AGRICULTURE during Amrit Kaal

- Infrastructure and investment
- Start-up ecosystem
- Higher exports
- Resilient agriculture
- Climate change
- Inclusive growth
- Waste to wealth

G20 भारत 2023 INDIA

आज़ादी का अमृत महोत्सव

# AGRICULTURAL DEVELOPMENT REPORT 2022-23

भा.कृ.अ.प.– राष्ट्रीय कृषि आर्थिकी एवम् नीति अनुसंधान संस्थान
ICAR – NATIONAL INSTITUTE OF AGRICULTURAL ECONOMICS AND POLICY RESEARCH

The ICAR-National Institute of Agricultural Economics and Policy Research (NIAP) was established by the Indian Council of Agricultural Research (ICAR) to strengthen agricultural economics and policy research in the National Agricultural Research System comprising a network of ICAR institutions and State Agricultural Universities. The mandate of the Institute is:

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

ICAR-NIAP has emerged as a think tank in the area of agricultural policy and it has contributed to increased participation of the ICAR in agricultural policy-making. Besides ICAR, the Institute regularly provides research based inputs to the NITI Aayog, Government Departments, States, and other stakeholders for policy decisions in diverse areas related to agriculture.

# Agricultural Development Report 2022-23

भाकृअनुप – राष्ट्रीय कृषि आर्थिकी एवं नीति अनुसंधान संस्थान
ICAR - National Institute of Agricultural Economics and Policy Research
(Indian Council of Agricultural Research)
New Delhi - 110 012

ICAR-NIAP. 2023. Agricultural Development Report 2022-23. ICAR-National Institute of Agricultural Economics and Policy Research, New Delhi.

**Editors**
Dr Pratap S Birthal
Dr Raka Saxena
Dr Purushottam Sharma
Dr Kiran Kumara T M

**Published**
March, 2023

**Published by**
**Dr P S Birthal**
Director
ICAR–National Institute of Agricultural Economics and Policy Research
New Delhi - 110 012



**Printed at**
M/s Chandu Press, 469, Patparganj Industrial Estate, Delhi 110 092.

# Contents

# List of Tables

# List of Figures

# PREFACE

I am pleased to put before you the 2nd Agricultural Development Report from the ICAR-National Institute of Agricultural Economics and Policy Research. The report provides policy prescriptions based on analytical rigour and objectivity. It covers several aspects related to growth prospects and emerging sustainability issues in Indian agriculture. The policymakers have been according due emphasis on enhancing self-sufficiency in oilseeds, and these efforts have started yielding the gains. The global economic impacts of Covid-19 pandemic and the Russia-Ukraine conflict are a matter of concern, and this report also looks into their impacts on Indian agriculture. Other important features of the report include the strategies for improving outreach and effectiveness of FPOs, prospects for agricultural exports, and drivers of food inflation. Besides, it also provides a brief on the research activities of the ICAR-NIAP undertaken in 2022-23.

I am grateful to Dr Himanshu Pathak, Secretary, DARE & Director General, ICAR for his encouragement and motivation to the faculty and staff of this Institute in bringing out this important publication for the public and policymakers. I am also extremely grateful to Dr Suresh Pal, former Director, ICAR-NIAP for initiating this important activity at this Institute. I thank my all colleagues for their contribution to this report. My sincere thanks are due to Drs Raka Saxena, Purushottam Sharma and Kiran Kumara T M for their painstaking efforts in bringing out this report in its present form. I am also thankful to Drs Vikas Kumar and Devesh Kumar Pant for their support in hindi translaton and proof reading.

**Pratap S Birthal**
Director

# कार्यकारी सारांश

### *चार प्रतिशत कृषि वृद्धि दर*

सकल घरेलु उत्पाद में कृषि का योगदान निरंतर कम होने के बावजूद देश की अधिकांश आबादी अपनी आजीविका के लिए कृषि पर निर्भर है। अतः सतत विकास के लक्ष्यों जैसे शून्य भूखमरी, गरीबी में कमी, पोषण में सुधार और असमानताओं को कम करने के लिए भारत में कृषि विकास को बढ़ावा देना अत्यंत महत्वपूर्ण है। कृषि का वर्तमान विकास, पशुधन और मत्स्य उप-क्षेत्रों में निहित है जिनकी वार्षिक वृद्धि दर क्रमशः 7.7 एवं 8.8 % रही है। जबकि फसलों में वार्षिक वृद्धि दर 2.7 - 2.9 % रही है। ऐसा अनुमान है कि वर्ष 2021-37 के दौरान, यदि सार्वजनिक एवं निजी निवेश में क्रमशः 8 % तथा 5 % की वृद्धि होती है तो कृषि क्षेत्र में 4% की वृद्धि हो सकती है।

