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ICAR-NIAP Annual Report 2017-18

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PREFACE

Acceleration of agricultural development through application of science and innovations has been the main goal of ICAR-NIAP. The Institute therefore has been working on policy and institutional reforms to promote science-led growth. It continued its efforts in 2017-18 also for policy analysis to step-up the reform process. The research programs for 2017-18 to 2019-20 were initiated and three projects in collaborative mode are in the areas of agricultural transformation, commodity value chains and regional crop and resource planning. The collaborating institutions are state agricultural universities, institutes of ICAR and Indian Council of Social Science Research, and general universities.

Important research contributions during the year under report pertain to strategy for doubling farmers' income, advances in agricultural R&D policy, climate-resilient agriculture, mapping of agricultural commodity value chains and pattern of structural transformation of agriculture. The Institute also initiated research projects on agricultural foresight analysis, non-farm employment, gender mainstreaming, research impact, and commodity modelling. In terms of policy dialogue, strategy for doubling farmers' income and implications of Goods and Services Tax for agriculture, commodity price stabilization, evaluation of R&D organizations, price policy and self-sufficiency in pulses production are some of the areas where NIAP provided proactive inputs for decision making.

Capacity development for agricultural policy research is another important goal of NIAP and the Institute organized short courses and training sessions for collaborating partners and other social scientists. The Institute also organized a training program for the probationers of Indian Economic Service. The Institute also shared the responsibility of reform process in ICAR and facilitated Peer Review of ICAR and Outcome Review for XII Plan and acted as a Member Secretary of both the Committees. In view of outstanding scientific contributions, two Fellowships of the Indian Society of Agricultural Economics (Mumbai) were awarded to NIAP scientists, besides several other professional recognitions.

We sincerely thank Dr T. Mohapatra, Secretary, DARE and Director General, ICAR, Sh. Chhabilendra Roul, Special Secretary, DARE and Secretary, 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 and strength throughout the year for successful completion of various activities. I personally thank all my colleagues for their cooperation, Dr Kingsly Immanuelraj and Dr Raka Saxena for coordination of publication of the Annual Report, and Dr Prem Chand, Ms Jaya Jumrani, Ms Arathy Ashok, Ms Sonia Chauhan, Ms Umeeta Ahuja and Mr Deepak Tanwar for their help in compilation of the material.

(Suresh Pal)
Director

30 June, 2018

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LIST OF ACRONYMS

ACIAR	Australian Centre for International Agricultural Research
ADG	Assistant Director General
AERA	Agricultural Economics Research Association
AERR	Agricultural Economics Research Review
AKMU	Agricultural Knowledge Management Unit
ARIMA	Autoregressive Integrated Moving Average
ASRB	Agricultural Scientists Recruitment Board
ATIC	Agricultural Technology Information Centre
BHU	Banaras Hindu University
CAS	Current Awareness Service
CD ROM	Compact Disc Read-Only Memory
CDAC	Centre for Development of Advanced Computing
CEEW	Council on Energy, Environment & Water
CGIAR	Consultative Group on International Agricultural Research
CGST	Central Goods & Services Tax
CIAE	Central Institute of Agricultural Engineering.
CIMMYT	International Maize and Wheat Improvement Centre
CIPT	Centres for International Projects Trust
CIRAD	Centre international de recherche agricole pour le développement
CPCRI	Central Plantation Crops Research Institute
CPRI	Central Potato Research Institute
CSAUAT	Chandra Shekhar Azad University of Agriculture and Technology
CSIR	Council of Scientific & Industrial Research
CSWRI	Central Sheep and Wool Research Institute
DAC&FW	Department of Agriculture Cooperation and Farmers Welfare
DARE	Department of Agricultural Research and Education
DDS	Document Delivery Service
DG	Director General
DKMA	Directorate of Knowledge Management in Agriculture
DoI	Digital Object Identifier

DRPCAU	Dr. Rajendra Prasad Central Agricultural University
e-NAM	e-National Agricultural Market
EPW	Economic and Political Weekly
ERNET	Education and Research Network
ERP	Enterprise Resource Planning
FAO	Food and Agriculture Organization
FMS	Financial Management System
FOCARS	Foundation Course for Agricultural Research Services
GoI	Government of India
GPF	Gross Provident Fund
GST	Goods and Service Tax
HRMS	Human Resources Management System
HYPM	Half-Yearly Progress Monitoring
IARI	Indian Agricultural Research Institute
IAS	Indian Administrative Service
IASRI	Indian Agricultural Statistical Research Institute
ICAR	Indian Council of Agricultural Research
ICIBAG	International Conference on Integrative Biology & Applied Genetics
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ICT	Information and Communication Technology
IEG	Institute of Economic Growth
IES	Indian Economic Service
IFPRI	International Food Policy Research Institute
IGNOU	Indira Gandhi National Open University
IGST	Integrated Goods & Services Tax
IHC	India Habitat Centre
IIC	India International Centre
IIFSR	Indian Institute of Farming System Research
IISWC	Indian Institute of Soil and Water Conservation
IIT	Indian Institute of Technology
IIWM	Indian Institute of Water Management
IJAE	Indian Journal of Agricultural Economics
IJAS	Indian Journal of Agricultural Sciences
INRA	Institute National de la Recherche Agronomique

ISAE	Indian Society of Agricultural Economics
ISO	International Organization for Standardization
IT	Information Technology
IWRS	Indian Water Resources Society
JSC	Joint Staff Council
LAN	Local Area Network
MGMG	Mera Gaon Mera Gaurav
MIDH	Mission for Integrated Development of Horticulture
MIS	Management Information System
MoA&FW	Ministry of Agriculture and Farmers Welfare
MOU	Memorandum of Understanding
MSP	Minimum Support Price
NAARM	National Academy of Agricultural Research Management
NAAS	National Academy of Agricultural Sciences
NABARD	National Bank for Agriculture and Rural Development
NARS	National Agricultural Research System
NASA	National Aeronautics and Space Administration
NASC	National Agricultural Science Centre
NBPGR	National Bureau of Plant Genetic Resources
NCF	Nature Conservation Foundation
NDRI	National Dairy Research Institute
NHRDF	National Horticultural Research And Development Foundation
NIAP	National Institute of Agricultural Economics and Policy Research
NISCAIR	National Institute of Science, Communication and Information Resources
NASC	National Agricultural Science Complex
NISTADS	National Institute of Science, Technology and Development Studies
NITI	National Institution for Transforming India
NKN	National Knowledge Network
NPL	National Physical Laboratory
NPS	National Pension System
NRAA	National Rainfed Area Authority
PAU	Punjab Agricultural University
PDF	Portable Document Format
PERMISNET	Personnel Management Information System Network

PIMS	Project Information and Management System
PME	Priority Monitoring and Evaluation
PMFBY	Pradhan Mantri Fasal Bima Yojana
QRT	Quinquennial Review Team
R&D	Research and Development
RAC	Research Advisory Committee
RC for NEH	Research Complex for North Eastern Hill
RTI	Right To Information
SAARC	South Asian Association for Regional Cooperation
SAUs	State Agricultural Universities
SDGs	Sustainable Development Goals
SEBI	Securities and Exchange Board of India
SGST	State Goods & Services Tax
SQL	Structured Query Language
TAAS	Trust for Advancement of Agricultural Sciences
TARINA	Technical Assistance and Research for Indian Nutrition and Agriculture
TCI	Tata Cornell Institute for Agriculture and Nutrition
TCP	Technical Cooperation Project
TERI	The Energy and Resources Institute
TNC	The Nature Conservancy
WDRA	Warehousing Development and Regulatory Authority
WHO	World Health Organization
WICT	World Congress on Information and Communication Technologies

विशिष्ट सारांश

भाकृअनुप–राष्ट्रीय कृषि आर्थिकी एवम् नीति अनुसंधान संस्थान (ICAR-NIAP) कृषि अर्थशास्त्र और नीति अनुसंधान में उत्कृष्टता को बढ़ावा देने तथा इसे बनाये रखने के लिए सतत् प्रयासरत् है। यह संस्थान भारतीय कृषि अनुसंधान परिषद् को विश्वसनीय एवं साक्ष्य–आधारित सुझावों द्वारा नीति संबंधी विचार–विमर्श तथा निर्णय लेने में सहायता करता है साथ ही में परिषद् के लिए एक विशेषज्ञ समूह (Think Tank) के रूप में कार्य करता है। यह संस्थान कृषि क्षेत्र में उभरती चुनौतियों और उनको दूर करने की रणनीतियों तथा कृषि विकास के लिए प्राथमिकताओं के निर्धारण के बारे में नीति–निर्माताओं तथा परिषद् को जागरूक बनाता है। यह संस्थान परिषद् के अन्य संस्थानों, राज्य कृषि विश्वविद्यालयों तथा अन्य सरकारी विभागों के साथ मिलकर अनुसंधान कार्य करता है। इस संस्थान में सामयिक महत्व के विषयों पर अनुसंधान कार्य तीन प्रमुख क्षेत्रों–प्रौद्योगिकी एवं टिकाऊ विकास, कृषि प्रगति एवं विकास, तथा विपणन, व्यापार एवं संस्थागत विकास में किये जाते हैं। अनुसंधान कार्यों के अतिरिक्त, संस्थान ने क्षमता निर्माण गतिविधियाँ, कार्यशालाएं, विचार मंथन सत्रों, प्रशिक्षण कार्यक्रमों एवं नीति चर्चाएं आयोजित की। वर्षावधि 2017–18 में वाह्य वित्तपोषित परियोजनाओं सहित संस्थान का कुल व्यय 673 लाख रूपये था।

कृषि प्रगति एवं विकास

भारतीय कृषि में बदलाव के विश्लेषण हेतु एक अध्ययन किया गया तथा परिणाम दर्शाता है कि उत्पादों की संरचना में बड़ा बदलाव आया है। धान्य फसलों का योगदान लगभग स्थिर हो गया है, जबकि फल, सब्जियाँ और पशुधन, विकास के प्रमुख स्त्रोत बन गये हैं। उप–सीमांत किसानों के 30 प्रतिशत तथा सीमांत किसानों के 20 प्रतिशत से अधिक किसानों ने अपनी आय को कृषि और गैर–कृषि क्षेत्रों में मजदूरी करके अर्जित की। जम्मू और कश्मीर, तमिलनाडु तथा आंध्रप्रदेश में फसल क्षेत्र के सापेक्ष इसके संबंधित क्षेत्रों में वृद्धि में तेजी दिखी, जबकि पश्चिम बंगाल, हिमाचल प्रदेश, मध्य प्रदेश, असम, कर्नाटक और महाराष्ट्र प्रान्तों में कृषि में बदलाव का स्तर अपेक्षाकृत धीमा था।

1990 के दशक से कृषि में वास्तविक मजदूरी इसके सीमांत श्रम उत्पादकता तथा 2000 के मध्य के दशक से इसके औसत श्रम उत्पादकता की अपेक्षा तेजी से बढ़ रही है, जोकि भविष्य में मजदूरी बढ़ने की संभावना का संकेत देती है और कृषि में मशीनीकरण के लिए अधिक अवसर प्रदान करती है। समयावधि 1993 से 2015 के दौरान, पंजाब, मध्यप्रदेश और जम्मू तथा कश्मीर राज्यों में गैर–कृषि ग्रामीण रोजगार में 100 प्रतिशत से ज्यादा की वृद्वि हुई है। हांलाकि, गैर कृषि क्षेत्रों में संलग्न कर्मचारी भूमिहीन अथवा सीमांत किसान हैं और सामयिक (Casual Work) कार्य कर रहे हैं। शक्ति–चालित मशीनों के क्षेत्र–वार, फसलवार तथा भूमि–आकार के अनुसार इनके प्रयोग के रूझान विश्लेषण से पता चलता है कि समय के साथ मशीनीकरण बढ़ रहा है। देश स्तर पर मशीनीकरण के सूचकांक का स्तर वर्ष 2004–05 में 21.5 प्रतिशत से बढ़कर वर्ष 2014–15 में 24.4 प्रतिशत हो गया। पंजाब प्रान्त में मशीनीकरण सूचकांक सबसे अधिक (44.7 प्रतिशत) तथा पश्चिम बंगाल में सबसे कम (9.8 प्रतिशत) मिला।

डेयरी क्षेत्र के माध्यम से किसानों की आय बढ़ाने के एक अध्ययन में पता चला है कि दुधारू पशुओं में संकर–प्रजनन को विशेष रूप से सबसे कम आय के क्षेत्रों–पूर्वी पठार तथा अर्द्ध–शुष्क कटिबंध में बढ़ाना चाहिए। इसके अलावा, उत्पादन और गैर कृषि व्यवसाय के अवसरों, विशेषरूप से छोटे पैमाने पर दूध प्रसंस्करण हेतु तालमेल बिठाने के लिए सबसे कम प्रदर्शन वाले क्षेत्रों में उत्पादन गतिविधियों के साथ मूल्य

वर्धन गतिविधियों को जोड़ने की आवश्यकता है। राज्य सरकारों को शोध संस्थान के साथ मिलकर पशुधन विकास कार्यक्रमों तथा सेवाओं को सुनिश्चित करने की आवश्यकता है जिससेकि पशुपालक पशुधन क्षेत्र में पैदा हो रहे अवसरों का लाभ उठा सकें।

समयावधि 2001 से 2006 के दौरान फसल बीमा योजनाओं के तहत व्याप्ति का विश्लेशण दर्शाता है कि प्रधानमंत्री फसल बीमा योजना के शुरू होने के बाद वर्ष 2016 में कुल कृषि क्षेत्रफल का 28 प्रतिशत हिस्सा बीमा योजना के तहत लाया गया। प्रधानमंत्री फसल बीमा योजना के तहत लाये गये किसानों का राज्यवार विश्लेषण दर्शाता है कि महाराष्ट्र में सबसे अधिक किसानों ने बीमा कराया उसके बाद राजस्थान तथा मध्य प्रदेश का स्थान रहा। वर्ष 2016–17 के रबी मौसम में उत्तर प्रदेश में सबसे अधिक किसानों ने फसल बीमा कराया उसके बाद राजस्थान तथा मध्य प्रदेश का स्थान रहा। पीएमएफबीवाई के तहत प्रीमियम की अपेक्षा कम दावा का अनुपात दर्शाता है कि पिछली योजनाओं की तुलना में प्रधानमंत्री फसल बीमा योजना आर्थिक रूप से अधिक व्यावहारिक है। इस योजना की विशाल सम्भावना के बावजूद, फसल नुकसान की अनुमान विधियाँ अपर्याप्त हैं। राज्य सरकारों द्वारा सूचना जारी होने में देरी तथा कट आफ तिथियों के बढ़ाने के कारण समस्याओं के बढ़ने की आशंका होती है।

भारत में पोषण सुरक्षा के अंतर–अस्थायी तथा अंतर–स्थानिक विश्लेषण से पता चलता है कि शहरी परिवारों के सभी आय वर्गो में कैलारी की न्यूनता है इसके बाद प्रोटीन की कमी मिली। अतएव उर्जा और प्रोटीन के पर्याप्त सेवन के बारे में जागरूकता पैदा करना नितान्त आवश्यक है जिससेकि परिवार के लोग जीवन शैली में परिवर्तन करके अपने भोजन में आवश्यक उर्जा और प्रोटीन सम्मिलित कर सके। इसके अलावा, एक आकलन विधि पर पूरी तरह आश्रित न रहकर, अनेक विधियों से भारत में कुपोषण तथा पोषण में कमी का मूल्याकंन एवं प्रसार किया जाना चाहिए। भारत में पोषण बदलाव का विश्लेषण दर्शाता है कि केवल समान कैलोरी मानक को अपनाने से कैलोरी की कमी की संभावना भ्रामक हो सकती है। स्वास्थ्य, रहन–सहन का वातावरण तथा अन्य संबंधित सामाजिक बुनियादी ढ़ाचें कैलोरी अन्तर्ग्रहण को प्रभावित करने में महत्वपूर्ण भूमिका निभाते हैं। उन राज्यों के परिवारों में पोषण सेवन तथा इसके अन्तर्ग्रहण की संभावना अधिक होती है जिनमें बीमारियों तथा संक्रमण का स्तर कम होता है।

तम्बाकू सेवन की आर्थिकी विशलेषण से पता चलता है कि क्षेत्रवार तत्वों को एकीकृत करके तम्बाकू के उपयोग को नियन्त्रित करने में अधिक सहायता मिलती है। कृषि विविधीकरण पर ध्यान देने वाले आपूर्ति उपायों को मांग उपायों के पूरक के रूप में दीर्घकालिक उपायों के रूप में माना जा सकता है। इस बात पर भी जोर दिया जाना चाहिए कि आपूर्ति–पक्ष के वैश्विक नियंत्रण के बिना देश के भीतर केवल मांग–पक्ष के उपायों को उचित समय के अन्दर तम्बाकू पर नियंत्रण का लक्ष्य प्राप्त नहीं कर सकता।

कृषि विपणन एवं व्यापार

बाजार संबंधी खुफिया सूचना पर आधारित नेटवर्क परियोजना में 40 से अधिक गैर पारंपरिक प्रमुख कृषि वस्तुओं (जिनमें अनाज, दालें, तिलहन, फल, सब्जियाँ, मसालें तथा अधिक मूल्य वाली वस्तुएं) को शामिल कर किसानों को विश्वसनीय एवं समय पूर्व मूल्य पूर्वानुमान का विश्लेषण किया गया। इस परियोजना में पूरे देश से 14 संस्थान शामिल थे। कृषि वस्तुओं के मूल्य पूर्वानुमान का विश्लेषण वैज्ञानिक विधियों को प्रयोग करके किया गया ताकि किसान समय पूर्व सूचित होकर बाजार संबंधी मूल्य जोखिम नियंत्रित कर सकें। किसानों को फसलों की बुवाई के पूर्व 180 से अधिक तथा फसलों की कटाई के पूर्व 263 से अधिक मूल्य पूर्वानुमान विभिन्न संचार माध्यमों जैसे व्यक्तिगत सम्पर्क, एसएमएस, दूरदर्शन, रेडियो, विश्वविद्यालयीय वेबसाइटों, सामाजिक मीडिया आदि पर प्रसारित किये गये।

समय के साथ सटीक मूल्य पूर्वानुमान, इसके नवीन सांख्यिकी माडलों के प्रयोग से प्राप्त हुए है, हालांकि, बागवानी तथा दलहन फसलों के पूर्वानुमान अस्थिर रहे। सभी बाहरी प्रभावी कारकों तथा उनकी कीमतों के सन्दर्भ में आलू तथा प्याज की फसलें काफी संवेदनशील हैं। उपलब्ध मूल्य पूर्वानुमान के आधार पर किसानों ने

वस्तुओं का श्रेणीकरण करके उन्हें बाजार में अनुकूल समय पर बेचा जिससेकि फसलों की अच्छी कीमतें मिली। इस परियोजना के तहत क्षेत्रीय अध्ययनों में मूल्य पूर्वानुमान, बुनियादी विपणन ढ़ांचे तथा मूल्यों के बीच संबंध तथा किसानों के निर्णय लेने के प्रभाव आदि अनेक अध्ययन किये गये। किसानों को समयवद्ध उपलब्ध पूर्वानुमान तभी अधिक उपयोगी एवं सटीक होगें जब बाजार ढांचा तथा अन्य संबंधित सुविधाएं मुहैया करायी जाती हैं।

कमजोर परिवहन तथा संचार नेटर्वक किसानों को बाजार तक पहुँचने से रोकते हैं तथा साथ ही में बिचौलियों/अनौपचारिक खरीददारों के लिए उपभोक्ता द्वारा चुकायी गयी कीमत में हिस्सेदारी के लिए अवसर प्रदान करते हैं। चावल तथा गेहूँ फसलों की बिक्री हेतु छोटे किसान कुछ मामलों में स्थानीय व्यापारियों तथा कारक विक्रेताओं के ऊपर आश्रित थे। जिससे बड़े किसानों की अपेक्षा सीमांत किसानों को 15–16 प्रतिशत कम मूल्य मिले, जोकि खरीदारों के साथ उनकी निर्वल सौदाशक्ति को दर्शाता है। अध्ययन से पता चलता है कि सूचना का प्रभाव तुलनात्मक रूप में अधिक होता है। लेकिन केवल सड़कों की उपलब्धता ही पर्याप्त नहीं है जबतक कि इसके साथ सही सूचना नहीं मिलती। परिवहन ढ़ांचे में जरूरी निवेश से किसानों तथा विक्रेताओं की कीमतें घटेगीं जोकि कृषि बाजार की दक्षता में सुधार के लिए जरूरी है। बाजारों में सुधार के साथ इनमें विपणन सूचना प्रणाली के विकास तथा किसानों एवं विक्रेताओं के बीच सूचना का आदान–प्रदान आवश्यक है।

कृषि वस्तुओं की मूल्य श्रखंला के आधुनिकीकरण हेतु वित्तीय, नीतिगत तथा संस्थागत आवश्यकताओं का विश्लेषण किया गया। इसके अतिरिक्त, योजना में कृषि वस्तुओं के उत्पादन तथा उनकी उपभोक्ताओं को बिक्री में संलग्न मूल्य श्रंखलाओं के प्रतिचित्रण (mapping) का प्रावधान है। परियोजना में विशेष ध्यान मूल्य वर्द्धन तथा खाद्य सुरक्षा मुद्दों पर केन्द्रित है। इससे नीति निर्धारकों तथा निर्माताओं को कमियां दूर करने तथा कृषि वस्तुओं की मूल्य श्रंखलाओं की ताकत पर अधिक लाभ प्राप्ति को दिशा मिलेगी। परियोजना में कुछ मूल्य श्रंखलाएं– उत्तर प्रदेश में भैंस का मांस, केरल में समुद्री मत्स्यपालन, कर्नाटक में टमाटर, पर्वोत्तर हिमालयी राज्यों में जैविक अदरक तथा जम्मू और कश्मीर मे सेब आदि प्रमुख रूप से अध्ययन के लिए चयनित की गई हैं।

प्याज के मूल्य में गिरावट के विश्लेषण से पता चलता है कि उत्पादन में उतार–चढ़ाव और इसकी मांग की बदलती प्रवृत्ति दो प्रमुख तत्व हैं जोकि इसके मूल्य में भारी गिरावट/बढ़ोत्तरी का कारक बनते हैं। अध्ययन से स्पष्ट हुआ है कि किसी भी साल प्याज के उत्पादन तथा उसके अगले साल बाजार में आवक के बीच मजबूत तथा सार्थक संबंध है। पिछले 12 वर्षो की अवधि (2005–06 से 2016–17) के दौरान प्याज के उत्पादन में चार बार गिरावट आयी है तथा उसके अगले वर्ष प्याज की बाजार आवक में भी गिरावट आयी है। अध्ययन का सुझाव है प्याज के बाजार आपस में समाकलित हैं इससे इनके बीच मूल्य संचरण तीव्रता से होता है। अतएव इनके बाजार मूल्य तथा आवक पर किसी केन्द्रीय संस्था को लगातार ध्यान रखना चाहिए, जिससे सरकार को अग्रिम सूचना प्राप्त हो सकें और प्याज के घरेलू बाजार मूल्य की स्थिति तथा इसके न्यूनतम निर्यात मूल्य (minimum export price) को निर्धारित करने में सहायक हो सके।

कृषि विपणन प्रणाली में मौजूद संस्थागत तथा आधारभूत बाधाओं के कारण होने वाली हानियों को मापने के उद्देश्य से तिलहन वस्तुओं के विक्रय हेतु बाजार एकीकरण एवं मूल्य संचरण परियोजना का शुभारम्भ किया गया। अध्ययन में मिला कि संस्थागत तथा आधारभूत समस्याएं तिलहन उत्पादन को हतोत्साहित करती हैं जिससेकि मूल्य संचरण तथा बाजार दक्षता प्रभावित होती है, जोकि किसानों के फायदे के लिए आवश्यक शर्तें हैं।

तिलहनों तथा दलहनों के मध्यावधि पूर्वानुमान प्रमुख आर्थिक चरों–उत्पादन, मांग, स्टाक, व्यापार, मूल्य तथा नीतिगत कारकों को ध्यान में रखकर विकसित किये जा रहे हैं जोकि इनके पूर्वानुमान तथा नीतियों के प्रभाव विश्लेषण में सहायक होगें। ये पूर्वानुमान मुख्यतया दो धान्य फसलों– चावल और गेहूँ तथा अन्य राज्यों की कुछ प्रमुख फसलों जोकि पूरक तथा संपूरक के रूप में

प्रयुक्त होती हैं, विकसित किये जा रहें हैं। यह माडल दुनिया के बाकी हिस्सों/देशों के साथ वस्तुओं के व्यापार प्रवाह और देश में वस्तुओं की कीमतों को ध्यान में रखकर पूरी तरह बाजार सिद्धान्तों पर आधारित है। इस माडल में देश के विभिन्न क्षेत्रों के लिए अलग–अलग आपूर्ति समीकरणों तथा स्थानिक आयामों को शामिल किया गया है। एक अन्य अध्ययन में खाद्य तेल के बाजारों में परस्पर समाकलन का विश्लेषण दर्शाता है कि उत्पादकों तथा उपभोक्ताओं के बीच एक दिशात्मक करणीय संबंध मिला, जबकि पाम आयल और मूगँफली के संबंध में द्वि–दिशात्मक करणीय संबंध मिले। ऐन्जेल ग्रैंगर थ्रेसहोल्ड को–इंटीग्रेशन (Engel Granger Threshold Co-Intergration) का प्रयोग करके खाद्य तेल बाजारों में अपूर्ण प्रतिस्पर्धा संबंधी तत्वों की पुष्टि हुई तथा आमतौर पर सममित मूल्य संचरण की अवधारणा खारिज हुई।

प्रौद्योगिकी एवं सतत् विकास

अनुसंधान संस्थानों द्वारा कृषि में प्रौद्योगिकियों के विकास एवं नवाचार, नीतियों तथा आने वाली चुनौतियों के समझने में कृषि में प्रौघोगिकी दूरदर्शिता का अध्ययन सहायक होता है। इस अध्ययन में पौधा किस्म और कृषक अधिकार संरक्षण अधिनियम के तहत पंजीकृत पौध किस्मों की प्रवृत्ति का विश्लेषण किया गया। वर्ष–दर–वर्ष कुल पंजीकृत पौध किस्मों की संख्या में बढ़ोत्तरी मिली। किसानों द्वारा पंजीकृत अधिकतर पौध किस्में उड़ीसा प्रदेश के जेपोर–कोरापुट (Joypore -Koraput) क्षेत्र से संबंधित थी। अध्ययन दर्शाता है कि निजी कम्पनियों ने 395 खाद्य पौध किस्में तथा 214 गैर खाद्य पौधे किस्में पंजीकृत करायी। उपरोक्त पंजीकृत किस्मों में प्रमुख रूप से चावल की 120, मक्का की 108 और कपास (टेट्राप्लायड) की 122 किस्में थी। सरकारी क्षेत्र (परिषद् के संस्थानों और राज्य कृषि विश्वविद्यालयों) द्वारा कई तरह की पौध किस्में पंजीकृत कराई गई, जिनमें से 74 प्रतिशत से अधिक किस्में खाद्य फसलों की थीं।

कृषि अनुसंधान में निवेश सघनता तथा इसके प्रभाव का मूल्यांकन दर्शाता है कि कृषि अनुसंधान एवं शिक्षा में निवेश में कमी के बावजूद इसका प्रभाव आकर्षक रहा है। अध्ययन में दर्शाया गया है कि चावल अनुसंधान ने अधिक संख्या में सुगंधित तथा सूखा रोधी किस्में विकसित की हैं। पिछले बत्तीस वर्षो की समयावधि (1980–2012) में फसल क्षेत्र की 'कुल कारक उत्पादकता' में वृद्धि 1.76 प्रतिशत थी, जिसमें तकनीकी सुधार का योगदान 43 प्रतिशत तथा शेष योगदान प्रेक्षत्र के आकार के कारण था। इसके अलावा अध्ययन का अनुमान है कि प्रति हेक्टेयर कृषि अनुसंधान व्यय में एक प्रतिशत की वृद्धि से कृषि उत्पादकता में 0.084 प्रतिशत की वृद्धि हो सकती है। इसी तरह प्रति व्यक्ति आय में एक प्रतिशत की वृद्धि से गरीबी में 0.37 प्रतिशत कमी आने की संभावना है। अध्ययन में सुझाव दिया गया है कि कृषि प्रसार सेवाओं में निवेश से अच्छे परिणाम मिलेगें तथा कृषि तकनीकों के प्रयोग में बढ़ोत्तरी के लिए सूचनाओं की पहुँच बढ़ाने की आवश्यकता है।

मोबाइल आधारित ऐप के प्रयोग का प्रभाव विश्लेषण दर्शाता है कि इसके प्रयोग से समयावधि 2007–2022 के दौरान कुल आय 914.08 करोड़ रूपये होने का अनुमान है तथा साथ ही में इसका वास्तविक वर्तमान मूल्य 911.2 करोड़ रुपये होगा। मोबाइल आधारित ऐप से होने वाली आमदनी की आंतरिक वापसी दर 316 प्रतिशत रहने का अनुमान है। एक अन्य अध्ययन में कृषि शिक्षा में सूचना संचार तकनीकों के प्रभाव का विश्लेषण दर्शाता है कि सूचना तकनीक के प्रयोग से छात्रों में अकादमिक विकास हुआ है। इंटरनेट की गति, बुनियादी सुविधाएं, ई–संसाधनों की उपलब्धता, सूचना संचार उपकरणों के परिचालन ज्ञान और उन उपकरणों तक पहुँच; सूचना संचार तकनीकों के छात्रों के बीच अपनाने में महत्वपूर्ण कारक हैं। इसके अतिरिक्त कम्पयूटर की उपलब्धता तथा इसका प्रशिक्षण और विश्वविद्यालय परिसर में वाईफाई की उपलब्धता आदि कारक; शिक्षकों के बीच सूचना संचार तकनीक को अपनाने में सहायक होते हैं।

'कृषि में जलवायु परिवर्तन हेतु राष्ट्रीय नवाचार' अध्ययन में स्थान विशेष के लिए अनुकूल रणनीतियों की प्राथमिकता निर्धारित की गयी। अध्ययन में विभिन्न बुनियादी सुविधाओं, पोषण, आर्थिक विकास, स्वास्थ्य,

स्वच्छता, कार्यबल तथा वातावरण से संबंधित प्राचालों को ध्यान में रखकर अनेक सूचकांक विकसित किये गये। अध्ययन में एक एकीकृत आजिविका सुरक्षा सूचकांक (SLSI) विकसित किया गया। जिससे वर्तमान अनुकूलन की स्थिति तथा रणनीतियों के अपनाने में मदद मिलती है। अध्ययन दर्शाता है कि देश के 637 जनपदों में से 163 जनपदों में कृषि आजीविका सुरक्षा कम थी, जोकि प्रमुख रूप से उत्तर प्रदेश, मध्य प्रदेश, अरूणांचल प्रदेश तथा महाराष्ट्र प्रान्तों में स्थित हैं। अध्ययन ने कृषि उत्पादन, बागवानी, कृषिबानिकी और मत्स्यपालन में कई अनुकूल रणनीतियों की पहचान की है।

गेहूँ फसल के सन्दर्भ में जिलेवार आकड़ों के प्रयोग द्वारा उष्मागत तनाव का नुकसान विश्लेषण दर्शाता है कि उष्मागत तनाव (heat stress) से नुकसान समय के साथ बढ़ा है। सिंचाई के प्रयोग से गर्मी से प्रेरित नुकसान को कम करने में मदद् मिली। गर्मी प्रेरित नुकसान की बढ़ती प्रवृत्ति को देखते हुए भविष्य में इससे नुकसान बढ़ने की संभावना है। 'सिंचाई जल प्रबंधन में संस्थागत नवाचार' के एक अध्ययन में मिला कि पंचायतीराज संस्थाएं पानी वितरण से संबंधित मामलों के निपटानें में काफी सहायक हैं। सिंचाई संबंधी एक अन्य अध्ययन में सूक्ष्म सिंचाई का प्रभाव मूल्यांकन दर्शाता है कि सूक्ष्म सिंचाई के तहत निवेश तथा क्षेत्रफल में बढ़ोत्तरी समयावधि 2005–06 से 2017–18 में अधिक रही तथा वर्तमान में निवेश तथा क्षेत्रफल के बीच एक रूपता है। राजस्थान (20.3%), आंध्रप्रदेश (15.3%), महाराष्ट्र (15.2%), गुजरात (12.4%) तथा कर्नाटक (11.0%) आदि राज्यों ने सूक्ष्म सिंचाई प्रणाली को बहुत प्रोत्साहन दिया। बागवानी फसलें सूक्ष्म सिंचाई में सबसे अधिक लाभान्वित रहीं। प्रक्षेत्र सर्वेक्षण आधारित आकड़ों के विश्लेषण से पता चला है कि राजस्थान प्रान्त के बीकानेर जनपद में फब्बारा सिंचाई विधि को अपनाकर लाभार्थी किसानों ने अधिक क्षेत्रफल में बुवाई की तथा अधिक उपज प्राप्त की।

कृषि के विभिन्न घटकों के बीच मूल्य एवं मात्रा में असमानता के सन्दर्भ में फसल ज्यामिती को फिर से निर्धारित करने संबंधी एक अध्ययन में मिला कि कृषि परिस्थितिकी के अनुसार बाजार खुफिया तंत्र को फसल नियोजन, फसल सघनता और उत्पादन कारकों के प्रबंधन को ध्यान में रखकर दिशा दिखाना होगा। इस अध्ययन में कृषि उत्पादन को टिकाऊ बनानें की चुनौतियों से निपटने के लिए ग्रीनहाउस गैस के उत्सर्जन तथा पानी की घटती आपूर्ति को ध्यान में रखने की आवश्यकता है। भले ही सभी और अन्य पहेलियों में समरूपता आये, समाधान के रूप में क्या बुवाई करनी है? कहाँ बुवाई करनी है? कब बुवाई करनी है? और कितने क्षेत्रफल में बुवाई करनी है? आदि बुनियादी चिंताओ को ध्यान में रखने की आवश्यकता है।

कृषि में स्थायित्व एवं बुंदेलखण्ड क्षेत्र में प्राकृतिक संसाधनों के कुशल उपयोग के सन्दर्भ में एक अध्ययन किया गया। अध्ययन में मिला कि पिछले कुछ वर्षों में सतही जल की अपेक्षा भूमिगत जल के प्रयोग में वृद्धि हुई है जिससेकि भूजल स्तर में गिरावट आयी है। इस क्षेत्र में कुल सिंचाई जल उपलब्धता 17 बिलियन घन मीटर है, जिसमें सतही जल की हिस्सेदारी 60 प्रतिशत और भूमिगत जल की हिस्सेदारी 40 प्रतिशत है। इस क्षेत्र में प्रति हेक्टेयर शुद्ध बुवाई क्षेत्रफल के लिए उपलब्ध जल का अनुमान 0.41 हेक्टेयर मीटर है। एक अन्य संबंधित अध्ययन 'इष्टतम फसल योजना (Optimum Crop Plan) में उपलब्ध संसाधनों के आधार पर एक बहुत अनुकूल फसल चक्र को सुझाना है जिससेकि खेतिहर किसानों का सतत् विकास सुनिश्चित हो सके।

बिहार प्रान्त में एक इष्टतम फसल पद्धति का विश्लेषण दर्शाता है कि अधिक पानी चाहने वाली फसलों जैसे चावल, गेहूँ और जूट के क्षेत्रफल में कमी लाकर तथा कम पानी चाहने वाली फसलों – मक्का, दालें और सब्जियों के अन्तर्गत क्षेत्रफल में बढ़ोत्तरी करके, वर्तमान उपलब्ध जल संसाधनों से किसानों की आय में 7.8 प्रतिशत की वृद्धि की जा सकती है तथा उपलब्ध सिंचाई जल में 25 प्रतिशत की वृद्धि करके किसानों की आमदनी को 20.4 प्रतिशत तक बढ़ाया जा सकता है। एक अन्य संबंधित अध्ययन में तमिलनाडु प्रान्त में अधिक पानी चाहने वाली फसलों जैसे केला और हल्दी के क्षेत्रफल में कमी तथा अन्य फसलों के क्षेत्रफल में बढ़ोत्तरी का सुझाव दिया गया है। नवीन इष्टतम फसल योजना में सब्जियों,

वाणिज्यिक और गन्ना फसलों को समाहित करने का भी सुझाव दिया गया है जिससेकि मौजूदा फसल योजना की तुलना में कुल कृषि क्षेत्रफल में 20 प्रतिशत तथा किसानों के आमदनी में 27 प्रतिशत की वृद्धि प्राप्त की जा सके। इस अध्ययन में सूक्ष्म सिंचाई प्रणाली, मृद्रा और जल संरक्षण कार्यक्रमों तथा स्थान विशेष के लिए लघु सिंचाई संरचनाओं के स्थापन हेतु अनुदान जैसे सहायक उपायों को मजबूत करने की आवश्यकता पर बल दिया गया है।

महाराष्ट्र में विभिन्न प्रसार सेवा प्रदाताओं के सन्दर्भ में एक विश्लेषण प्रसार कर्मचारियों तथा भूजोतों के अनुपात जानने हेतु किया गया, तथा इसमें विभिन्न संस्थाओं के बीच काफी अंतर मिला। कृषि विज्ञान केन्द्रों के प्रति कर्मचारी पर 4166 किसान आश्रित थे, जबकि कृषि प्रौद्योगिकी प्रबंधन संस्था के प्रति कर्मचारी पर कम किसान निर्भर थे। अध्ययन में मिला कि जहाँ कहीं भी संबंधित कर्मचारियों की सख्या सीमित है, सूचना संचार तकनीकों के प्रयोग बेहतर परिणाम दिलाने में सहायक हो सकते है। जहाँ कौशल विकास पर जोर दिया जाना है वहाँ कृषि विज्ञान केन्द्र तथा प्रत्यक्ष सम्पर्क विधियाँ अधिक सहायक हो सकती है। पूर्वी भारत में चावल फसल में किसानों की तकनीक तक पहुँच और इनके अंगीकरण का अध्ययन दर्शाता है कि पुरूषों की पहुँच का ईएएस 22.5 प्रतिशत जबकि महिलाओं के लिए इसका स्तर केवल 7.5 प्रतिशत था। ईएएस के प्रमुख स्त्रोतों में सार्वजनिक संस्थाएं पहले स्थान पर थीं और उसके बाद निजी संस्थाओं की पहुँच थी। पूर्वी क्षेत्र में सूचनाओं की पहुँच में इलेक्ट्रानिक माध्यमों की पहुँच कम थी। अध्ययन में ईएएस किसान तथा गैर ईएएस किसानों के बीच रासायनिक उर्वरकों तथा जीवनाशियों के प्रयोग के बीच काफी अन्तर था। इसके अतिरिक्त इनकी प्रक्षेत्र उत्पादकता एवं विपणन अतिरेक में भी काफी असमानता थी।

संयोजन और अन्य कियाकलाप

प्रतिवेदन वर्ष में भाकृअनुप–राष्ट्रीय कृषि आर्थिकी एवम् नीति अनुसंधान संस्थान (ICAR - NIAP) ने अनेक सरकारी विभागों एवं विकास संस्थाओं के साथ अपने संबंधों को मजबूत किया, इनमें प्रमुख रूप से कृषि एवं किसान कल्याण मंत्रालय, उपभोक्ता मामलें मंत्रालय, जल संसाधन मंत्रालय, वित्त मंत्रालय, राष्ट्रीय कृषि एवं ग्रामीण विकास बैंक, नीति आयोग तथा राज्य सरकारें शामिल हैं। संस्थान ने पेशवरों और विकास संस्थाओं के बीच अपनी पहुँच बढ़ाने के लिए क्षमता निर्माण तथा अन्य पेशेवर गतिविधियाँ आयोजित की और अपने प्रकाशनों को प्रसारित किया। संस्थान ने भारतीय कृषि अनुसंधान परिषद् के वरिष्ठ अधिकारियों (शिष्टजन) की गठित समीक्षा बैठकें आयोजित की। प्रतिवेदन अवधि में संस्थान ने 'वस्तु एवं सेवा कर' विषय पर एक कार्यशाला आयोजित की जिसमें परिषद्, सरकारी विभागों और उद्योग जगत के कई वरिष्ठ अधिकारियों ने भाग लिया। संस्थान द्वारा आयोजित गतिविधियों में प्रमुख रूप से संस्थान का वार्षिक दिवस (2 मई), अन्तर्राष्ट्रीय योग दिवस, स्वच्छ भारत मिशन के तहत अनिवार्य गतिविधियों का आयोजन, हिन्दी पखवाड़ा और 'मेरा गांव मेरा गौरव' के तहत किसानों से नियमित वार्तालाप, आदि शामिल हैं। संस्थान नकदी रहित लेनदेन और सरकार के ई–खरीद पोर्टल के माध्यम से वस्तुओं की खरीद जैसे सुधारों को कार्यान्वित कर रहा है।

EXECUTIVE SUMMARY

ICAR-National Institute of Agricultural Economics and Policy Research (NIAP) has been making persistent efforts to promote and sustain excellence in agricultural economics and policy research in the country. It serves as a think tank for ICAR through credible research to actively participate in decision making and facilitate various research and policy reforms. The Institute also sensitizes policy planners and ICAR about the emerging challenges and priorities for agricultural development and the strategy to address them. A part of the work is done in collaboration with ICAR institutes, State Agricultural Universities (SAUs) and other government departments. Research is mainly conducted under three broad themes, viz. Technology and Sustainable Agriculture, Agricultural Growth and Development and Markets, Trade and Institutions. Besides research, the Institute has undertaken capacity building activities and organized a number of workshops, brainstorming sessions, trainings and policy discussions. The total expenditure incurred, including externally funded projects in 2017-18 was Rs 1184.4 lakh. A brief account of research and other activities undertaken by the Institute during the year under report is given below.

