ANNUAL REPORT 2018-19

भाकृअनुप - राष्ट्रीय कृषि आर्थिकी एवं नीति अनुसंधान संस्थान

ICAR – National Institute of Agricultural Economics and Policy Research

(Indian Council of Agricultural Research)

Annual Report
2018-19

ICAR – National Institute of Agricultural Economics and Policy Research
(Indian Council of Agricultural Research)
New Delhi - 110 012

ICAR-NIAP Annual Report 2018-19

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Preface

The ICAR-National Institute of Agricultural Economics and Policy Research (NIAP) has been a partner with the Indian Council of Agricultural Research and Government Departments for agricultural policy reforms and farmers' welfare. The year under report has witnessed strengthening of this partnership and advancing the role of technology in doubling farmers' income and promoting sustainability of agricultural systems. The Institute has also fostered partnership with sister institutes of ICAR, state agricultural universities and other academic institutions. Outreach of the research programs and publications has also shown significant improvement. Independent evaluation has shown that rate of citation of NIAP publications is the highest among ICAR institutes.

The significant research contributions of the Institute pertain to the area of structural transformation of agriculture, climate-resilient agriculture, mapping of agricultural commodity value chains, commodity modelling, gender mainstreaming, resource use planning, and micro-irrigation. The Institute was also engaged in policy dialogue with Department of Agriculture, Cooperation and Farmers' Welfare for doubling farmers' income, ease of doing agri-business, and price forecasting. Commodity price stabilization, evaluation of R&D organizations, and export policy are some of the areas where the Institute has provided proactive inputs for decision making.

Capacity development for agricultural policy research is another important mandate of NIAP and the Institute organized short courses and training sessions for collaborating partners and other social scientists. The Institute also organized two training programs for the probationers of Indian Economic Service. The Institute also shared the responsibility of reform process in ICAR and facilitated Outcome Review of ICAR. The Institute maintained linkages with Ministry of Finance, NITI Aayog, CG Centres, NABARD and other organizations of repute.

On behalf of the Institute, I sincerely thank Dr T. Mohapatra, Secretary, DARE and Director General, ICAR; Sh. Sushil Kumar, Additional Secretary, DARE and Secretary, ICAR, and Sh. B. Pradhan, Additional Secretary, DARE and Financial Advisor, ICAR for their guidance and continuous support. Thanks are also due to Dr N S Rathore, Deputy Director General (Ag Education) and Dr G Venkateshwarlu, Assistant Director General (EQA&R) for their support in undertaking various activities of the Institute. Members of the Institute Management Committee and Research Advisory Committee provided guidance for successful completion of various activities. I sincerely thank all my colleagues for their cooperation, particularly Dr S. K. Srivastava for coordination of the Annual Report, and Dr Prem Chand, Dr Balaji S. J. and Mrs Sonia Chauhan for their help in compilation of the material.

(Suresh Pal)
Director

31 May, 2019

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List of Acronyms

AAEA	Agriculture & Applied Economics Association
AAU	Assam Agricultural University
ACIAR	Australian Centre for International Agricultural Research
ACZ	Agro Climatic Zones
ADG	Assistant Director General
AE	Allocative Efficiency
AERA	Agricultural Economics Research Association
AHP	Analytical Hierarchy Process
AKMU	Agricultural Knowledge Management Unit
ANGARU	Acharya N. G. Ranga Agricultural University
APLM	Agricultural Produce and Livestock Marketing
APMC	Agricultural Produce Market Committee
APO	Asian Productivity Organisation
ARDL	Autoregressive Distributed Lag
ARS	Agricultural Research Service
ASRB	Agricultural Scientists Recruitment Board
ATARI	Agricultural Technology Application Research Institute
ATET	Average Treatment Effect of Treated
ATMA	Agricultural Technology Management Agency
BHU	Banaras Hindu University
BSMA	Broad Subject Matter Area
BVICAM	Bharati Vidyapeeth's Institute of Computer Applications and Management
CAEPHT	College of Agricultural Engineering and Post-Harvest Technology
CAS	Current Awareness Service
CASI	Conservation Agriculture Sustainable Intensification
CAU	Central Agricultural University
CAZRI	Central Arid Zone Research Institute
CD	Compact Disc
CE	Cost Efficiency
CEO	Chief Executive Officer
CGE	General Equilibrium
CGIAR	Consultative Group on International Agricultural Research
CHC	Custom Hiring Centres
CIFE	Central Institute of Fisheries Education
CIMMYT	International Maize and Wheat Improvement Centre
CPGS	College of Post Graduate Studies
CPH	Central Plateau and Hills
CRS	Constant Return to Scale
CSSRI	Central Soil Salinity Research Institute
CTRI	Central Tobacco Research Institute
CV	Coefficient of Variation
DAC&FW	Department of Agriculture Cooperation and Farmers Welfare
DARE	Department of Agricultural Research and Education
DBT	Direct Benefit Transfers
DDG	Deputy Director General
DDS	Document Delivery Service
DEA	Data Envelopment Analysis
DFI	Doubling Farmers' Income
DKMA	Directorate of Knowledge Management in Agriculture
DMI	Directorate of Marketing & Inspection
DMSP	Defense Meteorological Satellite Program
EAS	Extension and Advisory Services
EASRCA	Southeast Asian Regional Center for Graduate Study and Research in Agriculture
ECH	East Coastal Plains and Hills
EPH	Eastern Plateau and Hills
EPW	Economic and Political Weekly
EQA&R	Education Quality Assurance and Reforms
ERNET	Education and Research Network
ERP	Enterprise Resource Planning
FA	Forwarding Agents
FAO	Food and Agricultural Organization
FBOs	Farmer Based Organisations
FCI	Food Corporation of India
FICCI	Federation of Indian Chambers of Commerce and Industry
FMS	Financial Management System
FPO	Farmer Producer Organizations
FRP	Fair and Remunerative Prices
GHG	Green House Gases

GIS	Geographic Information System
GM	Gnetically Modified
GMM	Generalized Methods of Moments
GPF	Gross Provident Fund
GPH	Gujarat Plains and Hills
GSDP	Gross State Domestic Product
GSVA	Gross State Value Added
HAU	Haryana Agricultural University
HER	Eastern Himalayan Region
HYPM	Half-Yearly Progress Monitoring
IAAE	International Association of Agricultural Economists
IARI	Indian Agricultural Research Institute
IASRI	Indian Agricultural Statistical Research Institute
ICAE	International Conference of Agricultural Economics
ICAR	Indian Council of Agricultural Research
ICRIER	Indian Council for Research on International Economic Relations
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ICT	Information and Communication Technology
IEG	Institute of Economic Growth
IFPRI	International Food Policy Research Institute
IES	Indian Economic Services
IFAD	International Fund for Agriculture Development
IFFCO	Indian Farmers Fertiliser Cooperative Limited
IFPRI	International Food Policy Research Institute
IIMR	Indian Institute of Millets Research
IISH	Indian Institute of Spices Research
IIT	Indian Institute of Technology
IIVR	Indian Institute of Vegetable Research
IIWM	Indian Institute of Water Management
ILL	Inter Library Loan
ILRI	International Livestock Research Institute
IMC	Inter-Ministerial Committee /Institute Management Committee
IPCC	Intergovernmental Panel on Climate Change
IPRS	Intellectual Property Rights
IRC	Institute Research Council
IRF	Impulse Response Functions
IRRI	International Rice Research Institute
ISEC	Institute for Social and Economic Change
ISO	International Organization for Standardization
IVRI	Indian Veterinary Research Institute
IWGI	Irrigation Water Governance Index
IWMI	International Water Management Institute
JKHPMC	Jammu & Kashmir Horticultural Produce Marketing and Processing Corporation Ltd.
JNKVV	Jawaharlal Nehru Krishi Vishwa Vidyalaya
JSC	Joint Staff Council
JV	Joint Ventures
KHMS	Kulachi Hansraj Model School
KVKS	Krishi Vigyan Kendras
LAN	Local Area Network
LGP	Lower Gangetic Plains
M&A	Mergers and Acquisitions
MAYA	Motivating and Attracting Youth in Agriculture
MFC	Marginal Factor Cost
MGMG	Mera Gaon Mera Gaurav
MGNREGS	Mahatma Gandhi National Rural Employment Guarantee Scheme
MGP	Middle Gangetic Plains
MI	Micro Irrigation
MIS	Management Information System
MoA&FW	Ministry of Agriculture and Farmers Welfare
MOFPI	Ministry of Food Processing Industries
MPUA&T	Maharana Pratap University of Agriculture and Technology
MSP	Minimum Support Price
MVP	Marginal Value Product
NRRI	National Rice Research Institute
NAARM	National Academy of Agricultural esearch Management
NAAS	National Academy of Agricultural Sciences
NABARD	National Bank for Agriculture and Rural Development
NAFED	National Agricultural Cooperative Marketing Federation of India Ltd
NAHEP	National Agricultural Higher Education Project
NARS	National Agricultural Research System
NASC	National Agricultural Science Centre
NBPGR	National Bureau of Plant Genetic Re-

	sources
NCAER	National Council of Applied Economic Research
NDRI	National Dairy Research Institute
NGOS	Non-Governmental Organisations
NIASM	National Institute of Abiotic Stress Management
NITI	National Institution for Transforming India
NKN	National Knowledge Network
NRAA	National Rainfed Area Authority
NRAKAS	National Rajbhasha Krinyan Society
NRCSS	National Research Centre on Seed Spices
NRM	Natural Resource Management
NSSO	National Sample Survey Office
OB	Outcome Budget
OBC	Other Backward Class
OECD	Organisation for Economic Co-Operation and Development
OMIFCO	Oman India Fertiliser Company
PAD	Precision Agriculture for Development
PAU	Punjab Agricultural University
PCA	Principal Component Analysis
PDS	Public Distribution System
PELT	Pruned Exact Linear Time
PERMISNET	Personnel Management Information System Network
PHC	Pre-Harvest Contractor
PIMS	Project Information and Management System
PMFBY	Prime Minister Fasal Bima Yojna
PMKSY	Pradhan Mantri Krishi Sinchyaee Yojana
PMO	Prime Minister's Office
PPI	Peoples Participation Index
PVAR	Panel Vector Auto Regression
QML	Quasi-Maximum Likelihood
R&M	Rapeseed and Mustard
RAC	Research Advisory Committee
RCEP	Regional Comprehensive Economic Partnership
RFIS	Reliance Foundation Information Service
RII	Rural Infrastructure Index
RIS	Research and Information System for Developing Countries
RMSE	Root Mean Square Error
RNFE	Rural Non-Farm Employment
RTI	Right To Information
SAARC	South Asian Association for Regional Cooperation
SAU	State Agricultural Universities
SC	Schedule Caste
SDG	Sustainable Development Goal
SE	Scale Efficiency
SEM	Structural Equation Model
SFAC	Small Farmers' Agribusiness Consortium
SID	Simpson's Diversification Index
SKUAST-K	Sher-E-Kashmir University of Agricultural Sciences & Technology of Kashmir
SLA	Sustainable Livelihood Approach
SLSI	Sustainable Livelihood Security Index
SPH	Southern Plateau and Hills (SPH)
SQL	Structured Query Language
ST	Schedule Tribe
TCI	Tata Cornell Institute for Agriculture and Nutrition
TE	Technical Efficiency
TERI	The Energy and Resources Institute
TGP	Trans Gangetic Plains
TNAU	Tamil Nadu Agricultural University
TRIPS	Agreement on Trade-Related Aspects of Intellectual Property Rights
UDC	Upper Division Clerk
UGP	Upper Gangetic Plains
UNDP	United Nations Development Programme
UPDES	Uttar Pradesh Department of Economics & Statistics
USDA	United States Department of Agriculture
VAR	Vector Auto-Regression
VAW	Village Agricultural Workers
VDSA	Village Dynamics in South Asia
VPO	Village Producer Organizations
VRS	Variable Return To Scale
WCH	West Coastal Plains and Hills
WDR	Western Dry Region
WDRA	Warehousing Development and Regulatory Authority
WEAI	Women Empowerment in Agriculture Index
WHR	Western Himalayan Region
WIPO	World Intellectual Property Organization
WPH	Western Plateau and Hills
WPI	Wholesale Price Index
WTO	World Trade Organisation
WUA	Water User Associations

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भाकृअनुप–राष्ट्रीय कृषि आर्थिकी एवम् नीति अनुसंधान संस्थान, नई दिल्ली, कृषि नीति अनुसंधान के क्षेत्र में भारतीय कृषि अनुसंधान परिषद् के लिए विशेषज्ञ दल के रूप में कार्य करता है। संस्थान स्वयं द्वारा संचालित तथा वित्त पोषित और सहयोगात्मक अनुसंधान परियोजनाओं के माध्यम से समसामयिक कृषि विकास के मुद्दों पर नीतिपरक शोध कार्य करता है तथा साथ ही में क्षमता निर्माण/प्रशिक्षण कार्यक्रमों के द्वारा कृषि अर्थशास्त्र एवम् नीति अनुसंधान को सुदृढ़ करने में लगातार प्रयासरत है। संस्थान कृषि विकास में उभर रही चुनौतियों एवं प्राथमिक. ताओं और इनके समाधान के लिए रणनीतियों के बारे में परिषद् को अवगत कराता है। संस्थान में शोध कार्य प्रमुख रूप से तीन व्यापक क्षेत्रों, जैसेकि कृषि वृद्वि एवं विकास, प्रौद्योगिकी एवं टिकाऊ कृषि और विपणन एवं व्यापार के अन्तर्गत किये जाते हैं। वित–वर्ष 2018–19 की समयावधि में संस्थान द्वारा प्राप्त शोध उपलब्धियों एवं संचालित अन्य गतिविधियों का एक संक्षिप्त झलक निम्नवत हैः–

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कृषि में वृद्वि एवं विकास विषय के अन्तर्गत अध्ययनों में प्रमुख रूप से कृषि एवं ग्रामीण अर्थव्यवस्था में संरचनात्मक बदलाव, क्षेत्रीय विकास, कृषि प्रगति में बुनियादी सुविधाएं एवं भौगोलिक कारक, कृषि में प्रौद्योगिकियाँ, संस्थागत एवं नीतिगत उपायों के प्रभाव, नियमन (governance) की भूमिका तथा पोषण एवं लैंगिक विषय शामिल थे।

राज्यो में ग्रामीण अर्थव्यवस्था का विविधीकरण गैर कृषि गतिविधियों की तरफ विभिन्न स्तरों पर हो रहा है। गैर कृषि गतिविधियों की ओर श्रमिकों के संचरण में उच्च शिक्षा एवं प्रशिक्षण कारकों का सकारात्मक संबंध मिला। स्नातक एवं व्यावसायिक प्रशिक्षण प्राप्त व्यक्तियों को अपने समकक्षों की तुलना में गैर कृषि क्षेत्रों में रोजगार पाने की संभावना क्रमशः 9.3 गुणा एवं 3.3 गुणा अधिक रही।

कृषि की अपेक्षा गैर कृषि क्षेत्र, बेरोजगारी और गरीबी को कम करने में अधिक प्रभावी हैं। सेटेलाइट नाइट डाटा गरीबी को मापने का एक उपयुक्त संकेतक है। इस प्रकार के आकड़ों का उपयोग करके अनुमानित गरीबी संबंधी नीतिगत प्रश्नों के उत्तर, जोकि गरीबी दरों पर निरंतर श्रृखंला के अभाव के कारण सीमित होते हैं, को विभिन्न आर्थिक मॉडलीकरण में प्रयुक्त किया जा सकता है।

साक्ष्यों से पता चलता है कि पशुधन एवं मत्स्यिकी उपक्षेत्रों में आकर्षक वृद्धि से कृषि में समावेशी वृद्धि हुई है। उत्पादकता के पशिरप्रेक्ष्य में छोटे राज्य, बड़े राज्यों के अनुरूप आगे बढ रहे हैं। इसी प्रकार आधारभूत आदानों तक किसानों की पहुँच अधिक सुगम हुई है जिसके कारण सीमान्त एवं लघु कृषक अपनी आय बढ़ानें में सक्षम हुए हैं।

सरकार द्वारा किसानों की आय संबंधी मुद्दों को चर्चा के केन्द्र में लाया गया है और उन्हें किसानों की आय के लिए बढ़ाने हेतु कल्याणकारी रणनीतियों के रूप में शामिल किया गया है। परिवार स्तरीय विश्लेषण दर्शाता है कि किसानों की आय स्रोतों एवं भूमि आकार श्रेणियों के बीच वितरण में असमानता है। ग्रामीण साक्षरता, फसल–सघनता, सिंचाई और ऋण उपलब्धता आदि का. रकों की आय असमानता में 34 प्रतिशत की भागीदारी है, अतः इन कारकों को आय वितरण को समान करने में ध्यान देने की आवश्यकता हैं। 'जनपदों के बीच में' भी कृषि विकास और किसानों की आय में असमानता है। जिसके लिए विकासपरक योजनाओं में क्षेत्र–स्तरीय प्राथमिकताओं की आवश्यकता है। इसके साथ ही बिहार राज्य में किए गये एक अध्ययन में पता चला है कि राज्य के 38 जिलों में से 12 जिलों में अधिक आय असमानता के साथ कृषि विकास का स्तर कम है।

किसानों की आय बढ़ानें वाली रणनीतियों में पारम्परिक खेती को पशुधन एवं गैर कृषि व्यवसायों की तरफ विविधिकरण करना एक प्रमुख रणनीति है। महत्वाकांक्षी जिलों (नीति आयोग द्वारा चिन्हित) में किये गये एक अध्ययन से प्रदर्शित हुआ है कि सीमान्त एवं लघु किसानों में पशुधन और गैर कृषि व्यवसायों को अपनाने की अधिक सम्भावना है। अधिक शिक्षित और पक्का मकान रखने वाले किसानों में पशुधन और गैर–कृषि व्यवसायों के साथ कृषि में विविधिकरण करने की अधिक प्रवृति मिली। वहीं दूसरी ओर, सार्वजनिक वितरण प्रणाली तथा मनरेगा योजना तक पहुँच वाले ग्रामीणों में कृषि व्यवसाय से दूसरे व्यवसायों में जाने की गति धीमी मिली। उत्तर–प्रदेश में जनपद स्तरीय एक अध्ययन से ज्ञात हुआ कि बुनियादी सुविधाओं जैसेकि

शुद्ध सिंचित क्षेत्रफल, ग्रामीण विद्युतीकरण, ग्रामीण सड़कें, दूरभाष, विद्यालय, अस्पताल और कृषि बाजार में सुधार करने से फसल विविधिकरण को बढ़ावा मिलता है।

पूर्वी भारत में एक जनपद स्तरीय अध्ययन में किसानों की आय बढ़ाने में पशुधन एवं दुग्ध उत्पादकता की भूमिका का आँकलन किया गया। पूर्वी राज्यों में (पूर्वी उत्तर प्रदेश को छोड़कर) दुधारू गाय एवं भैस की औसत दुग्ध उत्पादकता इसकी औसत राष्ट्रीय उत्पादकता के मुकाबले कम है। साथ ही में राज्य के भीतर एवं राज्यों के बीच व्यापक असमानता है। तकनीकी बदलाव, पशु प्रजनन, आहार आपूर्ति, पशु चिकित्सा सेवाएं एवं बाजार आदि दुग्ध उत्पाकता बढ़ाने में सकारात्मक असर डालते हैं। दुग्ध उत्पादकता अन्तर को कम करने में पशुपालकों तक बेहतर सुविधायें एवं सम्बन्धित अनुसंधान एवं विका संस्थान सार्थक भूमिका निभाते हैं इसलिए इन तक पहुँच बढ़ाने के लिए प्रयास में तेजी लाई जानी चाहिए।

फसल उद्यमिता में economy वशिबंसम की प्राप्ति में छोटे आकार की जोत एक प्रमुख बाधा है। हालाँकि राष्ट्रीय प्रतिदर्श सर्वेक्षण से साक्ष्य मिलता है कि वर्ष 2003–13 के दौरान किसानों द्वारा खेती के लिए पट्टे पर भूमि देने में बढ़ोत्तरी हुई है। इस सन्दर्भ में प्रमुख राज्यों आन्ध्र प्रदेश, हिमाचल प्रदेश, केरल, उड़ीसा तथा छत्तीसगढ़ में प्रति परिवार पट्टे पर ली गयी कृषित क्षेत्रफल में वृद्धि आकर्षक रही। इसके अतिरिक्त भू–जोत आकार किसानों को अपनी कृषि मशीनरी रखने की क्षमता को प्रभावित करता है जोकि फसल उत्पादकता में महत्वपूर्ण योगदान करती है। यद्यपि कस्टम हायरिंग केन्द्र एक महत्वपूर्ण संस्थागत तन्त्र के रूप में उभर रहे हैं फिर भी कृषि मशीनरी तक किसानों की पहुँच सुनिश्चित करने में अनेक चुनौतियाँ हैं।

चीनी के सन्दर्भ में बाजार दबाव पर सार्वजनिक नीतियों के प्रभावों का अध्ययन किया गया। अध्ययन से पता चला है कि उचित एवं लाभकारी मूल्य (FRP) और सार्वजनिक वितरण प्राणली (PDS) चीनी के मूल्यों पर उल्लेखनीय प्रभाव डालते हैं। इनके प्रभाव कम से कम विगत दो–तीन वर्षों से समान बने हुए हैं। शासन व्यवस्था के सन्दर्भ में, सिंचाई जल नियमन सूचकांक तैयार किया गया जिसमें वर्ष 2003–04 और 2013–14 की अवधि में राजस्थान, उत्तर प्रदेश एवं मध्य प्रदेश में सार्वजनिक सिंचाई प्रणाली में सुधार हुआ है।

पोषण में सुधार एक विकास परक संकेतक है। अध्ययन में पता चला है कि वर्ष 2011–12 में ग्रामीण एवं शहरी भारत में कैलोरी खपत में गिरावट का रूझान मिला। साथ ही में परम्परागत रूप में अनाज से प्राप्त कैलोरी को वर्तमान में अधिक ऊर्जा युक्त पदार्थों जैसेकि चीनी, खाद्य तेल, माँस, मछलियाँ एवं दुग्ध उत्पादों की खपत से प्राप्त किया जा रहा है। लैंगिक मुद्दों के एक अध्ययन से यह पता चला है कि जलवायु परिवर्तन का प्रभाव भिन्नात्मक है और पुरूषों की तुलना में महिलायें इनके प्रति अधिक संवेदनशील हैं।

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वर्षावधि 2018–19 में प्रौद्योगिकी और टिकाऊ कृषि से जुड़े मुद्दों जैसेकि जलवायु परिवर्तन का प्रभाव, अनुकूलनता एवं संवेदनशीलता, फसल एवं संसाधन उपयोग नियोजन, प्रभावी जल उपयोग प्रौद्योगिकियाँ, पेटेट्स तथा उभरते संस्थान एवं उनकी कियाविधि जोकि तकनीकों के प्रसार एवं सरकारी संस्थान शामिल हैं।

जलवायु संक्षोभ – जैसेकि वर्षा में कमी तथा उष्मागत दबाव, कृषि उत्पादकता पर प्रतिकूल प्रभाव डालते हैं। जलवायु सक्षोभ के बढ़ने से उपज क्षति बढ़ती चली जाती है एवं दीर्घावधि में इनका प्रभाव अधिक होता है। अर्थमितीय विश्लेषण से यह ज्ञात हुआ है कि विविधी. करण का कृषि की अनुकूलनता सुधार पर सकारात्मक सीमान्त प्रभाव होता है। जलवायु दबाव का प्रभाव फसलों एवं कृषि – जलवायु क्षेत्रों में भिन्न होता है जिसके लिए विशेष अनुकूलन रणनीतियों को प्राथमिकता से अपनाने की आवश्यकता है। जलवायु जोखिम की संवेदनशीलता और आजीविका सुरक्षा के सन्दर्भ में प्रवासन एक महत्वपूर्ण रणनीति के रूप में उभर कर सामने आया है। हालाँकि इसका प्रभाव प्राकृतिक संसाधनों, आर्थिक सु. रक्षा और अन्य सामाजिक–राजनीतिक कारकों तथा इसके उद्गम एवं गंतव्य दोनों पर पड़ता है।

संसाधन उपयोग दक्षता एवं कृषि की टिकाऊ क्षमता को सुधारने में फसल नियोजन का विशिश्ट स्थान है। जल उपलब्धता एवं Foot Print के आधार पर, पूर्वी एवं मध्य भारत के कृषि–जलवायु क्षेत्र, उत्तरी–पश्चिमी और दक्षिण–पश्चिमी क्षेत्रों की तुलना में धान की खेती के लिए अधिक उपयुक्त हैं। यह विश्लेषण सभी जलवायु क्षेत्रों में फसल पद्धतियों के पुनः समीक्षा की आवश्यकता पर बल देता है। बुन्देलखण्ड क्षेत्र में फसल उपयुक्तता के आँकलन से पता चला है कि अधिकांश मौजूदा फसलें या तो मामूली या सीमान्त रूप से खेती के लिए उपयुक्त हैं।

प्रौद्योगिकियों के अंगीकरण एवं इनके प्रभाव का आँकलन टिकाऊ कृषि प्रणालियों में एक महत्वपूर्ण पहलू है। असम के बाढ़ संवेदी क्षेत्र में धान की बाढ़ सहिष्णु उन्नत किस्मों को अपनाने सम्बन्धी एक अध्ययन में पता चला कि दो–. तिहाई से अधिक किसान आधुनिक किस्मों से मिलने वाले अधिक लाभ के बावजूद पारम्परिक बाढ़ सहिष्णु किस्मों को अपना रहे हैं। पारम्परिक किस्मों की खेती मे आदानों की कम आवश्यकता और कम प्रबन्धन शामिल हैं। एक अन्य अध्ययन में पाया गया कि हैप्पी सीडर (Happy Seeder) पुआल प्रबन्धन हेतु एक उपयुक्त तकनीक है जिसके कारण आदान लागत में कमी तथा पानी एवं ऊर्जा की बचत होती है। इस तकनीक को अपनाकर सर्दियों में पुआल जलाने के कारण उत्पन्न घने कोहरे की समस्या को काफी हद तक कम किया जा सकता है। पुआल प्रबन्धन के लिए किसानों द्वारा सुझाए गये अन्य उपायों जैसेकि फसल अवशेष प्रबन्धन मशीनों पर अनुदान, न्यूनतम समर्थन मूल्य में अवशेष प्रबन्धन लागत को शामिल करना और मिलों एवं कारखानों में पुआल के उपयोग को बढ़ावा देना हैं।

जल एक सर्वाधिक महत्वपूर्ण प्राकृतिक संसाधन है और इसकी उत्पादकता एवं उपयोग दक्षता में सुधार हेतु प्रयास किये जा रहे हैं। सूक्ष्म सिंचाई विधि को अपनाकर पानी की बचत के साथ खेती से प्राप्त शुद्ध लाभ पर सकारात्मक प्रभाव पड़ता है। वर्ष 2018–19 तक सूक्ष्म सिंचाई प्राणाली के अर्न्तगत कुल 10.4 मिलियन हेक्टेयर क्षेत्रफल आच्छादित किया गया है। आन्ध्र प्रदेश, तेलंगाना, महाराष्ट्र, गुजरात और कर्नाटक राज्यों द्वारा सूक्ष्म सिंचाई प्राणाली के तहत क्षेत्रफल आच्छादन में प्रभावी प्रगति प्राप्त की है। राज्यों के बीच सूक्ष्म सिंचाई योजनाओं को लागू करने वाली प्रशासनिक प्रक्रियाओं में भिन्नता मिली। सूक्ष्म सिंचाई प्राणाली की विभिन्न अवस्थाओं में जन भागीदारी इसके अंगीकरण में एक महत्वपूर्ण भूमिका निभाती है। तेलंगाना राज्य में एक प्रक्षेत्र स्तरीय सर्वेक्षण से प्रदर्शित हुआ है कि जल उपयोगकर्ता संघों की बैठकों में किसानों की भागीदारी होने से टैन्क सिंचाई प्राणाली में जलापूर्ति की प्रभावशीलता बढ़ती है। जल टैन्कों का पुनर्स्थापन करने से सिंचाई की संख्या में सुधार आता है तथा खेती से अधिक लाभ मिलता है।

उत्पादन पद्धतियों, प्राकृतिक संसाधनों, पर्यावरण एवं सामाजिक व्यवस्था के बीच सम्पर्क कृषि विकास के पर्यावरणीय थ्ववज Prints को कम करने में अधिक प्रभावी हुए है। इस सन्दर्भ में पारिस्थितिकी सेवाओं पर साक्ष्यों का संकलन, इन्हें बढ़ानें में शोध एवं विकास की भूमिका तथा विकास प्रक्रियाओं में पारिस्थितिकी सेवाओं को मुख्य धारा में लाने के लिए प्रयास करने की आवश्यकता है।

अनुसंधान एवं प्रौद्योगिकी विकास में किसानों की भागीदारी को महत्व दिया जा रहा है। भारतीय कृषि अनुसंधान परिषद् के 'फारमर फर्स्ट' कार्यक्रम का उद्देश्य भागीदारी द्वारा प्रौद्योगिकी विकास करना, किसानों की आय बढ़ाने के लिए स्थान विशिष्ट एवं आवश्यकता आधारित तकनीकों का एकत्रीकरण, मूल्यांकन एवं परिष्करण करना है। 'फारमर फर्स्ट' कार्यक्रम को इस प्रकार विकसित किया गया है जिससे कि समस्या की पहचान, इसके प्राथमिकीकरण और प्रयोगों के आयोजन एवं मौजूद परिस्थिति में प्रबन्धान सुनिश्चित हो सके। संस्थान फारमर फर्स्ट कार्यक्रम के प्रभाव आँकलन में संलग्न है।

किसानों द्वारा प्रौद्योगिकी को अपनाने में सामाजिक तन्त्र का काफी प्रभाव होता है। एक प्रभावी सामाजिक तन्त्र जैसेकि शिक्षा का स्तर, गांव में संगठन, पारस्परिक संवाद आदि इसके अंगीकरण की दर में सुधार लाते हैं। प्रसार प्राणाली पर किये गये एक अध्ययन में विभिन्न प्रसार एवं परामर्शी सेवा प्रदाताओं के बीच भिन्न स्तर वाली बहुलवादी प्रवृति मिली जोकि इनके बीच अभिसरण और समन्वय को दर्शाती है। प्रसार एवं परामर्शी सेवाओं तक पहुँच रखने वाले किसान, इन सेवाओं तक पहुँच नहीं रखने वाले किसानों की तुलना में तकनीकी रूप से अधिक दक्ष थे।

पेटेन्ट सम्बन्धी मुद्दों द्वारा प्रौद्योगिकी प्रबन्धन के क्षेत्र में एक प्रभुत्ववाली स्थिति हासिल हुई है। कृषि क्षेत्र में पेटेन्ट में रूझान एवं स्वरूप की जाँच से पता चलता है कि वर्ष 1990–2007 के बीच प्रदान किये गये अधिकांश पेटेन्ट चीन देश के हैं। भारत में कृषि पेटेन्ट की प्रगति हाल के वर्षों में वैश्विक औसत से कहीं अधिक रही है।

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विपणन एवं व्यापार विषय के अन्तर्गत किये गये अध्ययनों में मूल्य पूर्वानुमान, कृषि वस्तुओं की मूल्य श्रृंखला, स्थानिक मूल्य सचंरण, मूल्यों में उच्चावचन, बाजार सुधार और कृषि आदान बाजारों में नीतिगत मुद्दों पर ध्यान केन्द्रित किया गया। मूल्य पूर्वानुमान कृषि वस्तुओं के उत्पादन एवं विपणन के सन्दर्भ में निर्णय लेने में अधिक उपयोगी होते हैं। देश के 13 प्रमुख राज्यों में 40 खाद्य वस्तुओं के लिए समुचित मूल्य पूर्वानुमान मॉडल विकसित किये गये जिनमें पूर्वानुमान की सटीकता लगभग 90 प्रतिशत थी। अध्ययन में कृषि उत्पादन मण्डी समिति द्वारा आँकड़ों की रिर्पोटिंग

कियाविधि का मानकीकरण और विश्वसनीय पूर्वानुमान हेतु आँकड़ों में विसंगति का समाधान करने की जरूरत की ओर संकेत किया गया है। मॉडलिंग फ्रेमवर्क में कृत्रिम बुद्धि चातुर्य तकनीकों को शामिल करके व्यापक स्तर पर पूर्वानुमान प्रभावशीलता में सुधार किया जा सकता है।

कृषि मूल्यों में स्थरीकरण लाना सरकार का मुख्य ध्येय रहा है। प्याज के थोक मूल्यों में दीर्घावधि रूझान का विश्लेषण करने पर वर्ष 1982–2017 की अवधि में 9 संरचनात्मक अवरोधों के साथ उच्च स्तर का उत्तार–चढ़ाव देखने को मिला। विश्लेषण में यह पाया गया कि मूल्यों में स्थिरता कम अवधि तक रही और अस्थिरता की स्थिति अधिक प्रभावी हो रही है। उत्पादन से लेकर खपत बाजारों में मूल्य संचरण हो रहा है। जोकि विभिन्न स्तरों पर बाजारों के बीच एकीकरण का परिचायक है। सरसों की वर्टिकल विपणन श्रृंखला में एकीकरण और मूल्य संचरण पर किये गये एक अध्ययन में मिला कि सरसों और खाद्य तेलों के बीच दीर्घावधि सतुंलन है। सरसों और इसके तेल के थोक मूल्य में असममित सम्बन्ध है। सरसों तेल के थोक मूल्य में 10 प्रतिशत की कमी से तिलहन के मूल्य में 4 प्रतिशत की कमी मिली, लेकिन तेल मूल्यों में बढ़ोत्तरी होने पर तिलहन के मूल्य में केवल 1.7 प्रतिशत की बढ़ोत्तरी मिली।

कटाई–उपरान्त प्रबन्धन और विपणन के लिए कृषि वस्तुओं की मूल्य श्रृंखला का मानचित्रण करना महत्वपूर्ण है। कर्नाटक राज्य में, वर्ष 2018–19 में बाजार सर्वेक्षण द्वारा टमाटर की मूल्य श्रृंखला का मानचित्रण किया गया। विश्लेषण दर्शाता है कि कटाई–उपरान्त विभिन्न स्तरों पर रख–रखाव के दौरान कुल 16.36 प्रतिशत नुकसान हुआ। एक अन्य अध्ययन में, जम्मू–कश्मीर राज्य में सेब की मूल्य श्रृंखला तथा इसमें सम्मिलित विविध स्तरीय मध्यस्थों की पहचान की गई। साक्ष्य दर्शाते हैं कि पोषणिक अनाजों से सम्बन्धित मूल्य श्रृंखलाओं और संस्थाओं में अधिक सुधार की गुजांइश है।

कृषि आदान बाजार अनेक चुनौतियों जैसेकि गुणवत्ता बीजों की कमी, कीटनाशी क्षेत्र में नवोन्मेषी एवं शोध विकास में कमी तथा उर्वरक क्षेत्रों में सरकारी सहायता नियमन का सामना करना पड़ रहा है। कृषि आदान क्षेत्र की गत्यात्मक प्रवृत्ति, सम्बन्धित नीतियों एवं नियमों का पुनः समीक्षा और इनमें तेज गति से सुधार लाने की आवश्यकता है। कृषि आदानों से सम्बन्धित नई नीतियों की समीक्षा से पता चला है कि सार्वजानिक एवं निजी क्षेत्र की सहभागिता में बढ़ोत्तरी, बीजों के सन्दर्भ में शोध एवं विकास, कीटनाशकों के सन्दर्भ में गुणवत्ता नियन्त्रण तथा उर्वरकों के सन्दर्भ में विदेशी संयुक्त उद्यमों के लिए मौजूदा नीतियों को मजबूत करने की आवश्यकता है।

पारम्परिक विपणन प्रणाली की चुनौतियों से उबरने के लिए भारत सरकार द्वारा विपणन सुधारों की शुरूआत की गई है। हालाँकि राज्यों के बीच विपणन सुधार की गति में असमानता है और इनमें संतुलित विकास सुनिश्चित करने हेतु तेजी लाने की आवश्यकता है। मॉडल कृषि उत्पादन एवं पशुधन विपणन (प्रोत्साहन एवं सुविधा) अधिनियम 2017 को अपनाने हेतु राज्यों को प्रोत्साहित करने के लिए रणनीतियों की समीक्षा करने की आवश्यकता है। राज्यों के बीच नियमन एवं सुधारों की प्रभावशीलता का आँकलन करने के लिए कृषि करने में आसानी एवं व्यवसाय संबन्धी एक फ्रेमवर्क का सुझाव दिया गया है जिससे कृषि विकास में तेजी आने की अपेक्षा है।

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शोध के अतिरिक्त, संस्थान द्वारा किसानों की आय दोगुना करने की अन्तर्मंत्रालयी समिति, अनिवार्य जिन्सों पर निगरानी हेतु अन्तर्मंत्रालयी समिति, राज्य योजना बोर्ड, छत्तीसगढ़ सरकार को और विभिन्न नीति गोष्ठियों जैसेकि निर्यात नीति का निरूपण एवं नीति आयोग में अनुसंधान एवं विकास प्रयोगशालाओं की रैंकिंग फ्रेमवर्क तैयार करने में नीतिगत एवं तकनीकी आदान–प्रदान किया गया। यह संस्थान कृषि, सहकारिता एवं किसान कल्याण विभाग का एक ज्ञानपरक साझीदार है और इसके द्वारा देश में बाजार सूचना और मूल्य पूर्वानुमान प्रणाली के विकास के लिए संस्थागत प्रयास किया जा रहा है। संस्थान द्वारा परिषद् की नतीजा समीक्षा समिति को सहयोग एवं सुविधा प्रदान की गई। वर्ष 2018–19 के दौरान संस्थान द्वारा सामयिक मुद्दों पर कुल 13 कार्यशालाओं एवं प्रशिक्षण कार्यक्रमों का आयोजन, क्षमता निर्माण और छात्रों को शिक्षण प्रदान करके योगदान दिया गया। वर्ष 2018–19 के दौरान संस्थान की कुछ अन्य महत्वपूर्ण गतिविधियाँ जैसेकि संस्थान का वार्षिक दिवस (2 मई), हिन्दी पखवाड़ा, स्वच्छ भारत मिशन, अन्तर्राष्ट्रीय योग दिवस और मेरा गाँव मेरा गौरव आदि शामिल थीं। संस्थान द्वारा नकद रहित लेन–देन और सरकार के ई–खरीद पोर्टल के माध्यम से वस्तुओं एवं सेवाओं की खरीद आदि सुधारों को लागू किया जा रहा है।

Executive Summary

ICAR-National Institute of Agricultural Economics and Policy Research (NIAP) acts as a think tank of the Indian Council of Agricultural Research (ICAR) in the area of agricultural and policy science. ICAR-NIAP undertakes policy studies on contemporary agricultural development issues through in-house and collaborative research, and makes persistent efforts in strengthening agricultural economics and policy research through capacity building and training programmes. The Institute also sensitizes policy planners and ICAR about the emerging challenges and priorities for agricultural development and strategies to address them. The research is mainly conducted under the three major themes, viz. Agricultural Growth and Development, Technology and Sustainable Agriculture, and Markets and Trade. A brief account of research achievements and other activities undertaken by the Institute during the year 2018-19 is given below.

Research Achievements

Agricultural Growth and Development

The studies under the theme Agricultural Growth and Development focussed on structural transformation of agriculture and rural economy, regional development, underlying infrastructure and demographic related drivers of growth, effects of technological, institutional and policy measures on growth, role of governance, nutrition and gender issues.

The rural economy is diversifying towards non-farm activities at varying rate across the states. The movement of labour towards non-farm activities is positively associated with higher education and training. The graduates and persons with vocational training are 9.3 times and 3.3 times more likely to obtain non-farm jobs over their counterparts, respectively. The poverty reducing impact of non-farm employment was larger than that of farm sector. The satellite night data have been found as a suitable proxy of poverty and the predicted poverty using this data can be used to model various economic relationships to answer relevant policy questions, which otherwise are limited by the unavailability of continuous series on poverty rates.

The evidences revealed that agricultural growth has turned more inclusive in the recent years, with an impressive performance in livestock and fisheries sub-sector. Smaller states are converging with bigger states in productivity. Similarly, access to basic inputs have become more inclusive, and enabled marginal and small farmers to raise their income.

The Government has brought farmers' income into the core of its deliberations and incorporated it as the fulcrum of its welfare strategy. A household-level analysis revealed that distribution of farmers' income is unequal to varying degree across income sources and land-size classes. Rural literacy, cropping intensity, irrigation and credit availability explain 34 per cent variation in income inequality and have significant equalizing impact on distribution of farm income. There also exists an inter-district inequality in agricultural development and farmers' income, which warrants regional level prioritization in development planning. Notwithstanding, a study in Bihar revealed that 12 of the 38 districts have low level of agricultural development with high income inequality.

One of the strategies of enhancing farmers' income is to diversify from traditional cultivation to livestock and non-farm businesses. A study conducted in the Aspirational Districts (identified by NITI Aayog) showed that marginal and small farmers are more likely to shift towards livestock and non-farm based occupations. A farmer with higher level of education and *pucca* house has greater tendency to diversify his farm with livestock and non-

farm occupations. On the other hand, access to public distribution system and MGNREGS jobs slow down workers shifting from agricultural occupations. Another meso-level study in Uttar Pradesh revealed that improvement in infrastructure such as net irrigated area, village electrification, road length, number of telephone, schools, hospitals, and agricultural markets encourage crop diversification.

The role of livestock in enhancing farmers' income has been examined using the district-level estimates on milk productivity in eastern India. The average yield of in-milk cattle and buffaloes in eastern states, except eastern Uttar Pradesh is below the national average with wide inter and intra-state variations. Milk yield responds positively to technological change in animal breeding, feed supplies, veterinary services and markets. The relevant R&D institutions need to play productive role to control productivity gaps and efforts may be up-scaled to provide better outreach to livestock farmers.

Small size of land-holding is a major constraint in achieving economy of scale in the crop enterprise. However, farmers are increasingly leasing-in lands for cultivation which is evident from the National Sample Surveys that average per household leased-in area in the country has increased between 2003 and 2013. Among the major states, Andhra Pradesh, Himachal Pradesh, Kerala, Odisha and Chhattisgarh have witnessed considerable increase in per household leased-in area. Farm-size also affects farmers' ability to own farm machinery which significantly contributes to crop productivity. Different modes of Custom Hiring Centres are emerging as an important institutional mechanism, though with respective challenges and opportunities in providing farmers' access to farm machinery.

The influence of public policies on market forces has been ascertained by conducting a case study in sugar sector. The analysis revealed that the government interventions in Fair and Remunerative Prices (FRP) and Public Distribution System (PDS) prices have considerable influence on sugar prices. Impacts are immediate and persist at least for two or three years. In the context of governance, Irrigation Water Governance Index has been constructed, which reveals improvement in governance in public irrigation system in Rajasthan, Uttar Pradesh and Madhya Pradesh during 2003-04 and 2013-14.

Improvement in nutrition is an outcome indicator of development. The analysis revealed reversal in the declining trend in calorie in rural and urban India since 2011-12. Further, the source of calories is shifting from grains to sugar, oil, meat, fish and dairy products. The study on gender issues concluded that the impacts of climate change are gender differentiated and female is more vulnerable than male owing to more exposure and less adaptive capacity.

Technology and Sustainable Agriculture

During 2018-19, more than 20 studies have been conducted on Technology and Sustainable Agriculture related issues such as climate change impacts, resilience and vulnerability, crops and resources use planning, efficient water use technologies, patents, and emerging institutions and mechanisms involved in dissemination of technologies and government support.

The climatic shocks, i.e. rainfall deficit and heat-stress, adversely affect agricultural productivity and the damage increases with increasing severity of climatic shocks. In the long-run, these effects get accentuated. The econometric analysis ascertained that diversification has a positive marginal effect on improving resilience of agriculture. The impacts of climatic shocks vary across the crops and agro-climatic zones (ACZs), which necessitate region-specific interventions and prioritization of adaptation strategies. Migration has emerged as a significant adaptation strategy to manage vulnerability and secure livelihoods to climatic risks. However, it affects both the place of origin and destination via its impact on natural resources, economic security and other socio-political factors.

Crop planning assumes significance in improving resources use efficiency and sustainability of agriculture. On the basis of water availability and footprints, agro-climatic zones of eastern and central India have been found to be more sustainable for paddy cultivation as compared to north-western and south-western zones. This necessitates cropping pattern re-alignment across the zones. Crop suitability assessment in Bundelkhand region indicated that most of the existing crops are either moderately or marginally suitable for cultivation.

The assessment of adoption and impact of technologies are crucial aspects of sustainable agricultural systems. A case study on adoption of flood tolerant improved variety of paddy in flood prone zones of Assam revealed that more than two-thirds of the farmers prefer traditional flood tolerant varieties despite higher return of modern varieties. This is due to lesser requirement of inputs and management practices in cultivation of traditional varieties. In an another study, Happy Seeder has emerged as a successful paddy straw management technology, which is associated with reduction in input cost and saving in water and energy. The adoption of this technology can also reduce the problem of dense smog to a large extent during winter induced by paddy straw burning. Other measures suggested by farmers to manage paddy straw are availability of residue management machines on subsidy, addition of paddy residue management cost in MSP, and promote use of paddy straw in mills and energy generation plants.

Water is the most important natural resource and efforts are being extended to improve water productivity and use efficiency. The adoption of micro-irrigation technology has a positive impact on net returns from cultivation and water saving. By the year 2018-19, a total of 10.4 million ha (Mha) has been covered under micro-irrigation system (MIS). The states like Andhra Pradesh, Telangana, Maharashtra, Gujarat and Karnataka have registered an impressive growth in MIS coverage. It is found that administrative mechanisms in implementation of micro-irrigation schemes vary across the states. People's participation at different stages of MIS programmes plays an important role in its adoption. The field-level evidences from Telangana showed that participation of farmers in meetings of Water User Associations increases the effectiveness of water delivery system in tank irrigation system. The rehabilitation of tank results in increase in irrigation numbers, improvement in inclusiveness of access to irrigation and higher returns from crop cultivation.