### *कृषि अस्थिरता के भयप्रद क्षेत्रीय स्वरुप*

लोक कल्याण को प्रभावित किए बिना, प्राकृतिक संसाधनों के टिकाऊपन को सुनिश्चित करना एक मुख्य नीतिगत विषय है। भारत में, कृषि स्थिरता के विभिन्न क्षेत्रीय स्वरुप/ढांचे इंगित करते हैं कि इसके सुधार के लिए क्षेत्रवार प्राथमिकताओं की आवश्यकता है। भूमि में कम जैविक कार्बन, कम जल उत्पादकता, अधिक बंजर भूमि, कम आदान-उपयोग दक्षता और कम निवेश, विभिन्न राज्यों में आम चिंता का कारण है। अधिक आदान अनुदान के कारण, मिट्टी की प्रतिकूल पीएच, उर्वरकों का अत्यधिक उपयोग, भूमि में कम जैविक कार्बन, और भूजल का अतिदोहन हो रहा है। लेजर से भूमि समतलन, शून्य जुताई, सीधी/सीडड्रिल से बोआई, सटीक जल प्रबंधन और फसल विविधीकरण जैसे कार्य आर्थिक और पर्यावरणीय स्थिरता में सुधार कर सकते हैं।

क्षेत्र-विशेष अनुकूल नीतियाँ और समग्र दृष्टिकोण समय की मांग है। पूर्वी और उत्तर-पूर्वी राज्यों में अपेक्षाकृत बेहतर जल टिकाऊपन है, लेकिन अविकसित भूजल संसाधन और समस्याग्रस्त भूमि, सामाजिक-आर्थिक स्थिरता को प्रभावित करते हैं। इस क्षेत्र में फसल प्रणाली और उद्यमों के विविधीकरण, सिंचाई क्षमता का दोहन, मशीनीकरण में सुधार और टिकाऊ भूमि प्रबंधन क्रियाओं पर ध्यान केंद्रित करते हुए, संसाधनों के कुशल संरक्षण के लिए रणनीति की आवश्यकता है। शुष्क और अर्ध-शुष्क क्षेत्र, फसल और पशुधन विविधीकरण के माध्यम से प्रतिरोधकक्षमता दिखाते हैं। इन क्षेत्रों में कृषि स्थिरता के लिए सहायक सेवाओं का प्रावधान और सार्वजनिक संसाधनों का पुनरुद्धार महत्वपूर्ण है।

### *बजट 2023-24 द्वारा कृषि के सतत और समान विकास की नींव*

कृषि क्षेत्र के लिए केंद्रीय बजट, 2023-24, कृषि-खाद्य उत्पादन प्रणाली के सतत् विकास में उभरती चुनौतियों के प्रबंधन करने में भविष्योन्मुखी है। यह बजट, वर्तमान में, सरकार द्वारा शुरू किये गए प्रयासों जैसे भूमि एवं जल संसाधनों तथा उत्पादन जोखिमों के प्रबंधन, पशु और फसलों की बीमारियों की रोकथाम और नियंत्रण, ग्रामीण बुनियादी ढांचे के मजबूतीकरण, कृषि के डिजिटलीकरण एवं कृषि सेवाओं के प्रावधानों द्वारा, कृषि एवं सम्बंधित गतिविधियों की नींव को मजबूत करता है। इसके अतिरिक्त पीएम-प्रणाम योजना प्राकृतिक संसाधनों के स्वास्थ्य को बहाल करने में मदद करेगी जबकि गोबरधन योजना का उद्देश्य कृषि अपशिष्ट को धन में परिवर्तित करना है। पीएम-विकास योजना, मुख्य रूप से, यह सुनिश्चित करेगी कि ग्रामीण विकास में कोई भी पीछे न रहे।

