using water conservation technologies. The study finds that 13543 hectares of sugarcane, mainly in western Uttar Pradesh and Tamil Nadu, is deteriorating the groundwater resources. The recommendations emanating from the study include the implementation of regionally differentiated agricultural price policy, payment for ecosystem services and a greater focus on productivity enhancement in the eastern India.

Table 2.9: Potential and critical areas of rice, wheat and sugarcane in India (000 ha)

Category	Para-meter	Rice	Wheat	Sugar-cane
Critical areas	LLO	99.95	274.0	13.2
	HLC	1717.3	378.8	-
	HLO	108.3	-	-
Potential areas	HHS	5626.1	2893.0	851.5
	HHC	1526.3	432.6	1783.5
	LHS	905.0	5014.5	430.6

Note: LLO-Low spread, low yield & over-exploited groundwater; HLC-High spread, low yield & critical groundwater; HLO-High spread, low yield & over-exploited groundwater; HHS- High spread, high yield & safe groundwater; HHC- High spread, high yield & critical groundwater; LHS - Low spread, high yield & safe groundwater

Resource Use Planning for Sustainable Agriculture

J.M. Singh, Jatinder Sachdeva, Jasdev Singh, Priyanka Agarwal, Rajni Jain, Sulakshana Rao and Baljinder Kaur

An attempt has been made to assesses the feasibility of an incentive-oriented volumetric irrigation water-saving policy and its effect on cropping patterns, water use and farmers' income and to suggest crop plans for sustainable use of resources in Punjab. Using the plot-level data from the Comprehensive Scheme for Studying the Cost of Cultivation of Principal Crops, three different scenarios are constructed by simulating the effect of resource reallocation and changes in policies on crop diversification, resource use, and net economic margins. Scenario S1 presents the effect of optimizing the existing resource use allocation. The effect of water pricing policies has been analysed in the subsequent two scenarios. Scenario S2 simulates the impact of a uniform volumetric water pricing policy for all the crops. In contrast, in Scenario S3, differential water pricing is considered depending on the volume of water use. In this Scenario, farmers who save irrigation water are paid for, while those who over-use groundwater beyond a benchmark, say farmers' water allotment right (WAR), pay for it. We expect that the payment for saving water and pricing for its over-use will change cropping patterns towards less water-using crops and will induce farmers adopt water-saving irrigation technologies. In both the Scenarios, a range of water prices, varying between Rs 1/m^3 to Rs 5/m^3 at Rs 1/m^3 is analysed. Irrigation water use in rice, the most important staple food crop grown under the best management practice (4488 m^3/ha), is assumed as WAR, above which farmers pay for its use. The difference between irrigation water use and WAR shows the volume of water saved.

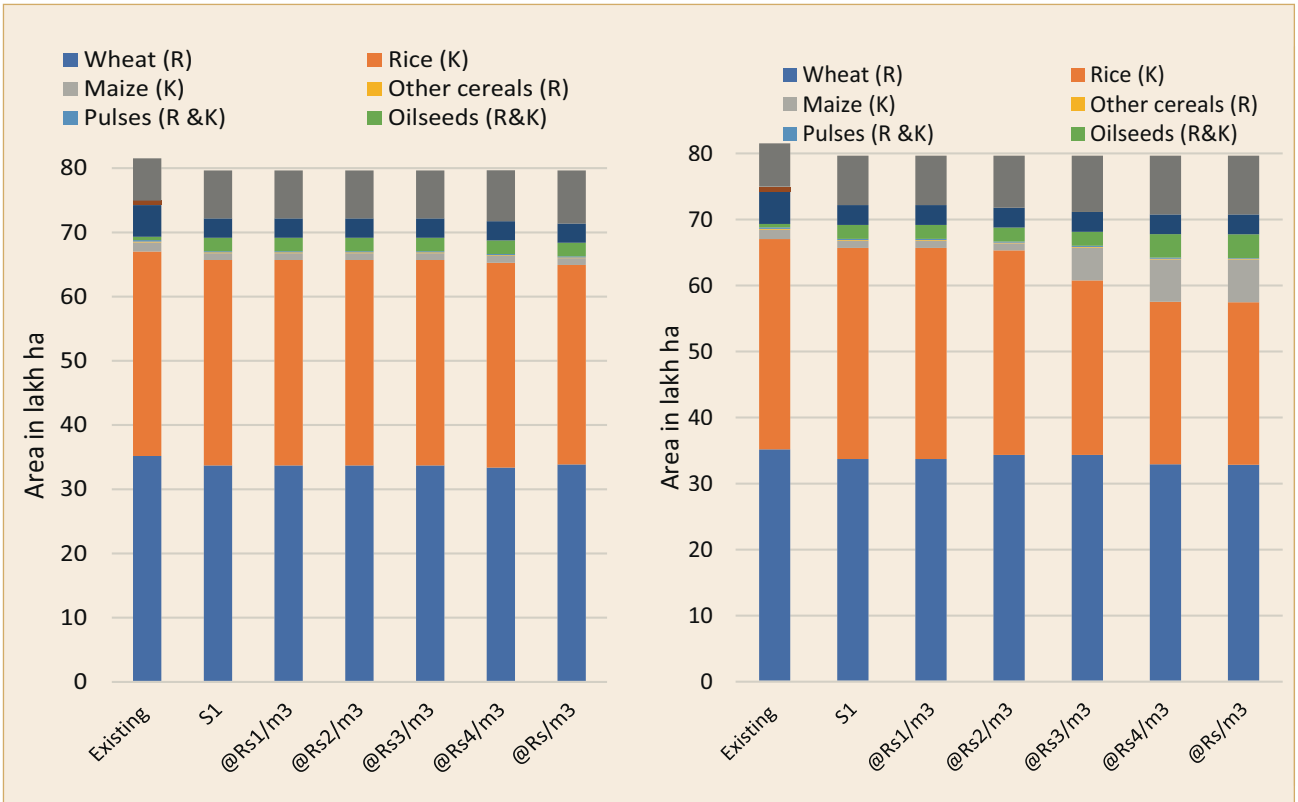
The findings reveal that at the current rate of groundwater withdrawal there is a limited possibility of agricultural intensification. Although optimal resource allocation has the potential of saving water by 8%, it alone is unlikely to break the rice-wheat mono-cropping pattern. The analysis of two different volumetric irrigation water pricing shows that differentiated water pricing is more effective in halting the groundwater depletion as the area under rice is replaced by low water-using crops

like maize and oilseeds (Figure 2.8). However, adequate investment in irrigation water supply infrastructure, is required mainly for installing water meters. The change in irrigation water policy is necessary but not sufficient to promote diversification, halt groundwater depletion and improve sustainability of agricultural production systems, a paradigm shift in technology and agronomic practices is needed. Concerted efforts are needed for the large-scale adoption of technologies like Direct Seeded Rice (DSR) and short-duration rice varieties. Besides saving water, these will also help reduce labour requirement and mitigate greenhouse gas emissions. In the long-run, the policies should aim at phasing out subsidies and mainstreaming the payment for ecosystem services in agricultural development agenda.

Carbon Sequestration Potential of Sustainable Agricultural Practices

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

Various studies on sustainable agricultural practices (SAPs) in Indian agriculture are synthesized through a meta-analysis to quantify their carbon sequestration potential and economic feasibility. The SAPs include integrated nutrient management (INM), organic amendment, zero/minimum tillage, crop rotation, residue retention, intercropping and biochar. Biochar appears the most effective in carbon sequestration (33.75% to 49.26%), and crop rotation the least (7.19%). Overall, C sequestration of SAPs is higher in the semi-arid regions. Crop rotation, zero/minimum tillage and INM respectively sequester 18.01%, 13.02%



(a) With uniform water pricing **(b) Differentiated water pricing**

Note: S1 indicates optimization with existing policies; @Rs1/m^3 to @Rs5/m^3 are the water prices varying between Rs. 1/m^3 to Rs 5/ m^3 at Rs. 1/m^3 interval; K=Khrif season crop; R=*Rabi* season crop; A= Annual crop.

Figure 2.8: Cropping pattern and livestock in existing vis-à-vis optimal plans in Punjab

and 11.13% higher C in this region than in the humid subtropical region. The effect of climate on C sequestration of biochar does not differ much. However, the organic amendments sequester 27.82% additional C in the humid-subtropical region than in the semi-arid region. The effect of soil texture on C sequestration shows that moderately fine soils have a higher C sequestration potential. Organic amendment (56.11%), biochar (51.10%) and crop rotation (26.82%) have a positive effect on SOC in these soils. Whereas INM (20.29%), zero/minimum tillage (12.65%) and intercropping (22.58%) have higher C sequestration in the moderately coarse soils. The dynamics of C sequestration of SAPs suggest that additional C can be sequestrated for 40 years (2.62 tonnes/ha), and afterwards it starts declining. Inclusion of legumes in the cropping system, clay-rich soils, irrigation, rainfall and climate are positively associated with carbon sequestration. The economic assessment of additional carbon sequestered represents carbon credits worth Rs 3400 to Rs 70236/ha/annum.

Ecosystem Services from Watersheds

D.C. Meena and Suresh Pal

Watersheds provide several ecosystem services. India is one of the leading countries to implement watershed programs. Studies provide location-specific estimates of ecosystem services, varying across watersheds depending on its size and locational characteristics such as soil types, rainfall, and land cover or vegetation, people's participation and implementing agency. To identify the factors that influence ecosystem services, this study systematically reviewed scientific studies evaluating the watershed programs. This analysis has considered 125 watersheds employing preferred reporting items for systematic reviews and meta-analyses. Results

Table 2.10: Key determinants of watershed ecosystem services

Variables	Variable description	GWR	Soil retention
	Intercept	-0.34	13.50
Geographical location	Western Himalayan and Shiwalik foothills zone	**1.47****	23.44
	Gujarat plain & hill zone	1.35*	12.32
	Southern zone	1.11	9.86
	Central and Western plateau-hill zone	0.98	9.44
Rainfall	Continuous variable	0.00002	**-11.54***
Size of watershed	Macro (>1000 ha)	**0.69****	**13.65****
Implementing agency	Governments	0.78	5.08
Soil types	Alluvial soil	0.47	**21.57***
	Red soils	0.30	4.50
	Sandy loam soils	0.26	1.27
People's participation	High	**1.12*****	**34.04*****
	Medium	0.08	6.94
R^2		0.45	0.60
Number of observations		69	56

Note: *, **, and *** indicate levels of significance at 10, 5, and 1 %, respectively

show that ecosystem services from watersheds differ significantly across agro-climatic zones. Macro watersheds are better than micro watersheds, in terms of soil retention. People's participation in planning, implementation and management significantly enhances the ecosystem services. Results also show higher soil retention in watersheds with alluvial soil than in those with black cotton soils. Implementing large size watersheds (macro-level) with active people's participation is required to harness the potential benefits of watersheds.

Crop Diversification for Sustainable Development of Agriculture

P. S. Birthal and Jaweriah Hazrana

Crop diversification is considered an efficient path for improving farm productivity and reducing downside risk exposure. Using a panel of district-level data this study has assessed the productivity and risk benefits of crop diversification. The findings indicate that the productivity benefits of crop diversification outweigh its risk benefits, but both have weakened over time. Further, there is a considerable spatial heterogeneity in the benefits of diversification. It has a greater potential of risk-reducing in the arid zone, but not in high rainfall and irrigated zones. At the farm level, the decision on crop choices and acreage allocations happen under uncertainty without prior knowledge of its expected outcomes, and the findings on both the productivity and risk benefits of crop diversification are robust enough to inspire farmers to adopt it as an integral component of their farming systems. There is a need to create awareness about the benefits of crop diversification. The findings also suggest the need to improve farmers' access to information and financial institutions to improve their capacity to adopt climate-smart technologies and practices. Also, there is a need to improve the contexts and contents of agromet advisories and their timely delivery to farmers to enable them to make informed risk management decisions. Finally, the significant differences in the productivity and risk benefits of farming system diversity call for evolving regionally differentiated crop diversification strategies for adaptation to climate change, and the need to support these through appropriate infrastructure and institutions for sustainable development of agriculture.

Sustainability Issues in Groundwater Irrigation in Eastern Gangetic Plains

S.K. Srivastava, Avinash Kishore and Jaspal Singh

The study has examined the spatial and temporal changes in the groundwater level in Bihar and also estimated groundwater extraction costs under different energy policy regimes. According to the Central Groundwater Board (CGWB) data, the average groundwater level in Bihar is 6.37 meters below ground level (mbgl), varying from 0.74 mbgl to 16.11 mbgl in the pre-monsoon season (May 2019). About 92% of the wells in the state have a shallow water level of less than 10 mbgl and 8% of the wells have groundwater level of more than 10 mbgl. The shallow groundwater depth in most areas offers scope to sustainably and economically utilize groundwater resources and harness groundwater-agricultural development linkages. Figure 2.9 shows the spatial heterogeneity and temporal changes in groundwater levels in pre- and post-monsoon seasons. The groundwater in north Bihar is at a shallower level compared to South Bihar. During the pre-monsoon season, the groundwater level in most of the north Bihar remains below 5 mbgl, whereas in south Bihar groundwater level goes up to 10 mbgl. A substantial recharge takes place during the monsoon season and the extraction rate of groundwater remains lower than its recharging rate. In the post-monsoon season, the groundwater level rises in most areas of the state. The Mann-Kendall (MK) test shows no significant change in groundwater level between

pre – and post-monsoon seasons in more than 70% of the wells.

At present, shallow tubewells are the predominant groundwater structure in the state. However, most groundwater structures are energized by diesel. With the rising diesel prices, irrigation with diesel pumps are becoming costlier. Nonetheless, with improvement in power infrastructure farmers are gradually shifting from diesel to electricity for energizing the pumps. A shallow tubewell operated using diesel incurs Rs 2.40 to extract one cubic meter (m^3) of groundwater while an electric shallow tubewell incurs Rs 0.60/m^3. Such a large difference in the cost of water extraction

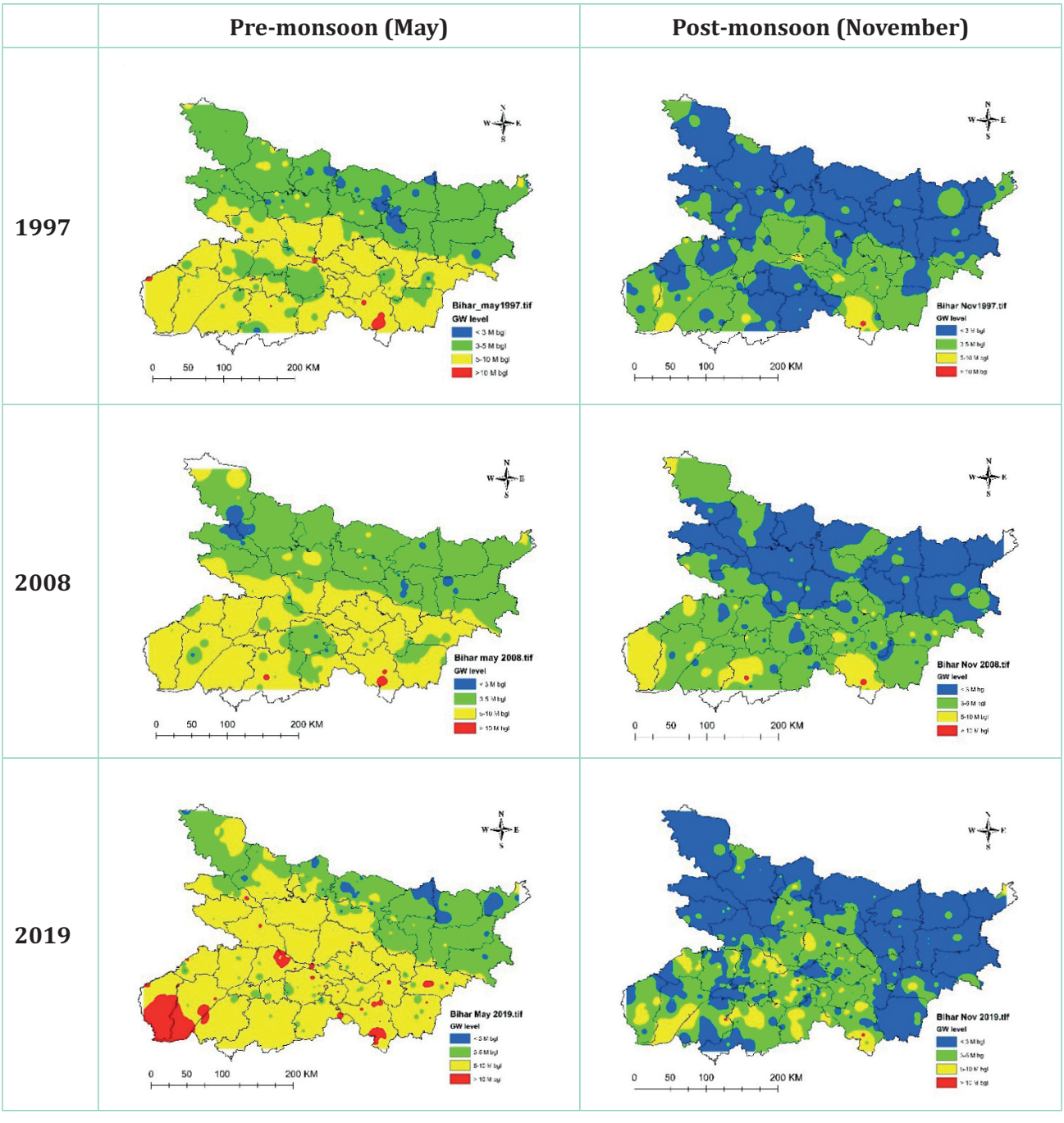


Figure 2.9: Spatial heterogeneity and temporal changes in groundwater level in pre and post-monsoon seasons

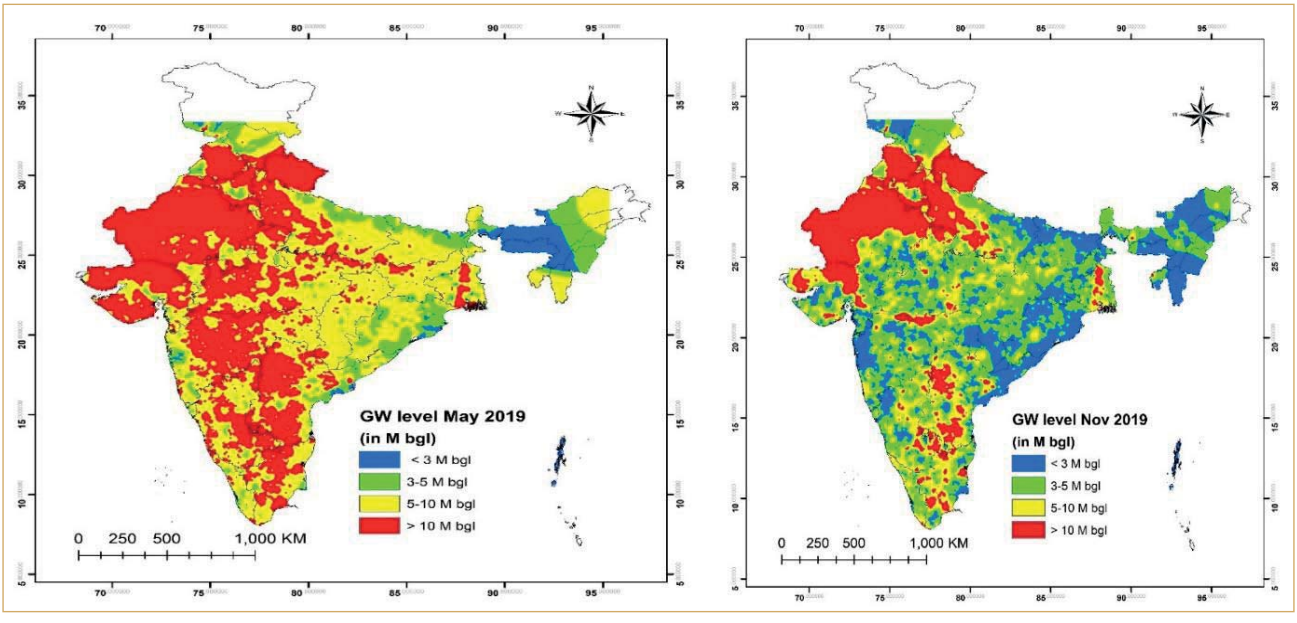
by diesel and electric pumps is primarily accounted for by differences in the energy costs and the utilization levels of the pumps. There is ample scope to diversify energy sources toward electricity by improving the power infrastructure and suitable energy policies. Bihar has pro-rata and flat-rate tariff systems for metered and unmetered connections, respectively. At the same utilization level of pumps, the energy cost per unit volume of groundwater extracted under flat-rate tariff system is 6.75 times higher than the pro-rata based tariff. Lower energy cost under the pro-rata tariff system provides an economic rationale for installing meters on the electric operated pumps.