The linkages among the production systems, natural resources, environment and social system have now become more prominent to reduce environmental foot prints of agricultural development. In this context, an effort has been extended to collate evidences on ecosystem services, assess role of R&D in enhancing them and mainstreaming ecosystem services in the development processes.

The involvement of farmers in research and development of technology is gaining importance. The farmers FIRST programme of ICAR aims at participatory technology development, assemblage, assessment, refinement for location specific and need based technologies for the farmers for enhancing their income. The farmer FIRST programme is developed as farmer in a centric role for research problem identification, prioritization and conduct of experiments and its management in farmer's condition. ICAR-NAIP is engaged in impact assessment of farmers FIRST programme.

Adoption of technology by the farmers is greatly influenced by social network characteristics. The adoption rate can be improved by targeting the contact persons having better social network characteristics such as education level, land holding, association in village organization, frequency of interaction, etc. The study on extension system revealed its pluralistic nature and linkages with varying degree have been observed among different extension and advisory services (EAS) providers indicating convergence and coordination among them.

Farm households having access to EAS operate with comparatively higher technical efficiency than those without access to EAS.

Patents related issues have occupied a dominant position in the area of management of technologies. The examination of trends and patterns in patents in agriculture sectors shows that most of the patents granted during 1990 to 2007 are from Asian countries, particularly China. India's growth in cumulative patents filed in agriculture is higher than the global average during the recent years.

Markets and Trade

The studies under the theme Markets and Trade focussed on price forecasts, value chains of agricultural commodities, spatial price transmissions, price volatility, market reforms, and policy issues in agricultural inputs market.

Price forecasts are immensely useful to the farmers in making decision regarding production and marketing of agricultural commodities. Appropriate price forecasting models for about 40 food commodities in 13 major states have been developed with forecast accuracy up to 90 per cent. The study points out a strong need to standardize data reporting mechanisms at the APMCs and to address data discrepancies issues for generating reliable forecasts. Incorporation of artificial intelligence techniques in modelling framework can improve forecast efficiency to a large extent.

Stabilizing agricultural prices remains a major objective of the Government. An analysis of long-run trend in wholesale prices of onion revealed high degree of volatility with 9 structural breaks during the period 1982 to 2017. It is further observed that length of the period with stable prices is reducing and shorter phases with greater instability are becoming pronounced overtime. The price transmission from producing to consuming markets are also taking place, indicating spatial market integration with varying degree. Another study on integration and price transmission in the vertical marketing chain of mustard oilseeds showed that there is a long-run equilibrium relationship between the wholesale prices of mustard oilseed and oil. The wholesale prices of mustard oilseeds and oil exhibit asymmetric relationship. A 10 per cent decrease in wholesale price of mustard oil leads to 4 per cent decrease in prices of oilseeds, but increase in oil prices increases oilseed prices only by 1.7 per cent.

Mapping value chain of agricultural commodities is crucial for post-harvest management and marketing. By conducting market surveys in Karnataka, value chain of tomato has been mapped during 2018-19. Further, the analysis shows 16.63 per cent post-harvest losses in tomato during handing at different segments of commercialization. Another study identified various actors involved in apple value chain in Jammu & Kashmir and documented their value addition activities. The evidences also pointed out a great scope to improve marketing of nutri-cereals through strengthening value chain and institutions.

The agri-input market is facing several challenges such as lack of quality seeds, lower innovation and R&D in pesticide sector, and subsidy governance in fertilizer sector. Considering the dynamic nature of the sector, the policies and regulations need to be realigned and reformed in a faster pace. A review of new policies in input sectors points out the need to strengthen the existing policies to build public-private partnership, for R&D in case of seeds, for quality control in case of pesticides, and for foreign joint ventures in case of fertilizers.

In order to overcome the challenges of traditional regulated marketing system, Government of India initiated reforms in agricultural marketing. However, the pace of market reform has been uneven across stares and needs to be geared up to ensure balanced development across states. It calls for revisiting the strategy required to encourage states to adopt Model Agricultural Produce and Livestock Marketing (Promotion & Facilitation) Act, 2017. To assess the effectiveness of governance and reforms undertaken by Indian states, a framework of Ease of Doing Agri-Business has been suggested which would contribute in fostering agriculture development.

Other Achievments and Activities

Apart from research, ICAR-NIAP provided significant policy and technical inputs to Inter-Ministerial Committee of Doubling Farmers' Income, Inter-Ministerial Committee on Monitoring Prices of Essential Commodities, State Planning Board, Government of Chhattisgarh, and represented ICAR at various policy forums, viz. formulation of New Export Policy and developing framework of ranking of R&D labs in NITI Aayog. The Institute is a knowledge partner of Department of Agriculture Cooperation and Farmers Welfare (DAC&FW) and undertaking a major programme to institutionalize the capacity for development of market information and price forecasting system in the country. ICAR-NIAP also facilitated outcome review of the Council. The Institute contributed to capacity building by organising 12 workshops and trainings on the topical issues, and through teaching and student guidance during 2018-19. Organization of ICAR-NIAP Annual Day on 2nd May, celebration of Hindi Pakhwara, Swachh Bharat Mission, International Yoga Day, and regular interaction with farmers through Mera Gaon Mera Gaurav were some other important activities of the Institute during 2018-19. The Institute is also implementing the reforms like cashless transactions, and procurement of goods and services through e-procurement portals of the Government.

CHAPTER 1

ICAR-NIAP: An Overview

Significant Research Achievements

Capacity Building

Policy Interactions

Research Output

Awards and Recognitions

Participation in Scientific Activities

Management Committee Meetings

Other Institute Activities

Personnel and Budget

ICAR-NIAP

Vision

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

Mission

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

Mandate

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

The National Institute (formerly Centre) of Agricultural Economics and Policy Research (NIAP) was established in 1991 by the Indian Council of Agricultural Research (ICAR). ICAR-NIAP is located at 28°37′56.7″N latitude and 77°10′17.2″E longitude in New Delhi. The Institute is committed to provide a leadership role in strengthening agricultural economics and policy research within the National Agricultural Research System (NARS). It acts as a think tank of ICAR in the area of agricultural economics and policy research, and provides credible research-based inputs to the Council to actively participate in policy debates and decisions. Besides ICAR, the Institute also provides regular technical and policy inputs to NITI Aayog, various ministries at the Centre and States and to many other stakeholders for policy decisions related to food and agriculture.

Over the last three decades, ICAR-NIAP has been contributing significantly to the growth of the discipline of agricultural economics. The Institute has guided the Council in prioritization of its research agenda so as to improve efficiency and equity in agricultural research, and made significant contributions towards understanding of the contemporary issues and the challenges of agriculture. Specifically, the Institute has made notable contributions in the areas like assessment of agricultural R&D, research prioritization, investment and subsidies, technological change, agricultural sustainability, diversification, domestic market reforms, international trade, institutional innovations, market intelligence, livestock economics, commodity outlook, prices and demand forecasts. ICAR-NIAP acknowledges importance of partnerships in forging strong alliances to tackle common research problems and in shaping the trajectory of agricultural growth through policy-oriented research and communications.

To accomplish its vision and mandate, ICAR-NIAP undertakes and promotes agricultural policy research, training and policy interfacing programs focusing on:

1. Policy studies on contemporary agricultural development issues through in-house, collaborative and consultancy research
   - R&D policy and technology management
   - Natural resource and environmental economics
   - Agricultural development, markets and trade
2. Strengthening agricultural economics and policy research
   - Capacity development by facilitation, networking and dissemination of information
   - Training programs and collaborative research
   - Enhancing ICAR participation in policy decisions through policy dialogue and institutional linkages

Institute Activities

Research activities

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

Broadly, ICAR-NIAP research portfolio under the theme Agricultural Growth and Development comprises structural transformation of agriculture and disparities in development, agricultural diversification and drivers of growth, farm and non-farm linkages for enhancing farmers' income, property rights, gender and agriculture-nutrition-health linkages. Technology and Sustainable Agriculture theme includes policy studies on climate change, natural resources management and environment, risk in agriculture, valuation of environmental services, agro-climatic zonal planning, resource use efficiency, impact of agricultural technology, and performance evaluation of agricultural extension system. Under Markets and Trade theme, thrust is on policy studies on market reforms, infrastructure development, mapping value chains, market intelligence, marketing efficiency, commodity

outlook, price forecasts, price transmission, food quality and food safety, innovations in input markets, credits and farm services, agricultural trade pattern and international agreements. The Institute is actively engaged in collaborative and multi-disciplinary research in a network mode by involving agricultural economists, social scientists, and biological scientists.

Capacity building

ICAR-NIAP plays a key role in strengthening capacity and human resources development in the field of agricultural economics and policy research. The network projects are used to develop formal linkages among the institutions within and outside NARS and to exchange modern concepts and advanced analytical skills among the researchers on contemporary issues in agricultural economics and policy research. The Institute regularly organizes capacity building workshops and trainings to keep pace with the new developments in the discipline. Association with the Post Graduate School of the Indian Agricultural Research Institute (IARI) for teaching and guiding M.Sc. and Ph.D. students are other capacity building activities of the Institute.

Policy interface activities and communications

ICAR-NIAP contributes to policy formulation through participation of its faculty in policy dialogues, debates and several committees of Central and State Government. The Institute has a history of publishing regularly Policy Papers, Discussion Papers, Policy Brief, etc on contemporary policy issues which serves as a medium for constructive critique, and sensitization of peoples' representatives and policy makers.

Organization and Management

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

Research Advisory Committee (RAC) comprising eminent professionals outside

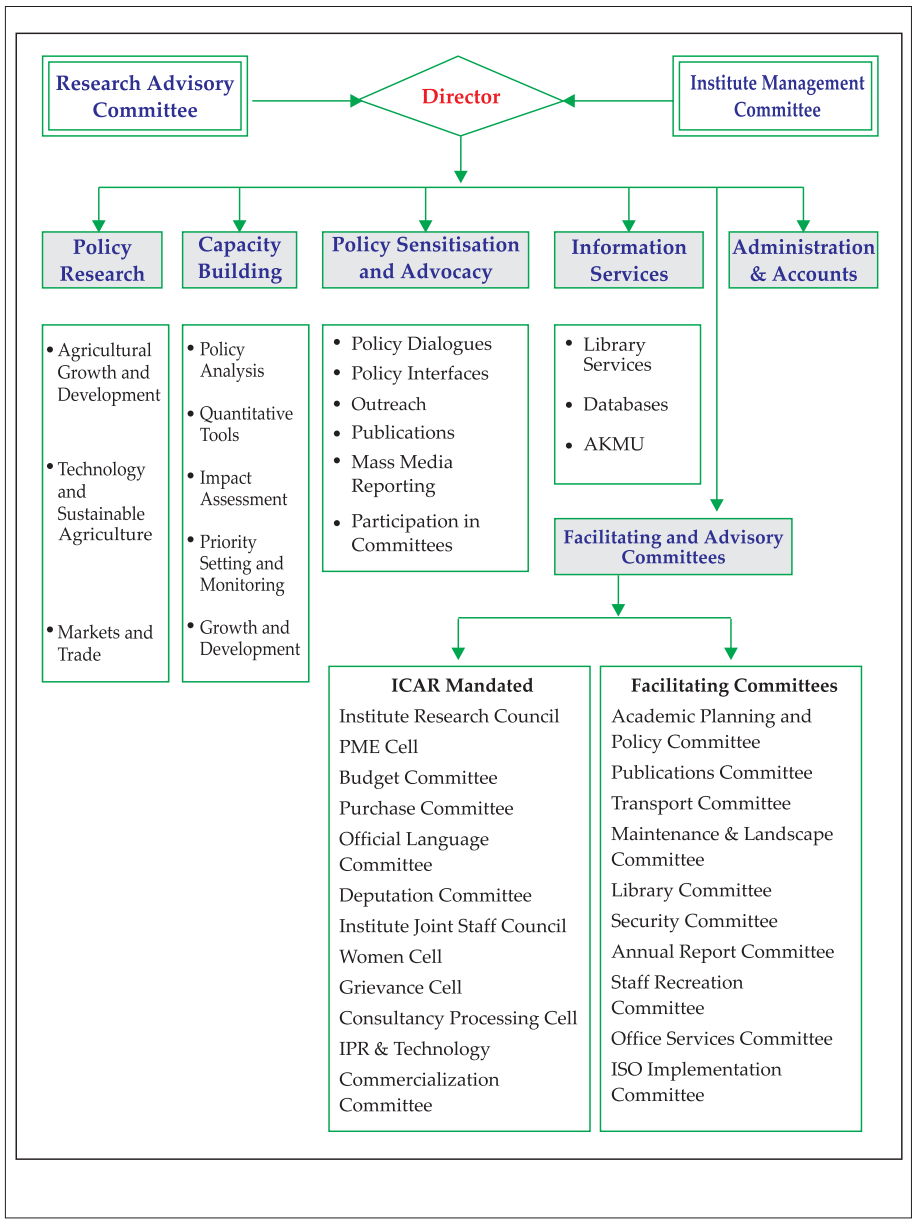


Figure 1.1. Organogram of ICAR-NIAP

the ICAR system, ICAR officials and farmers' representatives, guides the Institute in planning research thrusts and strategies. Initiatives in human resource development, approaches towards improving policy dialogues and evaluation are some other areas in which the Institute receives guidance from RAC. Prof. Abhijit Sen, Former Member, Planning Commission is the Chairman of the present RAC which is constituted by the Council for the three years from June 21, 2017.

The functioning of the Institute is supervised by the Institute Management Committee (IMC). Besides RAC and IMC, a number of internal committees and cells, including those mandated by ICAR, are operating for an efficient and decentralized management of the Institute. The Joint Staff Council (JSC) promotes healthy interaction and congenial work environment at the Institute. Director conducts regular meetings with staff, mostly every month, to discuss scientific and management issues to elicit suggestions for the cordial functioning of the Institute. The organogram of the Institute is given in figure 1.1.

Information and Facilitating Services

Agricultural Knowledge Management Unit (AKMU)

AKMU manages research information and products, and provides other research related information through electronic and web mode. The goal of AKMU is to strengthen information management using modern technologies. The unit is also helping in implementation of IT reforms and management system.

AKMU is well equipped with latest computers, servers, higher end internet security firewall (Fort iGATE 301e), centralised antivirus server and analytical software like SPSS, STATA, LIMDEP, GIS, GAMS, Stella, E-Views and SAS. For data management and in-house software development, SQL server and Visual Studio facilities are also available. NKN leased line of 100 mbps has been functional to enhance quality and timeliness of network connectivity. All staff members of the Institute have been provided

Agricultural Knowledge Management Unit at ICAR-NIAP

with latest computers and software, LAN, email account, internet facilities and other required computational facilities. ICAR email system is being fully used by ICAR-NIAP staff. AKMU maintains video conferencing facility at the Institute. The management information system (MIS) modules developed by the Council like FMS, PERMISNET, PIMS, HYPM, etc are fully functional and maintained by AKMU.

Management Information System (MIS)

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

Financial management: Solutions for General Ledger, Account Payable, Account Receivable, Cash Management, Fixed Assets Management, Budget Management and grants.

Snapshot of MIS and FMS in ICAR

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

Material management: Solutions for Purchase and Inventory Management.

Human resource: Employee 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 ICAR employees.

Library

ICAR-NIAP has a specialized collection of print, electronic and digital resources. Presently, library subscribes Economic and Political Weekly (EPW) digital archives & database like EPW Research Foundation (India time series data base), Indiastat and Districts of India. Electronic databases are available through LAN to the library users. Library is conducting innovative information literacy programme of J-Gate, Consortium for e-Resources in Agriculture for ICAR-NIAP staff. This library is housing a total of 7398 publications including books, journals, bulletins, CD ROMs, database publications, reports, SAARC publications and other reference materials, etc. The library has subscription of 16 international journals and 18 national journals. Institute's library has reserved a separate section for books of official language (Hindi).

ICAR-NIAP Library

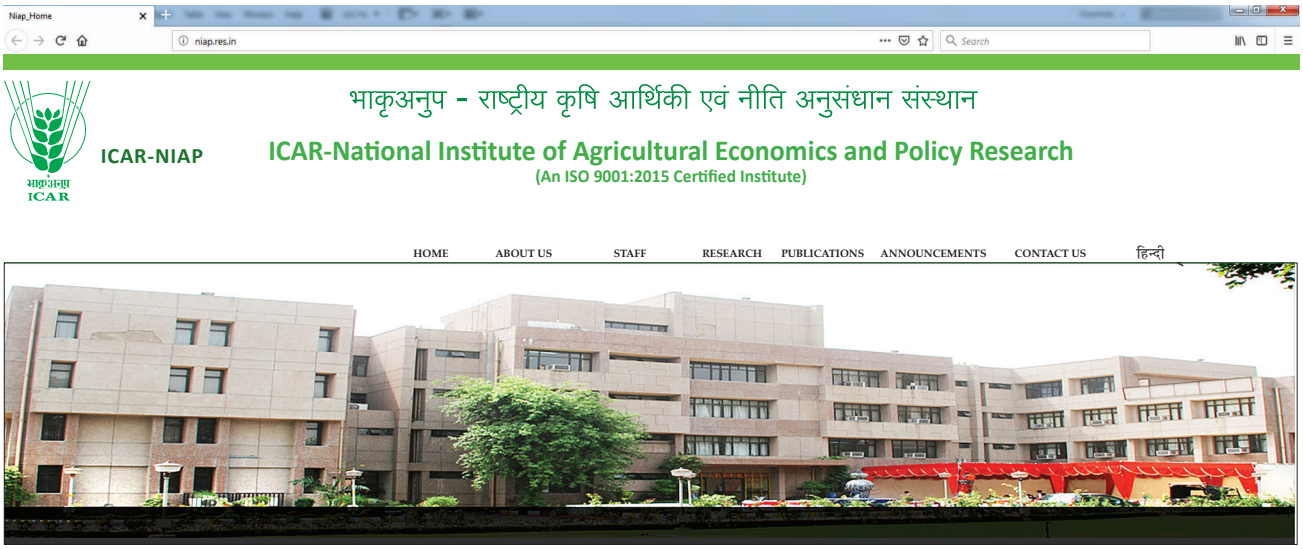
During 2018-19, the library procured publications which includes 8 reference books, 17 official language books, 3 CD ROM and 12 database publications. The library also acquired 24 gift publications. The library is playing active role in timely dissemination of scientific and technical information for research via Document Delivery Service (DDS), Current Awareness Service (CAS), Newspaper Clipping Service, Resource Sharing Activities in other sister institute's libraries like IARI, IASRI. Inter Library Loan (ILL) facility on reciprocal basis from the CGIAR Centres like IFPRI, IWMI, CIMMYT, IRRI, ILRI is available at the Institute.

Exhibition-Cum-Record Room

Exhibition-cum-record room is to display and document research and other accomplishments of the Institute. It displays all ICAR-NIAP publications, annual reports, and publications of scientists, recognitions and awards received by the Institute and the scientists. A photo gallery displays memories of all important events organized by the Institute.

ICAR-NIAP website

The Institute website (http://www.niap.res.in) in English and Hindi, provides a clear impression of the Institute with all the latest information and activities, particularly about its staff, infrastructure, research projects, publications, employment, tenders, RTI information and linkages. The website is hosted by Education and Research Network (ERNET), New Delhi, and is updated on a regular basis. All publications, viz. Policy Papers, Policy Briefs, Working Papers, PME Notes, Workshop Proceedings, etc. of ICAR-NIAP are available on the website.



Welcome to ICAR-NIAP

ICAR-National Institute (formerly Centre) of Agricultural Economics and Policy Research (NIAP) was established by the Indian Council of Agricultural Research (ICAR) in March 1991 to strengthen agricultural economics and policy research in the national agricultural research system. Application of principles of economics in planning and evaluation of agricultural R&D and policy research to promote science-led agricultural and rural development have been the main goals of ICAR-NIAP. The Institute is committed to provide a leadership role in strengthening agricultural policy research, undertaking empirically sound policy research, and providing knowledge-based input for policy decisions. The Institute also acts as a think tank of ICAR and helps it to actively participate in policy making.

Home page of NIAP website (www.niap.res.in)

Human Resources

The staff position at ICAR-NIAP during 2018-19 is given in table 1.1.

Table 1.1. Staff position at ICAR-NIAP during 2018-19

Name of the Post	Sanctioned strength	In position	Vacant
R.M.P	1	1	0
Scientific Staff	25	21	4
Technical Assistant	5	5	0
Administrative and Supporting Staff	14	11	3
Total	**45**	**38**	**7**

ISO 9001:2015 Certification

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

CHAPTER 2

- ICAR-NIAP: An Overview
- **Significant Research Achievements**
- Capacity Building
- Policy Interactions
- Research Output
- Awards and Recognitions
- Participation in Scientific Activities
- Management Committee Meetings
- Other Institute Activities
- Personnel and Budget

Network projects	:	3
Eternally funded projects	:	8
Institute funded projects	:	11
Consultancy/Contract projects	:	2

Agricultural Growth and Development	:	22 studies
Technology and Sustainable Agriculture	:	26 studies
Markets and Trade	:	10 studies

Theme I

AGRICULTURAL GROWTH AND DEVELOPMENT

Excerpts

- Rural employment is diversifying towards non-farm activities at varying rate across the states. Higher education and training positively influence labour movement toward non-farm sectors. The increased demand for labour in non-farm sectors pushes farm wages upwards. Non-farm employment is a major contributor for reduction in rural poverty when compared to agriculture.
- Marginal and smallholders are more likely to shift towards both livestock and non-farm based occupations. Access to PDS, better housing and MNREGA jobs slow down workers shifting from agricultural occupations.
- Agricultural growth has turned more inclusive in the recent years, with an impressive performance in livestock and fisheries sub-sectors. Smaller states are converging with bigger states in productivity. Similarly, access to basic inputs have become more inclusive, and enabled the marginal and small farmers to raise their income.
- Distribution of farmers' income is unequal to varying degree across income sources and land-size classes. Rural literacy, cropping intensity, irrigation and credit availability have significant equalizing impact on distribution of farm income.
- There exists wide inter and intra-state milk productivity gap in eastern India. Milk yield responds positively to technological change in animal breeding, feed supplies, veterinary services and markets.
- Improvement in infrastructure like net irrigated area, village electrification, road length, number of telephone, schools, hospitals, agricultural markets encourage crop diversification.
- In Andhra Pradesh, Himachal Pradesh, Kerala, Odisha and Chhattisgarh, farmers are increasingly leasing-in lands for cultivation followed by Bihar, Punjab, Tamil Nadu and West Bengal.
- Government interventions in Fair and Remunerative Prices (FRP) and Public Distribution System (PDS) prices have considerable influence on sugar prices. Impacts are immediate and persist at least for two or three years.
- Farm mechanisation significantly contributes to increasing paddy output across all farm-size categories. The impacts are larger on relatively small farm. Varying modes of institutional mechanisms exist for Custom Hiring Centres with respective challenges and opportunities in providing farmers' access to farm machineries.
- Reversal in the declining trend in calorie intake has been observed in rural and urban India since 2011-12. The source of calories is shifting from grains to sugar, oil, meat, fish and dairy products.
- Irrigation Water Governance Index revealed improvement in governance in public irrigation system in Rajasthan, Uttar Pradesh and Madhya Pradesh between 2003-04 and 2013-14.
- The impacts of climate change are gender differentiated and female is more vulnerable than male due to more exposure and less adaptive capacity.
- The coverage of farmers and cultivated area under *Prime Minister Fasal Bima Yojna* (PMFBY) decreased, while the sum insured increased between 2016-17 and 2017-18. Yield loss estimation, standardizing the use of technology for crop loss assessment and timely settlement of claims, high actuarial premium rates, increasing the coverage of shared and tenant croppers and creating awareness among farmers on the crop insurance are the key issues of concern for PMFBY.

Structural Transformation, Regional Disparity and Institutional Reforms in Agriculture

Suresh Pal, SJ Balaji, Subash SP, Jagdambe S and Shiji CP

Inclusive agricultural growth

The agriculture sector grew at annual rate of 2.9 per cent during 2011-12 to 2017-18. The performance of agriculture varied across the sub-sectors and regions. The sub-sectors like livestock and fisheries sub-sectors registered significantly higher growth of 7.2 per cent and 8.5 per cent, respectively, as compared to crop sub-sector. The gross state value added (GSVA) growth in crop sub-sector was more than 4 per cent in Madhya Pradesh, Andhra Pradesh, Chhattisgarh and West Bengal. In case of livestock sub-sector, the growth was more than 8 per cent in Madhya Pradesh, Tamil Nadu, Rajasthan, Andhra Pradesh, Himachal Pradesh, Jammu & Kashmir and Bihar. Similarly, Andhra Pradesh and Madhya Pradesh witnessed more than 8 per cent growth in fisheries sub-sector. The agriculture growth was found to be inclusive which is depicted by a better performance of states like Madhya Pradesh, Rajasthan and Odisha where land and labour productivity levels are relatively less.

Access to basic inputs by the farmers has also turned more inclusive during the recent years. The share of marginal and small farmers using improved paddy seeds has risen from 68 per cent to 81 per cent and 71 per cent to 86 per cent between 2003-04 and 2013-14, respectively. Similar trend has been observed in the use of chemical fertilizers. This inclusivity together with other factors has helped marginal and small farmers to raise their income level. The net income from crops of the farmers with less than 0.4 hectare land holding has more than doubled, from Rs.687/month to Rs. 1,488/month, and the income of farmers with land holding between 0.4 and 1.0 hectare has increased by 1.2 times between 2012-13 and 2015-16. The income of landless households from livestock sub-sector has witnessed 1.8 times increase during this period. Overall, the average monthly income of agricultural households has increased by 40 per cent from Rs. 6,426 to Rs. 8,931.

Productivity convergence in agriculture

The diversification towards livestock based production system along with improvements in access to inputs has led the low-productive states to grow fast in the recent years. This process, formally known as 'convergence' in development literature, was tested using statistical framework with alternate growth specifications, viz. a) neo-classical non-human capital version, b) human capital augmented version, and c) factor accumulation version. The neo-classical variants were extended further to incorporate initial technology and convergence was studied under constant and varying rates of technological progress across states during 1982 to 2015.

The results revealed that convergence is a discontinuous and relatively short-run process in this case (Table 2.1). Both neoclassical and factor accumulation models indicated absence of conditional convergence in agricultural labour productivity during the past three and a half decades. Breaking the entire period further into post-liberal (1992-2015) and post-recovery (2006-2015) periods showed while there is no conditional convergence in the former, post-recovery period in agriculture exhibited convergence at extremely slow rates. The average speed of convergence varied between 0.22 per cent and 0.25 per cent. Further, while capital intensification was found pro-convergent in the low-productive states during this recovery period, technology was found pro-divergent in factor accumulation framework. The study suggests for accelerating physical and human capital investment in agriculture in low-productive Indian states for achieving inclusive agricultural growth.

Table 2.1. Status of β-convergence in alternate growth models

β-Convergence	1982-2015	1992-2015	2006-2015
A. Neo-Classical Model			
Without Controlling Initial Technology			
a. Unconditional			
Barro & Sala-i-Martin (1992)	0.0005	-0.0047	-0.0198*** (0.0022)
b. Conditional			
Mankiw, Romer & Weil (1992) i	-0.0079	-0.0061** (0.0003)	-0.0214*** (0.0024)
Mankiw, Romer & Weil (1992) ii	-0.0077	-0.0062** (0.0003)	-0.0221** (0.0025)
Mankiw, Romer & Weil (1992) iii	-0.0115* (0.0004)	-0.0063	-0.0217*** (0.0024)
Mankiw, Romer & Weil (1992) iv	-0.0108	-0.0054	-0.0224*** (0.0025)
After Controlling Initial Technology			
a. Unconditional			
Barro & Sala-i-Martin (1992)	0.0009	-0.0032	-0.0196*** (0.0023)
b. Conditional			
Mankiw, Romer & Weil (1992) i	-0.0086	-0.0042	-0.0211*** (0.0024)
Mankiw, Romer & Weil (1992) ii	-0.0084	-0.0046	-0.0221** (0.0025)
Mankiw, Romer & Weil (1992) iii	-0.0012* (0.0003)	-0.0052	-0.0209*** (0.0024)
Mankiw, Romer & Weil (1992) iv	-0.0106	-0.0056	-0.0217** (0.0025)
B. Factor Accumulation Model			
a. Unconditional			
Taylor (1999) v	0.0013 (0.0429)	-0.0032 (0.0037)	-0.0284*** (0.1707***)
b. Conditional			
Taylor (1999) vi	-0.0029	-0.0069*	-0.0261***
Taylor (1999) vii	(0.0361)	(-0.0065)	(0.1201)
Taylor (1999) viii	-0.0036 (0.0372)	-0.0082* (0.0111)	-0.0299*** (0.1764***)
Taylor (1999) ix	-0.0037	-0.0070*	-0.0257***
Taylor (1999) x	(0.0357)	(-0.0074)	(0.1203)
Taylor (1999) xi	-0.0042 (0.0366)	-0.0082* (0.0100)	-0.0295*** 0.1759***)

Note: a) Reported figures are the coefficients of initial income variable in relevant models; b) Figures in parentheses indicate speed of convergence in neo-classical model and coefficient of initial technology growth in factor accumulation model; i. constant technology growth; ii. constant technology growth, augmented with human capital; iii. varying technology growth; iv. varying technology growth, augmented with human capital; v. controlled for initial technology, vi. constant technology growth; vii. controlled for initial technology with constant technology growth; viii). controlled for initial technology with constant technology growth, augmented with human capital; ix. varying technology growth; x. controlled for initial technology with varying technology growth; xi. controlled for initial technology with varying technology growth, augmented with human capital

*** ** * are significant at 1%, 5% and 10% level, respectively

Crop diversification and infrastructure development in rural Uttar Pradesh

In collaboration with Lucknow University

There exists widespread regional disparity in the agriculture sector in Uttar Pradesh. Risk instabilities have further aggravated the situation of agriculture in the state which require due attention. This study measured simpson's diversification index (SID) across districts, regions and agro-climatic zones for the period 2004-05 to 2015-16. Further, rural infrastructure index (RII) was constructed using principal component analysis (PCA) technique based on eight key variables related to the economic, social and institutional infrastructure.

The findings revealed widespread fluctuations in SID and RII at district level, but the fluctuations tended to decrease considerably at administrative regional level. Further, SID and

RII were found to be positively correlated and move in the same direction. In other words, with the increase in the level of crop diversification, rate of development of rural infrastructure also rises. The results of the random effect panel regression revealed that rural infrastructure index, percentage of loan distribution of primary sector in total loan distribution, per hectare fertilizer and minimum temperature had a positive and statistically significant impact on crop diversification, whereas rain variability and maximum temperature had negative impact. Among the infrastructure related variables, net irrigated area, village electrification, road length, no. of telephones, number of schools, no. of hospital agricultural markets and per hectare consumption of fertilizer have positive and significant impact on crop diversification. This clearly highlights the fact that these drivers can have a greater impact in increasing the crop diversification in Uttar Pradesh.

Table 2.2. Growth and variability in value of output of agriculture sector at district level during 2004-05 to 2015-16

		Variability (per cent)		
	Levels	L-Low [Less than Q1 value: 10.00]	M-Moderate [From 10.00 to 16.50]	H-High [More than Q3 value: 16.50]
Growth rate (per cent)	**L-Low [Less than Q1 value: 0. 89]**	Allahabad, Bijnor, GB Nagar, Ghazipur, Jaunpur, Kanpur Nagar, Lucknow, Mathura, Moradabad, Saharanpur and Sitapur **Districts: 11 (15.71%)**	Ambedkar Nagar, Azamgarh, Gorakhpur, Kanpur Dehat, Mirzapur and Siddharth Nagar **Districts: 06 (8.57%)**	Banda, Barabanki, Hamirpur, Jalaun and Pratapgarh **Districts: 05 (7.14%)**
	M-Moderate [From 0.89 to 3.50]	Auraiyya, Bahraich, Etawah, Hardoi, Kheri, Maharajganj and Sultanpur **Districts: 07 (10.00%)**	Agra, Baghpat, Balrampur, Basti, Chandauli, Fatehpur, Firozabad, Gonda, JP Nagar, Kannauj, Mau, Meerut, Pilibhit, Raibreilly, Shajahanpur, Unnao and Varansi **Districts: 17 (24.28%)**	Lalitpur **Districts: 01 (1.43%)**
	H-High [More than Q3 value: 3. 50]	Aligarh, Bulandshahr and Mainpuri **Districts: 03 (4.28%)**	Farrukhabad, Muzzafarnagar, Sant Kabeer Nagar, Sant R Nagar and Shravasti **Districts: 05 (7.14%)**	Badaun, Ballia, Bareilly, Chitrakoot, Deoria, Etah, Faizabad, Ghaziabad, Haathras, Jhansi, Kaushambi, Kushinagar, Mahoba, Rampur and Sonbhadra **Districts: 15 (21.43%)**

Source : Author's Calculations based on UPDES data

Table 2.2 presents classification of districts based on growth and variability in value of output of agriculture during 2004-05 to 2015-16 into three groups, i.e. low, moderate and high based on quartile values. About 16 per cent of the districts exhibited low growth-low variability, 24 per cent exhibited moderate growth-moderate variability and 21 per cent exhibited high growth-high variability in output. These evidences reaffirm the argument that growth leads to variability.

Literacy: The driver of rural non-farm employment

Spatial clustering of rural households was studied along with relative influence of different push and pull factors in influencing farm-nonfarm choices in Tamil Nadu using the household level information provided in the Employment and Unemployment Survey (2011-12). The spatial pattern studied using Getis-Ord indices indicated presence of 'cold spots' in central region comprising eight districts and found no 'hot spots' or high-employment clusters in the state (Figure 2.1). Literacy has a critical influence on entering into high-paying non-farm jobs. The 14 per cent out of 16 per cent workers employed in manufacturing, 8 per cent out of 11 per cent workers in construction, and 5 per cent out of 6 per cent workers in trade were literate during 2011-12.

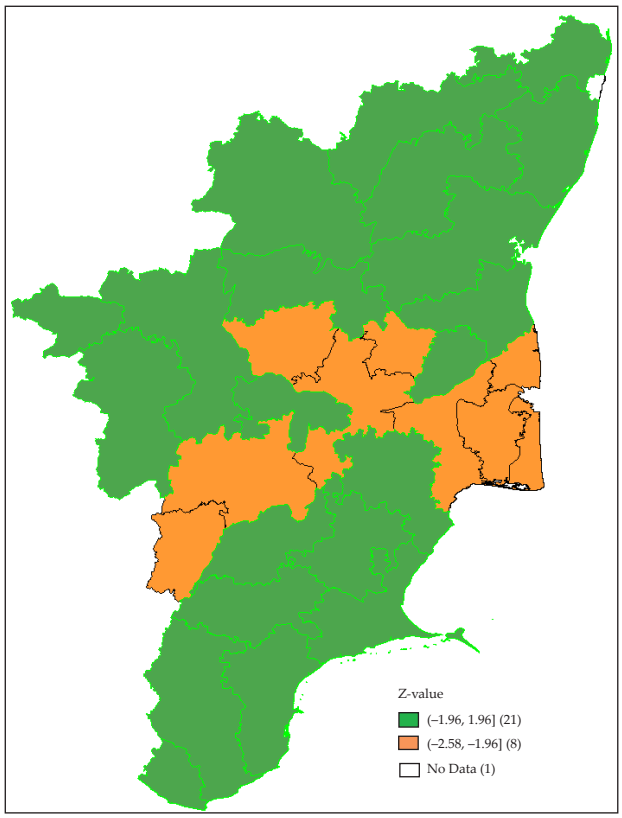


Figure 2.1. Getis-Ord indices and spatial correlation in rural nonfarm employment in Tamil Nadu

Higher education and training was found to be significantly associated with access to non-farm occupations. The estimates of odds-ratio out of logistic regression showed that graduates and persons with vocational training were 9.3 and 3.3 times more likely to obtain non-farm jobs over their counterparts, respectively. Large farmers were less likely to shift into non-farm occupations. Interestingly, neither high agricultural income, which holds workers within agriculture, nor wage-gains in non-agriculture, which pulls labour from agriculture, were found to influence farm-nonfarm decisions. Nor the districts with higher per capita income had higher non-farm employment. It was observed that literacy, human capital factor, has significant influence in shifting rural labour into non-agricultural enterprises.

Land leasing in agriculture: Pattern across states

In collaboration with Institute for Social and Economic Change

The examination of land leasing pattern, based on the NSSO data, revealed that average per household leased-in area in India has increased between 2003 and 2013. Among the major states, average per households leased-in area was the highest in Rajasthan followed by Punjab, Madhya Pradesh, Haryana and Gujarat, whereas it was the lowest in Jammu & Kashmir, Himachal Pradesh, Kerala and West Bengal during 2013. Further, average leased-in area has increased in Andhra Pradesh, Madhya Pradesh, Gujarat, Tamil Nadu and Karnataka and declined in Rajasthan, Punjab, Uttar Pradesh, West Bengal, Maharashtra and Chhattisgarh between 2003 and 2013. The ratio of leased-in land to total operational area was higher than the national average (11.6%) in Andhra Pradesh (59.0%), Bihar (30.7%), Punjab

(29.1%), Odisha (20.5%), Telangana (18.6%), West Bengal (17.3%), Haryana (16.4%) and Tamil Nadu (15.03%) in 2013. Between 2003 and 2013, the ratio of leased-in land to the total operational area increased in Andhra Pradesh, Telangana, Bihar and Punjab. On the other hand, states like Uttar Pradesh, Maharashtra and Assam witnessed no significant change. Table 2.3 presents inter-state variation in farmers' leasing-in behaviour the study period.

Table 2.3. Classification of the states based on the percentage of households reporting leased-in area (2003 vs 2013)

SN	Particulars	States
1	Considerably increasing	Andhra Pradesh, Himachal Pradesh, Kerala, Odisha, Chhattisgarh
2	Huge variation but increasing	Bihar, Punjab, Tamil Nadu and West Bengal
3	Huge variation but declining	Gujarat, Haryana, Maharashtra and Uttar Pradesh
4	Continuously increasing but very small changes	Rajasthan and Karnataka
5	Almost constant	Assam, Jammu & Kashmir, Jharkhand, Madhya Pradesh

Source: Various round of NSSO

Governance in irrigation

In collaboration with Jawaharlal Nehru University

Governance in public irrigation systems exerts a significant influence on performance of agriculture. Irrigation water governance index (IWGI) has been constructed using 20 indicators at the state level and changes in relative position of the states in irrigation governance between 2003-04 and 2013-14 have been examined. The estimated value of IWGI varied from 5.15 in Gujarat to 0.54 in Assam during 2003-04 and from 5.17 in Punjab to 0.52 in Assam during the year 2013-14 (Figure 2.2). During 2003-04, the top five states in the overall performance of irrigation governance were Gujarat (5.15), Tamil Nadu (5.10), Haryana (5.05), Punjab (5) and Maharashtra (4.86). However, the position of Gujarat and Tamil Nadu dropped from first and second to eighth and fourth, respectively by the year 2013-14. Among the states, Rajasthan, Uttar Pradesh and Madhya Pradesh have progressed and moved up in the ranking. The states with poor level of governance during 2003-04 were Assam, Odisha, Jharkhand, Himachal Pradesh, Jammu and Kashmir, Uttarakhand and Bihar with IWGI scores ranging between 0.54 to 3.33. The ranking of these states did not change much in the subsequent year 2013-14.

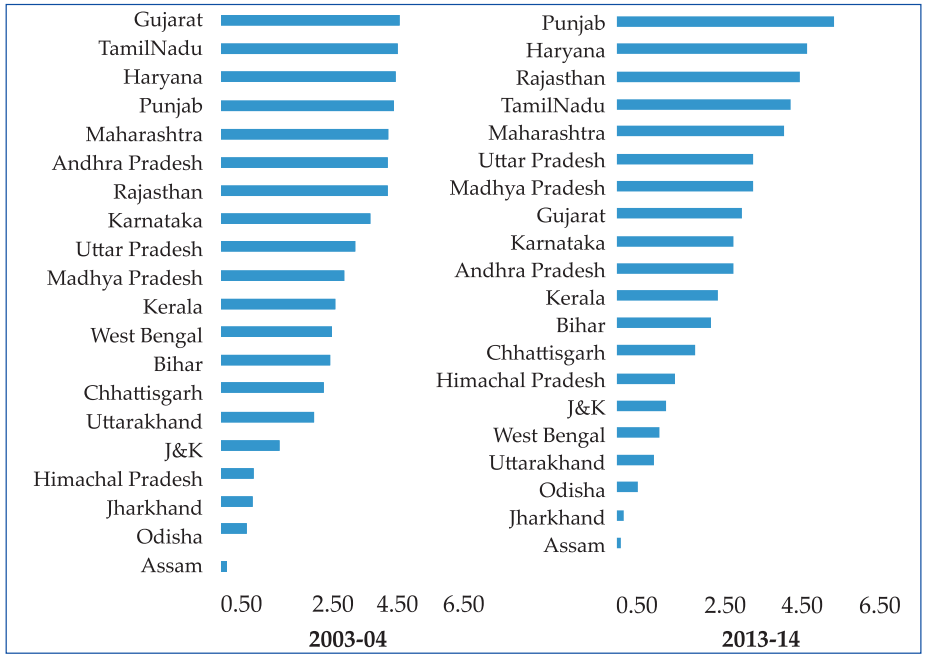


Figure 2.2. Irrigation Water Governance Index: 2003-04 and 2013-14

Market forces and sugar price determination

In collaboration with Madras Institute of Development Studies

The study analysed the impact of different market forces and government interventions on sugar prices in India. Autoregressive Distributed Lag (ARDL) Model and Impulse Response Functions (IRF) were used to estimate the impact and inter-relationship among sugar price and its determinants, viz. sugar prices at market and PDS, fair and remunerative prices (FRP), per capita GSDP, jaggery prices, molasses production, population, net exports of sugar, area under sugarcane, sugar recovery rate and sugar levy rate.

The results of ARDL model suggested that there exists a long-run equilibrium between sugar price and its determinants of public policy measures and other market forces. Specifically, increased level of FRP, area under sugarcane and levy percentage had a negative influence on sugar prices. The rise in FRP leads to increase in area under sugarcane and thereby excess sugarcane and sugar production, which subsequently results in reduction in sugar prices. Similarly, increased level of levy proportion on the sugar production makes the sugar mills to sell the sugar at the rate nearer to the levy or the PDS price to get reasonable profit. This kind of market behaviour adversely affects the capacity of the sugar mills.

The results of the impulse response function were also consistent with a priori assumption about the relationship between sugar price and its determinants. The findings suggested that sugar price formation is sensitive to cyclical changes in FRP, PDS price, Jaggery price, per-capita GDP, molasses production, recovery rate and levy percentage. Thus, the study clearly reveals that government policy interventions such as FRP, PDS price and levy proportion have an influence on the sugar price determination. Any unexpected shocks in these policy measures have immediate impact on the sugar price in the current period which persists for two or three years. This implies that the sugar market structure takes at least two to three years to regain the equilibrium position that was distorted by the unexpected policy shocks. Overall, these findings implied that the sugar sector has been persisting with the help of subsidies and controls by government over the years.

In order to break this cyclical behaviour of sugar market in India, policy issues should be concentrated in four different stages. First, sugarcane production cost should be reduced through technological innovation. In India, sugarcane is a labour intensive crop with a substantial amount of cost for hiring labour. Hence, more investment and subsidies in technological innovation or mechanization is an appropriate measure for reducing labour requirement and associated cost. Second, yearly demand for sugar and its derivatives like molasses, jaggery etc., and resources availability should be assessed; and according to this, the crop plans at the regional level should be prepared to avoid the surplus of cane and sugar production. Third, farmers should be linked with all level of marketing of sugar and its derivatives so that profit and loss can be proportionately distributed to each stakeholder involved in the sugar marketing system. Fourth, diverting the surplus production to the production of molasses and jaggery is another viable opportunity. Appropriate capacity building measure is necessary to capture and divert the surplus production to other processing units like energy and bio-fuel sectors. The last two decades have witnessed fast growth in biofuel production due to ambitious government policies aimed at mitigating environmental degradation and improving energy efficiency across the world.