Agricultural Growth and Development

The transformation of Indian agriculture was studied and the results showed major changes in the composition of output. The contribution of cereals has almost stagnated, while that of fruits, vegetables and livestock sector has become the major source of growth. More than 30 per cent of sub-marginal and around 20 per cent of marginal farmers derived their income through wage earnings, in both farm and non-farm occupations. Jammu & Kashmir, Tamil Nadu and Andhra Pradesh have witnessed a faster increase in the allied sector's share, relative to crop sector. The pace of transformation was relatively slow in West Bengal, Himachal Pradesh, Madhya Pradesh, Assam, Karnataka and Maharashtra.

The real wages in agriculture have risen faster than its marginal labour productivity since 1990s and faster than the average labour productivity since mid-2000s, indicating the possibility of rising wages in future, thus offering greater scope for mechanization in agriculture. Rural non-farm employment has increased by more than 100 per cent in the states of Punjab, Madhya Pradesh and Jammu and Kashmir during the period 1993 to 2015. However, many of the workers are doing casual work and most of them are landless or marginal farmers. The trend analysis of use of machine power across regions, crops and farm sizes shows that mechanization has been increasing over time. Mechanization index for the country as a whole increased from 21.5 per cent during 2004-05 to 24.4 per cent during 2014-15. Punjab ranked high with an index of 44.7 per cent, whereas West Bengal ranked as low as 9.8 per cent.

The study on enhancing income through dairy sector revealed that crossbreeding of milch animals should be geared up, especially in the least performing zone (LPZ) of eastern plateau and semi-arid tropics, to boost farmers' income. Further, efforts need to be made to link the production with value addition activities in LPZ to create synergies between production and non-farm business opportunities,

particularly small scale milk processing. The state governments, in conjunction with research institutions have to play a major role in ensuring that livestock development programmes and services enable the livestock keepers to take full advantage of the emerging opportunity in this sector.

An analysis of crop insurance schemes and their coverage from 2001 to 2016 indicates that the year 2016 witnessed the highest coverage in terms of area insured (28 per cent of GCA) after introduction of the Pradhan Mantri Fasal Bima Yojana (PMFBY). State-wise coverage under PMFBY shows that Maharashtra tops in terms of proportion of farmers insured followed by Rajasthan and Madhya Pradesh. For Rabi in 2016-17, maximum farmers covered were in Uttar Pradesh followed by Rajasthan and Madhya Pradesh. The low claim to premium ratio under PMFBY signifies that crop insurance is economically more viable compared to previous schemes. Despite its huge potential, crop-loss estimation methods are inadequate. Delays in issuing notifications and extension of cut-off dates by the state governments can potentially lead to the adverse selection problem.

Inter-temporal and inter-spatial changes in nutritional security in India pointed out that calorie deficiency is more prevalent among urban households across all income classes, followed by protein deficiency. There is a strong need to create awareness about adequate intakes of energy and protein, bring in attitudinal and lifestyle changes, and ingest higher energy and protein. Further, different measures, rather than relying on a single measure, should be adopted for evaluating the prevalence of undernourishment and malnourishment in India. The analysis of nutrition transition in India suggested that insight on prevalence of calorie deficiency, based on uniform calorie threshold norm alone is likely to mislead. Health, environment and other associated attributes such as social infrastructure have a significant role in influencing the calorie intake across the states. Specifically, households residing in the states where the prevalence of disease and infection is lower are likely to have better nutrient absorption rates in comparison to those residing in less healthy ones.

The study on economics of tobacco showed that an integrated approach towards tobacco control, incorporating region-specific elements, seems to have better mileage in achieving the objective of controlling the use of tobacco. The supply-side measures focusing on agricultural diversification may be considered as long-term measures to supplement the demand-side measures. It should also be emphasized that only the demand-side measures within a country without global control of supply side, may not achieve the goal of tobacco control within a reasonable period of time.

Agricultural Markets and Trade

The Network project on "Market Intelligence" was carried out to provide reliable and timely price forecasts to farmers for more than 40 major non-traditional agricultural commodities (including more of high value commodities covering cereals, pulses, oilseeds, fruits, vegetables, spices along with fibre crops) through a network of 14 institutions throughout the country. Price forecasts for agricultural commodities were developed using scientific analysis to allow producers to make better-informed decisions and manage price risk. More than 180 pre-sowing and 263 pre-harvest price forecasts were disseminated through various means like personal contacts, SMS, television, radio, university websites, pamphlets and social network to the farmers before sowing and during harvests to facilitate informed and intelligent decisions by the farmers.

With innovations in application of statistical models, greater precision in price forecasts

was achieved overtime; however, forecasts of certain categories like horticulture and pulses remained volatile. Potato and onion are extremely sensitive to the impact of external influences on their prices. The farmers changed the marketing pattern, by storing commodities and selling them when prices were high, as per the price forecast information provided to them. The project also entailed regional studies which helped in understanding the price movements, linkages between marketing infrastructure and price behaviour, impact on farmers' decision making, etc. Timeliness, adequacy and reliability of forecast will be more useful for farmers if these are supported by market infrastructure and other logistics.

Poor transport and communication networks restrict farmers from accessing markets, and thereby create opportunities for middlemen or informal buyers to increase their share in the price paid by the consumers. Even in rice and wheat crops, small farmers were more dependent on informal channels, comprising local traders and input dealers. In some cases, paddy prices realized by the marginal farmers from local traders and input dealers are 15-16 per cent lower than those realized by large farmers, reflecting the differences in their bargaining power vis-à-vis buyers. The study revealed that the impact of information is comparatively strong, indicating that presence of roads itself is not sufficient, but it is effective when combined with reduction in asymmetry in information. In improving the efficiency of agricultural markets, the policy should promote investment in transportation infrastructure that reduces the cost of marketing, for both farmers and traders. Also, improvement in markets needs to be accompanied by development of market information system to reduce asymmetry in information between farmers and traders.

The project on "Promoting Value Chains of Agricultural Commodities"examined the value chains of important agricultural commodities with the aim to suggest financial, policy and institutional requirement for their modernization. Besides, the project would also include mapping of the supply chains, right from production to delivery to consumers. The special focus would be on product transformation for value addition and food safety issues. This would provide insight to planners and policy makers to reduce the weaknesses and capitalize on strengths of value chains of agricultural commodities. The buffalo meat in Uttar Pradesh, marine fisheries, tomato in Karnataka, organic ginger in NE Himalayan states, apple in J&K, are some of the selected value chains of agricultural commodities.

The analysis of recurring onion price shocks reveals that the main reasons for severe and frequent price shocks are production fluctuations and changes in nature of demand for onion. The study established a strong and significant association between onion production in any given year and the market arrivals in the following year. During the last 12 years period from 2005-06 to 2016-17, production of onion witnessed decrease in four years, followed by a decline in the market arrivals in the subsequent year. The study suggests that as onion markets are highly co-integrated, price transmission from one market to the other would be quick. Hence, there should be continuous monitoring of prices and market arrivals by some agency of the Central Government, which should also provide advance information to the Government about implications of production fluctuation on prices. Also, the role of Minimum Export Prices (MEP) in easing the domestic price situation is significant.

The project "Market Integration and Price Transmission in Tradeable Agricultural Commodities: Oilseeds" was formulated with the objective to measure the welfare loss that is due to existing institutional and infrastructural constraints in agri-marketing system. The

existing institutional and infrastructural constraints severely dis-incentivise oilseed producing farmers by limiting perfect price transmission and market efficiency, which are necessary conditions for the welfare of the farmers.

The Agricultural Outlook Model for oilseeds and pulses is being developed to generate medium and long term projections on key economic variables such as production, demand, stocks, trade, prices and policy, and to develop scenario analysis of policy impacts on those projected variables. These models also focus on two major staple food grains, viz. rice and wheat, and other state specific major crops to account for substitute and complementary relationships among them. It is an open model as it takes into account the trade flows of the commodities with respect to the rest of the world and endogenous prices are attached to the world market prices. Spatial dimensions have been incorporated by specifying supply side equations separately for different regions in the country. The study on market integration in edible oils showed that there exist unidirectional Granger causality at producer and consumer ends, and bidirectional causality was found between palm oil wholesale price and groundnut wholesale price, implying unequal role of market players. By using Engle Granger Threshold Co-Integration analysis, the study rejected the widely and usually followed assumption of symmetric price transmission and thereby established presence of imperfect competition elements in edible oil markets.

Technology and Sustainable Development

The study on technology foresight in agriculture seeks to understand the trends in agricultural research and innovation for developing technologies, institutions and policies that might be helpful in meeting upcoming challenges. The trends among plant varieties registered under 'Protection of Plant Varieties and Farmers Right Act (PPV&FRA) were analyzed. Over the years, there has been an increase in the total number of varieties registered. Majority of the varieties registered by the farmers came from the Jeypore-Koraput region in Odisha. Private companies had registered the varieties in both food (395 varieties) and non-food crops (214 varieties). The varieties were mostly from rice (120 varieties), maize (108 varieties), and tetraploid cotton (122 varieties). Public sector (ICAR, SAUs) had diverse set of crops and more number of varieties was registered in food crops (74 per cent).

The analysis of investment intensity and impact of agricultural research showed that there is under investment in agricultural research and education in spite of impressive impacts. Taking the example of rice, the study showed that agricultural research has contributed quantitatively in terms of increase in number of varieties and qualitatively by developing fine grain aromatic and stress tolerant varieties. Total factor productivity growth of field crops was 1.76 per cent per annum during 1980 to 2012; and 55 per cent of this was attributable to technological change, 43 per cent to technical improvement and 3 per cent to scale of farming. Further, it is estimated that one per cent increase in agricultural research expenditure per hectare may lead to 0.084 per cent increase in agricultural productivity. Similarly, one per cent increase in per capita income is likely to reduce poverty by 0.37 per cent. The results further suggested that returns to investments in extension services are quite attractive, and there is a scope for increasing outreach of information to accelerate spread of agricultural technology.

Impact assessment of mobile based app using Economic Surplus Model found that over the period of 2007 to 2022, this app is likely to produce total surplus of Rs. 9140.85 million, with net present value of Rs. 9111.94 million.

The internal rate of return was estimated to be 316 per cent. Another study on impact of ICT in agricultural education indicated that ICT has improved academic development of students. Internet speed, infrastructure facilities, availability of e-resources, operational knowledge of ICT tools and access to ICT were found to be most important factors for enhancing its adoption among the students, while training, computer availability and Wi-Fi availability in university campus were most significant factors for adoption of ICT among the faculty.

Under the strategic research component of "National Innovations in Climate Resilient Agriculture" (NICRA), location specific adaptation strategies were prioritized. The study developed several indices using the parameters relating to infrastructure, nutrition, economic development, health, sanitation, workforce, agriculture, and environment. An integrated Sustainable Livelihood Security Index (SLSI) was developed to identify and understand the relevance of various indicators for assessing the current resiliency status and adaptation strategy. The study identified 163 districts out of 637 having lower agricultural security, with most of the districts lying in the states of Uttar Pradesh, Madhya Pradesh, Arunachal Pradesh and Maharashtra. The study further identified several adaptation strategies across agriculture production, horticulture, agro-forestry and fisheries.

Assessment of vulnerability of wheat to heat stress using district-level data showed that heat-induced loss has increased over time. The harmful effects were slowed down with irrigation by moderating the heat stress. Given the tendency of a rise in heat stress in future, there is a possibility of accentuating its negative effect on crop production. A study of institutional innovations in irrigation water management observed that PRIs have played significant role in resolving the disputes related to water distribution. Another study on micro-irrigation showed that area coverage and promotion expenditure on micro irrigation during the period 2005-06 to 2017-18 have consistently increased, yet they converged in the recent time. Rajasthan (20.3 percent), Andhra Pradesh (15.3 percent), Maharashtra (15.2 percent), Gujarat (12.4 percent) and Karnataka (11.0 percent) have promoted micro-irrigation much effectively than the other states. Horticultural crops are the major beneficiary of micro irrigation system. The study further revealed that with the adoption of sprinkler irrigation, significant change in cropped area and yields of major crops are noticed on farmers' fields of Bikaner district of Rajasthan.

Keeping the value and volume mismatch of various components of agriculture, the study on re-designing crop geometry revealed that crop planning, cropping intensity, and input management need to be led by market intelligence and characteristics of agro-ecology. Agricultural development must be tempered by the challenge of making agricultural production sustainable, while keeping in control greenhouse gas emissions and conserving dwindling water supplies. Regardless of how all these and other puzzle pieces fall into place, the solution lies in addressing the basic concerns of what to grow, where to grow, when to grow and how much to grow.

A study in collaborative mode was undertaken to address the issues of sustainability of agriculture and efficient use of natural resources in Bundelkhand region. The study found that over the years there has been a heavy shift from surface to groundwater sources leading to depletion of groundwater table in the zone. The study estimated total irrigation water availability of 17 billion cubic meters from all sources with the composition of 60 per cent surface and 40 per cent ground water. The irrigation water availability per hectare of net sown area (NSA) in the region was estimated at 0.41 ha mm. Further work on Optimum

Crop Plan based on resource availability aims to bring out best suited cropping pattern that will promote sustainable development of farm and farming community.

The optimization of cropping pattern in Bihar revealed an increase in area under less water using crops like maize, pulses and vegetables, while decline in area was found under paddy, wheat and jute with existing water use. The study further showed that the optimum model at existing use of groundwater resource can contribute 7.83 per cent increase in farmers' revenue compared to the existing one, and with 25 per cent increased water, farmers' revenue may increase to the extent of 20.42 per cent. A similar study in Tamil Nadu suggested a decrease in area under high water consuming crops such as banana and turmeric, while higher area allocation was suggested under all other crops. Vegetables, commercial crops and sugarcane are suggested to be the most potential crops in the new optimum plan which gives rise to an increase in gross cropped area by 20 per cent and farmers' revenue by 27 per cent, as compared to the existing crop plan. The study highlighted the need for strengthening supportive measures like micro irrigation system, soil and water conservation programmes and more location specific subsidy support in minor irrigation structures.

Assessment of capacity of different Extension Advisory Service providers in terms of staff to agricultural land holdings ratio in Maharashtra indicated a wide gap among different organisations. It was as high as 4166 farmers/ staff in case of KVKs while lower in case of ATMA Staff. The study observed that wherever staff numbers are limited, ICT platforms help in better coverage. When emphasis is on skill development, then direct contact methods are very important and KVKs played an important role in such areas. Another study on intra-household access dynamics of EAS in Eastern India and its effects on technology adoption, yield and income in rice revealed higher access of men to EAS (22.51 percent) than women (7.48 percent). Predominant source of EAS was private agencies followed by public agencies. Access to advisories through electronic media was very low in the eastern region. Significant differences in use of chemical fertilizers and pesticides, as well as higher yield and marketed surplus between the households with and without access to EAS were found in the study.

Linkages and Other Activities

ICAR-NIAP also strengthened its linkages with various government departments and development agencies. Notable among these are Ministry of Agriculture and Farmers Welfare, Ministry of Consumer Affairs, Ministry of Water Resources, National Bank for Agriculture and Rural Development, Ministry of Finance, NITI Aayog, CG Centres and various state governments. The Institute also accelerated dissemination of publications, capacity building and other professional activities for larger participation of professionals and development agencies. NIAP also facilitated Peer Review of Indian Council of Agricultural Research and organised a number of interaction meetings of the Review Committee with different stakeholders. A sensitization workshop on Goods and Services Tax was organized for senior officials of ICAR, government departments and industry. Organization of NIAP Annual Day on 2nd May, participation in International Yoga Day, celebration of Swachh Bharat Mission through mandated activities, Hindi *Pakhwara*, and regular interaction with farmers through Mera Gaon Mera Gaurav are some other important activities of the Institute. The Institute is also implementing the reforms like cashless transaction and procurement of goods through e-procurement portals of the Government.

I PROFILE OF ICAR-NIAP

The National Institute of Agricultural Economics and Policy Research (NIAP), established in 1991 by the Indian Council of Agricultural Research (ICAR), is committed to strengthen agricultural economics and policy research in the National Agricultural Research System (NARS) of the country. The Institute acts as a think tank of ICAR and helps the Council through credible research to actively participate in policy debates and decision making. It serves as the nodal agency of ICAR for policy research and perspective planning of ICAR in view of changes at farm level and macroeconomic environment at national and international levels.

Location

The Institute is located in the Pusa Campus in New Delhi. It has in its close vicinity several institutes of ICAR and CSIR, viz. Indian Agricultural Research Institute (IARI), Indian Agricultural Statistics Research Institute (IASRI), National Bureau of Plant Genetic Resources (NBPGR), National Physical Laboratory (NPL), National Institute of Science, Technology and Development Studies (NISTADS) and National Institute of Science, Communication and Information Resources (NISCAIR). The Institute is very close to the National Agricultural Science Complex (NASC) which houses National Academy of Agricultural Sciences (NAAS), regional offices of nine Centres of the Consultative Group on International Agricultural Research (CGIAR) and offices of many professional societies. Thus, the Institute has the locational advantage in terms of multidisciplinary studies, inter-institutional interactions and research linkages, library facilities, etc.

Vision

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

Mission

To 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

Research Activities

Research activities of NIAP are broadly covered under the following three major theme areas: (1) Technology and Sustainable Development; (2) Agricultural Growth and Development; and (3) Markets, Trade and Institutions.

As a part of policy advocacy, the Institute organizes workshops and participates actively in policy debates and interactions where issues of major policy interests are discussed by the policymakers, academicians and stakeholders, etc. The Institute also organizes events where distinguished scholars and policymakers

debate policy issues for developing a deeper understanding of various development issues. Trainings and capacity building in frontier areas of agricultural economics and policy research are accorded high priorities by the Institute.

The Institute maintains close linkages with several national and international organizations involved in agricultural economics research and development. Collaborative research projects, seminars, workshops, publications and participation in policymaking bodies are the usual modes of policy interface which help improve the outreach of the Institute. The Institute regularly brings out publications like Policy Paper, Policy Brief, Conference Proceedings, and Working Papers, besides publication of research articles in journals of national and international repute. These serve as the main agents for dissemination of its research findings. The Institute has succeeded in integrating social science research into agro-biological research, and through its credible policy research and communication, has come to the expectations of its sponsors and stakeholders.

Management

The Research Advisory Committee (RAC) comprising eminent professionals, mostly from outside the ICAR system, ICAR official and farmers representatives, guides the Institute on its research activities. Prof. Abhijit Sen, President, Indian Society of Agricultural Economics (ISAE), is the Chairman of the present RAC. The RAC provides guidance to 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.

The functioning of the Institute is supervised by the Institute Management Committee (IMC). Besides, 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 illustrated in Figure 1.

INFRASTRUCTURAL FACILITIES

Agricultural Knowledge Management Unit

AKMU at NIAP is managing research information and products, and providing other research related information through electronic and web mode. The goal of AKMU is to strengthen information management using modern technologies within NARS. The unit is also helping in implementation of IT reforms and management system of ICAR. The major objectives are:

1. To put information close to managers and scientists
2. To build capacity to organize, store, retrieve and use the relevant information
3. To share information about NARS using NIAP website, and
4. To provide the technical assistance and instrumental support to the researchers on miniature basis

To attain these objectives, AKMU is well equipped with latest computers, servers, firewall (Fort iGATE 80c), 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

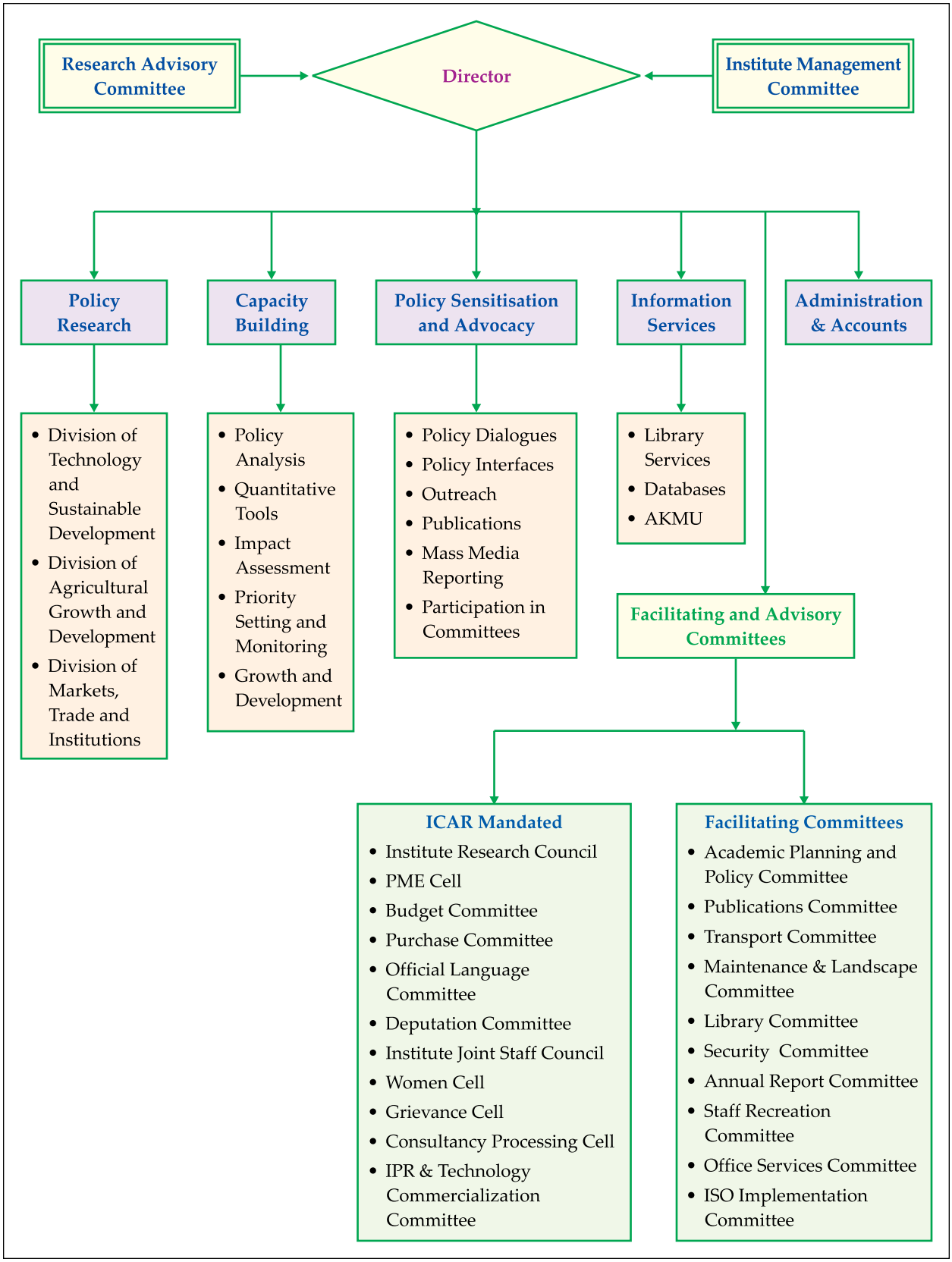

Figure 1 : Organogram of NIAP

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 with latest computers and software, LAN, email account, internet facilities and other required computational facilities. ICAR email system is being fully used by NIAP scientists now and ERP and FMS are fully operating. AKMU has been instrumental in installing video conferencing facilities at the institute.

MIS developed and used within ICAR like PERMISNET, PIMS, HYPM, MIS-FMS and many others as required by the Council are made use for various purposes.

Agricultural Knowledge Management Unit at NIAP

ISO 9001:2008 Certification

ICAR-NIAP operates a quality management system which complies with the requirements of ISO 9001:2008. It has initiated the process of upgrading the ISO certification 9001: 2008 to 9001:2015. ISO 9001:2015 and specifies requirements for a quality management system within an organization needs to: a) demonstrate its ability to consistently provide products and services that meet customer and applicable statutory and regulatory requirements, and b) enhance customer satisfaction through the effective application of the system, including processes for improvement of the system and the assurance of conformity to customer and applicable statutory and regulatory requirements.

Implementation of MIS-FMS

A centralized 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 & Payroll. Various functionalities provided by these modules are as follows:

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

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

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

d) **Human Resource:** Employee information, HR policies, Leave Management, Performance and Appraisal System.

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

Library

ICAR-NIAP library provides reading materials to scientists, agricultural policy makers, students and other stakeholders in the NARS. It 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 being made available through LAN to the library users. Library is conducting innovative information literacy programme of J-Gate, Consortium for e-Resources in Agriculture for NIAP staff. This

library is housing a total of 7354 publications including books, journals, bulletins, CD ROMs, database publications, reports, SAARC publications and other reference materials, etc. The Institute's library has subscription of 16 international journals and 18 national journals. Institute library has reserved a separate section for books of official language (Hindi).

Display of new arrivals in the library

During the period under report, the library procured publications which includes 8 reference books, 25 official language books, 6 CD ROM and 15 database publications. The Library also acquired 116 gift publications. 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.

Exhibition-cum-Record Room

Exhibition cum record room is a showcase to display and document research and other accomplishments of the Institute. It displays all 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.

NIAP Website

The Institute website (http://www.ncap.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 Institute's website is hosted by Education and Research Network (ERNET), New Delhi, and is updated on a regular basis. All the NIAP publications, viz. Policy Papers, Policy Briefs, Working Papers, PME Notes, Workshop Proceedings, etc. are available on the website.

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

Budget

The expenditure of NIAP and staff position for the year 2017-18 are presented in Tables 1 and Table 2, respectively.

Table 1: NIAP expenditure during 2017-18 (Rs. Lakhs)

Head	Grant Expenditure
Grants for creation of Capital Assets (CAPITAL)	
Equipment	15.42
Information Technology	27.32
Library Books and Journals	13.35
Others	9.73
Total Capital expenditure	**65.82**
Grants in Aid-Salaries (REVENUE)	
Total Establishment Expenses	**495.83**
Grants in Aid-General	
Research and Operational Expenses	178.29
Administrative Expenses	178.01
Others	59.97
Total expenditure Grants in Aid-General	**416.27**
Grand Total	**977.92**

Note: The expenditure on research for NEH and Tribal regions was part of the expenditure on research Programmes

Table 2: NIAP staff position during 2017-18 (Number)

S. No.	Name of the Post	Sanctioned strength	In position	Vacant
1.	R.M.P	1	1	0
2.	Principal Scientist	6	5	1
3.	Sr. Scientist	6	3	3
4.	Scientist	13	15	0
5.	Technical Assistant	4	4	0
6.	Technician	1	1	0
7.	Administrative Officer	1	1	0
8.	Assistant Administrative Officer	1	1	0
9.	Assistant Finance & Accounts Officer	1	1	0
10.	Private Secretary	1	1	0
11.	Assistant	4	4	0
12.	Junior Stenographer	1	1	0
13.	Upper Division Clerk	1	1	0
14.	Lower Division Clerk	2	0	2

II SIGNIFICANT RESEARCH ACHIEVEMENTS

AGRICULTURAL GROWTH AND DEVELOPMENT

Structural Transformation and Institutional Reforms in Agriculture[1]

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

Developmental process is described as a gradual shift of labour from low-productive to high-productive sectors alongside corresponding changes in output composition. India's history has been no exception either. However, the rate of decline in labour share of agricultural sector has been slower than in its output composition. Between 1981 and 2016, share of agricultural labour in total labour came down from 70 per cent to 42 per cent, while the share of agricultural output in the gross domestic product dropped faster from 42 per cent to 15 per cent (Table 3). The sectoral changes in output composition indicate that the decline in agricultural output has been accompanied by output generation in community, social and personal services during the 1980s, in trade, hotels and restaurants during the 1990s, and in financial sector after the mid-2000s. Interestingly, though trade and hotels have absorbed part of the labour, employment shares have not shifted towards those sectors where output levels have changed. Much of the workforce has rather shifted to the construction sector. Between 2005 and 2016, the workers' share in construction sector drastically increased from 5.6 per cent to 14.4 per cent. Barring construction and trade sectors, all the remaining sectors have failed to absorb labour, in spite of an increase in the output shares.

At the national level, industrialization phase is yet to develop fully with a rising share of manufacturing and service sector labour. To

Table 3: Sectoral changes in output and employment composition in India (1981-2016)

Sector	Output share (%)				Employment share (%)			
	1981	1991	2005	2016	1981	1991	2005	2016
Agriculture	41.81	34.11	23.26	15.42	69.83	64.78	56.72	41.99
Mining and quarrying	3.48	4.70	4.14	3.10	0.52	0.71	0.58	0.52
Manufacturing	13.49	15.24	16.49	17.85	10.43	10.62	11.25	11.77
Electricity, gas & water supply	1.45	1.99	2.24	1.98	0.28	0.32	0.24	0.25
Construction	8.03	7.57	8.85	8.39	1.99	3.74	5.61	14.40
Trade, hotels, restaurants	6.94	7.43	10.29	11.97	6.60	8.27	10.79	11.93
Transport, storage, communication	3.61	3.86	5.45	6.99	2.04	2.77	4.01	4.63
Finance, insurance, real estate, business	2.00	3.24	7.19	14.56	0.49	0.81	1.56	3.29
Community, social, personal	19.20	21.88	22.08	19.76	7.81	7.99	9.23	11.24

Source: Computed using India - KLEMS database, https://www.rbi.org.in/scripts/BS_PressReleaseDisplay aspx?prid=43504

[1] Part of the work is done in collaboration with Network Project (Structural Transformation, Regional Disparity and Institutional Reforms in Agriculture) Partners-Jawaharlal Nehru University, Lucknow University and Madras Institute of Development Studies.

better understand the developmental stages, an analysis was undertaken for the 17 major Indian states. Over the last six decades, the share of manufacturing sector output has been rising only for one-third of the states. None of the states has started to experience industrialization in the past 30 years. Between 1981 and 2016, Punjab, Haryana, Kerala, Karnataka, Himachal Pradesh and Uttar Pradesh have been relatively faster in reducing both output and employment in agriculture. The states at the other extreme are West Bengal, Assam, Bihar, Maharashtra and Madhya Pradesh. To understand the employment shifts further, district-level estimates have been generated for the years 1987 and 2011-12 using NSS EUS data. Districts in the northern and eastern states have higher rates of declining workforce in agriculture. The southern and central regions are relatively slower, and the districts in the western region depict low levels of shift in agricultural workforce (Figure 2). Within agriculture, the 'less farmers and more agricultural labour' trend was prominent in the southern states, while the opposite was true for districts of eastern India.

To study the role of inter-sectoral-shifts in national growth, a decomposition analysis was undertaken for the period 1982-2012. An increase in labour productivity had been the major source of growth during this period. Employment's contribution to growth had either been negative or negligible since mid-1990s, supporting the notion of 'jobless growth'. Inter-sectoral-shifts have contributed positively to growth, though with varying magnitudes. A major cause of this shift could be attributed to a consistent rise in the real wages in non-agricultural occupations. The non-farm sector's real wages have grown at a faster rate compared to the agricultural sector and thus attracted labour. The real wages have risen faster than the marginal labour productivity since 1990s and faster

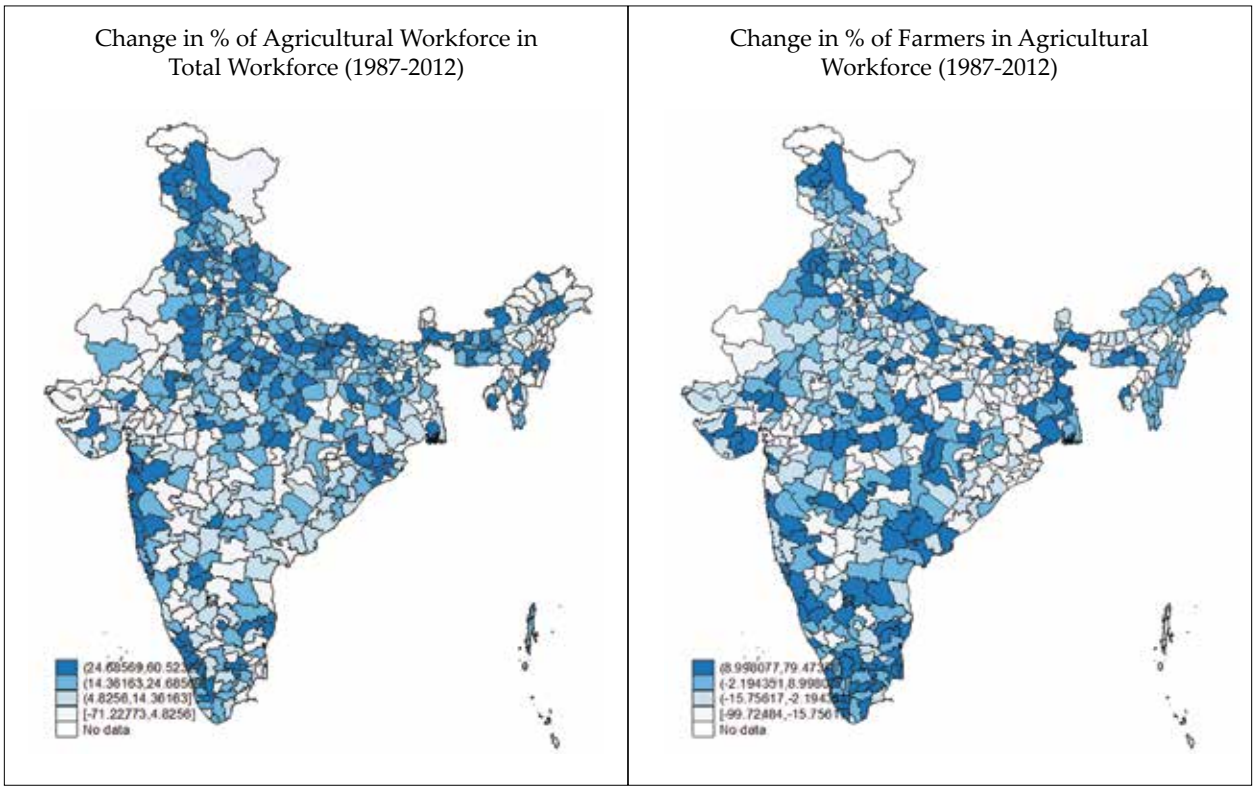

Figure 2: Spatial distribution of changes in agricultural workforce (1987-2012)

than the average labour productivity since mid-2000s, indicating the possibility of rising future wages. While the output share dropped significantly in agriculture, its composition has undergone major changes. Contribution of cereals has almost stagnated, while that of fruits and vegetables and livestock sector has become the major source of growth. Having crop-livestock output share as the measure of transformation in agriculture, state of transformation was studied for the period 1991-2016. Jammu & Kashmir, Tamil Nadu and Andhra Pradesh had been much faster in increase in allied sector share relative to the crop sector. Level of transformation was relatively slow in West Bengal, Himachal Pradesh, Madhya Pradesh, Assam, Karnataka and Maharashtra. Studying labour-oriented changes in agriculture revealed that the share of farmers in total agricultural workforce had consistently dropped down, especially since 1980s. More than 30 per cent of sub-marginal and around 20 per cent of marginal farmers derive their income through wage earnings, in both farm and non-farm occupations.

Role of investment in agricultural growth

Investment in agriculture is a major source of growth as well as transformation. Adding investments in irrigation along with investments in other sub-sectors of agriculture, Andhra Pradesh, Maharashtra, Gujarat, Karnataka and Madhya Pradesh have attracted a major share of public investments in absolute terms. Rather, investment per hectare indicates highest agricultural investments in Jammu & Kashmir (Rs. 6,198/ha), Haryana (Rs. 2,220/ha), Tamil Nadu (Rs. 1,455/ha), Kerala (Rs. 1,326/ha) and Himachal Pradesh (Rs. 1,131/ha), and investments in irrigation was higher in Andhra Pradesh (Rs. 30,254/ha), Karnataka (Rs. 29,267/ha) and Maharashtra (Rs. 28,818/ha). While the quantum of investment indicates preference, their efficiency in usage might vary across states. In order to study the efficiency in investments made in irrigation, stochastic frontier technique (using both time varying and non-varying approaches) has been employed in the study. Investment efficiency ranges from as high as 95 per cent in Uttar Pradesh to less than 10 per cent in Himachal Pradesh, Kerala and Assam (Figure 3). Further, investment efficiency has declined in almost all the states, indicating the need for interventions for its improvement.

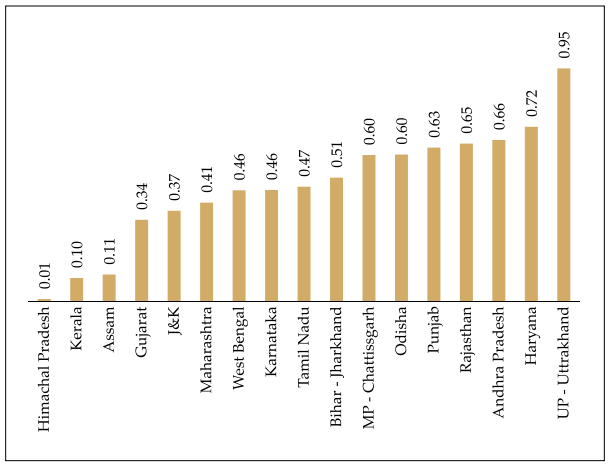

Figure 3: Technical efficiency in public investment in irrigation (1981-2013)

Rural Non-Farm Sector in India

Subash S.P, Prem Chand and Balaji S.J.