Improving Groundwater Sustainability through Groundwater-Energy Nexus

S.K. Srivastava, Jaspal Singh, Darshna Mahida and Subhash Chand

Efficient management of groundwater is crucial to sustaining food security. There exists a considerable spatial variation in the availability of groundwater on account of several hydrological and agro-climatic factors (Figure 2.10). About 37% of the monitoring wells have water level of more than 10 metre below ground level (mbgl) during the pre-monsoon season. More than 50% of the wells in Rajasthan, Punjab, Haryana and Gujarat have groundwater level more than 10 mbgl. At the same time, in the states such as Odisha, Bihar, Chhattisgarh, Jharkhand, West Bengal and Andhra Pradesh, less than 25 % of the wells have groundwater level of more than 10 mbgl. Such spatial variation in groundwater level has implications for cost of groundwater irrigation. Although monsoon replenishes the groundwater supplies, 16.3% of wells exhibit groundwater level at a deeper level (>10mbgl) during the post-monsoon (November) season.

The Mann-Kendall (MK) test shows no significant trend in the groundwater level in 65% wells during pre-monsoon and 70% during post-monsoon season. About 24% of the wells have experienced a significant decline in groundwater level during pre-monsoon season. During post-monsoon season, about 18% of the wells have shown a declining trend. The findings suggest



Pre-monsoon, 2019 **Post-monsoon, 2019**

Figure 2.10: Spatial variation in groundwater level in 2019

prioritization of technological solutions and policy interventions in the areas experiencing declining trends in groundwater.

The level of groundwater is directly proportional to the access to affordable energy. A district-wise analysis shows a positive association between electricity supply (measured as the share of wells energized through electricity) and groundwater utilization. (Figure 2.11). About 23% of the districts have groundwater utilization level of more than 90%, which signifies unsustainable use of groundwater for irrigation. About 84 % of the wells are energized with electricity, which is supplied either free or at subsidized rates. On the other hand, most districts with less than 50% groundwater utilization (mostly located in eastern regions) lack assured supply of affordable electricity, resulting in under-utilization of the groundwater resources. Thus, rationalization of electricity tariffs, based on region-specific conditions, is essential for sustainable management of groundwater resources.

It is to be noted that electricity/energy is not the only factor in groundwater utilization. Several states with electricity as a predominant energy source have also been categorized as 'safe' in terms of groundwater utilization (Figure 2.12).

Institutions and Technology for Agricultural Water Management

S.K. Srivastava, Darshna Mahida and Subhash Chand

India has made considerable progress in physical development of irrigation, but an engineering-focussed approach has remained insufficient to address the emerging challenges in water management. The issues of poor water-use efficiency, low crop yields, inequity, conflicts, inadequate utilization of water potential created and environmental costs have emerged as major challenges. These issues are deeply embedded in the poor institutional development and cannot be resolved merely through the engineering solutions. This suggests a need for reforms in water institutions for bringing efficiency in the use and management of water resources.

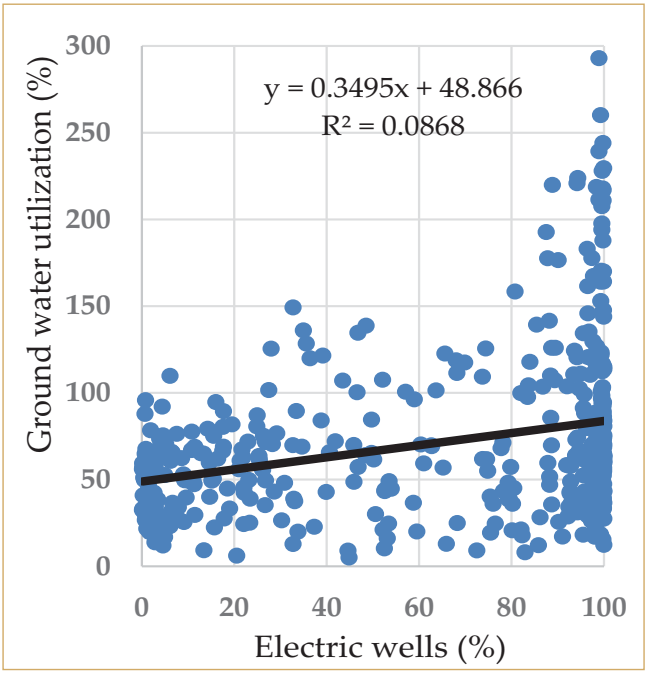


Figure 2.11: Association between groundwater utilization and electricity

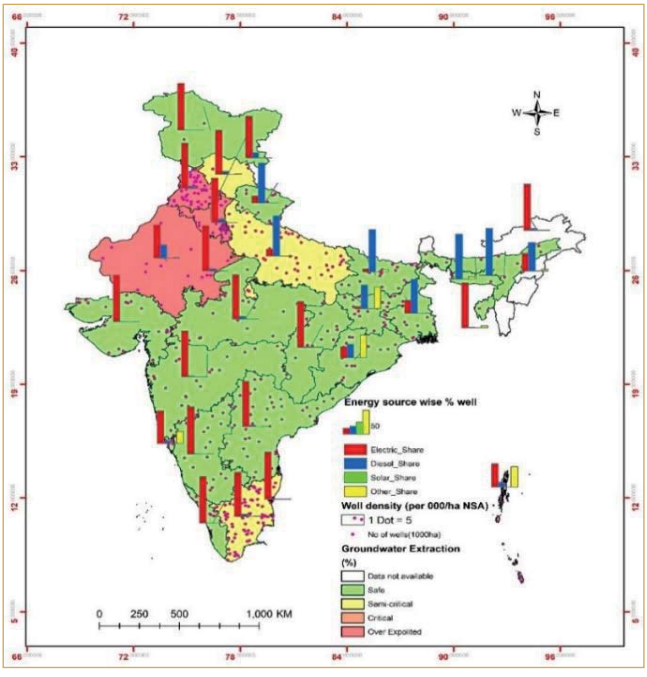


Figure 2.12: Spatial variation in groundwater utilization, energy composition and well density

Institutions are formal as well as informal. Formal institutions are founded on legally binding laws, regulations and orders governing actions of individuals or groups, while informal institutions emerge from values, conventions, norms and customary ways of doing things embedded in social practices and cultures and can be equally binding. Institutions are also defined as "entities configured from legal, policy and organisational rules and practices structurally linked and operationally embedded within a well-specified environment."

An institute has two parts, i.e., structure and environment. Institutional environment features in the overall historical, socio-economic, cultural and political setting, while institutional structure emerges from an interactive effect of policies, laws and administrative aspects. An institutional structure is entrenched within an institutional environment and has bi-directional flow of effects. The institutional structure comprises policy, law, and administration.

The structural framework of India's water institutions is presented in Figure 2.13. Administration plays a critical role in implementing laws and policies at the ground level. In India, constitutionally, water being a state subject, is managed by the state governments. The central government, however, provides necessary guidance in managing water resources and financial support for capital-intensive projects and research. It also formulates and updates model water policies and laws for the states to act upon. The issues related to inter-state and international water sharing and management fall in the jurisdiction of central government.

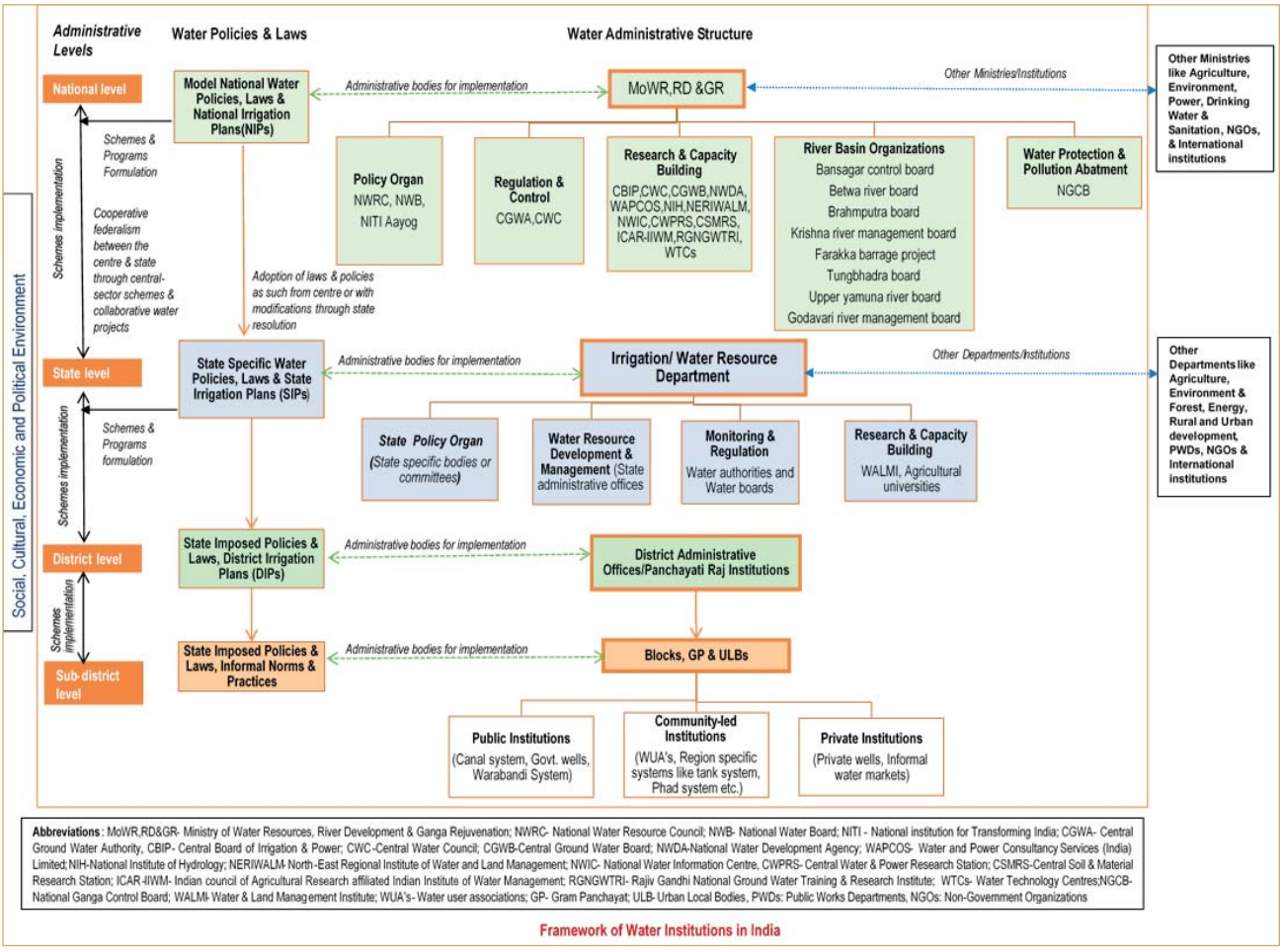


Figure 2.13: Framework of water institutions in India

Progress of Micro Irrigation and its Contribution to Crop Yield

Sant Kumar, Prabhat Kumar and Md. Awais

Water use efficiency (WUE) in Indian agriculture is low, 25-35%, as compared to 55% in developed countries. The main reason is the widespread use of flood irrigation, and the solution lies in bringing more area under micro-irrigation (MI). With the launch of Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) and area under MI has increased rapidly, from 3.1 million hectares in 2005 to 12.9 million hectares in 2021 (Figure 2.14).

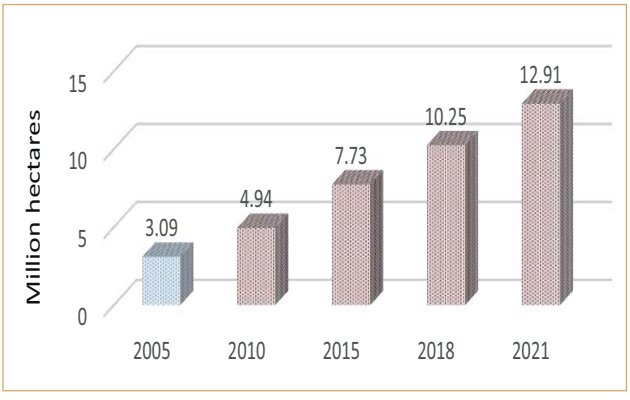


Figure 2.14: Status of micro irrigation in India

Crop-wise area coverage under MI is provided in Table 2.11. During 2016-21, a total of 55.3 lakh hectares was brought under MI. Under sprinkler irrigation, cereals covered the largest area of 26.75 lakh hectares (54%), followed by oilseeds (20%), horticulture (12%) and pulses (7.6%). Drip irrigation covered 28.57 lakh hectares; the highest are being under horticulture (41%), followed by cereals (39.5%), and commercial crops (12.9%). Drip irrigation also covered mango, banana, citrus, guava, pomegranate, grapes, tomato, potato, onion, okra and leafy vegetables.

To examine the contribution of irrigation through MI system to crop yields, the Shapley decomposition method was used. The MI accounted 71% increase in yield of wheat and 27% in the case of rapeseed and mustard (Table 2.12). Its contribution to gram yield was insignificant.

Table 2.11: Crop group-wise area coverage under micro irrigation

Crop group	Micro irrigation (000 ha), 2015-16 to 2020-21			
	Drip	Sprinkler	Total	% share
1.Horticulture	1183	324	1508	27
Fruits	399	13	412	27
Vegetables	348	134	482	31
Spices	419	172	591	39
Medicinal & aromatics	8	4	13	0.9
Flowers	7	0.3	7	0.5
2.Pulses	4	202	207	3
3.Oilseeds	47	532	579	10
4.Commercial (cotton, sugarcane) crops	367	46	414	7
5.Cereals	1127	1447	2575	46
6.Other crops	126	121	247	4
Total	2856	2675	5532	100

Table 2.12: Contribution of different farm input to crop yield

Explanatory variables	Wheat		Gram		Rapeseed & Mustard	
	Coefficient	Shapley % R2	Coefficient	Shapley % R2	Coefficient	Shapley % R2
Ln (seed in kg/ha)	0.078	0.932	0.081	8.333	0.005	10.334
Ln (fertilizer kg/ha)	0.020	1.097	-0.069	3.447	-0.010	2.683
Ln (labour man-days/ ha)	0.115***	20.438	0.140	22.188	0.026	6.557
Ln (irrigation hours/ ha)	0.096***	70.701	-0.003	0.884	0.133**	27.374
Ln (machine hours/ ha)	-0.055	1.167	0.597***	45.396	-0.144**	40.902
Ln (manure q/ha)	0.021	5.666	0.067	19.751	0.020	12.149
Intercept	2.557		0.293		3.444	
R^2	0.546		0.674		0.358	
Prob> F	0.000		0.000		0.047	
No. of observations	81		56		34	

Note: *** and ** indicate statistical significance at 1 and 5%, respectively.

Yield and Returns from Organic Ginger in North Eastern Region of India

Ram Singh, S. Passah, N. Anandkumar Singh, S. M. Feroze, A. Choudhury, L. Geetarani Devi, Larinsangpuii, A. Anuradha Devi, Shiv Kumar, Abhimanyu Jhahjria and Suresh Pal

The higher productivity of organic ginger in Sikkim compared to the conventional ginger grown in Meghalaya and Mizoram contradicts the evidence that organic agriculture results in lower yield. The higher yield of ginger in Sikkim is due to the improvements in soil fertility and management skills of the growers, which could be due to implementation of a mission on organic agriculture in the state since 2003.