### *खाद्य तेलों में आत्मनिर्भरता*

खाद्य तेल का बढ़ता आयात चिंता का विषय है। खाद्य तेल का आयात वर्ष 1998-99 में 2.6 मिलियन टन था जो तेजी से बढ़कर 2020-21 में 13 मिलियन टन से अधिक हो गया है, जो उनके घरेलू उत्पादन 11 मिलियन टन से भी अधिक हो गया है। देश पॉम तेल के लिए इंडोनेशिया और मलेशिया पर, सोयाबीन तेल के लिए अर्जेंटीना और सूरजमुखी तेल के लिए यूक्रेन और रूस पर निर्भर है। वर्ष 2020-21 में, देश ने 7.5 मिलियन टन कच्चे पाम तेल, 2.9 टन कच्चे सोयाबीन तेल और 1.9 टन कच्चे सूरजमुखी तेल का आयात किया। दूसरी ओर, तिलहन में 50% से अधिक का उपज अंतर है, जो तकनीकी हस्तक्षेपों के माध्यम से उत्पादन को बढ़ाने की महत्वपूर्ण क्षमता का संकेत देता है।

प्रौद्योगिकी को अपनाने, क्षेत्र विस्तार तथा खाद्य तेलों पर सीमा शुल्क (अन्तराष्ट्रीय व्यापार शुल्क) में वृद्धि से, तिलहन और खाद्य तेलों के उत्पादन में बढ़ोतरी करने में मदद मिलेगी। यदि बिना पर्याप्त तिलहन उत्पादन क्षमता की वृद्धि के, सीमा शुल्क में बढ़ोतरी की जाये तो केवल मंहगाई में वृद्धि की आशंका है। जबकि तिलहन उत्पादन विकास से सीमा शुल्क में बढ़ोतरी के बाद भी मंहगाई दर में कमी देखी गयी है। खाद्य तेलों पर सीमा शुल्क हटाने का तिलहन उत्पादन पर विपरीत प्रभाव पड़ता है। इससे खाद्य तेल के आयात में वृद्धि होती है परन्तु तिलहन उत्पादन में वृद्धि नहीं होती है। हालांकि उपभोक्ताओं को सीमा शुल्क में कमी से लाभ होता है, लेकिन सरकार की लागत बढ़ जाती है। क्षेत्रीय स्तर पर अन्य फसलों की अपेक्षा तिलहन के तुलनात्मक लाभ को समझने पर ध्यान देना चाहिए। आयातित सस्ते तेलों के साथ खाद्य

तेलों के सम्मिश्रण पर प्रतिबंध जैसी नीतियां उनके तिलहन एवं खाद्य तेलों के उत्पादन को प्रोत्साहित कर सकती हैं।

### *सुप्रचालन तंत्र और मूल्य-श्रृंखला प्रबंधन*

कृषि आपूर्ति चेन की प्रभावशीलता और उपभोक्ता मूल्य में किसानों की हिस्सेदारी बढ़ाने के लिए, उत्पादन उपरांत प्रबंधन महत्वपूर्ण होता जा रहा है। कृषि विपणन दक्षता में वृद्धि के लिए एक नयी विपणन बाज़ार व्यवस्था की अवधारणा को अपनाने की आवश्यकता है। भोजन खपत स्वरुप, अधिक मूल्य वाले गैर अनाज खाद्य उत्पादों जैसे फलों, सब्जियों एवं पशु उत्पादों के पक्ष में बदल रहा है। इस प्रकार, कृषि विविधीकरण विकास का एक प्रमुख संचालक होगा। फिर भी, कृषि-पारिस्थितिक अक्षयनिधि और बाजार आसूचना को फसल योजना के लिए आधार बनाने की आवश्यकता है। इसके अतिरिक्त यहाँ उत्पादन समूहों से टर्मिनल बाजारों तक मूल्य श्रृंखलाओं की दक्षता में सुधार हेतु कृषि प्रसंस्करण की महत्वपूर्ण भूमिका है। इस प्रकार, उत्पादक, प्रतिस्पर्धी एवं विविधिकृत कृषि क्षेत्र हेतु, ठोस आधार बनाने के लिए नीतिगत बदलाव की आवश्यकता है।