The trends in rural non-farm employment at state-level during 1993-2015 were analysed using various NSSO rounds and Labour Bureau reports on "Employment and Unemployment Surveys" (EUS). States like Tripura (52.4 per cent), Kerala (43.6 per cent), West Bengal (36.7 per cent) and Manipur (36.2 per cent) had high non-farm employment in 1993 (Figure 4.a). In 2011, rural non-farm employment was the highest in Tripura (69.2 per cent), followed by Kerala (68.6 per cent) and Manipur (54.5 per cent) (Figure 4.b). During 2015, it was the highest in Himachal Pradesh (76.6 per cent) followed by Kerala (70.2 per cent), Tripura (68.4 per cent) and Sikkim (58.1 per cent).

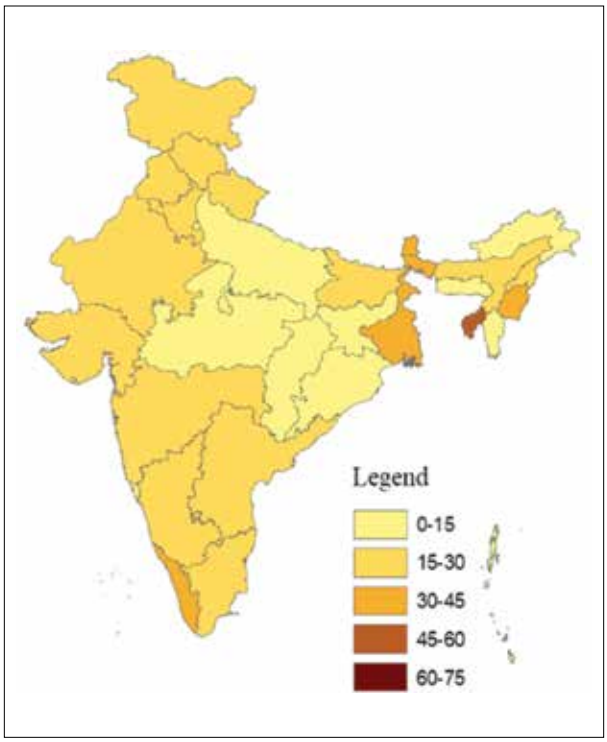

Figure 4 a: Share (%) of rural non-farm employment across states (1993)

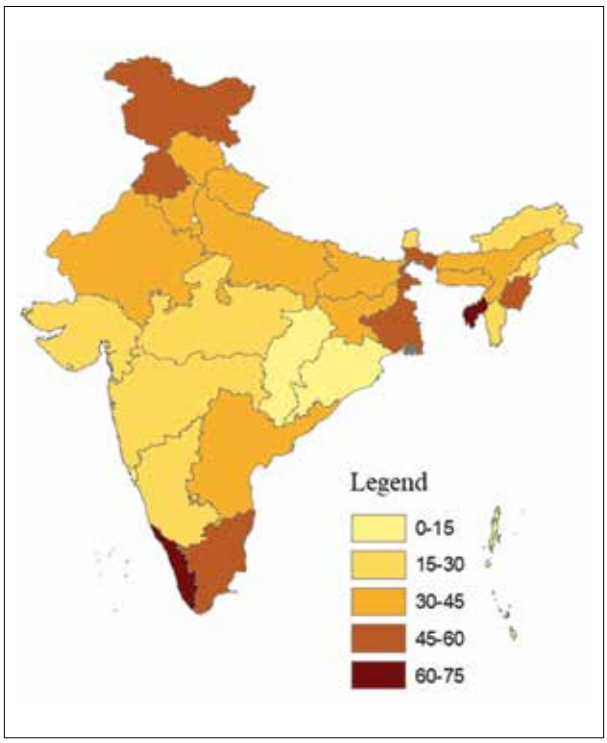

Figure 4 b: Share (%) of rural non-farm employment across states (2011)

In rural India, the movement of labour from farm to non-farm sector was more visible among individuals doing casual work, particularly those who were landless or had marginal landholdings. The movements in state-level monthly wages for the period from 1998 to 2013 indicate that wage rates across the states for different occupations have increased over time with a significant shift after 2009. During the same period, the wage difference between males and females had also increased. The initial assessment of the trends and patterns of rural non-farm income and wages shows dynamic changes in the last two decades.

Strategy for Doubling Income of Farmers

Raka Saxena, Naveen P Singh, Usha Ahuja, Balaji S J, Ranjit K Paul, Rohit Kumar, Md Arshad Khan, Biswa Bhaskar Chaudhary and Deepika Joshi

Strategies for doubling farmers' income need balance between both macro and meso environments. The yield gaps reflect loss in potential yield of the crops due to misallocation of resources and inadequate crop management. Nevertheless, bridging yield gaps is critical for, doubling income and need policy attention for the two major crops as these are grown by majority of the farmers in different parts of the country. The positive role of irrigation in productivity enhancement is unanimously accepted. Assured and timely irrigation not only encourages the farmers to take up the crops in field but also ensures higher production and thus income. The yield and income differential estimates with and without irrigation (Table 4) clearly signify that expanding irrigation coverage would be important for achieving the ambitious goal by 2022-23.

Table 4: Gains from irrigation on crop yield and farmers' income (2013-14)

Crop	State	Yield (quintals/ha)		Income (Rs./ha)	
		without irrigation	with irrigation	without irrigation	with irrigation
Rice	West Bengal	40.18	48.11*	51091	61369*
	Uttar Pradesh	35.76	40.33*	58659	59808
	Punjab	48.51	58.55*	96215	95995
	Odisha	28.38	52.85*	33064	63423*
	Chhattisgarh	30.69	37.25*	38927	45595*
Gram	Rajasthan	7.27	12.55*	20369	38853*
	Maharashtra	10.47	12.88*	30075	37155*
	Karnataka	9.42	10.59	28238	32250
Rapeseed & Mustard	Rajasthan	13.03	15.25*	39182	46189*
	Madhya Pradesh	14.66	15.43	43125	45779
	Haryana	13.44	17.14*	38714	49770*
	Uttar Pradesh	9.58	12.02*	28923	36948*
	West Bengal	10.82	13.04*	34051	40835*
	Gujarat	2.77	15.39*	8121	46045*
Cotton	Gujarat	0.38	22.54*	71094	109089*
	Maharashtra	17.81	20.03*	81735	91764*
	Andhra Pradesh	16.91	17.42	69778	72545
	Karnataka	14.78	16.63*	70639	81113
	Punjab	17.20	17.40*	89168	89148

Source: Computed by authors, *: Significant at 5% level of significance.

Crop diversification is also important and this may include shifting orientation from cereal dominance to high value crops (HVC) like horticulture. Even, as pulses are becoming a high value commodity, shift in favour of pulses can meet the nutritional as well as income security. Table 5 shows ratios of the gross revenue from fruits and vegetables to the gross revenue from cereals. Jammu & Kashmir and Himachal Pradesh, due to their agro-ecological typologies, are highly suitable for cultivation of horticultural crops. Small farmers in Himachal Pradesh are able to earn 23 times returns in HVC as compared to cereals. Cultivation of vegetables is profitable (in terms of gross returns) for small and marginal farmers in majority of the states, except Haryana and Uttarakhand. The diversification strategy requires strong emphasis on regional crop planning and preparation of optimum crop plans for identification of competitive crops which ensure reasonable income, nutrition along with sustainability to particular agro-climatic conditions.

Table 5: Ratio of the gross returns of high value crops to the gross returns from cereals

State	Marginal farmers (< 1 ha)		Small farmers (1-2 ha)		All categories	
	Fruits	Vegetables	Fruits	Vegetables	Fruits	Vegetables
Andhra Pradesh	0.8	1.0	2.2	1.7	1.7	2.4
Assam	1.7	1.7	2.5	1.1	1.9	1.5
Bihar	1.1	1.9	19.1	2.4	4.8	1.9
Chhattisgarh	-	2.7	2.4	4.1	2.2	3.2
Gujarat	1.9	1.8	1.9	2.6	2.1	1.7
Haryana	0.9	2.0	-	1.0	0.7	1.6
Himachal Pradesh	22.2	3.5	23.6	4.5	22.0	3.6
Jammu & Kashmir	28.5	1.4	10.4	1.9	27.9	1.4
Jharkhand	12.0	2.9	18.4	3.1	13.1	2.9
Karnataka	2.8	6.6	3.2	3.7	3.1	4.5
Kerala	2.6	1.7	2.1	1.7	2.4	1.6
Madhya Pradesh	-	2.5	-	2.5	-	2.5
Maharashtra	2.5	2.3	4.7	3.8	4.7	2.7
Odisha	9.9	2.8	2.3	2.6	9.2	3.5
Punjab	-	0.6	-	2.5	1.9	1.4
Rajasthan	-	1.3	-	1.0	0.4	1.5
Tamil Nadu	5.1	2.9	6.0	2.3	5.6	2.9
Telangana	-	2.5	0.7	3.6	1.0	1.7
Uttar Pradesh	1.8	1.9	3.1	1.6	2.3	1.9
Uttarakhand	3.7	2.1	-	0.7	3.4	2.1
West Bengal	3.6	2.2	4.4	2.4	3.7	2.2
Rest of the states	0.9	0.5	0.9	1.3	0.9	0.6
All States	6.1	2.1	4.5	2.1	5.9	2.2

Source: Computed by authors based on unit record NSSO data (2014).

To realize the goal of doubling farmers' income by 2022-23, it is important that the sources of growth in income are identified. Increase in TFP would be a significant contributor to output growth. Most importantly, commodity prices are subject to fluctuations due to changing demand and supply conditions. Instability in prices of vegetables remains a matter of concern; policymakers as well as all the participants along the food supply chain have an interest in the instability in agricultural prices. Irrigation management can bring a substantial growth in output and stability of yield and prices. Micro-irrigation can also bring substantial gains in productivity and resource use efficiency. Volatility can also be addressed through proper market information and intelligence efforts. Besides, effective post-harvest management and small-scale food processing at household-level would facilitate growth in farmers' income.

Enhancing the Livestock Incomes with Special Focus on Dairy Sector

Raka Saxena, Naveen P. Singh, Bishwa Bhaskar Choudhary, Balaji S.J., Ranjit K. Paul and Usha Ahuja

Livestock sector is now being considered as one of the promising sectors for enhancing farmers' incomes. This study looks into this sector's potential with special focus on dairying. The districts of major states were delineated into four broad zones based on livestock incomes using K-means clustering technique. These were named as: (i) least performing zone (LPZ), (ii) average performing zone (APZ), (iii) good/ moderate performing zone (GPZ), and (iv) well performing zone (WPZ). A wide variation was observed in distribution of districts into different zones. A large number of districts fell under LPZ (Figure 5) in almost all the states. Livestock farming appeared to be a sound source of income in Haryana and Gujarat as more than 50 per cent of geographical area of these states was under GPZs and WPZs, and area under LPZ was as low as 14 per cent in Haryana and 16 per cent in Gujarat. The entire state of Chhattisgarh and a majority of the districts in almost all the eastern and southern states were least performing in terms of livestock incomes.

The drivers of livestock income were identified through a multiple regression framework. A significant buffalo to cattle ratio (Table 6) highlights the importance of buffalo in generating income. Crossbreed's adoption and its milk yield contribute significantly in

Figure 5: Distribution of districts across the livestock zones, number

enhancing the income. Thus, crossbreeding strategy should be geared up, especially in LPZ to boost incomes. Although indigenous cattle do not have any significant influence on income, due attention on the productivity enhancement of local cows would be a win-win strategy owing to their good adaptation potential to climate stresses compared to buffaloes and crossbreeds. In LPZs of many states, agricultural households rely on non-farm income sources. Therefore, efforts need to be made to link value addition and processing activities in LPZs to create synergies between the producing zone and non-farm business opportunities in terms of small-scale milk processing. The state governments in conjunction with research institutions can play a major role in ensuring that livestock development programmes and services enable the livestock keepers to take full advantage of these opportunities. Specific priorities to foster investment on sustainable livestock development need to be listed for promoting livestock intensification amongst smallholders.

Table 6: Determinants of livestock income: Double-log function

Dependent variable: Livestock Income		
Variables	**Parameter estimates**	**Standard error**
Intercept	14.88	0.92
Buffalo to cattle ratio	0.16*	0.03
Buffalo milk yield	-0.39	0.26
Crossbred to indigenous	0.09*	0.02
Crossbred milk yield	0.42**	0.18
Indigenous cattle milk yield	0.25	0.15
Crop share	-1.58*	0.15
Non-farm share	-0.92*	0.1
Smallholder share	-0.28	0.17
R-squared	0.35	
Number of observations	335	

Note: *significant at 1 per cent level, **significant at 5 per cent level.

Inter-temporal and Spatial Changes in Nutritional Security in India

Jaya Jumrani

In this study, temporal as well as spatial changes in the nutritional security were evaluated on the basis of incidence of undernutrition (calorie deficiency) and malnutrition (protein deficiency) using household-level Consumer Expenditure Survey (CES) data of the National Sample Survey Office (NSSO) from 50th (1993-94) and 68th Rounds (2011-12). The study also analysed the scale of nutritional insecurity, both at the national and sub-national levels. The findings indicate that there has been a reduction in the actual calorie intakes across locale and expenditure classes during the 18-year period. According to the demographically and activity-adjusted ICMR-NIN norms, almost 60 per cent of the population in rural areas and 54 per cent in urban areas were undernourished during 1993-94 (Table 7).

Table 7: Prevalence of undernutrition and malnutrition across various income groups

Locale and Expenditure class	Undernourishment (%)		Malnourishment (%)	
	ICMR-NIN norm (1993-94)	ICMR-NIN norm (2011-12)	ICMR-NIN norm (1993-94)	ICMR-NIN norm (2011-12)
Rural				
Poor	78.65	84.67	45.97	51.44
Middle income	38.41	60.5	18.36	27.99
High income	16.25	34.4	8.21	12.83
All rural	60.67	65.93	33.75	33.58
Urban				
Poor	77.8	82.37	57.96	61.07
Middle income	42.13	55.71	32.38	41.15
High income	14.5	28.27	12.21	21.97
All urban	53.55	55	40.46	40.83
Rural + Urban	58.97	62.97	35.36	35.55

Note: ICMR-NIN norms are adjusted for age, sex and activity status.

This incidence increased by five and one per centage points respectively in 2011-12. Protein deficiency is less severe than calorie deficiency and is more prevalent among urban households across all income classes.

As expected, the prevalence of hunger declined with rise in income. This rate of decline was, however, stronger in the earlier times. Across all income categories, a consistent increase was noted in the prevalence of undernourishment throughout the 18-year period across rural and urban India. Protein deficiency is less severe than calorie deficiency and is more prevalent among urban households across all income classes. Almost all the southern states and also Gujarat, Maharashtra and Assam were much more calorie deprived than the BIMORU (Bihar, Madhya Pradesh, Odisha and Rajasthan) states. These findings reiterate the fact that calorie and income poverty are not moving in tandem in India. Interestingly, the not-so-poor southern states also had such high rates of protein deficiency.

The state-specific changes in the measures of nutritional deficiency were estimated and then arranged in ascending order of their magnitude. These changes in the context of rural calorie deficiencies are depicted in Figure 6. Negative changes point towards deterioration while positive changes indicate improvement. Figure 6.a depicts that only Andhra Pradesh, Himachal Pradesh, and Maharashtra witnessed an improvement in the incidence of calorie deficiency. Rural areas of Jammu and Kashmir show the largest deterioration in all the measures of caloric deficiency seeking special policy focus.

Using the Foster-Greer-Thorbecke (FGT) measures, three measures of nutritional insecurity i.e., calorie deficiency indicator (N0), nutritional deficiency gap index (N1) and squared nutritional deficiency gap index (N2) were computed. These measure the headcount ratio, depth and severity of

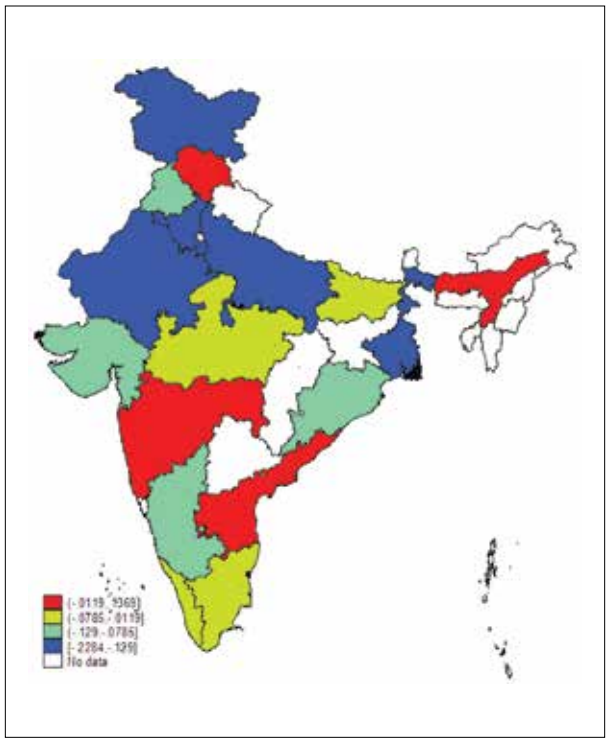

Figure 6.a : Spatial changes in rural headcount index of caloric insecurity (N0)

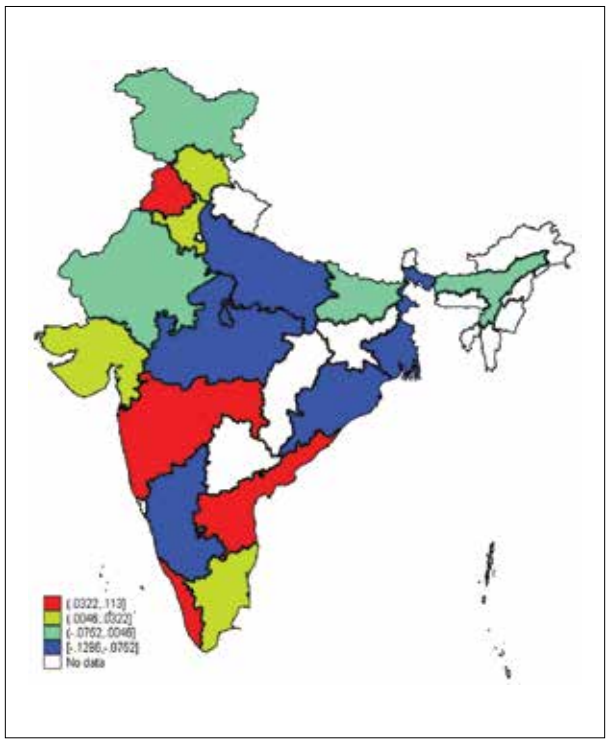

Figure 6.b: Spatial changes in urban headcount index of caloric insecurity (N0)

nutritional insecurity in a particular location. In terms of N0, rural areas of Himachal Pradesh experienced the biggest improvement, while rural Maharashtra observed the same for N1 and N2. In terms of the scale of nutritional insecurity, it is observed that overtime middle income households have fared the worst followed by high income and poor households in terms of reduction in caloric deficiency according to all the measures. The study concludes that there is a strong need to create awareness about adequate intakes of energy and protein and bring in attitudinal changes and adopt lifestyle changes to ingest higher energy and protein. Further, different measures, rather than relying on a single measure, should be adopted for evaluating the prevalence of undernourishment and malnourishment in India.

Looking Past the Indian Calorie Debate : What is happening to Nutrition Transition in India?

Md. Zakaria Siddiqui, Ronald Donato and Jaya Jumrani

The factors influencing calorie consumption were evaluated using large nationally-representative household-level data from the 50th, 61st and 68th CES Rounds of NSSO. The spatial nature of health environment and infrastructure, and its likely effects on caloric needs were also analysed. The disaggregated picture of calorie intake over time by rich and poor classes (Figure 7) revealed that a considerable shift was observed in consumption patterns away from calories derived from carbohydrates towards those derived from fat-based products, particularly for poor segments of the population.

The state-level and sector-specific prevalence rate of disease, was computed based on the proportion of households within a state which suffered from at least one of the specified illnesses using the data from 69th NSSO Round. The cross-sectional analysis for 2011-12 (68th Round) revealed that in addition to the household-level covariates, state-level contextual factors such as social infrastructure have a significant role in influencing calorie intakes across states.

Specifically, households residing in states where the prevalence of disease and infection is lower and thus better nutrient absorption

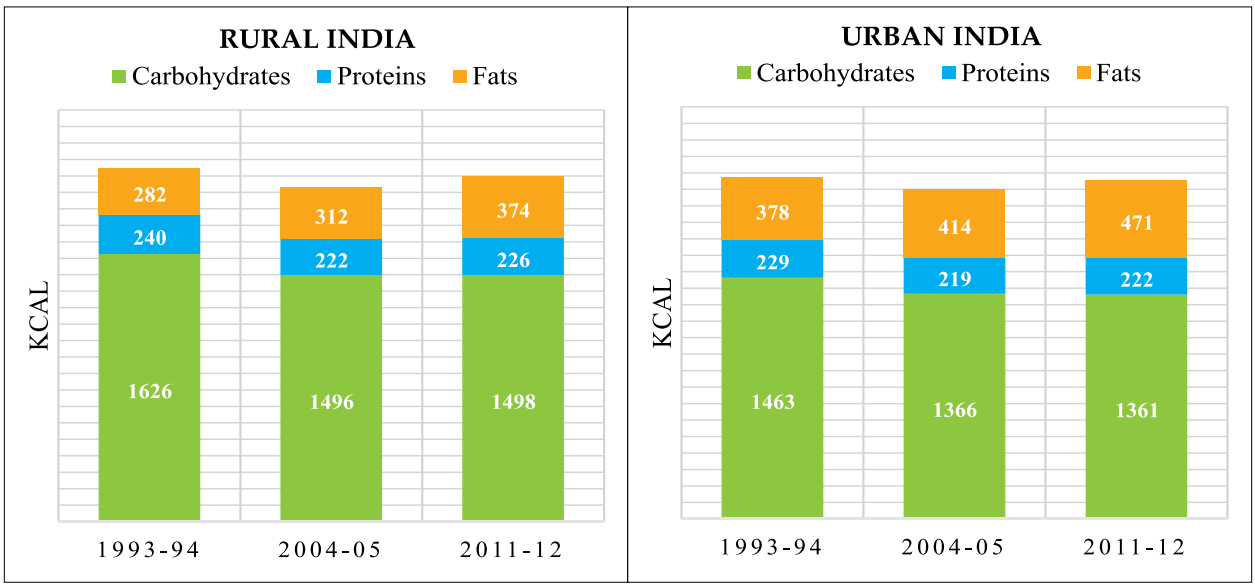

Figure 7: Changes in calorie intake and its composition (Kcal)

rates are more likely to have lower caloric requirements in comparison to those residing in less healthy ones.

Performance of *Pradhan Mantri Fasal Bima Yojana*

Pavithra S., Jaya Jumrani and Arathy Ashok

Crop insurance is an important instrument for risk pooling among farmers. India implements one of the largest crop insurance programmes in the world, the *Pradhan Mantri Fasal Bima Yojana* (PMFBY) with lower premium rate and village or village panchayat as the insurance unit. Other major features of the scheme include localized risk coverage for hailstorms, landslides and inundation, prevented sowing and post-harvest losses under cyclonic and unseasonal rainfall conditions. Under this scheme, premium paid by the farmers ranges between 1.5 and 5 per cent, and premium subsidy is applicable for all the notified crops. The cumulative number of farmers covered under the scheme until Rabi 2016-17 is 574 lakhs.

In 2015-16, the program witnessed the highest coverage in terms of area insured (28 per cent of gross cropped area). State-wise coverage under PMFBY shows that Maharashtra tops in terms of proportion of farmers insured (27.36 per cent) followed by Rajasthan (15.26 per cent) and Madhya Pradesh (10.08 per cent) (Figure 8). In Rabi 2016-17, maximum farmers covered were in Uttar Pradesh followed by Rajasthan and Madhya Pradesh (Figure 8). The low claim to premium ratio under PMFBY indicates that the crop insurance product is economically more viable compared to previous schemes. Despite its huge potential, the scheme is not devoid of challenges. Crop-loss estimation methods are still inadequate. In terms of the classification of loanee and non-loanee farmers, it has been noted that for some states such as Maharashtra, Jharkhand and Tamil Nadu, the share of non-loanee farmers was significantly higher than their loanee counterparts. This is probably due to the absence of a unified classification framework. Delays in issuing notifications and extension of cut-off dates by the state governments can potentially lead to the adverse selection problem. Proper formation of clusters, timely entry of information online and use of advanced technologies still need to be fine-tuned.

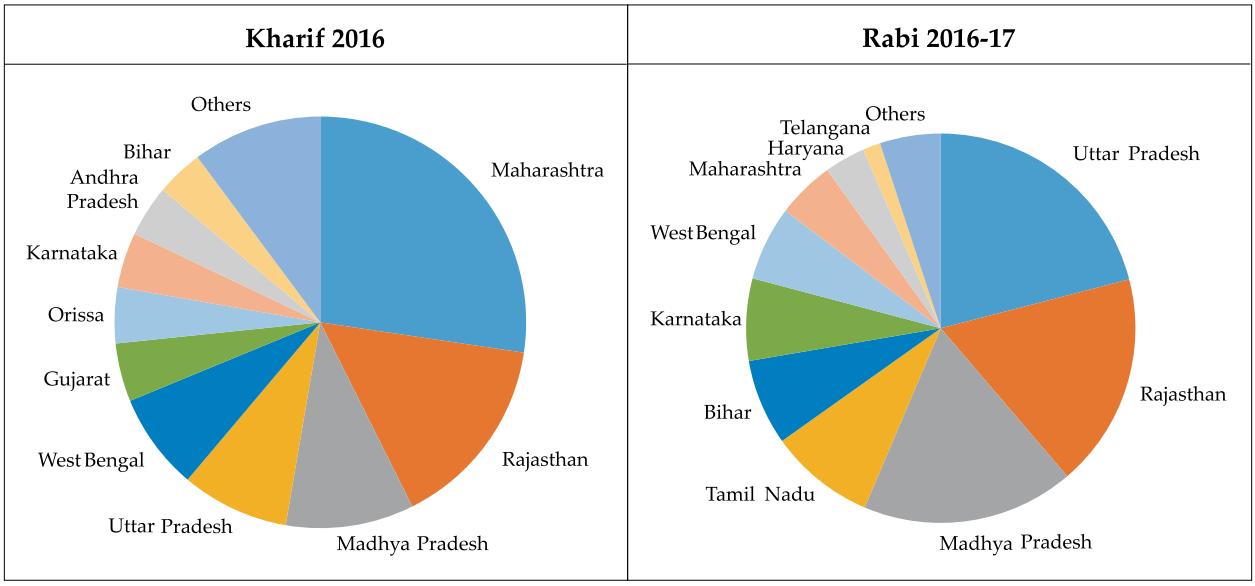

Figure 8: State-wise share (%) in PMFBY coverage (farmers insured)

Patterns of Farm Mechanization in India

Nalini Ranjan Kumar

Over the years, the annual sale of tractors and power tillers has continued to grow, and reached around 7 lakhs and 56,000, respectively during 2013-14 (Figure 9). In terms of tractor intensity, Haryana with 93 tractors per 1000 hectares (ha) tops the list while Kerala scores the least with 3.7 tractors and all-India average is 40.8 tractors in 2015-16. To better understand the trends in mechanization across states and crops, mechanization index (I_m), a ratio of cost of machine labour to cost of total labour (human + animal + machine) was computed. West Bengal was estimated to be as low as 9.8 per cent and Punjab was at 44.7 per cent, with a national average of 24.4 per cent during 2014-15.

There exists an increasing trend in farm mechanization across regions, crops and farm size categories over time. Mechanization index for the country as a whole increased from 21.5 per cent in 2004-05 to 24.4 per cent in 2014-15. However, the growth in mechanization during the period 2004-05 to 2014-15 was very high for some crops like jute (563 per cent), sunflower (113 per cent), lentil (97.3 per cent), maize (78.6 per cent) while for rapeseed and mustard, sesamum, wheat, sugarcane, and bajra, the mechanization index declined to 23.5 per cent, 19 per cent, 11 per cent, 6 per cent and 5.5 per cent, respectively (Figure 9). This might be due to an increase in area under these crops in less mechanized states and reduction in area in high mechanized states, and also due to an increase in labour wages in comparison to machine labour overtime. Diversity in adoption of farm implements across different regions and farm size categories can also be witnessed. Adoption of farm implements varied from 44.26 per cent in case of tractors to as low as 0.08 per cent in case of self-propelled transplanters during 2011-12. Agricultural

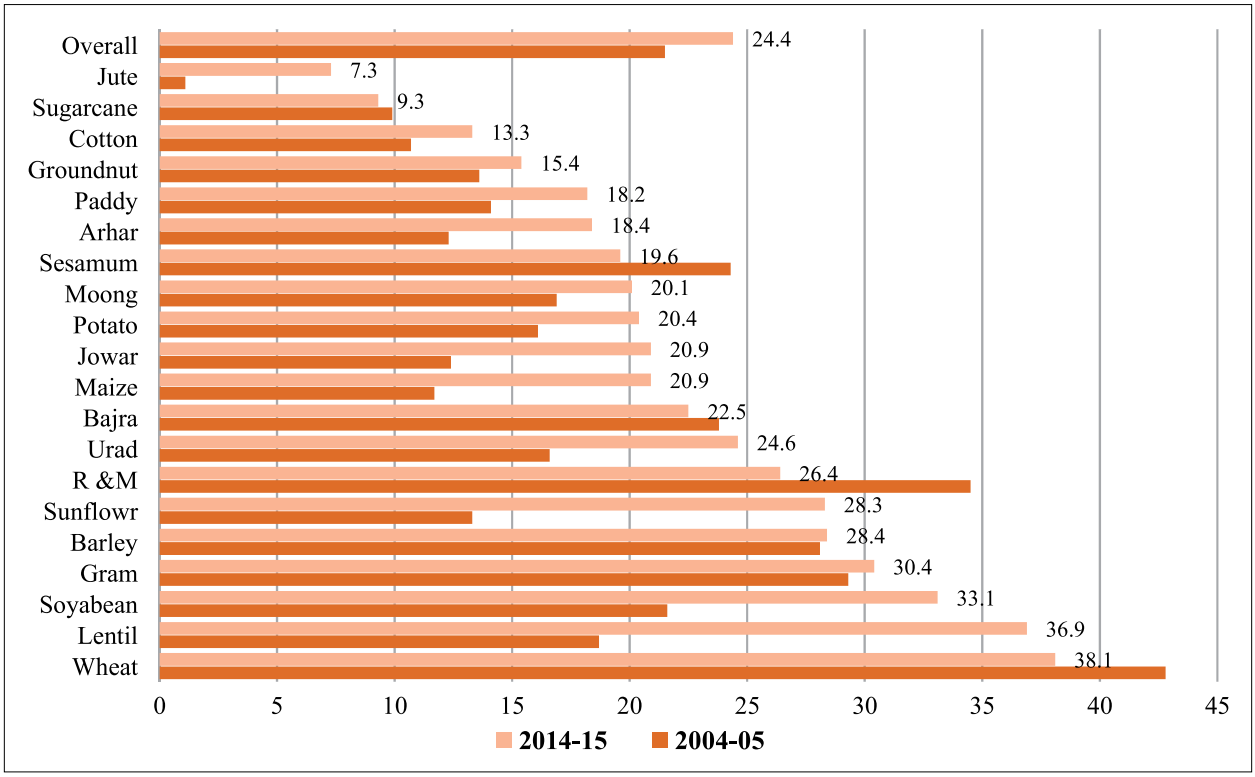

Figure 9: Changes in mechanization index of crops in 2014-15 vis-a-vis 2004-05

tractor was the most adopted implement among all the farm implements across all the regions of India, except North East Hill (NEH) region where power tillers were more popular.

AGRICULTURAL MARKETS AND TRADE

Pesticide Use in Indian Agriculture: Market Structure and Policy Issues

Subash S.P., Prem Chand, Pavithra S., Balaji S.J. and Suresh Pal

The trends in production and consumption, market structure and policy issues of pesticides in India were explored. Though there is an increasing trend in consumption of pesticides, roughly 50 per cent from period 2009-10 to 2014-15, the per hectare use of pesticide in India is much lower as compared to other countries (Figure 10). Pesticide consumption is the highest in Maharashtra, followed by Uttar Pradesh, Punjab and Haryana. Pesticide production in India is dominated by insecticides and fungicides followed by herbicides and rodenticides. The shares of fungicides, herbicides and rodenticides are growing over the period and replacing the insecticides share. Indian firms mostly import technical grades, or formulations which are protected through patents, and exports formulations. Brazil, USA and France are the major destinations for export of agro-chemicals from India (Table 8).

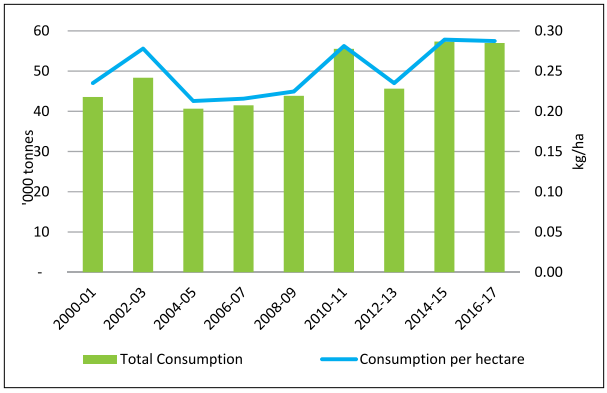

Figure 10: Trend in consumption of pesticides (technical grade) in India

The Insecticides Act (1968) and Insecticides Rules (1971) regulate import, registration, production, sale, transport, distribution and use of pesticides. The Central Insecticide Laboratory (CIL) is mandated to test the referral samples submitted by any officer or agency of the Central or State Government, while State Pesticide Testing Laboratories (SPTL) mainly test the samples taken at the manufacturing and point-of-sale for quality control.

Table 8 : Major export and import destinations for agro-chemicals in 2016-17 (tonnes)

	Country	Insecticides	Fungicides	Herbicides
Export	Brazil	9437.61	42898.27	20457.02
	U S A	3275.35	8307.82	6095.06
	France	Nil	7954.77	Nil
Import	China	11095.18	2220.28	15243.93
	Germany	1065.93	1523.81	-
	Japan	Nil	Nil	2428.02
	Israel	Nil	Nil	4732.66

Bio-pesticides have the potential to control crop losses and reduce negative environmental externalities. The study highlights importance of regulations and encourage the use of cost-effective and environmentally safe pesticides, and recommends uniformity in testing procedures, deregistration of outdated hazardous pesticides, point-of-sale quality assurance and competition promoting policies in the pesticide sector.

Farmers' Choice of Market Channels and Producer Prices in India

P. S. Birthal

Poor transport and communication restrict farmers from accessing remunerative markets and thereby create opportunities for rent seeking by informal buyers, i.e. local traders and middlemen. The informal buyers earn

rent because of information asymmetry where traders and middlemen know about prices and market conditions, and farmers either do not know or know imperfectly. Making use of two data-sets, i.e. Census of India (2011) that contains information on village-level amenities, and a large-scale nationally representative survey of farm households conducted by National Sample Survey Office in 2012-13 that provides information on sales of farm produce, we identify correlates of farmers' choice of market channels for paddy and wheat and subsequently the effect of road infrastructure and information on the prices received from different channels. From Figure 11, it is clear that about 80 per cent of the farmers do not receive government-determined minimum support price (MSP). This is because of the higher cost of transportation and information acquisition they, especially small farmers, are more dependent on informal channels, comprising local traders and input dealers. Some farmers also avail inputs and credit from them against their commitment of sale of produce as collateral.

The prices from informal channels are significantly lower; 9 to 13 per cent for paddy and 7 to 12 per cent for wheat (Table 9). Further, the price realization from other than government channels appear to be positively related to the scale of production or marketed surplus. Paddy prices realized by the marginal farmers from local traders and input dealers are 15-16 per cent lower than those realized by large farmers reflecting the differences in their bargaining power vis-à-vis buyers. Further, note that the prices from sales in the regulated markets are also lower than the MSP. However, those who sell in the regulated markets also receive lower prices than MSP.

The findings clearly show a positive association between prices and farmers' access to transportation and information (Figure 12). The impact of information is comparatively strong, indicating that presence of roads itself is not sufficient, but it is effective when combined with reduction in asymmetry in information.