Gains from Improved Technology Adoption in Disadvantaged Regions

Raka Saxena, Mohd. Arshad Khan and Vinita Kanwal

The study scrutinizes the significance and determinants of technology adoption in dryland regions of Bundelkhand. The study is based on a primary survey conducted in the

Table 2.13: Difference in yield of ginger between the organic and conventional state

States	Yield (Rs/ha)			Economic returns (Rs/ha)		
	Mean Difference	t-value	p-value	Mean Difference (Rs/ ha)	t-value	p-value
Sikkim *vs* Mizoram	1.05	5.38	0.000***	106296.85	9.12	.000***
Sikkim *vs* Meghalaya	1.35	7.91	0.000***	94697.94	8.91	.000***
Sikkim *vs* Arunachal Pradesh	-0.78	-4.31	0.000***	96871.02	9.05	.000***

Note: *** Significant at 0.01%

Jhansi district; in respect of three technologies, viz., high yielding variety, micro-irrigation, and mechanization. The findings indicate the favouritism of the relatively young generation towards adoption of new technologies. Additionally, owning a job card is positively associated with the adoption of new varieties. A job card ensures additional income, which in turn improves farmers' capacity to invest in technology adoption. The study also establishes an affirmative and significant effect of household income from cultivation on the adoption of improved crop varieties. On the other hand, income from regular salaries has a negative impact on technology adoption. Credit (outstanding loan amount) positively influences the adoption of modern varieties. Participation in community organizations and training also enhance adoption positively and significantly. Possession a KCC (Kisan Credit Card) emerged as an important determinant of farm mechanization, besides the land and non-farm income. Interestingly, farmers who shifted to improved crop varieties during the last five years reported significant improvement in crop yields. Further, the adoption of sprinkler irrigation has led to higher yield and water use efficiency. Water use efficiency due to micro-irrigation is enhanced by 55-65%.

Mechanization, Farm Size, and Paddy Production in the Indo-Gangetic Plains

Nalini Ranjan Kumar and Shivendra Srivastava

A mechanization index has been constructed as the ratio of the cost of machine-use to the sum of the costs on human, animal and machine use on individual plots, and a weighted average of the same represents the level of mechanization for a state. The mechanization index for major paddy growing states in the Indo-Gangetic Plains (IGP) across farm classes for 2016-17 is presented in Table 2.14. Punjab has the highest level of mechanization (0.28), followed by Haryana (0.22), Bihar and Uttar Pradesh (0.20) and West Bengal (0.14). Across farm classes, the marginal farmers in Punjab have a higher level of mechanization. In other states, no definite association is observed between mechanization and farm size.

Based on the mechanization index, farmers are categorised into three groups: low-adopters – mechanization index of less than or equal to 0.20; medium-adopters – mechanization index of more than 0.20 but less than or equal to 0.4; and high-adopters with mechanization index of more than 0.4. Accordingly, the distribution of paddy-growing households is presented in Table 2.15. More than two-thirds of the farm households are low-adopters, 30.2% have

Table 2.14: Mechanization index for paddy across farm classes

State	Marginal	Small	Semi-Medium	Medium	Large	Overall
Bihar	0.19	0.20	0.19	0.21	0.20	0.20
Haryana	0.23	0.24	0.23	0.23	0.20	0.22
Punjab	0.32	0.28	0.29	0.28	0.28	0.28
Uttar Pradesh	0.21	0.23	0.20	0.15	0.15	0.20
West Bengal	0.12	0.13	0.13	0.10	0.16	0.13
IGP	0.28	0.15	0.19	0.26	0.25	0.14

medium level of mechanization, and only 2.4% are highly mechanized. Across states, Punjab has 5.5% farms highly mechanised and 77% moderately mechanized. At the same time, West Bengal is the least mechanised, with 88.1% of farmers being the low-adopters.

Table 2.15: Distribution of sample farms across machine adopter categories (%)

State	Low	Medium	High
Bihar	53.0	45.5	1.5
Haryana	52.6	43.4	4.1
Punjab	17.6	76.9	5.5
Uttar Pradesh	62.0	31.8	6.2
West Bengal	88.1	11.0	0.9
IGP	67.5	30.2	2.4

Table 2.16 presents the use of labour, cost of production, crop yield and returns from paddy in relation to the level of mechanization. Human labour has a negative relationship with mechanization. The use of animal labour is extremely low across all levels of mechanization.

Paddy yield is the highest, 68.3 q/ha in Punjab, ranging from 63.0 q/ha at the low level of mechanization to 72.6 q/ha at high level of mechanization. A similar situation is observed in other states. This means farm mechanization helps realize higher yields. The cost of cultivation (A2+FL), which includes all the paid-out costs, is presented in Table 2.16. A critical examination suggests that mechanization reduces the cost of production. Gross income is positively associated with mechanization. A similar story unfolds in the case of net returns. In general, these findings imply a positive effect of mechanization on crop yield and profit.

Table 2.16: Use of labour, cost of production, yield and profit (Rs/ha)

Level of mechanization	Human labour	Animal labour	Machine labour	Yield	Gross income	Cost A2+FL	Return over cost A2+FL
Low	27688	839	3606	42.8	66108	45213	20895
Medium	15845	48	6084	53.3	81685	37130	44555
High	11352	10	9550	53.4	79122	35147	43975
Overall	21572	440	4977	48.0	73847	41078	32769

Information Search Behaviour of Cotton Growers in Maharashtra

Vinayak Nikam and Arathy Ashok

Using data from household survey of 645 cotton farmers from the Jalgaon and Yavatmal districts of Maharashtra, this study sheds light on cotton growers' information search behaviour. Farmers' interviews revealed that more information is required on plant protection, marketing and varietal selection. Further, based on the number of information sources farmers were clustered in three groups using K means clustering: high searchers, medium searchers and low searchers. On average, high searchers accessed 8.61 information sources, medium searchers 6.54, and low searchers 4.40. The search behaviour of farmers was analysed in relation to their socio-personal characteristics, production-related variables and access to information from particular source. The younger farmers access information from more number of sources. High searchers have a higher level of formal education. Farm size too has a

positive influence on their information search. Membership in village organizations has a positive association with search behaviour of the farmers. The social status of the farmers also affects the information search. More number of farmers from the lower social status are medium searchers and most of the farmers from high social status are low searchers. Irrigation has little effect on their search behaviour. Innovativeness is negatively associated with the search behaviour; as high searchers show less innovativeness. High searchers had a lower cost of cultivation, higher output and net profit compared to lower searchers.

Evaluation of Successful Interventions under the Integrated Livelihoods Support Project (ILSP) of Uttarakhand and the Lessons for Out-scaling

P. Sharma, Prem Chand, Kiran Kumara T.M., Shiv Kumar, Subhash Chand and A. Jhajhria

The Government of Uttarakhand sponsored a study to evaluate the Integrated Livelihood Support Project (ILSP) in 11 hill districts being implemented since 2013. The study reviewed and analysed the strategies, institutional mechanisms and processes followed for implementation of the Project. Besides, several rounds of focused group discussions were conducted involving beneficiaries and other stakeholders. The major interventions implemented under the project were chain-link fencing, farm machine banks, market infrastructure and linkages, low density polyethylene (LDPE) tanks and other irrigation infrastructure, branding (HILANS) and collective marketing, dairy development, fodder development, fallow land development, and growth centres for processing and business. All the activities were planned and implemented through village community institutions. Strengthening the crops and livestock value chains was the primary focus of the project. Product branding and collective marketing of farm produce under HILANS was one of the main market interventions. Many innovative agri-business and micro-enterprises (bakery, *ringal* products, Prasad units, agro-processing units, etc.) have come up in the project area, motivating rural people to diversify their income sources. The project interventions resulted in a 45% increase in the real income of the households. The business viability of livelihood collectives was assessed, and suggested measures for improving viability and sustainability of these collectives, and out-scaling of project interventions.

AGRICULTURAL MARKETS AND TRADE

Trajectory of Indian Agricultural Exports: Competitiveness, Diversification, and Growth Linkages

Raka Saxena, Rohit Kumar, Sonia Chauhan and Raman M.S.

The study has examined the trends and composition of agricultural exports from India. It has also looked into the geographical diversification of exports. In addition, it has examined the relationship between exports and agricultural growth. There are three major structural breaks in exports delineating four phases (i) 1990-91 to 1994-95, (ii) 1995-96 to 2005-06, (iii) 2006-07 to 2010-11, and (iv) 2011-12 to 2019-20. The performance of cereal exports has remained more or less stable. The share of cotton in the total exports declined from 25% in 2001 to about 20% in the recent years. Exports of meat and edible meat offal and fish and crustacean have performed well. Their share has increased from 3.2% in 2001 to 9% in 2018. Note, India is the largest exporter of crustaceans. The shares of coffee, tea, and spices have remained almost stable. The trade flow pattern shows that fennel, coriander, and cumin have consolidated their trade advantage.

Table 2.17: Multi-structural breaks

Multiple breakpoint tests
Compare information criteria for 0 to M globally determined breaks
Date: 11/24/21 Time: 11:53
Sample: 1 30
Included observations: 30
Breaking variables: C
Break test options: Trimming 0.15, Max. breaks 5

Schwarz criterion selected breaks:	2
LWZ criterion selected breaks:	2

Breaks	# of Coefs.	Sum of Sq. Resids.	Log-L	Schwarz* Criterion	LWZ* Criterion
0	1	2.73E+11	-386.5202	23.04351	23.09435
1	3	2.28E+10	-349.3021	20.78905	20.94522
2	5	9.95E+09	-336.8559	20.18605	20.45305
3	7	8.18E+09	-333.9315	20.21783	20.60209
4	9	6.70E+09	-330.9227	20.24400	20.75310
5	11	5.95E+09	-329.1545	20.35287	20.99592

* Minimum information criterion values displayed with shading

Estimated break dates:
1: 22
2: 17, 22
3: 13, 18, 22
4: 13, 18, 22, 27
5: 6, 14, 18, 22, 27

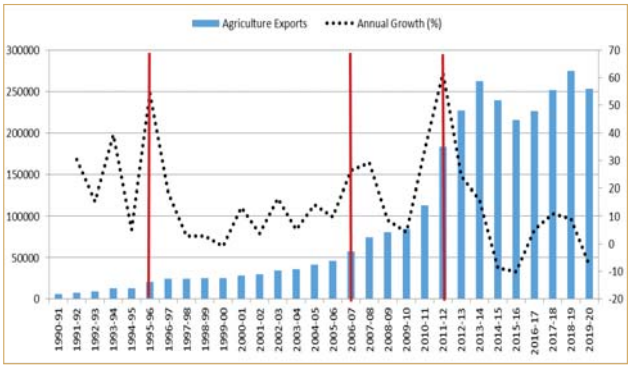


Figure 2.15: Delineation of phases in agricultural exports (Rs Crore)

Export diversification was studied employing Herfindahl-Hirschman (HH) index. Figure 2.16 presents the product diversification index of selected commodities from 2001 to 2020. A higher HH index indicates that India already exports to many existing markets, while a low HH value indicates concentration indicating the potential for expansion. Export destinations for products

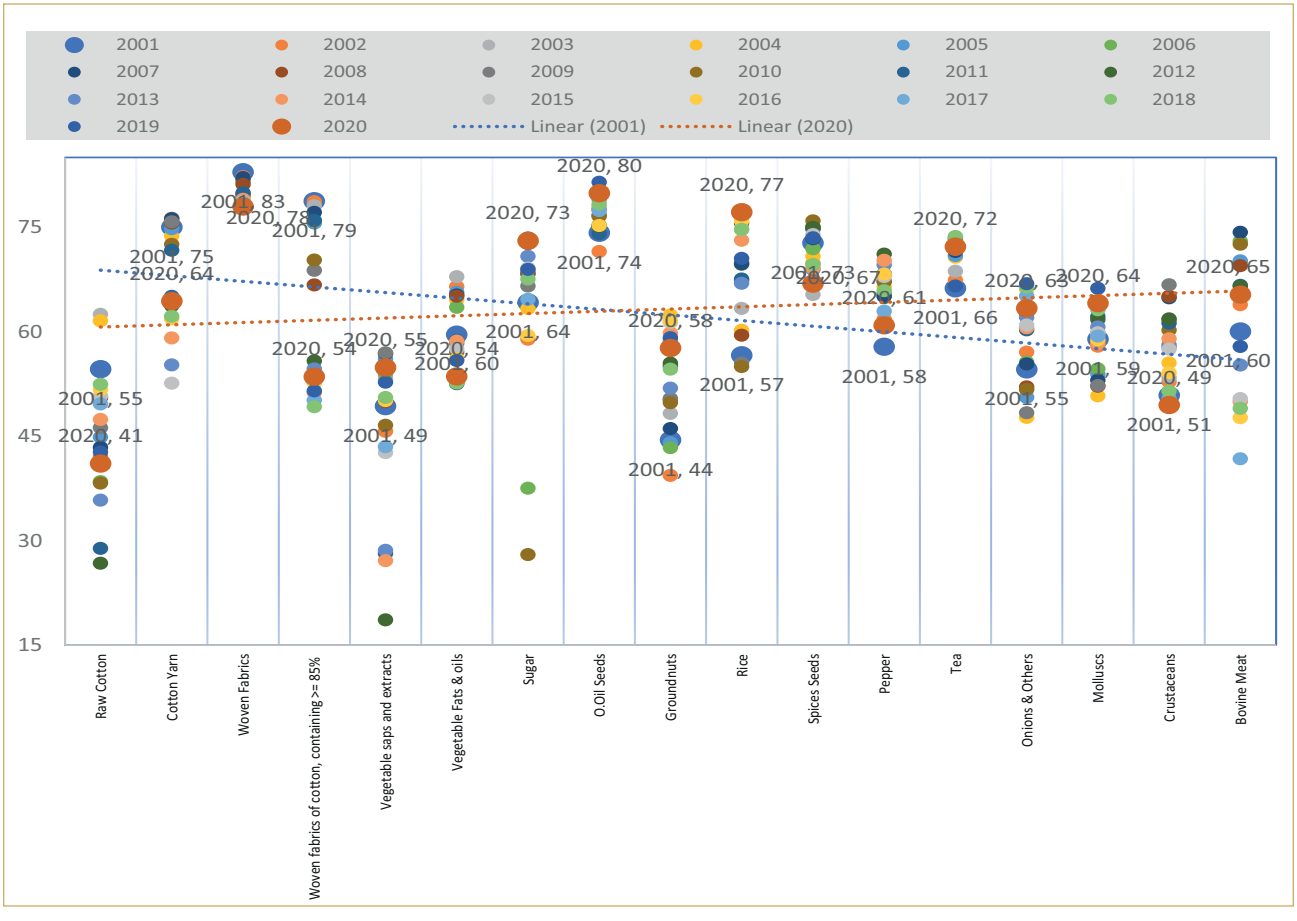


Figure 2.16: Product diversification index

like woven fabrics of cotton and other oilseeds and oleaginous fruits have expanded. The product diversification index for rice increased gradually, from 56.59% in 2001 to 77.13% in 2020, while that for unprocessed cotton it declined gradually.

The hypothesis of export-led growth is supported by the exports of several commodities, i.e. onion, pepper, rice, fennel, coriander, cumin, and tea.

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

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

This study adds to our understanding of the composition, direction, and competitiveness linkages in the exports of crustaceans. India is the largest crustacean exporter, followed by Ecuador and Canada. The USA is the most important destination for India's crustacean exports. The revealed comparative advantage (RCA) of India, Ecuador, and Canada has increased over time. There is unidirectional causality in RCA from Canada to India, and from Canada to Ecuador. Further, a unidirectional causality is observed in India's crustacean export and RCA. India can reap further gains through competitiveness enhancement and strengthening international market intelligence. The causality results suggest a unidirectional causality in RCA from Canada to India, and to Ecuador. The relationship could be positive or negative, given the trade performance of Ecuador and India. Further, the causality is unidirectional that flows from India's crustacean export to India's RCA. This means that the India has been successful in generating international demand for crustaceans. India needs to keep investing in R&D and innovative technologies for improving quality and reducing loss to sustain the RCA in the long-run. As Ecuador and India are close competitors, any change in RCA of Ecuador will impact the crustacean demand from India.

Table 2.18: Pre- and Post-WTO scenario of crustaceans export from India and other exporting countries

		Crustacean exports (Million US$)				Share (%)			
		Pre-WTO	Post-WTO			Pre-WTO	Post-WTO		
		TE1992	TE2000	TE2010	TE2019	TE1992	TE2000	TE2010	TE2019
India to	World	439	855	877	4,640	100.0	100.0	100.0	100.0
	USA	60	161	213	2,011	13.6	18.9	24.3	43.3
	Viet Nam	0	5	7	734	0.0	0.6	0.8	15.8
	China	0	21	11	454	0.0	2.5	1.3	9.8
	Japan	253	462	197	336	57.6	54.1	22.5	7.2
	UAE	10	24	36	172	2.3	2.8	4.1	3.7
	United Kingdom	37	41	55	130	8.3	4.8	6.3	2.8
	Belgium	0	8	70	116	0.0	1.0	8.0	2.5
	Canada	2	9	34	104	0.4	1.1	3.9	2.2
	Netherlands	7	13	33	96	1.5	1.5	3.8	2.1
	Others	70	111	221	487	16.3	12.7	25	10.6

		Crustacean exports (Million US$)				Share (%)			
		Pre-WTO	Post-WTO			Pre-WTO	Post-WTO		
		TE1992	TE2000	TE2010	TE2019	TE1992	TE2000	TE2010	TE2019
Major global exporters	World	5,603	10,849	15,813	29,433	100.0	100.0	100.0	100.0
	India	439	855	877	4,640	7.84	7.88	5.54	15.76
	Ecuador	503	584	744	3,398	8.97	5.39	4.71	11.55
	Canada	372	889	1,519	2,890	6.63	8.20	9.60	9.82
	Viet Nam	0	279	1,471	2,207	0.00	2.57	9.30	7.50
	Russian Federation	0	37	144	1,239	0.00	0.34	0.91	4.21
	Indonesia	744	1,004	952	1,564	13.28	9.25	6.02	5.31
	Argentina	339	584	394	1,210	6.05	5.39	2.49	4.11
	China	355	341	858	1,264	6.34	3.14	5.43	4.29
	Thailand	1,060	1,425	1,493	1,068	18.92	13.13	9.44	3.63
	USA	461	485	608	1,012	8.23	4.47	3.85	3.44
	Netherlands	29	128	400	658	0.51	1.18	2.53	2.23
	Others	1,301	4,238	6,353	8,283	23.2	39.1	40.2	28.2

Source: UNCOMTRADE database

Tapping the Untapped in Horticultural Exports: An Approach Based on Product Mapping and Seasonality

Raka Saxena, Anjani Kumar, Ranjit Kumar Paul, Raman M. S. and Rohit Kumar

This study (i) maps the export of horticultural commodities and analyses their competitiveness, (ii) examines temporal shifts in product movements, and (iii) analyses seasonality to identify commodities and countries to enhance India's horticultural exports. Product mapping allows stakeholders to better understand export performance and implement export enhancement strategies. The study also analyses selected commodities' untapped export potential and strategies to enhance exports. Product mapping is based on the Revealed Symmetric Comparative Advantage (RSCA) and Trade Balance Index (TBI). Seasonal advantages were examined through a modified QS-test (QS) and Friedman-test (FT) and export potential indicator (EPI) developed by the International Trade Centre (ITC). The comparative advantage for India's cucumbers and gherkins (preserved) is the highest. The TBI for cucumbers and gherkins indicates India's strength as an exporter. Capsicum (fresh), tomato, and sweetcorn represent a considerable trade balance, but comparative disadvantages exist.