Rural Non-Farm Sector in India

Subash SP, Md. Ejaz Anwer, Prem Chand, Rajeev Ranjan Kumar and Aditya KS

Rural non-farm employment: Trends and structure

The study examined changing structure of rural non-farm employment (RNFE) in Indian states between 2011-2 and 2015-16 using annual surveys data of Labour Bureau. The change in the share of non-farm employment in total

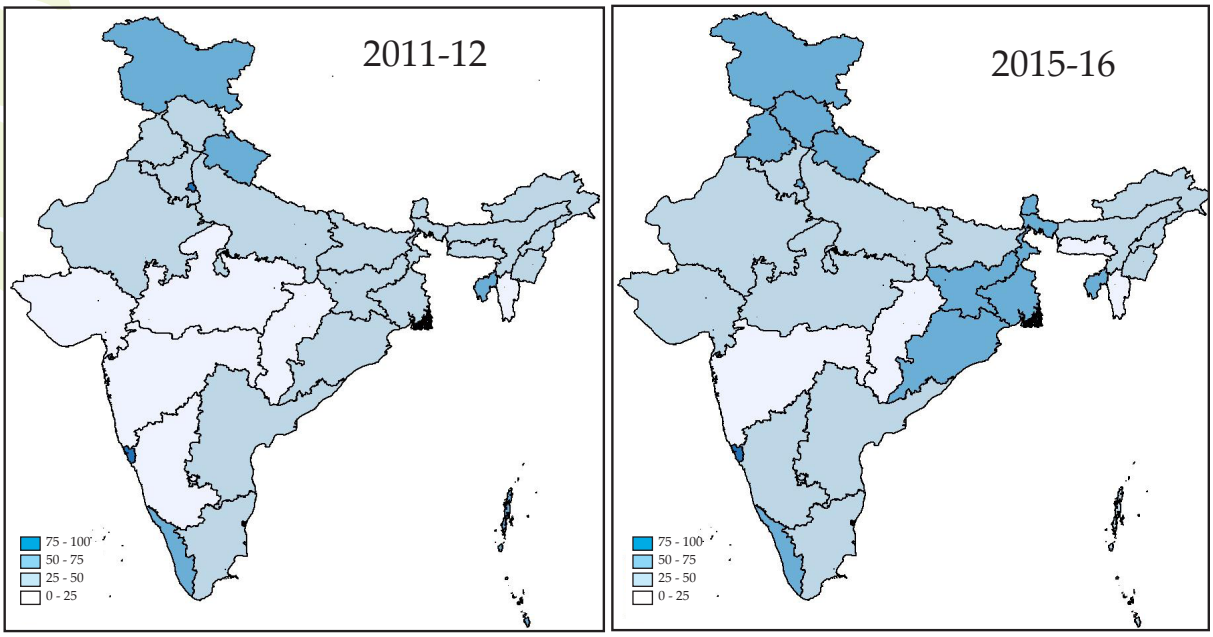


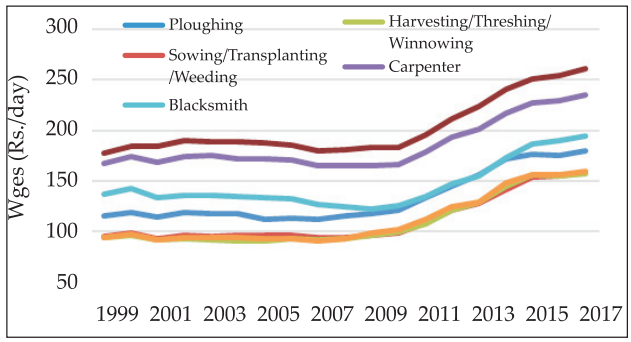
Figure 2.3. Rural non-farm employment across states (2011-12 & 2015-16)

employment was found to be positive in most of the states (Figure 2.3). In Himachal Pradesh (100%) and Madhya Pradesh (93%), the shares had almost doubled during the study period. Positive changes were also observed in Odisha (53%), Jharkhand (51%), Rajasthan (39%), Sikkim (37%), Karnataka (29%), Uttar Pradesh (28%), Punjab (27%), Gujarat (26%), Bihar (21%) and West Bengal (20%). On the other hand, states like Chhattisgarh (-15%), Meghalaya (-25%), Uttarakhand (-11%), Jammu and Kashmir (-9%) and Kerala (-2%) witnessed decline in the share of RNFE. Overall, the share of RNFE is increasing at aggregated level which implies a declining trend in the dependence of workforce on farm employment.

A comparison of rural non-farm employment (RNFE) estimates of NSSO with Labour Bureau's annual survey estimates for 2011-12 revealed that estimates from both surveys are correlated with each other (Spearman's rho = 0.821, P value < 0.001). This implies that both surveys are comparable to a large extent. The study suggests that policies and programmes should be designed to support and enhance the non-farm employment prospects in rural areas.

Rural farm-nonfarm wage linkage

The linkage between farm and non-farm wages in rural India was examined using occupation-wise average wage data of Labour Bureau for the period 1999-2017. Overall, the wage rates across all categories increased after implementation of the Mahatma Gandhi National Rural Employment Guarantee Scheme (Figure 2.4). Panel vector auto regression (PVAR) model employed explored the relationship between farm and non-farm wages. The suitability of PVAR model was assessed using structural breaks and auto-correlation tests. The PVAR model selection, estimation and inferences were



Note: CPI-RL (2009–10=100) is used as a deflator

Figure 2.4. Trends in farm and non-farm wages in India (1999 to 2017)

based on generalized methods of moments (GMM) framework. The null-hypothesis of the Granger causality wald test is that the excluded variables do not Granger-cause equation variable. The results showed that wages given for mason operation granger-cause wages of ploughing, sowing and harvesting operations. This implies that non-farm wages (mason wages) are influencing farm wages (ploughing, sowing & harvesting). In other words, demand for labours in construction sector influence wages in agricultural operations. This also shows that increase in non-farm wages could also have an effect on farm wages and not-vice versa.

Rural farm-nonfarm-poverty linkages

The farm-nonfarm-poverty linkages in rural India were established using structural equation model (SEM) which helps in capturing both direct and indirect effects. For the analysis, state level repeated data on farm and non-farm wages, expenditure on food and non-food items and poverty rate were collected for the years 1993, 1999, 2004, 2009, and 2011. Tests for joint normality and conditional normality showed presence of non-normality in the data. Log transformation of the data was avoided as they are sensitive to the direction of estimates. Therefore, quasi-maximum likelihood (QML) method was adopted instead of maximum likelihood method for estimation as it relaxes the normality assumption.

The results revealed that rural non-farm employment has a significant direct effect on poverty reduction, whereas both farm and non-farm wages have indirect effect on poverty reduction. Non-farm wages were found to be a significant driver of non-farm employment. The study showed that non-farm employment is a major contributor for reduction in poverty in rural areas when compared to agriculture. Thus, emphasis should be given to non-farm employment generation and wages for reducing poverty.

Machine learning application for predicting rural poverty

Increased availability of satellite imageries and rapid development in algorithms to process imagery data has spurred interest amongst economist to use high frequency imagery data for meaningful economic interpretations. One such application is to use satellite night light data as an indicator of poverty (Figure 2.5). As poverty statistics in India is released once in

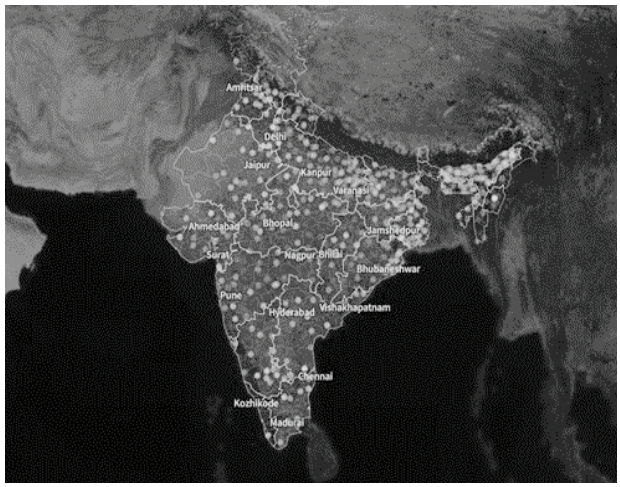


Figure 2.5. Satellite night light data

five years, high frequency night lights data can be used to predict poverty in the years where official poverty statistics is not available. The study explored use of satellite night light data and machine learning algorithms (artificial neural network) to predict rural poverty at sub-national level. The data was collected from an open access night light data provided by the University of Michigan. The dataset named 'India Lights API' provides rural night light data for a period of 20 years, from 1993 to 2013 for about 6,00,000 villages across India (http://india.nightlights.io/#/about). The data was extracted from the satellite pictures of the earth for every night under the Defense Meteorological Satellite Program (DMSP) of the U.S. Department of Defense.

The night light data was compared with per capita domestic product as a predictor for the model. The graphical approach (K-density plots, box plot and violin plot) and root mean square error (RMSE) were used to compare

the prediction performance of the model. The line named as poverty is the measured value and others are the predicted values using night light and per capita GDP. The night light data was found as a better predictor of poverty than of per capita domestic product. Such predictions using satellite data can be used as a complement to the existing data-sets. This will facilitate economist for modelling the economic relationships in understanding poverty and provide more frequent and local estimates for policy makers. The predicted poverty data can be used to model various economic relationships to answer many relevant policy questions, which otherwise are limited by the unavailability of continuous series on poverty rates. However, these models rely heavily on validity of statistical inference and to be used only for modelling purpose with suitable adjustments.

Doubling Farmers' Income in India by 2022

Suresh Pal, Raka Saxena, Usha R Ahuja, Naveen P Singh, SJ Balaji, Ranjit Kumar Paul, Md. Arshad Khan, Gururaj B, Rohit Kumar, Vinita Kanwal, Bishwa Bhaskar Choudhary, Deepika Joshi, Kuldeep Sharma and Puneet Sharma

Strategy and implementation

The Government brought farmers' income into the core of its deliberations and incorporated it as the fulcrum of its strategy. The major sources of growth operating within the traditional agriculture sector include i) improvement in crop productivity, ii) improvement in livestock productivity, iii) resource use efficiency or saving in cost of production, iv) increase in cropping intensity, and v) diversification towards high value crops. Further, the following two sources of growth operate outside the traditional agriculture sector but contribute to farmers' income, vi) improvement in real prices received by farmers, and vii) shift from farm to non-farm occupations.

The DFI recommendations emphasize a lot on promoting marketing, logistics and supply chain along with price support. Operation Green, which focuses on bringing the price stability in tomato, onion and potato, has been initiated on the lines of operation flood with a focus on agri-logistics, processing and professional management. Farmer Producer Organizations (FPO) of less than Rs. 100 crores turnover were exempted income tax for first five years to encourage professionalism in post-harvest value addition. Organic farming by village producer organizations (VPO) and FPOs is being encouraged. The e-NAM, a mission for integration of APMCs across the country through a common online market platform to facilitate pan-India trade in agriculture commodities, helps to provide better price discovery through transparent auction process based on quality of produce along with timely online payment is functional. Now there are 16 states in which 585 APMC market have been integrated with e-NAM platform. Besides, a number of other schemes and programmes have been started for enhancing the income of farmers and their welfare.

Enhancing farmers' incomes from livestock in eastern India

The role of livestock in enhancing farmers' income in eastern India has been examined using district level estimates on milk productivity from the integrated sample survey reports and situation assessment survey (2012-13) data. The evidences showed that average yield of in-milk crossbred cattle in eastern states, except eastern Uttar Pradesh, was below the national average. The productivity of indigenous cattle and buffalo was also not very impressive. In case of buffalo, the performance of West Bengal, Jharkhand and Chhattisgarh was relatively high. Though the inter-state productivity gap indicates significant productivity differentials, huge differentials exist even within the states, more severely in Bihar. Major form of disposal of milk was through direct sale to other households except in eastern UP and West Bengal where it was through local traders. Only about 23 per cent of milk in Bihar and Odisha was disposed through cooperative and government agencies. Majority of states received higher prices by selling through the local traders. Price offered by cooperative and government agency was

Table 2.4. Determinants of livestock income

Variables	Parameter Estimate	t-Value
Dependent variable: Livestock income (Rs/annum)		
Explanatory variables		
Intercept	15.50	8.32
Buffalo to cattle ratio	0.05	0.02
Buffalo milk yield (litres/day)	0.08*	2.25
Crossbred to Indigenous cattle ratio	0.11*	2.15
Crossbred milk yield (litres/day)	0.27*	2.31
Indigenous cattle milk yield (litres/day)	0.17	0.53
Crop share in total income (%)	-1.34*	-3.95
Non-farm share in total income (%)	-1.18*	-4.75
Small holder share (%)	-1.60*	-2.98
R^2	0.68	
Number of observations (n)	92	

Note: *Significant at 1% Level ; Double-log model

relatively less in most states, except eastern UP.

The study also attempted to identify the drivers of livestock income through multiple regression (Table 2.4). Buffalo to cattle ratio does not have any significant impact on livestock income but the emphasis on buffalo breeding and rearing may boost the livestock income as indicated by positive and significant coefficient of buffalo milk yield. Further, livestock income would significantly increase if the crossbred to indigenous cattle ratio improves. Therefore, it is imperative to encourage the crossbred adoption along with better maintenance of the animals to improve household income. The inverse relation between income from livestock and crop sources was also established by the negative and significant value of the regression coefficient. Non-farm business remains a major source of income for small and marginal farmers. The state governments in conjunction with research institutions have to play a major role in ensuring that livestock development programmes related to breed development and health services to enable the livestock owners to take full advantage of this opportunity. The relevant R&D institutions need to play productive role to control the productivity gaps. The efforts may be up-scaled to provide better outreach to livestock farmers.

Drivers of income inequality among agricultural households

This study assessed the inequality in farmers' income and its decomposition across major sources and landholding categories along with determinants using the household level information provided in the situational assessment survey of agricultural households

Table 2.5. Determinants of farm income inequality

Variables	Coefficient	Std. Error
Dependent variable: log (Gini coefficient)		
Explanatory variable:		
Irrigation intensity (%)	0.006	0.01
Rural literacy (%)	-0.164*	0.07
Small and marginal holding share (%)	-0.053**	0.03
Cropping intensity (%)	-0.208*	0.06
Credit per holdings (Rs.)	-0.189*	0.07
Number of observations (n)	565	
Adjusted R-squared	0.348	
F-statistic (p- value)	5.83 (0.00007)	
Estimation method:	Stepwise Least Square model	
Selection method	Stepwise forward	

Note: ** and * indicates significance at 1% and 10% level, respectively ; Double-log model

(2012-13). The Gini coefficient was used to examine the overall distribution of income and inequality across sources and land size classes. Among various sources, income from crops was more evenly distributed, whereas Gini value for non-farm business income was the highest. Inequality in livestock income decreased with increase in landholding size while it was positively related in case of income earned from wages & salaries. It is noteworthy to mention that distribution of income is relatively more unequal among the farmers with more than 4 hectares of land. Similarly, income from livestock is biased towards the lower income strata. The other two sources, viz. wages & salaries and non-farm business have inequality-increasing effect within the given farm size class.

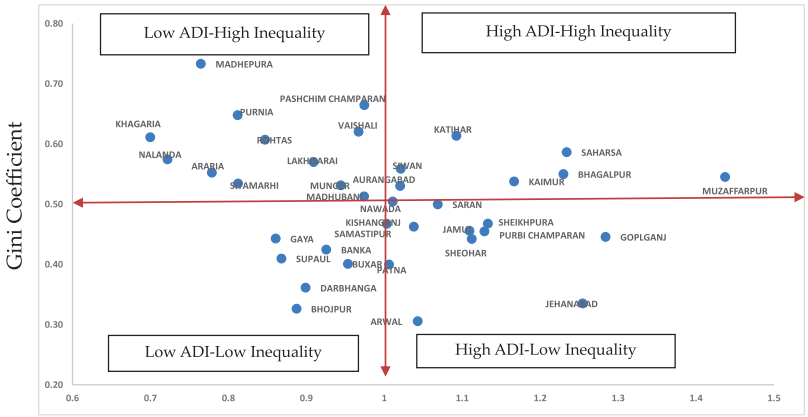


Figure 2.6. Income inequality vis-à-vis agriculture development

Agricultural development and inequality in Bihar

The purpose of the study was to delineate Bihar into different income zones based on district level crop income estimates. For this, K-means clustering technique was used and four broad income zones were identified, viz. poor income zone, low income zone, moderate performing zone and well-performing zone. More than two-third of state (28 out of 38 districts) was characterized into moderately and low performing zone. The indicators, namely size of land holding, cropping intensity, irrigation intensity, area under high value crops, institutional credit and literacy were considered for the computation of a combined rank-score.

Further, Gini-coefficient was used to study inequality. Agricultural development index (ADI) and the income inequality, when plotted in a scatterplot, revealed that most of the districts fall between the range of 0.4 to 0.6 in the Gini index range except Madhepura and Arwal showing the highest and the lowest values (Figure 2.6). Though the districts Katihar, Saharsa, Bhagalpur, Muzaffarpur, and Kaimur ranked high as per the perspective of agricultural development but also suffered from high income inequality. Priority should be given to target districts falling in the low ADI and high inequality zone.

Drivers of agricultural households' shift in aspirational districts

This study delineates the aspirational districts of the country into two broad typologies based on K-means clustering technique using the indicators, namely irrigation intensity, cropping intensity, rural literacy, rainfall and

The contribution of crop sector in total inequality (77%) was even higher than its share in total income (76%) resulting in its elasticity exceeding unity. On the other hand, very low Gini correlation of wages & salaries along with its low share in total income resulted in its equality restoring potential with marginal effect of 0.016 cent. As shown in table 2.5, the selected drivers of inequality had a significant impact and explained 34 per cent variation. Rural literacy, cropping intensity and credit were found to have significant equalizing impact on the distribution of farm income. Availability of irrigation ensures adoption of modern technology on the farm resulting in significantly higher income. A unit increase in rural literacy resulted in decline in the inequality by 0.16 per cent. Access to institutional credit to small and marginal reduces their dependence on non-formal sources like moneylenders and traders thereby had inequality decreasing effect on income distribution. Cropping intensity increases the income from crop cultivation and hence reduced inequality.

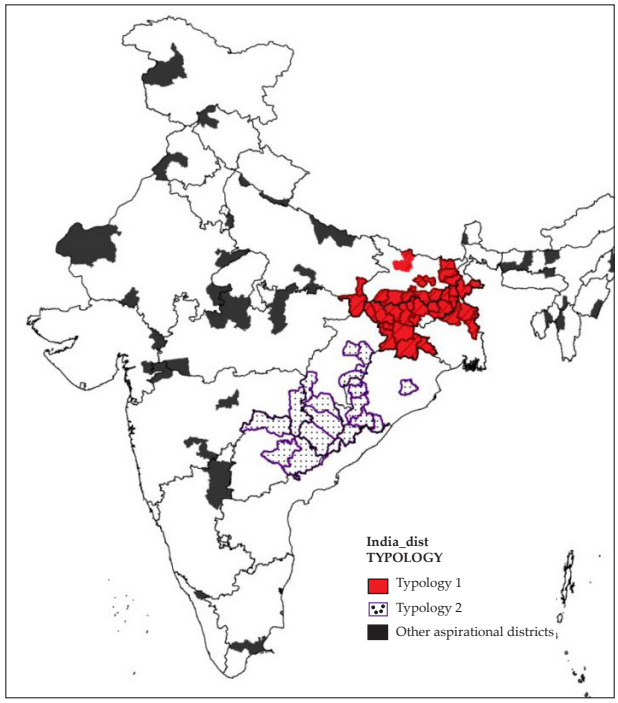


Figure 2.7. Delineation of broad typologies within aspirational districts

credit availability. Two broad typologies were obtained within the districts as shown in figure 2.7, which would help in formulating income policy. Further, to identify various socio-economic factors influencing the probability of shifting from traditional cultivation to non-cultivation sources, two scenarios were examined through the probability of shifting from cultivation to livestock (Scenario I) and probability of shifting from cultivation to non-farm business (Scenario II). A multi-chotomous variable representing different income sources were used as the dependent variable and a multi-choice model was employed.

In both the typologies, land holding size had significant negative impact on the probability of shifting from cultivation to livestock while the square of land owned was found to be positively related. The results also indicated that in typology-1, holding the job card reduces the probability of shifting to livestock as sole source of income. Also, an educated farmer has greater tendency to diversify his farm with livestock. On the other hand, in typology-2, when a farmer holds ration card, the household will be reluctant in shifting to livestock for his earning. Also, household size was significant driving force responsible for farmers shifting to other source of income.

Further, shifting towards non-farm enterprises was significant and positively related with the pucca home structure and was negatively influenced by land area possessed. This indicates that if the land under cultivation is limited, the households often opt for non-farm business for a living. In typology-1, male headed households were found to have significant positive relation with the shifting from traditional cultivation to non-farm business. In typology 2, possessing ration card and MGNREGA job card were negatively related with diversifying from cultivation hence households getting subsidized ration as well as assured labour employment were less likely to undertake non-farm business enterprises.

Farm Mechanization on Small and Marginal Farms

Nalini Ranjan Kumar and SV Bangararaju

Institutional mechanism of custom hiring centres

Institutional mechanism of custom hiring centres (CHC) was assessed in Madhya Pradesh where CHC model promoted by the state Government is doing well. Primary data were collected from selected stakeholders involved in the operationalization of CHCs in Bhopal and Hoshangabad districts. It was observed that the state government's backend subsidy to establish customs hiring centres suffer with payment defaults. Beneficiaries in many cases were large farmers who operated most of the machineries for own farms than lending to the other farmers. The other operational modes of CHCs were a) private operators, b) cooperatives, and c) corporates. EM3 Agri Services was a start-up in agriculture sector that operated CHC under corporate sector. Each centre, managed through information technology (IT) enabled system and manned by agronomy professionals, was equipped to deliver the entire suite of basic and precision operations throughout the farming value chain. This included topography, soil analysis, seed-bed preparation, sowing, fertilizer application, weed/pest control, top dressing, harvesting and post-harvest operations. The differences among various forms of institutional arrangements are shown in table 2.6.

Table 2.6. Institutional arrangements in custom hiring centres (CHC) in Madhya Pradesh

Particular	Farmer entrepreneur CHC	Samadhan Kendra (EM3 an Start up)	CHC run by Directorate of Agricultural Engineering (Government)
Process for requisition of CHC services	Phone/ personal contact	Phone/ personal contact/ mobile App	Application with Land record, Aadhaar card and cash deposit
Prioritisation of customer	First cum first serve, and urgency of the operation	First cum first serve	First cum first serve
Timely completion work of all the customer	Mostly	Mostly	Yes
Time of collection of service charge	Some portion after completion of service and mostly at the time of harvest	30% at the time of work and 70% at the time of harvest	In advance
Whether services are available on credit	Yes (40-50% as credit)	Yes (70% as credit)	No
Customer satisfaction with CHC services	Yes	99% satisfied	No
Conflict between CHC and customer	Very rare but sometime for payment that get delayed	Yes but resolved with negotiation	No
Further plan	Combine harvester, Laser land leveller, Processing and other improved machineries	Input supply and complete solution for farming	No
Do you earn sufficient to sustain CHC operation and livelihood	Yes	Breakeven for the centre	Except driver salary all expenses met with the rentals collected
Any financial constraints	Sometime demand of liquid money to meet the fuel purchase expense then arrange purchase of fuel on credit from petrol pump	No	No
Sources of capital	Loan + subsidy and own saving	Company	Government
Terms and conditions of acquiring funds from financial institutions	Land records, FD and urban properties and mortgaging of purchased farm machineries	Corporate	Nil
Any hurdle in getting credit	Yes	Not aware	Nil
Earning sufficient to run CHC and earn a livelihood	Yes	Yes	NA
Facility for repair and maintenance of farm machineries	Poor facility	Own workshop	Own workshop
Major constraints in running CHC	Cash to run CHC on credit and Getting financed the CHC from bank and servicing of farm machineries.	Providing services on credit.	Not much
Annual Turnover (Rs. Lakh/ CHC)	11.5	NA	3.5
Return over variable cost profit (Rs. lakh/CHC/annum	5.38	0	1.6

The CHC operators opined that collaterals asked by the banks/financial institutions from prospective operators for sanctioning loans should not be the urban properties and fixed deposit, rather it should be on the basis of land records and hypothecation of farm machines/ implements only. They further shared that the combinations of farm machineries and implements under CHC should not be fixed. It should be made flexible and left to the operators to choose the combinations depending upon the requirement of the areas and availability with the farmer's operators. From beneficiaries' side, especially the marginal and small farmers, lack of cash for the payment of machine hiring charges, smaller plots leading to consume more time to carry out mechanical operations, less prioritization of operators when the service is necessary were the major constraints. Unawareness on modern machineries like laser leveler, zero-till seed drill, happy seeder and paddy transplanter, were the other issues observed in the study region.

Impact of farm mechanization on paddy output

Production function analysis was performed to assess the quantitative contribution of mechanization in paddy output. Paddy output was regressed with crop area, mechanization index, seed, manures and fertilizers, insecticides, total capital, miscellaneous cost, canal and other irrigation charges and human labour cost. These variables jointly explained 80 per cent variation in total output of paddy (Table 2.7). The variables, namely crop area, seed, manures and fertilizers, insecticides, human labour, canal and other irrigation charges, total capital cost, and mechanization index significantly influenced the total output of paddy. The coefficients of mechanization index were highly significant and positive for all the farm size categories indicating mechanization has contributed significantly in increasing paddy output.

Table 2.7. Estimated coefficients of Cobb-Douglas production function

Coefficients	Marginal	Small	Semi-medium	Medium	Large	Overall
Dependent Variable: Paddy output (Rs)						
Explanatory variables						
Intercept	6.68***	Overall	7.36***	6.82***	7.68***	7.37***
Crop area (ha)	0.55***	0.59***	0.67***	0.70***	0.85***	0.65***
Mechanization index	0.01***	0.02***	0.01***	0.01***	0.01*	0.01***
Seed (Rs)	0.17***	0.11***	0.09***	0.14***	0.03*	0.10***
Manures and fertilizers (Rs)	0.01***	0.01***	0.01***	0.01***	0.01	0.01***
Insecticides (Rs)	0.03***	0.02***	0.03***	0.03***	0.03***	0.03***
Total capital (Rs)	- 0.01	- 0.02***	0.02***	0.07***	0.05***	0.01***
Miscellaneous cost (Rs)	- 0.01	- 0.01	- 0.01	-0.01**	-0.01*	-0.01***
Canal and other irrigation charges (Rs)	0.01	0.01	0.01***	0.01***	0.01***	0.01***
Human labour cost (Rs)	0.30***	0.30***	0.26***	0.23***	0.25***	0.27***
Returns to scale	1.07	1.04	1.11	1.19	1.22	1.08
R^2	0.80	0.80	0.81	0.85	0.86	0.85

Note: 'ns' indicate not significant
*** , ** and * indicate significance at 1%, 5% and 10% level, respectively.

The overall coefficient of mechanization index (0.013) indicated that with improvement in mechanization index by 10 per cent, return from paddy will increase by 0.13 per cent. The higher value of coefficients of mechanization index on smaller farm in comparison to larger farms indicated higher scope of mechanization on smaller farms as compared to larger farms. Thus, improvements in farm mechanization will help farmers in obtaining more output at lesser cost thereby higher income in paddy cultivation. The benefit of mechanization will be more on small farms. Hence, in country like India where small and marginal farms account for more than 85 per cent of total farms, mechanization will help in improving overall production, productivity, labour efficiency and income of farmers.

Nutrient Demand and the Effect of Women Empowerment in Improving Nutritional Outcomes

Jaya Jumrani and Usha Rani Ahuja

The objectives of the study were two-fold: a) to estimate the responsiveness of nutrient demand to income changes, and b) to evaluate the impact of women empowerment in agriculture on nutritional outcomes. The preliminary patterns in terms of consumption expenditure and nutrient intakes revealed an increase in monthly per capita calorie intake after 2011-12 (Figure 2.8). Between 1993-94 and 2011-12, there had been a decrease in the consumption of cereals as well as pulses from 14 (11.5) kg/month to 12 (10) kg/month in rural (urban) India. Other food categories such as milk and milk products, eggs, edible oils, and meat, fish etc., witnessed an increase in their consumption. Sugar intake as well as intake of fruits, vegetables etc. had reduced in urban areas but not for rural areas. A decline was witnessed in the share of calories derived from grains in both the sectors. There was a shift away from these items towards more calorie-dense foods such as sugar, oils, meat, fish and dairy products. Similar patterns were also visible in terms of expenditure shares.

The status of women empowerment in agriculture was assessed for three eastern states, namely Bihar, Odisha and Jharkhand using the computation based on IFPRI's Women Empowerment in Agriculture Index (WEAI) (Table 2.8). Highest number of empowered women were residing in Jharkhand (18.1%) followed by Odisha (8.8%) and Bihar (8.1%).

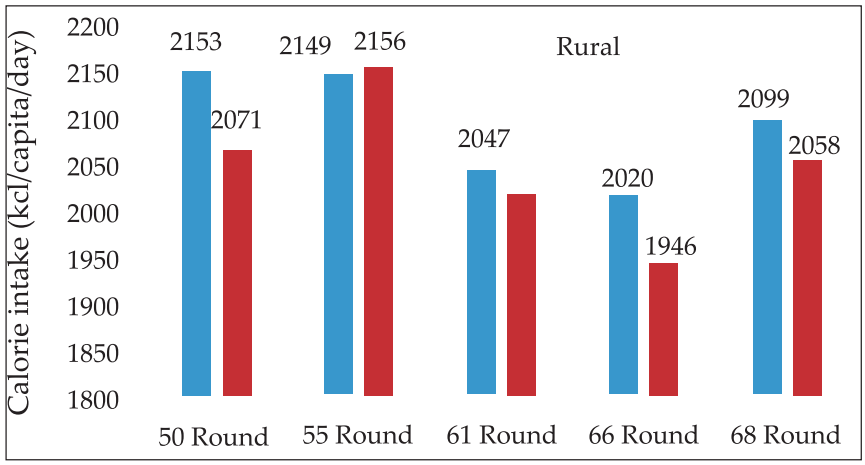


Figure 2.8. Daily per capita calorie intake (kcal) in India

Table 2.8. Status of women empowerment in agriculture

Particulars	Bihar	Jharkhand	Odisha	Overall
5DE	0.638	0.700	0.630	0.658
0.9*5DE	0.574	0.634	0.568	0.593
GPI	0.899	0.970	0.920	0.928
0.1*GPI	0.089	0.097	0.092	0.093
WEAI	**0.664**	**0.730**	**0.660**	**0.684**

Source: Estimated using VDSA's Village Level Survey datasets.
Notes: GPI refers to Gender Parity Index, 5DE refers to five domains of empowerment and WEAI = 0.9(5DE) + 0.1(GPI)

Climate Change Impact, Adaptation and Mitigation: Gender Perspective

Usha Ahuja and Vinayak Nikam

The study was undertaken to assess the gender differential vulnerability and impact of climate change. Primary data were collected from rural households of six districts from Rajasthan, Himachal Pradesh and Odisha (representing agro-ecosystem affected by droughts, landslides and cyclones) using personal interview of male and female in the household. The sustainable livelihood approach (SLA) suggested by DFID (2001) was used for studying the vulnerability and impact of climate change on men and women. Potential impact was calculated by adding sensitivity and exposure values. Vulnerability of women to the effects of climate change was assessed by calculating the vulnerability index given by IPCC-IV (2001) formula. It was observed that in all the six districts females were marginally more vulnerable than male due to more exposure and less adaptive capacity as compared to males. It was further observed that in case of male, vulnerability index ranged from 0.020 in Mandi district of Himachal Pradesh to 0.18 in Bhadarak district of Odisha whereas for female it ranged from 0.06 in Kullu district of Himachal Pradesh to 0.29 in Bhadarak district of Odisha.

Potential impact of climate change was compared to adaptive capacity to see the extent of coping capability of the farmers (Figure 2.9). For females, the potential impact in all the selected states was more and adaptive capacity was less as compared to males which clearly indicates that females are more vulnerable to the climatic events. Further, it was found that in case of males the coping mechanism available in terms of adaptive capacity and can cope up the climatic vagaries from 46 per cent in Barmer to 63 per cent in Mandi and in case of females, it ranged from 39 per cent in Bhadark to 59 per cent in Kullu.

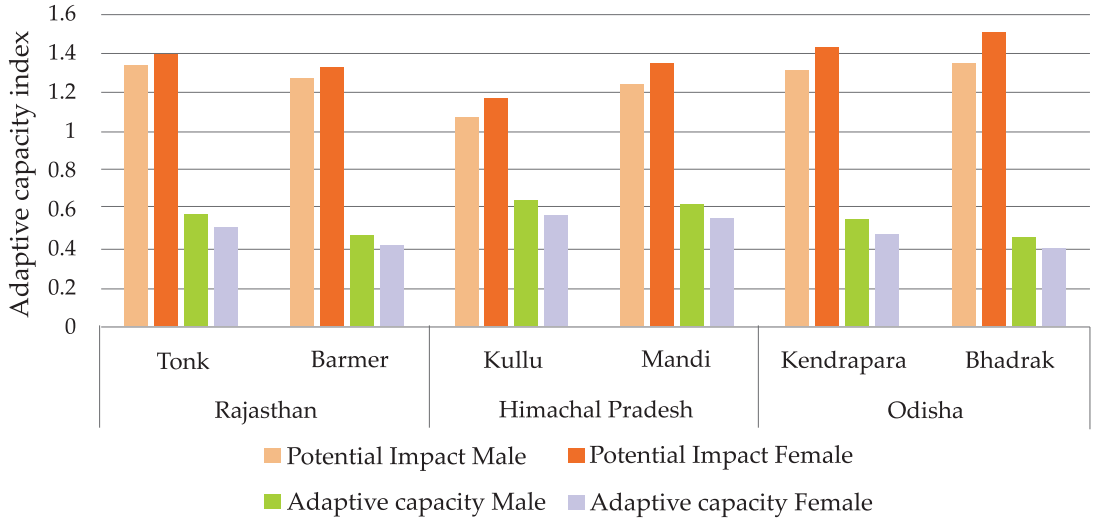


Figure 2.9. Potential impact and adaptive capacity indices

Gender differential impact of climate change using five capitals

The results from the impact of climate change indicated that in human capital women were impacted more as compared to males in all the selected districts and the difference was minimum in Mandi district of HP (2.50 for males and 2.76 for females) and maximum in Kendrapara district of Odisha (3.50 for males and 3.61 for females) (Table 2.9). Climatic events have impacted natural capital moderately and both the genders were more or less affected equally. Climatic events have impacted social capital as well, moderately ranging from 2.9 to 3.4 points and both the genders were more or less affected equally. Financial capital was affected most in Odisha followed by Himachal Pradesh and Rajasthan. Interestingly, in Rajasthan, females were affected less as compared to other two states.

Table2.9. Gender differential impact of climate change using SLA approach

Types of Capital	Gender	Rajasthan		Himachal Pradesh		Odisha	
		Tonk	Barmer	Kullu	Mandi	Kendrapara	Bhadrak
Human Capital	Male	3.19	3.31	3.09	2.50	3.50	3.59
	Female	3.40	3.48	3.24	2.76	3.61	3.87
Natural capital	Male	3.51	3.54	3.55	2.83	3.54	3.64
	Female	3.54	3.55	3.63	3.08	3.55	3.83
Social Capital	Male	2.91	3.33	3.32	2.92	3.15	3.27
	Female	3.21	3.28	3.40	3.37	3.30	3.43
Financial Capital	Male	3.06	3.06	3.39	3.00	3.35	3.63
	Female	2.92	2.92	3.41	3.07	3.47	3.88
Physical Capital	Male	2.72	2.97	3.88	2.80	3.47	3.88
	Female	2.92	3.24	4.06	2.79	3.82	4.13

*Impact was calculated on 5-point scale

Supply Response in Indian Dairying

PS Birthal, Ghanshyam Pandey, J Jumrani and J Hazrana

This study assessed responsiveness of dairying activity to prices, and non-price factors that could have caused an upward shift in dairy production function. India's dairy production system is typically a smallholder system primarily based on non-cash inputs, and the findings show that the stock of dairy animals as well as their yields are inelastic to prices of both milk and feed. Milk yield, however, responds positively to technological change in animal breeding, feed supplies, veterinary services and markets.

India's dairy sector has not received much policy attention. It has remained under-invested, and also neglected by the financial institutions and extension systems. The results suggest that dairy policy should concentrate on providing farmers improved technologies, quality feeds, support services and markets for sustainable increase in milk production. The prescriptions, however, do not undermine the importance of price instrument in the growth of dairy sector. Milk prices in India have remained subdued for long. The current system of milk pricing is based on fat and solid-non-fat contents, and does not consider cost of production. A suitable pricing policy is essential to create incentives for the adoption of improved technologies, and use of quality inputs and services for achieving higher yield and optimizing the herd matching available feed resources.

Crop Insurance in India

Pavithra S., Jaya Jumrani and Arathy Ashok

The *Prime Minister Fasal Bima Yojna* (PMFBY) is the recently launched crop insurance scheme in India in order to overcome some of the limitations in the existing crop insurance schemes. The present study aims to assess the overall coverage, farmers' willingness to pay and role of information with respect to the PMFBY scheme in India. The PMFBY has aimed to increase the area under crop insurance coverage by 50 per cent towards the end of 2018-19.

During 2016-17, 56.28 million hectare cultivated area (28.63% of gross cropped area) of 57.32 million farmers was covered under PMFBY in the country. The claims to premium ratio of the scheme at the All India level was 0.72 (Table 2.10). The ratio was more than one in Andhra Pradesh (1.06), Karnataka (1.19), Kerala (1.34) and Tamil Nadu (2.79). The proportion of farmers benefitted through the PMBFY scheme at the all India level was 24.96 per cent (14.30 million farmers). The proportion of farmers

benefitted was higher in Andhra Pradesh, Gujarat, Karnataka, Maharashtra, and Tamil Nadu in comparison to the other states. Average sum insured per ha of insured area in the major states ranged from Rs. 17,017 in Rajasthan to Rs. 60,493 in West Bengal. The average sum insured per ha in the country stood at Rs. 36,145.

risk in 2017-18, which was a good monsoon year, de-duplication due to Aadhaar being made mandatory for coverage etc.

On the implementation side, the key issues of concern for PMFBY are yield loss estimation, standardizing the use of technology for crop loss assessment and timely settlement of claims,

Table 2.10. Details on the coverage of PMFBY in major states for 2016-17

State	Farmers insured (No. in Million)	Area insured (Million Ha)	Sum insured per ha (Rs)	Farmers' premium (Rs crores)	Governments* share in premium (%)	Farmers benefitted (% of insured)	Claims: Premium Ratio
Maharashtra	12.01	7.44	32,932.74	692.32	85.39	24.21	0.49
Rajasthan	9.17	10.39	17,017.05	366.22	85.58	31.64	0.74
Madhya Pradesh	7.18	12.02	30,625.22	733.12	80.97	18.36	0.52
Uttar Pradesh	6.84	5.92	43,932.35	475.96	57.45	16.84	0.50
West Bengal	4.13	2.00	60,493.16	230.1	68.34	12.54	0.58
Karnataka	2.74	2.95	36,579.40	259.48	83.40	54.42	1.19
Bihar	2.71	2.45	48,146.95	204.62	85.55	8.13	0.25
Gujarat	1.98	2.84	43,368.61	249.39	89.44	34.37	0.53
Odisha	1.82	1.32	55,071.51	142.63	73.54	9.26	0.80
Andhra Pradesh	1.78	1.58	55,354.77	199.27	76.43	49.48	1.06
Chhattisgarh	1.55	2.42	29,923.90	136.49	58.10	8.82	0.49
Tamil Nadu	1.41	1.30	52,078.67	112.54	90.83	83.94	2.79
Haryana	1.34	2.08	56,520.51	196.53	46.07	16.38	0.81
All India	57.32	56.28	36,145.31	4,216.04	81.13	24.96	0.72

Note: *Includes both the Central and State Governments contribution in the gross premium.

In 2017-18, PMFBY covered an area of 52.10 million hectares of GCA, covering 52.00 million farmers in 2017-18, the total sum insured being Rs. 2,07,896 crores. This shows a decline in the number of farmers covered and area insured by 9.09 per cent and 7.61 per cent, respectively compared to the previous year, though the sum insured increased by 2.18 per cent. Such decline in the coverage of farmers under PMFBY in 2017-18 is attributed to factors like the announcement of Debt Waiver Scheme in Maharashtra and Uttar Pradesh, farmer's perception of mitigated high actuarial premium rates, increasing the coverage of shared and tenant croppers and creating awareness among farmers on the crop insurance. Institutional factors such as strengthening the manpower and availability of technology and other resources, timely notification of crops, structured grievance addressable mechanism, timely settlement of claims and coordination among the implementing agencies could play a key role in effective implementation of the PMFBY scheme.

Theme-II

TECHNOLOGY AND SUSTAINABLE AGRICULTURE

Excerpts

- Climatic shocks reduce agricultural productivity, and the effects get accentuated in the long-run. Crop diversification has positive marginal effect on improving resilience of agriculture. Impacts of climatic shocks vary across the crops and agro-climatic zones (ACZs) which necessitate region-specific interventions and prioritization of adaptation strategies.
- Migration has emerged as a significant adaptation strategy to manage vulnerability and secure livelihoods to climate risks. However, it affects both the place of origin and destination via its impact on natural resources, economic security and other socio-political factors.
- Intra-ACZs variations in sustainable livelihood security necessitate prioritization of vulnerable areas to arrest regional imbalances, prevent over-exploitation and to leverage unutilized potential of ACZs.
- Agro-climatic zones of eastern and central India are more sustainable for paddy cultivation as compared to north-western and south-eastern zones. This necessitates cropping pattern re-alignment across the zones based on water availability and footprints.
- Wheat sowing with Happy Seeder is a successful paddy straw management technique which is associated with reduction in input cost and saving in water and energy.
- In flood affected areas of Assam, more than two-third of the farmers prefers traditional flood tolerant varieties despite higher return of modern varieties. This is due to requirement of less inputs and management practices in cultivation of traditional varieties.
- Crop suitability assessment in Bundelkhand region indicated that most of the existing crops are either moderately or marginally suitable for cultivation.
- Evidences from Telangana revealed that rehabilitation of tank results in increase in irrigation numbers, improvement in inclusiveness of access to irrigation and higher returns from crop cultivation.
- Most of the patents in agriculture granted during 1990 to 2007 are from Asian countries, particularly China. India's growth in cumulative patents filed in agriculture is higher than the global average growth during recent years.
- Among the different typologies of mergers and acquisitions (M & A), vertical M & A significantly improves the patents counts among acquiring and acquired firm, while Horizontal M & A have negative effect.
- Adoption of micro-irrigation technology has positive impact on net returns from cultivation. The administrative mechanisms in implementation of micro-irrigation schemes vary across the states. People's participation at different stages of micro-irrigation programme play important role in its adoption.
- The shifting of subsidy transfer from its traditional method to direct benefit transfer as transformative pro-poor policies in Uttar Pradesh have positive impact and is gaining popularity.
- Indian extension system is of pluralistic nature and linkages with varying degree have been observed among different extension and advisory services (EAS) providers indicating convergence and coordination among them. Farm households having access to EAS operate with comparatively higher technical efficiency than those without access to EAS.
- Social network greatly influences adoption of information communication technology by the farmers. The adoption rate of the technology can be improved by targeting the contact persons having better social network characteristics such as education level, land holding, association in village organization, frequency of interaction etc.

Research Priorities and Policies for Climate Resilient Agriculture

Crop diversification and resilience of agriculture to climatic shocks

PS Birthal and J Hazrana

Frequent occurrence of extreme climatic events adversely affects agricultural productivity and food supplies. Risk-averse farmers, who anticipate occurrence of a shock, often rely on ex ante risk management strategies, such as building of savings, diversification towards non-farm activities and choosing a less risky crop portfolio, to achieve a stable stream of income. This study assessed the dynamic effects of climatic shocks, *i.e.* rainfall deficit and heat-stress on agricultural productivity and the contribution of crop diversification in mitigating harmful effects of such shocks. Figure 2.10 shows that both the rainfall-deficit and heat-stress damage agricultural productivity, and the damage increases with increasing severity of climatic shocks.

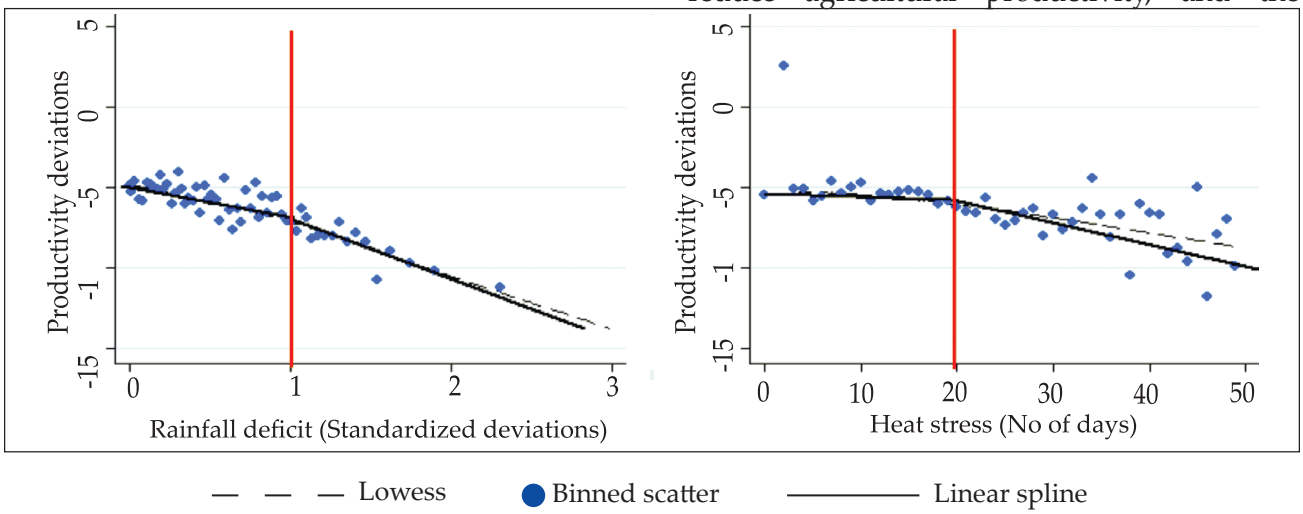


Figure 2.10. Binned scatter plot of climatic shocks and productivity deviations

The contribution of crop diversification in mitigating the harmful effects of climatic shocks was assessed by plotting climatic shocks and agricultural productivity at two levels of system diversity, i.e. less than 50 per cent and more than 50 per cent of the mean level of diversification index (Figure 2.11). There is a negative association between productivity and rainfall-deficit as well as heat-stress at low-level of system diversity. At higher level of the diversity, although the effects of climatic shocks remain negative, but are not as prominent as at the low level.

The econometric analysis ascertained the role of diversification in improving resilience of agriculture using a dynamic panel-data approach (Table 2.11). The marginal effect of rainfall-deficit and heat-stress is negative and significant confirming that climatic shocks reduce agricultural productivity, and the effects get accentuated in the long-run. On the other hand, marginal effect of diversification is positive and significant and the gains are larger in the long-run. Marginal effects of climatic shocks as well as diversification vary across seasons. For *kharif* season, the marginal effects of rainfall-deficit and heat-stress are negative and that of diversification are positive. For *rabi* season, the short-run marginal effects of climatic shocks and diversification are not significant. However, the long-run marginal effects of rainfall-deficit are negative, but not that of heat-stress. Diversification has positive effects.