These findings have important implications for agricultural policy. The policy should focus on improving efficiency of agricultural markets and their outreach by investing in transportation infrastructure that reduces

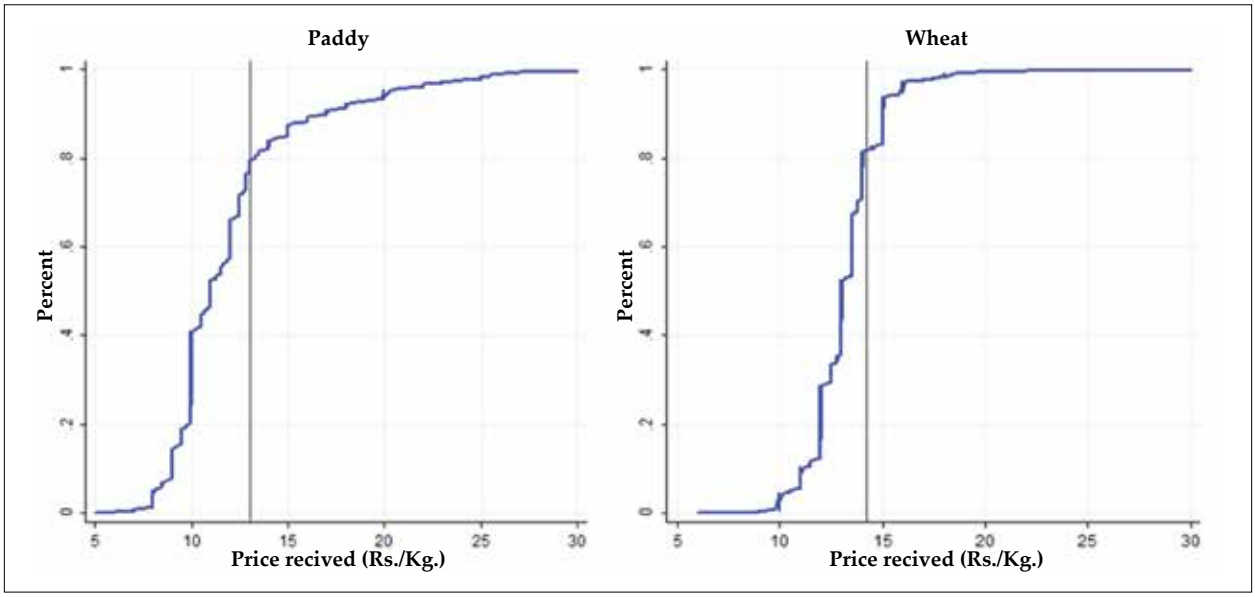

Figure 11: Cumulative distribution of producer prices

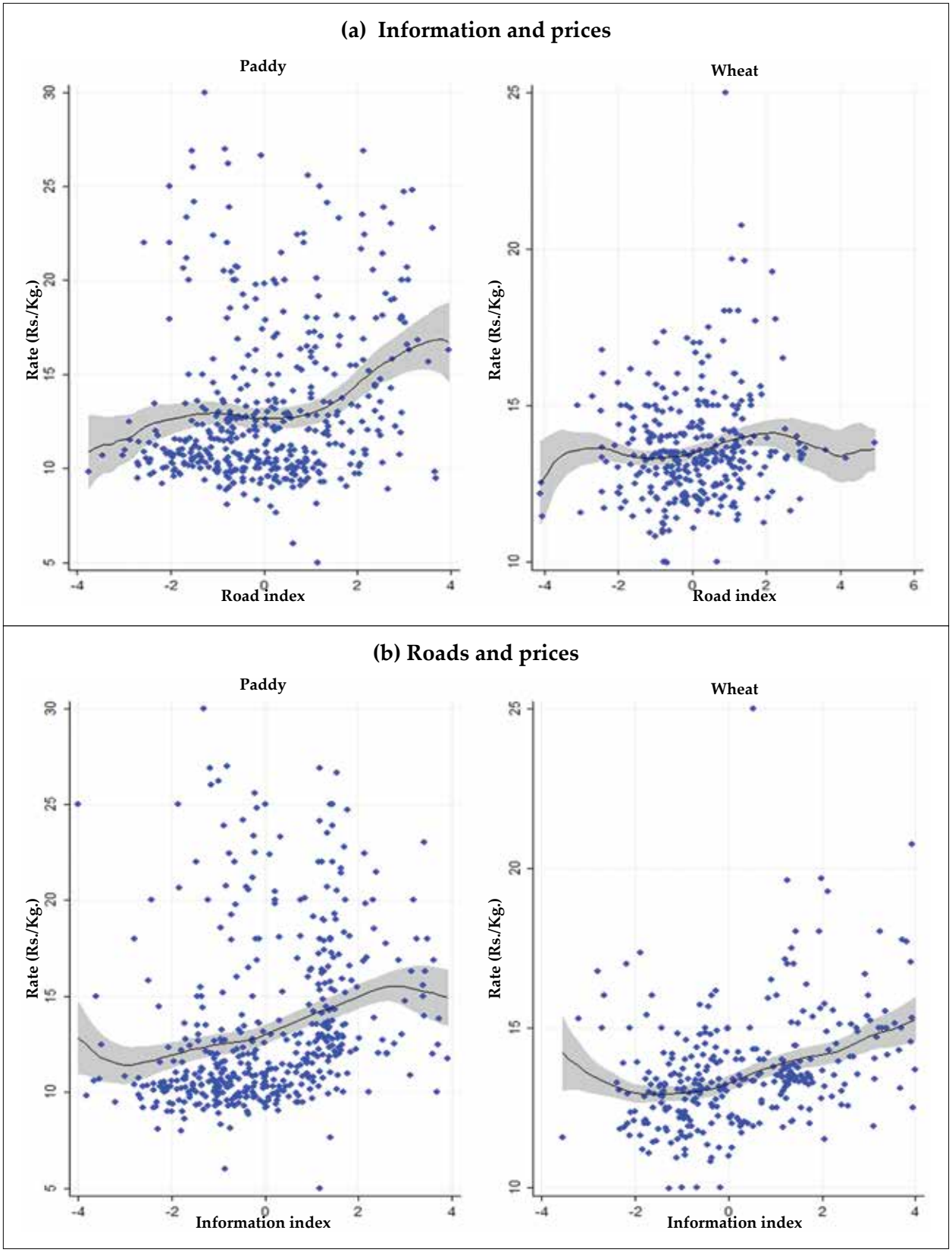

Figure 12: Roads, communication networks and producer prices

Table 9: Prices realized by farmers from different market channels (Rupees per kg)

Farm class	Local traders	Regulated markets	Input dealers	Government agencies	Processors	All
Paddy						
Marginal (<1 ha)	11.27 (0.15)	12.69 (0.36)	11.30 (0.30)	12.73 (0.15)	10.74 (1.24)	11.53 (0.17)
Small (1-2 ha)	11.48 (0.20)	12.12 (0.37)	11.80 (0.29)	13.18 (0.36)	11.85 (0.84)	11.83 (0.17)
Medium (2-4 ha)	12.36 (0.28)	14.71 (1.07)	12.52 (0.64)	12.88 (0.17)	13.38 (1.39)	13.02 (0.33)
Large (>4 ha)	13.27 (0.59)	13.85 (0.62)	13.49 (0.86)	13.83 (0.51)	14.08 (1.07)	13.64 (0.35)
Total	11.48 (0.14)	12.93 (0.32)	11.64 (0.23)	13.03 (0.17)	11.37 (1.00)	11.86 (0.14)
Wheat						
Marginal (<1 ha)	12.59 (0.14)	13.70 (0.15)	12.26 (0.37)	14.34 (0.15)	12.45 (0.74)	12.85 (0.12)
Small (1-2 ha)	12.86 (0.18)	13.62 (0.13)	12.63 (0.24)	14.15 (0.15)	14.24 (1.43)	13.22 (0.10)
Medium (2-4 ha)	13.48 (0.29)	13.84 (0.11)	13.00 (0.31)	14.40 (0.11)	12.88 (0.33)	13.71 (0.12)
Large (>4 ha)	13.51 (0.19)	14.11 (0.24)	14.05 (0.36)	14.10 (0.13)	15.57 (1.30)	13.99 (0.13)
Total	12.81 (0.12)	13.77 (0.08)	12.58 (0.24)	14.24 (0.09)	13.22 (0.64)	13.20 (0.09)

Figures in parentheses are standard errors clustered at village-level.

cost of trade for both farmers and traders. Improvements in markets need to be accompanied by development of market information systems to reduce asymmetry in information between farmers and traders. Finally, the financial institutions need to improve their outreach to smaller farmers to reduce their dependence for credit on local traders and input dealers who often tie it with output sale and extract rent by paying less than the market price.

Market Intelligence

Raka Saxena, Naveen P. Singh, Pavithra S. and Ranjit K. Paul

The Network project on Market Intelligence (2013-17) was carried out to provide reliable and timely price forecasts to farmers for more than 40 major non-traditional agricultural commodities through a network of 14 institutions throughout the country. Price forecasts for agricultural commodities were developed using scientific analysis to allow producers to make better-informed decisions and manage price risk. More than 180 pre-sowing and 263 pre-harvest price forecast were disseminated through various means like personal contacts, SMS, television, radio, university websites, pamphlets, Facebook, WhatsApp and YouTube etc. to the farmers before sowing and during harvests to facilitate informed and intelligent decisions by the farmers.

To provide the reliable information to the farmers, it is essential that forecast prices turn out to be closest to the actual market prices. It indicates the degree of closeness

of the forecasts to the actual market prices and reflects the quality of forecasts. Through innovations in methodological approaches followed, we could attain greater precision in forecasts overtime; however, certain categories like horticulture and pulses remained volatile (Figure 13). Potato and onion are extremely sensitive crops in terms of the impact of all external influences to the prices. The pre-harvest forecasts, due to obvious reasons, were more precise than pre-sowing harvests.

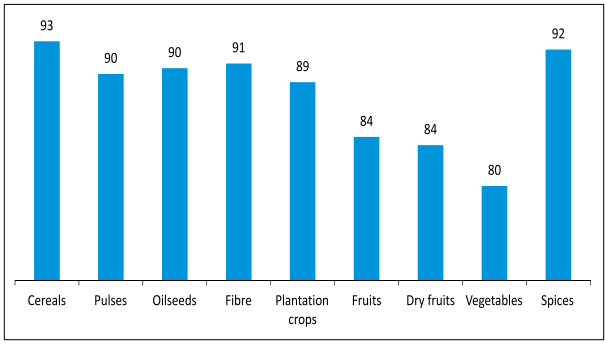

Figure 13: Price forecast accuracy for various crop categories (%)

The impact of price forecasts on the stakeholders was also examined. As hypothesized, the farmers changed the marketing pattern as per the price forecasts provided to them, farmers stored the commodities and sold when the prices were high as per the price forecast information. The details of quantity stored and price realized following the price advisories for selected commodities are given in Table 10. The prices for potato crop were expected to be low during March and high during May 2016 in Uttar Pradesh. This information was efficiently utilized by few farmers; they stored the crop

Table 10: Quantity sold and price realized for selected agricultural commodities, 2016-17

	Crops	Quantity stored (quintal)		Price received (Rs./quintal)	
		With price forecast	Without price forecast	With storage	Without storage
Gujarat	Castor	532	440	3281	3262
	Cotton	1154	1157	5124	4958
	Cumin	189	142	13518	13426
	Groundnut	878	1463	4792	4553
	Tur	390	319	8856	8852
Kerala	Black pepper	4	2	675-700	500-550
Maharashtra	Green gram	81	37	8250	6500
	Maize	297	95	1425	1250
	Onion (kharif)	10925	4225	770	650
	Red gram	158	70	7750	5300
	Soybean	104	50	3100	2850
Telangana	Bengal gram	128	12	4900	4000
	Chilli (kharif)	360	42	11000	8200
	Chilli (rabi)	36	10	12500	9500
	Green gram	114	26	7200	5500
	Groundnut (kharif)	104	30	4900	4000
	Maize (kharif)	522	145	1400	1250
Uttar Pradesh	Bengal gram	15	5	5763	5083
	Mustard	45	25	3760	3496
	Potato	85	15	911	655

during March-April and sold it in May which led to realization of 30-40 per cent higher price by them. The average increase in revenue (per quintal) of farmer was estimated to be Rs. 100-150 per quintal. Similarly in case of Gujarat, the cotton farmers benefitted from the price forecast information. The farmers followed the price advisory and the incremental gain realized per farmer was Rs. 36,000. Besides these, the project had also conducted studies which helped in understanding the price movements, linkages between marketing infrastructure and price behaviour, impact on farmers' decision making etc. Market intelligence efforts are extremely important and need to be institutionalized over time.

Demand and Supply Analysis of Sugarcane[2]

Balaji S. J.

To understand the linkages of crop sector with rest of the economy, sugarcane was taken as a case, and domestic and international demand and supply factors associated with sugarcane were studied. Farm-level factors that influence the adoption behaviour of sugarcane over other competing crops were first studied, and supply-enhancing factors were analysed later. To address the problem simultaneously, Heckman's sample selection model was adopted using more than 35,000 farm households' characteristics provided by the NSSO's Situation Assessment Survey (2012-13). The results of the study revealed that market price of competing crops such as paddy and cotton have negative relationship with crop selection and quantity of sugarcane produced.

Minimum support price was also positively related to the choice and output of sugarcane. Also, crop diversification, farm size, family size, availability of credit and insurance has positive relationship the sugarcane production at the farm level. To understand the factor demand and output supply factors further, restricted Translog profit function was employed and elasticities of factor demand and output supply were computed using plot-level cost of cultivation data. Results revealed that inputs compete with each other in use (Table 11). Higher the price of an input, lesser was the demand for itself and competing resources, shown by the negative elasticities. Output prices had a positive effect on input use.

Table 11: Input demand and output supply elasticities for sugarcane (2011-12 to 2013-14)

Quantity Input/Output	Prices of					
	Output	Fertilizer	Labour	Machine	Land	Capital
Fetilizer	2.460*** (0.105)	-2.004*** (0.095)	-0.344*** (0.072)	-0.112*** (0.023)	3.572*** (0.959)	-1.838*** (0.666)
Labour	2.018*** (0.061)	-0.064*** (0.013)	-1.924*** (0.051)	-0.030*** (0.011)	3.536*** (0.957)	-1.810*** (0.665)
Machine	1.821*** (0.124)	-0.175*** (0.036)	-0.248*** (0.095)	-0.344*** (0.040)	3.490*** (0.961)	-1.912*** (0.667)
Output	-3.040*** (0.081)	0.576*** (0.024)	2.531*** (0.076)	0.273*** (0.019)	2.906*** (0.953)	-1.649** (0.663)

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

[2] This work is done in collaboration with MIDS (Chennai)

Value Chains of Agricultural Commodities in India[3]

Shiv Kumar, Abimanyu Jhajharia and T. K. Immanuelraj

In India, the existing marketing structure for agricultural commodities is unorganised and inefficient, wherein value addition is done in very limited scale. This is mainly due to poor connectivity of supply chains in agricultural commodities in general, perishable commodities in particular, as most of these products are sold outside primary markets, and their market infrastructure and information are inadequate. Further, investment in food processing is very low, and food safety issues are not paid adequate attention.

On the consumption side, structural changes are happening at faster rate than changes in production front. The consumption requirements are not adequately responded by changes in the processing, marketing and production systems. The drivers of structural change can work well when (a) supply chains are compact, (b) there is adequate flow of information, and (c) there is capacity to respond to these drivers of change.

This project intends to examine present status of value chains of key agricultural commodities with the aim to suggest financial, policy and institutional requirement for their modernization.

Besides, it would not only cover present marketing arrangements for select agricultural products but also include mapping of the supply chains right from production to delivery to consumers. The special focus would be on product transformation for value addition and food safety issues. This would provide insight to planner and policy makers to reduce the weaknesses and capitalize on strengths of value chains of agricultural commodities. Specific value chains for selected commodities is given below.

Meat

India's meat production is around 21 per cent to total value of output from livestock sector, only next to milk group. In a span of 11 years from 2006, its production increased from 2.3 million tonnes to 7.4 million tonnes (2016-17). Globally, India has emerged as a leader, captured around 22 per cent market share during 2013-14. This is mainly attributed to safe, quality meat production with better infrastructure in export oriented processing sector. Moreover, to regulate the flow of clean, safe and hygiene meat in the country, the various legal measures/laws were put in place to govern the meat industry. India's food regulations were harmonized as per international standards to regulate their manufacture, storage, distribution, sale and import enabling unidirectional compliance by stakeholders involved in meat value chains.

However, literature and past experience reveals that there is potential of economic losses due to diseases like Foot and Mouth Disease (FMD), Hemorrhagic Septicemia (HS), Peste des Petits Ruminants (PPR), Classical Swine Fever (CSF) and Brucellosis, have reportedly caused losses to the extent of Rs. 14000 crores (2013), Rs. 5255 crores (2014), Rs. 4500 crores (2017), Rs. 429.91 crores (2014) and Rs. 22000 crores (2015), respectively. Application of value chain approach to manage, livestock disease risk and improve food safety assumes greater importance.

Marine fisheries products

Marine fishery sector contributes around 4 share in agricultural GDP. During 2017, marine fishery export forms around 3 per cent

[3] This work is done in collaboration with IVRI, NDRI, IIHR, CAU, SKUAST and CMFRI.

of total agri-product exports. According to CMFRI estimates, private capital Investment was Rs. 22,662 crores in the year 2015. The maximum private investment channelled into mechanized fish catch (Rs. 20,810 crores and 91.83), followed by motorized boat (Rs. 1,498 crores and 6.61) and rest in non- mechanized boat (Rs. 354 crores and 1.56). This shows the sector has attained substantial private capital augmentation for mechanization of marine fishery. The literature reveals marketing efficiency of marine fishery sector was around 50-60 per cent across states.

Tomato

Karnataka is the leading tomato producer state in southern India. The yield of tomato is highest (33.94 t/ha), except Andhra Pradesh, as compared to the national average (24.36 t/ha). The annual technological gain (yield) in tomato production has been around 2.11 per cent during the period TE 2003-04 to TE 2016-17. The annual growth in fresh tomato export is around 50 per cent in value terms which shows spectacular performance. Currently, India is able to enhance share of export in production of tomato from 0.11 in TE 2003-04 to 1.75 in TE 2016-17.

Organic ginger

India is the largest producer of ginger accounting 0.65 million tonnes (30 per cent) out of global production of 2.15 million tons in 2014-15. As per FAO statistics, China occupied second place with about 21 per cent; Nepal came in third place with about 13 per cent share. The North Eastern states are the major supplier of ginger, accounting for about 26.61 per cent of total area and 24.82 per cent of the total ginger production of the country. Meghalaya, Mizoram and Arunachal Pradesh are the leading states. Ginger is grown as main cash crop, supporting the livelihood and improving the economic level of many ginger growers. A large number of tribal farmers still practice the traditional methods of cultivation with the utilization of organic input, which are generally safe, eco-friendly, less expensive, and hence has huge potential under premium organic trade.

Apple

Apple is one of the important temperate fruit crops, accounts for 76 million tonnes in world production, in 2012. China alone contributed almost half to the world production (49 per cent), followed by United States (< 5 per cent), Turkey (3.8 per cent), Poland (3.8 per cent), and India (2.9 per cent). Jammu and Kashmir, Himachal Pradesh, Uttarakhand and Arunachal Pradesh are the major apple producing states of India. Jammu and Kashmir contributes 65-68 per cent of total production of India and generates an income of Rs. 5000 crores annually for the state. Nevertheless, production system in India is plagued with weak production and supply chain, poor marketing strategies, low transparency in the marketing system which have turned the terms of trade against producers. Due to powerful intermediaries in the marketing system, present marketing has an inherent tendency to give more benefits to these intermediaries at the cost of small apple growers.

Econometric Analysis of Import Demand of Pulses in India

Sharath S. Yeligar, Shiv Kumar, D.R. Singh and Parwin Arya

India's per capita consumption of pulses has been declining continuously while aggregate demand has been simultaneously increasing due to demographic and socio-economic changes. Over the decade, pulse import grew by 35 per cent. Even, during 2016, the government of India took an unprecedented step to explore the possibility of leasing land in African countries and Myanmar, to grow pulses for export back to India. This study

attempts to understand the important factors that lie behind the increasing import demand using trade data from 1980-81 to 2013-14. The dynamic ordinary least squares (DOLS) model was used to capture short term and long term import demand elasticity of major pulses.

The result reveals that the relative price (domestic wholesale vs international price) of pulses was significant only in the short run, not in the long run. This implies that import of pulses cannot influence in the long run through changes in prices or tariffs, as domestic prices are much higher than world price. Amongst other factors, income and urbanization were influencing in the long run. With existing vibrancy of Indian economy, rising pace of urbanization and per capita income would persistently boost the import demand for pulses. The study concludes that import demand is not likely to go down rather go up. Hence, to meet the increasing demand, Govt. can procure the pulse through long term formal agreements with exporting countries which can reduce the instability in pulse import to a large extent. Operation of this formal trade ensures assured supply at predetermined prices and predetermined time. Besides, this study suggests that imports need to operationalized quickly as per seasonality and harvest time of the exporting countries.

Production–Trade–Price Linkages and Onion Price Shocks

Raka Saxena and Ramesh Chand

Onion prices in India are highly volatile. The price spikes are turning frequent and severe over time, sometimes creating a situation of price crisis. The main reasons for severe and frequent price shocks are production fluctuations and changes in nature of demand for onion. Considering this, a study was conducted to analyse various dimensions related to production, trade, consumption, prices and price transmission in onion with a view to suggest suitable policy options to control or mitigate the recurring onion price shocks. Price transmission analysis was applied to analyse the linkages and transmission of onion prices to different domestic markets, export and onion Wholesale Price Index (WPI). The market behaviour was studied using data on onion arrivals and prices in Azadpur market in Delhi; Lasalgaon, Pune and Solapur markets in Maharashtra; Bengaluru and Hubli markets in Karnataka; and Indore market in Madhya Pradesh.

This becomes evident from close examination of the sequence of change in production, market arrival and prices during the crisis year and in the year preceding the price crisis for the state of Maharashtra. A very strong and significant association is seen between the production in any given year and market arrivals in the state in the following year. During 2005-06 to 2016-17, production of onion witnessed decline in four years, followed by a decline in the market arrivals in the subsequent year in each case (Table 12). The next change was witnessed in domestic prices. In year 2007-08, the production declined by about 4 per cent leading to decline in arrivals in 2008-09 by about 9 per cent. This sequence got repeated in the same way in years 2009-10, 2012-13 and 2014-15, where production decline of about 20, 17 and 9 per cent led to 17, 16 and 12 per cent decline in the arrivals, respectively. The decreased arrivals immediately impacted the market prices.

As understood, the minimum export prices (MEP) should ease the domestic price situation of onion as the export policy relies heavily on the tool of MEP to correct the onion inflation. It is assumed that MEP should correct the onion inflation with one time lag. Figure 14 demonstrates the changes in MEP in a month and changes in onion inflation (measured through onion WPI) during the subsequent month.

Table 12: Trends in production, arrival and prices of onion in Maharashtra

Year	Production (Th tons)	Arrival (Th tons)	Price (Rs/ton)	Change in Production (%)	Change in Arrival (%)	Change in Price (%)
2005-06	2469	2321	396			
2006-07	2812	2417	537	13.9	4.1	35.6
2007-08	2713	2985	564	-3.5	23.5	5.0
2008-09	3933	2719	734	44.9	-8.9	30.1
2009-10	3146	4113	860	-20.0	51.3	17.2
2010-11	4905	3405	1051	55.9	-17.2	22.2
2011-12	5638	3308	594	14.9	-2.8	-43.5
2012-13	4660	3702	878	-17.3	11.9	47.8
2013-14	5864	3108	1489	25.8	-16.1	69.6
2014-15	5362	3548	1333	-8.6	14.2	-10.5
2015-16	6529	3132	1382	21.8	-11.7	3.7
2016-17	-	5603	660	-	78.9	-52.2

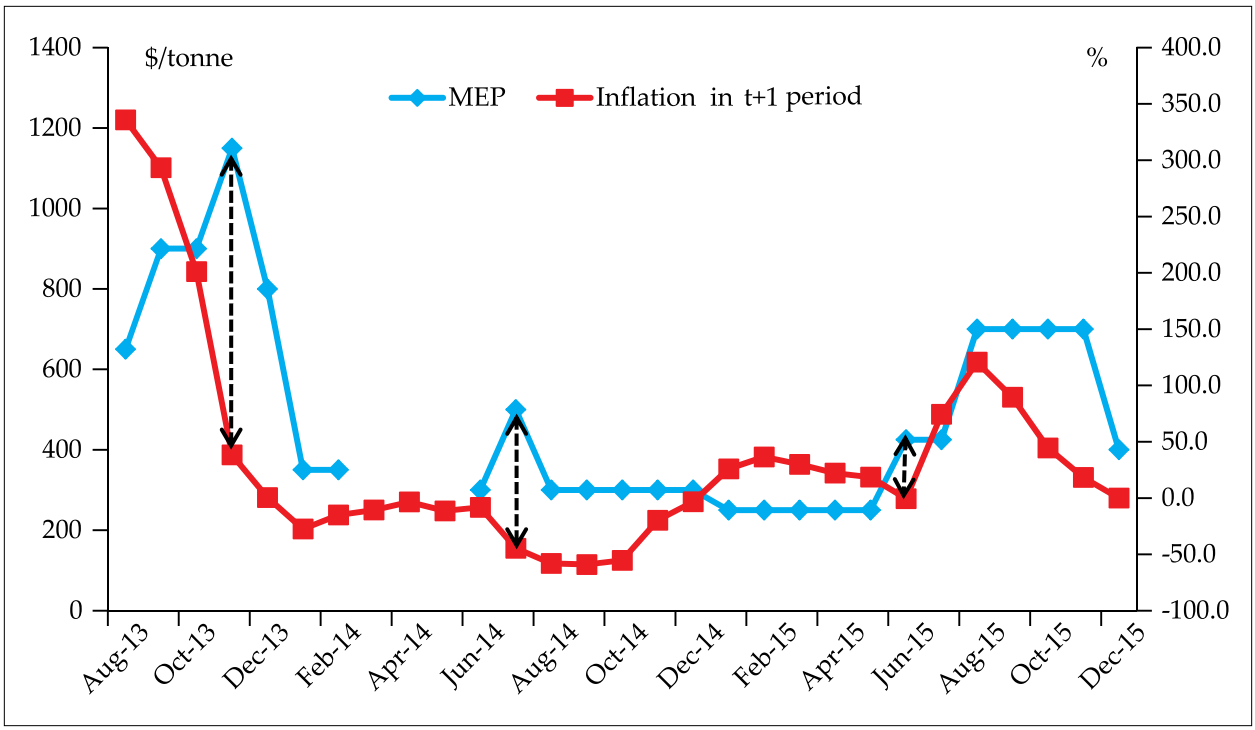

Figure 14: Comparison of changes in minimum export prices and onion inflation

The plots of both the series clearly demarcate that imposition of higher MEP in November 2013, July 2014 and June 2015 was able to lower the onion inflation in subsequent months, i.e. December 2013, August 2014 and July 2015. However, MEP is just one factor in controlling the inflationary situation caused due to onion; it is largely governed by the management of domestic supply situation of onion.

Onion markets are highly co-integrated with each other and thus prices are transmitted from one market to the other quickly. There should be continuous monitoring of prices and market arrivals by some agency of the Central Government, which should also provide advance information to the Government about implications of production fluctuation on prices. This should be followed by appropriate and early action, based on market intelligence to regulate trade, like liberalising import, restriction on export and check on hoardings.

Asymmetric Price Transmission in Groundnut

T.K. Immanuelraj, Shiv Kumar and Abimanyu Jhajharia

Being the largest importer of edible oils, third largest consumer in terms of per capita consumption, fourth largest oil seed producer in the world, India's presence in global edible oil market is very significant. The stagnation in oilseeds production and increasing effective demand through increasing per capita income, and population growth, cheap edible oil in the international market have widened the demand supply gap. Hence, India's import demand for edible oils have continued to increase over the years (Figure 15). Of late, edible oil imports is around 15 million tonnes in 2016-17, accounting for nearly 70 per cent of total consumption in the country. The major components of edible oils are palm and soft oils. The palm oil is the cheapest among all the edible oils, accounts two-thirds of total edible oils import, mainly sourced from Indonesia and Malaysia. In relation to home-grown edible oils, namely groundnut oil, mustard oil, sunflower and soya oil, the palm oil is much cheaper.

The area under oilseed cultivation has stagnated between 26–28 million hectares over the last several years. Though, breakthrough in oilseed productivity, and attaining self-sufficiency in oilseeds and edible oils production seems to be elusive dream, there has been a conscious attempt in recent years to improve production by adjusting price parity of oilseeds through increase of Minimum Support Price (MSP), implementing schemes like National Mission on Oilseeds and Oil Palm, regulating import prices through tariff rate, and taking up various other measures related to technology, institutions and policy.

However, the fact of existing institutional and infrastructural constraints in agri-marketing system in the country that severely dis-incentivise oilseeds producing farmers are not undeniable. Because they limit perfect price transmission and the market efficiency which is necessary condition for the welfare of the farmer. The nature of vertical integration and price transmission in the marketing chain of groundnut oil was carried out using monthly price series secondary data from 2009 to 2017. The co-integration results reveal that all the market price series were co- integrated. The results of granger-causality test shows that bidirectional causality was found between palm oil wholesale price and groundnut wholesale price, implying both prices are interdependent and move in tandem. However, at the producer and consumer end, uni-directional causality was found signifying that groundnut seed price and groundnut oil

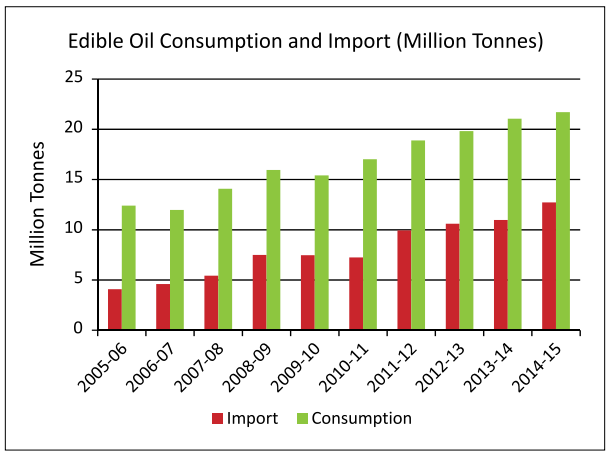

Figure 15: Edible oil's import and consumption

retail price were determined by groundnut oil wholesale price.

The special significance of the study is rejecting the usually followed assumption of symmetric price transmission using Engle Granger Threshold Co-Integration. The results revealed that though there is long-run equilibrium relationship found between the price series of groundnut oilseed and wholesale groundnut oil, adjustment to the disequilibrium was not symmetric as assumed by usual co-integration studies. The positive shock coefficient was estimated to be -0.07 and insignificant, implying that if the groudnut oilseed price increase, immediately that shock (disequilibrium) transmitted to wholesale groundnut oil price, but the adjustment or the rate at which the disequilibrium is eliminated is only seven per cent, so the wholesale price stays high for long time. However, if the groundnut oilseed price decreases, wholesale oil price also decreases, but disequilibrium is eliminated speedily at the rate of 50 per cent. So, it comes back to equilibrium. The conclusions emerging from the study is that market is not working favourably for farmers in case of oilseeds.

TECHNOLOGY AND SUSTAINABLE DEVELOPMENT

IPRs and Indian Seed Industry

Venkatesh P, Nithyashree ML and Suresh Pal

The composition of the applications filed by different institutions shows that about 32 per cent of the applications (8465) were filed by private sector and most of these were in the new variety (NV) category. Concentration of the applications for proprietary material was the highest in cotton, followed by vegetables. This implies that applications were more for those crops which have commercial interests like cotton, and the applications of extant varieties (EVs) are perhaps with the intention of benefit sharing in case these varieties are used for breeding of proprietary materials. In case of farmers varieties (FVs), almost all the applications were filed for cereal crops, particularly rice, and very few applications were for pulses and oilseeds. Interestingly, four applications had been filed under the NV category by the farmers. Overall, private sector accounts for 32 per cent of the total applications, while the public sector owns 16 per cent of the applications and the rest were submitted by farmers. Most of the applications (80 per cent) filed by the public sector were for EVs, mainly for cereals and pulses, and only 11 per cent were for fibre crops. On the contrary, the private sector has a diversified portfolio with more applications for the varieties of fibres, cereals and vegetables. The applications for pulses and oilseeds were rather less. This implies that the private sector focused on all the crops with commercial seed market and paid comparatively less attention to the crops where public R&D is high and mostly OPVs are used by farmers.

Although Indian PVP fee structure was the low in comparison to other countries, it was considered high by small seed companies (less than Rs 1000 million annual turnover) and only a few of their best performing varieties were applied for protection. On the other hand, large companies (more than Rs 5000 million annual turnover) opined that fee was nominal. This is more so when protected varieties realize 11-16 per cent premium on seed prices over the unprotected crops, which should be more than enough to recover the cost of protection and earn some profit. The benefits could be much higher for the varieties having large adoption. Thus, economics also favours PVP, but private seed companies would like to see expansion of the infrastructure of the Authority for timely testing of varieties and enforcement of the Act in case there are disputes. Therefore, it may be stated that there is demand for PVP from

all the sectors and the cost of establishing PVP is not that high. At the same time, private seed companies are using biological and legal protection for their material. The use of protected gene has certainly increased seed prices of cotton; but this has not affected its accessibility to large number of farmers as more and more companies are selling seed containing the gene. As of now, there appears to be no concentration of the protected gene based seeds but one can't rule out the possibility of their dominance in future. Another major concern is access of small seed companies to protected genes which may be beyond their means, and therefore these companies are left with no other option but to look towards public agencies for access to novel genes, or work in consortium mode to survive in the market. Thus, IPRs will provide a mechanism for flow of material among private seed companies. Also, it should help foster partnership between public and private sectors and thereby accelerate flow of material to farmers.

Protection of Plant Varieties: Status and Trends

Subash, S.P., Arathy Ashok and Suresh Pal

This study seeks to understand the trends in agricultural research and innovation for developing institutions and policies that might be helpful in meeting the upcoming challenges. The trends among plant varieties registered under the Protection of Plant Varieties and Farmers' Right Act (PPV&FRA), 2001 were analysed. Over the years, there has been an increase in the total number of varieties registered. Since 2013, number of varieties registered by farmers had increased sharply (Figure 16). The sudden spurt in the registration of farmers' varieties can be attributed to the efforts undertaken by the PPV&FR Authority and Government of Odisha. Majority of the varieties registered by farmers came from the Jeypore-Koraput region

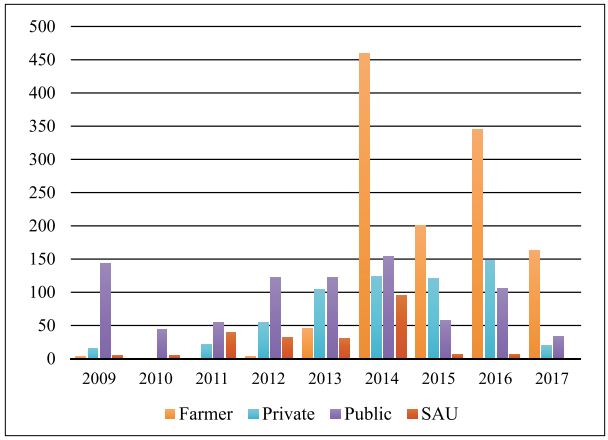

Figure 16: Total number of varieties by applicant category

in Odisha. The Department of Agriculture of Government of Odisha facilitated the farmers in this region to file their applications. The PPV&FR Authority also has made considerable efforts in organizing awareness activities in collaboration with ICAR, state agricultural universities (SAUs), non-governmental organizations (NGOs) and other civil societies.

In terms of crop-wise composition of varieties (Figure 17), rice varieties predominated among farmers' varieties (96.6 per cent). Private companies had registered both in food crops (395 varieties) and non-food crops (214 varieties). The varieties were mostly for rice (120 varieties), maize (108 varieties) and tetraploid cotton (122 varieties). Public sector (ICAR, SAUs) had diverse set of crops and

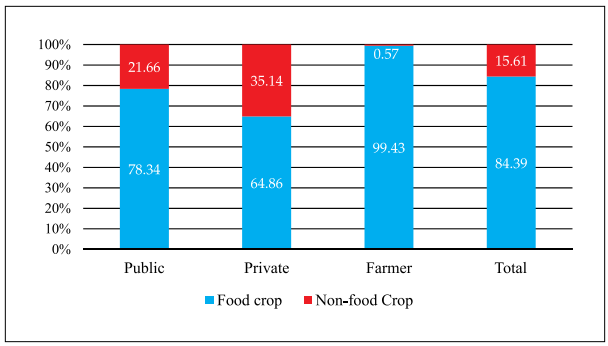

Figure 17: Crop and beneficiary-wise categorization of plant varieties registered under PPV&FRA

more number of varieties were registered in food crops (74 per cent). The study shows that only public sector is focusing on the protection of varieties of diverse food and non-food crops. Private companies are limited in their coverage mostly to few food and non-food crops.

Funding of Agricultural Extension

Suresh Pal

Government funding for extension during 1960s and 1970s has been quite erratic due to dependence of extension on agricultural development projects for funding and changing priorities of the government. During the early 1970s, government increased investment in agriculture to achieve food self-sufficiency, and as a result, extension funding in real terms (at 2011 prices) doubled during this period; but it registered a declining trend thereafter. After a marginal correction during the early 1980s, the real funding again started rising since the mid-1980s—a period of expansion of Training &Visit system in the country. There was again a sharp uptrend in the real funding from the mid- 2000s (Figure 18). As a result, the real expenditure in the triennium ending 2013 was more than double of that during 2001-03. This period coincided with system-wise institutionalization of the ATMA model. The real funding registered more than five-fold increase since the early 1980s and about eleven times increase since the early 1960s. Thus, the trend in public expenditure on extension is consistent with that observed for the agricultural sector and major institutional changes made in the extension approach.

Intensity of the Funding: Another way to assess funding is to compute various intensity ratios such as expenditure as per centage of agricultural gross domestic product (AgGDP), expenditure per farm household and expenditure per hectare of agricultural land. As seen from Figure 18, the increase in the expenditure intensity was sharp in the second half of 1980s, which was maintained during the 1990s. The ratio however again rose sharply in the second half of the last decade, reaching 0.18 per cent during the triennium ending 2013. This is less than half of the research intensity (0.40 per cent) in this period. Other ratios of extension intensity also echo the same trends. Except for a marginal correction during the early 1980s expenditure, per farm

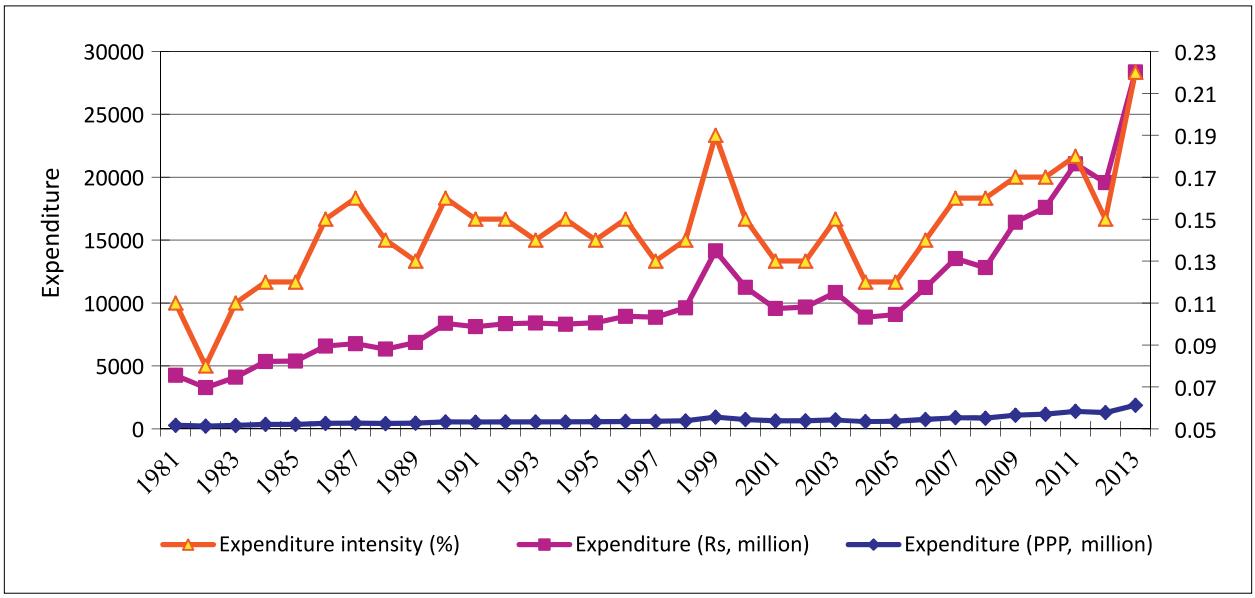

Figure 18: Trends in real public expenditure (2011 prices) on agricultural extension

household and per hectare of agricultural land showed a rising trend in real terms. However, major increase in the ratios was seen during the 1980s and 2000s. In TE 2013, the country spent Rs 166.29 per farm household and Rs 162.53 per ha at 2011 prices.

This ratio of extension to research intensity is broadly consistent with the international funding pattern, but certainly the extension intensity is low in absolute terms, given the size of the country and diversity of production environments. Taking extension intensity as half of that of research intensity, a norm for the former should be 0.22 for developing countries and one per cent for developed countries—a level already achieved in other countries in the mid-1980s. Thus, extension intensity is much lower in India, which is not surprising as research intensity is also low in comparison to the international levels.

Performance of Extension and Advisory Service (EAS) Providers in Maharashtra

Vinayak Nikam and Arathy Ashok

Pluralism in Extension and Advisory Service (EAS) provision is clearly evident in Maharashtra. The major EAS providers in the state can be categorised as government, co-operative, private, non-governmental organisations (NGOs) and farmer based organisations (FBOs). Government EAS providers include, line departments, Agricultural Technology Management Agency (ATMA), Krishi Vigyan Kendras (KVKs), ICAR institutes and State Agricultural Universities (SAUs). IFFCO and KRIBHCO, major fertilizer cooperatives in India, are also actively involved in providing advisory services to farmers in addition to input provision. BAIF Development Research Foundation (NGO), Agrostar (Private) and number of FBOs, viz. Maharashtra State Grape Growers Association (MRDBS), Abhinav Farmers's Club, Sai Pravara Shetkari Producer Company, Sahyadri Farms etc. also facilitate extension and agro-advisory provision in the state.