The econometric tests establish that seasonality is more in exports of fruits and spices than vegetables. This is because of specific harvesting seasons of these commodities. Amongst vegetables, exports of cucumber, dried onion, and fresh capsicum are seasonal. Cashewnut in-shell is mostly exported during October to December; guavas during March- April; and oranges during November to March. Production of grapes, watermelons, melons, tamarinds, peaches, and others is highly seasonal. However,

dried grapes and fresh coconuts are exported throughout the year. Cucumbers are exported during February-March and July-August, and dried onions in March. Fresh capsicum exports also exhibit a seasonality pattern. A strong seasonality pattern is observed in dried capsicum, nutmeg, coriander, cumin, ginger, and turmeric. Dried capsicum is exported during February - March, and cumin from February to June. Coriander is exported from March to May, and ginger during October to March. Many commodities, especially cucumber (preserved), shelled cashewnut, guava, mango, fresh grapes and melons, appear to have a seasonal advantage. Products like cucumber, dried onion, shelled cashewnut, guava, mango, and tamarind have a comparative seasonal advantage. These findings suggest following of a differentiated export strategy for different commodities based on the seasonal windows in the international market.

Impact of Tariff Hike on Indian Edible Oil Sector

Balaji S. J., Umanath M. and Arun G.

India imports around 60% of its domestic edible oil demand, and palm oil comprises 60% of it. It imports 54% palm oil from Indonesia and 37% from Malaysia. Such a heavy dependence on imports costs the public exchequer and makes the domestic market vulnerable to international supply and price shocks.

The Government of India launched Technology Mission on Oilseeds (TMO) in May 1986 to enhance oilseeds production. In 1992-93, oil palm was brought into the ambit of the mission. The Oilseeds Production Program (OPP) and the Oil Palm Development Program (OPDP) were brought under the Integrated Scheme of Oilseeds, Pulses, Oil Palm and Maize (ISOPOM) that came into operation in April 2004. In August 2014, the scheme ISOPOM was subsumed with Integrated Development of Tree Borne Oilseeds and Oil Palm Area Expansion (OPAE) under the National Mission on Oilseeds and Oil Palm (NMOOP) In August 2021, the Union Cabinet approved the launch of a new scheme named National Mission on Edible Oils – Oil Palm to boost the efforts further (NMEO-OP). These policies have helped enhance production of oilseeds and edible oils but the increase is not commensurate with the rise in demand. During 2004-14, oilseeds and edible oil production grew around 4% a year. But the growth in domestic demand has been much stronger, 9.6% a year.

Tariffs are an effective instrument to make imports expensive. Tariff hikes curb imports in a competitive economy, triggering domestic firms and farms to expand their production. On this front, a hypothetical economy is constructed that attempts to raise tariffs for the edible oils it imports to encourage domestic oilseeds and edible oil production. Potential economy-wide impacts of this hike was estimated, calibrating a 3-sector Computable General Equilibrium (CGE) model to a Social Accounting Matrix (SAM) representing the Indian economy, focusing on the production and price gains to the farmers and the domestic edible oil industries. Using the IFPRI's Social Accounting Matrix for India for 2017-18 as base, a Social Accounting Matrix (SAM) was developed to assess the economy-wide impacts of tariff-hikes.

Following that, the Total Factor Productivity (TFP) growth in both oilseeds and edible oil sectors was estimated to understand the potential of technology in enhancing the production. The Malmquist Productivity Indices (MPI) was estimated for this purpose. For estimating TFP growth in oilseeds, the information contained in the Cost of Cultivation (CoC) has been used, covering the period 2004-05 to 2017-18. The TFP growth in the edible oil industry is estimated for

2013-14 to 2017-18 using the statistics published in the reports of the Annual Survey of Industries (ASI) (Ministry of Statistics and Program Implementation, Government of India).

As an ex-ante measure, different scenarios are assumed. In Scenario 1, the country is presumed to impose the highest tariffs it levied in the past on different edible oils, expecting an improvement in its domestic production and processing capacity. One shall note that leaving palm oil, the tariff rates at present are equivalent to the highest rates as in the past. This protectionist approach is presumed to intensify in Scenarios 2 and 3, where an additional 25% and 50% tariff hikes are presumed over the existing rates. Tariff rates presumed in different scenarios are displayed in Table 2.19. The simulation results are displayed in Table 2.20, and the estimated TFP growth rates are shown in Table 2.21.

Results show that tariff hike raises import prices and reduces edible oil imports. For instance, in Scenario 3, which levies the highest tariff, the edible oil import decline by over 20%. These tariff hikes and subsequent rise in oilseeds production still bring higher prices to the farmers and the edible oil industries, primarily due to the persisting gap between the domestic demand and the supply after the hike.

Price gains vary from 2.4% to 6%, depending on the tariff hike. Scenario 5, which excludes sunflower oil from tariff imposition, generates lower price gains, whereas Scenario 3 brings the highest gain. Price gains to the processing industries are relatively less as compared with the oilseed producers, ranging between 1.2% and 2.9%. Overall, the results suggest tariff hikes signal moderate but positive impacts on domestic oilseeds and edible oil production but considerable price gains – especially to the farmers. It indicates that both the farmers and the edible oil industries enhance their production and receive better prices when tariffs are hiked. But the existing rate of technology growth(TFP) is barely sufficient to bridge the gap in production caused by such hikes, calling for the need to enhance the adoption of technology in both the oilseeds and the edible producing sectors that shall enhance the outputs rapidly.

Table 2.19: Tariffs assumed under different scenarios

Item	Tariff rate (%)						
	Base	S-1	S-2	S-3	S-4	S-5	S-6
Crude palm oil	30.25	48.40	37.81	45.38	48.40	37.81	45.38
RBD palmolein	41.25	59.40	51.56	61.88	59.40	51.56	61.88
RBD palm oil	41.25	59.40	51.56	61.88	59.40	51.56	61.88
Crude soybean oil	38.50	38.50	48.13	57.75	38.50	48.13	57.75
Crude sunflower oil	38.50	38.50	48.13	57.75	38.50	38.50	38.50
Crude rapeseed oil	38.50	38.50	48.13	57.75	38.50	48.13	57.75
Refined soybean oil	49.50	49.50	61.88	74.25	49.50	61.88	74.25
Refined sunflower oil	49.50	49.50	61.88	74.25	49.50	49.50	49.50
Refined rapeseed oil	49.50	49.50	61.88	74.25	49.50	61.88	74.25

Table 2.20: Simulation results: Impact of tariff hikes

Impacts	Scenarios					
	1	2	3	4	5	6
Tariff hike (% over the base rate)	*27.54*	*25.00*	*50.00*	*27.54*	*19.71*	*39.42*
Price effects						
Domestic price of domestic output						
a. Oilseeds	3.3	3.0	6.0	3.3	2.4	4.7
b. Edible oil	1.6	1.5	2.9	1.6	1.2	2.4
Import price						
a. Oilseeds	-	-	-	-	-	-
b. Edible oil	4.7	4.3	8.5	4.7	3.4	6.7
Composite commodity price						
a. Oilseeds	3.4	3.0	6.0	3.4	2.5	4.8
b. Edible oil	2.4	2.1	4.1	2.4	1.6	3.3
Producer price						
a. Oilseeds	3.3	3.0	6.0	3.3	2.4	4.7
b. Edible oil	1.6	1.5	2.9	1.6	1.2	2.4
Production effects						
Quantity of domestic output						
a. Oilseeds	1.0	0.9	1.8	1.0	0.8	1.5
b. Edible oil	1.7	1.5	2.9	1.7	1.2	2.3
Quantity of imports						
a. Oilseeds	-	-	-	-	-	-
b. Edible oil	-11.9	-10.8	-20.4	-11.9	-8.7	-16.5

Table 2.21: TFP growth in oilseeds

Commodity	TFP Growth (%)
Groundnut	4.58
Sesamum	-0.95
Soybean	-0.93
Rapeseed & mustard	0.06
Sunflower	4.58
Total oilseeds	1.47

Vertical Price Transmission in Pulses and Oilseeds

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

The study analyses the speed and direction of price transmission along the value chain of pulses and oilseeds using weekly data on wholesale and retail prices from 2012 to 2021. The value chains studied are: Chain-I: Grain Wholesale –Oil/ Dal Wholesale; and Chain-II: Oil/ Dal Wholesale –Oil/Dal Retail. The unit root tests (ADF and PP) for all the data series of pulses and oilseeds at the level and first difference indicate that data series are integrated of order one.

The value chains of pulses indicate an asymmetric price transmission. The point estimates of positive and negative shocks indicate that negative shocks adjust faster than the positive shocks (Table 2.22). For gram in Chain-I, the speed of adjustment of positive

and negative shocks for the wholesale price of dal is 4.45% and 13.95%, respectively in one week. Thus, the positive shocks in gram Chain-I take about 22 weeks to be absorbed into the system, while a negative shock gets adjusted into the system within 7 weeks. Similarly, in the case of other pulses, the positive shocks take a longer time to get digested into the system than the negative shocks. The greater persistence of positive shocks implies higher upstream prices even when the downstream prices are declining.

For oilseeds, there is an asymmetric price transmission along the value chain. The point estimates of the speed of adjustment of positive and negative shocks are found to be significant in both the value chains, except the positive shock in the mustard value Chain-II. The negative shocks adjust faster than the positive shocks in the case of soybean, mustard and groundnut in Chain-I and all the oilseeds in Chain-II. The speed of adjustment of positive and negative shock to wholesale prices of soybean oil in Chain-I are 4.98% and 8.79% respectively within one week. Thus, the positive shocks in soybean Chain-I take nearly 20 weeks to get digested into the system, whereas the negative shocks take 11 weeks to adjust to the long-run equilibrium. Similarly, in the case of other oilseed value chains the positive shocks persist for a longer duration than the negative shocks.

The asymmetric price transmission characterizes the pulses and oilseed value chains suggesting the lack of perfect information flow across the pulses value chain actors. Strong market intelligence and information system would help contain the market distortions.

Table 2.22: Speed of adjustment in the pulses value chain

Chain	Shock	% shock corrected in one week				
		Gram	Arhar	Lentil	Moong	Urad
Chain-I	Positive	4.45	0.56^{ns}	4.23	1.00^{ns}	2.82
	Negative	13.95	5.39	0.44^{ns}	6.42	13.83
Chain-II	Positive	2.55^{ns}	4.42	3.55	4.38	0.66^{ns}
	Negative	4.98	76.37	34.93	18.70	11.35

ns= non-significant

Table 2.23: Speed of adjustment in the oilseeds value chain

Chain	Shock	% shock corrected in one week			
		Soybean	Groundnut	Mustard	Sunflower
Chain-I	Positive	4.98	3.47	2.96	13.11
	Negative	8.79	15.15	9.26	4.87
Chain-II	Positive	7.23	3.92	3.37^{ns}	8.42
	Negative	14.00	14.12	13.40	24.04

ns= non-significant

Organic Chilli Production in the North Eastern Hill Region, India

R. Singh, S. Passah, N.A.K. Singh, S.M. Feroze, A. Larinsangpuii, Anuradha Devi, Shiv Kumar and A. Jhahjria

The North East (NE) Region of India is hub of spices such as large cardamom, ginger, turmeric, black pepper, chilli and bay leaf. Arunachal Pradesh is the largest producer of large cardamom (20.39%) in the North Eastern Region. This study looks into the value chain of large cardamom in Arunachal Pradesh. The study is confined to Hayuliang market in Anjaw district, a major collection centre for large cardamom. A sample of 50 cardamom farmers is taken, 31 from Tafraliang village and 19 from Chirang village. The data pertains to 2017 to 2020. Apart from Hayuliang market (local); another Tinsukia market (terminal market) was also selected to collect the information on disposal of the large cardamom. Farmers sell most of the produce, retaining about 0.53% for home consumption and 0.73% for in-kind gift to friends and relatives. The produce from producer to primary wholesalers to secondary wholesalers/ traders to retailer to consumers. This channel is preferred by 84% of the farmers. Given the huge marketable surplus indicates a scope of opening market yards at cluster of villages.

Farmers' Access to Input Markets, Technical Information, and Produce Disposal Pattern

Abimanyu Jhajhria

This study looks into the changes in farmers' access to input markets, technical information and farm produce disposal pattern using data from the Situation Assessment of Agricultural Households surveys for 2012-13 and 2018-19. For all crops, most farmers source seeds from the local market. Direct sale of quality seeds by cooperatives and government agencies is not much. Likewise, farm households procure other inputs from the local market, input dealers and cooperative and government agencies. Around 41% of the households accessed technical advice from various agencies/sources in 2012-13, and their proportion increased to 49% in 2018-19. Progressive farmers, input dealers and electronic & print media remain the main sources of technical advice.

The information on marketing of produce was compared for 2012-13 and 2018-19. For majority of crops, 40-50% households sell their produce. In 2012-13, most of the produce was sold to either local private traders or in mandis. A small quantity, except paddy and wheat, is sold to cooperatives and other public agencies. There is no major change in the amount sold to cooperatives and government agencies between 2012-13 and 2018-19.

List of Research Projects

Table 2.24: Completed and ongoing research projects

Title of project		Project area	Project period	Project team
Externally funded Projects (Completed)				
Research priorities and policies for climate-resilient agriculture		National Professor Scheme	February 2017-February 2022	P.S. Birthal Prabhat Kishore
Externally funded Projects (Ongoing)				
Management and impact assessment of farmer FIRST		Technology and Sustainable Development	February 2017- March 2024	Shiv Kumar, Rajni Jain Vinayak Nikam Ankita Kandpal Kingsly I.T.
Strategic Research component of National Innovations on Climate Resilient Agriculture (NICRA)		Technology and Sustainable Development	April 2017-Contd.	Nalini Ranjan Kumar S.K. Srivastava N.P. Singh
Improving groundwater sustainability through analyzing groundwater-energy nexus		Technology and Sustainable Development	April 2021-26	S.K. Srivastava Subhash Chand Ranu Rani Sethi (ICAR-IIWM) Ankhila R.H. (ICAR-IIWM)
Doubling farmers' income in India: Estimation, strategy and aspirational districts		Growth and Development	April 2017-March 2023	Suresh Pal Raka Saxena Balaji S.J.
Network Project (Ongoing)				
Ecosystems, agribusiness and institutions having following components			April 2021-March 2026	P.S. Birthal
1.1	Component I: Inclusive agricultural development (hill and arid agriculture)	Technology and Sustainable Development	April 2021-March 2026	Prem Chand Khem Chand Kiran Kumar T.M.
1.2	Component II: Impact of agricultural technology	Technology and Sustainable Development	April 2021-March 2026	Ankita Kandpal, Vinayak Nikam
1.3	Component III: Market information system	Agricultural Markets and Trade	April 2021-March 2026	Purshottam Sharma Kingsly I.T. D.C. Meena
1.4	Component IV: Farmers' income, governance impacts and agricultural trade	Agricultural Growth and Development	April 2021-March 2026	Raka Saxena Balaji S.J.

Title of project	Project area	Project period	Project team
Institute Funded Projects (Completed)			
Crop insurance in India: Progress, farmers' willingness to pay and role of information	Agricultural Growth and Development	April 2020-September 2021	Vikas Kumar Khem Chand
Assessing impacts of conservation agriculture in South Asia: A meta-analysis	Technology and Sustainable Development	December 2019-November 2021	Kiran Kaumara T.M. Ankita Kandpal Suresh Pal
Institute Funded Projects (Ongoing)			
Performance and impact of farmer producer organisations	Technology and Sustainable Development	April 2021-March 2024	Vinayak Nikam Prem Chand
Institutions and technology for agricultural water management	Technology and Sustainable Development	April 2021-March 2024	S.K. Srivastava Subhash Chand
COVID led changes in agricultural sector and food consumption	Technology and Sustainable Development	April 2020-March 2023	S.K. Srivastava Raka Saxena Purushottam Sharma Balaji S.J. D.C. Meena Abhimanyu Jhajharia
Farm mechanization- The role of custom hire services and rural labour market	Technology and Sustainable Development	April 2020-March 2023	Nalini Ranjan Kumar S.K. Srivastava
Agricultural price analysis and forecasting	Agricultural Markets and Trade	April 2020-March 2025	Purshottam Sharma Kingsly I.T. Shiv Kumar
AI and machine learning for supply forecasts	Technology and Sustainable Development	April 2021-March 2026	Rajni Jain Dilip Kumar Abimanyu Jhajhria Anshu Bharadwaj Sapna Nigam
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 D.C. Meena K.R. Chaudhary M.S. Chauhan

Title of project	Project area	Project period	Project team
R & D investment and innovation outcomes in Indian agriculture	Technology and Sustainable Agriculture	August 2020-March 2025	Ankita Kandpal
Sustainable intensification of agriculture	Technology and Sustainable Agriculture	April 2020-March 2024	Prem Chand Kiran Kumar T.M. D.C. Meena

Table 2.25: Consultancy and contract research projects

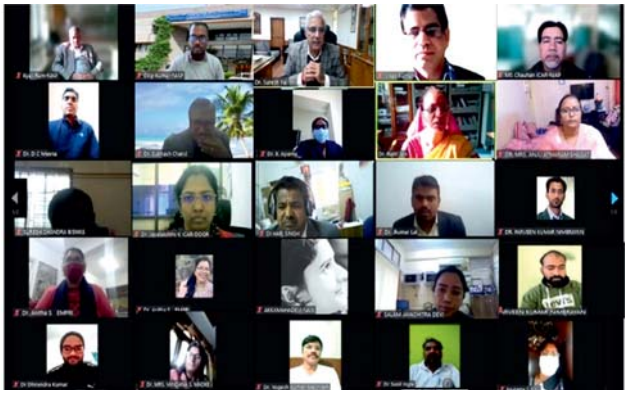
Name of the scientist	Institution to which consultancy provided	Area of consultancy/contract research
S.K. Srivastava	International Food Policy Research Institute, Washington DC	Analysis on sustainability issues in groundwater irrigation in eastern Gangetic plains (Bihar and West Bengal)
Purushottam Sharma, Prem Chand, Shiv Kumar, Abhimanyu Jhajhria and Kiran Kumar T.M.	Uttarakhand Government	Impact assessment of the Integrated Livelihoods Support Project (ISLP) of Uttarakhand and lessons for out-scaling
Khem Chand Vikas Kumar Raka Saxena	NRAA, MoA&FW, Government of India, New Delhi	Management and institutional recommendations for bringing reforms in PMFBY

3 Capacity Building

Seminars, Workshops and Trainings Organized

Analytical Techniques for Decision Making in Agriculture

Under the SC Sub Plan, a Winter School on 'Analytical Techniques for Decision Making in Agriculture' was organized during February 5-25, 2022. The purpose was to familiarise social scientists with recent advances in analytical techniques. More than 900 applications from the ICAR institutes, SAUs and NGOs were received for this training program, and finally, 120 candidates were selected for participation. Quantitative techniques taught by experts were highly appreciated by the participants for their usefulness in their research.