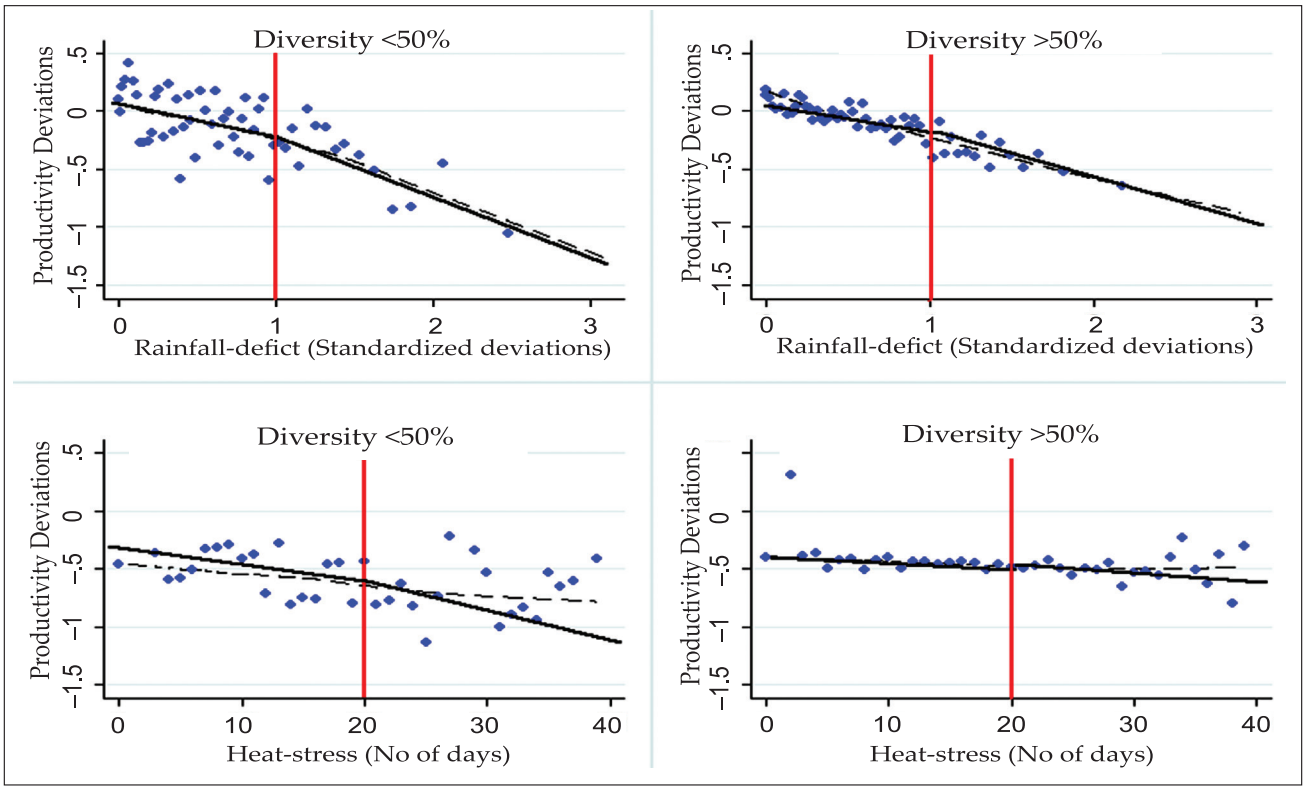


Figure 2.11. Binned scatter plots of climatic shocks and productivity deviation

These findings have two clear implications for policies aiming at making agriculture climate-resilient. First, since the climatic shocks are location-specific, there is a need to strengthen location-specific early warning systems to provide farmers timely information on weather conditions so that they are better-prepared to choose crops and other agronomic practices in anticipation of a weather shock. Yet, another related issue is of strengthening the agricultural information and input delivery systems, especially for seeds and agronomic practices that play an important role in management of risks ex ante. Second, there is a need to emphasize research on crop breeding for stress-tolerance. Unlike other management options, stress-tolerant seeds are not expensive, are easy to multiply and provide long-term solution.

Table 2.11. Short-run and long-run marginal effects

Particulars	Overall	*Kharif*	*Rabi*
Short-run			
Rainfall-deficit	-0.13*** (0.01)	-0.05*** (0.01)	0.01 (0.01)
Heat-stress	-0.51*** (0.19)	-1.10*** (0.15)	0.47* (0.11)
Diversification	1.41*** (0.31)	0.21*** (0.09)	0.16(0.16)
Long-run			
Rainfall-deficit	-0.38 *** (0.04)	-0.09*** (0.01)	-0.22*** (0.01)
Heat-stress	-1.51*** (0.18)	-2.52*** (0.11)	1.22*** (0.09)
Diversification	4.14*** (0.49)	0.22*** (0.01)	0.23*** (0.02)

Note : Figures in parentheses are standard errors; Significance level: *p<0.10, ** p<0.05, **p<0.01

Strategic research component of national innovations on climate resilient agriculture (NICRA)

Naveen P Singh, Arathy Ashok, Surendra Singh and Bhawna Anand

Impact of climate change on crop yields: Agro-climatic zone level assessment

The study examined the impact of changes in rainfall and temperatures on yields of major *kharif* and *rabi* crops at agro-climatic zones (ACZ) level. Data on crop yields and economic variables, viz. irrigated area, road length, rural literates, tractors, fertiliser consumption and pump set were paired with weather parameters to develop a large scale district-level panel set for the period 1966-2011, spread across 14 agro-climatic zones (excluding island region). The marginal effects of change in climate parameters (both temperature and rainfall) incorporating adaptations are shown in table 2.12 and table 2.13. A decline in rice yield was observed in most of the ACZs, with highest reduction of 1.43 per cent found in WHP followed by EHR (covering north-eastern states and part of West Bengal) where it reduced by 1.30 per cent. On the other hand, in UGP, rice yield rose by 1.01 per cent. In case of maize, the maximum reduction in yield occurred in MGP (2.89%) and EHR (2.07%), while it was least affected in EPH and ECH. During the period cotton was positively impacted by climate variations in WPH comprising districts of Madhya Pradesh and Maharashtra. However, as shown in Table 2.12 in GPH and WDR, cotton yield showed reduction of 0.32 and 0.30 per cent. Groundnut rose by 0.31 and 0.17 per cent in SPH (Andhra Pradesh, Telangana, Karnataka and Tamil Nadu) and in ECH (Andhra Pradesh, Odisha, Puducherry and Tamil Nadu).

Table 2.12. Agro-climatic zone wise climate change impact on major crops in *kharif* season (%)

Agro-Climatic Zone	Rice	Maize	Groun-dnut	Sorghum	Pigeon pea	Cotton	Pearl Millet	Soybean	Sugar-cane
Western Himalayan Region (WHR)	-1.43	-0.36	-	-	-	-	-	-	-
Eastern Himalayan Region (HER)	-1.30	-2.07	-	-	-	-	-	-	-
Lower Gangetic Plains (LGP)	-0.44	-0.31	-	-	-	-	-	-	-
Middle Gangetic Plains (MGP)	-0.55	-2.89	-	-	-0.76	-	-	-	-
Upper Gangetic Plains (UGP)	1.01	-0.32	-	-	-	-	-	-	-
Trans Gangetic Plains (TGP)	-0.54	-	-	-	-	-0.27	-	-	-
Eastern Plateau and Hills (EPH)	-0.79	0.21	-	-	-0.28	-	-	-	-
Central Plateau and Hills (CPH)	-	-0.28	-0.26	-0.91	-	-	-0.22	-0.43	-
Western Plateau and Hills (WPH)	-	-0.91	-	0.50	-	1.04	-	0.40	-
Southern Plateau and Hills (SPH)	-0.19	-0.82	0.31	0.42	-	-0.20	-	-	-
East Coastal Plains and Hills (ECH)	-0.56	-0.27	0.17	0.33	-	-	-	-	-0.26
West Coastal Plains and Hills (WCH)	-0.50	-	-	-	-	-0.28	-	-	-0.89
Gujarat Plains and Hills (GPH)	-	-0.32	-	-	-	-0.30	-	-	-
Western Dry Region (WDR)	-	-	-	-	-	-0.32	-	-	-

Source : Authors estimation from VDSA and Indian Meteorological Department database.

The sorghum crop is positively influenced by climate change in all the growing regions except CPH (covering Madhya Pradesh, Rajasthan and Uttar Pradesh). In case of Soybean yield rose by 0.40 per cent in WPH, while it reduced by 0.43 per cent in CPH. Climatic variations negatively impacted sugarcane in both ECH and WCH.

Table 2.13. Agro-climatic zone wise climate change impact on major crops in *rabi* season (%)

Agro-Climatic Zone	Wheat	Barley	Rapeseed	Linseed	Chickpea
WHR	-0.44	-0.14	-	-	-
EHR	-	-	-1.05	-	-
LGP	-	-	-0.32	-	-
MGP	-2.86	-1.08	-	-	-
UGP	-0.36	-	-	-	-
TGP	-0.15	-0.91	-0.75	-	-
EPH	0.20	-	-	-0.68	-
CPH	-	-	0.24	-	-
WPH	-0.18	-	-	-	-
SPH	-0.04	-	-	-	-0.04
ECH	-0.04	-	-	-	-0.03
WCH	-0.03	-	-	-	-0.02
GPH	-0.34	-	-	-	-
WDR	-	-0.10	-	-	-

Source: Authors estimation from VDSA and Indian Meteorological Department database.

In the *rabi* cropping season, wheat yield was negatively affected by climate change in all the growing regions except EPH (Table 2.13). The highest reduction in wheat occurred in MGP (parts of Uttar Pradesh and Bihar). Barley showed a decline of around 1.08 per cent in MGP and 0.90 per cent in TGP. The yield loss of 1.05, 0.32 and 0.75 per cent was estimated for rapeseed in EHR, LGP and TGP. However, in CPH (part of Madhya Pradesh, Rajasthan and Uttar Pradesh), rapeseed was benefited from climate change. During the period, linseed declined by 0.68 per cent in EPH.

The empirical results show that climate change is adversely affecting *rabi* and *kharif* crop yields across agro-climatic regions and this necessitates the need to formulate region-specific interventions and plans and prioritization of adaptation strategies to deal with current and future climate change for evolving farmers-centric climate adaptation and mitigation policy.

Climate vulnerability assessment in semi-arid and arid region of Rajasthan

Improved knowledge of vulnerability to climate change is essential for prioritization of vulnerable regions, targeting constraints to effective adaptation and to design appropriate response and mitigation strategies. In this context, climate vulnerability was assessed in Rajasthan. District level data on climate and socio-economic indicators were compiled to compute vulnerability index, conceptualized as a combination of four components; crop production loss, sensitivity, exposure and adaptive capacity. The standard IPCC methodology was used to characterize vulnerable districts. Homogenous districts were clustered into three groups of low (0-33th percentile), medium (34th-66th percentile) and high (67th 100th percentile) as shown in figure 2.12.

Based on the overall vulnerability index, Hanumangarh, Jaisalmer, Ganganagar, Bundi and Bharatpur were grouped as districts with high degree of vulnerability to climate change. On the other hand, on account of lower crop production losses, lesser sensitivity and higher degree of adaptive capacity, Sirohi, Dungarpur, Pali, Jhunjhunun, Ajmer, Jaipur, Jalore, Banswara, Churu, Jhalawar and Dausa reported

lowest level vulnerability. The dynamicity exists in space and time among these districts with respect to climate change vulnerability and this study suggests a continuous and periodical characterization for priority setting, thereby channelizing resources to the vulnerable regions aimed to enhance climate change resilience.

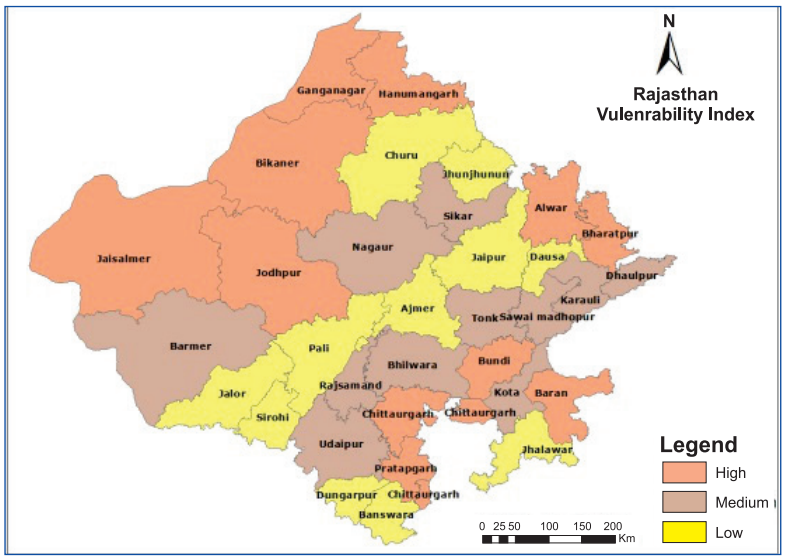


Figure 2.12. Classification of districts of Rajasthan based on climate vulnerability index

Climate change and migration: Insights from large-scale household data

Extreme weather events such as cyclones, floods, droughts and desertification adversely affect rural livelihoods and intensify the process of migration, as an adaptation option. This study examined the dynamics of climate induced migration in 17 states and three UTs which reported migration due to natural disaster, viz. flood in Gangetic Plain Regions, drought in Southern parts and cyclones in Coastal region. The study used 64th round of National Sample Survey Office (June 2007-July 2008) data on Employment, Unemployment and Migration. The results indicate that land size, religion, social group, education and age significantly influence migration (Table 2.14). Farmers belonging to SCs & STs category are less likely to be migrated. Further, illiterate and married person migrate on account of secured livelihood. Technical and general education positively influence the migration decision. Among the climatic parameters, higher variability in rainfall is more likely to cause migration.

Table 2.14. Determinants of migration (migration = 1, otherwise = 0)

Variables	Coefficient	Odds Ratio
Sector (Rural = 1, Otherwise = 0)	0.46*	1.58
Land size (Marginal = 1, Otherwise = 0)	0.15*	1.16
Religion (Hindu = 1, Otherwise = 0)	0.59*	1.81
Social group (SC & ST = 1, Otherwise = 0)	-0.26*	0.77
Technical Education (Illiterate = 0, Otherwise = 0)	0.81*	2.25
General Education (Illiterate = 0, Otherwise = 0)	0.04*	1.04
Marital Status (Married = 1, Otherwise = 0)	1.76*	5.79
Gender (Male = 1, Otherwise = 0)	-1.81*	0.16
Age (Above 16 = 1, Otherwise = 0)	0.98*	2.66
Consumption Expenditure (Rs/person/mont)	-0.01^{NS}	1.00
Maximum Temperature (^{0}C)	-0.01^{NS}	1.00
Minimum Temperature (^{0}C)	-0.01^{NS}	1.00
Rainfall (mm)	0.01^{NS}	1.00
Constant	-3.09*	0.05
Number of Observations	569651	

Note: * Denotes significant and NS denotes non-significant
Source: Estimated from unit level NSSO 64th Data, 2008

Against the increasing uncertainty in climate variables, migration has emerged as a significant adaptation strategy to manage vulnerability and secure livelihoods to climate risks. However, migration affects both the place of origin and destination via its impact on natural resources, economic security and other socio-political factors. Investment in different areas promoting rural growth and development is crucial for addressing the push factors at the grass-root level.

Mainstreaming climate change adaptation in rural development policy

Strengthening farmers' capabilities and making their livelihoods more resilient to the unpredictable weather perils, necessitates the need to mainstream climate adaptation into the rural development programmes. This study developed a typology of technological, informational, natural resources management and economic constraints to adaptation that prevents up-scaling efforts and adaptation by farmers. A framework for mainstreaming was thus developed for India's decentralized planning wherein information percolates from the village/ panchayat/ district to the state and national level as illustrated in figure 2.13.

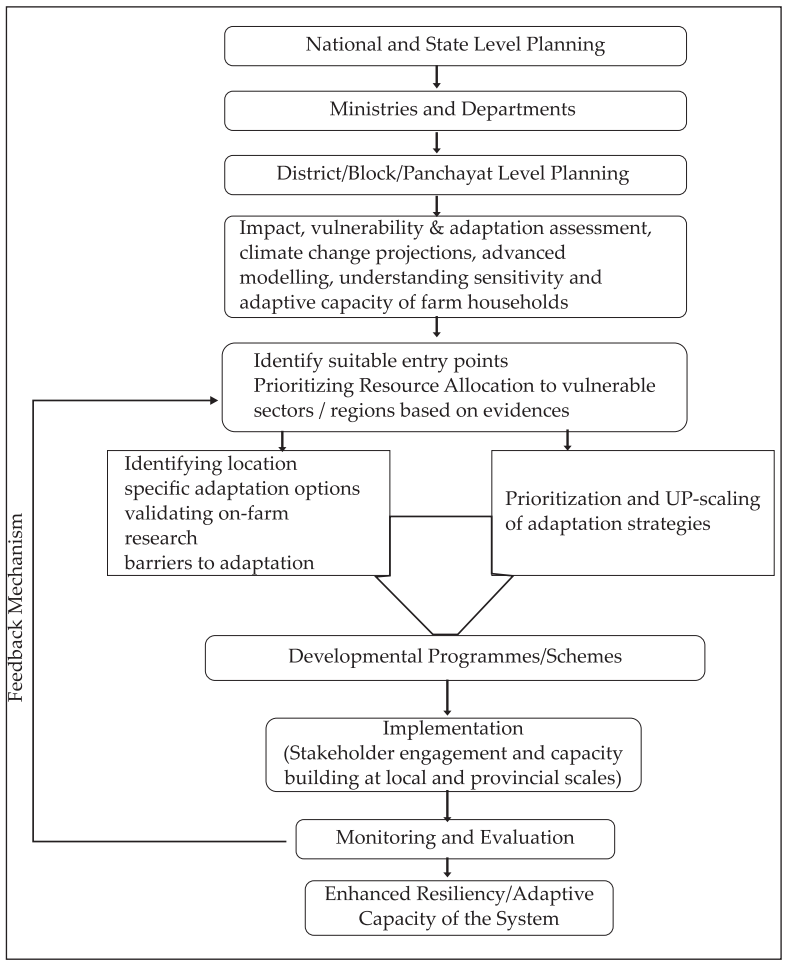


Figure 2.13. Framework for mainstreaming climate change adaptation

Mainstreaming requires coherence across multiple policy scales for developing possible synergy between micro-macro levels and addressing several cross-cutting issues. Therefore, each ministry/ department needs to carry an independent climate risk/ vulnerability assessments based on repository of collated grass-root information. The participation of local communities and institutions is crucial element in analyzing vulnerability, visible impacts and addressing region specific constraints. For appropriate adaptation options, various strategies must be evaluated for avoiding possible maladaptation. Suitable entry points in the form of developmental programs need to be identified for infusing both the climatic considerations, barriers and prioritized adaptations strategies. Moreover, strong local monitoring and evaluation is crucial for regular assessment of strategies, for successfully addressing vulnerability and adaptation constraints.

Moreover for mainstreaming programmes related to productivity enhancement and production augmentation, rural livelihood security, natural resource management, risk financing, food grain management and research & extension were selected. The identified constraints faced by the rural/ farm households to adaptation were mapped with the appropriate policy options in the rural developmental landscape. It was found that several programmatic interventions exist in the current rural development framework of the government that can help achieve the twin objective of adaptation and development, provided it effectively captures climatic

considerations. The approach augers well prioritization of resource allocation across different developmental programmes and ministries.

Dissecting the livelihood security of agro-climatic zones in India

This study examined the livelihood security status of agro-climatic zones in India using district level data. For this, a sustainable livelihood security index (SLSI) was constructed using more than 45 indicators encompassing eight dimensions of development; agriculture, economic, environment, infrastructure, health, nutrition, sanitation, and workforce. The relative performance of ACZs in terms of SLSI is illustrated in table 2.15. It was found that WCG (covering southern states of Kerala, Goa, and parts of Karnataka, Maharashtra and Tamil Nadu) had the highest SLSI ranking due relatively better status in nearly all the developmental dimensions, except nutrition and workforce.

EHR (North Eastern states and part of West Bengal) and UGP (parts of Uttar Pradesh) secured the lowest ranking. Lesser agriculture sustainability and poor sanitation in case of EHR and workforce insecurity along with inadequate nutrition in UGP contributed to poor ranking. Second and third positions were attained by WPH (parts of Madhya Pradesh and Maharashtra) and TGP (Haryana, Punjab, parts of Rajasthan, Delhi and Chandigarh). Higher agriculture security in the former and better health and sanitation security in the latter were some major factors leading to relatively better positioning of the two zones.

Table 2.15. ACZ wise ranking of sustainable livelihood security index (SLS)

Agro Climate Zones	Infrastructure Index	Economic Index	Agricultural Security Index	Environmental Index	Health Security	Nutritional Index	Sanitation Index	Workforce Index	Sustainable Livelihood Security Index	Rank
WHR	0.56	0.52	0.42	0.59	0.57	0.82	0.71	0.29	0.56	8
EHR	0.47	0.50	0.31	0.52	0.53	0.85	0.63	0.29	0.51	14
LGP	0.48	0.56	0.40	0.68	0.74	0.81	0.50	0.30	0.56	9
MGP	0.53	0.42	0.44	0.44	0.77	0.80	0.58	0.35	0.54	11
UGP	0.49	0.53	0.47	0.46	0.66	0.65	0.71	0.22	0.52	13
TGP	0.71	0.48	0.46	0.39	0.81	0.81	0.90	0.28	0.61	3
EPH	0.51	0.44	0.44	0.56	0.72	0.81	0.51	0.32	0.54	12
CPH	0.54	0.47	0.42	0.52	0.71	0.80	0.62	0.32	0.55	10
WPH	0.68	0.47	0.69	0.46	0.74	0.78	0.72	0.32	0.61	2
SPH	0.73	0.46	0.47	0.53	0.81	0.78	0.76	0.28	0.60	5
ECH	0.67	0.48	0.37	0.52	0.76	0.78	0.71	0.28	0.57	7
WCG	0.75	0.49	0.56	0.58	0.83	0.77	0.80	0.23	0.63	1
GPH	0.74	0.41	0.37	0.44	0.79	0.77	0.78	0.28	0.57	6
WDR	0.60	0.54	0.48	0.61	0.80	0.81	0.70	0.30	0.60	4

When the zones were delineated into four different clusters, namely very low (0-25th percentile), low (26th-50th percentile), medium (51st-75th percentile) and high (76th-100th percentile), TGP, WPH and WCG were found as highly developed regions while EHR, MGP, UGP and CPH were the least developed zones. The medium developed status of TGP, WPH, ECH and WDR zones in case of infrastructure security implies the zones if backed by sufficient allocation the zones can be further pushed towards higher status. In terms of economic sustainability, TGP, CPH and WPH occupied the status of lower developed zones, while

MGP, EPH, SPH, GPH descend to the least secured category. In terms of environmental sustainability, WHR, LGP and WDR became highly secured regions. Moreover, WHR, EHR, UGP and CPH were the least developed in terms of adequate access to health provisions. Based on the selected indicators, WPH, WCG and WDR were recognized and regarded as highly while EHR, LGP, ECH and GPH as least agriculturally developed zones.

Intra-ACZ variations were observed under SLSI and its dimensions. The policy insights from the analysis, suggests the need for prioritizing vulnerable/ less developed areas to arrest regional imbalances, prevent over-exploitation and to leverage unutilized potential of agro-climatic zones. Suitable policy interventions need to be directed towards *in situ* barriers such as infrastructure gaps, lack of irrigation connectivity, inadequate housing and sanitation facilities for ensuring sustainable livelihoods.

Evaluating food security status in Rajasthan

This study examined the food security status along its three major dimensions; availability, accessibility and stability in Rajasthan using more than 15 indicators. Districts were later categorized into four groups; low (0-25th percentile), medium (26th-50th percentile), high (51st-75th percentile) and very high (76th-100th percentile) as shown figure 2.14 (a to d). The results revealed that Baran had the highest food availability, whereas Dungarpur, Sirohi, and Banswara were categorized as districts with the lowest availability. Districts like Jaipur, Kota, Jodhpur, Udaipur, Bikaner and Ajmer had relatively better access to food owing to greater per capita state domestic product, higher literacy rate and urbanization, respectively.

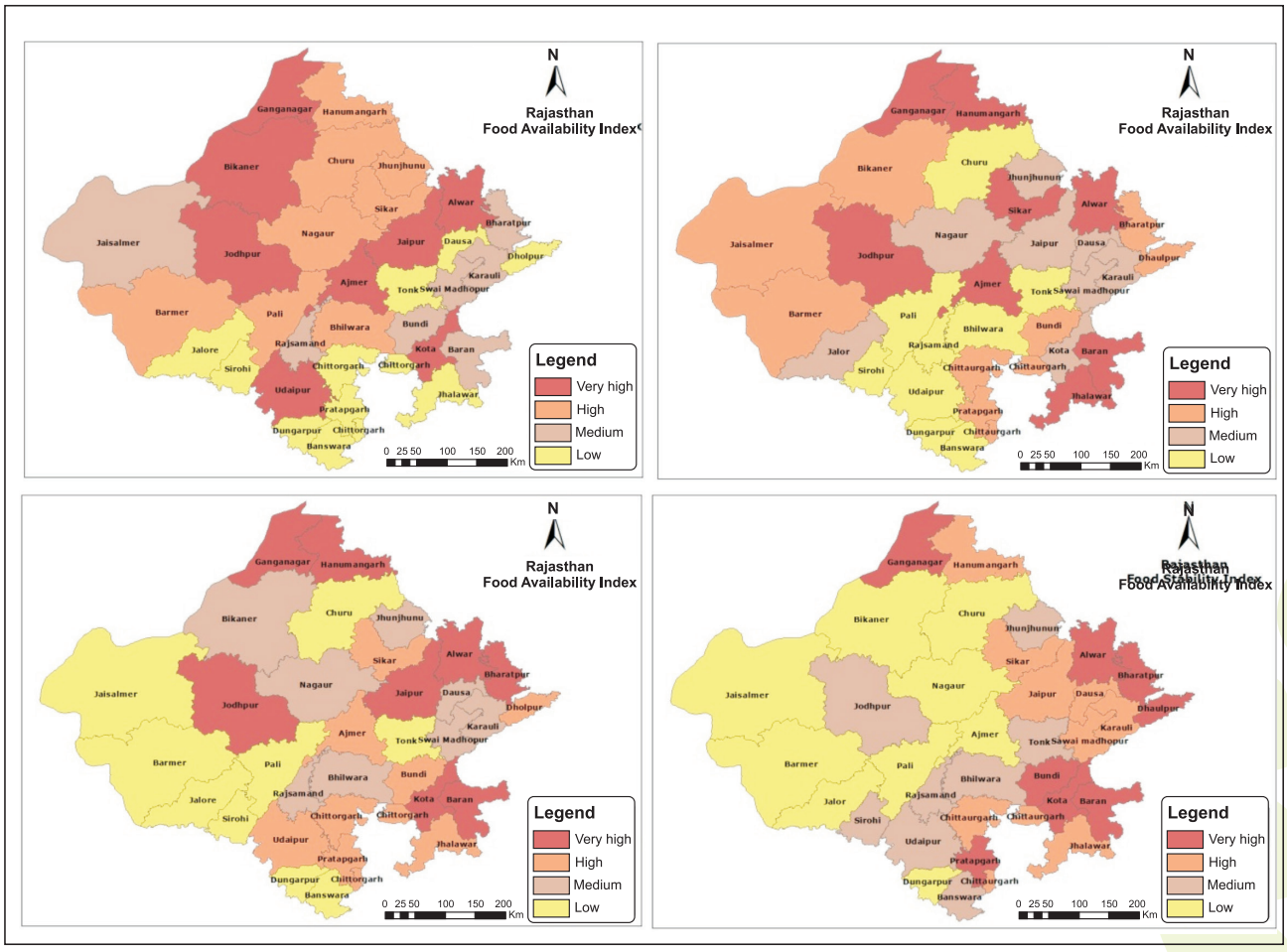


Figure 2.14. District maps showing index based security status for Rajasthan

Districts like Jalore, Pratapgarh, Banswara, and Sirohi were grouped under low level of food accessibility. Better storage capacity and higher irrigated area contributed to highest food stability in Ganganagar, Baran, Kota and Dholpur. On the other spectrum, Barmer rated the least stable district in term food production. Overall, the finding indicate that Dungarpur, Jalore, Churu, Banswara, Sirohi, Tonk, Jaisalmer, Barmer and Pali districts had the lowest degree of food security. On the other extreme, Ganganagar, Kota, Baran, Alwar, Jaipur, Bharatpur, Jodhpur and Hanumangarh were categorized under very high level of food security in Rajasthan. While evaluating the status of food security in the districts of Rajasthan, it was discerned that there exists significant inequalities in food security across districts due to variation in socio-economic variables. Hence, policy prescriptions need to be drawn to improve food availability, food accessibility and food stability through cropping intensity, better irrigation facilities and bio-fertilisers, application of modern technology and high yielding varieties on one hand and increased public spending in agriculture, development of infrastructure and food-grain storage, enhanced credit flow in market on the other, apart from creating more job opportunities in non-farm sector, thereby making a sustainable food security.

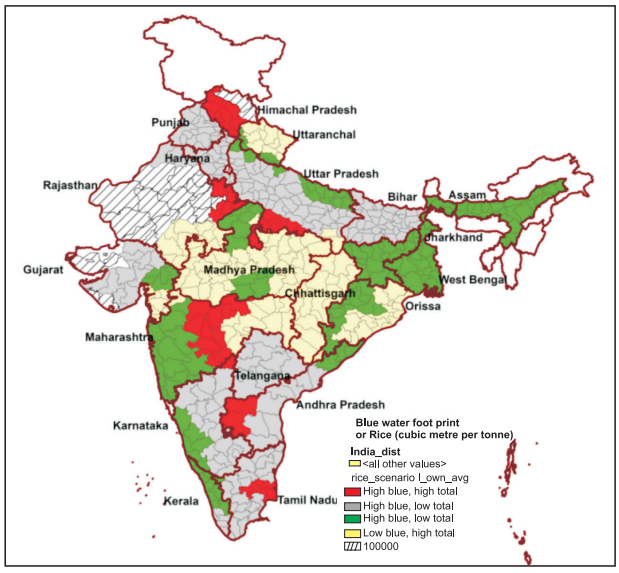


Figure 2.15. Identification of ACZs for rice production based on water use

Resource Use Planning for Sustainable Agriculture

Prem Chand, Suresh Pal, Rajni Jain, Subhash Chand, Prabhat Kishore, Sulakshana Rao C, Priyanka Agarwal

Identifying sustainable rice and wheat cultivation zones in India

This study estimated water footprints and identified the sustainable rice and wheat agro-climatic zones in India. The zones with different combinations of blue and total water footprints were categorized as highly sustainable (low blue and low total water footprints), sustainable (low blue and high total water footprints), low sustainable (high blue, low total water footprint) and unsustainable (high blue, high total water footprints) taking average water footprints of all the zones as the benchmark. Most of the agro-climatic zones of Assam, West Bengal, Odisha and Jharkhand; coastal and high rainfall hilly regions of Karnataka, Andhra Pradesh, Tamil Nadu, Maharashtra and Kerala; Tarai zones (low lying wet zones) of Uttrakhand and Uttar Pradesh; and Satpura plateau, Grid region and central Narmada valley of Madhya Pradesh were most suitable for rice cultivation. Contrary to this, scarce rainfall zone of Andhra Pradesh, dry zones of Karnataka, central plateau zone of Maharashtra, Bundelkhand

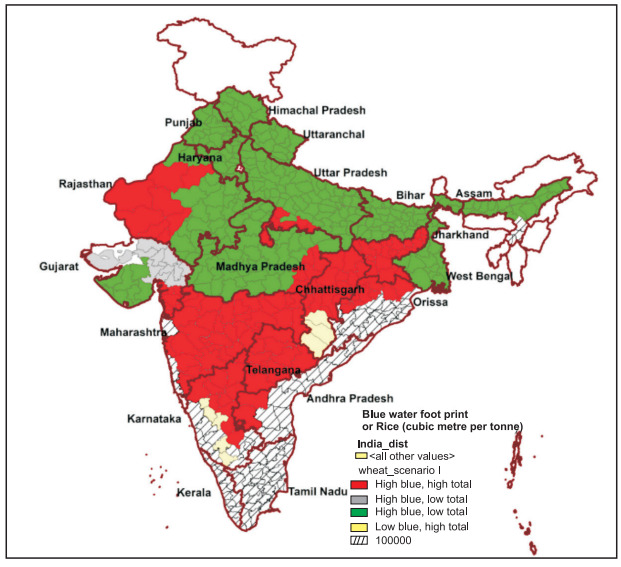


Figure 2.16. Identification of ACZs for wheat production based on water use

of Uttar Pradesh, western zones of Punjab, northern and southern alluvial zones of Bihar, and northern zones of Rajasthan were among the least suitable zones (Figure 2.15). Policy intervention in terms of restriction on flooded rice cultivation is required in the latter zones.

In case of wheat, agro-climatic zones of western Rajasthan, Karnataka, Maharashtra, Chhattisgarh and Telangana were in the category of either unsustainable or low sustainable (Figure 2.16). In southern state of Telangana and Karnataka, unsustainability in wheat cultivation does not pose a serious threat as it is not a major crop in the region. However, in Rajasthan and Maharashtra considerable area is under wheat which necessitates promotion of alternative low water requiring *rabi* crops like mustard, gram, etc. ACZs of Assam, Madhya Pradesh, Bihar, Uttar Pradesh, Punjab and Haryana were found to be most suitable for wheat cultivation. Spread of wheat cultivation in non-traditional state of Assam may reduce the burden on fresh water sources to a certain extent. However, water conservation for supplementary irrigation and strengthening irrigation facilities is required for expansion of area under wheat in the state. Cultivation assisted with technological interventions is advocated in arid and semi-arid zones with high blue water footprints. The findings emphasize a much needed cropping pattern re-alignment across the zones based on water availability and footprints.

Economics of paddy straw management technologies in Punjab

In collaboration with Punjab Agricultural University

This study analysed the economics of wheat cultivation under different methods of paddy straw management adopted by the farmers before sowing of wheat crop. Data were collected from 85 farmers practicing paddy straw management techniques and farmers undertaking conventional method of wheat sowing after burning paddy straw from Ludhiana and Sangrur districts of Punjab during 2017-18. It was found that technologies like wet/dry mixing of paddy straw in soil before wheat sowing put financial burden of about Rs. 1000 to 1700 per acre on the farmers. This technique is environmental friendly. But in case of heavy textured soil, wet mixing of paddy straw raises the level of moisture due to which wheat sowing gets delayed. The use of Happy Seeder technology in wheat sowing was associated with reduction in input cost without significant yield loss as compared to conventional method. Wheat sowing using Happy Seeder also saves water and energy as it requires less irrigation as compared to other straw management technologies. However, there are some constraints like problem of rodents, less availability of happy seeder machine, and high HP tractors required for operating it. These problems can be tackled by following the adequate crop protection practices along with making these machines available to the farmers on custom hire basis. To a large extent, adoption of this technology can also reduce the problem of dense smog during winter induced by paddy straw burning.

The health hazards of straw burning were well known to the sample farmers but a very short window between paddy harvesting and wheat sowing compels them to opt burning of paddy straw. Some of the measures suggested by the farmers to manage paddy straw are, availability of residue management machines on subsidized rate, addition of paddy residue management cost in MSP, and promote use of paddy straw in paper mills and energy generation plants.

Adoption and economics of flood tolerant varieties of paddy in Assam

In collaboration with Assam Agricultural University

Paddy, a major crop and source of livelihood to farmers in Assam, is adversely affected by occurrence of flood. This study examined management strategies and economics of indigenous as well as improved flood tolerant varieties by conducting a primary survey (150 sample size) in five flood prone agro-climatic zones of the state. More than 70 per cent of the net cropped area of the region is affected by flood. Nearly 78 per cent of the area under paddy was found to be covered by flood tolerant rice

varieties. However, nearly two-third (61.33%) of the farmers growing flood tolerant varieties were using indigenous bao-dhaan variety, whereas remaining farmers adopted improved varieties, namely Sawarna Sub1 and Ranjit Sub1 as a coping strategy against flood. Most of the farmers growing traditional bao-dhaan variety were small holders, whereas large farmers were using improved varieties. The average net return from traditional variety was found to be lower than the improved varieties. However, the farmers due to low requirement of inputs and management practices preferred traditional variety bao-dhaan. These traditional varieties are also rich in iron, protein, anti-oxidant elements and are mostly grown as organic which has high potential in international market. Linkages with international markets by strengthening value chain will not only help in coping up with flood but also increasing the income of the farmers in the state. Alteration in date of sowing was other commonly adaptation strategy followed by farmers. It was also found that 40 per cent of the farmers gave up crop production and shifted to livestock rearing for their livelihood.

Crop suitability analysis using multi-criteria decision making

The study examined suitability of the current crops in Bundelkhand region using various biophysical, socio-economic and infrastructural parameters applying multi-criteria decision-making. Analytical hierarchy process (AHP) technique was used to prioritise the criteria, combine them and reach an overall suitability for each crop in the region. Suitability of 13 major crops of Bundelkhand region, namely arhar, bajra, gram, groundnut, jowar, maize, mustard, paddy, potato, sesamum, soyabean, sugarcane and wheat was assessed across all 13 districts of the region. Crop suitability is determined as per categories (S1, S2, S3, and N) recommended by Food and Agricultural Organization (FAO) in its land evaluation framework. Each attributes were standardised and matched with the thresholds (attribute value based criterion for each suitability class) determined separately for each crop. The results revealed that most of the existing crops are moderately suitable or marginally suitable for cultivation in Bundelkhand. However, some crops like arhar in Damoh, Datia and

Table 2.16. Suitability class-wise maximum area available for major crops in Bundelkhand

Crop	Existing area (000 ha)			Maximum area (000 ha)			% of NSA (000 ha)		
	S1	S2	S3	S1	S2	S3	S1	S2	S3
Arhar	23	72	0	783	3345	0	19	81	0
Bajra	0	35	0	0	4128	0	0	100	0
Gram	0	857	0	0	4128	0	0	100	0
Groundnut	32	62	0	1331	2797	0	32	68	0
Jowar	0	88	0	0	4128	0	0	100	0
Maize	0	33	1	0	3370	758	0	82	18
Mustard	0	95	26	0	3370	758	0	82	18
Paddy	0	100	148	0	4128	0	0	100	0
Potato	0	6	5	0	0	4128	0	0	100
Sesamum	190	239	0	949	3179	0	23	77	0
Soybean	89	484	104	594	3534	0	14	86	0
Sugarcane	0	18	1	0	2615	1513	0	63	37
Wheat	0	1710	152	0	3824	304	0	93	7

Note : SI-highly suitable, S2-moderately suitable, S3-marginally suitable

Panna; groundnut in Chattarpur, Damoh, Datia and Panna; Sesamum in Banda, Lalitpur and Mahoba; Soybean in Banda and Lalitpur are highly suitable. Based on composite suitability analysis, maximum area available under major crops in Bundelkhand is shown in table 2.16.

It is observed that crops like arhar, goundnut, sesamum and soybean falls under highly suitable category for some part of the Bundelkhand region and maximum available area under these crops varies from 14-32 per cent only. Most of the crops cultivated in Bundelkhand are under moderately suitable category and the area available under these categories varies from 60 to 100 per cent. Maize, mustard, potato, sugarcane crops have some area in this region which is marginally suitable only. Further analysis revealed that farmers in the region assign more weightage to socio-economic parameters than bio-physical parameters while planning their crops. Thus, there is a need for revising price policy so as to improve socio-economic suitability of crops in favour of bio-physically suitable crops.

Impact of micro irrigation in southern Haryana

In collaboration with Chaudhary Charan Singh Haryana Agricultural University

Continuous depletion of groundwater resources and low water use efficiency necessitate adoption of improved methods of irrigation and cropping pattern realignment in Haryana. This study assessed the impact of micro irrigation on cropping pattern, crop productivity, costs and returns using primary data from 80 sample households of Mahendergarh district. With the introduction of sprinkler irrigation, a shift in cropping pattern from traditional crops to less risky and profitable crops has been observed. In *kharif* season, area diverted towards cotton, while in *rabi*, it is being replaced by mustard and wheat. Besides pulses, the area under cluster bean remained less than 10 per cent of total *kharif* cropped area due to adoption of remunerative crops.

Though net returns were relatively lower under sprinkler irrigation, its introduction increased the rental value of land by 5 to 7 times which otherwise remains very low. Therefore, when the returns were computed over the variable cost, these were found significantly higher under sprinkler system as compared to rain-fed condition. Another benefit of introduction of sprinkler has been noticed in term of more area coverage under irrigation and timely application of irrigation water at critical crop stages. The study suggests for creation of awareness among the farmers about water saving irrigation technologies.

Impact of tank rehabilitation on agriculture in Warangal district of Telangana

In collaboration with ICAR-Indian Agricultural Research Institute

This study examined the small farmers' access (inclusiveness) to tank irrigation, role of water users associations in promoting the inclusiveness and the impact of tank rehabilitation on revival of tank irrigation system based on primary data collected from 3 rehabilitated tank commands of Warangal district of Telangana. Rehabilitation of tanks resulted in increase in water storage capacity of tanks which in turn increased number of irrigation days by 50 per cent in the command. Tank rehabilitation has improved the inclusiveness in the access to tank irrigation as marginal and small farmers mostly depend on tanks for irrigation water. Farmers perceived that participation in meetings of water user associations (WUAs) increases the effectiveness of the delivery system.

Comparison of costs and returns from tank fed paddy cultivation before (2015) and after tank rehabilitation (2018) revealed that with the availability of more irrigation water, farmers incurred more expenditure on complementary farm inputs but realized nearly 40 per cent higher yields. The investment in tank rehabilitation has improved the access to tank irrigation and its inclusiveness on account of higher increase in the irrigation on marginal and small farms. It also generated impressive returns. Hence, investment in tank rehabilitation may also be undertaken in other areas for more inclusive growth of agriculture.

The small and marginal farmers' participation in tank water user associations should also be promoted by educating them about the benefits of efficient water user associations.

Agricultural Sustainability in India

Suresh Pal, Chhabilendra Roul, SK Chadhari and Prem Chand

Over exploitation and degradation of natural resources has become a major threat to sustainable agricultural production in India. This study aims to develop a robust framework to assess the sustainability of Indian agriculture. The framework will be empirically tested in irrigated ecosystem of the county for its scalability across the country. In the first stage, study has identified 144 indicators encompassing biophysical (soil, water, biodiversity, climate change and environment) and socio-economic indicators based on literature survey. In the second stage, four thematic workshops with the experts in the respective areas have been organized to finalize the list of indicators, measurability and data sources. Totally, 113 indicators have been finalized with the help of experts in respective fields. Out of these, 17 indicators are related to soil parameters, 26 related with water, 29 indicators related with biodiversity, climate change and environment and 41 indicators related to socio-economic dimension. Further, selected indicators would be filtered based on measurability and data availability. Required data are being collected from secondary sources, published literature as well as discussion with experts. Based on the information collected, composite sustainability index will be calculated. Construction of indices involves normalization of quantitative and qualitative data into a single comparable data point, followed by assigning weight to the indicators and finally aggregating the values of different indicators to arrive at a single composite agricultural sustainability index. The obtained index values would be linked with the public policies in order to have a direct impact in enhancing agricultural sustainability in the study area.

Agriculture and Ecosystem Services

Suresh Pal and Sulakshana Rao C

The UN sustainable development agenda of SDGs (SDG 15) gives a clear recognition that inclusive development, improved life on earth and climate resilient systems is essential for achieving development ambitions. The specific targets for 2030 are reducing poverty by half, reduction in GHG emission and reversing desertification and resource depletion (UNDP, 2015). All these goals can be achieved if productivity of agricultural systems is increased to ensure adequate income to farmers, structure and processes of ecological systems are improved, and processes to degrade resources are reversed. The linkages between the production systems, natural resources, environment and social system have now become more prominent to reduce environmental footprints of agricultural development. In particular, understanding of agriculture-ecosystem interactions and trade-offs is essential for considering agriculture and ecosystems in a holistic manner and corrections of those processes which contribute to negative environmental footprints. Agriculture as a manmade ecosystem both provides and relies upon services of natural ecosystems. These ecosystem services for well-being of people (health, livelihood, survival) and sustaining life on earth are getting increasing attention of researchers and policy makers. Besides provisioning services from agriculture such as provision of food, fibre and fuel, ecological services are soil conservation, water quality, carbon sequestration, biodiversity conservation, etc. An effort was made to collate evidences on ecosystem services, assess role of R&D in enhancing them and mainstreaming ecosystem services in the development processes.

Understanding ecosystem services provided by agriculture is complex as the interaction between agriculture and its ecosystem is bidirectional. However, these interactions and contributions to ecosystem services vary considerably because of wide diversity in agricultural ecosystems, arising mainly due to differences in cropping systems and environment. Therefore, purpose of the analysis should be to reward ecosystem

Table 2.17. Suitability class-wise maximum area available for major crops in Bundelkhand

Interventions	Enhanced ecosystem services	Institutional aspect
Sand dunes stabilization	**Provisioning service** • Fodder, Fuel, Timber • Supporting and regulating services • Soil fertility, soil erosion control, water conservation, carbon sequestration • Net sown area increase	Need for partnership with different stakeholders
Conservation agriculture	• Improved soil health • Reduced weather risks • Reduce chemical load • Saving of irrigation water • Lower GHGs emission	• Technologies like micro irrigation, and precision nutrient management • Subsidy on farm machines used for conservation agriculture
Soil and water conservation / watershed management	• Nitrogen accumulation • Phosphorous accumulation • Sediment control	• Holistic systems approach • Institutions for collective actions of all the stakeholders • Technology-driven management system
Biological amendments	• Enhancement in plant growth and nutrient uptake, nodulation and yields; improved soil fertility	Production and distribution of bio-fertilizers and other agriculturally important micro-organisms

services and take suitable measures to reduce the dis-services. Understanding of these issues becomes easier when multi-functionality characteristics of agro-ecosystems is taken into consideration and economic, ecological and social dimensions are given due emphasis. Technological interventions to enhance these ecosystem services are listed in table 2.17.