Majority of the EAS providers target all categories of farmers and crops except few FBOs which provide support to farmers who produce mainly fruits and vegetables. BAIF gives emphasis to livestock production besides agriculture and natural resource management and serve nearly to 2.5 lakhs beneficiaries in the state. Field visits, trainings and demonstrations are the predominant methods of EAS delivery in case of government actors and the Department of Agriculture provides ICT based advisory through M-Cropsap application mainly on crop pest surveillance and advisory provisions. Krishi Vigyan Kendra, Babhaleshwar operates a Community Radio Station for providing agriculture related information to farmers. MRDBS, with 30,000 members provide regular training to Grape Growers in Maharashtra and provide mobile-based advisory services. Agrostar, working on e-commerce platform also provides mobile based advisories through their app 'Agri Doctor' and call centre. Kisan Call Centres by Ministry of Agriculture is managed by IFFCO in the state. IFFCO also provides information related to the latest mandi prices, weather forecast, best practices tips related to agriculture, animal husbandry and horticulture through IFFCO Kisan application.

Assessment of capacity of different EAS providers in terms of staff to agricultural land holdings ratio indicated that in the department of agriculture, one agricultural assistant (also called village level worker) was serving 1704 agricultural land holdings while in case of ATMA staff the ratio was only 1:33. Jointly the staff of agriculture department and ATMA are serving 1068 agricultural land holdings/staff. When ratio analysed for KVK, Babhleshwar it was as much high as 4166 farmers per

staff worker. In case of MRDBS, BAIF and Agrostar, the corresponding ratios were 1230, 454, and 4000, respectively. It was observed that wherever the staff numbers are limited, ICT platforms helps in better coverage. When emphasis is on skill development, then direct contact methods are very important and KVKs played an important role in such areas. FBOs had huge potential for doing crop specific EAS interventions in the state.

Intra-household Access and Impact of Extension and Advisory Services in Eastern India

Arathy Ashok, Prakashan Chellattan Veettil and Vinayak Nikam

Eastern region in India is reported to have poor agricultural growth, in spite of the endowment of natural resources. Penetration of the green revolution in the region was reported to be poor and the productivity differentials of crops are found to be high. Access to EAS helps to improve the decision-making ability of farmers related to agricultural production technologies, leading to better farm productivity and farmers' well-being. A study was done to explore the intra-household access dynamics of EAS in Eastern India and its effects on technology adoption, yield and income in rice. Study indicated that men had access to EAS in 22.51 per cent of the households while access of women was found to be very low (7.48 per cent). Predominant source of EAS was private agencies followed by public agencies. Access to advisories through electronic media was very low in the eastern region (Figure 19). With respect to the type of advice received, fertilizer related information was predominant followed by seed and pest and disease management. Women's access to advisories was found to have better in case of seeds (6.19 per cent) than other inputs (Figure 19).

Preliminary analysis on the effect of EAS access on technology adoption and yield in case of rice showed that there is significant difference in use of chemical fertilizers and pesticides between the households with access to EAS and without access to EAS which may be attributed to EAS access through private agencies, mainly input dealers. Households with access to EAS were also found to have

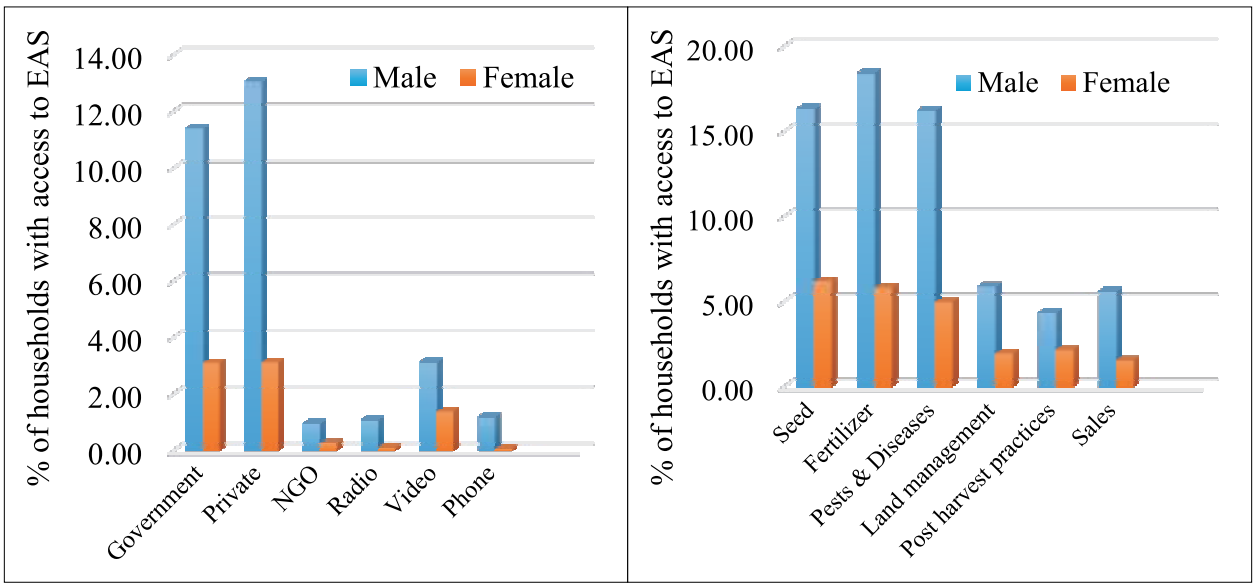

Figure 19: Sources and types of EAS in Eastern India

significantly higher yield and market income (Table 13). However, no significant effect of access to EAS was found on adoption of hybrids.

Table 13: Effect of EAS access on technology adoption, yield and income

Variablest	House-holds with access to EAS (N=1431)	House-holds without access to EAS (N=4252)	Difference
Adoption of hybrids	0.07	0.11	0.04
Chemical fertilizer (kg/ha)	270.79	241.81	28.98***
Cost of pesticide (Rs./ha)	1196	591	605***
Yield (q/ha)	32.84	25.99	6.85***
Market income (Rs./ha)	15372	8528	6844***

Note: *** denotes significance at 1 per cent level of significance.

Gender inclusiveness in access to EAS indicated that, out of the total households with access to EAS, 70 per cent had access to male members only, 11 per cent had access to female members only and 19 per cent households had inclusive access in terms of gender. Further, study on the effect of gender differential access to EAS showed a heterogeneous effect on seed rate, chemical fertilizer usage and yield in rice. The inclusive access households were found to performed better. Inclusive access households were found to have 236.24 kg/ha higher yield than the men or women only access households.

Intensity and Impact of Agricultural Research in India

Shiv Kumar, P. S. Birthal, Jaya Jumrani, R. K. Paul, Showkat Bhatt, Jaweriah Hazrana, Bister Joshi and Amit Kumar

Investment in agricultural research: Agricultural research in India is mainly public-funded activity. The governments have consistently provided funds for agricultural research. The total government expenditure on agricultural research and education (R&E) has increased from Rs. 11.9 billion in 1975/76 to Rs. 113.8 billion in 2014-15 (at 2011-12 prices). Despite the fact that R&D has potential to offer long term solutions to the problems of agriculture sector, the research intensity measured as expenditure on research as proportion of agricultural GDP in the country remained much below (0.4 per cent) than in China (0.54 per cent), Brazil (1.52 per cent), average for developed countries (>2 per cent) and general recommended of 1.0 per cent for developing countries. Thus, there is a clear case of under investment in agricultural R&E in India.

Contributions of agricultural research: Technology is capable of offering better durable solutions for managing the problems of agriculture. Hence, the role of agricultural research and development (R&D) is critical in managing problems and challenges facing agriculture. The contributions of agricultural R&D are illustrated in the case of varietal development in rice. During the 1970s, 127 varieties were released, which reached to 223 in the 1980s, to 257 in 1990s, and further rose to 301 during 2001-2012. Besides, rice-breeding programme also witnessed some qualitative changes over time. The share of varieties with fine quality (long slender) grain increased from 29 per cent in 1970s to 36 per cent in 1990s, and the share has however declined to 28 per cent during 2001-2012 but with notable contribution in terms of basmati varieties like Pusa 1121 and Pusa 1509. There is a significant increase in the number of varieties developed for marginal production environments, as well as those tolerant to biotic stresses. These varietal developments contributed to marked reduction in yield variability even in rainfed areas of eastern India. Hybrid rice varieties have also been bred and have evinced yield

advantage of 15-20 per cent. Thus, maintaining high and stable yield with fine grain quality is a major gift of rice breeding programme. Owing to high rainfall variability, increased cost of irrigation water and awareness to take one more catch or cash crop to earn extra profit from per unit of land, the focus has also been on breeding short to medium duration varieties. These varieties constituted about half of the total varieties released during 1980s and 1990s, have reached close to 80 per cent during 2001-2012.

Economic benefits: Another way to look at the potentiality of investment is the internal rate of return (IRR) which provides the idea of potential profitability and quick recovery of investment. Adoption of improved technology on farmers' field leads to higher crop yield in turn leading to higher production. As an example, impact of India's first triple disease resistant (TLCV, Bacterial Wilt and Early Blight) tomato hybrid (Arka Rakshak) developed in 2010 has an adoption rate of about 70 per cent and is likely to generate economic surplus of Rs.16.54 crores with internal rate of return of 91 per cent in Karnataka state alone.

Total factor productivity of field crops: Growth in total factor productivity of field crops and its sources for the period 1980-2012 were studied. The preliminary results shows that TFP growth (field crops only) is 1.76 per cent per annum. The growth in TFP is affected by technological change, technical improvement and scale efficiency. The decomposition analysis further revealed that 55 per cent change in TFP is attributable to technological change (shift from traditional to new technology), 43 per cent is due to technical improvement (improved resource use efficiency) and 3 per cent is due to scale of farming.

Returns of spending in agricultural growth and poverty reduction: It was estimated that the returns to investment in agricultural research (2.47 per cent) rank next only to investment in private investment in irrigation . In low-income states, investment in agricultural R&D ranked number 2 next to investment in private irrigation. It was further found that Rupees one million investment on Ag R&D reduces poverty by 1231 of rural people, and private irrigation by 1286. Spending on R&D helps to facilitate growth and reduce poverty through public-private investment, income, productivity and other pathways. The research evidence has shown a rate of return of about 12 per cent on investment in agricultural R&D during 1980-2010. One per cent increase in agricultural research expenditure per hectare may lead to a 0.08 per cent increase in agricultural productivity, with the implied absolute effects being larger. Simply a one per cent increase in per capita incomes reduces poverty by 0.37 per cent.

Research-Extension linkages: Potential gains from investment in research may remain undermined due to lack of supporting infrastructure and institutions. The research has shown that farmers who use information realize 12 per cent higher returns per hectare than those who do not. The impact of information is higher in the case of diversified systems as compared to farms specialized in food grains. Further, the investment in public extension services has not kept pace with rising demand for information in agriculture. Investment on agricultural research and development has been shown to have considerable potential for enhancing farm productivity and in alleviating poverty. A 12 per cent higher net income per hectare for users translated into an additional Rs. 1,140 per hectare of cropped area (at 2002-03 prices). This was much higher than the expenditure on public extension services (Rs. 29/ha), and also on the research and education (Rs. 157/ha) in 2002-03. This implies that under-investment in public extension may limit realization of potential gains in agricultural productivity

from spending more on agricultural research. The results suggest that returns on investments in extension services are quite attractive, and certainly there is a scope for increasing outreach of information for spread of agricultural technology.

Redesigning Crop Geometry to Meet Ecosystem Needs and Farmers' Welfare

Ashok Dalwai, Raka Saxena, Suresh Pal, Pawanexh Kohli and Md. Arshad Khan

India produces surplus foodgrains, which contributes vastly to food security; however, grains alone cannot assure nutritional security. The area and value pyramid (Figure 20) shows that in case of field crops, 42 per cent of the area under major cereal crops (rice, wheat and maize) contributes only 20 per cent to the value; and in contrast horticulture with just 7 per cent area contributes 23 per cent to the value created. Accordingly, there is an evident need to change the cropping system to suit the ecology and the consumers' preferences, so as to ensure that value is captured across all aspects of concern. In majority of states maximum area is occupied under foodgrains, followed by oilseeds, whereas area under remunerative crops like nutri-cereals and horticultural crops is quite low (Figure 21).

India has the ability to meet the food and nutritional demands of its growing population and rising incomes. Looking at foodgrain production, India is self-sufficient or rather surplus. Thus, there is ample scope to shift some area under cereals to high nutrition and value crops. The volume of production is a function of large tracts of arable land and in general the productivity of crops in India is lower than those in other countries. A measure of the crop yield potential, attainable yield and the corresponding yield gap is crucial, so as to suggest appropriate policy measures. The need is to look for various physical, biological, socio-economic and institutional aspects which are responsible for these yield gaps.

Shifting area from staple to high value crops in consonance with agro-climatic conditions

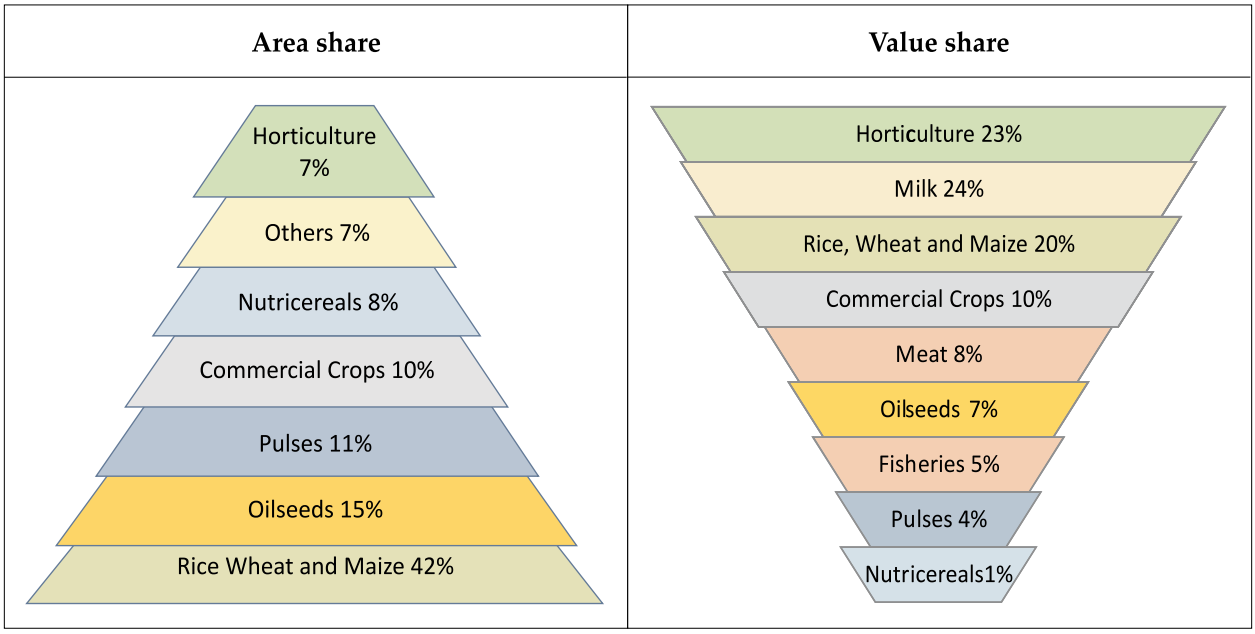

Figure 20: Area and value pyramid

and resource endowments can lead to a sizable increase in the returns for farmers. With appropriate produce and specific infrastructural & logistic support, a chunk of area can be shifted to high value commodities for generating higher returns to farmers. The change in the existing crop geometry will require investing in tandem to develop strong structural support for these highly perishable produce types. The land-use pattern varies across states and significant area is categorised under barren and unculturable land and other uncultivable land which comprises more than 10 per cent as a whole for India. This area can be judiciously brought under cultivation following suitable land management practices.

Farmers and other stakeholders in the agricultural value system require to adjust according to changing dynamics, which today are defined by farmers' income and environmental sustainability. Crop planning, cropping intensity, input management need to be led by market intelligence and agro-ecology. Agriculture has got the potential to support the manpower currently involved in it, through productive and remunerative employment, within the framework of their prevailing assets and expertise. Agricultural development must be tempered by the challenge of making agricultural production sustainable, keeping in control greenhouse gas emissions and conserving dwindling water supplies, while meeting the target of feeding industries and a growing population. Regardless of how all these and other puzzle pieces fall into place, the solution lies in addressing the basic concerns of what to grow, where to grow, when to grow and how much to grow.

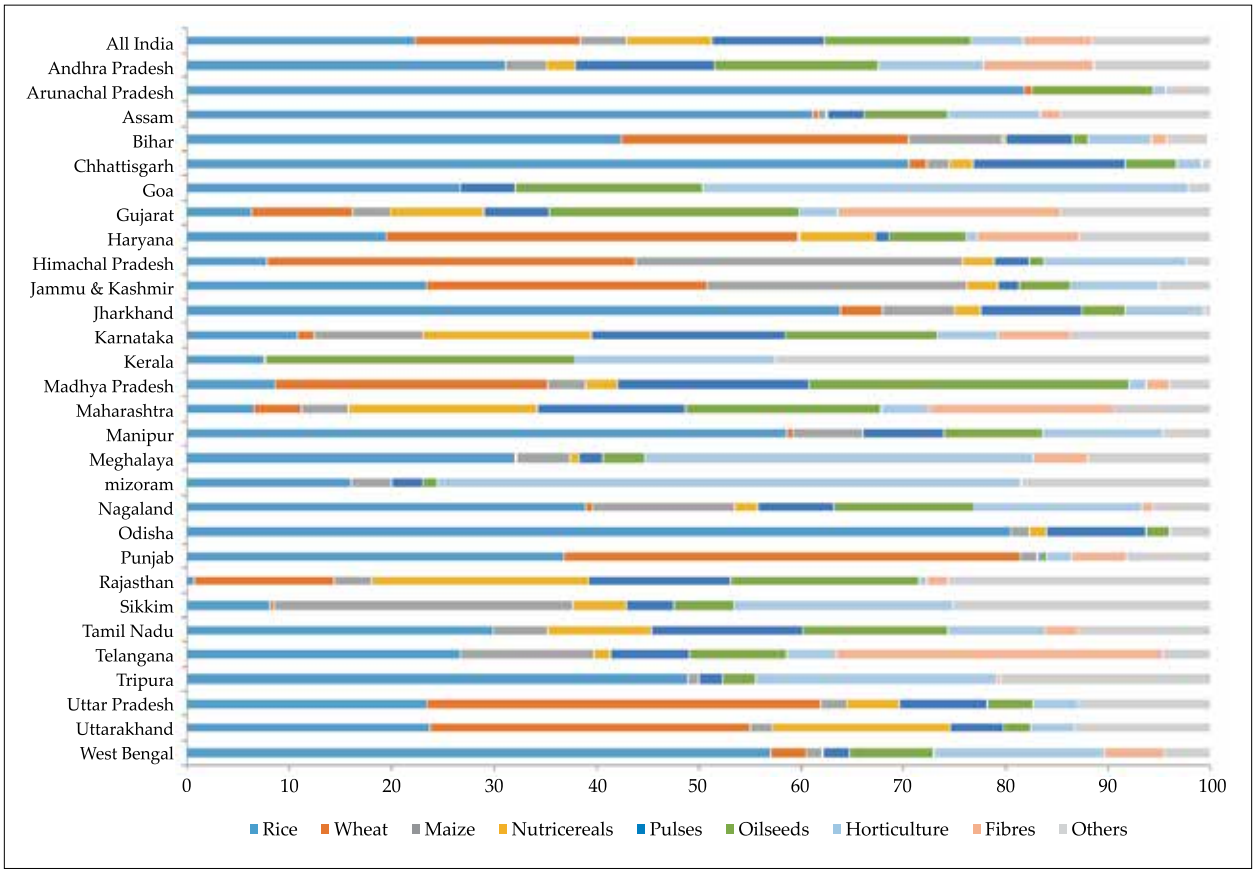

Figure 21: Crop geometry of states (crop area share (%) in gross cropped area, 2014-15)

Sources of Growth and Factors Affecting Pulses Production in India

Prem Chand, Suresh Pal and Sant Kumar

The production of pulses which was hovering at 10-14 million tonnes up 2009-10, increased to 23.13 mt during 2016-17. During the period 2013-14 to 2016-17, an additional area of 5.38 m ha was covered under pulses in the country which was mainly contributed by pigeon pea and black gram (1.38 m ha, each) and green gram (1.07 m ha). The increase in area under pigeonpea was in central and south-western states, namely Maharashtra (0.4 m ha), Karnataka (0.37 m ha), Madhya Pradesh (0.23 m ha), Telangana (0.17 m ha), Gujarat (0.14 m ha) and Andhra Pradesh (0.12 m ha). In case of black gram, the additional area coverage was mainly in Madhya Pradesh (47.71 per cent), Rajasthan (18.88 per cent), Odisha (13.75 per cent), Maharashtra (9.74 per cent), Gujarat (9.17 per cent) and Uttar Pradesh (8.51 per cent). Rabi black gram has mainly increased in the state of Andhra Pradesh. An additional area of 1.07 m ha under green gram was shown, out of which more than half was in the state of Rajasthan (52.52 per cent).

High prevailing market price of pulses is one of the important factors in bringing additional area under pulses in the country. An increase of 77 per cent point in WPI of pulses during 2015 as compared to previous year was observed, whereas it was almost constant in case of cereals and oilseeds. The increase was higher in the crops that gained more additional area, i.e. black gram (117 per cent points) and pigeonpea (100 per cent points) than the other pulses. A significant increase in MSP and bonus on pulses substantially (16 to 34 per cent increase during 2013-14 to 2016-17) supported by increase in procurement of pulses may also have induced farmers to bring additional area under pulses.

For promoting pulses in rice-fallow areas in eastern India, a new initiative launched under RKVY as a sub-scheme to bring area of rice fallow in Eastern India under pulses and oilseeds cultivation. The additional area of 1.09 m ha under *rabi* pulses mentioned earlier, is contributed by these eastern rice fallow states, namely Chhattisgarh, Bihar, Jharkhand, Odisha and West Bengal. Some of the other important strategies adopted by Government are extension of operational area of NFSM, programme on Additional Area Coverage of Pulses during *rabi*/summer and crop diversification programme implemented in the original green revolution states. Besides, initiatives like distribution of seed mini-kits, subsidy on production of quality seed, creation of 150 pulse seed hubs, strengthening breeder seed production, strengthening/establishing production units of bio-fertilizers and bio-control agents, etc., also have been taken to increase pulses production in the country.

Resource Use Planning for Sustainable Agriculture

Prem Chand, Rajni Jain, Subhash Chand, Prabhat Kishore, Lungkudailiu Malangmeih and Sulakshana Rao

Current land use pattern in many of the states are not based on principle of comparative advantage. Cropping pattern in various regions are inefficient in terms of resource use and unsustainable from natural resource use point of view, resulting into serious misallocation of resources, efficiency loss, indiscriminate use of land and water resources, and adversely affecting long term production prospects. Therefore, a network project on "Resource Use Planning for Sustainable Agriculture" is being undertaken with the overall objective of developing optimum resource use plans under various resource constraints and technology/ policy interventions. So far the study on resource endowment, changes in land use and

cropping pattern, identification of issues and constraints, and crop suitability for one of the selected regions, i.e. Bundelkand have been conducted.

Changes in land use and cropping pattern: During the period of 1970-71 to 2014-15, gross cropped area (GCA) has increased by 2.19 m ha both horizontally by converting wastelands into cultivation (0.71 million ha) and vertically through multiple cropping (1.57 m ha). The increase in double-cropped area is certainly helpful in increasing production in the region but at the same time, it has implication for resources, particularly water, as average rainfall in the region is declining over the years. There has been a decline in area under permanent fallow but current fallow are increasing. Declining area under pastures and grazing lands may affect feed and fodder availability as area under cultivated fodder is already low (1.13 per cent of GCA in UP Bundelkhand and 0.36 per cent in MP-Bundelkhand) in the zone. It is observed that there has been a considerable shift in area from cereals to oilseeds and pulses.

Shift in irrigation pattern: The area irrigated in the region has increased considerably from 17.19 per cent in 1970/71 to over 63 per cent during 2014/15 increasing at the rate of 4 per cent per annum. The increase is more visible after 1990s because of both surface as well as ground water facilities created during the decade. Over the years, there has been a heavy shift from surface to groundwater sources leading to depletion of groundwater table in the zone. In 2004, only three blocks from the zone were under semi-critical category, whereas in 2013, 16 blocks have come under semi-critical, two under critical and three under overexploitation category.

Water resources in Bundelkhand: Total irrigation water availability of 17 Billion Cubic Meters is estimated in the zone from all sources with the composition of 60 per cent surface and 40 per cent ground water. The area irrigated in the region is more from ground water sources (57.53 per cent) than the surface water. The irrigation water availability per hectare of net sown area (NSA) in the region was estimated 0.41 ha mm. However, with adoption of high water demanding crops (rice and wheat occupying >40 per cent of NSA) used irrigation is more than 60 per cent of available water. This explains how the agriculture leads to over exploitation of irrigation water. Therefore, further study on Optimum Crop Plan based on resource availability at agro-climatic zone level and its replication in other agro-ecologies is in progress to bring out best-suited cropping pattern that will promote sustainable development of farm and farming community.

Suitability of paddy in Bundelkhand region: Though agro-climatic diversity of country can support cultivation of wide varieties of crops, but every crop may not be sustainable in each region either economically or ecologically due to unsustainability of natural resources in longer run. Therefore, being high water requiring crop, suitability of paddy in Bundelkhand region of Madhya Pradesh based on various biophysical parameters, viz. temperature (oC), rainfall (mm), pH, texture, electrical conductivity (EC dS/m), organic carbon (OC %), and slope (%), depth (cm) was carried out. The data were collected from various sources such as IMD, IWP MET data, ICAR-geo portal, soil health card scheme, etc. The suitability manual developed by NBSS-LUP (2006) was used as suitability criteria and FAO, 1976 suitability classification was adopted in the present study.

Suitability maps for paddy for all eight biophysical parameters in all the six districts of Bundelkhand region of Madhya Pradesh were prepared and we found that all the districts were under highly suitable category as there was no much variability in soil depth, EC and temperature across the districts. The individual suitability maps were overlaid and

an overall suitability map were obtained by applying the worst-criteria principle (Figure 22). The Study found that cultivation of paddy is not suitable in Datia and Chattarpur districts while it is marginally suitable for Tikamgarh, Sagar, Damoh and Panna districts.

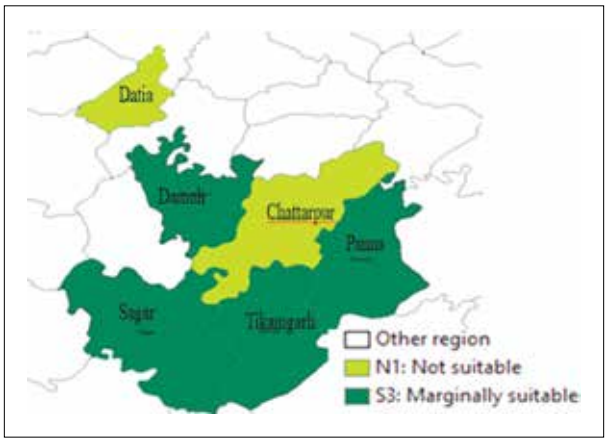

Figure 22: Overall suitability map for paddy in MP Bundelkhand

Increasing Farm Income by Optimizing Cropping Pattern for the State of Bihar[4]

Rajni Jain, T K Immanuelraj, S K Srivastava and Raju S S

Bihar agriculture exhibits challenges such as shrinking net sown area, non-availability of quality seeds, major irrigation through diesel pump sets (more costly), inadequate storage facilities, inadequate processing industries for agricultural producers, and stagnant production of crops. Out of total available ground water of 26.27 BCM, state has utilized only about 40 per cent for irrigation purpose. In this study, an attempt has been made to revise the existing cropping pattern using linear programming considering land and groundwater as constraints. Data of Comprehensive Cost of Cultivation Scheme, Ministry of Agriculture and Farmers Welfare, for the block year 2008-11 were used to estimate the net returns for obtaining an optimum crop plan for maximising farmers' profit. Diverse crops such as paddy, wheat, maize, lentil, moong, sugarcane, potato, jute, rapeseed & mustard, *khesari*, cauliflower, gram, okra, brinjal, onion, tomato, cabbage, arhar and other minor crops have been considered in the model.

Table 14 gives the existing and optimum cropping patterns under two scenarios, viz. existing ground water use (scenario-I) and 25 per cent increase in ground water use (scenario-II). It can be observed that area under kharif maize, rabi maize, arhar, kulthi, gram, lentil, khesari, moong, urad, pea, rapeseed & mustard, linseed, potato, cabbage, brinjal, cauliflower, okra, tomato, onion, sugarcane and chilli and other minor crops have increased in both the scenarios while area under paddy, wheat and jute have shown decline in scenario-I. This allocation has led to about 1.41 per cent decrease in GCA at existing water use while about 16 per cent rise in scenario-2.

The new optimum model at existing use of ground water resource can contribute 7.83 per cent increase in farmers' revenue compared to the existing one. Under the scenario-II, the model led to increase in farmers' revenue to the extent of 20.42 per cent. Thus, it may be inferred that if the water development is raised to 55 per cent from the existing level of only 44 per cent, the adoption of optimum crop plan would certainly raise the income of farming community of the state. The adoption of model may further be accelerated, if the cheap source of irrigation devices such as subsidized electric operated pumping sets and solar operated irrigation devices are made available to the farmers. Adoption of the recommendation would obviously raise the income of the cultivators on the one hand and augment the national exchequer on the other.

[4] This work is done in collaboration with RAU(S).

Table 14: Existing and optimal crop plan for Bihar

('000 ha)

Crop	Existing plan	Optimal plan	
		Scenario-I	Scenario-II
Paddy	3156	2900	3500
Wheat	2106	2000	2600
Maize_rabi	350	368	400
Maize_kharif	233	250	250
Lentil	173	200	200
Moong	161	200	200
Sugarcane	159	250	250
Potato	151	200	200
Jute	124	120	150
Rapeseed & mustard	87	110	110
Khesari	84	85	85
Cauliflower	62	70	70
Gram	59	70	70
Okra	58	70	70
Brinjal	55	60	60
Onion	53	56	56
Tomato	47	70	60
Cabbage	39	40	40
Arhar	27	40	40
Others*	118.51	124.5	139.5
GCA	7388	7283.48	8550.5
Change in GCA (%)	NA	-1.41	15.73
Change in farm revenue w.r.t. TE 2010-11 (%)	NA	7.83	20.42

Note: '*' includes linseed, pea, sunflower, urad, barley, kulthi, ragi & chilli; NA-not applicable,

Linear Programming Based Optimum Crop Model for Assam[5]

Rajni Jain, Kingsly Immanuelraj, S K Srivastava, Raju S S and Lungkudailiu Malangmeih

Assam, the gateway to the northeast is an agrarian state with rice as the staple crop. The productivity of the major crops like rice, pulses and oilseeds is yet to reach acceptable level despite various efforts in the past. This study was an exploration to develop an optimum crop mix for Assam to maximize the net returns ensuring the best use of land and other natural resources for the state. Attempts have been made to obtain crop combination under rainfed and irrigated area separately in both *kharif* and *rabi* season as there was a difference in the returns in each scenario. The model was developed using plot level data collected under "Comprehensive Scheme for Cost of Cultivation of Principal Crops of Directorate of Economics and Statistics, Ministry of Agriculture for the year ending 2010-11 and based on primary survey of some crops. Due to limitation of coefficients for some minor crops, only 21 crops were selected for obtaining optimum crop mix for the state.

It was observed that above 70 per cent of the cropped area is occupied in *kharif* season and most of the cultivable land is left fallow in rabi season. Considering the vast untapped water resource in the state and its potential to increase farm income by increasing assured irrigation, sensitivity analysis was carried out by gradually increasing the net irrigated area by one per cent in each subsequent iteration. At existing level of resources, the result from the Linear Programming model for optimum crop planning indicates higher returns than the existing plan (Rs. 39.30 hundred crore in optimum plan over 34.16 hundred crore in existing plan at market price) (Table 15). Sensitivity analysis also indicates that the profit could be increased substantially by bringing rabi fallow land under irrigation (Figure 23). This implies bringing more land under double or triple cropping considering the untapped available water in the state. Assam is faced with errant floods during rainy season and

[5] This work is done in collaboration with AAU.

droughts on the other hand especially in hilly zone. The flood water can be diverted into use by creating storage structures which can prevent the crop damage due to flood on one hand and make the water available for agriculture on the other. This can be achieved by proper investment and implementation from various departments.

Table 15: Gains due to optimum crop model over existing scenario

Parameters	Rainfed	Irrigated	Pooled
Net Cropped area in optimum model (000 ha)	3441.09	175.59	3616.68
Change in GCA (per cent)	9.87	0.49	9.38
Existing Revenue (Rs. crores)	3153.95	261.72	3415.67
Optimum Net Returns (Rs. crores)	3661.00	268.82	3929.82
Change in Farmers' Revenue (Rs. crores)	507.05	7.10	514.15
Change in revenue in optimal plan (per cent)	16	3	15

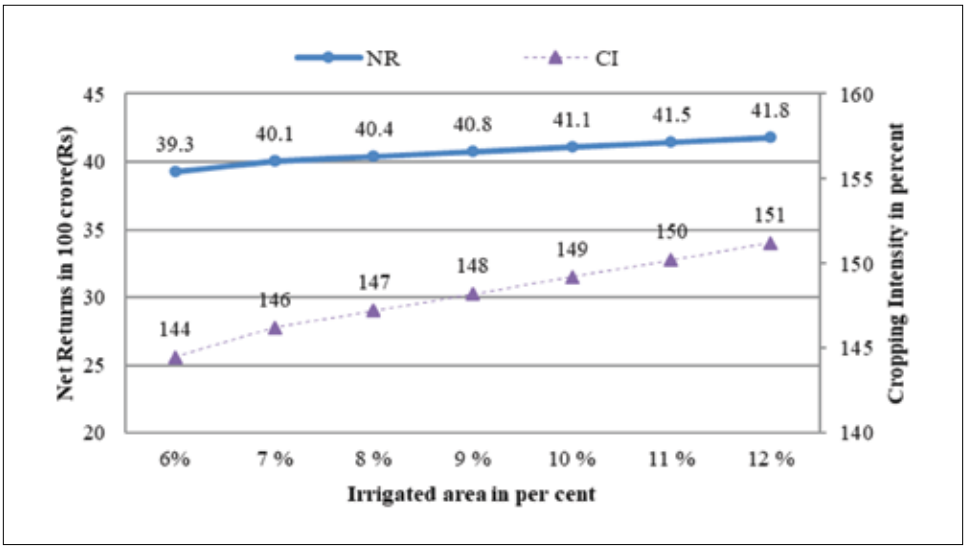

Figure 23: Increase in objective function with increase in irrigated area

Optimal Crop Allocation for Sustainable Resource Use in Tamil Nadu[6]

Rajni Jain, Immanuelraj T K, S K Srivastava and S S Raju

Optimal crop plan for Tamil Nadu was developed with the objective of maximising farmers' profit subject to land and water constraints. The plan suggests a decrease in area of minor cereals and other high water consuming crops such as banana and turmeric while increase in area under all other crops. Vegetables, commercial crops and sugarcane found to be the potential crops in the optimum plan resulting in increase of gross cropped area by 20 per cent and farmers' revenue by 27

[6] This work is done in collaboration with TNAU.

per cent as compared to the existing crop plan (Table 16). The increase in area under paddy, maize, bajra, blackgram and greengram in the optimal plan could be encouraged to achieve the goal of doubling farmers' income in the near future as well as achieve nutritional security of the state. Hence, the ongoing development programmes like ICDP, NFSM, ATMA, RKVY need to be further intensified by identifying zone-wise suitability of crops. Moreover, necessary supportive measures like micro-irrigation system, soil and water conservation programmes and more location specific subsidy support in minor irrigation should be given to water sensitive zones.

Table 16: Optimum crop plans for Tamil Nadu

Crops	Current Plan (Area in 000 ha)	% increase/decrease in area under optimal plans	
		Plan-I: At existing water use	Plan-II: 10% reduction in water use
Paddy	1876	13.65	4.21
Other cereals	638	-7.84	-5.64
Pulses	535	8.13	12.71
Oilseeds	503	27.44	29.42
Sugarcane	306	52.29	57.84
Other HWC (Banana & Turmeric)	143	-23.08	-22.38
Commercial crops	307	87.30	87.30
Vegetables	66	110.61	110.61
GCA (000 ha)	4374	19.56	17.03
Water used in BCM	27.24	-	22.45
Farmers revenue (Rs '00 Crores)	116.23	27.44	26.47

Note: HWC-High water consuming crops.

Impact Assessment of Mobile App Using Economic Surplus Model

Vinayak Nikam, Shiv Kumar and Immanuelraj T. K.

The mobile app *Abinitio* developed by ICAR-National Research Station for Grapes, Pune, was first commercialized by Express Weather Pvt. Ltd. Currently, it is being developed and maintained by S K Crop Tech Company. The App provides complete information and decision support system to farmers to take appropriate decisions on crop diseases, pest, irrigation, soil and fertiliser management through in depth insight. Besides this, information and forecasting about weather is also given to the farmers. The company has established 110 Automatic Weather Stations (AWS) in Nashik, Sangli, Pune and Solapur districts of Maharashtra with the help of state government and farmers. Each AWS covers area of 50 km^2 and gives real time information about the weather parameters to the farmers. Cost of the app for farmers has increased from Rs. 800/year in 2012 to Rs. 1200/year in 2017. The adoption of app has increased more than six times (from 800 to 5000) during last five years. Information is available in Marathi and English language.

The results of economic surplus method show that (Table 17) over the period of 2007 to 2022, this app would produce total surplus of Rs. 9140.85 million, net present value of Rs. 9111.94 million with net benefits of Rs. 4822.98 million. The Internal Rate of Return of 316 per cent generated so far is much higher than IRR of agricultural research and development (30 per cent) in National Agricultural Research System. This discerns not only economic power of mobile app technology in agriculture, but also helps in realizing the potential of agricultural technologies developed by NARS at farmers' field level. The results indicate the use of mobile app as an economically viable and feasible option to farmers to increase their income.

Table 17: Net present value, internal rate of return and benefit-cost ratio of Mobile app

Year	Adoption rate (%)	Change in total surplus (Rs. Million)	Research and development cost (Rs. Million)	Net benefit (Rs. Million)
2007	0.00	0.00	0.32	-0.32
2008	0.00	0.00	0.37	-0.37
2009	0.00	0.00	0.37	-0.37
2010	0.00	0.00	0.38	-0.38
2011	0.00	0.00	0.38	-0.38
2012	0.03	308.62	7.24	301.38
2013	0.03	443.53	5.74	437.79
2014	0.07	1882.96	7.14	1875.82
2015	0.10	1179.06	6.56	1172.50
2016	0.16	2799.74	6.66	2793.07
2017	0.16	2864.27	7.06	2857.20
2018	0.17	3255.76	6.86	3248.90
2019	0.18	3672.36	6.96	3665.39
2020	0.19	4114.07	7.06	4107.00
2021	0.19	4350.87	7.16	4343.71
2022	0.20	4830.24	7.26	4822.98
Net present value (NPV) (Rs. Million)				9111.94
Internal rate of return (IRR) (%)				316
Producer surplus (Rs. Million)				5466.13
Consumer surplus (Rs. Million)				3674.71
Total surplus (Rs. Million)				9140.85

Past values adjusted through WPI index, (2005); Discount rate of 10%.