Workshop on Research Network Project

A four-day workshop was organized during May 10-13, 2021, to discuss the work plan and activities of the newly launched network project. The Director of the ICAR-NIAP briefed about the earlier network research projects and highlighted key outputs from these. He lauded partners for bringing out a brief and timely report on the economic impact of NARS technologies and stressed the need for extending this work to cover socio-economic, nutritional and environmental dimensions of the impact.

Agricultural Household Income and Research Impact Assessment

A workshop on 'Agricultural Household Income and Research Impact Assessment' was organized on 29 November 2021 under the chairmanship of Dr. Trilochan Mohapatra, Secretary, DARE and DG, ICAR, to highlight the role of innovative technologies in enhancing farmers' income. The key findings covering the aspects of agrarian structure, investment behaviour, access to credit, input and information, product disposal pattern, and farmers' income from the Situation Assessment Survey 2018-19 were compared with those from the earlier surveys. Besides, a few case studies on the importance of promising technologies in enhancing farmers' income were also presented.

Agricultural Development Report 2020-21

The first 'Agricultural Development Report' was released on 22 June 2021 in the presence of Dr. Mruthyunjaya, Dr. P. K. Joshi and Dr. Ramesh Chand. The Report discussed the performance of Indian agriculture and the progress of the developmental schemes. The impact of COVID-19 on agriculture and rural economy and the measures to revive the economy were unique features of the Report. The recent policy reforms

of the Government, future outlook and budget expectations were other important topics included in the Report. Besides, the Report discussed the research highlights of the ICAR-NIAP briefly.

Webinar

A Webinar with a lecture on 'Assessing the Economic Impact of Agricultural Research' Dr. Keith Fuglie, Senior Economist, Economic Research Service, U.S. Department of Agriculture (USDA), was organized on 17 December 2021.

Training for the Officers of the Indian Economic Services

A one-week training program for the Officer-Trainees of the Indian Economic Service (IES) 2019 batch was conducted during 12-16 April 2021. This training program aimed to familiarize the trainee officers with the emerging issues in India's agricultural and rural economy.

Training under SC Sub Plan

The ICAR-NIAP organized a workshop on 'Nutritional Security through Backyard Vegetable Cultivation' in Basahra village in the Panipat district of Haryana on 26 October 2021. More than 250 farmers, the majority being women, participated in it. Packets of vegetable seeds were also distributed to the farmers.

Similar training was organized at Boraj village of Dudu block in the Jaipur district (Rajasthan) on 11 November 2021. Around 200 farmers participated in this training. The program was inaugurated by Dr. Arjun Singh Baloda, Director (Research), SKN Agriculture University, Jobner, Jaipur and emphasized the role of vegetables in improving the nutritional security through

ICAR-NIAP team at village Basahra, Block Samalkha, Panipat

home gardens. The scientists from ICAR-NAIP deliberated on the importance of vegetables in human nutrition. Besides, they interacted with farmers to understand the problems and constraints in agriculture.

Another similar training was organized at Bobas village of Dudu, and Pachar village of Jotwara blocks of the Jaipur district on 12 November 2021. More than 266 farmers participated in it. The ICAR-NIAP team interacted with the farmers on the constraints they faced in agriculture and guided them to adopt remedial measures. The team also created awareness about government schemes to increase farmers' income.

ICAR-NIAP team at Village Sithana, Block Madlauda, Panipat

Amrit Mahotsav Webinars

The ICAR-NIAP organized a webinar on 'Tools at Workplace for Personal Efficiency'' on 7 August 2021 to celebrate Azadi ka Amrit Mahotsav. Mr. Satinder Chawla, a renowned Scientologist, delivered the lecture. Another webinar on 'Spatial Technologies in Agriculture' was organized on 18 September 2021. Prof. Prakash Chauhan, Director IIRS, ISRO, delivered the speech.

4 Policy Interactions

- **Doubling Farmer's Income:** The ICAR-NIAP and the Ministry of Agriculture and Farmers' Welfare facilitated the compilation of a detailed list of points (LOPs) covering various dimensions of agricultural growth and farmer's income for the Parliament Standing Committee on Doubling of Farmer's Income by 2022.
- **Pradhan Mantri Kisan SAMPADA Yojna:** The Institute provided inputs on the Cabinet Committee on Economic Affairs draft note regarding the extension of Pradhan Mantri Kisan SAMPADA Yojna (PMKSY) during the 15th Finance Commission cycle (2021-22 to 2025-26).
- **Procurement and Distribution of Coarse Grains/Millets:** The Institute provided input for revising guidelines for procurement and distribution of coarse grains/millets and fortified rice.
- **MSP of BT Cotton Seed:** The Institute provided inputs on the MSP of Bt cotton seed for 2022-23.
- **Uttarakhand Development Report:** The ICAR-NIAP provided inputs for strengthening and sustainability of collective institutions, collective marketing of farm produce, and out-scaling of successful interventions in Uttarakhand.
- **Dairy Master Plan**: The Institute provided inputs to the International Livestock Research Institute to develop a conceptual framework for Dairy Master Plan.
- **Assam Agribusiness & Rural Transformation Project**: The Institute provided technical support to Assam Agribusiness & Rural Transformation Project (APART), the Government of Assam, in developing the mechanisms and building the capacity to implement the strategic action plans to push the agenda of agricultural development in Assam.
- **Growth Forecast**: The Institute provided inputs to NITI Aayog on agricultural growth forecasts for 2036-37.
- **Creating a Framework and Implementation Plan for India Digital Ecosystem of Agriculture (IDEA)**: The Institute provided inputs to the Taskforce for Creating a Framework and Implementation Plan for India Digital Ecosystem of Agriculture (IDEA), created by the Ministry of Agriculture & Farmers Welfare, Government of India.
- **Parliament Questions**: The Institute provided replies to 48 parliament questions on agricultural and food policies, farmers' income, agricultural sustainability and other important aspects of agriculture.

5 Research Outputs

Policy Paper

1. Saxena, R., Srivastava, S.K., Balaji, S.J. and Jhajhria, A. (2021). Changes in Indian Agriculture: Recent Household Evidence. Policy Paper 38, ICAR-National Institute of Agricultural Economics and Policy Research, New Delhi.

Research Papers in Peer-reviewed Journals

1. Abdulla and Kumar, Shiv (2021). Technical efficiency and its determinants in the Indian textile garments industry. *Research Journal of Textile and Apparel*, 25(4): 346-360.
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3. Ashok, A., Sreejith, S., Benjamin, D., Bindu, J. and Gopal, N. (2021). Ethnic foods and food-based traditional knowledge of fishing community in Kerala, India. *Fishery Technology*, 58 (1): 48-52.
4. Balaji, S. J. (2021). Product clusters, export promotion, and agricultural growth: A partial assessment of India's relative competitiveness in light of the agricultural export policy. 2018. *Indian Journal of Agricultural Marketing*, 35(1): 106-114.
5. Balaji, S. J., Arun, G., Suresh C. B. and Pal, S. (2021). Machine learning algorithms for quarterly GDP forecasting: A performance evaluation. *The Journal of Income and Wealth*, 43 (1&2): 1-15.
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13. Chand, K., Suresh, A., Dastagiri, M. B., Kumar, S. and Mandal, S. (2021). Fruit marketing, its efficiency and supply chain constraints in India: A case study. *The Indian Journal of Agricultural Sciences*, 91 (8): 1146-50.

14. Chand, P., Rao, S., Agarwal, P. and Jain, R. (2021). Sustainable intensification of water-guzzling crops: Identifying suitable cropping districts of India. *The Indian Journal of Agricultural Sciences,* 91 (8): 1117–1121.

15. Chand, S., Sarma, K. and Sethi, S.N. (2021). Present status, scope and opportunities of livestock and poultry production in Bay Islands, India. *International Journal of Livestock Research,* 11(4):75-87.

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2. Mahapatra, A. and Nikam, V. (2021). KASAM: A driver of sustainable agricultural development in the tribal regions of Odisha. In: Catalyzing Sustainable Development through Producers' Collectives: Case Studies from India's Hinterland (Eds., Tripathy K K, Wadkar S.K., and Singh A.). Notions Press Media Pvt. Ltd., 129-152.
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2. Balaji, S.J., Arun, G. and Babu, S.C. (2021) National Edible Oil Mission-Oil Palm: Towards self-sufficiency. *The Global Analyst*, 10(9), September.
3. Dixit, A.K., Ravishankara, K. M., Kumar, S., Sharma, A.K. and Bhandar, G. (2021). Integrating production with processing and converting waste into wealth: A success story in dairying from Andhra Pradesh. *Indian Farming*, 71(07): 34–38.
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12. Singh, A.K., Chahal, V.P., Kumar, S., Jhajhria, A., Amit and Abdulla (2021). Potential scaling strategies for Farmer FIRST Project. *Indian Farming*, 71(10): 04–07.

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14. गुप्ता गौरेन्द्र, पलसानिया डी आर, मंजनगौड़ा, उपाध्याय दीपक, चंद खेम एवं सुमन मंजु (2021)। चारा उत्पादन एवं संरक्षण तकनीकिया। खेती (6):25–27।

15. कुमार विकास एवं चंद खेम (2021)। प्रधानमंत्री फसल बीमा योजना, किसानो की आय में बढ़ोतरी और फसल जोखिम को कम करने का महत्वपूर्ण साधन, ग्रामीण विकास सन्देश (16):160–161।

16. नारायण प्रेम एवं चंद सुभाष (2022)। स्मार्ट कृषि तकनीकियों से किसानो की आय में सकारात्मक वृद्धि, हिन्दी पत्रिका, आईसीएआर–सीएसएसआरआई, करनाल, 105–110.

17. नारायण प्रेम (2021)। प्याज भंडारण की समस्या एवं समाधान। फल फूल मासिक पत्रिका, जुलाई–अगस्त, 29–31, आईसीएआर, नई दिल्ली

18. नारायण प्रेम (2021)। कृषि निर्यात में भारत की बढ़ती भागीदारी, कुरुक्षेत्र मासिक पत्रिका, अगस्त, 31–35।

Working / Discussion Papers

1. Dalwai, A., Kohli, P., Nagnur, S., Saxena, R. and Singh, R. (2021). India's Food System Policies. Discussion Paper. United Nations Food Systems Summit (UNFSS), New Delhi.

2. Pal, S., Srivastava, S.K. and Balaji, S. J. (2021). Agriculture and Food Policy for the Five Trillion-dollar Economy. Policy Paper no. 98, National Academy of Agricultural Sciences, New Delhi.

3. Sharma, S.K., Birthal, P.S., and Abhijit, D. (2021). WTO and Indian Agriculture Issues, Concerns and Possible Solutions. NAAS Policy Paper 102, NAAS, New Delhi.

Presentations in Conferences, Workshops, Symposia

1. Balaji, S.J. and Gopinath, M. (2021). Spatial income disparities and agricultural development in India. In: Conference proceedings of the 31st International Conference of Agricultural Economist (ICAE), International Association of Agricultural Economists (IAAE), August 17-31, 2021 (Virtual).

2. Balaji, S.J. and Pal, S. (2021). Agricultural productivity, pay-gap, and non-farm development: contribution to structural transformation in India. In: Conference proceedings of the 31st International Conference of Agricultural Economist (ICAE), International Association of Agricultural Economists (IAAE), August 17-31, 2021 (Virtual).

3. Balaji, S.J., Babu, S.C. and Pal, S. (2021). Understanding science and policy making in agriculture: a machine learning application for India. In: Conference proceedings of the 31st International Conference of Agricultural Economist (ICAE), International Association of Agricultural Economists (IAAE), August 17-31, 2021 (Virtual)

4. Chand, P., Pal, S., Kumara, T.M. K., Roul, C. and Naik, K. (2021). Assessment of biodiversity and environmental sustainability of Indian agriculture. Oral presentation (Pre-recorded), In: 2nd International Agrobiodiversity Congress on "Using Agrobiodiversity to Transform Food Systems", November 15 - 18, 2021.

5. Chand, S. and Chaudhary, K.R. (2021). Livestock insurance policy for risk aversion: Insights from ground level study in India. In: Proceedings of National Conference of

Indian Society of Agricultural Economics, Mumbai.

6. Das, A., Kumar, N. R. and Debnath, B. (2021). Policy implication to break poverty trap through investment in aquaculture activities, education and markets: Evidence from Tripura. In: Agribusiness Potential of North Eastern Region with Special Reference to Tripura (Seminar Proceedings), Eds Lahiri, D., Burark, S.S. and Satyanarayana, T., pp: 68-94.
7. Kanwal, V., Sirohi, S., Chand, P. and Thakur, A. (2021). Drought, hunger and malnutrition: spatial and socio-economic variations in the desert state of India. In: Conference proceedings of the 31st International Conference of Agricultural Economist (ICAE) organized by International Association of Agricultural Economists (IAAE), August 17-31, 2021 (Virtual), 315248. https://doi.org/10.22004/ag.econ.315248.
8. Kishore, A., Kishore, P., Roy, D. and Saroj, S. (2021). Impact of sweeping agricultural marketing reforms in a poor state of India Evidence from repeal of the APMC Act. In: Conference proceedings of the 31st International Conference of Agricultural Economist (ICAE) organized by International Association of Agricultural Economists (IAAE), August 17-31, 2022 (Virtual), https://ageconsearch.umn.edu/record/315092?ln=en.
9. Kishore, P., Singh, D.R., Srivastava, S.K., Kumar and P., Jha, G.K. (2021). Impact of subsoil water preservation act, 2009 on burgeoning trend of groundwater depletion in Punjab, India. In: Conference proceedings of the 31st International Conference of Agricultural Economist (ICAE) organized by International Association of Agricultural Economists (IAAE), August 17-31, 2022 (Virtual), https://ageconsearch.umn.edu/record/ 315198?ln=en.
10. Meena, D.C. (2021). Farmers' perception about climate change and adoption of soil and water conservation technologies in the semi-arid region, Agra, India. In: Conference proceedings on Soil and Water Management Technologies for Climate Resilience, Agricultural and Environmental Sustainability, Soil Conservation Society of India, New Delhi.
11. Prakash, P., Kumar, P., Kishore, P., Jaganathan, D. and Immanuel, S. (2021). Economic feasibility of polyhouse establishment with and without government subsidy support: A case of gerbera cultivation in Maharashtra, India. In: Conference proceedings of the 31st International Conference of Agricultural Economist (ICAE) organized by the International Association of Agricultural Economists (IAAE), August 17-31, 2022 (Virtual), https://ageconsearch.umn.edu/record/314961?ln=en.
12. Rana, R.K. and Chand, P. (2021). Socio-economic challenges and policy need for direct seeded rice. In: National Seminar on Promotion of Direct Seeded Rice (DSR): Prospect and Challenges amid COVID-19, June 12-13, 2021, ICAR-ATARI Ludhiana.

Others

1. Chand, P., Pal, S., Kiran, Kumara, T.M., Roul, C. and Naik, K. (2021). Assessment of biodiversity and environmental sustainability of Indian agriculture. Oral presentation (Pre-recorded), 2nd International Agrobiodiversity Congress on Using Agrobiodiversity to Transform Food Systems, November 15 - 18, 2021.
2. Jain, R., Begam, S. and Chand, P. (2021). Evolutionary computing for optimum crop planning. Special Proceeding, 23rd Annual Conference, Society of Statistics, Computer and Applications, pp 125-141 (ISBN #: 978-81-950383-0-5).

3. Kishore, A., Kishore, P., Roy, D. and Saroj, S. (2021). Impact of agricultural reforms in Bihar: Test case for new farm laws. Ideas for India-for more-evidence base policy by International Growth Centre, London School of Economics and University of Oxford. https://www.ideasforindia.in/topics/agriculture/impact-of-agricultural-reforms-in-bihar-test-case-for-new-farm-laws.html.

4. Kumara, K.T.M., Pal, S., Kandpal, A. and Chand, P. (2021). Carbon sequestration potential of sustainable agricultural practices: A Meta-Analysis of Evidence and Economic Assessments. In: Book of Abstracts: Soil and Water Management Technologies for Climate Resilience, Agricultural and Environmental Sustainability. pp163

5. Kumar, S., Kingsly, I.T. and Pandey, N.K. (2021). Returns from investment in potato research in India. Extended summary in Abstract Book of Indian Potato e-Conference (IPeC 2021). Indian Potato Association and ICAR-Central Potato Research Institute, Shimla.

6. Pal, S., Chand, P., Kumara, T.M.K. and Chaudhari, S. K. (2022). Agricultural sustainability in India- A parametric study. Research Report, ICAR-National Institute of Agricultural Economics and Policy Research, New Delhi.

7. Sharma, P., Chand, P., Kumar, K., Kumar, S., Chand, S. and Jhajhria, A. (2021). Evaluation of successful interventions under the Integrated Livelihoods Support Project (ILSP) of Uttarakhand and the lessons for out-scaling. Project report submitted to Department of Rural Development, Government of Uttarakhand.