### *कोविड महामारी उपरांत भारतीय कृषि की उत्साहजनक प्रतिक्रिया*

हालांकि, कोविड-19 महामारी के कारण अल्पकालिक बाधाओं के बावजूद भी, कृषि क्षेत्र ने प्रतिरोधक्षमता का प्रदर्शन किया। फिर भी, महामारी के बाद की अवधि में, कृषि के सकल मूल्य में वृद्धि दर धीमी हुई, जिसे तेज करने की आवश्यकता है। आवागमन प्रतिबंधों ने कृषि आपूर्ति श्रृंखलाओं को प्रभावित किया, किन्तु बाजार में आवक और अधिकांश वस्तुओं की कीमतों में कोई बड़ा परिवर्तन नहीं देखा गया। नीतिगत निर्णयों के कारण, वर्ष 2021 में निर्यात 50 बिलियन डॉलर को पार कर गया। देश ने निर्यात-बढ़ाने के उपायों की शुरुआत की, जैसे निर्यात शुल्क को समाप्त करना (अस्थायी), निर्यात प्रतिबंधों को समाप्त करना और पूर्व निर्यात अनुमति की आवश्यकता को समाप्त करना। इसके कारण, भारत के कृषि निर्यात का प्रदर्शन प्रशंसनीय रहा है। हालाँकि, महामारी के बाद, अंतर्राष्ट्रीय बाजार खाद्य संरक्षा और गुणवत्ता मानकों की आवश्यकताओं पर सख्त होते जा रहे हैं। इस प्रकार, भारत को व्यापार प्रतिस्पर्धा में सुधार के लिए, खाद्य गुणवत्ता और संरक्षा के लिए बुनियादी ढांचे में निवेश करने, वैश्विक सर्वोत्तम प्रक्रियाओं के बारे में जागरूकता बढ़ाने, आपूर्ति श्रृंखला के कारकों के बीच समन्वय लाने की अत्यंत आवश्यकता है।

### *रूस-यूक्रेन युद्ध से अल्पकालिक व्यवधान*

भू-राजनीतिक संघर्ष के कारण हुए आपूर्ति श्रृंखला व्यवधानों ने व्यापार और व्यापार लागतों को प्रभावित किया है जिससे मुद्रास्फीति में वृद्धि हुई। वस्तुओं की अधिक वैश्विक कीमतों से घरेलू कीमतें भी बढ गयी। खाद्य मूल्य मुद्रास्फीति का मुख्य कारण अनाज के मूल्यों में बढ़ोतरी हुई है। रूस द्वारा यूक्रेन पर आक्रमण करने के बाद से अनिश्चितताएं बढ़ी और इसके सामाजिक, आर्थिक और राजनीतिक प्रभाव दुनिया भर में महसूस किए गए। संघर्ष के कारण भारत के आर्थिक और व्यापारिक संबंधों में भी बदलाव आया है। व्यापार में रुकावट और बाद में खाद्य और ऊर्जा आपूर्ति में बाधा के कारण खाद्य मुद्रास्फीति में अचानक वृद्धि हुई। संघर्ष की शुरुआत के बाद करीब चार महीने तक कीमतें बढ़ती रहीं। हालांकि, बाद में कीमतें स्थिर हो गई। तेल, वसा और सब्जियों की कीमतें में कमी आई।

नए अनुबंधों और घरेलू नीतिगत निर्णयों के माध्यम से, आपूर्ति सुनिश्चित करने में सरकारी निर्णय प्रशंसनीय रहे हैं। इससे नए आपूर्तिकर्ताओं और आयात स्थलों का पता लगाना और संघर्ष के प्रतिकूल प्रभावों को टालने में भी सफल रहे। गेंहूँ, चावल और चीनी के निर्यात प्रतिबंधों से मुद्रास्फीति के दबाव को कम करने में मदद मिली है। फिर भी, व्यापार प्रतिबंधों, एवं मूल्य सीमा के कारण वैश्विक आर्थिक संभावनाओं में अनिश्चितता बनी हुई है, जिसका निकट भविष्य में, भारत में अनिश्चित प्रभाव, विशेष रूप से, अधिक आयात और कुछ वस्तुओं की अधिक घरेलू कीमतों के रूप में अनुभव किया जा सकता है। फिर भी, इस संघर्ष ने नए खाद्य व्यापार, खाद्य तेलों के आयात प्रतिस्थापन, और उर्वरक उत्पादन और उपयोग में नवाचारों के लिए रास्ते खोल दिए हैं।