ICT in Agricultural Education: Status and Impact

Rajni Jain, Pavithra S., Anshu Bharadwaj and Ranjit Paul

Infrastructural status of ICT: The Deans and Directors of the colleges of selected twelve State Agricultural Universities were surveyed to quantify the infrastructural status that is required for usage and availability of ICT in agricultural education. The indicators were computed and categorized into three groups, namely common, faculty and students. The ratio of total number of computers to students ranged from 0.05 in NDAUT to 0.48 in the LUVAS. Across the SAUs the computer-faculty ratio was more than one, except in case of GADVASU where it was 0.35. Except NDUAT and PAU, all the other SAUs reported 100 per cent of access to internet by the students. The proportion of students with access to internet was 50 per cent in PAU and only 1.67 per cent in the NDUAT. CSKHPKV offered 8 e-courses for the students and across all these universities all the courses offered by the respective universities were used by the students. There was no facility of e-course in the GBPUAT and NDUAT universities. Video-conferencing was not available in 25 per cent of selected universities (Table 18). Thus, there is tremendous potential in improving ICT infrastructure for agricultural education in selected state agricultural universities.

Table 18: Infrastructural status in state agricultural universities

Category	Indicators	%
Common	Range of number of E-courses available (number)	0-29
	SAUs with smart seminar halls	100
	SAUs with regular website updation	67
	SAUs with own domain email system	67
	SAUs with digital student report card system	22
Faculty	Computer availability	35-100
	Internet availability	100
	SAUs with video-conferencing availability	75
	SAU using biometric for staff	22
Student	Computer availability	5-50
	Internet availability	2-100
	SAU with students information system	56
	SAU with online admission	44
	SAU with online payment of fees in SAUs	22
	SAU with biometric for students in SAUs	22

Use of ICT initiatives and corresponding status: Recognizing the potential of ICT as a catalyst for improving the growth of higher education in agriculture and overcoming the challenges in higher education to some extent, many initiatives have been taken in agriculture education. The study found that nearly 50 per cent faculties have been using CERA and other online journals mainly for their research work (Figure 24). Other ICT initiatives of ICAR, though important for agricultural education, are being used by 12-25 per cent of faculty

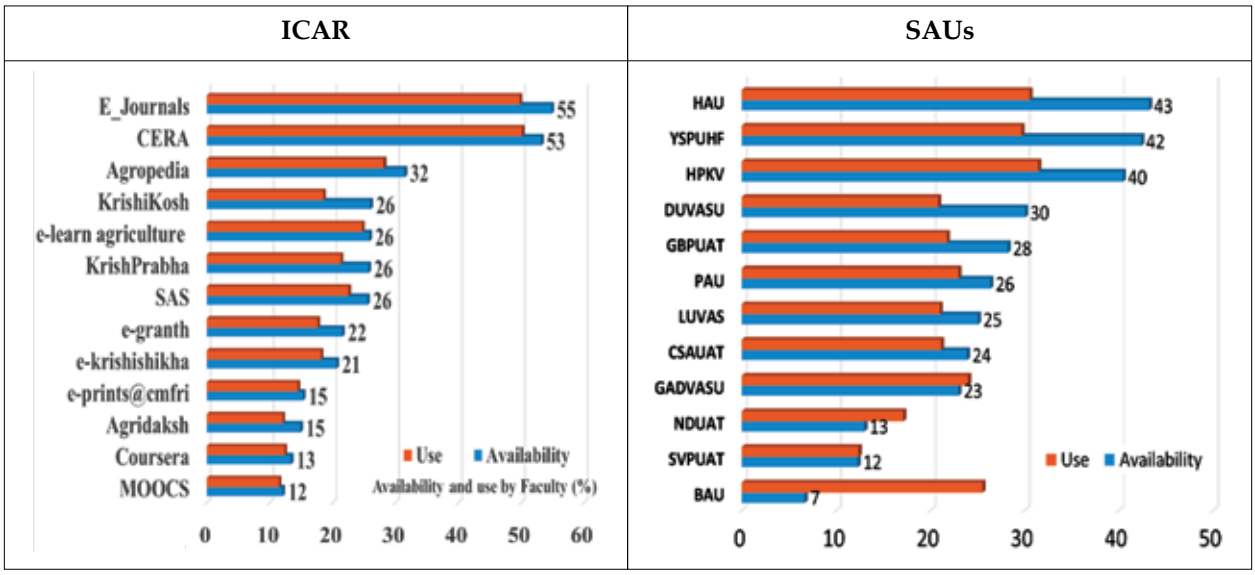

Figure 24 : Status of availability and use of ICT initiatives by the faculty in ICAR and SAUs

only. Availability and use of ICT applications vary from university to university. Use of ICT initiatives vary from 12-32 per cent in State Agricultural Universities. It was highest in HPKV (32 per cent) followed by HAU and YSPUHF. Except few, all the universities used the initiatives less than the capacity. Interestingly Banda Agricultural University (BAU) has use 4 times the availability of initiatives. Based on inputs from faculty, there are mainly two reasons for low usage namely (i) lack of training, and (ii) lack of time for self-exploration and learning.

Impact of ICT in agricultural education: It was observed that majority of the respondents (70-90%) agree to improvement in their academic development using ICT (Figure 25). To understand various factors, students from all 12 universities were surveyed regarding how adoption of ICT can be improved in agricultural education. The analysis showed that good internet speed, infrastructure facilities, availability of e-resources, operational knowledge of ICT tools and access to ICT are most important factors for enhancing its adoption. Statistical analysis is also done separately for students and faculty based on each university and also combining all the universities together. It is found that fellowship and course under study as important factors for adoption of ICT among students due to the reason that fellowship assists them in financing computer and internet facilities even if the access to university resources is not available. Training, computer availability and WIFI availability in university campus are most significant factors for adoption of ICT among faculty.

The results showed that students and faculty need to be exposed to various tools of ICT and also various online application software. Study observed many bottlenecks such as access to ICT resources, lack of training and skills, poor infrastructure, lack of qualified faculty, poor or inadequate availability of

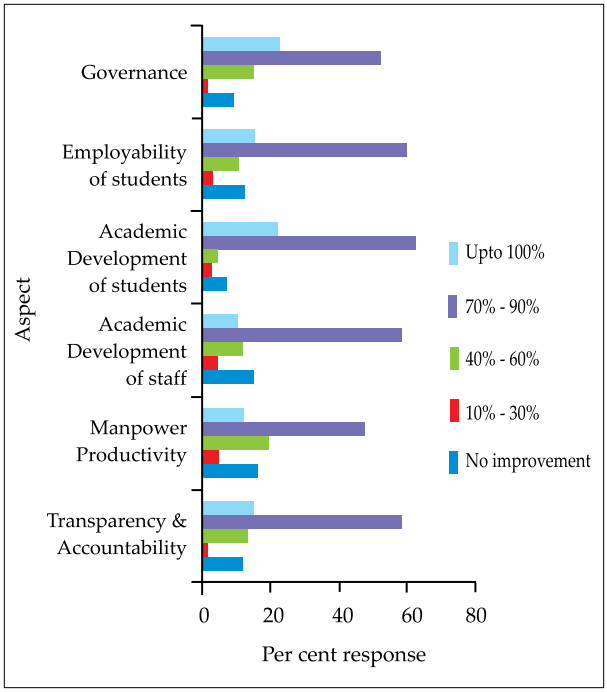

Figure 25: Impact of ICT in agricultural education

interactive multimedia, online class courses in agricultural domain, self-learning modules and poor signal strength of WIFI. To improve the use of ICT in agriculture education, there should be regular awareness programmes for students, teachers and administration. Also, course curriculum should include IT courses, qualified faculty vacancies should be created. Innovative methods should be developed to increase competency in ICT. Thus multi-pronged approach can help in achieving information literacy in agriculture.

Institutional Innovations in Irrigation Water Management

Subhash Chand, Shiv Kumar, N. Ravisankar and R.C. Srivastava

PRI and Warabandi system in managing canal water: A study on Institutional innovations in irrigation water management systems was carried out in Saharanpur district of Uttar Pradesh and Rohtak district of Haryana on the basis of declining canal command areas using

Discussion of project team with farmers regarding salinity increased due to ground water pumping

primary data of 2015-16. The study explored the role of Panchayat Raj Institution (PRIs) in managing common resources (commons), including conflict resolving under *warabandi*. The study observed that as compared to UP, PRIs were more active and effective in Haryana in avoiding encroachment and equitable distribution of water and conflict resolving (Table 19).

Table 19: Role of Panchayat Raj Institutions in canal water management

Type of activities	Saharanpur (UP) N=301	Rohtak (Haryana) N=302	Total (%)
Channel maintenance	278 (92.36)	266 (87.79)	544 (90.1)
Conflict resolving	186 (61.79)	209 (68.08)	395 (65.4)
Water distribution equity	157 (52.16)	148 (58.74)	304 (50.5)
Water saving advice	62 (20.59)	79 (26.09)	141 (23.3)
Common water resource management	250 (49.83)	247 (81.52)	497 (82.2)
Avoidance of encroachment	130 (43.19)	251 (82.84)	381 (63.1)

Note : Figures in parenthesis indicate the per cent to total.

The major source of conflict in sharing of canal water was due to fragmentations and division of land holdings, followed by non-cooperation of fellow farmers, blocking main canal, less time allotted to individual, etc. The PRIs have played significant role in resolving the disputes related to water distribution. During 1990-2015, total 129 disputes have ended in strike in both the states (75 in UP and 54 in Haryana). PRIs have resolved maximum number of conflicts followed by friends and relatives. However, police and irrigation department also have resolved some of the conflicts. The compilation of respondents opinions in relation to better canal water management system shows that more than 70 per cent canal users were happy with *warabandi* system and reported to continue the existing system for maintenance of field channels. However, about 14 per cent have said that main channel should be maintained by member of *warabandi only*. About 30 per cent farmers have suggested that PRI and *warabandi* members together should maintain the field channels and more than 47 per cent desired that main channel should also to be maintained by them. However, 72 per cent canal water users have said that village ponds should be maintained by PRIs and *warabandi* farmers together.

Technical inefficiency in wheat production and their determinants: Study also explored the source of technical inefficiency associated in the wheat production. On an average farmers have received good yield of wheat crop (3.8 t/ha). This may be due to assured irrigation and increased use of groundwater. Among the different water market regimes, net buyers have recorded higher yield and returns. The results of maximum likelihood Estimates (MLE) of the parameters of stochastic frontier production function indicates potential of increasing the level of production through raising their optimum input uses. However, irrigation and land diesel pump sets, and investment in water transmission and other farm machinery needs

to be optimally used for higher farm efficiency. Though output elasticities for machine hours (0.48), quantity of seed (0.37), fertilizer (0.62) and water applied to wheat crop (0.22) were positive, lower output elasticities indicate scope of improvement. The return to scale of 1.897 indicates that wheat growers need to increase output elasticity to realize higher production by adoption of modern technologies (Table 20).

Table 20: Determinants of technical inefficiency of wheat growers

Variables	Coefficient estimated
Constant	7.54***
Age of Farm households (No of year)	-0.014 ns
Gender Factor (Women headed = 1 other = 0)	-01.04**
Education (No of years)	-0.10***
Total no of tractor/household	0.80ns
State dummy (Haryana = 1, UP = 0)	-1.13***
Water MGT dummy_1 (water buyers/ seller = 1, otherwise = 0)	-0.33ns
Water MGT dummy_2 (Net water buyer = 1, otherwise = 0)	0.05*
Total number of observation (N)	603
L R Chi square (7) statistics	53***

Notes: *** , **, and * indicates significance at 1%, 5% and 10 %, respectively; ns = not significant; Dependent variable is household level technical inefficiency estimated from the stochastic frontier analysis.

Impact of Micro-Irrigation: Coverage and Performance

Sant Kumar, Pramod Kumar and M. Awais

Considering the limited availability of water for future, National Mission on Micro-Irrigation (NMMI) scheme was launched during 2010 as an important component of *Pradhan Mantri Krishi Sinchayee Yojana* (PMKSY). The scheme was intended to increase area under improved method of irrigation and for better water use efficiency. This study assesses the impact of NMMI in bringing more area under micro irrigation across the states of India. The analysis of trend in area coverage and promotion expenditure on micro irrigation reveals that during 2005-06 to 2017-18 both area coverage and promotion expenditure have consistently and independently increased, yet they converged in the recent time.

Since 2005-06, there has been considerable progress in area under micro irrigation, consisting of 4.7 m ha under sprinkler and 3.9 m ha under drip system. The states promoting MI scheme faster are Rajasthan (20.3 per cent), Andhra Pradesh (15.3 per cent), Maharashtra (15.2 per cent), Gujarat (12.4 per cent), Karnataka (11.0 per cent), Haryana (6.7 per cent), Madhya Pradesh (5.0 per cent), Tamil Nadu (4.2 per cent) and Chhattisgarh (3.1 per cent). These nine states together accounted for more than 93 per cent of total area under MI in 2016-17. Rajasthan alone accounts for nearly one third of sprinkler-irrigated area of the country. Analysis further shows that states of Haryana, Gujarat and Karnataka are leading in adoption of sprinkler irrigation, while Andhra Pradesh, Maharashtra and Tamil Nadu have taken lead in adoption of drip system. Horticultural crops are the major beneficiary of micro irrigation system occupying 1.78 lakh hectares of micro irrigation. This increasing area can be attributed to favorable policies and

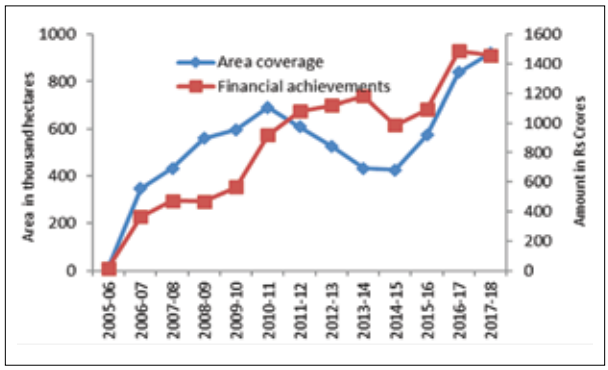

Figure 26: Progress of micro irrigation in India

assistance of the central and state governments for bringing more irrigated area under high value crops, and farmers' awareness of using limited water for better returns from farming.

An attempt was also made to assess the impact of sprinkler irrigation on farm households of Bikaner district of Rajasthan using field survey data. With the adoption of sprinkler irrigation, significant change in cropped area and yields of major crops were noticed on farmers' fields. Groundnut, a major *kharif* crop, benefitted the most indicating almost doubling of both area and yield after having irrigation using sprinkler system. Further, findings indicate that increase in both area and yield of other *kharif* crops like *guar, moth*, bajra and *moong*. However, the magnitude differs with each other. Among *rabi* crops, wheat, mustard and gram have benefitted more by sprinkler system than the other crops. Both area and yield of wheat increased three times whereas in case of gram area has tripled, while yield has doubled after introduction of sprinkler irrigation. Creation of irrigation facilities have also helped in introducing of new crop like Ishabgol in the district. The study suggests that with the use of micro irrigation, productivity of the crops are likely to increase substantially in future. Bringing more area under micro irrigation across various states may be helpful in increasing production of many crops.

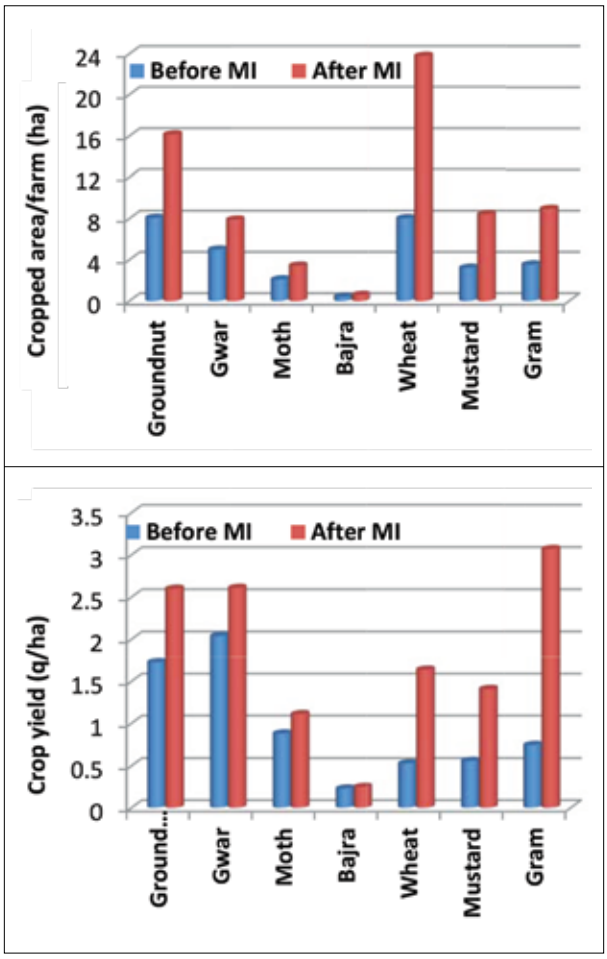

Figure 27: Change in cropped area and yield after adoption of sprinkler irrigation in Bikaner

Direct Benefit Transfer for Micro-Irrigation

Prabhat Kishore and P. S. Birthal

By alleviating capital constraint, input subsidies incentivise farmers to adopt productivity-enhancing technologies and good management practices. For long, the central and state governments have been providing subsidies on several inputs such as fertilisers, seed, electricity, machinery, equipments, etc., but the marginal and small farmers could not benefit much from these because of targeting errors. The Government of India, drawing on the experiences of several countries that have implemented direct benefit transfer program (DBT), started experimenting with direct transfer of input subsidies in 2013 in order to bring in transparency and accountability in targeting of intended beneficiaries. In 2014, the Government of Uttar Pradesh started implementing the DBT program for all kinds of agricultural subsidies. Since then, about two-thirds of the total 23.3 million farmers have registered for direct transfer of various agricultural subsidies (Table 21), and their distribution is fairly equitable across different zones of the state.

Table 21: Cumulative number of farmers registered for DBT in different zones, 2014-2017

Zone	Total number farmers (million)	% share in total	% of total farmers registered for DBT	% share in total farmers registered for DBT
Eastern	10.1	43.2	65.7	42.2
Western	7.3	31.2	66.6	30.9
Central	4.5	19.2	71.9	20.5
Bundelkhand	1.5	6.4	67.3	6.4
Total	23.3	100.0	67.3	100.0

In 2017-18, a total of Rs. 2983 million was transferred to 1.35 million farmers, each receiving about Rs. 2200. Bundelkhand is the most backward region in the state, and seems to have been favoured in DBT.

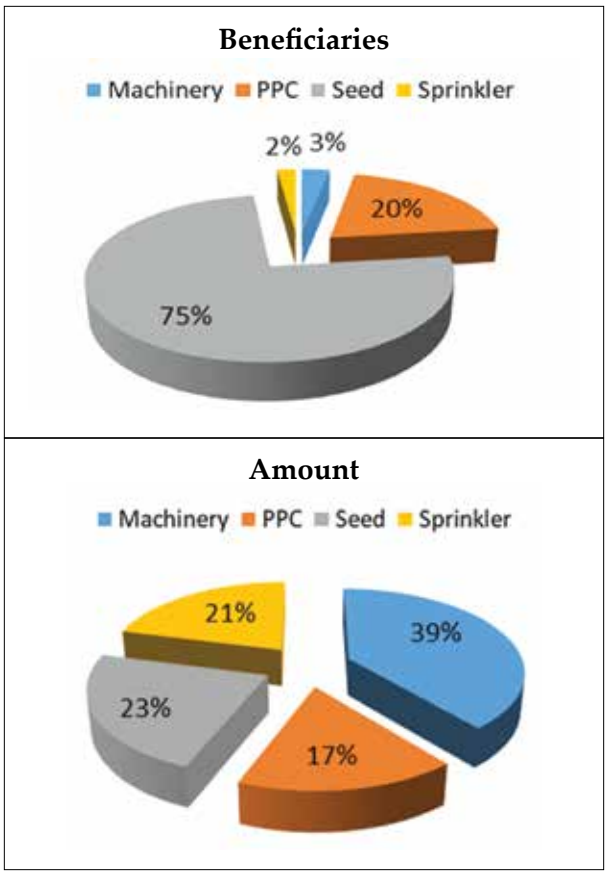

Figure 28: Beneficiaries of different categories of schemes and DBT amount disbursed, 2017-18

About three-fourths of the beneficiaries avail subsidies for seed, followed by plant protection chemicals (PPC), machinery and micro-irrigation. However, of the total amount disbursed the share of machinery is higher (39 per cent) as compared with other inputs that have almost an equal share (Figure 28).

Assessing Vulnerability of Wheat to Heat Stress

P. S. Birthal

There are limited studies that have assessed effects of extreme climatic events, confirm that these events have become more frequent in recent years, and are predicted to rise in future. Their consequences are likely to be more serious than changes in mean climate. Focusing on wheat, heat events were identified, and their consequences upon wheat production were subsequently analysed, considering spatial heterogeneity in yield and adaptation measures using district-level data. A heat event was counted as a period if the daily maximum temperature at a location remains at least 3°C higher over its long-term mean consecutively for three or more days. Since wheat is more sensitive to higher temperatures three months prior to harvest, heat events were identified from three months prior to harvest. The probit regression in Table 22 clearly shows a rise in the frequency and intensity of heat events. Distribution of heat events as well as heat-stressed is skewed towards lower bound indicating that probability of occurrence of two or more events is uncommon. Further, the probability of a heat event to last for a prolonged period, say more than ten days, is also rare.

Figure 29 shows spatial pattern in heat stress. Although, much of India is prone to heat-stress, it is the north-western region, where wheat is a dominant crop, is more exposed to heat stress. Eastern region and some parts of central region also experience heat stress but

Table 22: Probit estimates for trends in heat stress, 1966-2011

	Dependent variable: heat stress =1, zero otherwise							
	February		March		April		All	
	Heat-stressed	Heat	Heat-stressed	Heat	Heat-stressed	Heat	Heat-stressed	Heat
	days	events	Days	Events	days	events	days	events
Time	0.01063*** (-0.0006)	0.0059*** (-0.0006)	0.0038*** (-0.0006)	0.0028*** (-0.0006)	0.0024** (-0.0008)	0.0022** (-0.0007)	0.0039*** (-0.0006)	0.0021** (-0.0007)
Constant	-21.76*** (-1.105)	-12.50*** (-1.184)	-8.33*** (-1.250)	-6.39*** (-1.216)	-5.62*** (-1.492)	-5.26*** (-1.395)	-8.05*** (-1.160)	-4.31*** (-1.192)
No. of Observations	14306	14603	14603	14306	14306	14603	14306	14306

*Figures in parenthesis are district-clustered standard errors. ***, ** and * denote significance at 1%, 5% and 10%, respectively.*

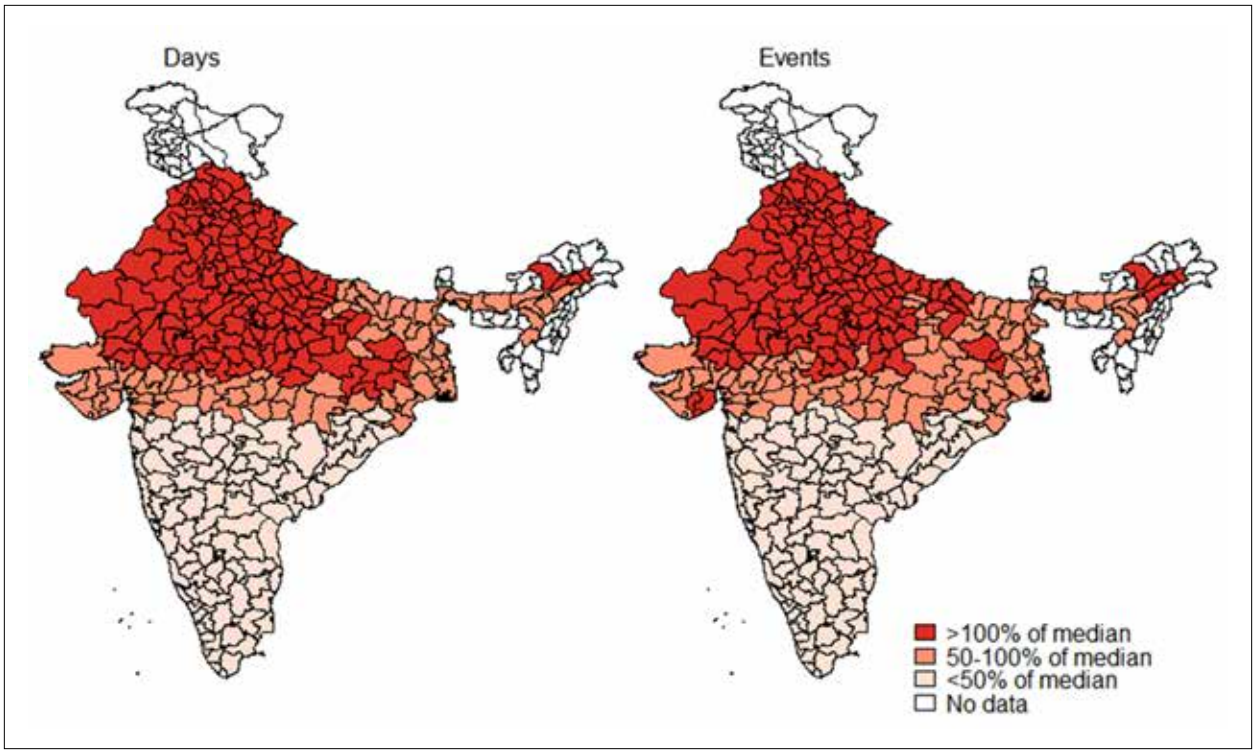

Figure 29: Spatial distribution of heat stress, 1996-2011

its frequency as well as duration are less. The effect of heat stress was measured using fixed effects panel regression, where crop yield is regressed on heat stress, its squared term and interaction with irrigation. The marginal effect derived from estimated regression coefficient shows an annual growth of two per cent in wheat yield during 1966-2011 (Table 23). The negative and significant coefficient on marginal effect of heat stress confirms its adverse effects on crop yield. While statistically significant positive marginal effect of irrigation reckons its positive contribution towards improving crop yield. Further, hypotheses related to changes

Table 23: Average marginal effects of heat

	Heat events	Heat-stressed days
Trend	0.019*** (0.000)	0.020*** (0.000)
Heat stress	-0.009*** (0.002)	-0.002*** (0.001)
Irrigation	0.072*** (0.020)	0.074*** (0.024)

*** significane at 1%.

Figures in parentheses are standard errors.

in the impact of heat stress on crop yield, and the effectiveness of irrigation in reducing the harmful effect of heat stress on crop were tested. The results reveal that heat-induced loss has increased over time. The harmful effect were slowed down with irrigation by moderating the heat stress. Given the tendency of a rise in heat stress in the future, there is a possibility of accentuating its negative effect on crop production. A few important messages that emerge from this study are as follows. Irrigation strategy should focus on improving water-use efficiency through the use of sprinkling and drip methods. There is a need to promote modern agronomic practices, such as residue mulching, zero-till, and balanced application of fertilizers that have been reported to improve resilience of crop to heat stress. Finally, crop breeding has a critical role in managing adverse effects of heat stress. The heat-tolerant traits embedded in seed provide an insurance against extreme events. These are not expensive to multiply, and provide long-term solution. Until recently, India's agricultural research focussed on breeding for higher yields, neglecting stress tolerance traits.

National Innovations in Climate Resilient Agriculture

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

Changing contours of climatic conditions is posing serious risks to the livelihoods of the farmers, especially in developing country like India where majority of the landholdings are small and marginal, and their limited resources base make them difficult to adapt. Enhancing resilience of rural communities to climate variations, necessitates a clear understanding of micro-level perceptions and adaptation issues. As climate variations are linked to the vulnerability of community, via affecting the dynamism of temperature and precipitation cycle - resulting into crop failures, groundwater depletion, farm unemployment, rural migration and increased indebtedness, thereby exacerbating the vulnerability of the community, this study was formulated with the objective to prioritizing location specific adaptation strategies.

Farmers employ a wide range of adaptation strategies, such as water conservation techniques, crop varieties of suitable duration and participation in non-farm activities and employment guarantee schemes to cope up with the climate variability. However, these autonomous responses by the farmers are severely constrained by several field level economic, informational, infrastructure, financial and institutional barriers. Of late, there is an emerging consensus among the developing nations towards mainstreaming adaptation into rural development and poverty alleviation policy and programmes for strengthening farmers' capabilities and making asset of the farm communities more resilient to unpredictable weather perils. The framework envisages developing coherent and conducive policy environment for resilient development through greater convergence between micro and macro-level. Figure 30 represents a general framework encompassing various areas for building resilience.

Assessment of vulnerability to climate change provides useful information to design policies for managing a variety of risks associated with

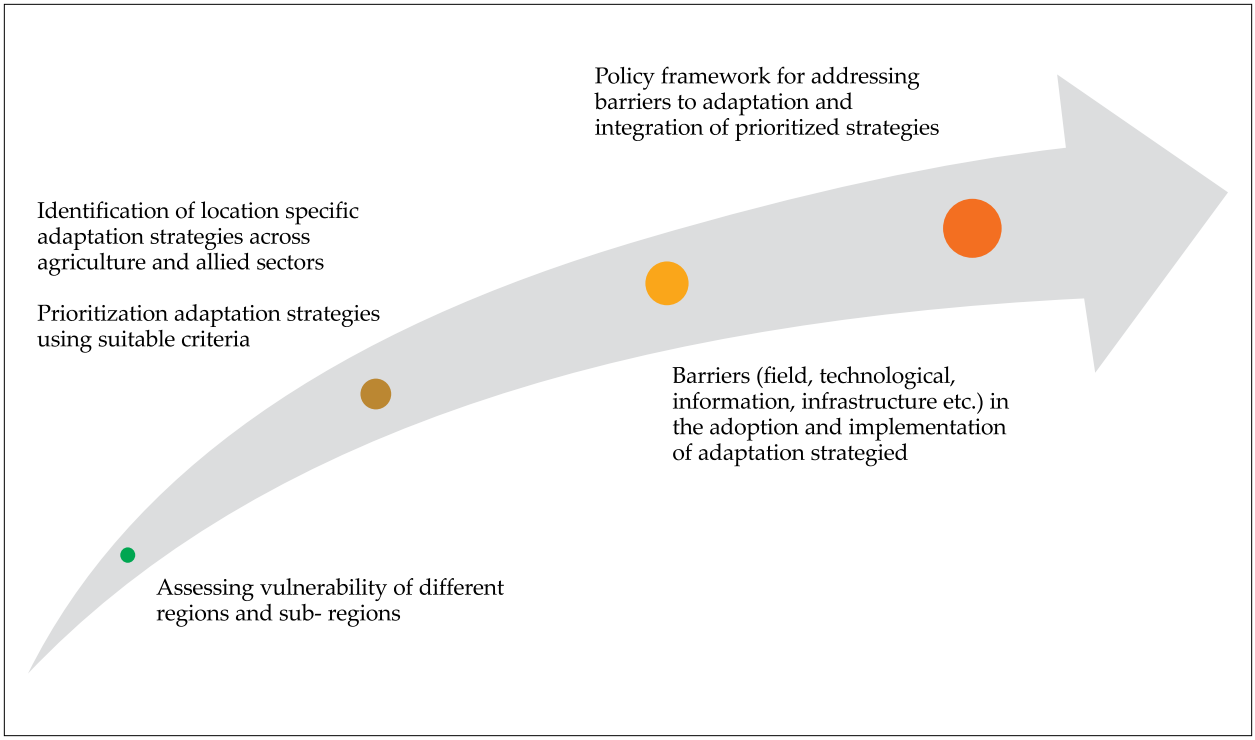

Figure 30: Framework for building resilience

climate change in agriculture. Using district level data, the study developed several indices like infrastructure, nutrition, economic, health, sanitation, workforce, agriculture, environment and an integrated Sustainable Livelihood security index (SLSI) to identify and understand the relevance of various indicators for adaptation and the current resiliency status of 637 district, 29 states and 14 agro-climatic zones (excluding island region) given by the Planning Commission. The indices were classified into four different clusters, namely Very low (0 to 25th per centiles), Low (26 to 50th per centile), Medium (51 to 75th per centile) and High (76 to 100th per centile). Table 24 shows the status of 14 agro-climatic zones in India based on weighted and unweighted SLSI.

The calculated SLSI indicates that majority of the agro-climatic zones have lower livelihood status. The major contributing factors for lower livelihood status were infrastructure, nutrition, health, sanitation and environmental status. Majority of agro-climatic zones recorded medium economic security status. Regions like Gujarat Plains and Hills show higher infrastructure status index. The agricultural status index reflects that majority of agro-climatic zones have either very low or low status, which is largely attributed to vagaries of nature; climatic parameters (rainfall and temperatures). Furthermore, the study also identified 163 districts out of 637 having lower agricultural security, with maximum districts lying in the states of Uttar Pradesh, Madhya Pradesh, Arunachal Pradesh, and Maharashtra. Out of these, 132 districts show improvement in the status on account of continued scientific research efforts in crops, technology development and policy interventions by the governments. Prioritization of location-specific adaptation strategies for building climate smart agriculture is one of the future planned activities of the project.

Table 24: Status of various Agro-climatic Zones with respect to different indices

Index	Very Low		Low		Medium		High	
	Relative	Weightage	Relative	Weightage	Relative	Weightage	Relative	Weightage
Infrastructure Status Index	2, 4, 6, 8	-	5, 7, 14	2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 14	1, 3, 9, 11	1, 10	10, 12, 13	13
Economic Status Index	1, 3, 5, 6	-	2, 4, 14	1, 6, 14	7, 8, 9, 12	2, 3, 4, 5, 7, 8, 9, 10, 11, 12, 13	10, 11, 13	-
Nutritional Status Index	1, 2, 3, 13	-	6, 8, 10	1, 2, 3, 5, 6, 7, 8, 9, 10, 12, 13, 14	5, 7, 9, 11	4, 11	4, 12, 14	-
Health Security Index	7, 8, 13, 14	-	4, 6, 9	1, 2, 3, 4, 5, 7, 8, 9, 11, 14	1, 2, 3, 12	6, 10, 12, 13	5, 10, 11	-
Sanitation Status Index	2, 4, 7, 8	1	5, 11, 14	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13	9, 10, 12, 13	1, 2, 3, 4, 6, 7, 8, 9, 14	1, 3, 6	-
Workforce Status Index	10, 11, 12, 13	-	1, 3, 6	5, 10, 12, 13	5, 7, 9, 14		2, 4, 8	-
Environment Status Index	1, 2, 4, 13	2, 3, 4, 5, 13	6, 10, 11	1, 6, 7, 8, 10, 11, 14	3, 5, 8, 12	9, 12	7, 9, 14	-
Agricultural Status Index	5, 6, 11, 13	1, 6, 7, 11, 12, 13, 14	7, 9, 12	3, 4, 5, 8, 9, 10	4, 8, 10, 14	2	1, 2, 3	-
Sustainable Livelihood Security Index	-	5, 6, 8, 13	4, 7, 14	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14	1, 2, 9, 11	-	3, 10, 12	-

Source: Authors Estimation. Note: Western Himalayan Region (1), Eastern Himalayan region (2), Lower-Gangetic Plain (3), Middle-Gangetic Plain (4),Upper-Gangetic Plain (5), Trans-Gangetic Plain (6), Eastern-Plateau and Hills (7), Central-Plateau and Hills (8), Western-Plateau and Hills (9), Southern-Plateau and Hills (10), East-Coast Plains and Hills (11), West-Coast Plains and Ghat (12), Gujarat-Plains and Hills (13), Western Dry Region (14)

Agro – Economics of Tobacco in India

Usha Rani Ahuja and N. P. Singh

The study aimed to raise awareness about the strategic significance of tobacco cultivation and its economics. It also undertook a comparative analysis and evaluated the potential impacts of tobacco control measures. On the whole, an integrated approach towards tobacco control, incorporating region-specific elements seems to have better mileage in achieving the objective of controlling the tobacco epidemic. The supply-side measures focusing on agricultural diversification may be considered as long-term measures to supplement the demand-side measures. It should also be emphasized that only demand-side measures within a country without global control of supply side may not achieve the goal of tobacco control within a reasonable period of time.

Given India's 33% share of the world's poor, its success in poverty reduction plays an important part in achieving the Sustainable Development Goals (SDGs) from a global perspective. This calls for a roadmap for gradually phasing out tobacco cultivation having short-, medium- and long-term strategies, incentives and support thereby providing succour to farmers to shift to viable alternatives. Therefore, reduction of tobacco use should be given high priority by the government. It is imperative that we better understand the nuanced development pathways and evidence-based policies for tobacco cultivation as well to control the tobacco epidemic in India. There is a need for further research to identify precisely as to how the different segments of Indian population and tobacco-use markets will respond to various public health tobacco control measures.

III TRAINING AND CAPACITY BUILDING

SEMINAR/WORKSHOP ORGANIZED

Impact Assessment of Agricultural Technology

One-day workshop on "Impact Assessment of Agricultural Technology" was organized on November 13, 2017 to provide a platform to ICAR institutions participating in the Network for impact assessment of technologies developed by the respective institutes. It would help to collate credible evidences on improved technologies together and make the impact more visible. The workshop was organized in two technical sessions viz. impact of agricultural technology and wrap up session besides the inaugural session. During inaugural address Deputy Director General (Education) Dr N.S. Rathore emphasized on estimating quality and social benefits of technologies, in addition to productivity gains. He also emphasized that while developing technologies, important aspects such as technical, economic, environmental feasibilities and social acceptance should be kept in mind. Dr Suresh Pal, Director, ICAR-NIAP elaborated the importance of impact assessment, data needs and institutionalization of impact assessment activity. In the workshop a total of 30 participants from 13 ICAR institutes participated and made presentations on various types and aspects of technologies. Workshop was concluded with discussion on work plan and its follow-up action.

Resource Use Planning for Sustainable Agriculture

The workshop on Network Project "Resource Use Planning for Sustainable Agriculture" was held under the chairmanship of Dr. Suresh Pal, Director, ICAR-NIAP on 17th February 2018. He briefly outlined the importance and need of the project. He indicated that resource constraints are rising and there are distortions in resource allocation, hence, there is a need to focus on the most limiting constraint and to improve the efficiency. He mentioned that the project needs to serve a great purpose of analyzing the current scenario and provide the best possible solution in a cost-effective way. Resource endowment and constraints across major agro-ecosystems and need for possible technological/policy interventions were presented by the partners. Major agro-

Workshop on "Impact Assessment of Agricultural Technology", November 13, 2017.

Workshop on "Resource Use Planning for Sustainable Agriculture", February 17, 2018.

ecological regions/agro-ecosystems discussed during the workshop included irrigated region (depletion of ground water), arid region (salinity of soils), eastern humid region, semi-arid region (depletion of ground water & soil erosion) and rainfed rice fallow system. Total 25 participants from partner centers and NIAP participated in the workshop.