Product Development

1. **MILKSAFEON:** Mobile App is developed under the ICAR-NIAP project on -Policy Imperatives for Promoting Value Chain of Agricultural Commodities in India and released by Secretary, DARE and DG (ICAR) on the occasion of the National Milk Day Celebration at NDRI, Karnal on November 26, 2021.

2. **FFP Portal:** The Farmer FIRST (Farm, Innovations, Resources, Science and Technology) Program, an FFP portal (https://ffp.icar.gov.in/) has been developed under the project-Management and Impact Assessment of Farmer FIRST Project and hosted in ICAR Data Center at Indian Agricultural Statistics Research Institute (IASRI), New Delhi. This program was initiated in October 2016 to provide a platform to farmers and scientists for creating linkages, capacity development, technology adaptation and application, on-site input management, feedback and institution building. The portal is developed using the NET framework, and it is web responsive. It is a single-window platform that provides basic and detailed information concerning all FFP projects. The portal facilitates the lead centers of the respective projects to update and upload all related information so that the knowledge generated in FFP can be disseminated to the farming community. Agricultural Technology Application Research Institute (ATARI) and the Agricultural Extension Division of ICAR monitor the project activities and progress under this program through this portal.

6 Awards and Recognitions

Recognitions

Suresh Pal

- Member, 'Sectional Committee on Social Sciences' National Academy of Agricultural Sciences, New Delhi.
- Member, 'Project Review Committee (PRC) on Science Technology and Innovation (STI) for Sustainable Development Goals (SDGs): Roadmaps for India', Government of India.
- Member, 'Committee on Issues to Broaden the Revenue Generation from Various Sources in ICAR', ICAR, New Delhi.
- Member, 'Committee on Ease of Doing Business', ICAR, New Delhi.
- Member, 'Committee for Providing Specific Views/Memorandum on Issues related to DARE/ICAR to the Fifteenth Finance Commission', ICAR, New Delhi.
- Member, 'Technical Committee on Market Intelligence (Supply Management, Price and Demand Forecasting)', MoA&FW, New Delhi.
- Member, Editorial Board, Indian Journal of Agricultural Sciences.
- Member Secretary, 'Committee 'Outcome Review of Various Schemes of ICAR for XII Plan Period', MoA&FW, GoI, New Delhi.
- Member, 'Inter-Ministerial Committee on 'Doubling Farmers' Income', DAC&FW, New Delhi.
- Member, 'Committee on Issues Relating to Considering of KVKs in Newly Created Districts', ICAR, New Delhi.
- Ex-Officio Member, State Agricultural Prices Board (SAPB), Kerala.
- Member, 'Committee for Economic Analysis of Alternative/Ex-situ Options of Crop Residue Management', ICAR, New Delhi.
- Member, 'Core-Committee on Policy Document on Futuristic Crop Planning for 2030/2050', ICAR, New Delhi.
- Member, 'Committee on the Need for Convergence to Strengthen Post-harvest and Marketing Infrastructure', DAC&FW, New Delhi.

Pratap Singh Birthal

- Chairman, 'Working Group for Farmers' Situation Analysis, Land and Livestock Holdings and All India Debt and Investment Surveys', National Sample Survey Office, Ministry of Statistics and Program Implementation, Government of India.
- Member, 'External Research Committee', National Bank for Agriculture and Rural Development, Mumbai
- 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', Government of Punjab.
- Member, 'Research Committee', Indian Society of Agricultural Economics, Mumbai.
- Chief Editor, Agricultural Economics Research Review, New Delhi.
- Editor, National Academy of Agricultural Sciences, New Delhi.
- Member, Research Advisory Committee, Central Potato Research Institute, Shimla.

Nalini Ranjan Kumar

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

Prem Chand

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

Rajni Jain

- Session Manager, 'Annual (Web) Conference on Recent Advances in Statistical Theory and Applications (RASTA 2022)', February 23-27, 2022.
- Co-Convener, International Symposium on 'Data Driven Agriculture and Natural Resource Management – Opportunities and Challenges', Indian Society of Agricultural Information Technology (INSAIT) in partnership with ICAR-NIAP, ICAR-NBSS&LUP and ICAR-IASRI during 21 - 22 January 2022.

Raka Saxena

- Co-Chaired, Technical Session 5: Agricultural Markets and Trade in the Annual Conference of Agricultural Economics Research Association (India) held at UAS Bangalore (27-29 October, 2021).
- Chaired a session at the National Conference on Corporate Governance and Sustainable competitiveness in Agricultural Collectives (Cooperatives and farmer Producers' Organizations) at Vaikunth Mehta National Institute of Cooperative Management, Pune, Maharashtra.
- Member, 'Expert Committee for United Nations Food Systems Summit', prepared the Discussion Paper for the Summit.
- Member, 'Taskforce on India Digital Ecosystem of Agriculture (IDEA)', Ministry of Agriculture & Farmers Welfare, Government of India.

Shiv Kumar

- Associate Editor, Agricultural Research and Bioinformatics Journal.
- Member, Editorial Board, Economic Affairs.
- Member, Institute Technology Management Committee of ICAR–Indian Agricultural Statistics Research Institute, New Delhi.
- Member, IMC of ATARI, Jabalpur.

S. K. Srivastava

- Member, 'Technical Advisory Committee for Evaluation of National Food Security Act 2013', NITI Aayog, Government of India, New Delhi.
- Co-opted member, 'BSMA Committees/ Sub-Committees of ICAR for Revision of ARS Syllabus for the Social-Sciences'

Awards

Vinayak R. Nikam

- 1st Prize in the 1st Case Documentation Drive 2019-20 by VAMNICOM, Pune, Maharashtra, for the case study on 'KASAM: A Driver of Sustainable Agricultural Development in the Tribal Regions of Odisha'.

Subhash Chand

Best Paper Award by Indian Society of Soil Conservation for the paper 'Leased farming degrading the farmlands? Analysis of farmers' perceptions in Andaman and Nicobar Islands, India, Indian Journal of Soil Conservation, 47 (3): 273-279 (Subhash Chand, Babulal Meena, Ghoshal Chaudhary, R.C. Srivastava and Khyali Ram Chaudhary.

Prem Chand

Young Agricultural Economist Award 2021, by the Agricultural Economics Research Association, New Delhi.

Kiran Kumara T.M.

- Best Oral Paper Presentation Award, in 30th National Web Conference (Virtual) on Soil and Water Management Technologies for Climate Resilience, Agricultural and Environmental Sustainability, November 14-16, 2021, for the paper 'Carbon sequestration potential of sustainable agricultural practices: A meta-analysis on evidence and economic assessment' (Kiran Kumara T.M., Suresh Pal, Ankita Kandpal and Prem Chand).

Balaji S.J.

- R.T. Doshi Award for Best Research Article by the Agricultural Economics Research Association(India) for the paper 'Structural transformation, export promotion policy options, and their impact on the Indian economy: a social accounting matrix (SAM) approach', published in the Agricultural Economics Research Review (Venkatesh P., B. D. Pal, S. K. Dubey, V. Sangeetha, M Balasubramanian, V. R. Renjini, D. R. Singh, A. Kar, S. J. Balaji, and S. Pal).

Jaya Jumrani

- Harsh Malhotra Memorial Prize for the Best Paper from the Centre for Development Economics, Delhi School of Economics, University of Delhi, New Delhi.

D.C. Meena

- Best Article Award for the paper 'Land degradation neutrality: Concept, approaches, and benefits', Agriculture & Food: E-newsletter, 4(2): 108-109.

Prabhat Kishore

- Best Paper Presentation Award in 30th National Web Conference organized by Soil Conservation Society of India during December 14-16, 2021.
- Certificate of merit by ICAR-IARI for contribution to National Web Conference organized by Vegetable Farmer Forum, ICAR-IARI-2020 on Economic Evaluation of Protected Cultivation of Capsicum in Maharashtra.

7 Participation in Scientific Activities

Table 7.1: Lectures delivered by ICAR-NIAP scientists

Name of the scientist	Topic	Venue & date
P. S. Birthal	Drivers and impact of climate adaptation strategy	ICAR-NIAP, New Delhi February 5-25, 2022
	Risk management in agriculture	UGC-Human Resource Development Centre, JNU, New Delhi, September 20-October 4, 2021
	Contract farming & PPP in the animal husbandry sector	Extension Education Institute, (Southern Region), Hyderabad, May 18-22, 2021
N. R. Kumar	Mechanizing agriculture: Regional diversity and innovative solutions	ICAR-NIAP, New Delhi, April 15, 2021
	Economics, marketing and export of potatoes in India	ICAR-CPRI, Shimla, February 5, 2022
	Factors affecting farm mechanization	ICAR-NIAP, New Delhi, February 8, 2022
Khem Chand	Agricultural insurance and credit in India	ICAR-NIAP, New Delhi, April 12-16, 2021
	Analysis of risk in crops and insurance support for farmers	ICAR-NIAP, New Delhi, February 5 - 25, 2022
	India budget 2022-What it means for research and innovation in agriculture	Science & Innovation Network, British High Commission, New Delhi, February 25, 2022
Rajni Jain	Multi-criterion approach for analysing state and district level agricultural infrastructural adequacy	NAARM, Hyderabad, February 24, 2022
	Artificial intelligence-based models for plant protection	ICAR-NCIPM, New Delhi, August 28, 2021
	Machine learning and big data	Department of Computer Science and Applications, Dr. Hari Singh Gour University, MP, June 24, 2021

Name of the scientist	Topic	Venue & date
	Rough set theory using R	Department of Computer Science and Applications, Dr. Hari Singh Gour University, MP, June 24, 2021
	Artificial intelligence and decision tree	ICAR-NIAP, New Delhi, February 10, 2022
	Classification using decision trees	ICAR-NIAP, New Delhi, February 18, 2022
Subhash Chand	Status and scope of inputs saving in agriculture production through micro-irrigation in India	ICAR-NIAP, New Delhi, February 5-25, 2022
Shiv Kumar	Agricultural policy reforms in Indian agriculture	ICAR-NIAP, New Delhi, April 12, 2021
	Economic surplus model for impact assessment of agricultural technologies	ICAR-NAARM, Hyderabad, December 20, 2021
	Farmers' innovative and successful experiences worth emulation for getting higher income	ATARI, Ludhiana, June 21, 2021
	Capacity-building program for the sustainable livelihood of tribal women	Amity University, Noida, February 3, 2022
	Value chain analysis and modelling	ICAR-NIAP, New Delhi, February 11, 2022
Raka Saxena	Facilitating agricultural trade, potential & prospects	Directorate of Marketing and Inspection, Nagpur, August 17, 2021
	Role of market intelligence (MI) in agriculture marketing	National Bank Staff College, NABARD, March 14, 2022
	Trade assessment methodologies	ICAR-NIAP, New Delhi, February 5-25, 2022
P. Sharma	Approaches of market integration and price transmission for agricultural commodities	ICAR-NIAP, New Delhi, February 5-25, 2022
	Commodity futures trade in India	ICAR-NIAP, New Delhi April 12-16, 2021
Prem Chand	Agricultural sustainability indicators	ICAR-ATARI, Pune, May 3-5, 2021
	Sustainability issues in agriculture and way forward	ICAR-NIAP, New Delhi, April 12-16, 2021
	Construction of composite index of sustainability	CCS HAU, Hisar, Haryana, December 9, 2021

Name of the scientist	Topic	Venue & date
	Planning of agri-enterprises for enhanced and sustainable farm income: A multi-objective modelling approach	CCS HAU, Hisar, Haryana, December 9, 2021
	Multi-objective optimization for sustainable agriculture	ICAR-NIAP, New Delhi, February 18, 2022
S. K. Srivastava	Economic, ecological and equity dimensions of groundwater irrigation in West Bengal	SCSI, New Delhi, December 14-16, 2021
	Managing natural resources in India	ICAR-NIAP, New Delhi, April 15, 2021
Kingsly I. T	Cereals outlook model	ICAR-NIAP, New Delhi, February 13, 2021
	Introduction to linear programming	ICAR-NIAP, New Delhi, April 14, 2021
D.C. Meena	Assessment of ecosystem services from watershed management	ICAR-NIAP, New Delhi, February 23, 2022
	Importance of backyard vegetable cultivation	ICAR-NIAP, New Delhi, October 26, 2021
Vinayak Nikam	Formation and functioning of Farmer Producer Organizations for inclusive extension and advisory services	Karnataka Veterinary, Animal and Fisheries Sciences University, Bidar (Karnataka) & National Agriculture Development Cooperative Ltd. (NADCL), July 16, 2021
	Farmer Producer Organizations: Formation, functioning and integration in value chain	ICAR-DOGR, Pune, May 7, 2021
	Innovative farmers' institutions and extension systems	ICAR-NIAP, New Delhi, April 13, 2021
	Functioning of Farmer Producer Organizations: New guidelines for sustainability	EEI, Nilokheri, Haryana, August 25, 2021
	Farmer Producer Organisations for emerging dairy enterprises	EEI Nilikheri, Haryana December 12, 2021
Jaya Jumrani	Food and nutritional security in India	ICAR-NIAP, New Delhi, April 12, 2021
	Nutritional security in India	UGC-JNU-HRDC, Jawaharlal Nehru University, New Delhi, September 22, 2021

Name of the scientist	Topic	Venue & date
Balaji S.J.	Agricultural growth: Performance and perspectives	ICAR-NIAP, New Delhi, April 14, 2021
	Machine learning models: Application in forecasting	Rani Lakshmi Bai Central Agricultural University, Jhansi, Uttar Pradesh, July 31, 2021
	Machine learning in agricultural policy decisions	VIT School of Agricultural Innovations and Advanced Learning, Vellore Institute of Technology, Vellore, Tamil Nadu, June 26, 2021
	Understanding agricultural transformation in India: Perspectives for the future	ICAR-NIAP, New Delhi, February 11, 2022
	Agents, interactions, and agricultural performance: The place for input-output models in quantitative policy analysis	ICAR-NIAP, New Delhi, February 21, 2022
Abimanyu Jhajhria	Agricultural value chains and policy imperatives	ICAR-NIAP, New Delhi, April 16, 2021
	Agricultural marketing reforms in India	CCS HAU, Hisar, December 10, 2021
	Fertilizer policy	ICAR-NIAP, New Delhi, February 15, 2022
Prabhat Kishore	Synthetic control method to assess impact of policy interventions: A case of water policy in Punjab	ICAR-NIAP, New Delhi, February 22, 2021.
Kiran Kumara T. M.	Meta-analysis in agricultural research	ICAR-NIAP, New Delhi, February 5-25, 2022
Dilip Kumar	Online survey: Data collection and pre-processing	ICAR- NIAP, New Delhi, February 19, 2022
	Survey Monkey: A cost-effective data collection software for social science research	Government Degree College, Varanasi, March 26-27, 2022

Table 7.2 Trainings attended

Name of the scientist	Name of the event	Venue and duration
Khem Chand	Priority setting, monitoring and evaluation (PME) of agricultural research projects	ICAR-NAARM, Hyderabad, October 25-30, 2021
Rajni Jain	Basics of geographical information system	Indian Institute of Remote Sensing, Dehradun August 27-October 22, 2021
	Fundamentals of remote sensing and GIS technology	Indian Institute of Remote Sensing, Dehradun September 14-28, 2021
Subhash Chand	Advances in extension research and evaluation methodology	ICAR-NAARM, Hyderabad, August 23- September 1, 2021
	Training program for liaison officers (SC/ST)	NPC through ISTM, Delhi, November 29-30, 2021
S.K. Srivastava	Data analysis in social sciences research	ICAR-NAARM, Hyderabad, October 4-8, 2021
Abimanyu Jhajhria	Investment treaties and investor-state dispute settlement system	Department of Economic Affairs and Centre for Trade and Investment Law, New Delhi, April 28-30, 2021
Prabhat Kishore, Jaya Jumrani	Winter School 2021	Delhi School of Economics, Centre for Development Economics and the Econometric Society, December 15-18, 2021
Dilip Kumar	Short course on remote sensing and image analysis (C-RS)	IIRS Dehradun, January 17-March 5, 2022
	Geospatial knowledge management for sustainable agriculture using open source GIS	ICAR-NAARM, February 14-19, 2022
	Programming of web and mobile applications using low-code platforms	ICAR-NAARM, July 07-12, 2021
Jaya Jumrani	Summer School	International Growth Centre Delhi, New Delhi, July 11-14, 2021

Table 7.3: Seminar/Conference/Webinar – Papers presented

Name of the scientist	Name of the event	Venue and duration
Subhash Chand	Status and importance of coastal forest: An economic analysis of Bay of Bengal mangrove, in the Annual Conference of the Soil Conservation Society of India	Odisha University of Agriculture & Technology, Bhubaneswar, December 15, 2021
Raka Saxena	Farm household income: Some recent evidences, *in* the National Workshop on Agricultural Household Income and Research Impact Assessment	ICAR-NIAP, New Delhi November 29, 2021
Balaji S.J.	Welfare implications of expanding conditional cash transfer policy in agriculture: Preliminary evidences under fiscal-neutral and deficit policy choices for India, *in* AAEA & WAEA Joint Annual Meeting 2021	Austin, Texas, USA, August 2, 2021
	Spatial income disparities and agricultural development in India, *in* 31st Triennial International Conference of Agricultural Economists (ICAE)	New Delhi, August 17-31, 2021
	Agricultural productivity, pay-gap, and non-farm development: Contribution to structural transformation in India, *in* 31st Triennial International Conference of Agricultural Economists (ICAE)	ICAE, New Delhi, August 17-31, 2021
	Understanding science and policy making in agriculture: A machine learning application for India, *in* 31st Triennial International Conference of Agricultural Economists (ICAE)	ICAE, New Delhi, August 17-31, 2021
	Welfare gains of inward-looking: An ex-ante assessment of general equilibrium impacts of protectionist tariffs in India's edible oil imports, *in* 29th Annual Conference of the Agricultural Economics Research Association (AERA)	Odisha University of Agriculture & Technology (OUAT), Bhubaneshwar, October 27-29, 2021
	Transforming rural economy: Farm-nonfarm linkages and poverty implications in rural India, *in* International Conference of the Asian Society of Agricultural Economists (ASAE)	Asia Society of Agricultural Economist (ASAE), Beijing, China, December 7, 2021