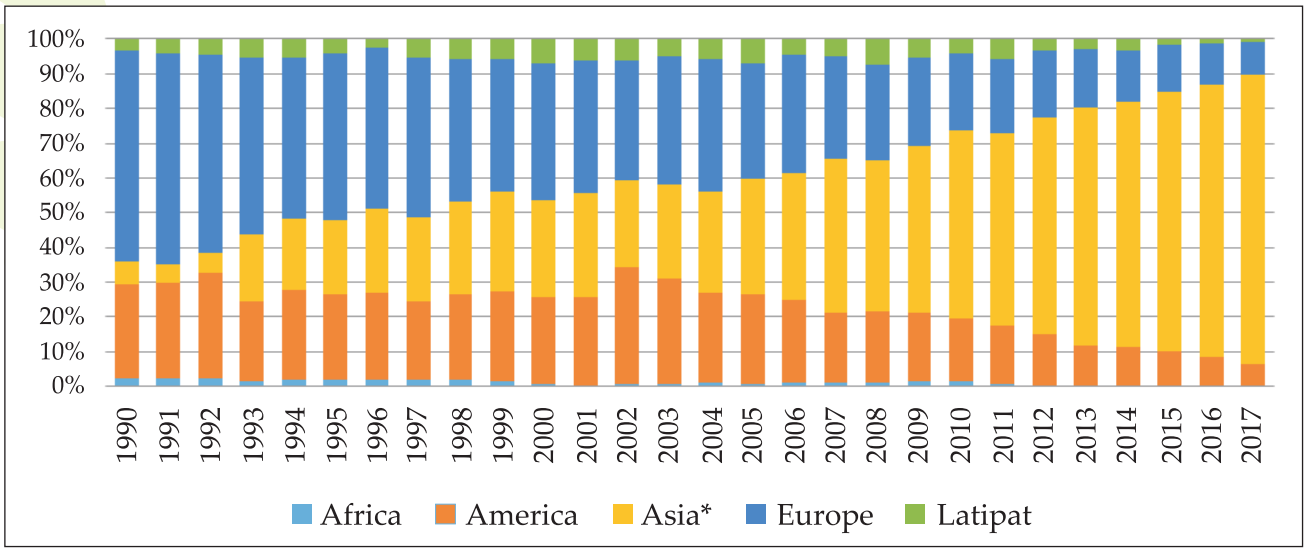
Once the role of ecosystem services is established, it is appropriate to pay to farmers and rural communities in lieu of ecosystem services provided by them. This needs development of an institutional mechanism which is responsive and inclusive in terms of participation of all the stakeholders. Mainstreaming ecosystem services in the development process must ensure its inclusion in planning and policy along with relevant action mechanism. The structure of the mechanisms may differ depending on the nature of service, but an effective partnership of government, farmers and other stakeholders is necessary for fair distribution of payments. In some cases like carbon sequestration, a trading mechanism can be designed and implemented at the national, regional or global levels. In others, rewards based on certification of farm practices on area basis or price support could be an option to begin with.

Technology Foresight in Agriculture

Subash SP, Md. Ejaz Anwer and Arathy Ashok

Trends and patterns of patents in agriculture sector

The objective of the study is to assess the trends and patterns of patents filed in agriculture sector in the world. The data on number of patents filed in agricultural sector was extracted from World Intellectual Property Organization (WIPO) patent scope database for the period 1990 to 2017. WIPO has a database of patents filed by 45 major countries. The results showed increasing trend in total number of patents registered in agriculture during the period under consideration (Figure 2.17). Among the regions, Asia constituted highest share (82.9%) in total patents filed in agriculture sector. The highest share of Asia in total patents is attributed to growth in number of patents filed by China.



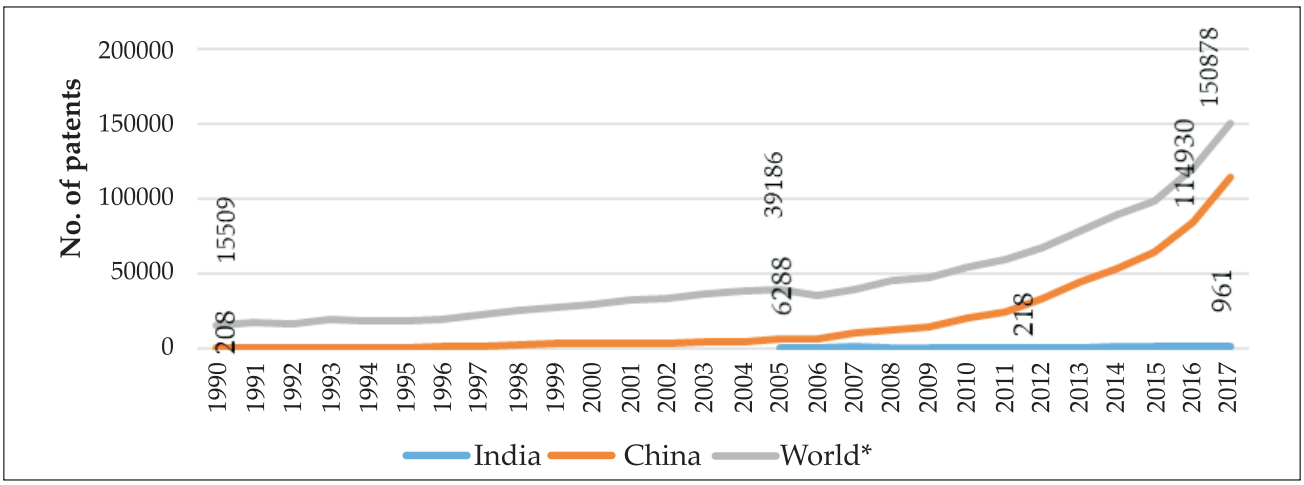
Note: *Asia including China.

Figure 2.17. Region-wise share of patents in Agriculture (1990-2017)

The number of patents filed in China has grown from 208 in 1990 to 6,288 in 2005, later it increased sharply to 1,14,930 patents in 2017 (Figure 2.18). The growth rate of China was more than double (28%) than that of India during 2005 to 2017. Nevertheless, the compound growth rate of cumulative patent filed in agricultural sector in India was 12.5 per cent which was higher than the growth rate of global total (11%). The steep rise in number of patents in China could be attributed to transformation in the Chinese economy and huge investment done by the Chinese Government in patenting their research from public institutions. Though India came up with reforms in its patent act in 2005, to meet the necessary obligations under TRIPS agreement, unlike China, in terms of number no steep growth is noticed. The study suggests more efforts and investment in promoting and filing of patterns by the public institutions are required.

Effect of mergers and acquisitions on innovations in agri-input companies

This study explored the effect of mergers and acquisitions (M&A) on innovation in agricultural input companies. Effect of innovation was

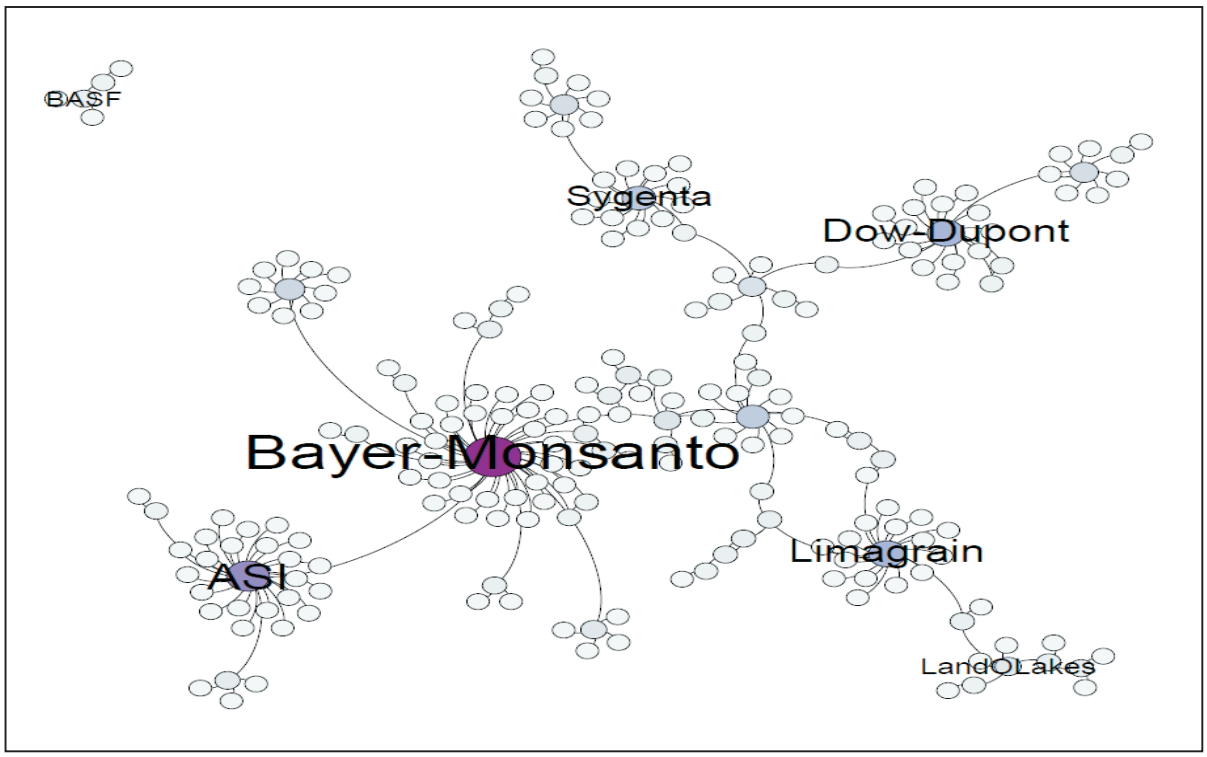


Note: In WIPO, India patent data is available from 2005

Source: Extracted from WIPO patentscope database. https://patentscope.wipo.int/search/en/search.jsf

Figure 2.18. Country wise comparison of patents trends in agriculture

quantified using change in ownership network among firms and its implication on technology licensing (genome editing technology) and using number of patents (as a proxy to measure innovation) filed by the firms. Ownership data of firms (given in Howard 2009) was used to explore the effect of M & A on the ownership network, and its effect on emerging genome editing technology. Using an ex-ante approach, network analysis technique was used to develop post-merger ownership scenario to understand its effect on licensing on agricultural seed industry (Figure 2.19).



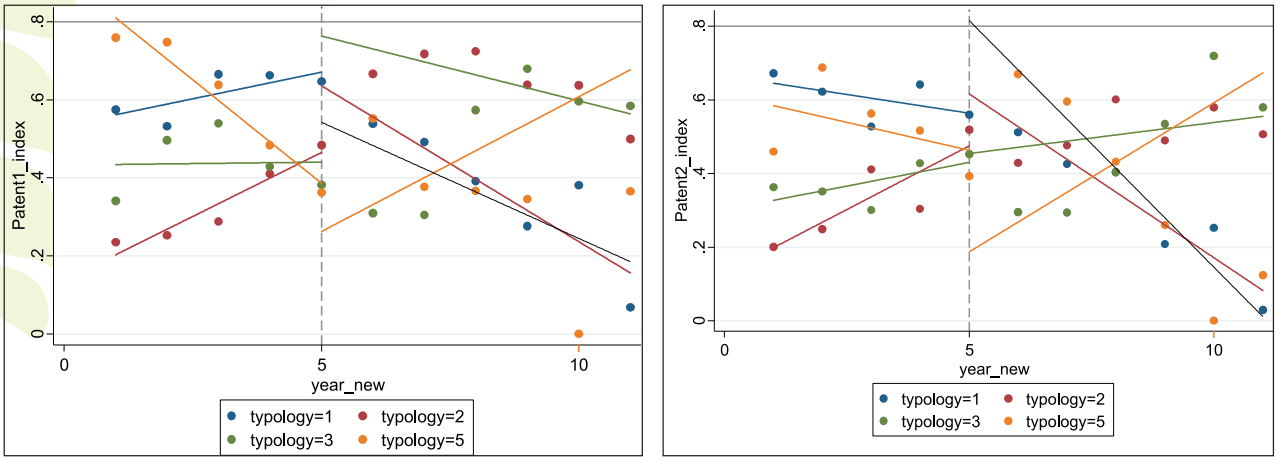
Note: Each nodes (circles) shows firms/companies and the line connecting them shows ownership linkage. Only major seed companies are shown in label. Force Atlas 2 Algorithm is used for network visualization.

Source: Authors visualization based on Howard (2009)

Figure 2.19. Post-merger ownership network of global seed companies

To explore the effect of M & A on patents, data was collected from secondary sources on M & A by major firms in agricultural sector in last three decades. Among the identified 56 M & A by major firms, 30 M & A were analyzed (rest were dropped due to lack of clarity on the M & A or no patents registered by acquiring/ acquired firms). The M & As are categorized into different typologies, viz. Horizontal (typology 1), Vertical (typology 2), Product extension (typology 3), Market extension (typology 4) and Conglomerate (typology 5). The data was visualized using bin scatter plots. In the post-M & A phase, the patent trends among acquiring firms were only positive in case of product extension, while it was positive in case of both vertical and horizontal M & A among acquired firms (Figure 2.20).

Comparing the average patents index scores of acquiring and acquired firms in pre and post M & A showed that there is a significant improvement in patents counts among acquiring and acquired firm in case of vertical M & A (Table 2.18). On the other hand, the effects were rather negative in case Horizontal M & A.



(Acquiring firms) (Acquired firms)

Note: 0-5 is the pre M & A period and 5-10 is the post M & A period

Figure 2.20. Bin scatter plot of patents among acquiring and acquired firms by typology

The analysis showed that such M & A could also lead to emergence of cross-licensing resulting in a 'Non-merger merger'; a situation similar to cartels in oligopoly. The results show that the effect on M & A on innovation depends on the typology of M & A. The effect of M & A on innovations should be looked into case by case basis and assessed based on the typology of M & A. The study also recommends using network measures together with other concentration measures and in-depth analysis in understanding the typology of the M & A to assess the effect of M & A.

Table 2.18. Effect of merger and acquisitions on patenting trends

Typology	Average patent index of acquiring company				Average patent index of acquired company			
	Pre	Post	Test statistics	Sign	Pre	Post	Test statistics	Sign
Horizontal	0.57	0.31	-3.22	***	0.56	0.24	-3.39	***
Vertical	0.33	0.64	3.96	***	0.34	0.53	2.47	**
Product Extension	0.36	0.56	2.09	**	0.29	0.52	2.08	**
Conglomerate	0.60	0.29	-2.09	**	0.52	0.28	-2.04	**

Note: Test statistics based Wilcoxon-sign rank test. Sign *** represent significance at 1%, ** represents significance at 5%. The cut-off year is excluded from the analysis.

Agricultural Innovations and Technology Management

Sant Kumar and M. Awais

The *Pradhan Mantri Krishi Sinchyaee Yojana* (PMKSY) is being implemented from the financial year 2015-16. One of the components of this scheme is 'per drop more crop'. Under this component, efficient water use methods like micro irrigation (MI) are being implemented to increase water use efficiency in the agriculture sector. By 2018-19, a total of 10.4 million ha (Mha) has been covered under MI. During the past four years of PKKSY, an additional 3.5 Mha have been covered under MI. More attention is given to cover horticultural and more water requiring crops like sugarcane, rice, etc. An account of crop area covered under drip and sprinkler system at all-India level during 2015-16 to 2018-19 is given in following section.

Crop group wise area under sprinkler system

A total of 15.07 lakh hectares area was covered under sprinkler system during the period 2015-16 to 2018-19 at all-India level. Of this, 71

per cent (10.7 lakh ha) was created under the crop categories named as other agricultural crops including wheat, paddy, coarse cereals, other crops (Table 2.19). Oilseed crops like groundnut, soybean and other oilseeds together shared another 20 per cent area (3 lakh ha) and Pulses covered nearly 4 per cent of area under sprinkler system during above period. Thus, sprinkler system is limited to agricultural crops like cereals, oilseeds and pulses, which is due to convenience of irrigation for these crops.

Table 2.19. Crop-category wise area under sprinkler and drip irrigation

(000 ha)

Crops groups	Sprinkler irrigation	Drip irrigation
Oilseeds	306.90	29.91
Pulses	62.36	2.87
Vegetables	33.47	288.86
Fruits	19.25	287.82
Flowers	0.02	5.18
Commercial crops (cotton, sugarcane)	16.71	212.38
Other crops (paddy, wheat, coarse-grains, etc)	1068.84	1001.66
Total	1507.55	1828.68

Data source : PMKSY

Crop group-wise area under Drip system

Under the drip system of irrigation, total 18.3 lakh hectares was created during the past four years in India. Of total area under drip method, about 54 per cent (10.1 lakh ha) was created under the crop category 'other crops', followed by 31.8 per cent under horticultural crops (2.9 lakh ha, each of fruits and vegetables) and 11 per cent under commercial crops (2.1 lakh ha). Evidances show that drip system has covered mainly horticultural crops (fruits and vegetables) and commercial crops (cotton and sugarcane), keeping 'other crop' category aside. Acreage under drip method was created mainly under fruits and vegetables in Andhra Pradesh, Telangana, Gujarat, Madhya Pradesh and Maharashtra.

Efficiency of Micro-Irrigation in Economizing Water Use in India

Subhash Chand, Prabhat Kishore, RS Pundir, SK Srivastava and RS Shekhawat

This study explored administrative process, adoption, constraints and determinants of micro irrigation in Punjab, Maharashtra, Gujarat and Andhra Pradesh. The administrative process adopted by different states in implementing micro-irrigation (MI) system was not found to be uniform. Selection of beneficiaries and subsidy norms, however, followed common guidelines. It is estimated that out of total 69.7 million hectare (Mha) net irrigated area, 42.2 Mha area potentially can be covered under MI. Presently, only 8.6 Mha (6.2% of net sown area) is covered under MI in country with wide spatial variation across the states. States like Andhra Pradesh (including Telangana), Maharashtra, Tamil Nadu, Gujarat and Karnataka have registered impressive growth in MI coverage. During 2006 to 2017, the value of location coefficient (share of a state's area under MI to its share in micro-irrigation potential) has increased from 0.30 to 5.37 in Andhra Pradesh, 0.25 to 2.30 in Gujarat, 0.65 to 1.74 in Maharashtra which indicates higher concentration of MIS in these states. On the other hand, in the states like Punjab with acute groundwater scarcity, penetration of MI technology was only 1.1 per cent during 2016-17. Such underutilized but potential states require more efforts in scaling up of adoption of MI.

The results of logistic regression revealed that adoption of MI is influenced by several factors (Table 2.20). Households with large family size, mobile users, opting for crop insurance and having their own tube well are more likely to adopt MI. Rain-fed area had negative and significant influence on adoption of MI in pooled observations. It was observed that

people's participation at different stages of MI programme play an important role in its adoption. In the states with higher area under micro irrigation such as Andhra Pradesh, Gujarat and Maharashtra, the value of peoples participation index (PPI) at different stage of the MI programme was found to be higher.

The unavailability of subsidy funds for installations for already approved MI schemes and identification of beneficiaries were major constraints faced by implementing agencies. Lengthy process, difficulties in maintenance, clogging, unreliable energy source and timely availability of services were the major constraints faced by the farmers.

Table 2.20. Determinants of micro irrigation adoption in different states

Adoption of MI	Pooled data	Punjab	Andhra Pradesh	Gujarat	Maharashtra
Family size (no)	0.12**	-0.17	0.29	0.49	0.30
Working labour (no)	-0.13	-0.09	-0.30	0.06	-1.34*
Schooling (years)	0.02	0.04	0.14**	0.01	-0.17
Mobile use (years)	0.13***	0.05	0.26***	0.89*	-0.21
Caste (Gen + OBC = 1 Otherwise =0)	0.24	0.33	1.42**	-2.63	1.23
Crop insurance (Yes = 1 No = 0)	2.68***	1.19**	0.94*	12.23**	10.72***
Water table depth (in feet)	0.01	0.02**	0.01***	-0.01	0.00*
Tube well ownership (Yes = 1 No = 0)	1.39***	-3.54***	2.99***	0.51	6.11***
Irrigated area (acre)	0.02	0.06	0.08	1.00*	-0.84***
Rain-fed area (acre)	-0.52**	-0.63	0.68	0.00	10.06
Constant	-2.48	0.26	-11.66***	-9.76	5.90
LR chi^2	*467.65*	*126.09*	*164.81*	*259.48*	*264.69*
Pseudo R^2	*0.41*	*0.49*	*0.58*	*0.65*	*0.67*

Note: * p<0.10, ** p<0.05, *** p<0.01

Direct Benefit Transfers for Micro-Irrigation in Uttar Pradesh

Prabhat Kishore and PS Birthal

Since 2014-15, Uttar Pradesh government has started DBT in agriculture for distribution of farm inputs to its scheme beneficiaries on the principle of "First come first serve". This study identified the performance of DBT and identified the determinants of participation in DBT scheme in the state. The DBT process followed for disbursement of agricultural subsidy in Uttar Pradesh is given in figure 2.21.

There has been equitable growth in number of beneficiaries in all the zones of the state. During 2016-17, Rs 133 crore Rupees were disbursed through DBT to 12.45 lakh farmers in Uttar Pradesh which increased to Rs 298 crore for 13.47 lakh farmers during 2017-18. Determinants of participation in DBT process were identified by applying sequential logit model on primary survey data of 481 households in two districts of Bundelkhand zone of UP (Table 2.21).

In first step, attempt was made to workout determinants for awareness of DBT process. Only 9 per cent of the sample households were not aware about the DBT process. Therefore, all variables considered in the model, except ownership of electric pump came out to be insignificant. In the second stage, among the DBT aware farmers, registered farmers were

compared with non-registered farmers. The results revealed that possession of smart mobile was associated with higher odd for registration as possessing smart mobile symbolises higher interest in newer technology and information. Other variables like farming experience, year of schooling, possessing tube well, electric pump and diesel pumps were found to be associated with the higher odds of registration for DBT. The scheduled caste and scheduled tribe farmers have taken more interest in the registration in comparison to general and OBC farmers. In third stage, out of registered beneficiaries, benefitted farmers were compared with cost non-benefitted farmers. The characteristics like membership with any social organization (gram panchayat, Self Help Group, co-operative etc.) have played a positive and significant role in availing benefits under DBT. Similarly, factors like year of schooling, ownership of electric and diesel pumps were found to be associated with the higher odd of getting benefits.

The shifting of subsidy transfer from its traditional method to direct benefit transfer as transformative pro-poor policies in Uttar Pradesh have positive impact as farmers are becoming aware about their entitlement. Selection of farmers and disbursement of subsidies is transparent and speedy which adds extra satisfaction to the farmers. Further, this new method of subsidy transfer will challenge fraudulent practices prevailing at different levels. Gaining economic security by DBT beneficiaries will bring more degree of financial independence and control over their condition. Government is trying to cover more number of farmers under DBT by imposing restriction for few years to avail same type of benefits once benefitted earlier. Due to concerted effort of government, awareness for DBT scheme has been so intensive that nearly 91 per cent of sampled farmers had information about it.

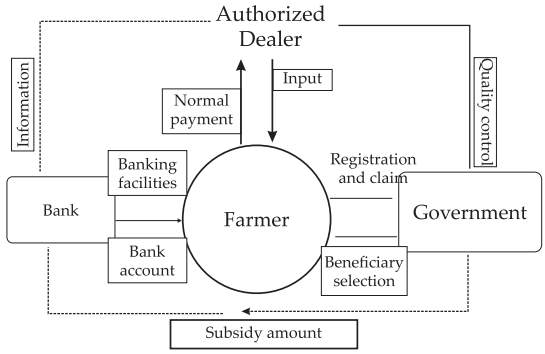


Figure 2.21. DBT process followed for disbursement of agricultural subsidy in Uttar Pradesh

Table 2.21. Determinants of DBT process in Uttar Pradesh

Sequential logit model (Odds Ratio)	Aware Vs Not aware (436 vs. 35)	Registered Vs Not registered (256 vs. 180)	Benefitted Vs Not benefitted (169 vs. 87)
Farming experience (years)	1.02	1.03***	1.01
Year of schooling (years)	1.04	1.12***	1.06*
Mobile type (Smart=1 otherwise 0)	1.83	2.13***	1.29
Member of social org. (Yes=1 otherwise=0)	2.59	1.55	3.77***
Kisan credit card (Yes=1 otherwise=0)	1.36	1.26	1
Category (Gen+ OBC=1, otherwise=0)	1.42	0.43**	1.16
Banking facilities(SCB=1 otherwise=0)	1.45	0.56***	0.82
Tubewell owner (Yes=1 otherwise=0)	0.61	1.69**	0.76
Electric pump owner (Yes=1 otherwise=0)	6.84*	1.79*	1.97*
Diesel pump owner (Yes=1 otherwise=0)	1.52	1.99***	1.82*
Constant	1.68	0.23**	0.58

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

Assessing Impact of Soil and Water Conservation Schemes and Innovative Agricultural Technology

Sant Kumar, Pramod Kumar, M. Awais and Subash SP

Factors determining adoption of micro-irrigation in Rajasthan

This study identifies key determinants of adoption of MI in Rajasthan. The adopters were found to engage more family workers on their farms than non-adopters (Table 2.22). Among human capital indicators like age, education and experience, sample households of both the groups had similar attributes. The average farm size of adopted farms was large than non-adopted farms and showed significant difference. Also, the adopted farms were younger than non-adopted farms.

About 63 per cent of farm households adopted sprinkler technology in their farms. The results of logit regression model showed that the age and farming experience had a negative but insignificant effect on adoption of sprinkler irrigation (Table 2.23). It was observed that younger farmers are availing government subsidy and adopting sprinkler on their farms. The adoption of MI leads to increase in gross cropped area thereby increase in cropping intensity and profits. Thus, MI technology is adopted by farm households having more number of family workers. The human capital variable of education has positive but insignificant effect on adoption of MI. The reason for insignificance of education may be that in Rajasthan sprinkler system is being practiced by most of the farmers from past several years and is no more considered as new technology.

Farm level impacts of micro-irrigation in Rajasthan

Farm-level evidences from Bikaner and Sikar districts of Rajasthan showed that adopters of sprinkler irrigation cultivated reasonably large area under irrigation than non-adopters in 2017-18. Farmers with sprinkler irrigation allocated large area under cash crops like groundnut, gram, mustard and wheat than their counterparts to maximize profit using limited irrigation water. Increase in crop yield was also noted due to adoption of sprinkler, ranging from 12 per cent in rapeseed and mustard to more than 40 per cent in bajra and gram. The cost as well as return from crop cultivation was higher on adopted farms over non-adopted farms (Table 2.24).

Difference in the observed outcome variables between adopters and non-adopters can not be solely attributed to the treatment under consideration. Therefore, impact of adoption of sprinkler irrigation was ascertained by estimating average treatment effect of treated (ATET). The results showed that use of sprinkler irrigation led to 53 per cent increase in irrigated area and Rs 17421/he increase in net return of the sample households.

Table 2.22. General characteristics of sample respondents

Particular	Adopters	Non-adopters	Difference
Average size of family	6.77 (3.32)	6.48 (3.18)	0.29**
Average workers per family	4.34 (2.40)	3.74 (1.94)	0.60
Average age of head of household (years)	49.30 (15.16)	52.55 (12.04)	-3.25
Average educational status (years)	7.10 (4.86)	6.10 (5.26)	1.00
Average farming experience (years)	27.30 (14.71)	30.58 (11.95)	-3.28**
Average farm size (hectares)	4.99 (5.33)	4.62 (3.12)	0.37***

Note: **significant at <5%; and ***significant at <10%. Figures within the parentheses are standard deviation.

Table 2.23. Factors influencing the adoption of sprinkler in study area

Variable	Coefficient	Std. Err.
Age of head of household (HH) (years)	-0.02	0.03
Farming experience of HH (years)	0.00	0.03
Years of schooling of HH (years)	0.03	0.04
Family labour in agriculture (number)	0.19**	0.10
Cultivated land (ha)	0.02	0.04
Constant	1.23	0.90
Log likelihood	-138.08	
Pseudo R^2	0.03	
Number of observations	259.00	

Note: **significant at 5% level

Table 2.24. Average costs and returns of major crops in the farms with and without micro-irrigation in Rajasthan

(Rs per ha)

Particular	Cost A2+FL	Gross value of output	Net return
***Kharif* crop**		**Guar**	
Adopter	40425.30	84199.90	36820.90
Non-adopter	33255.50	64375.30	31119.80
Difference	7169.80 (21.6)	12870.90 (20.0)	5701.10 (18.3)
		Bajra	
Adopter	35257.10	41976.60	6719.50
Non-adopter	25594.20	30030.80	4436.60
Difference	9662.90 (37.8)	11945.80*** (39.8)	2282.90 (51.4)
		Moth	
Adopter	40017.60	62069.50	22001.80
Non-adopter	30966.20	47450.40	16484.20
Difference	9051.40 (29.2)	14619.10 (30.8)***	5517.60 (33.5)
***Rabi* crop**		***Wheat***	
Adopter	63135.00	105822.90	42687.80
Non-adopter	55745.00	90970.00	35225.00
Difference	7390.00 (13.2)	14852.90 (16.3)	7462.80 (21.2)
		Rapeseed & mustard	
Adopter	53949.00	115823.90	61874.90
Non-adopter	50680.60	103805.60	53125.00
Difference	3268.40 (6.4)	12018.30 (11.6)	8749.90 (16.5)
		Chickpea	
Adopter	55415.90	101429.10	46013.20
Non-adopter	43237.30	81226.70	37989.30
Difference	12178.60 (28.2)	22202.40 (24.9)	8023.90 (21.1)

Note: ***significant at <1%. Figures within the parentheses show percentage difference.

To further verify the selection bias and impact on net returns of average sample households, Heckman two-stage model was applied (Table 2.25). Variables included in first stage of model like age, schooling, family labour and cultivated owned land (with log transformation) were having the expected signs but statistically insignificant. The results revealed no selection bias of respondents who adopted technology. This inference should be drawn with caution as the model fit is insignificant. There could be other important variables that might be influencing adoption of sprinkler technology. However, the results from second stage of the model showed significant impact of sprinkler technology and cultivated owned land on increased net returns. The net income of households who adopted sprinkler irrigation increased to an extent of Rs 18816, which is higher than what was obtained from the ATET model. Overall, the study shows a positive and significant impact of adoption of sprinkler irrigation technology on net returns.

Table 2.25. Impact of adoption of sprinkler irrigation

Variable	Coefficient	Standard Error
Dependent variable: Net return		
First Stage Model		
Age of head of household (HH) (years)	-0.01	0.02
Years of schooling (HH)	0.02	0.02
Farming experience (years)	0.00	0.02
Family labour in agriculture (number)	0.10	0.044**
Ln Cultivated owned land (ha)	0.01	0.02
Constant	0.72	0.53
Log likelihood	-138.10	
Pseudo R^2	0.03	
Number of obs	259.00	
Second Stage Model		
Adoption (Adopter =1; No-adopter=0)	18869.15	1903.68***
Ln Age (years)	-25.16	144.92
Years of schooling (HH)	-218.74	196.34
Farming experience (years)	-176.08	148.49
Ln cultivated land	3385.54	949.05***
Inverse mills ratio	-5052.13	5020.79
Constant	32327.72	8369.90***

Note: ***significant at <1%; and ** significant at < 5%.

Institutional Mechanisms in Irrigation Water Management and Water Markets in Northern India

Subhash Chand, Prabhat Kishore and Hubbalal

The study examined institutional arrangements of water management in command areas of eastern Yamuna canal in Uttar Pradesh. The survey conducted in Saharanpur (Head), Baghpat (Middle) and Ghaziabad (Tail) revealed that four categories of water market exits, namely Self-User, Self-User & Seller, Self-User and Buyer, and Buyer. More than 50 per cent of small and marginal farmers belonged to water Buyer category. On the other hand,

large farmers had their own water sources (Self-Users), though few also purchased water for the land parcels without own water source (Self-User & Buyer). It implies that large farmers meet most of their water demand from own sources. The prices paid by buyers of irrigation water from electricity drawn pumps increased sharply from Rs 48 per hour in 2012 to Rs 98 per hour in 2015. After 2015, the prices increased only marginally and reached the level of Rs 102 per hour in 2018. In case of diesel operated pumps, prices increased from Rs 100 per hour to Rs 150 per hour between 2012 and 2018.

Management and Impact Assessment of Farmer FIRST Project

Vinayak Nikam, Shiv Kumar, Abimanyu Jhajhria and Kingsly IT

The farmer FIRST program of ICAR is aimed at participatory technology development, assemblage, assessment, refinement for location specific and need based technologies for the farmers for enhancing their income and securing the livelihood. The farmer FIRST program is developed as farmer in a centric role for research problem identification, prioritization and conduct of experiments and its management in farmer's condition. This program brings farmers and scientists together in one platform to understand the requirement of Indian agriculture in modern age. The interplay of available resources at farm and implementing innovation emanating with modern science and technology in research domain at farmer field, led to emergence of farmer centric approach in agricultural research and extension. This necessitates the amalgamation, development and refinement of modern technology from research institutions with knowledge and wisdom of farmers. These processes not only enhance the use of appropriate technology capacity of the farmers, but also provide the feedback to the scientist to refine and fine tune it to local setting. There are around 50 projects throughout the country. The interventions of each project were broadly categorized into six modules viz. crop based, horticulture based, livestock and fishery based, natural resource management based, enterprise based and integrated farming system modules. The nature and scale of intervention under each module were prioritized and implemented based on technological need of farmers, location specificity, and availability of technology in the region. There are more than 400 interventions. Once the intervention in the form of technology, service and information, method, module specificity are introduced at farmer's field, it would generate impact. The moot point

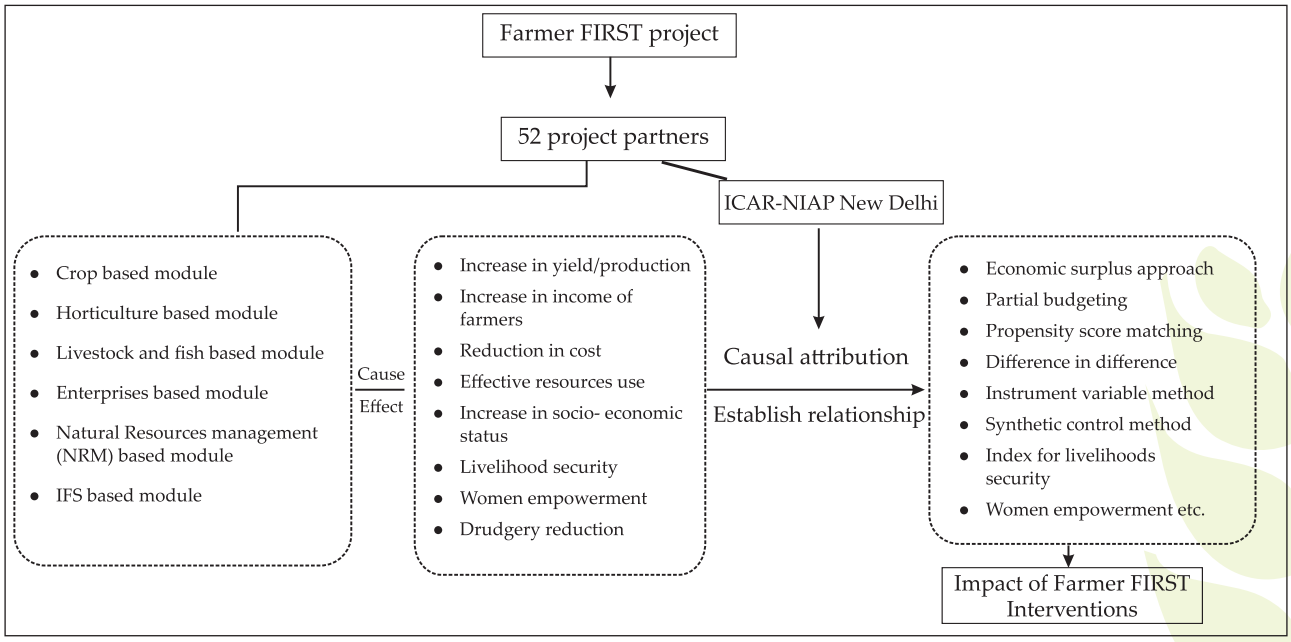


Figure 2.22. Framework for impact assessment of interventions under Farmer FIRST project

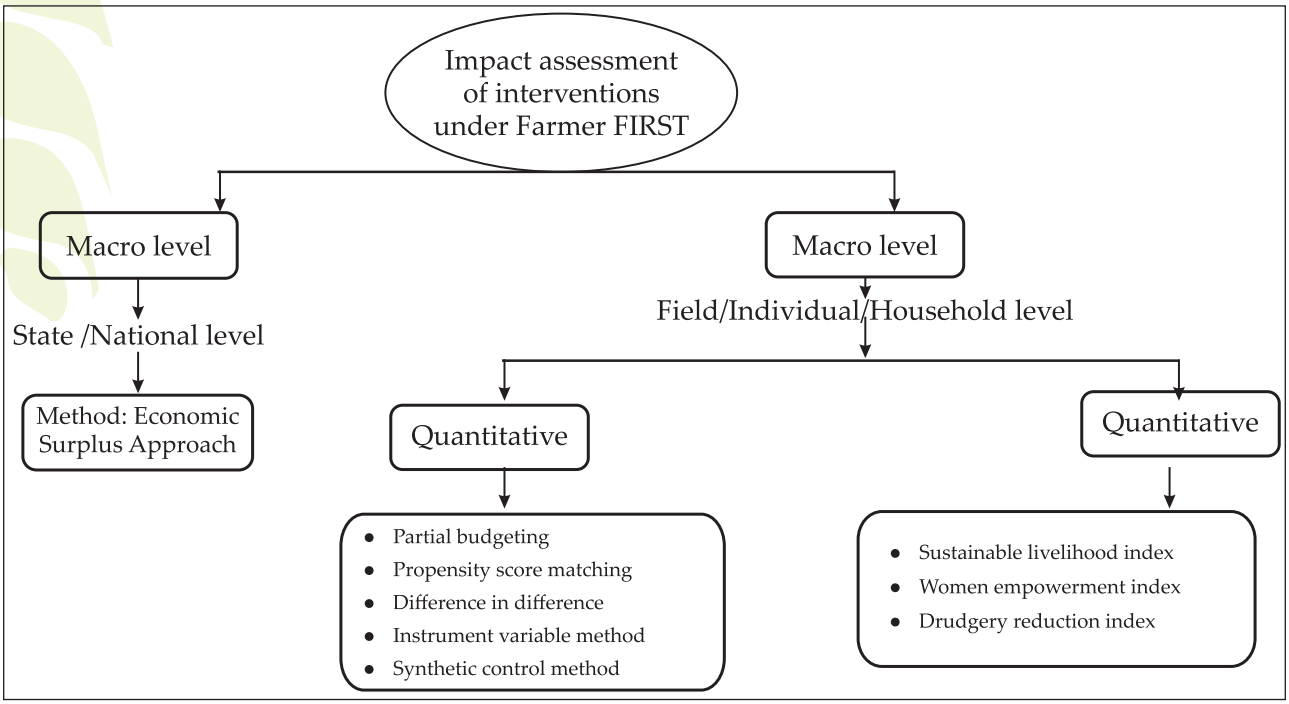


Figure 2.23. Impact assessment approaches for interventions under Farmer FIRST program

is to establish whether the intervention had a welfare effect on individuals, households, and communities, and whether this effect can be attributed to the concerned intervention. The impact assessment is done employing quantitative and qualitative methods using with-without and before-after approaches depending upon the sample size, diverse nature of interventions and difficulty in finding counterfactuals. The framework for impact assessment is presented in figure 2.22.

The ICAR-NIAP with the support of Institutes like CSSRI, Karnal; IISH, Lucknow; NRRI, Cuttak; and ATARI Jabalpur has conducted Group Meet/Review Workshop for Impact Assessment. The approach employed for impact assessment of interventions is presented in figure 2.23.

Based on hand-holdings and training of project partners, the research output emanating in the form of Success stories, Case studies, Research publications, Reports and Graphical abstract and Book forms are to be published by DKMA with the support of Division of Extension, ICAR. The empirical evidences would help in revisiting the approach and objectives of Farmer FIRST program if they are not going in right direction. Such deep insights discern clues to policy makers and planners about what went right and wrong during conceptualization and implementation of the project so that mid-course correction could be done.

Resource Use Efficiency in Cotton: Reflections from MGMG Villages

Sant Kumar, Nalini Ranjan Kumar, Rajni Jain, Balaji SJ, Abimanyu Jhajhria, Bangararaju SV and Md. Awais

This study provides evidence on resource use efficiency of cotton farmers in Palwal district of Haryana using farm level data for the agricultural year 2017-18, which was collected from 120 farmers of 4 adopted villages under Mera Gaon Mera Gaurav (MGMG). The resource use efficiency was estimated using Cobb-Douglas production function and the coefficients are given in table 2.26. The selected explanatory variables jointly explained 58 per cent variations in cotton yield. The coefficient of human labour (0.64) was positive and significant, implying that one per cent increase in use of human labour will lead to 0.64 per cent

increase in cotton yield. Likewise, other inputs like phosphatic fertilizers, micro-nutrient (zinc) and machine labour have also shown positive and significant association with cotton yield. However, resources like nitrogenous fertilizer, insecticide and irrigation showed negative returns indicating excessive use of these inputs. Thus, the levels at which these inputs are being used could be lowered from the existing levels without reduction in yield. The return to scale (0.78) indicated that if all inputs were increased by one per cent, yield of cotton will increase by 0.78 per cent and hence depicting decreasing returns to scale.

Table 2.26. Estimated Cobb-Douglas production function of Bt cotton in Haryana

Variable	Coefficients
Dependent variable: Yield (kg/ha)	
Explanatory variable	
Constant	- 1.13**
Human labour (number days)	0.64***
Phosphorus (nutrient in kg)	0.21***
Machine labour cost (in Rs)	0.11**
Zinc cost (in Rs)	0.01*
Nitrogen (nutrient in kg)	-0.15*
Pesticides cost (in Rs)	-0.03*
Irrigation cost (in Rs)	-0.01
Return to Scale	0.78
F-statistics	df (7,112) 21.65
R^2	0.58

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

The ratios of MVP to MFC were greater than unity (except nitrogen, pesticide and irrigation). This indicates that increase in the use of human labour, phosphatic fertilizer, machine labour and zinc, and reduction in use of nitrogen and pesticides will optimize the profitability of cotton farmers (Table 2.27). Hence, there is a need for adjustment in the use of inputs to improve profitability in cotton production.

Efficiency of cotton production

This study examined the efficiency of cotton farms in Palwal district of Haryana (India) using non-parametric method of data envelopment analysis (DEA). Farm level data were collected under *Mera Gaon Mera Gaurav* (MGMG) scheme from 120 farmers for agricultural year 2017-18. Input oriented model was used to measure farm efficiencies. Under the assumption of variable return to scale (VRS), 92 per cent of the sample farms were found to be operated with full efficiency, and remaining 8 per cent were operating with efficiency between 90 and 100 per cent (Table 2.28). The mean technical efficiency under VRS model was 0.973. This suggests that average farms were producing cotton with 97 per cent potential and there existed only 3 per cent managerial inefficiency. Under constant return to scale (CRS) assumption, 61 per cent farms were operating with full efficiency scores and another 30 per cent were operating between 90 and 100 per cent.

The estimation of allocative efficiency revealed that assuming VRS, more than one third farms were operating at full potential (100%), while remaining two-third farms were operating between 90 and 100 per cent efficiency levels. The estimates of mean scale efficiency (SE)

Table 2.27. Resource use efficiency in cotton production on sample farms in Haryana

Inputs	Coefficient	MVP	MFC*	Efficiency Ratio (r)
Human labour	0.64	360.01	292.52	1.23
Phosphorus	0.21	404.74	34.37	11.78
Machine	0.11	13.99	1.00	1.54
Zinc	0.01	586.26	1.00	1.76
Nitrogen	-0.15	4.27	1.00	-0.64
Pesticides	-0.03	40.47	1.00	-1.14

*MFC = for farm area is taken for a single cycle of production

Table 2.28. Frequency distribution of technical, scale, allocative and cost efficiency

Efficiency level (%)	TE CRS	TE VRS	SE	AE	CE
	No. of farms	No. of farms	No. of farms	No. of farms	No. of farms
1.00	73 (60.80)	110 (91.67)	31 (25.83)	43 (35.83)	28 (23.33)
0.90 <1.00	36 (30.00)	10 (8.33)	57 (47.50)	64 (53.33)	64 (56.67)
0.80< 0.90	10 (8.33)	0 (0.00)	29 (24.17)	13 (10.83)	24 (20.00)
0.70< 0.80	1 (0.83)	0 (0.00)	3 (2.50)	0 (0.00)	0 (0.00)
Mean	0.91	0.97	0.94	0.88	0.85
Std. dev	0.077	0.04	0.06	0.06	0.066
Minimum	0.67	0.84	0.76	0.73	0.71
Maximum	1.00	1.00	1.00	1.00	1.00

Note: TE = Technical Efficiency; SE = Scale Efficiency; AE = Allocative Efficiency; CE = Cost Efficiency; Figures in parenthesis indicates the percentage of total farms

0.937 indicate that farms are scale efficient as well. However, 74 per cent farms growing cotton were operating below 90 per cent. The SE describes the ability of the farm to choose the optimum level of resources. Inappropriate size of a farm (too large or too small) might be a cause of technical inefficiency.