TRAINING PROGRAMS

Summer School on Advanced Analytical Techniques for Decision Making in Agriculture

The Institute conducted a Summer School on "Advanced Analytical Techniques for Decision Making in Agriculture" from 10 July–30 July 2017, sponsored by the Education Division of ICAR. The aim of the training programme was to provide exposure to Faculty members/ Scientists at various State Agricultural Universities/ICAR Institutes on current econometrics/advanced statistical techniques/ modelling methodologies for decision making through use of various software packages with particular emphasis on applications in agriculture. Forty-two researchers from different disciplines of agricultural sciences applied for participation in the summer school. Out of 22 participants, 18 were from SAUs and 4 from ICAR institutes and 3 candidates from ICAR-NIAP. The participants represent 11 states i.e Bihar (1), Gujarat (4), Karnataka (2), Madhya Pradesh (1), Maharashtra (3), Punjab (3), Rajasthan (1), Tamil Nadu (2), Uttarakhand (2), Delhi (5) and Jharkhand (1). The participants were made aware about different current forecast modelling techniques/ multivariate analytical techniques through use of various software packages. The course has been structured in a series of modules with classroom lectures and practicals on computer, including demonstration of statistical software packages. The lectures delivered by speakers from ICAR system and guest faculty outside ICAR institutes on theoretical aspects and hands-on exercises covered were 54 and 34 respectively. All lectures and practical exercises were provided to participants in the form of Training compendium & e-manual. Overall success rate for the conduct of summer school training program was more than 90 percent by participants.

Inception-Level Training on Core Issues Related to Agricultural Sector

The inception level training program for Probationers of the Indian Economic Services (IES) was organized by ICAR-NIAP during June 5-9, 2017. During the training program twenty five topics related to core issues on agriculture were covered. Topic wise pre-training and post-training assessments were carried out. In the pre-training assessment, it was observed that they had low to medium level of knowledge in most of the topics related to agriculture. The overall post assessment score showed increase in the knowledge, indicated by 67 % of the total participants with medium level of knowledge and only about 33 % with low level of knowledge in the core issues of agriculture. This may be attributed to the proper selection of resource persons from agricultural economics, dairy and fisheries, extension, horticulture, breeding and plant protection. These professionals were chosen from various elite national organizations including NITI Aayog, Ministry of Finance, Commission for Agricultural Costs and Prices etc. to impart and enrich the understanding of the participants.

Sixty-six percent of the trainees found the topics as most useful, and the rest of them indicated the topics as just useful. Regarding the coverage of topics, 59 percent of the participants were of the opinion that topics were well covered, while 41 % of them rated

as fairly covered. Majority of the participants expressed that since duration of the training is short (5 days only), extending the training to an another week and adding more field visits would further improve the exposure of the participants.

Inception level training program for IES Probationers, June 5-9, 2017.

IV POLICY INTERACTIONS

- Knowledge partner with the Department of Agriculture, Cooperation and Farmers Welfare, and Member of the National Committee on Doubling Farmers' Income by 2022.
- Facilitating technological interventions led strategy, an initiative of ICAR for development of reports of all the states.
- NIAP facilitated Peer Review of Indian Council of Agricultural Research by the Committee constituted by the Ministry of Agriculture and Farmers Welfare.
- NIAP facilitated Outcome Review of Indian Council of Agricultural Research by the Committee constituted by the Ministry of Agriculture and Farmers Welfare.

Goods and Services Tax

In view of GST being effective from 1 July, 2017, ICAR-NIAP organized a consultation meet on 11 July, 2017. The meeting was inaugurated by Secretary DARE & DG, ICAR, Dr. Trilochan Mohapatra and was attended by Special Secretary DARE & Secretary, ICAR Sh. Chabilendra Roul, Deputy Director Generals of various SMDs, Assistant Director Generals and other senior officers of the Council. The curtain of the meet was raised by a brief overview of the purpose of the meeting by Dr Suresh Pal, Director, ICAR-NIAP. Later, Dr Naveen P Singh, Principal Scientist, ICAR-NIAP gave a detailed presentation on GST and its relevance for agriculture sector. The topics covered during the session included Indian economy – an overview, Existing Indirect Tax Structure in India, Introduction to G.S.T, Understanding CGST, SGST & IGST, Main Features of the GST Act, Benefits and challenges of GST, Agriculture sector in earlier regime, GST and its reflections on agriculture sector, e-NAM and GST and its relevance for ICAR's R&D. The presentations also showcased some illustrations on mechanism and Tax Benefit under GST. The idea of the consultation meet was to update the participants on the key issues relating to transition and the preparedness of the agriculture sector and ICAR as an organization for the same. The deliberations and interaction with them will be immensely useful to the participants. The meeting ended with a resolve to prepare a policy brief and FAQ on GST for wider dissemination of various stakeholders in Agriculture sector.

V OTHER INSTITUTE ACTIVITIES

NIAP-Annual Day

The Institute celebrated its 25th Annual Day on 2 May 2017. Dr. Harsh Kumar Bhanwala, Chairman, National Bank for Agriculture and Rural Development (NABARD) delivered 10th Dayanatha Jha Memorial Lecture on "Agriculture in Current Context-Opportunities and Challenges- NABARD's Perspectives". Dr R S Paroda, Chairman, TAAS, Dr Ramesh Chand, Member NITI Ayog and Dr T Mohapatra, Secretary, DARE and DG, ICAR graced the function.

NIAP 25th Annual Day Function.

Cultural program on 25th Annual Day of NIAP.

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 14-28 September, 2017 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.

Participation in ICAR Sports Meet

ICAR-NIAP participated in Inter-Zonal Sports Meet at IARI, New Delhi during 25-29 April, 2017. Ms. Sonia Chauhan participated in carom and chess competitions and brought laurel to the Institute by wining Silver Medal in Chess Competition (Women). ICAR-NIAP sports team also participated in ICAR Central Zone Sports meet at CIAE, Bhopal during 10-13 November, 2017.

Central Zone Contingent including NIAP staff at Inter-Zonal Sports Meet, 2017

Mera Gaon Mera Gaurav (MGMG)

Mera Gaon Mera Gaurav (MGMG) programme of the government aims at fulfilling dream of lab to land by regular contact of scientist with the farmers in the village. Under this programme, three teams have been formed in the institute and these teams have selected 15 villages from Rohtak, Palwal and Mewat districts of Haryana state. In the year 2017-18, eighteen visits were carried out by scientists in the selected villages; total 61 field activities were conducted which benefitted 1303 farmers. Meetings were conducted in selected villages for creating awareness among farmers about Pradhan Mantri Fasal Bima Yojana, Soil Health Card Scheme, maintenance of hygiene around their surroundings, Basmati varieties of paddy, need of community based organization, Minimum Support Price, e-NAM, water logging & saline ground water management etc.

Focus Group Discussion were conducted to identify the problems related to fish culture faced by farmers and alternate livelihood options for women. Farmers perception about soil testing, soil health card and its likely impacts on farming in Khokhiyaka and Jorkhera villages of Palwal district of Haryana were Studied. Literature support for the government scheme like Pradhan Mantri Fasal Bima Yojana was provided to the farmers. Farmers were advised for linking with market for fetching better prices; to buy quality seeds from National Seeds Corporation and IARI, New Delhi; to visit "Kisan Mela" to be organized in the month of March at IARI. Linkages were created with ATIC-IARI, New Delhi for fish seed availability. Major problems faced by the farmers were: limited access to fertilizers due to introduction of direct benefit transfer of fertilizer subsidy, low claim amount from crop insurance, low bargaining power of farmer, water logging & saline ground water and lack of awareness about the cleanliness & sanitation.

Yoga Day

Yoga is important to fitness and wellness. Yoga is a medium to achieve good physical and mental health and it is not expensive to practice. 3rd International Day of Yoga was celebrated at ICAR-National Institute of Agricultural Economics and Policy Research. On 21 June 2017, NIAP staff joined ICAR and IARI staff for yoga session. On this occasion, the yoga instructor explained about the importance of yoga in our daily life. Various yoga poses/ asana were demonstrated by the instructor and also explained about each yoga asana benefits.

NIAP joined ICAR and IARI staff for Yoga Day Celebration on June 21, 2017

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 15.9.17, Director, NIAP briefed the staff with the activities to be held in the Pakhwada i.e., from 15.09.2017 to 02.10.2017. He encouraged the staff to actively participate in spreading the awareness related to Swachh Bharat Mission. After that, Director, NIAP and staff cleaned the campus surroundings and outside.

On 17.09.2017 the employees of the institute celebrated the Seva Divas and devoted two hours out of their schedule in planting saplings in the compound and cleaned the entire premises of the institute. On 24.09.2017, the institute celebrated Samagra Swachhta Divas under Swachh Bharat campaign "Swachhta Hi Seva". The employees along with Director devoted 2 hours in cleaning the office premises, checking the water coolers and the garden area. On 25.09.2017, the Sarwatra Swachhta Divas was organised and NIAP employees along with Director devoted 2 hours in cleaning the surroundings like bus stand and the main road. On October 1, 2017 the employees of the Institute assembled and went to India Gate for cleaning the nearby Tourist spot. Staff of the Institute dedicated half day in cleaning the pond and surroundings of the India Gate and motivated the tourists to keep the city clean. On closing day i.e. 2.10.2017, prize distribution ceremony was organised and the work of outstanding performers during Swachhta Abhiyaan was recognised and appreciated. The best performers were awarded during the function.

Lectures and Meetings

- Meeting for scoping exercise with Dr. Wei Zhang and Dr. Man Li from the International Food Policy Research Institute (IFPRI) who were on scoping visit for a new project on land use in India and Bangladesh, funded by the NASA of the United States on November 16, 2017.
- Initiated lecture series on 'Agricultural Development and Policy' and the first lecture on "Governance and Agricultural Development" was delivered by Sh. P.K. Basu, Former Secretary, Department of Agriculture, Cooperation & Farmers Welfare, Ministry of Agriculture and Farmers' Welfare (MoA&FW), on 7 February, 2018.

VI AWARDS AND RECOGNITIONS

Suresh Pal

- Fellow, Indian Society of Agricultural Economics, Mumbai.
- Invited speaker at the Speaker's Research Initiative Group Workshop for the Members of Parliament, Parliament Library Building, New Delhi, March 21, 2018.
- Member, Research Program Committee, Indian Society of Agricultural Economics.
- Secretary, Agricultural Economics Research Association (AERA).
- Member, Committee on Doubling Farmers Income, DAC&FW, New Delhi.
- Member, Committee of Department of Agriculture Cooperation and Farmers Welfare (DAC&FW) and Warehousing Development and Regulatory Authority (WDRA) on the need for convergence to strengthen post-harvest and marketing infrastructure, Department of Agriculture Cooperation and Farmers Welfare.
- Member, 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, Committee for Peer Review of ICAR, Minister, Ministry of Agriculture and Farmers Welfare.
- Member Secretary, Committee for Outcome Review of various Schemes of ICAR for XIIth Plan, Ministry of Agriculture and Farmers Welfare.
- Member Secretary, Committee for Developing Appropriate Yardsticks for measuring quality of research undertaken by ICAR institutes, constituted by Secretary (DARE) and DG, ICAR.
- Member of an internal 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.
- Representative of ICAR in NITI Aayog's Task Force to prepare the framework with specific indicators to rank the scientific laboratories/institutions.
- Guest of Honor, International Conference on "Agribusiness in Emerging Economies", TERI School of Advanced Studies, New Delhi, January 3, 2018.
- Chaired a session on "Development, Credit, Institutions, Infrastructure & Services", National Conference on Agro-Economic Research, IEG, Delhi, January 30-31, 2018.
- Panelist, Policy Dialogue on "Innovations in Ensuring Remunerative Prices (MSP) to Farmers: Challenges and Strategies", New Delhi, March 23, 2018.
- Member Secretary, Meeting on Doubling Farmers' Income, IARI, New Delhi, June 7, 2017.
- Member, Expert Committee, NABARD, Mumbai.

P.S. Birthal

- ICAR Rafi Ahmad Kidwai Award-2016-2017.
- Fellow, Indian Society of Agricultural Economics 2017.
- Chief Editor, Agricultural Economics Research Review, 2016-17.
- Chairman, Sectional Committee (Social Sciences), NAAS.
- Member, Quinquennial Review Team, CSWRI, 2016.
- Member, Research Advisory Committee, Directorate of Weed Research 2015-18.
- Member, Research Advisory Committee, NDRI, 2016-18.
- Member, Research Advisory Committee, Indian Veterinary Research Institute, 2017-2020.
- Member, Institute Management Committee, Indian Institute of Maize Research 2015-17.
- Member, Editorial Board, SAARC Journal of Agriculture.
- Member, Standing Working Group on "Revamping agricultural extension system", State Planning Board, Government of Chhattisgarh from 2016 onwards.
- Member, External Research Committee, National Bank for Agriculture and Rural Development, Mumbai.
- Convener in the Panel Discussion session of Policy Dialogue on Incentives and Strategies for Scaling out Innovations for Smallholders. Trust for Advancement of Agricultural Sciences, New Delhi, 30-31 October 2017.

Nalini Ranjan Kumar

- Discussant in a session on "Commodity Studies", National Conference on Agro-Economic Research organized by the Agro-Economic Research Centres and Units of the Ministry of Agriculture and Farmers Welfare, Government of India, IEG, Delhi, January 30-31, 2018.
- Member, Editorial Board, Potato Journal, Indian Potato Association, ICAR-CPRI, Shimla.

Rajni Jain

- Session organiser cum Co-chairperson for special session on "Artificial Intelligence and Machine Learning Technologies for Rural and Agricultural Systems", 7th World congress on Information and Communication Technologies (WICT 2017), South Asian University, December 14-16, 2017.
- Session organiser cum Chairperson and member, Technical Programme Committee, for special session on "Computer Applications in Agriculture and Social Sciences", 5th International Conference on Computing for Sustainable Global Development, New Delhi, March 14-16, 2018.

N. P. Singh

- Member, IMC, ICAR-NIASM, Baramati, Pune.
- Member, Global Technology Watch Group-Sustainable Agriculture.
- Managing Editor, Agricultural Economics Research Review (AERR), October, 2017.
- Member, Editorial Board of Weather and Climate Extremes, Elsevier, Geneva.
- External Member, IGNOU, New Delhi.

- Member, Institute Management (IMC) Committee, ICAR-CCARI, Goa.
- Member, Moderation Board, IGNOU, New Delhi.
- Member, Commodity Derivatives Advisory Committee (CDAC), sub-group on spot price polling under aegis of SEBI, Mumbai, July, 2017.
- Resource Person, Meeting of Committee of Experts under MIDH ,4, Siri Institutional Area, Hauz Khas, New Delhi, 18 August 2017.
- Resource person for revisiting FOCARS at NAARM, Hyderabad.

Raka Saxena

- Attended meeting with Shri G. S. Shekhawat, Minister of State, Ministry of Agriculture and Farmers Welfare, GoI to discuss various issues and strategies for Doubling Farmer's Income, September 2017.
- Panelist, panel discussion on "Sustainable Agriculture and Doubling Farmers' Income, National Consultation on Sustainable Development Goals, SDG 2 - Zero Hunger, End hunger, achieve food security and improved nutrition and promote sustainable agriculture", India Habitat Centre, New Delhi, April 13, 2017.
- Participated in Consultative Committee of Parliament on "Agriculture – Doubling of Farmers' Income meeting", Parliament House, New Delhi, 2 November 2017.
- Moderator, session on "Doubling Farmers' Income", National Conference on Agriculture for Kharif Campaign, 2017 (25-26 April 2017). Also made the synthesis presentation, Vigyan Bhawan, New Delhi, April 26, 2017.
- Joint Sectary, Agricultural Economics Research Association (AERA).
- Member, Paper reviewing committee of International Conference on "Agribusiness in Emerging Economics", TERI, New Delhi, 3-4 January 2018.
- Chaired the session on "Public Policy issues in Agribusiness", International Conference on "Agribusiness in Emerging Economics", TERI, New Delhi, January 3-4, 2018.
- Discussant, Seminar on "R&D Technological Reforms in Agriculture", The Centre for Agricultural Policy Dialogue and Techno-Economic Research Institute, New Delhi, January 5, 2018.
- Resource Person, Meeting of Committee of Experts under MIDH, NCDC, Hauz Khas, New Delhi, 18 August 2017.

T. K. Immanuelraj

- Participant in the meeting of Inter-Ministerial Committee to review prices of essential commodities.

Subhash S.P.

- Dr. R. T. Doshi Foundation Awards for best paper at 25th Annual Agricultural Economics Research Association (India) conference held at ICAR-National Academy of Agricultural Research Management, Hyderabad, Telangana, India.

VII PUBLICATIONS

A. Edited Book

Pal, Suresh (2017) *Agricultural R&D Policy in India*, National Institute of Agricultural Economics and Policy Research, New Delhi.

B. Policy Papers

Birthal, P.S., Negi, D., and Roy. D. (2017) Enhancing Farmers' Income: Who to Target and How? *Policy Paper 30*, ICAR-National Institute of Agricultural Economics and Policy Research, New Delhi.

Saxena, R., Singh, N.P., Balaji, S.J., Ahuja, U.R. and Joshi, D. (2017) Strategy for Doubling Income of Farmers in India, *Policy Paper 31*, ICAR-National Institute of Agricultural Economics and Policy Research, New Delhi.

Singh, N.P., Ashok, A., Pavithra, S., Balaji, S.J., Anand, B. and Khan, M.A. (2017) Mainstreaming Climate Change Adaptation into Development Planning, *Policy Paper 32*, ICAR-National Institute of Agricultural Economics and Policy Research, New Delhi.

Saxena, R., and Chand, R. (2017) Understanding the Recurring Onion Price Shocks Revelations from Production-Trade-Price Linkages. *Policy Paper 33*, ICAR-National Institute of Agricultural Economics and Policy Research (NIAP), New Delhi.

C. Policy Briefs

Singh, N.P. and Bisen, J.P. (2017) Goods and Services Tax: What it holds for Agricultural Sector? *Policy Brief 42*, ICAR-National Institute of Agricultural Economics and Policy Research, New Delhi.

Subash, S.P., Chand, P., Pavithra, S., Balaji S.J. and Pal, S. (2017) Pesticide use in Indian agriculture: Trends, market structure and policy issues. *Policy Brief No. 43*, ICAR-National Institute of Agricultural Economics and Policy Research, New Delhi.

D. Training Compendium

Advanced analytical techniques for decision making in agriculture, compiled and edited by Shiv Kumar, Vinayak Nikam, Kingsly I M, Director, ICAR-National Institute of Agricultural Economics and Policy Research, New Delhi, July 2017.

E. Research Papers

Aditya, K. S., Subash, S. P., Praveen, K.V., Nithyashree, M.L., Bhuvana N and Sharma, A. (2017) Awareness about Minimum Support Price and Its Impact on Diversification Decision of Farmers in India. *Asia and The Pacific Policy Studies*, 4(3), 514-526.

Anbukkani, P., Balaji, S.J. and Nithyashree, M.L. (2017) Production and consumption of minor millets in India-A structural break analysis, *Annals of Agricultural Research*, 38(4), 1-8.

Anuja, A., Yadav, V.K., Krishnan, M. and Kumar, N.R. (2018) Catch rates and sustainable yield of Hook and Line Fishery- A Case Study of Kombuthurai

village of Thoothukudi district of Tamil Nadu. *Indian Journal of Geo-Marine Science* 47(02), 489-497.

Anuja, A., Yadav, V.K., Krishnan, M., Ananthan, P.S., Ramasubramanian, V., Kumar, N.R. and Madan, M.S. (2017) Trends in marine fish production in Tamil Nadu using Regression and Autoregressive Integrated Moving Average (ARIMA) model. *Journal of Applied and Natural Science*, 9(2), 653 - 657.

Balaji, S.J. and Pal, S. (2017) Does 'Space' Have a Say on Agricultural Households Income Choices? *Indian Journal of Agricultural Economics*, 72(3), 312-325.

Balaji, S.J. (2018) Structural Breaks, Yield Plateaus and Long Run Yield Trends in Indian Crop Sector, *Indian Journal of Economics and Development*, 14(1), 35-44.

Balaji, S.J., Jhajhria A., Kumar S., Immanuelraj, T.K. and Kar, A. (2017) Agriculture–nutrition linkages: A preliminary investigation for rural India, *Outlook on Agriculture*, 46(4), 302-308.

Balaji, S.J., Arivelarasan, T., Surendran, A., and Anbukkani, P. (2017) Pattern, Expenditure and Inequality in Food and Non-Food Consumption among Rural Households-A Micro Level Study in Tamil Nadu, *Indian Journal of Economics and Development*, 13(1), 105-110.

Balaji, S. J., Kishore, P., Saxena, R., Singh, N.P., and Franco, D. (2017) Technology-Policy Tradeoff in Doubling Farmers' Income: A Case Study on Pulses. *Agricultural Economics Research Review*, 30, 117-126

Birthal, P.S., and Joshi, P.K. (2017) Agricultural Value Chain Finance in India: Issues and Implications. *Journal of Responsible Finance*, 4,19-28.

Birthal, P.S., Chand,R., Joshi, P.K., Saxena, R., Rajkhowa, P., Khan,T., Khan, A., and Chaudhary, K.R. (2017) Formal versus informal: Efficiency, inclusiveness and financing of dairy value chains in Indian Punjab. *Journal of Rural Studies,* 54, 288-303.

Chand, P. Rao, S.C., Subash, S.P., and Malangmeih, L. (2018) Non-Farm Employment and Implication on Agriculture Sector in Rural India. *Indian Journal of Economics and Development*, 14 (1a), 283-292.

Chand, S., Naryan, P. and Chaudhary, K.R. (2017) Sources of risks in livestock production and their management strategies in northern India, *Indian Journal of Livestock Sciences*, 88 (5), 612–619.

Das, A. and Kumar, N.R. (2017) Impacts of Capture Fishery on Income and Its Equity among Fisher Households' of Tripura, *Indian Journal of Hill Farming*, 30(02), 290-294.

Gawa, S., Kumar, N.R., Prakash, S., Yadav, V.K., Hatte, V.M. and Mahida, N. (2017) Economic analysis of trout feed production in Jammu and Kashmir, India, *Journal of Applied and Natural Science,* 9 (4), 2385 – 2390.

Gawa, S. and Kumar, N.R. (2017) Economics and Factors Affecting Rainbow Trout (*Oncorhynchus mykiss*) Production in Kashmir. *Indian Journal of Agricultural Economics*,72(2), 166-176.

Gawa, S. and Kumar, N.R. (2017) Marketing of Trout- A Case Study of Kashmir Valley, India, *Journal of Natural Resource and Development*, 12(2), 39-42.

Gawa, S., Kumar, N.R., Mahida,N., Hatte, V.M. and Vinay A. (2017) A Study on Marketing Cost, Margin, Price Spread and Efficiency

of Fish Marketing in Unregulated Fish Markets in Srinagar, Jammu and Kashmir, *International Journal of Pure App. Biosci.* 5 (4), 300-308.

Gawa, S., Kumar, N.R., Mahida,N. and Hatte, V.M. (2017) Livelihood Option through Trout Seed Production in Jammu and Kashmir: An Economic Analysis, *Fishery Technology* 54, 209-214.

Gawa, S., Kumar, N.R., Mahida ,N., Hoilenting, Vinay A. and Hatte,V.M. (2017) A Study on Consumption Pattern of Trout in Kashmir Valley, India, *Int. J. Pure App. Biosci.* 5 (4), 290-299.

Hatte, V. M., Prakash, S., Krishnan, M., Kumar, N.R., Gawa, S. and Patil, S.V. (2017) Efficiency and Performance of Inland Fish Markets in Nanded District of Maharashtra: A Supply Chain Approach, *Int. J. Pure App. Biosci.* 5 (4), 1936-1944.

Jagadambe, S., Shiji, C.P., Subash, S.P., and Balaji, S.J. (2018) Effect of Non-farm Employment on Farm Commercialization in Agricultural Households in Rural India. *Indian Journal of Economics and Development*, 14 (1a), 298-303.

Jain, R., Chand, R., Singh A. (2017) Total Factor Productivity Growth in Indian Crop Sector, *Indian Journal of Agricultural Economics*, 72(4), 535-554.

Jain R, Kingsley I, Chand, R., Kaur, A., Raju, S S, Srivastava, S K, Singh J (2017) Farmers and Social Perspective on Optimal Crop Planning for Ground Water Sustainability: A Case of Punjab State in India, *Journal of Indian society of Agricultural Statistics*, 71(1), 2017, 75-88.

Jaybhay, S.A., Taware, S.P., Varghese, P., Nikam V.N. (2017) Soybean cultivation by farmers of Maharashtra: Identification and analysis of the problems. *Legume Research*. DOI: 10.18805/lr.v0i0.7842.

Jeyanthi, P., Chandrasekar, V., Ashok, A., Nair, V.R., Thomas, K.J., Jos, K.D. and Gopal, N. (2018) Institutional development and efficiency of fishermen co-operatives in marine fisheries: A case study from Kerala. *Fishery Technology*, 55, 79-85.

Jumrani, J. (2017) Inter-temporal and Spatial Changes in Nutritional Insecurity in India. *Agricultural Economics Research Review*, 30(2), 187-199.

Jumrani, J. and Birthal, P.S. (2017) Does consumption of tobacco and alcohol affect household food security? Evidence from rural India. *Food Security,* 9(2), 255-279. DOI: 10.1007/s12571-017-0660-8.

Kumar, S., Kingsly, T., Vinayak, N., Balaji, S.J., Vister, J., Ahmad,S.S. and Kumar, A. (2018) An Econometric Analysis of Structural Factors of Pulse Production in India: The Case of Chickpea in Maharashtra. *Agricultural Economics Research Review*, 29, 200.

Mittal, S., Subash, S.P, and Hariharan, V. (2017) Price volatility of Maize in India: Do international markets affect? *Indian Journal of Agricultural Marketing*, 31(2), 42-51.

Mugaonkar, P., Kumar, N.R., Shelar, G., Polanco, J. F., Ramsubramanian ,V. and Biradar, R. S. (2017) A Case Study on the Non-price Factors and Consumer Behaviour for Pangasius (*Pangasianodon hypophthalmus*) (Valenciennes, 1840) Consumption in Pune City, *India Fishery Technology*, 54, 279-286.

Nandhin, U., Arumugam, S. S., Balaji, S. J. (2017) Variations in Agricultural Production in Southern Parts of India - A Comprehensive Study, International Journal of Commerce, *Business and Management*, 6(1), 109-123.

Navghan, M., Kumar, N.R., Gawa, S. and Hoilenting (2017) Value Chain Analysis of Farmed Shrimp in Navsari District of Gujarat, *Int. J. Pure App. Biosci.* 5 (6), 352-357.

Navghan, M., Kumar, N.R., Prakash, S. and Sharma, R. (2017) An Empirical Assessment of Seafood Export Performance and Competitiveness in Gujarat, India, *Asian Journal of Agricultural Extension, Economics & Sociology*, 21(3), 1-11.

Nisar, U., Kumar, N.R., Yadav, V.K., Sivaramane, N., Prakash, S. and Qureshi, N.W. (2017) Economics and Resource-use Efficiency in Exotic Carp Production in Jammu & Kashmir, *Agricultural Economics Research Review*, 30 (2), 305-311.

Nisar, U., Kumar, N.R., Kumar, D.K., Gawa, S. and Anamika, S. (2018) Profitability, Investment Pattern and Constraints of Major Marketing Intermediaries Involved in Supply Chain of Exotic Carps in Jammu and Kashmir, India, *International Journal of Current Microbiology and Applied Sciences*, 7(02), 3130-3143.

Nedumaran, S. and Singh, N.P. (2017) Trade-offs between non-farm income and on-farm soil and water conservation investments of smallholder farmers in the semi-arid tropics of India. *Agricultural Economics Research Review*, 30(1), 47-56.

Pal, Suresh (2018) Input Delivery System in Agriculture Including Irrigation and Other Services and their Efficiency: The Role of Finance Sector, *Indian Journal of Agricultural Economics*, 73(1), 77-79.

Pavithra, S., Mittal, S., Bhat, S.A., Birthal, P.S., Shah, S.A. and Hariharan, V. (2017) Spatial and temporal diversity in adoption of modern wheat varieties in India. *Agricultural Economics Research Review* 30(1), 57-72.

Pavithra, S., Jumrani, J. and Pal, S. (2017) Role of optimal fertiliser use in boosting farm income. *Indian Journal of Fertilisers*, 13(12), 16-24.

Radhakrishnan, K., Prakash, S., Narayanakumar, R., Krishnan, M., Madan, M. S. and Kumar, N.R. (2018) Economic analysis of marine fishing crafts in Thoothikudi province, Tamil Nadu, *Indian Journal of Geo-Marine Science* 47(03), 653-659.

Reddy, V. and Immanuelraj T.K. (2017) Area, Production, Yield Trends and Pattern of Oilseeds Growth in India, *Economic Affairs*, 62(2), 327-334.

Saxena, R., Singh, N.P., Choudhary, B.B., Balaji, S.J., Paul, R.K., Ahuja, U., Joshi, D., Kumar, R., Khan, A., (2017) Can Livestock Sector be the Game Changer in Enhancing the Farmers' Income? Reinvesting Thrust with Special Focus on Dairy Sector, *Agricultural Economics Research Review*, 30, 265-277.

Saxena, R., Singh, N.P., Balaji, S.J., Ahuja, U., Kumar, R., and Joshi, D., (2017) Doubling Farmers' Income in India by 2022-23: Sources of Growth and Approaches, *Agricultural Economics Research Review*, 30(2), 59-76.

Sendhil, R., Ramasundaram, P., and Balaji, S. J. (2017) Transforming Indian agriculture: is doubling farmers' income by 2022 in the realm of reality? *Current Science*, 113(5), 848-850.

Siddiqui, M. Z., Donato, R. and Jumrani, J. (2017) Looking Past the Indian Calorie Debate: What is Happening to Nutrition Transition in India. *The Journal of Development Studies*, DOI: 10.1080/00220388.2017.1408798.

Singh, N.P., Anand, B. and Khan, M.A. (2018) Micro-level perception to climate change and adaptation issues: A prelude to mainstreaming climate adaptation into developmental landscape in India. *Natural Hazards*, 1-18. https://doi.org/10.1007/s11069-018-3250-y.

Singh J, Srivastava, S K, Kaur A, Jain R., Kingsley I., Raju, S.S, Kaur, P (2017) Farm size efficiency relationships in Punjab Agriculture: Evidences from Cost of Cultivation Survey, *Indian Journal of Economics and Development*, 13(2a), 357-362.

Srivastava S.K, Chand R, Singh J, Kaur, A., Jain R., Kingsley, I and Raju, SS (2017) Revisiting groundwater depletion and its implications on farm economics in Punjab, India, *Current science,* 113(03), 422-429.

Subash, S.P., and Jabir, A. (2018) Correlates of Agrarian Indebtedness among agricultural households in Rural India. *Journal of Agribusiness in Developing and Emerging Economies*.

Vatta, K., Sidhu, R. S., Lall, U., Birthal, P. S., Taneja, G., Kaur, B., Devineniand, N. and Alister, C. M. (2018) Assessing the economic impact of a low-cost water-saving irrigation technology in Indian Punjab: the tensiometer. *Water International*.

Venkatesh P., Nithyashree, M. L. and Pal, S. (2017) Indian Seed Industry in the Era of Intellectual Property Rights. In Suresh Pal (Ed.) *Agricultural R&D Policy in India*, National Institute of Agricultural Economics and Policy Research, 73-100.

Vinayak N., and Kumar, S., (2017) Agriculture and Extension Policies in India: Connect and Disconnect with Nutrition. *Indian Journal of Nutrition*. 4 (2), 161.

F. Book Chapters

Birthal, P.S., et al. (2017) Formal versus informal: Efficiency, inclusiveness and financing of dairy value chains, In G. Mani, P.K. Joshi and M.V. Ashok (eds), *Financing Agriculture Value Chains in India: Challenges and Opportunities*, Springer, Singapore.

Shinoj, P., Birthal P.S. and Immanuelraj, K. (2016) Employment and income diversification in rural India. In: Agrarian distress in India: Causes and remedies, ed. T. Haque. Concept Publishers, New Delhi.

Guillaume, G. and Pal, Suresh (2017) Socio-economic Assessment in Biosafety Decision-making in Developing Countries. In Suresh Pal (Ed.) *Agricultural R&D Policy in India*, National Institute of Agricultural Economics and Policy Research, 117-134.

Pal, Suresh (2017) Strengthening Delivery of Agricultural Extension Services in India: Experiences and Contemporary Issues. In Suresh Pal (Ed.) *Agricultural R&D Policy in India*, National Institute of Agricultural Economics and Policy Research, 33-52.

Pal, Suresh (2017) The Funding Trend, Institutional Development and Policy Perspective of Agricultural Research in India. In Suresh Pal (Ed.) *Agricultural R&D Policy in India*, National Institute of Agricultural Economics and Policy Research, 11-32.

Shaloo, P., Anbukkani, P.and Pal, S. (2017) Recent Productivity Trends and Impact of Technology in the Rice-Wheat System of the Indo-Gangetic Plains. In Suresh Pal (Ed.) *Agricultural R&D Policy in India*, National Institute of Agricultural Economics and Policy Research, 135-154.

G. Book Review

Changing Contours of Indian Agriculture: Investment, Income and Non-Farm Employment, Edited by Seema Bathla and Amaresh Dubey, Springer Nature Singapore Pvt. Ltd., 2017. pp. vii+242., *Agricultural Economics Research Review* 30(2): 312-314.

H. Popular Articles

Aditya, K. S., Subash, S. P., Praveen, K.V., Nithyashree, M.L., Bhuvana, N and Sharma, A. (2017) A failing safety net? India's minimum support price for agricultural crops. Policy forum. Asia & the Pacific Policy Society. 13 November 2017. https://www.policyforum.net/failing-safety-net/.

Ashok, A. and Madhu,V.R. (2017) Fishermen preferences towards gear-based fish conservation technologies in Sindhudurg district, Maharashtra. Fishtech Reporter, 3(1): 30-32.

Birthal, P.S. and Jumrani, J. (2017, Nov. 27) Reinvigorate livestock to double farmers' income. The Financial Express https://www.financialexpress.com/opinion/how-to-double-farmers-income-this-step-is-crucial-to-achieving-target-set-by-pm-modi/948791/.

Chand, P., Pal, S. and Kumar, S. (2017). Recent strategies and policies for enhancing pulses production in India. Employment News 28 (October 7-13, 2017).

Jumrani, J., Donato, R., and Siddiqui, M. Z., (2017, Dec. 13) Fighting hunger: How malnourished are Indians really? The Financial Express. https://www.financialexpress.com/opinion/fighting-hunger-how-malnourished-are-indians-really/971510/.

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I. Research Bulletin

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Senthil, R., and Subash, S.P. (2017) Indigenous Technical Knowledge (ITK) and Geographical Indications (GIs) in Agriculture and Protection Status. In training manual on Empowering Knowledge on Protection of Plant Varieties, IPRs and PGR related issues in Cereals. (Kumar, V., Gupta, A., and Singh G. P. eds). ICAR-Indian Institute of Wheat and Barley Research, Karnal, Haryana.

J. Working/Concepts Papers

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Sharma S, Jain R (2018) Speculating Missing Data Values during the Extraction Transformation Loading Process through AGRETL. In Proceedings of 5th International Conference on "Computing for Sustainable Global Development", 14-16 March, 2018, IEEE Conference ID: 42835, 2231-36.

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Subash, S.P., Gerard, M., Srinivas, K. and Sastry, K. (2017) Developing Intellectual Property and Technology Management Professionals in NARES: The case of NAARM. Occasional Paper 19, ICAR-National Academy of Agricultural Research Management, Hyderabad.

Subash, S.P and Srinivas, K. (2017) Socio-economic study on Community Based Seed Producers (CBSP) groups of women SHG group model in Uttar Pradesh. Consultancy project report. ICAR-National Academy of Agricultural Research Management, Hyderabad, Telangana, India.

K. Presentations in Conferences/ Workshops/Symposia

Ashok, A. Veettil, P.C. and Nikam, V. (2017) Intra household gender dynamics in access to agricultural extension and advisory services in Eastern India. Paper presented at National Seminar on 'Doubling Farmers Income and Farm Production through Skill Development and Technology Development', Bihar Agricultural University, Sabour, 28-30 November 2017.

Balaji S.J. (2017) Technology-Policy Tradeoff in Doubling Farmers' Income: A Case Study on Pulses. 25th annual conference of Agricultural Economics Research

Association (India), 7-9 November 2017, ICAR-NAARM, Hyderabad.

Birthal, P.S. (2017) Enhancing farmers' income: Who to target and how? In the National Conference on Sustainable Development Goals and India's Preparedness and Role of Agriculture, IFPRI-TAAS-ICAR, New Delhi, 11-12 May, 2017.

Birthal, P.S. (2017) Improving productivity of rice fallows in eastern India. Workshop on Green Revolution in Eastern India, IFPRI & TARINA, New Delhi, 9-10 October, 2017.

Birthal, P.S. (2017) Role of small farmer's in hill economy (Special lecture). Special lecture in the Annual conference of the Indian Society of Agricultural Economics, Shillong, 12-14 October, 2017.

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Birthal, P.S. (2018) Dairy development in India: Issues and perspectives. Keynote speaker, National workshop on Prospects of Dairy Development in Madhya Pradesh, Nanaji Deshmukh Veterinary Science University, Jabalpur, 6 January, 2018.

Birthal, P.S. (2018) India's agri-food policy in transition from food security to farmers' prosperity. Keynote paper in the National Seminar on 'Policy and technological Options for Doubling Farmers' Income, Centre for Research in Rural Development, Chandigarh, 22-23 March, 2018.

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Chand, S. (2017) Emerging informal water markets in *warabandi* system in Northern India, presented in Seminar on sustainable development goal: India preparedness and role of agriculture", IFPRI, Delhi office, 10-11 May, 2017.

Chand, S. and Srivastava, R.C. (2018) "Is *Warabandi* Irrigation System Fading Away in India: Constraints and way forward in Northern India"? Sustainable technologies for intelligent water Management, February 16-19, 2018, Indian Water Resources Society (IWRS), IIT Roorkee.

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Chand, S., Singh, S. and Bhattarai, M. (2018) Co-Existence of Barter system based transaction and modern Agribusiness in Andaman & Nicobar Islands: Efficiency and Equity. International conference on emerging economies 3-4 January 2018, TERI University, Delhi.

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Gerard, M., Gupta, M., Subash, S.P., and Sastry, K. R. (2018) Patent landscaping of CRIPSR-Cas9 technology in agriculture. 2nd Asia-Pacific Workshop on Innovation, IP and Competition, National Law University, New Delhi, 5 -10 February, 2018.

Gupta, M., Gerard, M., Subash, S.P., and Sastry, K. R. (2018) Patent landscaping of CRIPSR technology in agriculture. International Conference on Integrative Biology & Applied Genetics (ICIBAG-2018), Osmania University, Hyderabad, 15-17 March, 2018.

Kandpal A., Kar, A., Jha G.K, Immanuelraj, T.K (2017) Enhancing farmer's income through farm mechanization: A panel data study of paddy and wheat, Agricultural Economics Research Review, 30 (conference issue), 325.

Kumar, S., Kumar, P., and Awais, M. (2018) Policies and Institutions Influencing Effectiveness of Price Support Scheme of Major Crops of Rajasthan, in the Policy Dialogue on Innovations in Ensuring Remunerative Prices (MSP) to Farmers: Challenges and Strategies and Launch of Global Food Policy Report organized jointly by ICAR-NIAP, NAAS and International Food Policy Research Institute, Delhi Office, NASC Complex, New Delhi, 23 March, 2018.