Name of the scientist	Name of the event	Venue and duration
Prabhat Kishore	Food-groundwater-energy nexus in Indian agriculture, *in* 10th International Conference of Asia Society of Agricultural Economist (ASAE)	Beijing, China, December 6-8, 2021
	Impact of Subsoil Water Preservation Act, 2009, *in* 31st International Conference of Agricultural Economist (ICAE)	New Delhi, August 17-31, 2021
	Assessment of ecosystem services rendered by eastern Yamuna canal, India, *in* 29th National conference of Agricultural Economics Research Association (AERA)	Odisha University of Agriculture & Technology (OUAT), Bhubaneshwar, October 27-29, 2021
	Is water rate could only be criteria to assess viability of canal irrigation system? A case of eastern Yamuna canal, Uttar Pradesh, *in* 30th National Conference of Soil Conservation Society of India	Odisha University of Agriculture & Technology (OUAT), Bhubaneshwar, December 14-16, 2021
	Impacts of sweeping agricultural marketing reforms in a poor state of India: Evidence from repeal of the APMC Act, *in* 16th Annual Conference on Economic Growth and Development	Indian Statistical Institute, Delhi (ISI-D), December 20-22, 2021
Jaya Jumrani	Presented a paper on 'How responsive are nutrients in India? Some recent evidence" in 31st International Conference of Agricultural Economists	New Delhi, August 23, 2021

Table 7.4 : Workshop/Seminar/Conference/Webinar/ Lectures attended

Name of the scientist	Name of the event	Venue & duration
N. R. Kumar	COVID-19 and South Asia: A Conversation with Purvi Mehta, Arvind Panagariya, and Hossain Zillur Rahman	IFPRI, New Delhi, May 07, 2021
	Policy Discourse Series on Food, Nutrition, and Agriculture in India	Tata Cornell Institute (TCI), New Delhi, April 08, 2021
	An Introduction to Climate Change Science, Politics and Impacts	Centre for Science and Environment, Delhi, May 17-28, 2021

Name of the scientist	Name of the event	Venue & duration
	First Shaibal Gupta Memorial Lecture, 2021 – 'Under the Thumb of History?, by Professor Abhijit Vinayak Banerjee	ADRI, Patna, June 21, 2021
	Artificial Intelligence for Smart Agriculture	ICAR-RCER, Patna, July 22, 2021
	How to Make Effective Communication?	ICAR-NIASM, Baramati, July 23, 2021
	Ecosystem for Sustainable Farmer Producer Organization	ICAR-RCER, Patna, July 30, 2021
	Sustainable Integrated Cropping System Models for Enhancing Income of Farmers	ICAR-CPRI Shimla, July 30, 2021
	Climate Change and Agriculture	ICAR-NIASM, Baramati, August 13, 2021
	Transforming Food Systems under Changing Climate: Key Strategies and Actions	ICAR- (CRIDA) Hyderabad, August 23, 2021
	CGIAR's Engagement in the post-UN Food Systems Summit by Dr. Juan Lucas Restrepo	ICAR, New Delhi, October 25, 2021
	An Introduction to Best-Worst Scaling Technique for Analysing Preferences	IFPRI, New Delhi, September 9, 2021
	ICAR-NBFGR: Historical Perspectives and Salient Achievements	ICAR-CIFE, Mumbai, September 25, 2021
	Women's Struggle for Land in South Asia: Can Legal Reforms Trump on Social Norms?	UNU-Wider, December 09, 2021
	Gender and Nutri-sensitive Agriculture	ICAR- New Delhi, December 23, 2021
	International Women's Day	ICAR-IASRI, New Delhi, March 8, 2022
N. R. Kumar, Sant Kumar	Food and Nutrition for Farmers	ICAR, New Delhi, August 26, 2021
N. R. Kumar, Khem Chand, D. C. Meena, Abimanyu Jhajhria	2021 Global Food Policy Report: Transforming Food Systems after COVID-19	IFPRI, New Delhi, July 08, 2021
N. R. Kumar, Khem Chand, D.C. Meena, Balaji S.J., Abimanyu Jhajhria, Sant Kumar, P. Sharma	WTO and Indian Agriculture: Issues, Concerns and Possible Solutions	NAAS, New Delhi, October 7, 2021

Name of the scientist	Name of the event	Venue & duration
N. R. Kumar, Sant Kumar, D. C. Meena, Abimanyu Jhajhria	Agricultural Research Management System (ARMS)	ICT Unit ICAR, New Delhi, October 22, 2021
Suresh Pal, N. R. Kumar, Prem Chand, S.K. Srivastava, P. Sharma, D.C. Meena, Prabhat Kishore, Sant Kumar, Balaji S.J., Sant Kumar	Annual Conference of AERA	OUAT, Bhuwneshwar, October 27-29, 2021
N. R. Kumar, Subhash Chand	India's Options and Strategies for COP26 Negotiations	ICRIER, New Delhi, October 29, 2021
N. R. Kumar, Khem Chand, Prem Chand, P. Sharma, D.C. Meena	Eighty-first Annual Conference of the Indian Society of Agricultural Economics	SMVD University, Katra, December 01-03, 2021
N. R. Kumar, Khem Chand	Rethinking the Way We Farm in India	ICAR, New Delhi, January 24, 2022
Khem Chand, Sant Kumar	Emerging Challenges and Opportunities in Resource Management of Arid Region	ICAR-CAZRI, Jodhpur, September 27, 2021
Khem Chand	Role of Rural India in Sustainable Development	ICAR-NDRI, Karnal, June 26, 2021
	Expectation of agriculture sector from the union budget 2022-23	Krishi Jagran, New Delhi January 29, 2022
	The Paradox of Forest-Grassland Mosaics: Revisiting 'One Climate-one Biome' Paradigm in Shola Grasslands	ICAR-IGFRI, Jhansi, February 10, 2022
Subhash Chand	Evolution of Agricultural Extension Policies in India: Implications for Future	ICAR-NAARM, Hyderabad, September 15, 2021
	Covid-19 and the Indian Economy	Society for Economic Research in India, September 18-19, 2021
	Designing a Climate Law for India: Principles and Form	Centre for Policy Research, New Delhi, September 13, 2021
	Digital Field Book- Paperless Data Collection	CRIDA, Hyderabad, September 15, 2021
	Agricultural Census	ICAR-IASRI, Delhi, October 7, 2021

Name of the scientist	Name of the event	Venue & duration
	ICRIER's 13th Annual International G-20 Conference on Global Economic Coordination in the Age of Pandemic	ICRIER, New Delhi, October 6-8, 2021
	Estimating Economic Costs of Terrorism: The Case of Jammu and Kashmir	Dr. B. R. Ambedkar School of Economics, Bangalore University, Jnana Bharathi Campus, Bengaluru-72, Karnataka, August 27, 2021
	Professional Service Functions (Training, Consultancy, Contract Research and Contract Service Rules and Guidelines	ICAR-Indian Island Institute, Port Blair, August 21, 2021
	APO COE GP India-Taiwan Collaborative Mission Strategic Meeting on Smart Green Technology Co-Creation	National Productivity Council, Taiwan National Organization: China (CPC) Asian Productivity Center (APO COE GP) November 25, 2021
	Africa and India: Experiences with Transformation of Food and Agriculture and Opportunities for Learning and Collaboration.	Indian Council for Research on International Economic Relations (ICRIER), New Delhi, November 26, 2021
	Golden Jubilee Symposium on Rice Gennext Technologies for Enhancing Productivity, Profitability and Resilience of Rice Farming	ICAR-RRI, Cuttack, December 17, 2021
	Effective Implementation of Training Functions by HRD Nodal Officers of ICAR	ICAR-NAARM, Hyderabad, February 21-23, 2022
	International Symposium on Water Sustainability: Challenges, Opportunities and Technologies	Amrita School of Sustainable Development, March 24-26, 2022
	From Innovative Ideas to Scholarly Books in Environmental Sciences	Routledge Taylor and Francis group, March 30, 2022
Subhash Chand, Sant Kumar	Rice-fallow Management in Eastern India	ICAR Research Complex, Patna, Bihar, August 26, 2021

Name of the scientist	Name of the event	Venue & duration
Subhash Chand, D. C. Meena, Kiran Kumara T.M., S.K. Srivastava	30th National Conference on Soil and Water Management Technologies for Climate Resilience, Agricultural and Environmental Sustainability	Soil Conservation Society of India, and Odisha University of Agriculture & Technology, Bhubaneswar, December 14-16, 2021
Sant Kumar	Weather Forecasting for Agriculture	NRRI, Cuttack, April 16, 2021
	Food and Dietary Concepts of Ayurveda- Indian Traditional Wisdom of Food for Better Nutrition and Health	ICAR HQ, New Delhi, June 1, 2021
	World Environment Day lecture on Economy or Environment? Solving the Eternal Conflict	CIBA, Chennai, June 5, 2021
	Mixed Farming for Providing Sustainable Livelihood to Small Farmers	IIVR, Varanasi, July 3, 2021
	Building Resilience against Climate Change: Role of Technologies, Policies and Institutions	ICAR HQ, New Delhi, July 20, 2021
	Sustainable Options for Agricultural Crop Residues Management through Mushrooms	CIPHET, Ludhiana, August 31, 2021
	Organic Farming in Maharashtra: Challenges and Opportunities	NRCG, Pune, September 8, 2021
	Swasth Bharat: Nutritional Challenges with *Daal Roti*	IIW&BR, Karnal , September 21, 2021
	Fruits and Vegetables for Health and Nutrition	KSTI, DST and IIHR, November 8-11, 2021
Sant Kumar, D. C. Meena	Prime Minister's address on Mass Awareness Campaign for Large scale Dissemination of Climate Resilient Technologies and Methods	ICAR HQ, New Delhi, September 28, 2021
P. Sharma, Abimanyu Jhajhria, Dilip Kumar	International Symposium on Data-driven Agriculture and Natural Resource Management- Opportunities and Challenges	Indian Society of Agricultural Information Technology, January 21-22, 2022

Name of the scientist	Name of the event	Venue & duration
P. Sharma	Brainstorming Meeting on Advanced Technologies in Agriculture with focus on AI, ML and IOT	TIFAC New Delhi June 23, 2021
	Workshop on Entrepreneurship in Agriculture and Start-ups: Innovation and Incubation to Connect Science with Farmers	ICAR-IASRI, New Delhi August 10, 2021
	Workshop on Best-Worst Scaling Techniques	Australian Centre of International Agricultural Research, August 9, 2021
Prem Chand, Kiran Kumara T.M.	Agricultural Innovations	Asian Productivity Organization and Vietnam National Productivity Institute, Vietnam, September 15-17, 2021
Prem Chand	Growing Infrastructure Course - Enabling & Structuring for Private Sector Participation in Finance and Innovation	Singapore Management University, Singapore (Online) November 22-26 & December 1-3, 2021
Jaya Jumrani	Winter School 2021	Delhi School of Economics, Centre for Development Economics and The Econometric Society, December 15-18, 2021
S.K. Srivastava	India's National Water Policy-Issues and Suggestions	ICAR-NAARM, November 25-26, 2021
D.C. Meena	APO Digital Conference on Smart Agriculture	Republic of China and APO Secretariat, April 19, 2021
	International Webinar on Restored Our Earth	SKNAU, Jobner, April 22, 2021
	Nutritional Approaches of Dairy Foods for Healthy Life	BHU, Varanasi, June 01, 2021
	Shaping Agri-food System and Sustainable Development Goals for Smallholders: Where are the Solutions?	ICAR, New Delhi, July 9, 2021
	Enabling Regulations to Accelerate Agricultural Innovations	APO Secretariat, July 22, 2021

Name of the scientist	Name of the event	Venue & duration
	Integrated Farming System	ICAR- IIFSR, Modipuram, August 12, 2021
	Abiotic Stress Management in Agriculture	CSAUAT, Kanpur, August 10, 2021
	Rehabilitation of Ravine Landscape of Chambal Division of MP	ICAR-IISWC, RC, Agra, August 17, 2021
	Nutritional Security in India: Issues and Way Forward	ICAR-RCER, Patna, September 04, 2021
	Climate-Smart Agriculture in the context of Smallholder Farmers in the Himalayas	ICAR- VPKAS, Almora, September 08, 2021
	Agriculture in Post-independence India: Looking Back and Looking Ahead	ICAR, New Delhi, September 24, 2021
	Market Intelligence: Agricultural Market and Price Information System	MPUA&T, Udaipur, September 29, 2021
	Webinar on Diversifying Indian Agriculture & Food systems: New Opportunities for Farmers	ICAR-IISWC, Research Centre, Agra, November 03, 2021
	Secondary Agriculture & Sustainable Agriculture Supply Chain Management	ICAR-IISWC, RC, Kota December 07, 2021
	16th Annual Conference on Economic Growth and Development	ISI Delhi, December 20-22, 2021
Sant Kumar, D.C. Meena, Abimanyu Jhajhria	Agricultural Transformation in India	ICAR-IASRI, New Delhi, July 3, 2021
Vinayak Nikam	Policy Discourse Series on Food, Nutrition, and Agriculture in India Confirmation	CFNS, TCI and BAIF June 25, 2021
	Capacity Development for Agriculture Innovation Systems. Lessons Learned and Future Action of the Tropical Agriculture Platform Partnership	FAO, July 5, 2021

Name of the scientist	Name of the event	Venue & duration
Balaji S.J.	STEG Virtual Course on Key Concepts in Macro Development	Centre for Economic Policy Research (CEPR), London February 5 to May 7, 2021 (on various dates)
	2nd SANEM International Development Conference 2021	South Asian Network on Economic Modelling (SANEM), Bangladesh, June 17-19, 2021
	The India Policy Forum 2021	National Council of Applied Economic Research (NCAER), New Delhi, July 12-15, 2021
	Development Research in Practice: The DIME Analytics Data Handbook	World Bank, Washington DC, July 14, 2021
	DMEO Conversation Series: Designing Governments' Evaluation Strategies	NITI Aayog , August 27, 2021
	United Nations World Data Forum 2021	United Nations, October 3-6, 2021
	In-Finity Forum	Government of India & International Financial Centres Authority (IFSCA), December 3&4, 2021
	Food for All: International Organizations & the Transformation of Agriculture	World Bank Group, Washington DC, January 20, 2022
	Discussion with Leading Think Tanks	NITI Aayog, February 8, 2022
	DB-ADBI Innovation and Structural Transformation Database	Asian Development Bank Institute, Tokyo, February 22, 2022
	Prospects for Transitioning from a Linear to Circular Economy in Developing Asia	Asian Development Bank Institute, Tokyo, Japan, March 1, 2022
	Retail Food Prices and Implications for Food Security	International Food Policy Research Institute, Washington DC, March 29, 2022

Name of the scientist	Name of the event	Venue & duration
Kiran Kumara T M	Digital Multi-country Observational Study Mission on Emerging Models of Controlled-Environment Agriculture in Japan	Asian Productivity Organization July 27-29, 2021
	Review and Sensitization Workshops of ZTMUS/ITMUS/PMES under NAIF scheme	New Delhi, October 8, 2021
Dilip Kumar	सांख्यिकीय आनुवंशिकी और कृषि में इसके अनुप्रयोग	ICAR-IASRI, March 18-20, 2021
	कृषि में सांख्यिकीय मॉडलिंग एवं पूर्वानुमान	ICAR-IASRI, June 24-26, 2021
	Integrated Farming Systems: A Tool for Enhancing Income and Nutritional Security	ICAR-RCER, Patna, October 5-7, 2021
	Digital Field Book- Paperless Data Collection	Department of Genetics And Plant Breeding, Faculty of Agriculture, Animalia University September 15, 2021

Participation in other scientific events

Suresh Pal

- XXV ICAR Regional Committee No. II for West Bengal, Odisha, Telangana, Andhra Pradesh and the Union Territory of Andaman & Nicobar Islands, April 12, 2021
- Brainstorming Session on Regenerative Agriculture for Soil Health, Food and Environmental Security organized by TAAS, April 30, 2021
- Twenty-Eighth General Body Meeting and Foundation Day Program of NAAS, June 4-5, 2021
- High Level Monitoring Committee Meeting for Effective Planning, Implementation and Monitoring of Central Sector Scheme on Promotion of Agricultural Mechanisation for In-Situ Management of Crop Residue in the States of Punjab, Haryana, Uttar Pradesh and NCT of Delhi, June 25, 2021
- Director's Conference of ICAR Institutes, July 2, 2021
- Launch of HLPE Report on Promoting Youth Engagement and Employment in Agriculture and Food Systems, July 5, 2021
- Meeting on Agritech Task Force called by Secretary, DARE and DG, ICAR, July 5, 2021
- Launch of 2021 Global Food Policy Report: Transforming Food Systems after COVID-19, July 8, 2021
- 93rd ICAR Foundation Day, July 16, 2021
- 28th Dr. B.P. Pal Memorial Lecture on Resilient Agriculture: The Pivot For Sustainable Development, organized by ICAR-IARI, July 20, 2021
- XXVI Meeting of ICAR-Regional Committee No. V for Panjab, Haryana and Delhi, July 27, 2021
- 28th Annual General Body Meeting of NAAS, August 9, 2021

- High Level Monitoring Committee on Promotion of Agricultural Mechanization for In-Situ Management of Crop Residue in the States of Punjab, Haryana, Uttar Pradesh and NCT of Delhi', August 12, 2021
- 31st Triennial International Conference of Agricultural Economists (ICAE) organized by International Association of Agricultural Economists (IAAE), August 17- 31, 2021
- National Workshop on Bridging the Yield Gaps to Enhance Foodgrain Production: A Way Forward, organized by TAAS, ICAR, IRRI, ICRISAT and ICARDA, August 26, 2021
- Brainstorming Session on WTO and Indian Agriculture: Issues, Concerns and Possible Solutions, organized by NAAS on October 7, 2021
- High Level Monitoring Committee Meeting for Effective Planning, Implementation and Monitoring of Central Sector Scheme on Promotion of Agriculture Mechanization for In-Situ Management of Crop Residue in the States of Punjab, Haryana, Uttar Pradesh and NCT of Delhi, October 11, 2021
- XV Agricultural Sciences Congress on November 14, 2021.
- Farmers' Income and Research Impact Assessment, ICAR-NIAP, November 29, 2021
- Brainstorming Session on Regenerative Agriculture for Soil Health, Food and Environmental Security, organized by TAAS on November 30, 2021
- Discussion Meeting on Issues Related to Agriculture in Madhya Pradesh organized by Research and Information System for Developing Countries (RIS) on December 10, 2021, at India International Centre
- ICAR-Regional Committee No. III for Assam, Sikkim, Mizoram, Arunachal Pradesh, Nagaland, Tripura, and Meghalaya on December 11, 2021
- Roundtable Discussion on Nav Harit-Kranti: An Agro-Vision, organized by Patanjali Research Institute on December 19, 2021
- Annual Review Meeting of CG Centres, February 7, 2022
- Discussion with Leading Think Tanks, NITI Aayog, February 8, 2022
- Expert Consultation on Promoting Efficient Irrigation Technologies for Water Saving Across Scales and Sectors organized by IWMI, TAAS, ICAR, ICAR-IIWM, February 25, 2022
- 93rd AGM of the ICAR, March 26, 2022, at NASC Complex

Pratap Singh Birthal

- Brainstorming session on WTO and Indian Agriculture, organized by NAAS on October 7, 2021.
- Panellist in Brainstorming Session: Preparedness for Prevention of Transboundary Infectious Diseases of Livestock and Poultry in South Asian countries (SAARC countries) by National Academy of Agricultural Sciences (NAAS), International Livestock Research Institute (ILRI), South Asian Association for Regional Cooperation (SAARC) and Bangladesh Academy of Agriculture (BAAG) on February 15, 2022.
- Webinar on India's SDG-2 Challenge: Zero Hunger by 2030? organized by India Agriculture Advancement Group (IAAG) International on Feb 21, 2022.
- Panellist in International Conclave on Transition towards Sustainability of Agriculture: Role of Technology in Agriculture Supply Chain, organized by SRM University AP on June 3-4, 2022

- Chaired a Technical Session of the ISCA Webinar - International Symposium on Coastal Agriculture: Transforming Coastal Zone for Sustainable Food and Income Security organized by the Indian Society of Coastal Agriculture, during March 16-19, 2021

Nalini Ranjan Kumar

- Member of the Committee on Economic Analysis of Alternative/ Ex-Situ Crop Residue Management Options, MoA&FW, New Delhi

Rajni Jain

- Workshop on Implementation and Use of Agricultural Research Management System (ARMS), June 8, 2021, and December 23, 2021
- Virtual International Symposium on Data Driven Agriculture and Natural Resource Management, January 21-22, 2022

Shiv Kumar

- Management and Impact Assessment of Farmer FIRST Project, held at ICAR-ATARI, Jodhpur on February 14, 2022

Raka Saxena

- Brainstorming Session on Doubling Farmers' Income on October 01, 2021.