Performance and Impact Assessment of Agricultural Extension and Advisory Systems

Arathy Ashok, Vinayak Nikam and Prakashan Chellattan Veettil

Linkages among extension and advisory service providers in Maharashtra

Indian extension system is characterized by its pluralistic nature, wherein different service providers, viz. public, private, non-governmental organisations (NGOs), farmer based organisations (FBOs) etc. are involved in dissemination of advisory services, input provision and other services to the farmers. This study assessed various organisational aspects and linkages among different extension and advisory service (EAS) providers in Maharashtra. Total 28 organizations representing public EAS providers (two district agriculture offices, two state agricultural university, six Krishi Vigyan Kendras), FBO (three cooperatives, six farmer producers companies), NGOs (four in number) and private companies (five in number) were studied. Study of linkages among various EAS providers would help in understanding level of convergence and coordination among the various players involved in EAS.

Among public EAS providers, SAUs had strong linkages with other public organizations such as KVKs, agriculture department, and ICAR institutes. SAUs were also linked with the private companies, NGOs and FBOs but linkages were not as strong as that with other public EAS providers. As compared to SAUs, KVKs had stronger linkages with private companies, NGOs and FBOs. This was due to the fact that KVKs have contact with large number of farmers which private and NGOs capitalize for carrying out outreach programme. Many FBOs also remain in touch with KVKs for organizing trainings related to agriculture. District agriculture office had strong linkages with the NGOs and FBOs. Agricultural Technology Management Agency (ATMA) at district level is involved in formation of FPCs and other farmers' groups. After formation of FBOs, linkages continue in the form of guidance related to technical and financial matters. In case of cooperatives, 62.5 per cent of these were found to have linkages with public EAS organisations and 50 per cent with the FBOs. Interestingly, cooperatives had no linkages with private and NGOs. More than 50 per cent of NGOs had strong linkages with public, private EAS providers and with other

NGOs. About 66 per cent had no linkages with the FBOs.

FBOs were more connected with the public organisations. All FBOs had linkages with other FBOs. Some FBOs like Sahyadri Farms in state are serving as role model for the other FBOs and members regularly visit such FBOs to get required technical and procedural knowledge. About 56.25 per cent of the private EAS providers were strongly linked with the public extension organizations. Most of the time, private organizations take help or organize the programs in collaboration with the public institutions. Financial aid from private companies and technical expertise along with contact with farmers of the public organizations (KVK, ATMA) was mostly followed combination by private EAS providers for organizing various extension activities for the farmers.

Overall, the study reveals presence of linkages among all government organizations and all EAS providers with the government organizations indicating convergence and coordination among them. However, the degree of linkages varies among existing EAS in the state which implies that more synergy can be brought among EAS providers for effective delivery and use of EAS to the farmers.

Dynamics of extension and advisory service provisions in Odisha

The present extension and advisory service (EAS) provisions in Odisha was found to have a pluralistic nature. With the existing staff strength of Village Agricultural Workers (VAWs) in Department of Agriculture, VAW to land holding ratio was found to be 1:2011 in Odisha. Krishi Vigyan Kendras (33) are working in the state, majority hosted by Odisha University of Agriculture and Technology. In addition to these public EAS provisions, several private players are also emerging mainly through information and communication technology (ICT) platform. Major private sector EAS initiatives in the state include Reliance Foundation Information Service (RFIS), Precision Agriculture for Development (PAD) and IFFCO Kisan Sanchar Limited, most of them rely on ICT based platforms. RFIS disseminate agro-advisories, livelihood and health related information and disaster warning to farmers through voice and text messages, audio and dial out conferences, local cable TV, All India Radio, print media, Jio Chat, WhatsApp and field based programmes and trainings. At present they have more than 10 lakh beneficiaries in Odisha. Similarly, PAD a non-profit organization also provide customised agro-advisory services through mobile phones to nearly 1,60,000 beneficiary farmers in the state. IFFCO Kisan Sanchar Limited, provide their services to farmers in 30 districts of Odisha through mobile messages or calls. These initiatives can supplement the public extension service provision and help in bridging the information gap among farmers.

Pluralistic extension and technical efficiency of rice producing farms in eastern India

Improving agricultural productivity has always remained a key strategy for achieving food security and rural development agenda. Extension and advisory services (EAS) can reduce the productivity differentials in two ways; as a factor facilitating the adoption of technologies and/or as a factor which helps in achieving the efficient use of the existing technology or inputs by educating the farmers. At present, EAS is provided by multiple agencies in India. This study assessed the source-wise access to EAS and its effects on technical efficiency of rice producing farms in Eastern India using Rice Monitoring Survey data of International Rice Research Institute for 2015-2016. The study area included four states, viz. Bihar, Odisha, Uttar Pradesh (Eastern part) and West Bengal.

The results revealed that 25.05 per cent of the rice farming households had access to different EAS sources in the eastern region in 2015-16. Out of this, 19.69 per cent had EAS access through personal contact, 2.26 per cent through electronic media, and 3.16 per cent through both personal contact and electronic media. Further disaggregation shows that 36.71 per cent, 38.29 per cent and 20.36 per cent of the households having access to EAS (through

personal contact) receive these services from public sector, private sector (agri-business firms and input dealers) and both public and private sectors, respectively.

The technical efficiency estimates using stochastic frontier production function revealed that farm households having access to EAS operate at comparatively higher level of technical efficiency than those without access to EAS (Figure 2.24). Farm technical efficiency was also compared across households having EAS access from various sources. Technical

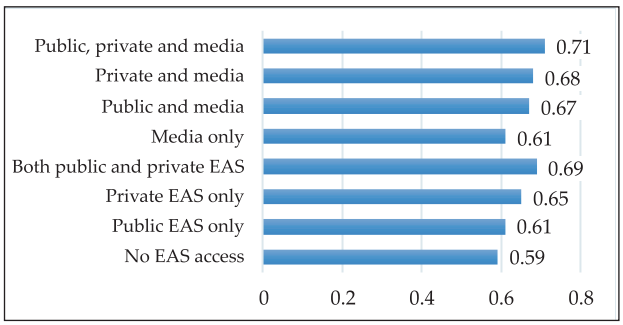


Figure 2.24. Technical efficiency of farms based on sources of EAS

efficiency was found to be highest in case of farm households having EAS access from public, private and media sources (0.71) followed by households having EAS access from public and private sources (0.69). Overall results of the study indicate that pluralistic EAS provision can have a synergistic effect on farm technical efficiency.

Impact Assessment of Agriculture Research and Development

Vinayak Nikam, Shiv Kumar and Kingsly IT

Social network factors affecting adoption of information communication technology by farmers

ICAR-National Research Centre for Grapes, Pune Maharashtra has developed a mobile app which gives location based information and forecasting about weather, pests and diseases. The mobile app is being commercialized by S K Croptech Pvt. Ltd. The effect of social network on adoption of mobile app was studied in Nashik and Sangli districts of Maharashtra with 800 grape growers including 100 non-adopters. Farmers were asked to name three important persons to whom they generally ask information related to agriculture and information about these three network persons, viz. education, land holding, association in village organization, distance from the farmer's residence, frequency of interaction etc. were collected to study the social network characteristics.

The factors like income, caste, number of smart phones in household were positively associated with the adoption of mobile app, whereas area under grapes, landholding size, and farming experience were negatively associated with the adoption of mobile app (Table 2.29). Among, social network factors, village adoption rate, member's education, landholding and communication in terms of frequency of interaction were significant determinants of adoption. With one per cent change in the village adoption rate, probability of adoption of mobile app increases by 3.65 per cent. Probability of adoption of mobile app increases by 1.13 per cent with one per cent increase in the frequency of interaction with the network members. Marginal effect of social network member's education and landholding was also higher in influencing the probability of adoption of mobile app.

Village adoption rate of the technology resembles to network behaviour which extension agent should understand before introduction of any technology in the village. Along with network behaviour, network characteristics are also important determinants of the adoption. Therefore, extension agent can target the farmers having better education level, higher landholdings and who frequently interact with the large number of farmers. There are more chances that other farmers from the area will include them in their social network, actively seek information and take adoption decisions in consultations with these farmers. Thus, they are likely to affect the information decision process of many farmers of the village. By targeting such farmers, extension agent can facilitate and enhance the adoption of new technology/ICT among the farmers.

Table 2.29. Estimates of logit model for adoption of Mobile app among grape cultivator

Explanatory variable	Estimated coefficient		Marginal effects	
	Coefficient	z-value	dy/dx	z-value
a) Individual characteristics				
Age	0.01	0.53	0.01	0.53
Family size	-0.10	-0.98	-0.01	-0.98
Education	0.08	1.07	0.01	1.08
Landholding	-0.35**	-2.40	-0.01**	-2.46
Cast	1.68**	2.40	0.06**	2.45
Farming experience	-0.06*	-1.74	-0.01*	-1.74
Area under grapes cultivation	-0.03***	-2.95	-0.01***	-3.05
Income	0.11***	3.34	0.01***	3.44
Smartphone	0.74*	1.94	0.03*	1.96
b) Social network member (SNM) characteristics				
Village adoption	0.96***	6.55	0.04***	7.62
SNM caste	-0.01	-1.47	-0.01	-1.48
SNM education	0.23***	2.61	0.01***	2.69
SNM landholding	0.24***	3.33	0.01***	3.45
SNM distance	0.13	1.59	0.01	1.6
SNM communication	0.30**	2.29	0.01**	2.31
SNM association	0.01	0.75	0.01	0.75

Note : (LR chi2(16) = 154.20, Prob > chi2 = 0.0000, Pseudo R^2 = 0.4474, Log likelihood = -95.2288)
***p ≤ .01; **p ≤ .05; *p ≤ .1.

Theme-III

MARKETS AND TRADE

Excerpts

- Appropriate price forecasting models for about 40 food commodities in 13 major states have been developed with forecast accuracy up to 90 per cent.

- Value chain of tomato in Karnataka has been mapped. The estimation shows 16.63 per cent post-harvest losses in tomato during handling at different segments of commercialization.

- Various actors in the value chain of apple in Jammu and Kashmir have been mapped and their functions have been documented.

- Wholesale prices of mustard oilseeds and oil exhibit asymmetric relationship. A 10 per cent decrease in wholesale price of mustard oil leads to 4 per cent decrease in prices of oilseeds, but increase in oil prices increases oilseed prices only by 1.7 per cent.

- Onion witnessed high volatility in wholesale prices with 9 structural breaks during the period 1982 to 2017. Length of the period with stable prices is reducing and shorter phases with greater instability are becoming pronounced overtime. The price transmissions from producing markets to consuming markets are taking place indicating spatial market integration with varying degree.

- The pace of market reforms has been uneven across states and needs to be geared up to ensure balanced development across states. It calls for revisiting the strategy required to encourage states to adopt Model Act as well as the APLM Act.

- Framework for Ease of Doing Agriculture Index assesses implementation of reforms undertaken by the states and helps in fostering agricultural development.

- The nutri-cereals have witnessed larger increase in prices than rice and wheat during last decade. Pearl millets contribute significantly to livestock sector in Rajasthan as a source of feed. There exists a great scope to improve its marketing through strengthening value chain and institutions.

Market Intelligence: Significance and Effectiveness of Agricultural Price Forecasts

Raka Saxena, Ranjit Kumar Paul, Pavithra S, Naveen P Singh and Rohit Kumar

Price forecasts are immensely useful to the farmers in making decision regarding production and marketing of agricultural commodities. This study analysed prices of more than 40 agricultural commodities in 13 major states, and produced reliable and timely short-term price forecasts during 2014-15 to 216-17. The methodological approach included combination of statistical modelling framework and price expectations of farmers and traders. Price forecasting was done in the preceding month of sowing and harvesting of the crop to ensure sufficient time for production and marketing decisions of the farmers. In case of perishable commodities, the forecasting was done weekly.

Several models of price forecasting were applied and the best model for each of the selected commodities was identified based on the standard statistical criterion. The commodity-wise models used for price forecasting is given in table 2.30. The forecast accuracy in cereals stood at about 90 per cent (Figure 2.25). In case of pulses, the evidence of pre-harvest (PH) forecasts being more precise than pre-sowing (PS) forecasts was much stronger. Extreme fluctuations were observed in prices of onion, potato and tomato crops resulting in lower accuracy in price forecasts for vegetable crops as a whole.

Table 2.30. Modelling approach used for price forecasting in selected crops

Crop Sub-group	Commodity	State	Forecast models used in the study		
			2014-15	2015-16	2016-17
Cereals	Fine paddy	Uttarakhand	ARIMA	ARIMA	ARIMA
	Maize	Uttar Pradesh	ARIMA	WINTER'S ADDITIVE	ARIMA
		Telangana	ARIMA	ARIMA	ARIMA, GARCH, SARIMA
		Odisha	SARIMA	SARIMA	SARIMA
		Gujarat	ARIMA	ARIMA	SARIMA
		Maharashtra	GARCH	ARIMA	ARCH, ARIMA
		Karnataka	ARIMA	ARIMA	ARIMA
	Pearl millet	Rajasthan	ARIMA	ARIMA	ARIMA
	Finger millet	Karnataka	ARIMA	ARIMA	ARIMA
Pulses	Chickpea	Rajasthan	ARIMA	ARIMA	ARIMA
		Madhya Pradesh	ARIMA	ARIMA	ARIMA
		Uttar Pradesh			ARIMA
		Telangana	ARIMA	ARIMA	ARIMA, GARCH, SARIMA
	Green gram	Maharashtra	GARCH	ARIMA	ARIMA, GARCH,
		Odisha	GARCH	SARIMA	SARIMA
	Pigeon pea	Madhya Pradesh	ARIMA	ARIMA	ARIMA
		Gujarat	ARIMA	ARIMA	SARIMA
		Maharashtra	ARIMA	ARCH	ARCH, ARIMA
		Karnataka	ARIMA	SARIMA	ARIMA, SARIMA
	Lentil	Madhya Pradesh		ARIMA	ARIMA
		Uttar Pradesh	ARIMA	ARIMA	ARIMA
	Cluster bean	Rajasthan	E-GARCH	E-GARCH	E-GARCH
Oilseeds	Groundnut	Telangana	ARIMA	ARIMA	ARIMA
		Odisha	SARIMA	SARIMA	SARIMA
	Soybean	Madhya Pradesh	ARIMA	ARIMA	ARIMA
		Maharashtra	GARCH	ARIMA	ARCH, ARIMA
	Mustard	Madhya Pradesh	ARIMA	ARIMA	ARIMA
Fibre crops	Cotton	Gujarat	ARIMA	ARIMA	SARIMA
		Odisha	SARIMA	SARIMA	SARIMA
		Telangana	ARIMA	ARIMA	ARIMA

Fruits and dry fruits	Apple	Jammu & Kashmir	ARIMA, GARCH	VAR	VAR
	Banana	Karnataka	ARIMA	ARIMA	ARIMA
		Meghalaya			SARIMA
	Cherry	Jammu & Kashmir	ARIMA, ARCH, GARCH	ARIMA	VAR
	Coconut	Kerala	ARIMA	ARIMA	ARIMA
		Odisha	SARIMA	ARIMA	SARIMA
	Mango	Uttar Pradesh		ARIMA	ARIMA
	Pineapple	North-east	ARIMA	SARIMA	SARIMA
Vegetables	Green pea	Uttarakhand	ARIMA	ARIMA	ARIMA
	Onion	Karnataka	ARIMA	ARIMA	EGARCH
		Maharashtra	SARIMA	ARIMA	ARIMA, ARCH GARCH
		West Bengal		ARCH/GARCH	ARCH-GARCH
	Potato	Uttar Pradesh	ARIMA	WINTER'S ADDITIVE	ARIMA
		Karnataka	ARIMA	ARIMA	ARIMA, SARIMA
		Uttarakhand	SARIMA	SARIMA	SARIMA
		Gujarat	ARIMA	SARIMA	SARIMA
		North-east	ARIMA	SARIMA	SARIMA
		West Bengal			ARIMA, SARIMA, GARCH
	Tomato	Uttar Pradesh	ARIMA	ARIMA	ARIMA
		North-east	ARIMA	SARIMA	SARIMA
		Uttarakhand	SARIMA	SARIMA	SARIMA
Spices and tuber crops	Black pepper	Karnataka	ARIMA	E-GARCH	EGARCH
		Kerala	ARIMA	ARIMA	ARIMA
	Coriander	Rajasthan	GARCH	E-GARCH	ARIMA
	Cumin	Rajasthan	ARIMA	E-GARCH	E-GARCH
		Gujarat			ARIMA
	Ginger	Odisha	GARCH	SARIMA	SARIMA
		Meghalaya	ARIMA	SARIMA	GARCH
	Turmeric	Odisha	SARIMA	SARIMA	SARIMA
		North-east	ARIMA	SARIMA	GARCH
		Karnataka	ARIMA	ARIMA	ARIMA, SARIMA

The study points out a strong need to standardize data reporting mechanisms at the APMCs and to address data discrepancies issues for generating reliable forecasts. Further, methodological improvements for incorporating the effects of extraneous variables are required because prices of agricultural commodities are significantly affected by many climatic and policy variables. Therefore, efforts shall be extended to develop infrastructure to provide real time data on price realized by the farmers as well as on critical extraneous variables. In this context, the use of remote sensing techniques can play a key role in getting the advanced information about the crop conditions at field level. Incorporation of

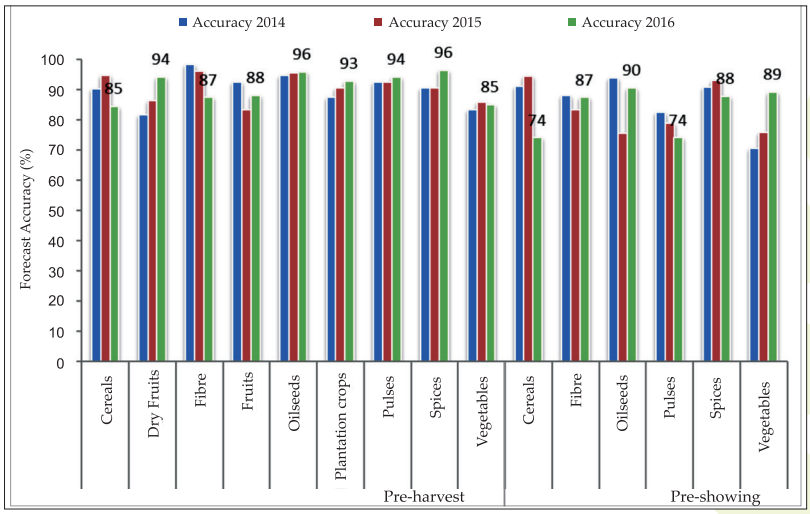


Figure 2.25. Forecast accuracy for major crop categories

artificial intelligence techniques in modelling framework can improve forecast efficiency to a large extent. In the long run, the market intelligence efforts need to be strengthened both at central and state level. The project activities may be linked with line departments for effective dissemination and institutionalization.

Policy Imperatives for Promoting Value Chains of Agricultural Commodities in India

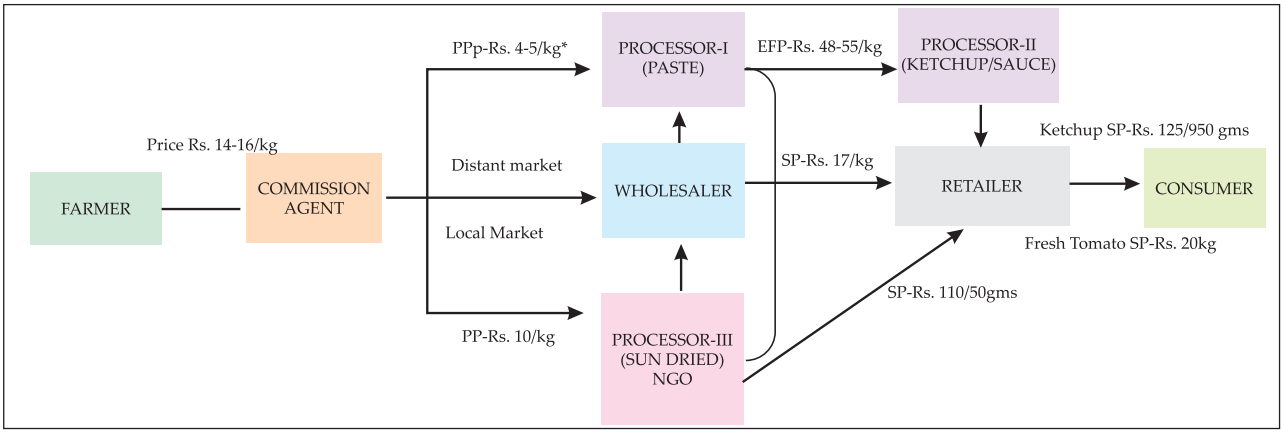
In collaboration with ICAR-Indian Institute of Horticultural Research

Tomato value chain

The value chain refers to this range of activities that brings a product or a service from its conception to its end use in a particular industry. The study maps value chain of tomato in Karnataka by conducting market surveys in and around the Bangalure city. Out of several products in the market, a few new products are crushed tomatoes, sun dried tomatoes, and canned tomatoes. The fast moving tomato products in the market are tomato ketchup, sauce, soups, paste and pickles. The flow diagram of tomato value chain map and value addition at each connecting points in the chain are presented in figure 2.26.

Post-harvest losses associated with handling of tomatoes were assessed at different levels. Initially, the losses are calculated in different stages after harvest and then the actual loss is calculated by deducting the overlapping amount. At the field level, after harvest the tomatoes with cracks, diseases, pest damage, rotten etc., were weighted and these losses were referred as farm level losses. The losses occurred during the transportation, handling, packaging and storage were classified, weighted and these losses were considered as market level loss. Another set of segment is loss at the retailers level, which includes loss occurred during loading and unloading of the tomatoes, cleaning, grading, unspent/leftover commodity.

Keeping the above criteria in the mind, assessment of post-harvest losses associated with handling of tomatoes at different segments of commercialization in the major tomato growing district of Kolar is presented in Table 2.31. Total losses were 16.63 per cent



Note: PP: Procurement price, EFP: Ex-factory price, SP: Sale price *: Processors procure tomatoes only when the prices drop to Rs 4-5/kg **: Based on order they purchase tomato from the commission agent

Figure 2.26. Tomato value chain in Karnataka

Table 2.31. Post-harvest losses in tomato at different stages of handling

Sl. No.	Particulars	Losses (%)	Causes of loss
1.	Field Level	7.42	Diseased, pests (yellowing & borer) and over ripe fruits
2.	Market level	4.32	Mechanical injury, over ripe and diseased
3.	Retailers level	4.89	Mechanical injury, rotten & over ripe
	Total	**16.63**	

consisting of 7.42 per cent at the field level, 4.32 per cent at the market level and 4.89 per cent at the retail level.

Mapping of apple value chains in Jammu & Kashmir

In collaboration with Sher-e-Kashmir University of Agricultural Sciences and Technology

The apple value chain map of various actors shown in figure 2.27 is based on survey conducted in the Baramulla region, which is the main center for commercial apple production and trade.

Farmers: The survey from the study area showed that the area under fruit trees was 29367 hectares out of which an estimated 84 per cent were apple farms. The apple growers can be grouped into two major categories. Small farmers with land holding under apple up to 1.0 ha who generally have a volume of production under 1000 boxes of apple. These farmers do not treat apple production as a commercial activity and have limited receptivity to improved technologies and little ability to make new investments in apple production. Yields among farmers in this category are estimated to be in 18 thousand kg per hectare range. Medium farmers cultivating over 1.0 - 2.0 ha of land under apple orchards. Such farmers operate as commercial farmers and invest in certified saplings of good genetic quality, prepare the soil on an annual basis, apply fertilizer and use gravity-fed flood irrigation. Most also apply pesticides, although recommended dosages and spraying schedules are rarely respected. These farms generally produce over 2000 to 3000 boxes of apples in a season. Most farmers in this category achieve yields in 40 to 50 thousand kg per hectare range.

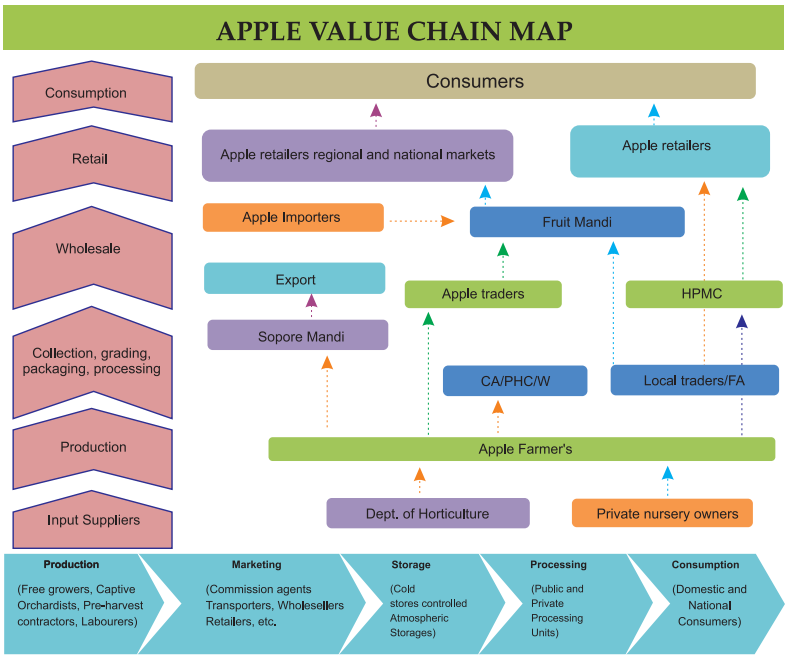


Figure 2.27. Apple value chain map in Jammu & Kashmir

Pre-harvest contractor (PHC): Pre-harvest contractors are the persons specialized in performing various marketing functions. They overcome the difficulty of small produce by way of contracting more than one orchard at a time and perform most of the marketing functions themselves. The majority of the orchardists usually give their orchards on lease for a season to these contractors, and the contractors in turn give them money on the basis of the prediction how many boxes of apple would the orchard produce in that particular season.

Commission agents (CA): A commission agent is a person operating in the wholesale market who acts as a representative of either a seller or a buyer. Orchardists consign their produce to commission agents in a particular market and they take over the physical handling of the produce and make arrangements for its sale, collect the money from the buyer, deduct their expenses and commission (normally 12%) and remit the balance to the seller.

Forwarding agents (FA): They are specialized persons operating in the apple producing areas. Their main business is to arrange the transportation of produce of their clients to different markets. For performing this function they charge commission (6%) on per box basis. These agents also supply packaging and other material to the orchardists.

Wholesellers (W): An estimated 90 per cent of all apples (both domestic and imported) pass through the wholesale markets of Kashmir.

The market provides the physical space where farmers, traders, and retailers come together in the greatest volumes. Although some actors bypass the wholesale market, main tendencies of the Kashmir apple market are determined within the confines of the wholesale markets—and particularly the one in Sopore.

Retailers: The retail sector remains largely dominated by small neighbourhood retail grocery stores (including stores with a range of products) and, especially, by the green (retail) market vendors. All retailers buy local and imported apples mainly from the distributors and occasionally from the wholesale markets. No clear quality or product differentiation is practiced at the retail level, although some retailers in wealthier areas tend to buy and sell produce that is of better and more standard quality, than retailers in lower income areas.

Jammu & Kashmir Horticultural Produce Marketing and Processing Corporation Ltd. (JKHPMC): The HPMC was established in the year 1974 in Jammu & Kashmir to modernize apple marketing system by developing infrastructure for the post-harvest handling of apples on scientific lines. At present there are two processing plants operating in Kashmir with a total annual capacity of 70,000 metric tonnes (MT) to process raw apple culls. JKHPMC has set up a mechanical grading house in producing area, transportation facilities both ordinary and refrigerated and fruit processing plant. It also sales processed product, i.e. the concentrated apple juice to various companies including Nestle. These facilities are offered to apple growers in the form of integrated marketing system to make use of them for better returns, through value addition.

Market integration and price transmission in agricultural commodities

TK Immanuelraj, Shiv Kumar and Abimanyu Jhajharia

Asymmetric Price Transmission in Rapeseed and Mustard

Rapeseed and mustard (R&M) constitutes one fourth area of total oilseeds grown in India. Haryana, Madhya Pradesh, Rajasthan and Uttar Pradesh produce over 80 per cent of total R&M production in the country. Rajasthan alone contribute almost half of the R&M production in the country. To examine the role of institutions and infrastructure in incentivizing oilseeds producing farmers, the nature of integration and price transmission in the vertical marketing chain of mustard oilseed was studied using monthly price data from 2009 to 2017.

Figure 2.28 reveals that the gap between wholesale oilseed and wholesale oil price are widening over the years. During 2009 to 2017, prices of retail edible oil, wholesale oil and wholesale oilseeds grew at annual average rate of 8.5 per cent, 7.8 per cent and 6.8 per cent, respectively. This shows that oil prices at wholesale and retail level have increased at higher rate than of oilseeds. Further, the coefficient of variation (CV) in oilseed prices was found to be more volatile than oil prices (wholesale and retail) during the study period. Similarly, wholesale price of oil were more volatile than retail price. The CV for delhi wholesale prices, retail prices of mustard oil were 2.4 per cent and 1.9 per cent, respectively, whereas the CV in oilseed prices across major mustard markets ranged from 5 to 9 per cent. This suggests that mustard oilseed producer faces high price fluctuation with lesser increase in price.

The co-integration analysis showed that there is a long-run equilibrium relationship between the wholesale prices of mustard oilseed and oil. The Engle Granger Threshold Co-Integration analysis revealed that long-run equilibrium relationship is non-linear and asymmetric.

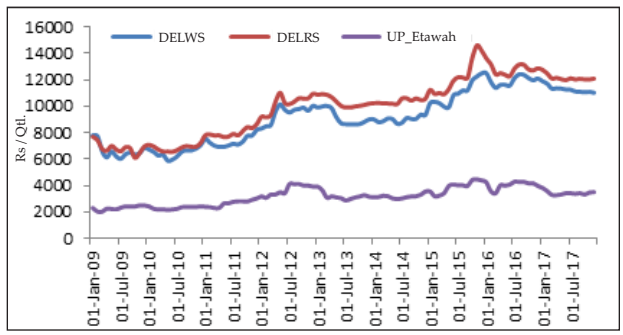


Figure 2.28. Price trend of rapseed & mustard oilseeds and edible oil

The positive shock coefficient was estimated to be 0.41 and significant, implying that if the mustard wholesale oil price decreases by 10 per cent, immediately that shock (disequilibrium) is transmitted to wholesale oilseed price and the oilseed price decreases by 4 per cent. However, if the mustard wholesale oil price increases, wholesale oilseed price increases only by 1.7 per cent. Overall the evidences shows that market is not working favourably for the oilseed farmers due to existing institutional and infrastructural constraints and it needs speedy market reformation.

Agricultural outlook model for pulses

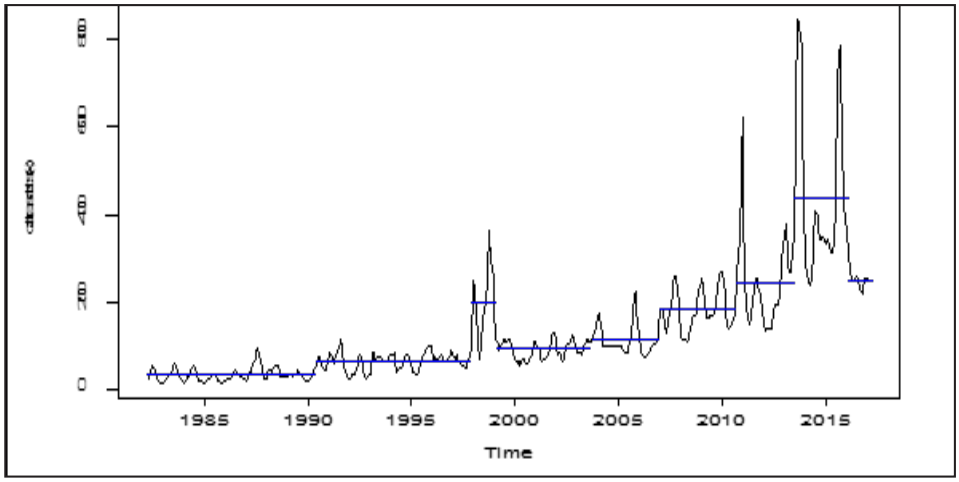
A review of the outlook models developed by national and international organization reveals that most models were built to generate advance information on key policy variables related to agriculture and allied sectors. Besides, they have been playing a key role in the academic and policy debate on the effect of agricultural and trade policies. Keeping this in mind, ICAR-NIAP is developing an Agricultural Outlook Model for pulses, to generate medium and long term projections on key economic variables such as production, demand, stocks, trade, prices and policy. The model has also been designed for developing simulations under alternative policy scenarios, a utility that may help the policy makers in evaluating the implications of alternative policy decisions and changes in the market dynamics.

Doubling Farmers' Income by 2022: Marketing Perspectives

Raka Saxena, Ranjit Kumar Paul, Naveen P Singh, Rohit Kumar and Mohd Arshad Khan

Price trajectory and transmission in onion

Among tomato, onion and potato (TOP), identified as price sensitive commodities, onion remains the most vulnerable commodity with instability of 4.3 per cent during 2011 to 2016. The price spikes in onion prices have become



Phase Vs	Phase	t-statistic	F statistic
Apr, 1982 to May, 1990	Jun, 1990 to Nov, 1997	-11.34*	1.68*
Jun, 1990 to Nov, 1997	Dec, 1997 to Jan, 1999	-5.92*	18.17*
Dec, 1997 to Jan, 1999	Feb, 1999 to Sep, 2003	4.68*	17.66*
Feb, 1999 to Sep, 2003	Oct, 2003 to Dec, 2006	-3.55*	3.12*
Oct, 2003 to Dec, 2006	Jan, 2007 to Sep, 2010	-7.60**	1.68**
Jan, 2007 to Sep, 2010	Oct, 2010 to Jun, 2013	-3.20*	5.22*
Oct, 2010 to Jun, 2013	Jul, 2013 to Feb, 2016	-5.20*	3.07*
Jul, 2013 to Feb, 2016	Mar, 2016 to Mar, 2017	5.77*	183.17*

Note: * and ** indicate the level of significance at 1 and 10 per cent level, respectively

Figure 2.29. Structural breaks in onion wholesale price index in India

bigger and more frequent during recent times. Statistically, the abrupt price changes detection corresponds to estimating the points which exhibit significant change in the statistical properties of a sequence of observations. Pruned exact linear time (PELT) method was used to find out multiple change points in the mean and variance of wholesale price index (WPI) of onion. The onion WPI has witnessed 9 structural breaks during 1982 to 2017 (Figure 2.29). The dissection of breaks revealed that the length of stable price phases has reduced over time and shorter phases with greater instability are becoming pronounced. The instability is largely contributed by supply side factors.

Using vector auto-regression (VAR) technique on weekly price data, transmission in onion prices among twelve major producing and consuming markets was analyzed. The selected markets include Delhi, Mumbai, Chennai and Kolkata as major consuming markets and Lasalgaon, Pimpalgaon, Pune and Solapur markets in Maharashtra; Bengaluru market in Karnataka; Indore market in Madhya Pradesh; Patna in Bihar; Mahuva market in Gujarat, as major producing markets. The analysis revealed that one unit change in lagged weekly price of Lasalgaon would change the prices in Kolkata, Mumbai and Delhi markets by 0.45, 0.42 and 0.39 units, respectively in the following week (Table 2.32). In case of consuming market linkages, Bengaluru prices significantly affect the Chennai market prices with the highest coefficient value followed by Mumbai, Pune, Solapur, Patna and Mahuva. Delhi onion price are influenced by Lasalgaon with high magnitude followed by Bengaluru and Solapur onion price. Pimpalgaon and Bengaluru markets influence Indore, Lasalgaon, Mahuwa and Patna markets besides their own lagged price changes. Markets in the leading state, i.e. Maharashtra, are pre-dominant in terms of onion supply and distribution and thereby create strong influences on other markets. Lasalgaon, Bengaluru and Solapur remain the

Table 2.32. Price transmission across markets: VAR coefficients with one week lagged prices

	Consumers' Markets				Producers' markets							
	Chennai	Delhi	Kolkata	Mumbai	Bengaluru	Indore	Lasalgaon	Mahuva	Patna	Pimpalgaon	Pune	Solapur
Dependent Consumers' Markets												
Chennai	0.47			0.2	0.35			0.13	0.16		0.17	0.17
Delhi	*	0.63			0.23		0.39		*			0.15
Kolkata			0.37	0.18	0.40		0.45		*			0.23
Mumbai	*			0.75	0.18		0.42					0.19
Dependent Producers' Markets												
Bengaluru				0.26	0.89		0.17					
Indore	*				0.25	0.51			*	0.31		0.12
Lasalgaon	*				0.30		0.75	*	*	0.20		0.15
Mahuva	*				0.32			0.52	*	0.16		
Patna	*				0.26		0.41		0.38	0.32	*	
Pimpalgaon	*				0.32		0.22	*	*	0.66	0.14	0.19
Pune	*			0.2		*	0.35				0.98	
Solapur	*				0.17	*	0.19		*			0.95

Note: The given VAR coefficients are significant at 5% level of significance
*indicates negative VAR coefficient. The blank cells indicate the non-significant coefficients

most influential producing markets causing the change in consuming markets besides their own influence. Thus, continuous market surveillance can provide early price signals and help to examine the extent of price influences.

Greater emphasis on nutri-cereals: Marketing policies for promotion of pearl millet

Millets, which are extremely nutritious and cost effective cereals, have been repositioned as 'nutri-cereals'. During 2016-17, 16.14 million tonnes millets were produced from 14.72 million hectares land. Among various forms of millets, pearl millet is the most extensively grown in India. Four states namely Rajasthan, Maharashtra, Gujarat and Uttar Pradesh account for about 90 per cent crop acreage. Significant improvement in pearl millet productivity at national level has been observed during last few years, primarily due to the highest seed replacement rates in Gujarat and Rajasthan. As the millets are getting momentum, the prices of millets have witnessed a sharp increase after 2010. Jowar, bajra, maize and ragi have witnessed higher growth in prices than rice and wheat during the last decade (Figure 2.30).

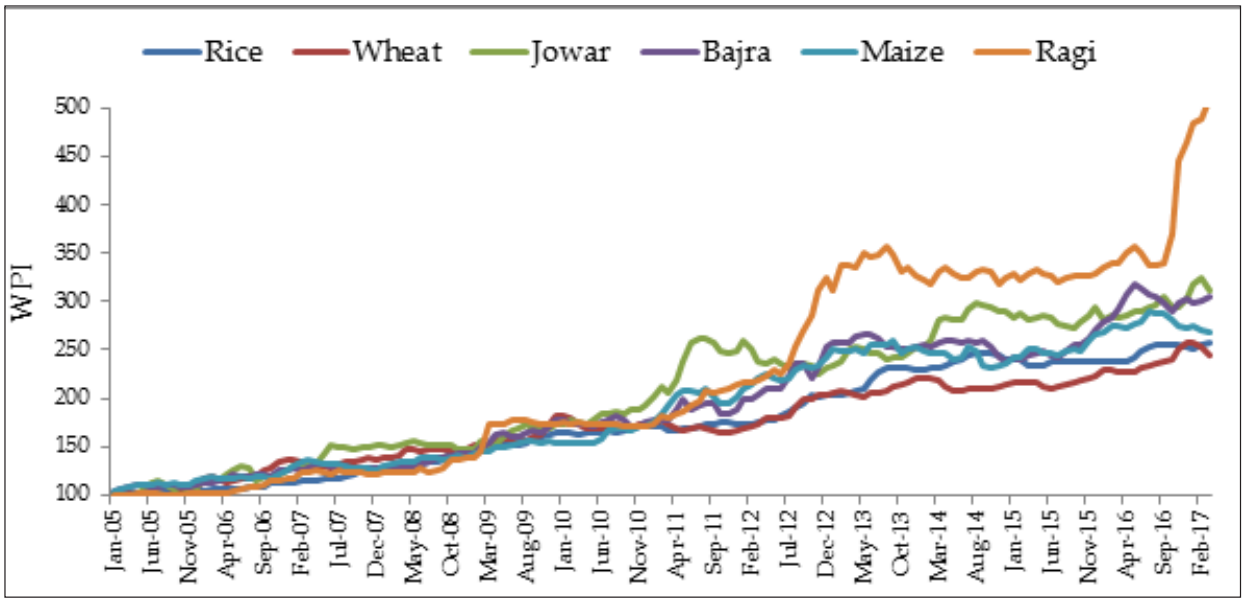


Figure 2.30. Trend in wholesale price index (2004-05 = 100) of major cereals

In Rajasthan, pearl millet remains a pre-dominant crop for closely fifty per cent of the agricultural households. As a major source of dry-fodder, it contributes significantly in the sustenance of livestock sector in the state. This is witnessed through higher livestock income and

Table 2.33. Performance of livestock activity in pearl millet dominant districts of Rajasthan

Indicator	Measured as	Districts reporting encouraging results
Higher livestock income	Livestock income (Rs/month)	Dausa (2613), Jodhpur (1337), Jalore (1608), Jaipur (1798), Jhunjhunu (2500), Dausa (2612) and Karauli (1972)
High productivity of indigenous cattle	Productivity of indigenous cattle (litres/day)	Jalore (4.06), Jaipur (4.77), Sikar (4.97) and Jhunjhunun (4.56)
High productivity of crossbred cattle	Productivity of crossbred cattle (litres/day)	Jodhpur (7.46), Nagaur (7.34), Jaipur (7.92), Sikar (8.33), Jhunjhunu (8.02) and Alwar (7.67)
High productivity of buffaloes	Buffalo productivity (litres/day)	Jodhpur (6.466), Churu (6.226), Jalore (6.126), Jaipur (6.896), Sikar (6.653), Jhunjhunun (6.478) and Alwar (6.624).

productivity of milch animals in pearl millet dominant districts (Barmer, Jodhpur, Nagaur, Churu, Jalore, Jaipur, Sikar, Jhunjhunu, Alwar, Bikaner, Jaisalmer, Dausa, Karauli, Bharatpur and Dholpur) in Rajasthan (Table 2.33). These districts occupy 93 per cent of pearl millet area in the state. Improvement in the nutritional quality of pearl millet used for feed and fodder purposes would go a long way to improve the efficiency and productivity of livestock.

There exists great scope to strengthen the existing marketing system for pearl millet as the produce is primarily disposed through the local private traders and to some extent through mandies. Promoting "nutri-marketing" is one of the solutions for greater awareness and improved consumption among the masses. Creation of awareness about the health and environmental benefits associated with the millets will aid demand creation for millets in the country. There is a need to promote value chains inclusive of diversified uses of pearl millet. Creation of farm-gate level primary processing clusters in the prime growing areas would go a long way in promoting the millet products.

Framework for Ease of Doing Agriculture Index

In collaboration with Department of Agriculture Cooperation and Farmers Welfare

The DAC&FW through DFI Committee has been aiming to reorient the agriculture sector by focusing on an income-centered approach rather than traditional approach of achieving farmers' welfare merely through augmenting the agricultural production. The redefined income approach given by the DFI committee focuses on higher profits from farming by achieving higher productivity, reduced cost of cultivation and remunerative prices of the produce. Agriculture being a State subject, the State Governments undertake formulation of perspective plans and ensure effective implementation of the programmes/schemes. Also, Government of India supplements the efforts of the State Governments through various Schemes/ Programmes. To ensure the reform agenda, it is important to construct a comparative index across states for assessing the implementation of reforms. Keeping this in mind, steps have been initiated by DAC&FW to rank the States through an index, i.e. Ease of Doing Agriculture (EDA). ICAR-NIAP, being the knowledge partner of DFI Committee, provided technical facilitation in designing the framework for Ease of Doing Agriculture Index. The basic apprehension is to consider farming not solely as a production oriented activity carried out to achieve food security for the country, but also as a commercial activity carried out by farmer as an entrepreneur. The index emphasizes on various dimensions including the production/productivity, increased price realization, decreasing input costs, risk mitigation and investment related attributes as its core components (Table 2.34). The index will help in fostering agriculture development among various states.