Pavithra, S. (2017) Bridging Yield Gaps. National conference on Green Revolution in Eastern India: Constraints, Opportunities and Way Forward organized by the International Food Policy Research Institute (IFPRI) and Tata Cornell Institute for Agriculture and Nutrition (TCI), NASC, Pusa, New Delhi, 9-10 October, 2017

Prakash P., Kishore, P., Jaganathan, D., Sheela, I. and Sivakumar, P. S. (2018) The Status, Performance and Impact of sweet potato cultivation on farming communities of Odisha, India, International Conference of Agricultural Economists, Vancouver, Canada.

Saxena, R. (2018) Doubling Farmers' Income (Keynote paper). International Conference on "Agribusiness in Emerging Economics", TERI, New Delhi, 3-4 January, 2018.

Saxena, R., Singh, N.P., Choudhary, B.B., S. J, B., Paul, R.K., Ahuja, U., Joshi, D., Kumar, R. and Khan, M.A. (2017) "Can Livestock Sector be the Game Changer in Enhancing the Farmers' Income? Reinvesting Thrust with Special Focus on Dairy Sector." Oral Presentation in the 25th Annual Conference of Agricultural Economics Research Association (AERA), ICAR-NAARM, Hyderabad, 7-9 November, 2017.

Singh, N.P. (2017) Market and Economic Analysis of Onion, Garlic and Potato in India. National Seminar on Innovative Technologies and Value Chain Management of Onion, Garlic and Potato for enhancing Farmers' Income, NHRDF, 2 November, 2017.

Subash, S.P. (2017) Pradhan Mantri Fasal Bima Yojana (PMFBY): Challenges and way forward. 71st Annual conference of Indian Society of Agricultural Statistics on Statistics and informatics for farmer's welfare held at ICAR-Directorate of Rapeseed-Mustard Research, Sewar, Bharatpur, Rajasthan, 25-27 November, 2017.

Subash, S.P. (2018) Effectiveness of competition laws: Case of recent global mergers in agricultural industry. 2nd Asia-Pacific Workshop on Innovation, IP and Competition, National Law University, New Delhi, 5 -10 February, 2018.

Subash, S.P., Aditya, K.S., Balaji, S.J. and Chand, P. (2017) Primary income sources of agricultural household in rural India: Deciphering meso-micro paradoxes using hierarchical analysis. 25th Annual Agricultural Economics Research Association, ICAR-National Academy of Agricultural Research Management, Hyderabad, Telangana, India, 7-9 November, 2017.

Subash, S.P., Aditya, K.S., Balaji, S.J. and Chand, P. (2017) Primary income sources of agricultural household in rural India: Deciphering meso-micro paradoxes using hierarchical analysis. Agricultural Economics Research Review 30 (Conference Number): 286.

Subhash Chand, Ravisankar, N., Kumar, Shiv, Srivastava, R.C., Bhattarai, M., Kishore, P. and Kumar, D. (2018) Institutional innovations in canal irrigation management system in India: Constraints and way-forward, Indian Association of Soil and water conservationists.

VIII ON-GOING RESEARCH PROJECTS

Sl. No.	Title of the Project	Project Team
Network Projects		
1.	Policy Imperatives for Promoting Value Chain of Agricultural Commodities in India	Shiv Kumar Abhimanyu Jhajhria T. K. Immanuelraj
2.	Resource Use Planning for Sustainable Agriculture	Prem Chand Rajni Jain Subhash Chand Prabhat Kishore
3.	Structural Transformation, Regional Disparity and Institutional Reforms in Agriculture	Suresh Pal Balaji S J Pavithra S. Subash S P
Externally-Funded Projects		
1.	Mainstreaming Adaptation Policies in Development Planning to Enhance Resilience of Indian Agriculture (Strategic Research Component of National Innovations in Climate Resilient Agriculture)	Naveen P Singh Arathy Ashok
2.	Management and Impact Assessment of Farmer FIRST Project	Shiv Kumar Rajni Jain Vinayak R Nikam T. K. Immanuelraj Abhimanyu Jhajhria
3.	Doubling Farmers' Income in India by 2021-22: Estimating Farm Income and Preparation of Strategic Framework	Raka Saxena Naveen P Singh Usha Ahuja Balaji S J Ranjit K Paul
4.	Climate Change, Impact, Adaptation, and Mitigation: Gender Perspective in Indian Context	Usha Rani Ahuja Vinayak Nikam
5.	Efficiency of Micro-irrigation in Economising Water Use in India: Learnings from Potential and under Explored States	Subhash Chand Prabhat Kishore R S Pundir S K Srivastava Ravinder Singh

6.	Agricultural Innovations and Technology Management	Sant Kumar
7.	Technology Foresight in Agriculture	Subash S P Arathy Ashok Suresh Pal
Institute Funded Projects		
1.	Institutional Mechanisms in Irrigation Water Management System and Water Markets in Northern India	Subhash Chand Prabhat Kishore Hubbalal
2.	Assessing Impact of Soil and Water Conservation Schemes and Innovative Agricultural Technology	Sant Kumar Pramod Kumar
3.	Direct Benefit Transfer for Micro-irrigation: Impact on Farm Performance	Prabhat Kishore P. S. Birthal
4.	Performance and Impact Assessment of Agricultural Extension and Advisory Systems	Arathy Ashok Vinayak Nikam
5.	Nutrient Demand and the Effect of Women Empowerment in Improving Nutritional Outcomes in India	Jaya Jumrani Usha Rani Ahuja
6.	Farm Mechanization on Small and Marginal Farms in India-Trends and Drives	Nalani Ranjan Kumar S V Bangara Raju
7.	Rural Non-Farm Sector in India: Trends, Structural Changes, Farm Growth and Poverty Linkages	Subash S.P. Prem Chand Balaji S J
8.	Crop Insurance Scheme in India: Progress, Framers Willingness to Pay and the Role of Information	Pavithra S
9.	Marketing Reform and Infrastructure	Raka Saxena
10.	Market Integration and Price Transmission in Agricultural Commodities	T. K. Immanuelraj

IX CONSULTANCY AND CONTRACT RESEARCH

Name of scientist(s)	Institution to which consultancy provided	Area of consultancy / contract research
Usha Rani Ahuja N. P. Singh	WHO	A Study on Agro-Economics of Tobacco in India

X RESEARCH ADVISORY COMMITTEE

The first meeting of IX Research Advisory Committee (RAC) was held on October 6, 2017 under the chairmanship of Prof. Abhijit Sen, President, ISAE and Former Member of Planning Commission.

Prof. Abhijit Sen, (Chairman)
President, ISAE,
New Delhi-110 067

Dr. A. K. Singh
Former Director
Giri Institute of Development Studies
Lucknow-226 016, Uttar Pradesh

Prof. Shashanka Bhide
Director
Madras Institute of Development Studies
Adyar, Chennai-600 020, Tamil Nadu

Dr. P N Mathur
Former ADG (Ext.)
ICAR, New Delhi – 110 012

Dr. P. K. Joshi
Director, South Asia,
IFPRI, New Delhi-110 012

Prof. Srijit Mishra
Director,
Nabakrushna Choudhury Centre for
Development Studies
Bhubneswar-751 013, Odisha

Mr. Sanjay Kumar (Member)
S/o Lt. Sh. Mahender Singh
Badarpur, New Delhi-110044

Mr. Jeet Ram Solanki
Ex. MLA
Pooth Kalan, Delhi-110086

Dr. Suresh Pal (Ex-officio)
Director
ICAR-National Institute of Agricultural
Economics and Policy Research
New Delhi-110012

Assistant Director General
(EQR) (Ex-officio)
Agril. Education Division
Indian Council of Agricultural Research
Krishi Anusandhan Bhawan-II
New Delhi-110 012

Dr. Usha Ahuja (Member Secretary)
Principal Scientist
ICAR-National Institute of Agricultural
Economics and Policy Research
New Delhi-110 012

Meeting of Research Advisory Committee (RAC) held on October 6, 2017.

XI INSTITUTE MANAGEMENT COMMITTEE

Institute Management Committee: The 26th Institute Management Committee Meeting was held on March 10, 2017.

Dr. Suresh Pal
Director & Chairman
ICAR-National Institute of Agricultural Economics and Policy Research (NIAP)
New Delhi - 110 012

Director
Directorate of Economics & Statistics
Delhi State, Old Secretariat
Delhi – 110 054

Director (Economics & Statistics)
Deptt. of Planning
Yojana Bhawan, Govt. of Uttar Pradesh
Lucknow, Uttar Pradesh

Dr. R.K. Grover
Director (HRM)
Haryana Agriculture University
Hisar, Haryana

Mr. Sanjay Kumar
R/o 187, Badarpur
New Delhi – 110 044

Mr. Jeet Ram Solanki
Ex. MLA, R/o H.No. 209
Pooth Kalanm
Delhi – 110 086

Dr. Anil Rai
Professor and Head
Centre for Agricultural Bioinformatics
Indian Agricultural Statistical Research Institute (IASRI)
New Delhi – 110 012

Dr. M.I. Krishnan
Head
National Academy of Agricultural Research Management (NAARM)
Rajendranagar, Hyderabad – 500 030
Telangana

Dr. Harbir Singh
Principal Scientist
ICAR-Indian Institute of Farming System Research (IIFSR)
Modipuram, Meerut
Uttar Pradesh

Dr. Amit Kar
Head
Division of Agricultural Economics
Indian Agricultural Research Institute
New Delhi – 110 012

Dr. G. Venkateshwarlu
Assistant Director General (EQR)
Education Division
Krishi Anusandhan Bhawan – II,
New Delhi – 110 012

Director (Finance)
Indian Council of Agricultural Research
Krishi Bhawan
New Delhi – 110 001

Ms. Neha Chandiok
Administrative Officer (Member Secretary)
ICAR-National Institute of Agricultural Economics and Policy Research (NIAP)
New Delhi – 110 012

Institute Management Committee Meeting held on March 10, 2017.

XII PARTICIPATION IN SCIENTIFIC ACTIVITIES

Suresh Pal

- Member, Board of Management, Navsari Agricultural University
- Regional policy dialogue organized by ACIAR and TAAS, Dhaka, Bangladesh, 8-9 September, 2017.
- Meeting of Committee to review policy research centres, Centre for Policy Research, Punjab University, Chandigarh,17 August, 2017.
- Research Advisory Committee (RAC) meeting of DAC&FW IEG, University Enclave, New Delhi August 5, 2017
- Parliamentary Standing Committee on Agriculture, Examination of Demands for Grants (2018-19), 22 February, 2018 Parliament House, New Delhi.
- First Meeting of the National Steering Group under SAMAVESH Initiative, 17 May, 2017, NITI Aayog, New Delhi.
- Meeting on Doubling Farmers' of Delhi, 7 June, 2017, IARI, New Delhi.
- Interaction meeting for the recommendation of NCF on MSP, 1 July, 2017, NITI Aayog, New Delhi.
- Meeting of Inter-Ministerial Committee to review the prices of essential commodities, 11 August, 2017, Krishi Bhawan, New Delhi.
- Meeting of Committee to review policy research Centres (Nominated by DG, ICAR), 17 August 2017, Centre for Policy Research, Punjab University, Chandigarh.
- Consultation meeting (NITI Aayog), 25 September 2017, NITI Aayog, New Delhi.
- 2nd Meeting of the Committee for restructuring and revamping of ASRB, 3 October 2017, NASC Complex, New Delhi.
- Parliamentary Standing Committee on Agriculture, Examination of Demands for Grants (2018-19), 22 February, 2018 Parliament House, New Delhi.
- ICAR Meeting on Doubling Farmers' Income under the Chairmanship of Prof. M. S. Swaminathan on 3 November, 2017, NASC, New Delhi.

Nalini Ranjan Kumar

- Facilitated the signing of MOU between ICAR-NIAP and DRPCAU, Pusa, Samastipur for the participation of Division of Agricultural Economics, in the Network project on "Structural Transformation, Regional Disparity and Institutional Reforms in Agriculture".

Sant Kumar

- Conducted Viva-voce of Post Graduate Student of the Department of Agricultural Economics of Banaras Hindu University, Varanasi of thesis entitled "Study on Marketed and Marketable Surplus of Rice and Wheat in Varanasi District of Uttar Pradesh, June 23, 2017.
- Second meeting of Committee on Ranking of ICAR Institutes NASC Complex, New Delhi March 9, 2018.

Subhash Chand

- Conducted Ph.D. Agricultural Economics student comprehensive Exam as External Examiner, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu March 25, 2018.

N. P. Singh

- Reviewer, Agricultural Systems, Elsevier, The Netherlands.
- Reviewer, Food Policy, IFPRI Washington, DC.
- Reviewer, Agricultural Research, NAAS, New Delhi.
- Reviewer, Indian Journal of Agricultural Economics (IJAE).
- Reviewer, Indian Journal of Agricultural Sciences (IJAS).

Raka Saxena

- Made a presentation on "Using Market Intelligence as an Effective Mechanism to Curb Price Volatility", National Meeting of Experts on Agriculture Markets, Price Data Visualization and Early Warning System, New Delhi, September 11-12, 2017.
- Reviewer, Agricultural Economics Research Review.
- Reviewer, Indian Journal of Animal Nutrition.
- Reviewer, Agricultural Research, NAAS, New Delhi.
- Reviewer, Journal of Dairy Research.

Prem Chand

- Participated in stakeholder Consultation on "Crop residue and air pollution" jointly organized by CIMMYT, BISA, The Nature Conservancy (TNC), and the Council on Energy, Environment & Water (CEEW), New Delhi, 3 November, 2017

T. K. Immanuelraj

- Member, Board of Studies, Division of Agricultural Economics, ICAR-IARI, New Delhi

XIII VISITS ABROAD AND FOREIGN DELEGATIONS

Name of Scientist	Nature of Visits	Place	Duration
Suresh Pal	SAARC FAO Regional Conference on Agricultural Trade Forum	SAC, Dhaka, Bangladesh	22-23 May, 2017
Suresh Pal	Regional policy dialogue organized by ACIAR and TAAS	Dhaka, Bangladesh	8-9 September, 2017

Foreign Delegations

- Round table meeting with USDA delegation led by Chief Economist, USDA and Minister Councilor at ICAR-NIAP on 1st September, 2017 to discuss the issues of market reforms, crop insurance, commodity outlook and global projections, trade opportunities etc.
- Delegation from Palestine visited ICAR-NIAP on 13 November 2017 to discuss the issues of risk and disaster management in agriculture.

US delegation at ICAR-NIAP.

XIV TEACHING

Teaching: PG Programs, IARI

Name	Course Name (credit hrs)	Course Leader/ Associate	Division
N. R. Kumar	Agricultural Economics (2+1)	Major Advisor	Agricultural Economics
	International Economics and Trade-II (2+1)	Major Advisor	ICAR-CIFE, Mumbai
	Economics of Development and Planning (3+0)	Major Advisor	ICAR-CIFE, Mumbai
	International Economics & trade-I (1+1)	Major Advisor	ICAR-CIFE, Mumbai
Rajni Jain	Artificial Intelligence (2+1) Rough Sets and Fuzzy Sets (2+1)	Course Leader Course Leader	Computer Application Computer Application
N. P. Singh	Agricultural Marketing	Leader	Agricultural Economics
T. K. Immanuelraj	Agricultural Price Analysis (2+1)	Leader	Agricultural Economics
	Agricultural Production and Resource Economics II (2+1)	Associate	Agricultural Economics
	Agricultural Production and Resource Economics IV (2+1)	Associate	Agricultural Economics
Vinayak Nikam	Fundamentals of Management in Extension (2+1)	Course Associate	Agricultural Extension
	Advance Management Techniques (2+1)	Course Associate	Agricultural Extension
	Organisational Behaviour (2+1)	Course Associate	Agricultural Extension

Student Guidance

Name	Degree (No. of Students)	Division	Advisory Committee
Nalini Ranjan Kumar	Ph.D. (3)	ICAR-CIFE, Mumbai	Major advisor
	M.Sc. (1)	ICAR-CIFE, Mumbai	Major advisor
	M.Sc. (1)	ICAR-CIFE, Mumbai	Member advisory
Rajni Jain	Ph.D. (4)	Computer Application	Chairman
	Ph.D. (3)	Computer Application	Co-Chairman
N. P. Singh	2 Ph.D. & 1 M.Sc.	Agricultural Economics	Chairman
	Ph.D & 1 MSc Agril. Econ, 1 PhD student SWCE	Economics & Environment Science	Co-Chairman/ Member
T. K. Immanuelraj	Ph. D	IARI, New Delhi	Co-Chairman

Degree Awarded

Doctor of Philosophy

Balaji S. J. in the discipline of Agricultural Economics, thesis title "Agricultural Growth, Rural Non-Farm Employment and Poverty" in India at 56th Convocation of IARI, New Delhi on 9 February, 2018.

XV LECTURES DELIVERED BY NIAP SCIENTISTS

Name of Scientist	Topic and Date	Organization
Suresh Pal	Transforming Indian Agriculture: Some Reflections, 5 June, 2017.	NASC Complex, New Delhi
	Inaugural function and keynote address for the trainees, 23 January, 2018.	ICAR-IARI New Delhi
	Doubling of Farmers' Income, 5 June, 2017.	ICAR, New Delhi
	NAAS Foundation Day Lecture on Transforming Indian Agriculture: Some Reflections on 5 June 2017.	NASC Complex, New Delhi
P.S. Birthal	Sources of growth in Indian agriculture, January 29, 2018.	ICAR-IARI, New Delhi
	Economic viability of Indian agriculture: Perspectives and challenges, 19 September, 2017.	ICAR-NDRI, Karnal,
Usha Ahuja	Agribusiness in Developing and Emerging Economies on Gender and ICT Issues in Agribusiness, 3 January, 2018.	TERI School of Advanced Studies, New Delhi
Nalini Ranjan Kumar	Potato Marketing and Export 24 July, 2017.	ICAR-CPRI, Shimla
	Economics and Marketing of Potato, 16 December, 2017.	ICAR-CPRI, Shimla
	Role of Aquaculture in enhancing Farmer's income, 5 October, 2017.	ICAR-IARI, New Delhi
	Advanced Analytical Tools for Decision Making in Agriculture, 22 July, 2017.	ICAR-NIAP, New Delhi
Rajni Jain	Decision Trees for classification, 25 July, 2017.	ICAR-NIAP, New Delhi
	Need assessment for Farmers' FIRST Portal for Enriching Knowledge and Integrating Technology, 18-19 September, 2018.	ICAR-Indian Institute of Soil Science, Bhopal
	Data organization and its need for farmer first, 23-26 October, 2017.	ICAR-IARI, New Delhi
	Rough set approach for policy analysis, 30 January, 2018.	ICAR- IARI, New Delhi

Subhash Chand	Entrepreneurial Development, 23 June - 13 July 2017.	ICAR-IARI, New Delhi
	Impact assessment of natural resource conservation programmes: a case study of watersheds.	IAR-IARI, Agronomy Division, New Delhi
	Importance of soil and water conservation measures for potato cultivation in hilly areas: An experience of Nilgiris Tamil Nadu, 24 July, 2017.	ICAR-CPCRI, Shimla
	Soil and water conservation measures and their socio economic impacts: A case study of integrated watershed Development program in Tamil Nadu, August, 2017.	ICAR- IIFSR, Modipuram, UP
N. P. Singh	Climate Change.	CSAUAT, Kanpur
	Vulnerability to Climate change: Adaptation strategies and layers of resilience on 8 June, 2017 in one-week training program for the Officer-Trainees of Indian Economic Service (IES), Ministry of Finance, 5-9 June, 2017.	ICAR-NIAP, New Delhi
Raka Saxena	Role of Marketing and Prices in Doubling of Farmer's Income, 8 June, 2017.	ICAR-NIAP, New Delhi
	Data and Knowledge Management through Market Intelligence to Curb the Farm Price Volatility, 28 September, 2017.	DKMA, New Delhi NHRDF
	Market and Economic Analysis of Onion, Garlic and Potato in India, 2 November, 2017.	ICAR-IIWM, Bhubaneswar
	Strategies and Policies to Double the Income of farmers by 2022, 6 February, 2018.	IARI, New Delhi
	Enhancing the Income of Delhi Farmers, 7 June, 2017.	ICAR-NIAP, New Delhi
	ARIMA model of Forecasting Theory and Practical, 13 July, 2017.	ICAR-NIAP, New Delhi
	Lecture on Public Policy and Sustainable Development on "Doubling Farmers Income" to IAS officers, on 22 February, 2018.	TERI, SAS, New Delhi
Prem Chand	Methods for measuring agricultural sustainability, 10-30 July, 2017.	ICAR-NIAP, New Delhi
T. K. Immanuelraj	Introduction to Linear Programming, 10-30 July, 2017.	ICAR-NIAP, New Delhi
	An introduction to DEA and SFA, 10-30 July, 2017.	ICAR-NIAP, New Delhi
	Co-integration analysis, 10-30 July, 2017.	ICAR-NIAP, New Delhi
	Introduction to optimization and Gams software, February, 2017.	ICAR-NIAP, New Delhi

Arathy Ashok	An introduction to causal inference.	ICAR-NIAP, New Delhi
Pavithra S.	Risk and Insurance in Agriculture, 5 - 9 June, 2017.	ICAR-NIAP, New Delhi
Vinayak Nikam	Agriculture and extension policies connect and disconnect with nutrition: Extension strategies for nutrition. September, 2017.	Division of Agricultural Extension, IARI, New Delhi
	Basics of meeting October, 2017.	Division of Agricultural Extension, IARI, New Delhi
Balaji S. J.	Yield Improvement in Cotton Cultivation: Impact of Irrigation, October, 2017.	ICAR-IARI, New Delhi
	Tracing Structural Breaks in Time Series Data, February, 2017.	ICAR-IARI, New Delhi
Prabhat Kishore	Advanced Analytical Techniques for Decision Making in Agriculture,	ICAR-NIAP, New Delhi
Subash S. P.	Propensity Score Matching, Regression discontinuity design & Social Network Analysis. 10-30 July, 2017.	ICAR-NIAP, New Delhi
	Regression Discontinuity Design for assessing impact of interventions 23 2017 - 13 October, 2017.	ICAR-IARI, New Delhi
	Regression Discontinuity Design for assessing impact of interventions, 23 January, 2018 – 12 February, 2018.	ICAR-IARI, New Delhi
	Case Study Research and Social Network Analysis, 11-16 December, 2017.	ICAR-NAARM, Hyderabad

XVI TRAINING, SEMINAR AND CONFERENCE ATTENDED

Training Programmes

Name of Scientist	Trainings	Place	Duration
Suresh Pal	Executive Development Programme on Leadership Development	ICAR-NAARM, Hyderabad	July 28-01 August, 2017
Subhash Chand	Competency enhancement programme on effective implementation of training functions by HRD Nodal Officers of ICAR	ICAR-NAARM, Hyderabad	February 15-17, 2018
Jaya Jumrani	Winter School organized by the Department of Economics, Delhi School of Economics, University of Delhi and Centre for Development Economics	DSE, New Delhi	December 13-15, 2017
Pavithra S.	Training workshop on Integrating systems modelling tools to support the scaling of climate smart agriculture in semi-arid regions	ICRISAT, Hyderabad	May 3-5, 2017
Arathy Ashok	Training programme on Science Policy & General Management	National Institute of Advanced Studies (NIAS), Bangalore	February 26 - March 09, 2018
Prabhat Kishore	Summer School on Advanced Analytical Techniques for Decision Making in Agriculture	ICAR-NIAP, New Delhi	July 10-30, 2017

Seminars, Conferences, Workshops etc.

Name of Scientist	Seminar/Conference/Workshop	Place and organization	Duration
Suresh Pal	Hunger and Nutrition Dimension of SDGs (Nomination by DG, ICAR)	India Habitat Centre, New Delhi	April 13, 2017
	Agricultural Outlook conference 2017 organized by Department of Agriculture, Cooperation and Farmers' Welfare	NASC Complex, New Delhi	April 28, 2017

	National Consultation on SDG 1	NITI Aayog, New Delhi	June 20, 2017
	Expert discussion at Embassy of the Federal Republic of Germany in New Delhi	German Embassy, New Delhi	July 5, 2017
	Round table discussion on Accelerating Agricultural Development in India through Agricultural Research and Extension. jointly organized by IFPRI, SFSA and NAAS	NASC Complex, New Delhi	July 17, 2017
	Regional Dialogue on Agricultural Mechanization in South Asia organized by IFPRI	NASC Complex, New Delhi	July 20–21, 2017
	Delhi Economics Conclave 2017	Hotel Taj Palace, New Delhi	July 22, 2017
	Policy Dialogue on Innovations in Ensuring Remunerative Prices (MSP) to Farmers: Challenges and Strategies, Organized by IFPRI	NASC Complex, Pusa, New Delhi	March 23, 2018
	International Conference on Advances in Potassium Research for Efficient Soil and Crop Management	NASC Complex, New Delhi	August 28-29, 2015
	National Workshop on Green Revolution in Eastern India: Constraints, Opportunities and Way Forward	NASC Complex, New Delhi	October 10, 2017
	77th Annual Conference of the Indian Society of Agricultural Economics	ICAR RC for NEH Region, Umiam	October 12-14, 2017
	Workshop on Building NRAA as a Knowledge Platform for the Rainfed Systems in the Country	NASC Complex, New Delhi	October 25, 2017
	Policy Dialogue on Incentives and Strategies for Scaling Out Innovations for Smallholder Farmers organized jointly by Trust for Advancement of Agricultural Sciences (TAAS) and Indian Council of Agricultural Research (ICAR)	NASC Complex, New Delhi	October 30-31, 2017
	25th Annual Conference of AERA on Doubling Farmers' Income: Options and Strategies	NAARM, Hyderabad	November 7-9, 2017

	Policy Dialogue on Agricultural Economy of Punjab at Punjab Agricultural University, Ludhiana	PAU, Ludhiana	November 21, 2017
	New age Himalayan farmers workshop on Perspectives and Experiences	NASC Complex, Pusa, New Delhi- 110012	November 29-30, 2017
	National Seminar on Challenges of Agricultural Policy Reforms in India	NITI Aayog, New Delhi	January 5, 2018
	Pre-budget discussion, organized by BW Media	IHC, New Delhi	January 19, 2018
	Seminar on Annual Budget 2018-19	The Leela Palace, Diplomatic Enclave Chanakyapuri, New Delhi	February 10, 2018
	World Bank Seminar on Water Resources	New Delhi	February 15, 2018
	Session on Role of e-National Agriculture Market (e-NAM) and draft APLM Act	New Delhi	March 17, 2018
	Inception Workshop cum orientation meeting of Technical Cooperation Project (TCP)	NITI Aayog, New Delhi	March 20, 2018
P. S. Birthal	25th Annual Conference of AERA on Doubling Farmers' Income: Options and Strategies	ICAR-NAARM Hyderabad	November 7-9, 2017
	National Conference on Sustainable Development Goals and India's Preparedness and Role of Agriculture organized by IFPRI, TAAS and ICAR	New Delhi	May 11-12, 2017
	National Workshop on Green Revolution in Eastern India: Constraints, Opportunities and Way Forward	NASC Complex, New Delhi	October 10, 2017
	Policy Dialogue on Agricultural Economy of Punjab	PAU Ludhiana, Punjab	November 21, 2017
	National seminar on Challenges of Agricultural Policy Reforms in India organized by Centre for Agricultural Policy Dialogue & Techno-economic Research Institute, and IIT Delhi	New Delhi	January 5, 2018

	Workshop on 'Sustainable Pathways to Revitalize Punjab Agriculture: Challenges and Opportunities organized by FAO, Punjab State Farmers' Commission, and CIPT, Chandigarh	Chandigarh	January 30-31, 2018
	National workshop on Prospects of Dairy Development in Madhya Pradesh	Nanaji Deshmukh Veterinary Science University, Jabalpur	January 6, 2018
	77th Annual Conference of the Indian Society of Agricultural Economics	Shillong, Meghalaya	October 12-14, 2017
	International conference on Agribusiness in Developing and Emerging Economies	TERI, New Delhi	January 3, 2018
	National Seminar on Policy and technological Options for Doubling Farmers' Income	Chandigarh	March 22-23, 2018
Usha Ahuja	International Conference on Agribusiness in Developing and Emerging Economies Organized by TERI School of Advanced Studies	10, Institutional Area, Vasant Kunj, New Delhi	January 3-4, 2018
Nalini Ranjan Kumar	Policy Dialogue on Innovations in Ensuring Remunerative Prices (MSP) to Farmers: Challenges and Strategies organised by International Food Policy Research Institute (IFPRI), jointly with the National Academy of Agricultural Sciences (NAAS), and ICAR- National Institute of Agricultural Economics and Policy Research	NASC Complex, Pusa, New Delhi	March 23, 2018
	Conference on Green Revolution in Eastern India: Constraints, Opportunities and Way Forward jointly organized by the International Food Policy Research Institute (IFPRI) and Tata Cornell Institute for Agriculture and Nutrition	NASC Complex, Pusa, New Delhi, India	October 9-10, 2017
Sant Kumar	National Workshop on Green Revolution in Eastern India: Opportunities and Way Forward	NASC Complex, New Delhi	October 9-10, 2017

	Policy Dialogue on Incentives and Strategies for Scaling Out Innovations for Smallholder Farmers	NASC Complex, New Delhi	October 30-31, 2017
	Policy Dialogue on Innovations in Ensuring Remunerative Prices (MSP) to Farmers: Challenges and Strategies and Launch of Global Food Policy Report	NASC Complex, New Delhi	March 23, 2018
Subhash Chand	National conference on Farmers First for western region organised by Indian Association of Soil and water conservationists, ICAR-IISWC & TI, Dehradun	Gujrat Agricultural University, Anand	February 1-3, 2018.
N. P. Singh	National Seminar on Innovative Technologies and Value Chain Management of Onion, Garlic and Potato for enhancing Farmers' Income	NHRDF	November 2, 2017
Raka Saxena	International Conference on Agribusiness in Emerging Economics	TERI, New Delhi	January 3-4, 2018
	25th Annual Conference of Agricultural Economics Research Association	ICAR-NAARM	November 7-9, 2017
Prem Chand	14th India Policy Forum, 2017	NCAER, New Delhi	July 11-12, 2017
	Indo-French Interactive Seminar on the Foresight Agrimonde-Terra for 2050: The Indian Perspective jointly organized by ICAR, Institute National de la Recherche Agronomique (INRA) and Centre international de recherche agricole pour le développement (CIRAD)	NASC Complex, New Delhi.	December 7-9, 2017
	25th Annual Conference of AERA onDoubling Farmers' Income: Options and Strategies	ICAR-NAARM Hyderabad	November 7-9, 2017
	Conference on Draft Pesticide management Bill 2017	Bharat Krishak Samaj, New Delhi.	March 5, 2018
Pavithra S.	Conference on "Green Revolution in Eastern India: Constraints, Opportunities and Way Forward" organized by the International Food Policy Research Institute (IFPRI) and Tata Cornell Institute for Agriculture and Nutrition (TCI)	NASC Complex, Pusa, New Delhi	October 9-10, 2017

Vinayak Nikam	1st International Extension Congress	Bhubaneshwar, Odisha	February 1-3, 2018
	National Seminar on Doubling Farmers' Income and Farm Production through Skill Development and Technology Apllication organised by Indian Society of Extension Education	BAU Sabour, Bihar	November 28-30, 2017
Arathy Ashok	National Seminar on Doubling Farmers' Income and Farm Production through Skill Development and Technology Apllication organised by Indian Society of Extension Education	BAU Sabour, Bihar	November 28-30, 2017
	Policy Dialogue on Incentives and Strategies for Scaling Out Innovations for Smallholder Farmers, Organized by TAAS	NASC Complex New Delhi	October 30-31, 2017
Balaji S.J.	25th Annual Conference of AERA on Doubling Farmers' Income: Options and Strategies	ICAR-NAARM, Hyderabad	November 7-9, 2017
Subash S.P.	Policy Dialogue on Innovations in Ensuring Remunerative Prices (MSP) to Farmers: Challenges and Strategies, Organized by IFPRI	NASC Complex, Pusa, New Delhi	March 23, 2018
	Policy Dialogue on Incentives and Strategies for Scaling Out Innovations for Smallholder Farmers, Organized by TAAS	NAAS Lecture Hall, NASC Complex New Delhi	October 30-31, 2017
	2nd Asia-Pacific Workshop on Innovation, IP and Competition	National Law University, New Delhi	February 5-10, 2018
	25th Annual Conference of AERA on Doubling Farmers' Income: Options and Strategies	ICAR-NAARM, Hyderabad	November 7-9, 2017
	Annual conference of Indian Society of Agricultural Statistics on Statistics and informatics for farmer's welfare	ICAR-Directorate of Rapeseed-Mustard Research, Bharatpur, Rajasthan	November 25-27, 2017
Prabhat Kishore	25th Annual Conference of AERA on Doubling Farmers' Income: Options and Strategies	ICAR-NAARM, Hyderabad	November 7-9, 2017

	National Conference on Farmers First for Conserving Soil and Water Resources in Western Region	Gujrat Agricultural University, Anand	February 1-3, 2018
	Policy Dialogue on Innovations in Ensuring Remunerative Prices (MSP) to Farmers: Challenges and Strategies	NASC Complex, Pusa, New Delhi	March 23, 2018
	National Workshop on Green Revolution in Eastern India: Constraints, Opportunities and Way Forward	NASC, Pusa, New Delhi	October 9-10, 2017

XVII OTHER ACTIVITIES AND DISTINGUISHED VISITORS

Media Interface

- DD Kisan, Market Intelligence, 7 and 9 October 2017.
- Pre-budget discussion, Indian habitat Centre, New Delhi, 19 January, 2018.
- DD Kisan, 'JAGO KISAN'," "खाद्य सुरक्षा और सार्वजनिक वितरण प्रणाली", 26 January, 2018.
- Krishi Darshan, Doordarshan, Budget, February 1, 2018.
- Land Tenure Security and Doubling Farm Income, IIC, New Delhi, 21 February 2018.
- Cultivating sustainable returns, The Economic Times, February 24, 2018.

TV/Radio Talks

Talk show Vad-Samvad at DD Kisan Studio on 27 June, 2017 at Asiad Games Village Complex, New Delhi.

Talk show at DD Kisan on 17 July, 2017 at Asiad Games Village Complex, New Delhi.

Talk show at DD Kisan on 1 December, 2017 at Asiad Games Village Complex, New Delhi.

Training of ARS probationers

The following scientists under training were attached to the Institute for their research orientation :

1) Utkarsh Tiwari (IISS, Bhopal)

2) Pramendra (CAZRI, Jodhpur)

Distinguished Visitors

Dr. Ramesh Chand
Member, NITI Ayog, New Delhi

Sh. P. K. Basu
Former Secretary, Department of Agriculture, Cooperation & Farmers Welfare
Ministry of Agriculture and Farmers' Welfare (MoA&FW)

Dr. Trilochan Mohapatra
Secretary, DARE and Director General, ICAR
Krishi Bhawan, New Delhi

Sh. Chhabilendra Roul
Special Secretary, DARE and Secretary, ICAR
Krishi Bhawan, New Delhi

Dr T Ramasami
Former Secretary
Department of Science and technology
Government of India, New Delhi

Dr. Ashok Dalwai
Special Secretary
Department of Agriculture, Cooperation and Farmers Welfare
New Delhi

Dr. Mruthyunjaya
Former Director, ICAR-NIAP and
National Director, NAIP
New Delhi

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

Dr. N. S. Rathore
DDG (Agricultural Education)
ICAR, New Delhi

Dr. S. K. Singh
Former Addl. Secretary (DARE) and Financial Advisor (ICAR), New Delhi

Dr. A. K. Singh
DDG (Horticulture)
ICAR, New Delhi

Dr. A. K. Singh
DDG (Agricultural Extension)
ICAR, New Delhi

Dr. J. K. Jena
DDG (Fisheries Science)
ICAR, New Delhi

Dr. R. B. Singh
Former President,
National Academy of Agricultural Sciences
New Delhi

Dr. Sudhir Bhargava
Member, Governing Body, ICAR

Dr. M. C. Varshneya
Former Vice-Chancellor
Kamdhenu University, and
Member, ICAR Governing Body

Dr. Madhur Gautam
Senior Economist
World Bank, Washington, DC

Dr. Ramesh Deshpande
India Agriculture Group
Washington, DC

Dr. Nicolas Rada
Senior Economist
ERS, USDA, Washington, DC

Dr. Javed Rizvi
Regional Director for South Asia
World Agroforestry Centre, (ICRAF)
New Delhi

Dr. H. Rahman
Director, South Asia
ILRI, New Delhi

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

Dr. Prabhu Pingali
Founding Director,
Tata-Cornell Institute and Professor
Charles H. Dyson School of Applied
Economics and Management
Cornell University, USA

Directors of different ICAR Institutes

Vice-Chancellor of different SAUs.

XVIII PERSONNEL

Scientific

Name	Designation
Dr. Suresh Pal	Director
Dr. P. S. Birthal	National Professor
Dr. Usha Rani Ahuja	Principal Scientist
Dr. Rajesh K. Rana	Principal Scientist (till 13 July, 2017)
Dr. Anjani Kumar	Principal Scientist (till 30 April, 2017)
Dr. Nalini Ranjan Kumar	Principal Scientist (from 20 July, 2017)
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) (from 3 April, 2017)
Dr. S. K. Srivastava	Scientist (SS) (On deputation from 20 March, 2017)
Ms. Arathy Ashok	Scientist (SS)
Dr. T. K. Immanuelraj	Scientist
Dr. Vinayak Ramesh Nikam	Scientist
Ms. Jaya Jumrani	Scientist
Ms. Pavithra S	Scientist
Mr. Balaji S.J.	Scientist
Mr. S. V. Bangaraju	Scientist
Dr. Abimanyu Jhajhria	Scientist
Mr. Prabhat Kishore	Scientist
Mr. Subash S. P.	Scientist (from 9 May, 2017)

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

Skilled Supporting Staff

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

XIX BUDGET

Head	Grant Expenditure, Rs. Lakhs
Grants for Creation of Capital Assets (CAPITAL)	
Equipment	15.42
Information Technology	27.32
Library Books and Journals	13.35
Furniture and Fixtures	0.00
Vehicle & Vessels	6.83
Other	2.90
Total Capital Expenditure	**65.82**
Grants in Aid-Salaries (REVENUE)	
Establishment Expenses (salaries)	
Establishment Expenses	495.83
Total Establishment Expenses	**495.83**
Grants in Aid-General	
Pension and Other Retirement Benefits	38.85
Travelling Allowances	12.55
Research and Operational Expenses	178.29
Administrative Expenses	178.01
Human Resource Development	3.17
Miscellaneous Expenses	5.40
Total Expenditure Grants in Aid-General	**416.27**
Grand Total	**977.92**
Plan Scheme Projects	**113.71**
Other Projects	**92.77**

Promotions

- Merit promotion of Dr. Raka Saxena, Senior Scientist to the next higher grade of Principal Scientist w.e.f. 09.03.2016
- Shri Satender Singh, Senior Technical Assistant (Driver) to the next higher grade of Technical Officer (T -5) w.e.f. 29.06.2016

New Joining

- Dr. Nalini Ranjan Kumar, joined as Principal Scientist on 20.07.2017
- Dr. Prem Chand, joined as Scientist (SS) on 03.04.2017
- Mr. Subash S. P., joined as Scientist (Agril. Economics) on 09.05.2017