S. K. Sriavastava

- Panelist in a session on Carrots, Sticks, Equity: Managing Over-pumped Groundwater Systems Sustainably, organized by International Water Management Institute on August 25, 2021.
- Panelist in Evidence Needs for Sustainable Food Systems and Resilient Livelihoods, organized by DMEO, NITI Aayog in association with World Food Program (WFP) on March 17, 2022

D. C. Meena

- Course Coordinator 21-day training on Analytical Techniques for Decision Making in Agriculture, organised by ICAR-NIAP, February 05- 25, 2022.
- Rapporteur for Plenary Session in International Symposium on Data-Driven Agriculture and Natural Resource Management – Opportunities and Challenges organized by INSAIT during January 21-22, 2022.

Balaji S. J.

- Co-convener of the Brainstorming Session on Agriculture and Food Policy for Five Trillion Dollar Economy, organized by NAAS on October 14, 2020

Prabhat Kishore

- Chaired a session on Revitalizing Asian Rural Economy: Agricultural Transformation, in the 10th International Conference of Asia Society of Agricultural Economist (ASAE), December 6-8, 2021

Participation in TV/Radio Talk

Suresh Pal

- Discussion on Budget, February 1, 2022, DD Kisan, New Delhi

P. Sharma

- Participated in a TV talk on Budget Discussion, DD Kisan, February 1, 2022
- DD Kisan Vichar Vimarsh on Budget Expectations for Farmers, DD Kisan, January 28, 20211
- Vichar Vimarsh (Program on *Rabi* MSP), DD Kisan, September 14, 2021

Raka Saxena

- Agriculture Budget Discussion, DD Kisan, February 3, 2022
- Food Safety Issues in Domestic and International Marketing, FM Gold Channel, June 1, 2021

8 Management Committee Meetings

Research Advisory Committee (RAC)

The first meeting of the Xth RAC of the ICAR-NIAP was held on 17 November 2021 to review research progress and future programs of the Institute under the chairmanship of Dr. Harsh K. Bhanwala, former Chairman, National Bank for Agriculture and Rural Development Mumbai. The Director of the ICAR-NIAP made a brief presentation on the Institute's research achievements during 2020-21 and on the proposed research programs for 2021-25. Detailed presentations on research projects were made by the conveners of different themes. The RAC members appreciated the research progress under different research projects and opined that the future research programs are aligned with the national goals and priorities. The Committee members who participated in the meeting are listed in Table 8.1.

Institute Management Committee (IMC)

The 30th meeting of the Institute Management Committee was held on December 4, 2021, under the chairmanship of the Director, ICAR-NIAP. He apprised the Members of the progress made by the Institute in different aspects of research and administration. The IMC members appreciated the progress made, and they also appreciated the field work done by the scientists for the benefit of the farmers.

Table 8.1. Research Advisory Committee

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, New Delhi	Member
Dr. A.K. Singh Former Director, Giri Institute of Development Studies (GIDS), Lucknow	Member
Dr. P. Kumar Former Head, Division of Agricultural Economics, ICAR-IARI, New Delhi	Member
Dr. Suresh Pal Director, ICAR-NIAP, New Delhi	Member
Shri Harbir Singh, Village-Dadlu, P.O. Rava, Dist. Kurukshetra, Haryana	Member
Sh. Rajpal Rana Mukhamelpur, Delhi	Member (Ex-Officio)
Dr. Khem Chand Principal Scientist (Ag. Economics), ICAR-NIAP, New Delhi	Member Secretary

Table 8.2. Institute Management Committee

Dr. Suresh Pal Director, ICAR-NIAP, New Delhi	Chairman
Dr. S. K. Soam, Head, ICM, lCAR-NAARM, Hyderabad	Member
Dr. D. P. Malik, CCS Haryana Agricultural University, Hisar, Haryana	Member
Shri Harbir Singh, Village-Dadlu, P.O. Rava, Dist. Kurukshetra, Haryana	Member
Shri Rajpal Rana, Mukhamelapur, Delhi.	Member
Dr. G.K. Jha Principal Scientist, ICAR-IARI, New Delhi	Member
Dr. T.M. Gajanana Principal Scientist, ICAR-IIHR, Bengaluru, Karnataka	Member
Dr. Mahesh Chander Head, Extension Education Division ICAR-IVRI, Bareilly, Uttar Pradesh	Member
Dr. K.P. Tripathi Principal Scientist, Education Division, ICAR, KAB·II, New Delhi	Member
Director, Directorate of Economics and Statistics, Delhi	Member
Director (Economics and Statistics) Department of Planning, Government of Haryana, Chandigarh	Member
Mr. Pawan Kumar Gupta, Sr. Finance and Accounts Officer, ICAR- NBPGR, New Delhi	Member
Administrative officer, ICAR-NIAP, New Delhi	Member Secretary

Institute Research Council (IRC)

The annual IRC meeting of the Institute was held on October 12, 2021, through video-conferencing under the chairmanship of the Director, ICAR-NIAP. The Chairman briefed the experts about the agenda of the IRC meeting and introduced the research themes. The experts appreciated the excellent research work done and provided valuable suggestions for further improvement. It was suggested to initiate research on big data analysis, RCTs (Randomised Controlled Trial), agriculture-nutrition linkages and behavioural economics.

9 Other Institute Activities

Foundation Day

The ICAR-NIAP celebrated its Foundation Day on 19 July, 2021. The function was presided over by Dr. Ramesh Chand, Member, NITI Aayog and was attended by several eminent personalities, including Dr. Trilochan Mohapatra, Secretary DARE and Director General, ICAR, Dr. Mruthyunjaya and Dr. Pramod Kumar Joshi. Dr. Derek Byerlee, former Lead Economist at the World Bank and Adjunct Professor at the Georgetown University, Washington, D.C. delivered the 15th Professor Dayanantha Jha Memorial Lecture. Besides, the Foundation Day Award was given to Dr. Smita Sirohi, Adviser (Agriculture and Marine Products), Embassy of India, Brussels.

Azadi ka Amrit Mahotsav Celebrations

ICAR-NIAP organized a webinar entitled 'Tools at Workplace for Personal Efficiency' on 7 August 2021. Mr. Satinder Chawla, a renowned Scientologist, delivered the lecture online via the zoom platform. About 137 persons, including NIAP staff, attended it online, and the rest watched the live program on Facebook.

ICAR-NIAP also organized a webinar on 'Space Technologies in Agriculture' on 18 September 2021. Dr. Prakash Chauhan, Director, Indian Institute of Remote Sensing, ISRO, presented various applications of satellite-based imageries for use in agriculture.

The ICAR-NIAP launched its first Agricultural Development Report 2020-21 on 22 June 2021. Dr. Mruthyunjaya and Dr. P. K. Joshi graced the occasion and commented on the Report.

Ambedkar Jayanti Celebration

ICAR-NIAP celebrated Ambedkar Jayanti on 14 April 2020. The staff read out the preamble of the Constitution of India and took the oath to abide by the constitutional duties.

Annual Sports Meet

ICAR-NIAP organized Annual Sports Meet on April 3-5, 2021. Badminton, Carrom, Table Tennis and Musical Chair competitions were conducted for staff of the Institute.

Anti-Terrorism Pledge

ICAR-NIAP staff took the Anti-terrorism pledge on 21 May 2021.

World No Tobacco day

ICAR-NIAP observed World No Tobacco Day on 31 May 2021.

Vigilance Awareness Week

ICAR-NIAP observed Vigilance Awareness Week from 26 October to 1 November 2021. Poster and essay writing competitions were organized to spread awareness about Independent India @ 75: Self-Reliance with Equity.

Poster competition during Vigilance Awareness Week

Hindi Pakhwara

For the implementation and extensive use of Hindi, the Rajbhasa Committee of the ICAR-NIAP organized a series of events during 14-28 September 2021. These included debates, essay writing competitions and poem recitation.

Constitution Day

The ICAR-NIAP observed 26 November 2021 as Samvidhan Diwas (Constitution Day).

Swachhata Pakhwara

The ICAR-NIAP organized Swachhata Pakhwara from 16-31 December 2021 to promote cleanliness in the Institute.

Kisan Diwas

The ICAR-NIAP observed Kisan Diwas on 23 December 2021 by organizing an interface meeting with farmers.

Promotion of Official Language

For extensive use of Rajbhasha, the Rajbhasha Committee of the Institute regularly monitors the progress of the implementation of the recommendations and guidelines issued by the Central Rajbhasha Department. The Rajbhasha Committee submitted quarterly progress reports to the Central Rajbhasha Department and ICAR Headquarter and a half-yearly progress report to Nagar Rajbhasha Karyanvyan Samiti. The Institute's Rajbhasha Karyanvyan Samiti organized quarterly workshops on various topics to motivate the staff to use Hindi in official works extensively.

The Institute's Rajbhasha Samiti implemented all the guidelines, circulars and instructions issued by ICAR as well as Central Rajbhasha Department, Government of India. The Institute has bilingual facilities in terms of Hindi fonts and Unicode for Hindi typing in all the computers. The Institute organized the following Hindi workshops : हिंदी कार्यशाला दिनांक 29.09.2021; विषय "राजभाषा, राष्ट्रभाषा एवं मात्रभाषा का एतिहास एवं हमारे संविधान में राजभाषा का प्रावधान पर"। इस अवसर पर भारतीय कृषि अनुसन्धान परिषद के सहायक महानिदेशक डा ऐ. के. व्यास ने विस्तार से व्याख्यान दिया । द्वितीय राजभाषा कार्यशालाः विषय "राजभाषा के नियमों अधिनियमों एवं हिन्दी पत्राचार" दिनांक 14.03.2022। राजभाषा कार्यशाला में श्री केशव देव, उपनिदेशक भारतीय कृषि अनुसंधान सं, थाननई दिल्ली स ने स्तारवि से भाषण दिया।

The Official language committee of the ICAR-NIAP organized a series of events during "Hindi Pakhawada" from 14 to 28 September 2021 to create awareness among staff about Hindi. These activities include debate in Hindi on 14.09.2021 विषयः नगदी रहित (केशलेश) अर्थव्यवस्था (पक्ष /विपक्ष) and essay competition on 20.09.2021: विषयः 1. सौर्य ऊर्जा का वैकल्पिक महत्त्व एवं भविष्य 2.कोरोना महामारी 2019 का भारतीय अर्थ व्यवस्था पर प्रभाव". The other activities include "प्रशासनिक ड्राफ्टिंग/पत्र लेखन" in Hindi. Hindi Phakhwada ended with poem recitation on 28.09.2021.

हिंदी कार्यशाला

संस्थान में हिंदी अनुवाद–कार्य कुशलता बढाने हेतु वर्चुअल कार्यशाला का आयोजन 23 जनवरी 2021 को किया गया, जिसमे संस्थान के समस्त वैज्ञानिकों, अधिकारियों एवं कर्मचारियों ने हिस्सा लिया और अनुवाद किया।

राजभाषा समिति की बैठक

राजभाषा समिति की तिमाही बैठक 30 जनवरी, 2021 को संपन्न हुई।

10 Personnel and Budget

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**	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	Senior Scientist
15.	Dr. Kingsly Immanuelraj T.	Senior Scientist
16.	Dr. Dinesh Chand Meena	Scientist
17.	Mrs. Arathy Ashok	Scientist
18.	Mrs. Pavithra Srinivasamurthy	Scientist
19.	Dr. Vinayak Ramesh Nikam	Scientist
20.	Ms. Jaya Jumrani	Scientist
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	Scientist
26.	Dr. Ankita Kandpal	Scientist
27.	Dr. Kiran Kumara T. M.	Scientist
28.	Mr. Dilip Kumar	Scientist

*Dr. Suresh Pal, Director, ICAR-NIAP, superannuated from the ICAR Service w.e.f. 31.03.2022

**Dr. Naveen Prakash Singh, Principal Scientist, is on deputation as a Member of the CACP, New Delhi

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.	Mr. Chander Vallabh	Administrative Officer
2.	Mr. Mohammad Irfan	Assistant Finance & Accounts Officer
3.	Mr. Inderjeet Sachdeva	Assistant Administrative Officer
4.	Mrs. Umeeta Ahuja	Private Secretary
5.	Mr. Yatin Kohli	Assistant
6.	Mr. Harish Vats	Assistant
7.	Mr. Deepak Tanwar	Personal Assistant
8.	Mr. Ajay Tanwar	Upper Division Clerk
9.	Mrs. Kanika Arora	Lower Division Clerk
10.	Mr. Mahesh Kumar	Lower Division Clerk

Skilled Supporting Staff

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

Promotions & Transfer

Sr. No.	Name & Designation
1	Dr. Balaji S.J., Scientist, was promoted to the next higher grade, from Level-10 to Level 11 under C.A.S. w.e.f 01.07.2019
2	Mr. Subash S.P., Scientist, was promoted to the next higher grade, from Level-10 to Level 11 under C.A.S. w.e.f 01.07.2020
3	Dr. Abimanyu Jhajhria, Scientist, was promoted to the next higher grade, from Level-10 to Level 11 under C.A.S. w.e.f. 01.01.2020
4	Mr. Prabhat Kishore, Scientist, was promoted to the next higher grade, from Level-10 to Level 11 under C.A.S w.e.f 05.07.2021

Sr. No.	Name & Designation
5	Dr. Shivendra Kumar Srivastava, Scientist, was promoted to the next higher grade, from Level 11 to Senior Scientist in Level 12 under C.A.S. w.e.f. 20.04.2019
6	Dr. Kingsly Immanuelraj T, Scientist, was promoted to the next higher grade, from Level 11 to Senior Scientist in Level 12 under C.A.S. w.e.f. 27.04.2020
7	Dr. Prem Chand, Senior Scientist, promoted to the next higher grade, from Level 12 to 13 A under C.A.S w.e.f. 21.04.2021
8	Dr.Vikas Kumar, Senior Scientist, was promoted to the next higher grade, from Level 12 to 13 A under C.A.S. w.e.f. 23.06.2021
9.	Mr. Deepak Tanwar, Stenographer Grade-III, was promoted to the post of Personal Assistant (Level 6) w.e.f. 15-3-2022

New Joining

S. No.	Name & Designation	Joined on
1.	Mrs. Kanika Arora, Lower Division Clerk	21.12.2021

Study Leave

S. No.	Name & Designation	Study Leave Period
1.	Mrs. Arathy Ashok, Scientist	01.08.2019 to 31.07.2022
2.	Mrs. Pavithra Srinivasamurthy, Scientist	19.08.2019 to 18.08.2022
3.	Mr. Subash S.P., Scientist	20.07.2021 to 19.07.2024
4.	Ms. Jaya Jumrani, Scientist	08.09.2021 to 07.08.2023

Retirement

S. No.	Name & Designation	Date of superannuation
1.	Dr. Suresh Pal, Director	31.03.2022

Transfer

S. No.	Name & Designation	Date of Transfer
1.	Dr. Abimanyu Jhajhria, Scientist	Transferred to ICAR-IISWC, Dehradun, Uttarakhand on 31-3-2022

Budget

Table 10.1: ICAR-NIAP Expenditure, 2021-22

(Rs. in Lakhs)

Head	Expenditure
Grant for Creation of Capital assets (Capital)	
Equipment	26.66
Information Technology	38.46
Library Books and Journals	24.91
Furniture & Fixtures	2.97
Others	0.00
Total Capital Expenditure (A)	**93.00**
Grant in Aid-Salaries (Revenue)	**777.23**
Pension and other Retirements benefits	31.00
Total Establishment Expenses (B)	**808.23**
Grant in Aid-General	
Travelling Allowance	0.80
Research and Operational Expenses	183.90
Administrative Expenses	214.38
Others	0.90
Total Expenditure Grant in Aid-General (C)	**399.98**
Grand Total (A+B+C)	**1301.21**
SCSP Grant in Aid Capital	18.73
SCSP Grant in Aid General	51.94
Total Expenditure SCSP (D)	**70.67**
Total Expenditure, including SCSP **(A+B+C+D)**	**1371.88**
Revenue receipt	**27.90**
Budget of Externally funded projects	**139.98**