Marketing Infrastructure and Reforms

Raka Saxena and Abhimanyu Jhajharia

In order to overcome the challenges of traditional regulated marketing system, Government of India initiated reforms in agricultural marketing with the formulation of the Model APMC Act during 2003. The Model Act recommended inter-alia, establishment of markets in the private and cooperative sectors, direct marketing, contract farming and farmers markets. Farmer's income particularly in the context of the small and marginal farmers is multi-sourced. This leaves the competitive marketing system as the only viable option. The new Model Act titled as "The State/UT Agricultural Produce and Livestock Marketing (Promotion & Facilitation) Act, 2017" is intended to introduce creative disruption in the current agricultural market environment of the country. This study intends to study the extent of implementation of APMC reforms, e-NAM reforms and futures trading in agriculture, examine the impact of marketing reforms on price realization, price-spread, marketing costs and marketing efficiency and farmers' income and evaluate the impact of market logistics and warehouse receipt system in improving the

Table 2.34. Framework for ease of doing agriculture index

Theme	Dimension	Specific Areas of Reforms
Improving marketing systems	Marketing reforms	Establishment of private markets, direct wholesale purchase of agriculture produce, establishment of farmer – consumer market in private sector, Facility of electronic trading, single point levy of market fee, unified single trading license, agriculture exports, democratic functioning of Mandi Samitis, bifurcation of Enforcement and Development wings
	Establishment of National Agriculture Market (eNAM)	Coverage of Agriculture markets under eNAM, extent of online trading, establishment of quality assaying labs, recognition of licenses of other States
	Development of Rural Haats	Infrastructure upgradation of rural haats linked to eNAM, Declaration of cold storage/silos etc as market yards
	Post Harvesting Infrastructure	Infrastructure of primary processing units, cold storage capacity, ripening chambers, total food grain storage capacity
	Public procurement on Minimum Support Price	Purchase of state specific major crops
Reducing costs of inputs	Optimal use of fertilisers	Coverage of area under organic farming, distribution of Soil Health Cards, infrastructure of soil testing labs, linking sale of fertilizers with Soil Health Cards
	Irrigation	Coverage under drip/sprinkler irrigation, irrigation intensity 1. Command Area Development 2. State specific initiatives to promote Micro Irrigation 3. Percentage of tube wells connected to Micro Irrigation 4. Promotion of renewable energy through solar pumps
Improving governance and organizational capacities	Land Reforms	Institutional Mechanism for convergence (Whether States have adopted the institutional set up proposed at State and District level for stakeholder involvement in agriculture)
	Organizational capacities	Strengthening of extension system
	Adoption of Model Agriculture Land Leasing Act.	Legalization of land leasing, ensuring complete security of land ownership right, removal of the clause of adverse possession of land, terms and conditions of lease to be determined mutually by the land owner and tenant, facilitating all tenants to access crop insurance and bank credit, incentivize tenants to make investment in land improvement, adoption of Model Contract Farming Act / Rules and ownership rights to women
	Farmers' Organizations	Expansion of farmer producer organizations, expansion of joint liability groups, functionality of credit cooperative sector
	Risk Mitigation	Coverage of area under crop insurance for rabi and kharif crops, non-loanee farmers insured, timely payment of share of premium by States, timely completion of crop cutting experiments, coverage of animals under insurance
Increasing production/productivity		Seed replacement rate in *kharif* and *rabi* season
Enforcement of Seed Act		Infrastructure of seed and pesticide testing labs, enforcement capacity farm mechanization
Investments in & for agriculture		Quantum of agriculture credit, incentives to farmers on agriculture credit, investment on agriculture through MNREGS, active KCCs, cedit limit given to farmers engaged in fisheries and animal husbandry, state's resources directly invested in agriculture
Scope for innovations		Successful and scalable innovation in the state in agriculture sector

marketing efficiency and farmers' incomes. It is revealed that the pace of reforms has been uneven across states and needs to be geared up to ensure balanced development across states. It calls for revisiting the strategy required to encourage states to adopt Model Act as well as the APLM Act.

Agricultural Input Markets in India: Recent Policy Reforms and Ways forward

Subash SP, SJ Balaji and Suresh Pal

The study reviewed the policies in three major input sectors, *viz.* seeds, pesticides and fertilisers. The agriculture input markets in India is undergoing numerous changes in terms of scale of operation, participation, and diversification. Various new policy reforms such as nutrient base subsidy scheme 2010, neem coated urea 2015, direct benefit transfer (2017) in fertilizers sector, price control order of Bt-cotton 2015, Seed Bill 2011 (pending) in case of seed sector, and the proposed pesticide management bill 2008 and Insecticides (Amendment) Draft Rules 2017 in case of pesticides are intended to have greater implications on restructuring the sector. The new policies and regulations are tailored for the changing dynamics in the input sector and are intended to have greater implications on restructuring the sector. The input sectors are governed by different actors and roles. A sector wise discussion on policies, challenges and way forward are given below.

Government policy intervention had shaped seed sector in the last 30 years. Two most recent policies which shaped or would shape the seed sector are Cotton Seed Price Control Order 2015, and the Seed Bill 2011 which is pending with the Government. Comparing Seed Bill 2011 with Seed Act 1966, there are major changes on registration, transgenic varieties, compensation to farmers, export import rules and penalties on spurious seeds. Cotton price control order, 2015 had regulated the price of transgenic cottons, though the act safeguarded farmers in short run, this might also have a long term impact on cotton seed markets. Major challenges in seed sector are non-availability of good quality seeds, spurious seed (Esp. Cotton and vegetables), policy dilemma over GM technology, lack of investment in R & D, Government regulatory interventions. Ensuring good quality seed and preventing spurious seed is a key priority in the sector. Government also needs to bring clarity on the GM technology and other emerging technologies in seed (CRISPR-Cas9). Domestic private sectors should be encouraged for investment in R & D and also to collaborate with public research institutions for R & D. The regulatory mechanism in the seed sector should be made predictable, transparent, fair and science-based.

Pesticide industry is shaped by intellectual property rights (IPRs) as the companies are characterized by R & D based and generic based. There is also a shift in the share of insecticide, fungicide and herbicide, with fungicides and herbicides growing more than insecticides. There are several regulatory hurdles in pesticides industry. A new innovation takes 9-10 years, whereas incremental innovations (newer formulations) take less than 1-2 year. This dis-incentivizes the companies for developing newer molecules. The proposed Pesticide Management Bill 2008 gives a data protection of three years for the new pesticides. One major concern is presence of counterfeit and spurious pesticides in the market, besides low awareness and lack of adequate technical expertise. Insecticides (Second Amendment) Rules, 2017 amendments to the Insecticides rules 1971, tries to create technical expertise among input dealers.

Fertilizer industry is capital driven and is highly subsided by Government. Marketing of fertilizers is regulated under Essential Commodities Act 1955 and Fertilizer Control Order 1985. Recently, government of India has come up with newer policies in this sector. Government of India mandated neem-coating for 100 per cent of domestic production in 2015. Other than the direct benefits, Government intention was to prevent the leakage of heavily subsidized urea's. The Direct Benefit Transfer (DBT) in fertilizers in India was rolled in all

Table 2.35. Import of fertilsers in India by companies

Year	Quantity of urea (Lakh MT)					Value
	From OMIFCO	Share in total (%)	Through STC	Share in total (%)	Total	(Million US $)
2011-12	20.69	26.41	57.65	73.59	78.34	3,222.48
2012-13	18.33	22.79	62.11	77.21	80.44	3,009.49
2013-14	21.21	29.92	49.68	70.08	70.89	1,968.36
2014-15*	10.8	14.79	62.22	85.21	73.02	2,098.61

Note: *Upto January, 2015. STC: State Trading Corporation; OMIFCO: Oman India Fertiliser Company.
Source: Ministry of Chemicals and Fertilizers, GoI.

states in 2018. It is designed to provide subsidy on the urea based on physical offtake by farmers. It would also help in reducing diversion of urea for non-agricultural purposes. The study emphasis on the need for rationalization of price of P&K fertilisers to mitigate the distortion in NPK ratio. Setting up of joint ventures (JVs) abroad to secure long term fertilizer supplies from locations where energy prices are cheap is necessary for ensuring a sustainable future. Such JVs (eg: OMIFCO) are emerging as a successful model in this direction (Table 2.35).

The study concludes that considering the dynamic nature of the sector, the policies need to be realigned and reformed in a faster pace. There is a need to strengthen policies to build partnership; public-private partnership, for R & D in case of seed, for quality control in case of pesticides, and for foreign joint ventures in case of fertilizers.

Impact Assessment of Agriculture Research and Development

Pusa Basmati 1121: An account of displaced Pakistan basmati competitiveness

TK Immanuelraj, Shiv Kumar, Vinayak Nigam

India and Pakistan are the major producers and exporters of basmati rice in the world. Presently, India contributes 70 per cent of the global production of basmati rice and has surpassed the Pakistan in its production and export. This study explores how Pusa Basmati (PB)-1121 variety enabled India's competitiveness over Pakistan in basmati cultivation.

During 1991-92 to 2015-16, export of basmati from India in volume and value terms increased at annual growth rate of 11.2 per cent and 17.4 per cent, respectively. India exported

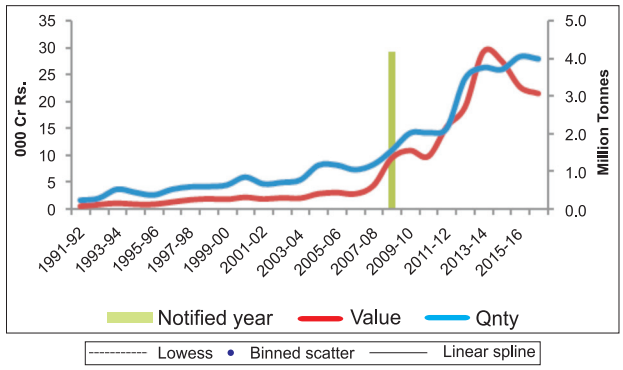


Figure 2.31. Volume and value of basmati export by India

40,00,471 MT of Basmati rice amounting to Rs. 21,604 crores (or 3,230.24 million USD) in 2016-17. Major importers were Saudi Arabia, Iran, United Arab Emirates, Iraq and Kuwait. PB-1121 variety is playing a crucial role in meeting the global demand of basmati rice. Until the notification of PB-1121 (2007-08), aromatic rice

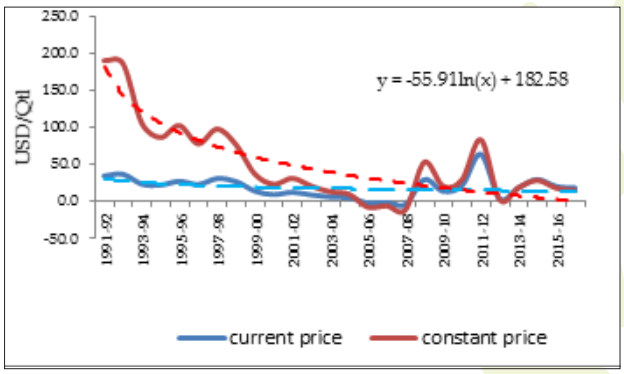


Figure 2.32. Price difference in basmati rice between India and Pakistan

export mainly consisted of traditional varieties and was rising at 8.2 per cent per annum. Subsequent to the notification, the annual growth rate in basmati export accelerated to 14.8 per cent (Figure 2.31). Until 2007-08 India lagged behind Pakistan in term of volume of basmati export. But, in the subsequent period which coincided with release of PB-1121, India surpassed Pakistan in basmati export.

Further, price difference of basmati rice between India and Pakistan has also narrowed down over the years (Figure 2.32). This was primarily due to reduction in average world prices of basmati on account of significant increased production in India. PB-1121 enabled India to supply quality basmati at cheaper price than the Pakistan to the world and thus improving India's competitiveness over Pakistan. The study estimated benefits enjoyed by producer, consumer and rest of the world using the concept of economic surplus. The total surplus generated over 13 years from its release is around Rs. 430,118 crore. The share of producer surplus (including processors), consumer surplus and rest of the world (RoW) in total surplus is around 58.6 per cent, 25.5 percent and 15.9 per cent, respectively. The internal rate of return is estimated to be 85 per cent.

List of Research Projects

Table 2.36. On-going research project

Title of the project	Project Area	Project period	Project team
Network Project			
Structural transformation, regional disparity and institutional reforms in agriculture	Agricultural Growth and Development	October 2017-March 2020	Suresh Pal, Balaji SJ Pavithra S Subash SP Nalini Ranjan Kumar
Resource use planning for sustainable agriculture	Technology and Sustainable Agriculture	October 2017-March 2020	Prem Chand Rajni Jain Subhash Chand Prabhat Kishore
Policy imperatives for promoting value chain of agricultural commodities in India	Markets and Trade	November 2017-March 2020	Shiv Kumar Abhimanyu Jhajharia TK Immanuelraj
Externally Funded Projects			
Doubling farmers' income in India by 2021-22: Estimating farm income and preparation of strategic framework	Agricultural Growth and Development	April 2017-March 2022	Suresh Pal Raka Saxena Naveen P Singh Usha Ahuja Balaji S J Ranjit Kumar Paul
Climate change, impact, adaptation, and mitigation: Gender perspective in Indian context	Agricultural Growth and Development	May 2017-April 2018	Usha Rani Ahuja Vinayak Nikam
Management and impact assessment of farmer FIRST project	Technology and Sustainable Agriculture	February 2017-March 2018	Shiv Kumar Rajni Jain Vinayak R Nikam T. K. Immanuelraj Abhimanyu Jhajhria

Agricultural sustainability in India – A parametric study	Technology and Sustainable Agriculture	June 2018-March 2020	Suresh Pal Chhabilendra Roul S K Chaudhari Prem Chand
Strategic research component of national innovations on climate resilient agriculture	Technology and Sustainable Agriculture	April 2017-March 2020	Naveen P Singh Arathy Ashok Bhawna Anand Surendra Singh
Efficiency of micro-irrigation in economising water use in India: Learnings from potential and under explored states	Technology and Sustainable Agriculture	December 2017-May 2019	Subhash Chand Prabhat Kishore R S Pundir S K Srivastava Ravinder Singh
Investments in ICAR leadership in agricultural higher education (2019-2021)	Technology and Sustainable Agriculture	February 2019-March 2021	Rajni Jain
Agricultural innovations and technology management	Technology and Sustainable Agriculture	November 2017-March 2020	Sant Kumar
Institute Funded Projects			
Farm mechanization on small and marginal farms in India- Trends and drivers	Agricultural Growth and Development	April 2017-March 2020	Nalini Ranjan Kumar SV Bangaraju T
Rural non-farm sector (RNFS) in India: Trends, structural changes, farm sector growth and poverty linkages	Agricultural Growth and Development	October 2017-March 2020	Subash S P Prem Chand Balaji, S J
Crop insurance in India: Progress, farmers' willingness to pay and role of information	Agricultural Growth and Development	October 2017-March 2020	Pavithra S Jaya Jumrani Arathy Ashok
Nutrient demand and the effect of women empowerment in improving nutritional outcomes in India	Agricultural Growth and Development	March 2018-March 2020	Jaya Jumrani Usha Rani Ahuja
Performance and impact assessment of agricultural extension and advisory systems	Technology and Sustainable Agriculture	April 2017-March 2020	Arathy Ashok Vinayak Nikam
Technology foresight in agriculture	Technology and Sustainable Agriculture	October 2017-March 2020	Subash, S P Arathy Ashok Suresh Pal
Direct benefit transfers for micro-irrigation: Impact on farm performance	Technology and Sustainable Agriculture	October 2017-March 2019	Prabhat Kishore P S Birthal

Institutional mechanisms in irrigation water management system and water markets in northern India	Technology and Sustainable Agriculture	October 2017-March 2020	Subhash Chand Prabhat Kishore Hubbalal
Assessing impact of soil and water conservation schemes and innovative agricultural technology	Technology and Sustainable Agriculture	November 2017-March 2020	Sant Kumar Pramod Kumar
Marketing reform and infrastructure	Markets and Trade	October 2017-March 2020	Raka Saxena Abhimanyu Jhajhria
Market integration and price transmission in agricultural commodities	Markets and Trade	April 2017-March 2020	T. K. Immanuelraj Abimanyu Jhajhria Shiv Kumar

Table 2.37. Consultancy and contract research projects

Name of the scientist	Institution to which consultancy provided	Area of consultancy/contract research
Pratap S Birthal and Shiv Kumar	Centre for WTO Studies, Indian Institute of Foreign Trade, Ministry of Commerce, Government of India, New Delhi	Tweaking Current Schemes in De-Minimus to Meet Green Box Criteria as per Legal Agreement on Agriculture
Pratap S Birthal	International Food Policy Research Institute, Washington DC	Transformation, and Sources of Growth in Southeast Asian Agriculture

CHAPTER 3

- ICAR-NIAP: An Overview
- Significant Research Achievements
- **Capacity Building**
- Policy Interactions
- Research Output
- Awards and Recognitions
- Participation in Scientific Activities
- Management Committee Meetings
- Other Institute Activities
- Personnel and Budget

Seminars/Workshops Organized : 10

Trainings Organized : 2

Seminar/Workshop Organized

Resource Use Planning for Sustainable Agriculture

Workshop cum seminar on "Resource Use Planing for Sustainable Agriculture" in collaboration with Institute of Agricultural Sciences, BHU Varanasi was organized during August 29-30, 2018 at BHU Varanasi. Professor A. Vaishampayan, Director, Institute of Agricultural Sciences in his inaugural address highlighted the need of high-end technologies such as use of remote session, GIS, precision agriculture, etc. in resources use planning. Dr. Suresh Pal, Director, ICAR-NIAP briefed about the project and felt the special need to address some of the issues like rice fallows, flood management, institutional interventions and issues in water governance, etc. Dr B. Singh, Director, ICAR-IIVR highlighted the role of horticultural crops in sustaining the income of farmers. Prof. (Ms.) B. Bose, Dean, Faculty of Agriculture welcoming the participants gave an overview of Institute of Agricultural Sciences. During the two days' workshop, network partners from AAU, BHU, MPUAT, HAU, IARI, PAU and TNAU presented the work progress and case studies on resource use planning from their respective regions. The workshop was attended by Heads of departments, senior faculty members and students. Dr. P. S. Badal, Professor, Department of Agricultural Economics proposed the vote of thanks.

Sustainability of Indian Agriculture: Natural Resource Perspective with Special Reference to Soil

National Workshop on "Sustainability of Indian Agriculture: Natural Resource Perspective with Special reference to Soil" was convened on September 8, 2018 at NASC Complex, New Delhi in collaboration with Indian Council of Agricultural Research. Dr. T. Mohapatra, Secretary, DARE and DG, ICAR in his inaugural address said that the monoculture of rice-wheat cropping system in Haryana and Punjab added the number of problem in the region. There is a need to follow system approach for measuring agricultural sustainability. No baseline is available to develop composite sustainability indicators (participant's voice). He emphasized that command area and area under water logging should also be considered for the study. Shri Chhabilendra Roul, Special Secretary DARE setting the context of the workshop highlighted the need for developing sustainability assessment framework exclusively for agriculture. Dr. Suresh Pal, Director, ICAR-NIAP welcomed the participants and briefed about the aims and objectives of the workshop. Dr S K Chaudhari, ADG (SWM), ICAR highlighted important soil indicators for sustainable agriculture. More than 60 participants including Assistant Director Generals, Senior Officials, Scientist and research scholars from different parts of the country attended the workshop.

Workshop cum seminar on "Resource Use Planning for Sustainable Agriculture" in collaboration with Institute of Agricultural Sciences, BHU Varanasi, August 29-30, 2018

Inaugural Address of Dr T. Mohapatra, Secretary, DARE and Director General, ICAR at NASC, September 8, 2018

Sustainability of Indian Agriculture: Natural Resource Perspective with Special Reference to Water

The National workshop was organized on October 11, 2018 in collaboration with ICAR-IIWM, Bhubaneswar under the chairmanship of Shri Chhabilendra Roul, Special Secretary, DARE & Secretary, ICAR. While addressing the delegates and participants, Shri Roul emphasized the need for agricultural sustainability indicators. He delivered a presentation on "Sustainable indicator framework and related concepts" and stressed the need for identification of water related indicators which can be measured with high level of convenience and integrating the existing water indicators in to a single composite index addressing both quantitative and qualitative aspects of water management in agricultural sector. Dr. Suresh Pal, Director, ICAR-NCAP and Dr. S.K. Chaudhari, ADG (SWM), NRM Division, ICAR gave brief background about the Workshop. Dr. S.K. Ambast, Director, ICAR-IIWM delivered the welcome address. About 60 participants including experts dealing with issues related to agricultural water management deliberated to finalize water related indicators for sustainability.

Sustainability of Indian Agriculture: Biodiversity, Environmental and Climate Change Perspectives

National workshop on "Sustainability of Indian Agriculture: Biodiversity, Environmental and Climate Change Perspectives" was organized on November 26, 2018 at NASC Complex, New Delhi. Shri Chhabilendra Roul, Special Secretary, DARE & Secretary, ICAR, inaugurated the workshop. In his inaugural address, Shri Roul urged the researchers for filling of data gap through generating quality data to operationalize the agricultural sustainability. Dr. Suresh Pal welcomed the participants and briefed about the purpose of the workshop. The workshop brought attention of the leading academicians to exchange and share their experience about the all aspects of biodiversity,

National workshop on "Sustainability of Indian Agriculture: Natural Resource Perspective with Special Reference to Water" in collaboration with ICAR-Indian Institute of Water Management, Bhubaneswar, October 11, 2018

environment, and climate resilience.

Sustainability of Indian Agriculture: Socio-Economic Perspective

Shri Chhabilendra Roul, Special Secretary, DARE & Secretary, ICAR stressed on assessing the sustainability holistically while inaugurating a one-day workshop on "Sustainability of Indian Agriculture: Socio-Economic Perspective" organised on November 27, 2018 at NASC Complex, New Delhi. He highlighted that sustainable use of natural resources and preservation and augmentation of ecosystem have always been a societal concern for human kind but objective assessment of sustainability has remained less probed. Dr. Suresh Pal, Director, NIAP emphasized on socio-economic indicators and importance of sustainability assessment. Experts in the field from different parts of the country presented socio-economic indicators for sustainability assessment and more than 50 participants attended the workshop.

Agriculture and Ecosystem Services

Two day seminar on "Agriculture and Ecosystem Services" was organized during May 28-29, 2018 to understand the ecosystem services and their incorporation into development process in the context of agriculture. The workshop was organized in five technical sessions; (i) valuation of ecosystem services; (ii) natural resource conservation and ecosystem services; (iii) ecosystem case studies; (iv) conservation agriculture and ecosystem services; and (v) climate change and agriculture, besides the inaugural session and panel discussion. In his keynote address Shri. Chhabilendra Roul, Special Secretary, DARE & Secretary, ICAR emphasized the significance of interdependence between agricultural production systems, people and environment. He also emphasized the need to assess the ecosystem services in developing countries so that suitable interventions can be made to enhance these services, or check their further deterioration. Dr. R.B. Singh, Former President, NAAS, underlined the relevance of science of sustainability that highlights the synergies and trade-offs in agriculture. Dr Suresh Pal, Director, ICAR-NIAP elaborated the concepts and methods in valuation of ecosystem services. During the panel discussion on day two, Dr. Kanchan Chopra, Former Director, IEG encouraged the thought of viewing agriculture as a system. She also advised a monetary assessment of intangible benefits from agriculture to the environment. Dr. P.K. Joshi, Director South Asia, IFPRI elucidated on how to capture impact of technology on enhancing ecosystem services. In the workshop total 50 participants working in the field of ecosystem, conservation agriculture, climate change and sustainability participated and presented their research. Workshop was concluded with discussion on ways to enhance ecosystem services and mainstreaming in the development process.

Policy Imperative for Promoting Value Chains of Agricultural Commodities

One day workshop on "Policy Imperative for Promoting Value Chains of Agricultural Commodities in India" was jointly organized by ICAR-NIAP and Central Agricultural University (CAU), Imphal on September 5, 2018 at CAU. The workshop was inaugurated by Prof. M. Premjit Singh, Vice-Chancellor, CAU. The workshop emphasized the need to move from conventional farming to organic farming in the North-Eastern states. It was felt to investigate declining area under organic farming in NER and livestock sector should be given priority to increase farmer's income. Prioritization of technology and varieties is essential. The workshop also emphasized on regular interaction of agricultural economists in future.

Development and Institutionalization of Capacity for Forecasting of Prices of Agricultural Commodities

One day workshop on "Development and Institutionalization of Capacity for Forecasting of Prices of Agricultural Commodities" was jointly organized by ICAR-NIAP and Department of Agriculture, Cooperation & Farmers Welfare on December 27, 2018 at ICAR-NIAP. The workshop was inaugurated by Dr. T. Mohapatra, Secretary DARE and DG, ICAR in kind presence of Dr. Ashok Dalwai,

CEO, NRAA, Dr. N. S. Rathore, DDG (Agril. Education), Sh. P. K. Swain, Joint Secretary (Marketing), DAC&FW, Dr. Suresh Pal, Director, NIAP and participants from SAUs, dignitaries from Karnataka Agricultural Price Commission, ISEC Bengaluru, central government and ICAR institutes. This was launch workshop for "Market Intelligence" project attended by 12 SAUs from 11 states, officials from DMI, DAC&FW and other institutes to decide upon future course of action in the project. The regionally important crops were selected to forecast pre-sowing and pre-harvest prices.

Development of Hill Agriculture: Policy and Institutional Imperative

ICAR- NIAP and SKUAST-K convened a national seminar on "Development of Hill Agriculture: Policy and Institutional Imperative" at SKUAST, Srinagar on October 1, 2018. The seminar was inaugurated by Prof. Abhijit Sen, Former Member, Planning Commission in the kind presence of Dr. A. K. Singh Deputy Director General (Horticulture & Crop Science), Prof. Nazeer Ahmed, Vice Chancellor, SKUAST, Dr. Suresh Pal, Director, ICAR-NIAP and other dignitaries from SAUs, State government and ICAR institutes. It was observed that agriculture in Himalayas is a less profitable venture. However, endeavor supported by the technology and isolated success stories of progressive farmers is a way forward. In agriculture, collective action with a location specific technology and social integration is needed.

Global Food Policy Report

Discussion on Global Food Policy Report 2018, IFPRI was organized on May 3, 2018. The discussion was chaired by Dr. T. Mohapatra, Secretary (DARE) and DG (ICAR) and was attended by all DGGs, other senior officials from ICAR, NIAP and IFPRI.

Training Programmes Organized

Induction-Level Trainings of Indian Economic Services Officers

Two one-week induction-level trainings of the Indian Economic Services (IES) Officers on "Core Issues in the Agricultural Sector" were organized during June 11-15, 2018 and December 31, 2018 to January 4, 2019. The trainings were sponsored by Ministry of Finance, Government of India, to orient the inducted IES Officers about the current agricultural environment in the country. 15 IES officers participated in the training conducted during June 11-15, 2018. While inaugurating the programme, Dr. A K Srivastava, Chairman, ASRB highlighted the role of diversification to address the issue of undernourishment and malnourishment in India. Dr. Suresh Pal briefed about the training programme. Total twenty-seven sessions were organized in the training programme, which included two visits to Agricultural Museum and Gene Bank,

Induction-level training on "Core Issues in the Agricultural Sector" during June 11-15, 2018 and December 31, 2018 to January 4, 2019

NBPGR. The themes of the sessions included wide varieties like agricultural input policies, price policies, climate vulnerability, sustainable agriculture, technology commercialization, IPR issues, marketing and value chain, sub-sector specific issues of livestock, dairy, fishery, etc. The intensive feedback was also taken from the participants. Dr. A. K. Singh, DDG, Agricultural Extension and Director, IARI was the chief guest during the valedictory session of the training.

The training conducted during December 31, 2018 to January 4, 2019 was attended by eight IES officers belonging to NITI Aayog, Department of Economic Affairs, Ministry of Coal, Ministry of Labour and Employment, Department of Land Resources, Ministry of Statistics and Programme Implementation and Labour Bureau. Twenty-six sessions were organized during training programme, which included lectures as well as field visits. Prof Ramesh Chand, Member, NITI Aayog inaugurated the training and deliberated on recent policy issues related to agriculture.

Teaching and Research Guidance to Students

Table 3.1. Teaching activities at PG school, ICAR-Indian Agricultural Research Institute

Name of the Scientist	Course Name	Credit hours	Course Leader/ Associate	Division
Rajni Jain	Artificial Intelligence	2L+1P (30)	Leader	Computer Application
	Rough Set & Fuzzy Set	2L+1P (20)	Associate	Computer Application
Nalini Ranjan Kumar	Macroeconomics I	3L+1P (8)	Associate	Agricultural Economics
	Macroeconomics II	3L+1P (9)	Associate	Agricultural Economics
Naveen P. Singh	Marketing Management	3L+1P (18)	Leader	Agricultural Economics
Shiv Kumar	International Trade	3L (18)	Leader	Agricultural Economics
	Fundamentals of Business Management	3L+1P (20)	Leader	Agricultural Economics
Kingsly Immanuelraj	Agricultural Price Analysis	2L+1P (15)	Leader	Agricultural Economics
	Agricultural Production and Resource Economics I	2L+1P (2)	Associate	Agricultural Economics
	Agricultural Production and Resource Economics II	2L+1P (15)	Associate	Agricultural Economics
	Agricultural Production and Resource Economics IV	2L+1P (5)	Associate	Agricultural Economics
Vinayak Nikam	Fundamentals of Management in Extension	2L+1P (4)	Associate	Agricultural Extension
	Advance Management Techniques	2L+1P (12)	Associate	Agricultural Extension
	Organizational Behaviour	2L+1P (12)	Associate	Agricultural Extension

Note : Figures within parentheses indicate number of lecturers delivered

Table 3.2. Guidance to post graduate students of PG School, IARI, New Delhi

Scientist	Student	Role in Advisory Committee	Thesis topic
Suresh Pal	Nithyashree, M.L., Ph.D (Agricultural Economics), ICAR-IARI	Chairman	Investment and development of food processing industry in India
Rajni Jain	Sreekumar Biswas, Ph.D (Computer Application), ICAR-IASRI	Chairperson	Document categorization using text mining in agricultural domain
	Kamalika Nath, Ph.D (Computer Application), ICAR-IASRI	Chairperson	Evolutionary algorithms for optimization of crop plan
	Sapna Nigam, Ph.D (Computer Application), ICAR-IASRI	Chairperson	Development of deep learning model for identification of major wheat diseases
Nalini Ranjan Kumar	Thrilok Belli BM, M.Sc (Agricultural Economics) ICAR-IARI	Chairman	Impact of custom hiring services on farm mechanization in Indian agriculture
Shiv Kumar	Chikkathimme Gowda, Ph.D (Agricultural Economics), ICAR-IARI	Chairman	An economic analysis of value chain of cumin (*Cuminum cyminum* L.) in India
	Neelakantappa P., M.Sc (Agricultural Economics), ICAR-IARI	Chairman	Contractual arrangements for potato in Gujarat: An economic investigation
	Kiran Kumara T.M., Ph.D (Agricultural Economics), ICAR-IARI	Chairman	Economic assessment of community based tank irrigation systems in rainfed region of Andhra Pradesh
Naveen P Singh	S Ujjwala Rani, Ph.D (Agricultural Economics), ICAR-IARI	Chairman	An economic evaluation of climate change on agricultural productivity in semi arid agro ecological region
	Jobin Sebastian, Ph.D (Agricultural Economics), ICAR-IARI	Chairman	Impact of climate change on rice based cropping system in east coast plains: An analysis in the coastal zones of Andhra Pradesh
	Philip Kuriachen, Ph.D (Agricultural Economics), ICAR-IARI	Chairman	An economic analysis of impacts and adaptation strategies in Bundhelkand region of central India
	Niranjan Sivalingam, Ph.D (Agricultural Economics), ICAR-IARI	Chairman	Climate change impact and resilience analysis

CHAPTER 4

- Icar-Niap: An Overview
- Significant Research Achievements
- Capacity Building
- **Policy Interactions**
- Research Output
- Awards and Recognitions
- Participation in Scientific Activities
- Management Committee Meetings
- Other Institute Activities
- Personnel and Budget

Number of Policy Interface of National Importance: 12

As a knowledge partner to DAC & FW, ICAR-NIAP is providing the policy and technical inputs to the inter-ministerial committee on Doubling Farmers' Income (DFI). ICAR-NIAP provided technical inputs in preparation of DFI strategies and also facilitated the implementation of DFI strategies. The Institute has also facilitated finalization of framework for Ease of Doing Agriculture across states. Specific case studies on examining the income enhancement options and penetration of policy reforms at the disaggregated level are being undertaken in disadvantaged areas. The final report of DFI committee got approval in October, 2018. Parallel action to implement various recommendations has started since the establishment of the DFI committee.

- As a representative of DARE/ICAR, ICAR-NIAP regularly participates and provides inputs to Inter-Ministerial Committee (IMC) constituted by Department of Consumers Affairs, Ministry of Consumers Affairs, Food and Public Distribution to review prices of essential commodities and agricultural scenario in the country. The Committee comprises representatives of consumers affairs and other departments of different ministries besides special invitees, viz. FCI, SFAC, Food and Supply Department of Delhi, NAFED, Mother Dairy etc. The Committee reviews the prices on weekly basis under the Chairmanship of the Secretary, Consumers Affairs/Senior Economic Advisor (CA) at Krishi Bhawan.
- Policy inputs to the Reserve Bank of India, Mumbai on "The developments in horticultural production and prices in India" (27 September) for monetary stability in terms of control on prices of tomato, onion and potato (TOP), which has emerged as an important issue having implications for food price inflation in India. Discussion held on the supply scenario of onion and potato, marketing & trade dimensions, policies and their implications on prices. Various interventions for correcting the price shocks were also discussed.
- The NITI Aayog has undertaken an exercise to develop a framework for rating and ranking of R&D labs. ICAR-NIAP represented ICAR and contributed to the development of framework and inputs have been provided on assessment of socio-economic impact. This framework

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is being implemented by the Office of Principal Scientific Advisor to the Government of India and NIAP will be the part of the process.

- ICAR-NIAP provided policy input on various aspects on agricultural market reforms. This includes revision of the APLM and Contract Farming Model Acts. The input was also provided on development of agro-processing clusters and new approaches of ensuring MSP to farmers.
- New export policy is in place. NIAP represented ICAR in formulation of the policy which is being implemented by the Department of Commerce.
- The DAC&FW is undertaking a major program to institutionalize the capacity for development of market information and price forecasting system. NIAP is a knowledge-partner of DAC&FW and shall develop the mechanism for price forecasting and development of AI platform.
- The outcome review of ICAR is under progress and NIAP is facilitating this exercise. Information on significant research outputs and their outcomes were compiled by NIAP and submitted to the Committee for finalization of the report.
- ICAR-NIAP provided inputs to the State Planning Board, Government of Chhattisgarh, on improving efficiency, equity and sustainability of alternative extension systems in the state.
- Deliberations with various stakeholders for improving contents and modalities for the implementation of Situation Analysis of Farm Households, Indebtedness and Livestock Survey of NSSO.
- ICAR-NIAP contributed to the National Academy of Agricultural Sciences (NAAS) in developing framework for ranking of ICAR research institutes. The institute facilitated in finalizing impact indicators and quantifying the performance of ICAR institutes.
- Director, ICAR-NIAP delivered two lectures on recent developments in Indian agriculture in a Special Seminar on agriculture organized under Speakers' Research Initiative (SRI). The seminar was chaired by Hon'ble Speaker of Lokshabha and attended by Hon'ble Members of Parliament.

At the National Conference on Doubling Farmers Income organized by DAC&FW

CHAPTER 5

- Icar-Niap: An Overview
- Significant Research Achievements
- Capacity Building
- Policy Interactions
- **Research Output**
- Awards and Recognitions
- Participation in Scientific Activities
- Management Committee Meetings
- Other Institute Activities
- Personnel and Budget

Edited Books	: 2
Peer Reviewed Research Articles	: 40
Abstracts/Conference Proceedings	: 22
Popular Articles	: 9
Book Chapters	: 8
News Paper Articles	: 8

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Kumar, S., Jhajhria, A. and Kingsly, I.T. (2019) Use of artificial intelligence in market intelligence system. Indian Farming: 69(03): 32-37.

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Paul, R., Arya, P. and Kumar, S. (2019) Use of artificial intelligence in statistical research. Indian Farming, 69(03): 28-31.

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Singh, N.P. (2019) Farm loan waivers-how to nip it in the bud. Economic Times, New Delhi, January 07.

Singh, N.P. and Anand, B. (2018) Farming in a warming world. The Hindu, New Delhi, December 15.

Singh, N.P. and Ranjith, P.C. (2018) Artificial intelligence is a game changer in agriculture. Financial Express, New Delhi, November 14.

Singh, N.P. and Bhawna, A. (2018) How to get the MSP vision to work. Financial Express, New Delhi, October 16.

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CHAPTER 6

- ICAR-NIAP: An Overview
- Significant Research Achievements
- Capacity Building
- Policy Interactions
- Research Output
- **Awards and Recognitions**
- Participation in Scientific Activities
- Management Committee Meetings
- Other Institute Activities
- Personnel and Budget

Membership in Committees/ Working Groups of National Importance	**: 14**
Number of Citation during 2018	**: 846**
Number of Awards	**: 8**

Suresh Pal

- Member, Committee for providing specific views/memorandum on all issues related to DARE/ICAR to the 15th Finance Commission, constituted by Secretary DARE & DG, ICAR.
- Member, Technical Committee on Market Intelligence (Supply Management, Price and Demand Forecasting).
- Member, Inter-Ministerial Committee for recommending strategy for doubling farmers' income, DAC&FW.
- Member, Committee for Agricultural Policies and Action Plans for a Secure and Sustainable Agriculture, constituted by Principal Scientific Advisor to the Government of India.
- Member, Core-Committee to prepare policy document on futuristic crop planning for 2030/2050.
- Member, Committee on the need for convergence to strengthen post-harvest and marketing infrastructure, DAC&FW and Warehousing Development and Regulatory Authority (WDRA).
- Member, Committee on the Model Contract Farming Act to examine the existing provisions of contract farming in various states and Union Territories and draft a template for model Contract Farming Act.
- Member Secretary, to undertake an outcome review of various schemes of ICAR for XII Plan Period, constituted by Hon'ble Agriculture Minister, MoA&FW.
- Member, Committee to study and suggest implementation plan for the recommendations made by the High Powered Committee constituted by the Govt. to review the structure and function of ICAR.
- Member, Committee to recommend the maximum sale price of Bt cotton seed for the year 2016-17.
- ICAR representative as Member of Task Force to prepare the framework with specific indicators to rank the scientific laboratories/ institutions.
- ICAR nominee for Committee constituted by Department of Science and Technology to review policy research centres.
- Theme Convenor, Panel Discussion in XIV Agricultural Science Congress at NASC, New Delhi.
- Member, Editorial Board of the Indian Journal of Agricultural Sciences
- Member, Committee to look into monetary ceiling of stationary items and to recommend revised ceiling for stationary required for high level conference
- Secretary, Agricultural Economics Research Association
- Member, Programme committee, Indian Society of Agricultural Economics
- Number of citation during 2018: 98.

PS Birthal

- Chairman, NSSO Working Group on Situational Analysis of Farm Households, Indebtedness and Livestock holdings, Ministry of Statistics and Program Implementation, Government of India.
- Member, Standing Working Group on revamping agricultural extension system, State Planning Board, Government of Chhattisgarh.
- Member, External Research Committee, National Bank for Agriculture and Rural Development, Mumbai.
- Chairman, Evaluation Committee of Technical Proposals of the M&E Consultancy for NAHEP, ICAR.
- Chief Editor, Agricultural Economics Research Review.
- Member, Editorial Board, SAARC Journal

of Agriculture.

- Member, Sectional Committee (Social Sciences), National Academy of Agricultural Sciences for selection of Fellows and Associate Fellows.
- Member, Quinquennial Review Team, Indian Institute of Rice Research, Hyderabad.
- Member, Quinquennial Review Team, Central Sheep and Wool Research Institute, Avikanagar.
- Member, Research Advisory Committee, Directorate of Weed Research 2015-18.
- Member, Research Advisory Committee, National Dairy Research Institute, 2016-18.
- Member, Research Advisory Committee, Indian Veterinary Research Institute, 2017-2020.
- Number of citation during 2018: 400.

Usha Ahuja

- Member, Core Group of the committee of the National Academy of Agricultural Sciences to develop a framework for ranking of the ICAR institutes.
- Number of citation during 2018: 6.

Nalini Ranjan Kumar

- Member, Editorial Board, Potato Journal, a Journal of Indian Potato Association, ICAR-CPRI, Shimla.
- Number of citation during 2018: 45.

Rajni Jain

- D.K. Desai Prize for the year 2017 by Indian Society of Agricultural Economics for the paper entitled "Total factor productivity growth in Indian crop sector".
- Member, Institute Member Committee, IASRI, 2018-19.
- Chairperson, Convener and Technical Programme Committee Member of special session on ICT applications in agriculture and social sciences, organised by Asian Federation of Information Technology in Agriculture (AFITA), at IIT Mumbai during 24-26 October 2018.
- Member, Executive Committee, Indian Society of Agricultural Information Technology (INSAIT), 2018-19.
- Evaluator, Mentor and Jury Member, ICAR Representative, Smart India Hackathon, 2019, organised by Ministry of Human Resource and Development at "Sri Sivasubramaniya Nadar College of Engineering, Chennai, Tamil Nadu, 2-3 March, 2019.
- Lead speaker in National Conference on Strategic Approaches for Developing World Class Agricultural Universities, ANGARU, Bapatla, 19-20 March 2019.
- Rapporteur, Session on current status of IT research activities in NARS and scope of emerging ICTs, National Consultation on ICT in Agriculture.
- Number of citation during 2018: 18.

Subhash Chand

- Chairman, Committee for selection of RAs and SRFs under DST project at NISTAD, New Delhi.
- Member, Final project review committee on reduction of atmospheric CO_2 over Delhi through non-disruptive and sustainable carbon sequestration: System design and proof of concept, NISTAD, Delhi.
- Subject matter expert invited by CAU, Pusa, Bihar for screening of applications for the selection of assistant professor.
- Interview board member for selection of agriculture field officers at CAU, Samastipur, Bihar.
- Nominee of Hon'ble Governor UP as expert for selection/CAS promotion process at Sardar Vallabhbhai Patel University of

Agriculture & Technology, Modipuram.

- Member, DPC for ARS Scientist, ICAR-NIAP, New Delhi, December 5, 2018.
- Number of citation during 2018: 13.

Sant Kumar

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

Naveen P Singh

- Member, Editorial Board, Agriculture Economics Research Review.
- Member, Editorial Board, Weather and Climate Extremes, Elsevier.
- Member, Indian Society of Agricultural Economics.
- Member, Editorial Board, Journal of Atmospheric Science Research.
- Member, FICCI Committee on commodity markets.
- Member, Institute Management Committee, ICAR-NIASM, Baramati.
- Member, Institute Management Committee, ICAR-IIMR, Ludhiana.
- Member, DPC for ARS Scientists at ICAR-CTRI, Rajahmundry, Andhra Pradesh.
- Member, DPC for ARS Scientists at ICAR-NIASM, Baramati, Pune.
- Member, DPC for ARS Scientist at ICAR-NRCSS, Ajmer.
- Member, DPC for ARS Scientist at ICAR-IIVR, Varanasi.
- Course Director, training on core issues in agricultural sector to Officials of Indian Economic Services (June 11-15, 2018).
- Member, committee for evaluation of quality attributes of non-IF journals received in the academy for assigning NAAS Score (2019).
- Number of citation during 2018: 108.

Shiv Kumar

- Associate Editor, Agricultural Research (NAAS, New Delhi).
- Reviewer, Water Economics and Policy.
- Number of citation during 2018: 59.

Raka Saxena

- Co-Chairperson, Session on issues, constraints and strategies for farm women in agriculture in "Mahila Kisan Diwas" celebrated by the Department of Agriculture, Cooperation & Farmers Welfare, New Delhi.
- Participant in the Parliament Committee meeting.
- Invited speaker at the Reserve Bank of India, Mumbai for a session on the developments in horticultural production and prices in India.
- Joint Secretary, Agricultural Economics Research Association, New Delhi.
- Member, Editorial Board, Agriculture Economics Research Review.
- Course Director, IES training (December 31, 2018 to January 4 2019) on core issues in agricultural sector.
- Reviewer, Agricultural Research Journal.
- Reviewer, Agricultural Economics Research Review Journal.
- Reviewer, Journal of Dairy Research.
- Reviewer, Indian Journal of Animal Nutrition.
- Chief Guest, Green Gold Programme in Kulachi Hansraj Model School (KKMS), Ashok Vihar for environmental awareness of school children.
- Number of citation during 2018: 49.

Prem Chand

- Expert Member of Selection Committee for the post of Technical Assistant/Field Supervisor at JNKVV Jabalpur.
- Number of citation during 2018: 9.

Vinayak Nikam

- Young Scientist Award by Society of Extension Education, Agra.
- Young Scientist Award by Indian Society of Extension Education, IARI, New Delhi.
- Number of citation during 2018: 6.

Jaya Jumrani

- Dr. R.T. Doshi Award 2017 for best research article published in Agricultural Economics Research Review.
- Number of citation during 2018: 6.

Balaji SJ

- Dr. R.T. Doshi Foundation Award for the best paper presentation (2nd position) at the 26th Annual Conference of the Agricultural Economics Research Association (India) at ICAR-National Dairy Research Institute, Karnal, Haryana during 15th-17th November, 2018.
- Recipient of grant under Uma Lele AERA India/AAEA Mentorship Program-2018 for research collaboration with the International Food Policy Research Institute, Washington DC.
- Panellist, for discussion on inclusive growth in agriculture at 14th Agricultural Science Congress (February 20-23), New Delhi.
- Number of citation during 2018: 26

Prabhat Kishore

- Dr. N. A. Majumdar award by Indian Society of Agricultural Economics for research paper entitled "Does APMC market increase farmer's income? Evidence from value chain analysis of sweet potato in Karnataka, India".

Subash SP

- Dr. N.A. Mujumdar Award for the best paper presented at the 78th Annual Conference of Indian Society of Agricultural Economics held in Delhi during November 1-3rd 2018.
- Reviewer, Journal of Agricultural Education and Extension.
- Number of citation during 2018: 3.

CHAPTER 7

- ICAR-NIAP: An Overview
- Significant Research Achievements
- Capacity Building
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- Research Output
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- **Participation in Scientific Activities**
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- Other Institute Activities
- Personnel and Budget

Table 7.1. Lectures delivered by ICAR-NIAP Scientists

Name of the Scientist	Topic	Venue and date
Suresh Pal	Sustainable agriculture and doubling famers income to ensure healthy food for all: SDG 2 roadmap framework	India Habitat Centre, New Delhi, May 08, 2018
	International agricultural trade and free trade agreements	Mascot Hotel, Thiruvananthapuram, Kerala, June 26, 2018
	Sustainable development goals	India Habitat Centre, New Delhi, August 07, 2018
	Development of arid agriculture	ICAR-CAZRI, Jodhpur, February 14, 2019
PS Birthal	Livestock and poverty	ICAR-Indian Veterinary Research Institute, Bareilly, September 06, 2018
	Issues and challenges for Indian agriculture	Indian Institute of Foreign Trade, New Delhi, October 11, 2018
	From food security to farmers' prosperity: Challenges, prospects and way forward	Indian Society of Agricultural Economics, New Delhi, November 01, 2018
	Impact of climate change on pig production: Policy requirements	ICAR-National Research Centre on Pig, Guwahati, November 20, 2018
	Sources of growth in agriculture in Southeast Asia	Phnom Penh, Cambodia, December 13, 2018
	Accelerating agricultural growth	VIT, Vellore, December 27, 2018
Nalini Ranjan Kumar	Theories of international trade	ICAR-CIFE, Mumbai, November 03, 2018
	Farm mechanization in Indian agriculture-Trends, challenges and initiatives	ICAR-NIAP, New Delhi, June 12, 2018 and January 03, 2019
Rajni Jain	Rough sets and its applications	BVICAM, New Delhi, April 15, 2018
	Regional crop planning for sustainable agriculture	ICAR-NIAP, New Delhi, June 14, 2018
	Optimum crop planning, A case study of Punjab	ICAR-IARI, New Delhi, July 19, 2018
	Country paper on irrigations in India: Status, challenges and options	Colombo, Sri Lanka, July 24, 2018
	Data pre-processing techniques	ICAR-IASRI, New Delhi, September 13, 2018
	Decision tree induction	ICAR-IASRI, New Delhi, September 13, 2018
	Association rule mining	ICAR-IASRI. New Delhi, September 13, 2018

	Mobile applications, transforming Indian agriculture	IIT Mumbai, October 24, 2018
	Regional crop planning	ICAR-NIAP, New Delhi, January 01, 2019
	Use of ICT for assessing quality in teaching and research	ANGARU, Bapatla, March 19, 2019
Subhash Chand	Irrigation development in India: Policy and institutions	ICAR-NIAP, New Delhi, June 14, 2018
	Water financing and water economics for the different states in India	National Water Mission, Pune, Govt. of India, September 14, 2018
	Watershed programmes & policies: Impact on Indian agriculture	ICAR-NIAP, New Delhi, January 01, 2019
Sant Kumar	Impact of agricultural research	ICAR-NIAP, New Delhi, January 01, 2019
Naveen P Singh	Climate change, agriculture and ecosystem services	ICAR-NIAP, New Delhi, May 29, 2018
	Vulnerability to climate change: Adaptation strategies and layers of resilience	ICAR-NIAP, New Delhi, June 13, 2018
	Agronomy education, training, technology and enabling policies to support income generating activities	MPUA&T, Udaipur, October 26, 2018
	Sustainable cold chains in doubling farmer income	Imperial Hotel, New Delhi, December 12, 2018
	Linking farmers to markets	Pusa, Krishi Vigyan Mela-2019, March 06, 2019
Shiv Kumar	Farmer producer organization (FPO): Formation and functioning	ICAR-IARI, New Delhi, January 11, 2018
	Value chains in agricultural commodities in India	ICAR-NIAP, New Delhi, June, 2018
	Contract farming in India	ICAR-IARI, New Delhi, July 16, 2018
	Food value chains	ICAR-NIAP, New Delhi, January 02, 2019
	Temporal and spatial dynamics of total factor productivity in field crops in India: A stochastic frontier approach	ICAR-CSSRI, Karnal, February 09, 2019
Raka Saxena	Agricultural schemes in the context of doubling farmers income	LINACRD- NCDC, Gurugram, June 01, 2018
	The developments in horticultural production and prices in India	Reserve Bank of India, Mumbai, September 27, 2018
	Doubling the farmer income through value chain integration	CCS National Institute of Agricultural Marketing, Jaipur, October 5, 2018

	Doubling farmers' income	Giri Institute of Development Studies, Lucknow, October 29, 2018
	Role of marketing and prices in doubling of farmers' income	ICAR-NIAP, New Delhi, June 11, 2018 and December 31, 2018
	Doubling farmers' income: Concepts and strategies	ICAR-IARI, New Delhi, January 17, 2019
	Marketing policies for promotion of pearl millet	ICAR-IARI, New Delhi, March 16, 2019
Prem Chand	Sustainability issues in agriculture	ICAR-NIAP, New Delhi, January 01, 2019
Arathy Ashok	Agricultural extension system in India	ICAR-NIAP, New Delhi, January 01, 2019
Kingsly Immanuelraj	Agri-commodity outlook and price modelling methods and applications	ICAR-NIAP, New Delhi, June 15, 2018
	Emerging issues in markets, institutions and resource use planning for sustainable agriculture	ICAR-IARI, New Delhi, July 19, 2018
Vinayak Nikam	Agriculture and extension policies in India, their role in amelioration of nutrition problem	ICAR- IARI, New Delhi, September 07, 2018
	Country paper on extension system in India	Colombo, Sri Lanka, September 21, 2018
	Farmers innovations: Case analysis	ICAR-NIAP New Delhi, January 04, 2019
Jaya Jumrani	Food and nutritional security in India	ICAR-NIAP, New Delhi, June 12, 2018 and January 03, 2019
Balaji SJ	Tracing structural breaks in time-series data	ICAR-IARI, New Delhi, July 28, 2018
	Structural transformation and policy reforms in agriculture	ICAR-NIAP, New Delhi, December 31, 2018
Abimanyu Jhajhria	Approach towards horticulture development	ICAR-NIAP, New Delhi, January 02, 2019
Prabhat Kishore	Direct benefit transfer	ICAR-NIAP, New Delhi, January 01, 2019
Subash SP	Multivalued treatment effect model	ICAR-IARI, New Delhi, July 23, 2018
	Social network analysis	ICAR-NAARM, Hyderabad, September 26, 2018
	Technology foresight in agriculture	ICAR-NIAP, New Delhi, January 04, 2019
	Stata basic training	Kerala Agricultural University Main campus, Kerala, March 27, 2019

Table 7.2. Training/Seminar/Conference attended

Name of the Scientist	Name of the event	Venue and duration
Suresh Pal	Round table dialogue on options and investment priorities for on serving natural resources, and addressing climate change and agricultural pollution	NASC, April 9, 2018
	Regional collaborative platform workshop for conservation agriculture sustainable intensification (CASI)	Kathmandu, Nepal, July 21-23, 2018
	30th International Conference of Agricultural Economics (ICAE 2018)	Vancouver, British Columbia, Canada, July 26 to August 04, 2018
	Regional Conference on motivating and attracting youth in agriculture (MAYA)	NASC, August 31, 2018
	Workshop of NIAP-CAU project entitled policy imperative for promoting value chains of agricultural commodities in India	CPGS, CAU, (Imphal), Umiam (Barapani), September 05, 2018
	National Seminar on development of hill agriculture policy and institutional imperative	SKUAST, Srinagar, October 01, 2018
	Conference under the auspices of Speaker's Research Initiative (SRI) on skill development for sustainable growth of organic farming in NE Region	Assam Administrative Staff College, Guwahati, October 09, 2018
	National Workshop on sustainability of Indian agriculture: Natural resources perspective with special reference to water	ICAR-IIWM, Bhubaneshwar, October 11, 2018
	Workshop on food systems dialogues	Bharat Krishak Samaj, India International Centre, New Delhi, October 25-26, 2018
	Special session on innovations in agriculture and agricultural economics research. 78th Annual Conference of the ISAE	IEG, IFPRI, TCI, November 03, 2018 NASC
	26th Annual Conference of Agricultural Economics Research Association (AERA)	ICAR-NDRI, Karnal, November 15-17, 2018
	Workshop on Sustainability of Indian Agriculture (Environment Biodiversity)	NASC Complex, New Delhi, November 26, 2018
	Workshop on Sustainability of Indian Agriculture (Socio-Economics)	NASC Complex, New Delhi, November 27, 2018

	Planning workshop on development and institutionalization of capacity for forecasting of prices of agricultural commodities	ICAR-NIAP, New Delhi, December 27, 2018
PS Birthal	30th International Conference of Agricultural Economics (ICAE)	Vancouver, Canada, July 27-August 02, 2018
	National Workshop sustaining animal food systems	ICAR-IVRI, Izatnagar, September 06, 2018
	6th International Conference on WTO, Trade and Agriculture: Issues and Challenges for Developing and Least Developed Countries	Indian Institute of Foreign Trade, New Delhi, October 11-12, 2018
	78th Annual Conference of the Indian Society of Agricultural Economics	NASC Complex, New Delhi, November 01-03, 2018
	26th Annual Conference of the Agricultural Economics Research Association	ICAR-NDRI, Karnal, November 15-17, 2018
	101st Annual Conference of the Indian Economic Association	VIT, Vellore, December 27-30, 2018
Nalini Ranjan Kumar	Discussion on global food policy report 2018	ICAR-NIAP, New Delhi, May 03, 2018
	Annual Conference of India Society of Agricultural Economics	NASC Complex, New Delhi, November 01-03, 2018
	Seminar on markets and states in India and China	ICAR-NIAP, New Delhi, November 14, 2018
	National Workshop on sustainability of Indian agriculture: Agro-biodiversity and environment and climate change perspectives	NASC Complex, New Delhi, November 26, 2018
	National Workshop on sustainability of Indian agriculture: Socio-economic perspectives	NASC Complex, New Delhi, November 27, 2018
	11th TAAS Foundation Day Lecture on Can India Achieve SDG 2 – Eliminate Hunger and Malnutrition by 2030 ? by Dr. Prabhu Pingali	ICAR-IARI, New Delhi, January 24, 2019
Rajni Jain	Workshop on innovative technologies for increasing agricultural water organised by APO	Colombo, Sri Lanka, July 23-27 2018
	National Workshop on artificial intelligence (AI) in agriculture: Status and prospects	NAAS, New Delhi, July 30-31, 2018

	International Conference on research frontiers in precision agriculture, organised by Asian Federation for Information Technology in Agriculture and Indian Society of Agricultural Information Technology	IIT Mumbai, October 24-26, 2018
	National Conference on strategic approaches for developing world class agricultural universities	Dr. NTR College of Agril. Engineering Bapatla, March 19-20, 2019
Subhash Chand	International conference on agribusiness in developing and emerging economies organized by TERI	TERI, Delhi, January 03-04, 2018
	National seminar on agriculture and eco-system services	ICAR-NIAP, New Delhi, May 28-29, 2018
	Global water security Conference for agriculture and NATURAL resources	Hyderabad, October 03-06, 2018
	26th AERA conference on agriculture and sustainable development goals	ICAR-NDRI, Karnal, November 15-17, 2018
	National workshop on sustainability of Indian agriculture: Agro-biodiversity and environment	NASC Complex, New Delhi, November 26, 2018
	National workshop on sustainability of Indian agriculture: Socio-economic perspective	NASC Complex, New Delhi, November 27, 2018
	National seminar on emerging food system in south Asia: Policy challenges and opportunities	IFPRI, New Delhi, December 04, 2018
	National seminar on farmers' friendly soil and water conservation technologies for mitigating climate change impact	ICAR-IISWCRTI RC, Ooty, January 31-February 02, 2019
Sant Kumar	Workshop on precision agriculture in India –Way forward	NASC Complex, New Delhi, August 27, 2018
	National Workshop on sustainability of Indian agriculture: National resource perspectives with special reference to soil	NASC Complex, New Delhi, September 08, 2018
	Attended 78th Annual Conference of Indian Society of Agricultural Economics (ISAE)	NASC Complex, New Delhi, November 01-03, 2018
	National Workshop on sustainability of Indian agriculture : Biodiversity perspective	NASC Complex, New Delhi, November 26, 2018
	National Workshop on sustainability of Indian agriculture: Socioeconomic perspective	NASC Complex, New Delhi, November 27, 2018

Naveen P Singh	National validation workshop on technology needs assessment	Indira Paryavaran Bhavan, New Delhi, March 09, 2018
	Workshop for revisiting foundation course for agricultural research services (FOCARS)	ICAR-NAARM, Hyderabad, March 15-16, 2018
	Policy dialogue on innovations in ensuring remunerative prices (MSP) to farmers: Challenges and strategies	NASC Complex, New Delhi, March 23, 2018
	5th meeting of GTWG- sustainable agriculture and validation workshop	NASC Complex, New Delhi, April 04-05, 2018
	National seminar on agriculture and ecosystem services	ICAR-NIAP, New Delhi, May 28-29, 2018
	Workshop on pigeonpea product design and management	ICRISAT, Hyderabad, August 14, 2018
	Workshop on sustainability of Indian agriculture	NASC Complex, New Delhi, September 08, 2018
	Seminar on global agri-connect 2018: 'Climate smart agricultural technologies and innovations: impact & way forward'	Le Méridien, New Delhi, October 12, 2018
	Symposium on emerging food system in south Asia: Policy challenges and opportunities	NASC Complex, New Delhi, December 04, 2018
Shiv Kumar	Policy dialogue on innovations in ensuring remunerative prices (MSP) to farmers: Challenges and strategies	ICAR-NIAP, New Delhi, March 23, 2018
	Seminar on social transfers and rural revitalization in India	NASC Complex, New Delhi, April 26, 2018
	Policy dialogue on small farm aggregation models in India	NASC Complex, New Delhi, August 10, 2018
	Policy dialogue on farmer producer organizations (FPOs) in India	NASC Complex, New Delhi, August 10, 2018
	Workshop on sustainability of Indian Agriculture: Natural resource perspective with special reference to soil	NASC Complex, New Delhi, September 08, 2018
	2nd India agricultural outlook forum 2018	NASC Complex, New Delhi, September 10-11, 2018

	Seminar on markets and states in India and China	ICAR-NIAP, New Delhi, November 14, 2018
	Workshop on sustainability of Indian agriculture: Agro-biodiversity and environment	NASC Complex, New Delhi, November 26, 2018
	Workshop on sustainability of Indian agriculture: Socio-economic perspective	NASC Complex, New Delhi, November 27, 2018
	Symposium on emerging food system in South Asia: Policy challenges and opportunities	NASC Complex, New Delhi,December 04, 2018
	Workshop on development of bio-fortified crops' value chains for nutritional security in South Asia	Institute of Economic Growth, Delhi, January 31, 2019
	Symposium on productivity growth with industry 4.0 standardization	FICCI, Federation House, Tansen Marg, New Delhi, March 13, 2019
	FFP group review workshop for impact assessment methodology	ATARI, Jabalpur, May 01, 2019
Raka Saxena	Policy Dialogue on innovations in ensuring remunerative prices (MSP) to farmers: Challenges and strategies	NASC Complex, New Delhi, March 23, 2018
	National Seminar on agriculture and eco-system services	ICAR-NIAP, New Delhi, May 28-29, 2018
	Workshop to discuss the parameters relating to natural resources with special reference to soil organized by ICAR-NIAP in collaboration with Indian Council of Agricultural Research	NASC Complex, New Delhi, September 08, 2018
	Agriculture and Sustainable Development Goals	ICAR-NDRI, Karnal, November 15-17, 2018
	Symposium, entitled emerging food system in South Asia: Policy challenges and opportunities as a part of Annual Board Meeting International Food Policy Research Institutes	Lecture Hall, NASC Complex, New Delhi, December 04, 2018
Prem Chand	Conference on global water security for agriculture and natural resources	Hyderabad, October 03-06, 2018
	26th Annual Conference of AERA on Agriculture and Sustainable Development Goals	ICAR-NDRI, Karnal, November 15-17, 2018

Vinayak Nikam	Regional Conference on motivating and attracting youth in agriculture	NASC Complex, New Delhi, August 30-31, 2018
	National Workshop on sustainability of Indian agriculture: Natural resource perspective with special reference to soil	NASC Complex, New Delhi, September 08, 2018
	AFITA/WCCA2018 conference on research frontiers in precision agriculture	IIT Mumbai, Maharashtra, October 24-26, 2018
	9th NEE Congress on climate smart agricultural technologies innovation and interventions	CAEPHT, Ranipool Sikkim, November 15-17, 2018
	National Workshop on sustainability of Indian agriculture: Agro-biodiversity and Environment	NASC Complex, New Delhi, November 26, 2018
	National Workshop on sustainability of Indian agriculture: Socio-economic perspective	NASC Complex, New Delhi, November 27, 2018
	ISEE National Seminar on integrated farming system for enhancing farmers income and nutritional security	WBUAFS, Kolkata, December 05-07, 2018
	Workshop on market intelligence	ICAR-NIAP, New Delhi, December 27, 2018
Jaya Jumrani	14th Annual Conference on growth and development	Indian Statistical Institute, New Delhi, December 19-21, 2018
Balaji SJ	Panel discussion on global food policy report, 2018	ICAR-NIAP, New Delhi, May 03, 2018
	National Seminar on agriculture and ecosystem services	ICAR-NIAP, New Delhi, May 28-29, 2018
	Seminar on computable general equilibrium (CGE) modelling, a tool for economic policy: achievements and new challenges	NCAER, New Delhi, October 10, 2018
	Seminar on markets and states in India and China	ICAR-NIAP, New Delhi, November 14, 2018

	26th AERA conference on agriculture and sustainable development goals	ICAR-NDRI, Karnal, November 15-17, 2018
	National workshop on sustainability of Indian agriculture: Agro-biodiversity and environment	NASC Complex, New Delhi, November 26, 2018
	National workshop on sustainability of Indian agriculture: Socio-economic perspective	NASC Complex, New Delhi, November 27, 2018
	Centenary second conference of the Indian Economic Association	Vellore Institute of Technology, Vellore, December 27-29, 2018
	Panel discussion on poverty, chronic poverty and poverty dynamics: Policy imperatives	India International Centre, New Delhi, January 23, 2019
	Workshop on productivity growth with industry 4.0 standardisation	FICCI, New Delhi, March 13, 2019
Abimanyu Jhajhria	National Seminar on agriculture and eco-system services	ICAR-NIAP, New Delhi, May 28-29, 2018
	Workshop on international agricultural trade and free trade agreements: Towards livelihood security of farmers	Thiruvanan-Thapuram, June 26-27, 2018
	Workshop on international marketing of agri-food products	Manila, Philippines, November 06-09, 2018
	Workshop on improvement of agriculture statistics	Kisan Bhawan, Panchkula, February 05-06, 2019
	CAFT training on recent advances in statistical modelling and forecasting for agricultural data analysis	ICAR-IASRI, New Delhi, February 23-March 15, 2019
Prabhat Kishore	National Conference enhancing credit flow to agriculture building strategies to fulfil 11 lakh crore disbursement targets in agriculture	FICCI, Federation House, New Delhi, April 24, 2018
	National Seminar on agriculture and ecosystem services	ICAR-NIAP, New Delhi, May 28-29, 2018
	CAFT training on emerging issues in markets, institution and resource use planning for sustainable agriculture	ICAR-IARI, New Delhi, July 12-August 01, 2018
	78th Annual Conference of Indian Society of Agricultural Economics	NASC Complex, New Delhi, November 01-03, 2018

	26th AERA Conference on agriculture and sustainable development goals	ICAR-NDRI, Karnal, November 15-17, 2018
	Workshop on sustainability of Indian agriculture: Agro-biodiversity and environment	NASC Complex, New Delhi, November 26, 2018
	Workshop on sustainability of Indian agriculture: Socio-economic perspective	NASC Complex, New Delhi, November 27, 2018
	Workshop on market intelligence	ICAR-NIAP, New Delhi, December 27, 2018
Subash SP	Conference on models for agricultural development: The experiences on farmer producer companies (FPC)	College of Kerala Agricultural University, Kerala, March 25-26, 2019
	30th International Conference of Agricultural Economics	Vancouver, Canada, July 28 – August 02, 2018
	78th Annual Conference of Indian Society of Agricultural Economics	NASC Complex, New Delhi, November 01-03, 2018
	26th Annual Conference of Agricultural Economics Research	ICAR-NDRI, Karnal, November 15-17, 2018
	4th National Conference on the Economics of Competition Law	Indian Habitat Center, New Delhi, March 01, 2019
Prem Narayan	Ek Divasiy (NRAKAS) Rajbhasha Workshop organized by ASRB, and Directorate of Knowledge Management in Agriculture	NASC, New Delhi, May 04, 2018

Participation in Other Scientific Events

Suresh Pal

- NARAKAS "Delhi Narakas Samalan" meeting, Indian Habitat Centre, New Delhi, April 18, 2018.
- Meeting with Hon'ble Minister of Agriculture and Farmers Welfare on demands in context of the farmers' situation in the country today. Minister's Committee Room, New Delhi, April 25, 2018.
- Meeting on recent trade policy measures taken by Government on agricultural commodities. Krishi Bhawan, New Delhi, May 9, 2018.
- Meeting of State Ministers, in-charge of Agricultural Marketing on Model Contract Farming Act, 2018. Vigyan Bhawan, New Delhi, May 22, 2018.
- Meeting on the development of a framework for ranking & rating of scientific institutions / laboratories. NITI Aayog, New Delhi, May 25, 2018.
- Meeting to finalize PPT on the recommendations of the working group on consumer affairs (Modi Report), Krishi Bhawan, New Delhi, June 6, 2018.
- The sitting of the Parliament Standing Committee on Agriculture. Parliament House Annexe, New Delhi, July 2, 2018.
- Release of final report by OECD and ICRIER on a study titled agricultural policies in India. India Habitat Centre, New Delhi, July 5, 2018.
- Meeting on consultation for developing the proposal on operation green. NITI Aayog and MOFPI, New Delhi, July 6, 2018.
- ICAR-CIMMYT Joint Workshop on conservation agriculture in India: Key leanings, research gaps and way forward for impact at Scale. NASC Complex, New Delhi, July 9-10, 2018.
- Discussion on Draft Punjab State Farmers Policy. India International Centre Annexe, New Delhi, July 19, 2018.
- Discussion on reorientation of all India coordinated rice improvement project. NASC Complex, New Delhi, August 17, 2018.
- 'India agricultural outlook forum 2018'. NASC Complex, Pusa, New Delhi, September 10-11, 2018.
- Meeting on Agricultural Export Policy. South Block, Prime Minister's Office (PMO), New Delhi, September 14, 2018.
- Attended Gandhi-Mandela legacy: Way forward. Research and Information System for Developing Countries (RIS), New Delhi, September 26, 2018.
- Meeting on reservation list of the investment chapter of regional comprehensive economic partnership (RCEP) agreement. North Block, New Delhi, October 12, 2018.
- Group of Officers meeting on observation/ suggestion made in Cabinet Meeting. Rashtrapati Bhawan, New Delhi, October 18, 2018.
- Discussion on the draft work plan (2018-2020) between ICAR and FAO. Krishi Bhawan, New Delhi, October 31, 2018.
- Meeting on draft framework for ranking and rating of scientific R&D Labs. NITI Aayog, New Delhi, November 28, 2018.
- Meeting on cooperative sector as a catalyst for development, NITI Aayog, New Delhi, December 20, 2018.
- Meeting with the consultative group on international agricultural research (CGIAR) centers to discuss their ongoing activities with India focus as well as their future plans. NASC Complex, New Delhi, January 24-25, 2019.
- Meeting of the Inter-Ministerial Committee (IMC) to monitor the implementation of Agriculture Export Policy. Udyog Bhawan,

New Delhi, February 7, 2019.

- Meeting to review the progress of all DFI Reports. Krishi Bhawan, New Delhi, March 18, 2019.
- Round table discussion with former Chairpersons and Members to discuss important issues including price policy facing the Indian agriculture. Krishi Bhawan, New Delhi, March 26, 2019.

PS Birthal

- Panel discussion on agricultural interventions and changes along the food value chains. Indira Gandhi Institute of Development Research, Mumbai, November 10, 2018.
- Panel discussion on ensuring inclusive and sustainable agriculture. VIT, Vellore, December 27-30, 2018.
- Discussant at seminar on subsidies and agricultural policy. Brookings India, New Delhi, January 24, 2019.
- Chaired a session on 'issues on hill agriculture' in the seminar 'development of hill agriculture: policy and institutional imperatives'. SKAUAT-K, Srinagar, October 01, 2018.

Rajni Jain

- Review meeting of the networking project on resource use planning for sustainability, BHU, Varanasi, July 29-30, 2018.
- National consultation on ICT in agriculture. NAAS Complex, New Delhi, March 6, 2019.

Sant Kumar

- 11th Dayanatha Jha Memorial Lecture on Centrality of Science and Prioritization of Agricultural R&D, ICAR-NIAP, New Delhi, May 02, 2018.
- Attended Meeting on Ranking of ICAR Institutes, NASC Complex, New Delhi, June 22, 2018.
- Attended 78th Annual Conference of Indian Society of Agricultural Economics (ISAE), NASC Complex, New Delhi, November 01-03, 2018.
- Attended 14th Agriculture Science Congress, NASC Complex, New Delhi, February 20-23, 2019.
- Committee to Recommend the Maximum Sale Price (MSP) of Bt Cotton Seed for year 2019-20, Krishi Bhawan, New Delhi, February 27, 2019.

Naveen P Singh

- Attended 11th IMC meeting of ICAR-IIMR, Ludhiana, March 18, 2019.
- Conducted the comprehensive exam at ICAR-NDRI, Karnal, December 13, 2018.
- Brainstorming meeting to identify new areas of researchable technologies with respect to agricultural engineering. NASC Complex, New Delhi, June 18, 2018.
- Meeting of ICAR outcome review committee, Krishi Bhawan, April 3, 2018.

Shiv Kumar

- Regularly attended Inter-Ministerial Committee constituted by Department of Consumer Affairs to monitor prices of essential commodities.
- Worked in the Committee for providing specific views/memorandum on issues related to DARE/ICAR to the Fifteenth Finance Commission.
- Represented ICAR-NIAP in the meeting of state Ministers, In-Charge of Agricultural Marketing on Modal Contract farming Act 2018 on April 27, 2018 at Krishi Bhawan, New Delhi.
- Contributed in preparation of document for Parliament on Outcome Budget (OB) 2019-20 for ICAR/DARE, October 25, 2018.
- Revised the course curricula of course ECONOMETRICS (STAT 572) of PG and

PhD degrees in agriculture for Sate Agricultural Universities as member of Broad Subject Matter Area (BSMA) Committees formed at the Council level for various subjects.

Prem Chand

- Participated in multi-country observational study mission on 'smart rice farming'. Tokyo, Japan, June 4-9, 2018.
- Attended TAAS Foundation Day Lecture on 'can India achieve SDG 2 – Eliminate hunger and malnutrition by 2030' by Dr. Prabhu Pingali. IARI New Delhi, January 24, 2019.
- Attended 4th edition of India Industry Water Conclave. FICCI, New Delhi, November 1-2, 2018.
- Participated and panellist in brainstorming session on 'present scenario and future roadmap for improvement in oilseeds production of U.P. in the context of doubling farmer's income'. U. P. Council of Agricultural Research, Lucknow and Rajya Krishi Utpadan Mandi Parishad, Uttar Pradesh, July 16, 2018.

Participation in TV/Radio talk

Suresh Pal

- DD Kisan, Sugar Economy, June 29, 2018
- DD Kisan, MSP, July 6, 2018
- DD News, MSP, July 7, 2018
- DD News, PM Asha, September 12, 2018
- DD News, Sugar Policy, January 22, 2019
- DD Kisan, *Vaad-Samvad*, PM ASHA, January 23, 2019
- DD Kisan, Interim Budget, January 30, 2019
- DD News, Interim Budget, February 5, 2019
- DD News, PM Kisan, February 22, 2019

Rajni Jain

- Niyojit Bhumi Upyog Se Badhta Munafa, Vad-Samvad, DD Kisan, 17 November, 2018
- Jaise Sandadhan Vaisi Kheti, Vichar Vimarsh, DD Kisan, 24 August, 2018

Subhash Chand

- Delivered a radio talk on Importance of micro irrigation in rainfed areas of Maharashtra. 11/09/2018 6.15pm.

Table 7.3. Visits abroad

Name	Nature of visit	Place and duration
Suresh Pal	Participated in the Regional Collaborative Platform Workshop for "Conservation Agriculture Sustainable Intensification (CASI)"	Kathmandu, Nepal, July 21 -23, 2018
	Participated in 30th International Conference of Agricultural Economics (ICAE 2018)	Vancouver, British Columbia, Canada, July 26 - August 4, 2018
PS Birthal	Participated in 30th International Conference of Agricultural Economics (ICAE) of International Association of Agricultural Economists (IAAE)	Vancouver, Canada, July 27-August 2, 2018
	Participated in the regional policy forum on agricultural transformation and market integration in the ASEAN region: Responding to food security and inclusiveness concerns, organized by the International Food Policy Research Institute (IFPRI) in partnership with the Southeast Asian Regional Center for Graduate Study and Research in Agriculture (EASRCA) and International Fund for Agriculture Development (IFAD)	Phnom Penh, Cambodia, December 13-14, 2018
Naveen P Singh	Discussant at partners meeting on foresight for sustainable food systems in the eastern gangetic plains organised by IFPRI-ACIAR	Kathmandu, Nepal, September 27, 2018
Prem Chand	Participated in multi-country observational study mission on 'Smart rice farming'	Tokyo, Japan, June 4-9, 2018
Subash SP	Participated in 30th ICAE of IAAE	Vancouver, Canada, July 28 - August 2, 2018
Abimanyu Jhajhria	Participated in workshop on international marketing of agrifood products sponsored by Asian Productivity Organisation (APO), Tokyo, Japan	Development Academy of the Philippines, Manila, Philippines November 6-9, 2018
Vinayak Nikam	Participated in the international workshop on smart agriculture extension models	Colombo, Sri Lanka, September 17-21, 2018
Rajni Jain	Participated in workshop on innovative technologies for increasing agricultural water productivity sponsored by APO	Colombo, Sri Lanka, July 23-27, 218

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Research Advisory Committee (RAC)

The present RAC is constituted by ICAR for the three years from June 21, 2017 with the composition as given in table 8.1. The Second meeting of IX Research Advisory Committee (RAC) of ICAR-NIAP was held on December 15, 2018 at ICAR-NIAP under the Chairmanship of Prof. Abhijit Sen, Former Member, Planning Commission and President, Indian Society of Agricultural Economics.

Table 8.1. Research Advisory Committee of the ICAR-NIAP till June 20, 2020

Prof. Abhijit Sen Former Member Planning Commission, New Delhi	Chairman
Dr. A. K. Singh Former Director Giri Institute of Development Studies, Lucknow	Member
Prof. Shashanka Bhide Director Madras Institute of Development Studies, Chennai	Member
Dr. P N Mathur Former ADG (Ext.) ICAR, New Delhi	Member
Dr. P. K. Joshi Director, South Asia IFPRI, New Delhi	Member
Prof. Srijit Mishra Director Nabakrushna Choudhury Centre for Development Studies, Bhubaneshwar	Member
Mr. Sanjay Kumar S/o Lt. Sh. Mahender Singh Badarpur, New Delhi	Member
Mr. Jeet Ram Solanki Ex. MLA Pooth Kalan, Delhi	Member
Dr. Suresh Pal Director ICAR-NIAP, New Delhi	Member (Ex-officio)
Assistant Director General (EQR) Agril. Education Division ICAR, New Delhi	Member (Ex-officio)
Dr. Usha Ahuja Principal Scientist ICAR-NIAP, New Delhi	Member- Secretary

The committee deliberated on research progress of the institute and the Action Taken Report of previous RAC's recommendations. The RAC advised to upscale the research on sustainable agriculture and frontier technologies in network mode. Other recommendations on research work were to focus on infrastructure, efficiency and institutions for strengthening of value chains, prospective issues on 'doubling farmers income' by taking cognizance of micro studies conducted by different institutions, diversification and transformation of agro-processing sector, and emphasize sub-sectors of agriculture and allied activities in research portfolio. Frequent organisation of workshops with stakeholders and enhancing cadre strength of the institute were other recommendations of the RAC.

Institute Management Committee (IMC)

The present IMC was constituted on February 1, 2017 for the three years with the composition as given in table 8.2.

Table 8.2. Institute Management Committee of the ICAR-NIAP till January 31, 2020

Dr. Suresh Pal, Director ICAR-NIAP, New Delhi	Chairman
Director Directorate of Economics & Statistics, Delhi	Member
Director (Economics & Statistics) Department of Planning, Yojana Bhawan, Lucknow	Member
Dr. R.K. Grover, Director (HRM) CCS, Haryana Agricultural University, Hisar	Member
Mr. Sanjay Kumar R/o 187, Badarpur, New Delhi	Member
Mr. Jeet Ram Solanki, Ex. MLA R/o H.No. 209, Pooth Kalanm, Delhi	Member
Dr. Anil Rai, Professor and Head Centre for Agricultural Bioinformatics, IASRI, New Delhi	Member
Dr. M. Krishnan, Head ICAR-NAARM, Hyderabad	Member
Dr. Harbir Singh, Principal Scientist ICAR-IARI, New Delhi	Member
Dr. Amit Kar, Head Division of Agricultural Economics, IARI, New Delhi	Member
ADG (EQR) Education Division, ICAR, New Delhi	Member
Director (Finance) ICAR, New Delhi	Member
Ms. Neha Chandiok, Administrative Officer ICAR-NIAP, New Delhi	Member Secretary

Institute Research Council (IRC)

The Institute Research Council (IRC), chaired by Dr Suresh Pal, Director of the institute, organized three meetings on April 20-21, 2018, August 18, 2018, and January 16, 2019 to discuss progress of the on-going research projects, evaluate and approve new research proposals and other important presentations by the scientists.

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ICAR-NIAP Annual Day

The Institute celebrated its 26th Annual Day on May 2, 2018. Function was started with the lighting of lamp. Prof. Sachin Chaturvedi, Director General, Research and Information System for Developing Countries (RIS) delivered 11th Dayanatha Jha Memorial Lecture on 'Centrality of Science and Prioritization of Agricultural R&D'. It was followed by panel discussion on agricultural inputs markets. The events ended with the cultural programme by children and family members of ICAR-NIAP staff.

Academic and social functions on Annual Day of ICAR-NIAP, May 2, 2018

Promotion of Official Language

For the implementation and extensive use of Rajbhasha among the staff of the Institute, a committee on Hindi official language was constituted by Central Rajbhasha Department. The Committee monitors the progress of various actions being taken and suggests measures for implementation of official language. It coordinates and helps in executing the Council orders and circulars from Central Rajbhasha Department, annual program guidelines and submits the progress reports timely. The Institute organized the monthly staff and quarterly meeting of Rajbhasha and Hindi workshop regularly.

The Institute Rajbhasha Samiti has been implementing the guidelines, circulars and instructions issued by Council and Central Rajbhasha Department, Government of India. Name plates and stamps are also bilingual in the Institute. Every computer system of the Institute has Unicode for Hindi Typing. In *"Mera Gaon Mera Gaurav"* programme, information is disseminated in Hindi language to the farmers.

The Official language committee of NIAP organized a series of events to celebrate *"Hindi Pakhwada"* during September 14-28, 2018 to generate more awareness among the staff about the use of Hindi. The activities which

were organized during the "Hindi Pakhwada" included essay competition to develop creative writing skill on various topics and debate in Hindi along with live discussion on burning topics. The opportunity was given to Non-Hindi speakers also to present their views in Hindi on any topic of their interest. A quiz competition was also arranged for general awareness in Rajbhasha. An overwhelming response was received from NIAP employees in the said events. The Hindi Pakhwada ended with poem recitation and prize distribution.

Swachh Bharat Mission

During the year, various cleanliness activities were conducted with the launch of Swachh Bharat Campaign 'Swachhta Hi Seva' in the Institute premises. On 15.09.2018, Director, ICAR-NIAP briefed the staff with the activities to be held in Pakhwara, i.e. from 15.09.2018 to 02.10.2018. Details of the activities performed during the Pakhwara are given in Table 10.1.

Table 9.1. List of activities organized during Swachhta Pakhwara (15.09.2018 to 02.10.2018)

List of activities (suggested by M/o Drinking Water and Sanitation)	Site of activity undertaken	Period/ dates	No. of employees participated
Organize awareness campaigns around better sanitation practices like using a toilet, hand washing, health and hygiene awareness	NIAP premises	15/09/2018 24/09/2018 02/10/2018	70
Volunteer for segregation of solid waste into non-biodegradable and biodegradable waste	NIAP premises	16/09/2018	8
Organize cleaning streets, drains and back alleys through awareness drives	NIAP premises	17/09/2018 18/09/2018	60
Toilet pit-digging exercise and other toilet construction activities	NIAP premises	19/09/2018	15
Conduct door-to-door meeting to drive behaviour change with respect to sanitation behaviors	Dasghara village	20/09/2018	10
Performa Swachhata related Nukkad Nataks/street plays, folk song and dance performances	Todapur village	21/09/2018 22/09/2018 23/09/2018	25
Debate on creating awareness about the Swachhta	NIAP premises	24/09/2018	70
Conduct Village or School-level rallies to generate awareness about sanitation	Pusa school	25/09/2018	8
Mobilize community to build compost pits, where organic matter decomposes to farm manure	NIAP premises	26/09/2018 27/09/2018	56
Organize waste collection drives in households and common or shared spaces	Pusa residential	28/09/2018	24
Make wall paintings in public places on the theme of Swachhata	NIAP premises	29/09/2018 30/09/2018	5

Activities under Swachh Bharat Mission at ICAR-NIAP

Mera Gaon Mera Gaurav (MGMG)

Mera Gaon Mera Gaurav (MGMG) scheme of the Government aims at fulfilling dream of lab-to-land by regular contact of scientist with the farmers in the village. Under this scheme, three teams have been formed in the institute; 15 villages of 7 blocks from Rohtak, Palwal and Mewat district of Haryana are selected. Benchmark survey of all villages has been carried out. During 2018-19, scientists conducted Kisan Goshtis on resource use pattern in cotton cultivation; resource use efficiency in agriculture; to know problems in agriculture. During visits scientists created awareness about the benefits of soil health card, benefits of improved variety of hybrid/ Bt type and advice for cultivation, seed treatment etc. Farmers were informed about benefits of various government schemes related to soil health cards scheme, crop insurance scheme, organic farming, *Pradhan Mantri Krishi Sinchayee Yojana* etc. Scientists identified the problems like not getting compensation of loss against the premium deposited for crop insurance; not getting document /proof of crop insurance provided by the insuring agency / banks against insured crop; lack of awareness on importance of soil testing, soil health card scheme, crop insurance, increasing salinity etc. Farmers have been advised to visit Pusa Institute and buy quality seeds from National Seeds Corporation and Pusa Institute. Farmers were sensitized about organic farming as government is giving more emphasis on organic farming. Literature on organic farming and its benefit (Hindi) was made available to the farmers in village, through which farmers were made aware about benefits of organic farming and advised to start on small part of their land. To create linkages, scientists also invited KVK staff to take part in the activities. List of activities undertaken under MGMG are given in table 9.2.

Scientists interacting with the farmers of Aterna village

Scientists interacting with the farm women at Chundika village of Mewat district of Haryana

Table 9.2. Activities undertaken by ICAR-NIAP under MGMG

Name of activity	No. of activities conducted	No. of farmers participated & benefitted
Visits to village by teams	15	327
Interface meeting/ Goshthies	17	327
Literature support provided (No)	10	252
Awareness created (No)	15	372
Linkages developed with other agencies (No. of agency)	3	137
Facilitation for new varieties, seeds, technology		
New varieties (No.)	3	175
Technology (No.)	6	267
Seeds (q)	1	45
Total	**67**	**1765**

Participation in ICAR Sports Meet

Mrs. Sonia Chauhan receiving Gold Medal in Chess Competition in ICAR Zonal Sports Meet 2018 at ICAR-IISS, Bhopal

The Institute participated in ICAR annual sports meet 2018 at ICAR-Indian Institute of Soil Science, Bhopal during November 12-15, 2018 with 14 member contingents. Mrs Sonia Chauhan brought laurels to the institute by securing 1st place in women chess championship. Dr. Kingsly, I. secured 3rd place in 800 meter race. Women chess team of ICAR-NIAP also participated in zonal sports event at ICAR-Indian Veterinary Research Institute, Bareilly during 25-27 February 2019.

Annual Sport Meet

Institute successfully conducted annual sport meet at ICAR-NIAP during March 19-20, 2019.

International Yoga Day

International Yoga Day at ICAR-NIAP, June 21, 2018

NIAP organized international yoga day in the campus of NIAP on June 21, 2018. Director along with the ICAR-NIAP team did many yoga exercises under the guidance of yoga experts. All the participants got benefitted.

Vigilance Awareness Week

NIAP staff observed vigilance awareness week by taking pledge, drawing posters, writing essays, attending trainings and workshops during the period October 29, 2018 to November 3, 2018. The theme of the week was "My Vision-Corruption Free India".

Poster competition during vigilance awareness week, October 29 to November, 3 2018

Distinguished Visitors

Dr. Ramesh Chand
Member, NITI Aayog

Dr. Trilochan Mohapatra
Secretary, DARE and Director-General, ICAR

Sh. Chhabilendra Roul
Secretary, Department of Fertilizers, GoI

Dr. R.B Singh
Ex-President, National Academy of Agricultural Sciences

Dr. N.S. Rathore
Deputy Director General (Education), ICAR

Dr. A. K. Singh
Deputy Director General (Agril. Ext.), ICAR

Prof. (Dr.) A. K. Srivastava
Member, Agricultural Scientists Recruitment Board

Dr. Mruthyunjaya
Former National Director, NIAP

Dr. A.K. Singh
Secretary, NAAS

Dr. Uma Lele
Development Economist

Dr. Derek Byrlee,
Adjunct Professor, Georgetown University, USA

Dr. P.K. Joshi
Director-South Asia, IFPRI

Dr. Deepak Pental
Former Vice-Chancellor, University of Delhi

Dr. Kanchan Chopra
Former Director, IEG
Staff of ILRI, CIMMYT, IITA visited NIAP for potential collaboration

Prof Sachin Chaturvedi
Director General
Research and Information System for Developing Countries (RIS)

Prof Dinesh K Marothia
Member, State Planning Commission Chhattisgarh
Yojana Bhawan, Atal Nagar (Naya Raipur), CG

Dr. M. L. Madan
Former Deputy Director General (Animal Science)
ICAR

Dr. P. G. Chengappa
Former Vice Chancellor, UAS, Bengaluru and
National Professor of ICAR

Foreign Delegation/Visitors

- USDA delegation headed by Dr Robert Johansson, Chief Economic and Ms. Jeanne F Bailey, Minister Counselor visited NIAP on April 24, 2018.
- Dr Derek Byerlee, formerly World Bank and member, IFPRI Board, interacted with ICAR-NIAP faculty on December 5, 2018.
- Dr Uma Lele, an independent scholar and development economist with four decades of international experience in research, operations, policy analysis, and evaluation in World Bank delivered a lecture on "Markets and States in China and India", 14 November, 2018.

Students Visitors

- Around 49 Students and 3 staff members of Agricultural College.
- Research Institute, Thanjavur, visited ICAR-NIAP on October 4, 2018.

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Personnel

Scientific

Name	Designation
Dr. Suresh Pal	Director
Dr. P. S. Birthal	National Professor
Dr. Usha Rani Ahuja	Principal Scientist
Dr. Nalini Ranjan Kumar	Principal Scientist
Dr. Rajni Jain	Principal Scientist
Dr. Subhash Chand	Principal Scientist
Dr. S. K. Pandey	Principal Scientist
Dr. Naveen P. Singh	Principal Scientist
Dr. Shiv Kumar	Principal Scientist
Dr. Raka Saxena	Principal Scientist
Dr. Prem Chand	Scientist (SS)
Dr. S. K. Srivastava	Scientist (SS)
Ms. Arathy Ashok	Scientist (SS)
Dr. Kingsly Imnanuelraj T	Scientist (SS)
Dr. Vinayak Ramesh Nikam	Scientist (SS)
Ms. Jaya Jumrani	Scientist (SS)
Ms. Pavithra S	Scientist (SS)
Mr. Balaji S.J.	Scientist
Mr. S V Bangaraju	Scientist
Dr. Abimanyu Jhajhria	Scientist
Mr. Prabhat Kishore	Scientist
Mr. Subash S. P.	Scientist

Technical

Name	Designation
Mr. Prem Narayan	Chief Technical Officer
Mr. Khyali Ram Chaudhary	Assistant Chief Technical Officer
Mr. Mangal Singh Chauhan	Assistant Chief Technical Officer
Mrs. Sonia Chauhan	Assistant Chief Technical Officer
Mr. Satender Singh	Technical Officer (Driver)

Administrative

Name	Designation
Ms. Neha Chandiok	Administrative Officer
Mr. Vinod Kumar Rai	Assistant Finance and Account Officer
Mr. Sushil Kumar Yadav	Assistant Administrative Officer
Mrs. Umeeta Ahuja	PS to Director
Mr. Inderjeet Sachdeva	Assistant
Mr. Sandeep Mathur*	Assistant
Mr. Yatin Kohli	Assistant
Mr. Harish Vats	Assistant
Mr. Deepak Tanwar	Jr. Steno
Mr. Ajay Tanwar	UDC

* He is on lien from 30.06.2018

Skilled Supporting Staff

Name	Designation
Mr. Mahesh Kumar	Skilled Supporting Staff
Mr. Mahesh Pal	Skilled Supporting Staff

Promotions

- ✓ Merit promotion of Dr. Kingsly Immanulraj T., Scientist to the next higher grade of Scientist (Sr. Scale) w.e.f 27.04.2015.
- ✓ Merit promotion of Mrs. Pavithra S., Scientist to the next higher grade of Scientist (Sr. Scale) w.e.f 15.09.2016.
- ✓ Merit promotion of Dr. Vinayak Ramesh Nikam, Scientist to the next higher grade of Scientist (Sr. Scale) w.e.f 01.01.2017.
- ✓ Merit promotion of Ms. Jaya Jumrani., Scientist to the next higher grade of Scientist (Sr. Scale) w.e.f 15.09.2017.

Retirement

Prof. Ramesh Chand, Ex- Director, Superannuation on 30 June 2018 (A/N).

Budget

Table 10.1. ICAR-NIAP expenditure and revenue during 2018-19

Head	Grant Expenditure
Grants for Creation of Capital Assets (Capital)	
Equipment	14.51
Information Technology	58.56
Library Books and Journals	11.71
Others	0.85
Total Capital Expenditure	**85.62**
Grant in Aid-Salaries (Revenue)	
Total Establishment Expenses (Salaries)	**627.85**
Grant in Aid-General	
Research and Operational Expenses	251.03
Administrative Expenses	150.91
Others	147.87
Total Expenditure Grant in Aid-General	**549.80**
Grand Total	**1263.27**

Revenue receipt (2018-19): 30,00,000/-

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

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