### *उत्साहजनक कृषि निर्यात*

वैश्विक कृषि-खाद्य बाजार में, भारत की हिस्सेदारी बढ़ रही है। देश, बासमती और गैर-बासमती चावल, मसालों और मछली जैसी वस्तुओं में निर्यात-प्रतिस्पर्धी है। अभी कई वस्तुओं की निर्यात क्षमता का दोहन नहीं किया गया है जो इंगित करता है कि कृषि निर्यात की हिस्सेदारी बढ़ने की गुंजाइश है। खाद्य संरक्षा और गुणवत्ता मानकों के मामले में, अंतर्राष्ट्रीय बाजार अधिक सख्त होते जा रहे हैं। खाद्य संरक्षा के मामले, अल्प स्वच्छता सुविधाओं, अपर्याप्त खाद्य संरक्षा के तरीकों एवं उनकी जानकारी और अपर्याप्त खाद्य संरक्षा प्रबंधन से जुड़े हैं। इन चुनौतियों का समाधान करने के लिए, निर्यात आपूर्ति श्रृंखला के साथ सर्वोत्तम प्रक्रियाओं को लागू करना जैसे उत्पादन स्तर पर अच्छी कृषि पद्धतियाँ (GAP), प्रसंस्करण स्तर पर अच्छी निर्माण पद्धतियाँ (GMP), और सभी स्तरों पर अच्छी संचालन के तरीकों (GHP) को अपनाना, महत्वपूर्ण है। तुलनात्मक लाभ को बढ़ाने के लिए एक बहुआयामी रणनीति की आवश्यकता है जिसमें बुनियादी ढ़ांचे और अनुसंधान में निवेश, अच्छी कृषि पद्धतियों को बढ़ावा देना, किसानों की दक्षता

निर्माण, ब्रांडिंग और विपणन, निर्यात का विविधीकरण, और प्रमाणन एवं गुणवत्ता आश्वासन प्रणाली को मजबूत करना शामिल है।

### *कृषि व्यवसाय उन्मुखीकरण के लिए स्टार्ट-अप पारिस्थितिकी तंत्र*

एफपीओ की प्रभावशीलता को उनकी दक्षता, इक्विटी, पर्यावरण, वित्तीय और सामाजिक पहलुओं के माध्यम से देखा जा सकता है। इनकी प्राप्ति हेतु उद्देश्यों की स्पष्टता, अच्छी अंतःक्रिया, अनुकूलता, उचित पैमाने और अनुपालन के माध्यम से लागत को कम करना आवश्यक है। एफपीओ की सफलता उनके संचालन के पैमाने, वित्त सुगमता, सूचना और प्रौद्योगिकी का अंगीकरण, प्रभावी बाजार संपर्क, अच्छे नेतृत्व, भागीदारीपूर्ण निर्णय लेने और समावेशिता में निहित है। इसे साकार करने के लिए सभी हितधारकों के समन्वित प्रयासों की आवश्यकता है। कृषि गतिवर्धक कोष की स्थापना से स्टार्ट-अप पारिस्थितिकी तंत्र को प्रोत्साहन मिलेगा जिससे आधुनिक तकनीकों, नवाचारों और सेवाओं के हस्तांतरण में मौजूदा प्रयासों को मजबूती मिलेगी और उद्यमिता एवं कृषि के व्यावसायीकरण के माध्यम से मूल्य-वर्धन को बढ़ावा मिलेगा।

### *कृषि विकास के लिए सूचना प्रोद्योगिकी और डिजिटलीकरण*

भविष्य की कृषि में, ज्ञान और सूचना की उपयोगिता बढ़ेगी कृषि विकास के लिए एक मजबूत कृषि प्रसार प्रणाली महत्वपूर्ण है। देश के प्रसार एवं सलाहकार सेवा तंत्र को आनेवाली चुनौतियों और अवसरों के अनुसार बदलने की आवश्यकता है। छोटी जोत वाले कृषकों की सूचना-आवश्यकताओं पर ध्यान देने की आवश्यकता है। साथ ही बदलते परिवेश में बाजारों से बेहतर संबंध हेतु बाजारोन्मुखी प्रसार पर व्यापक जोर देने की आवश्यकता है।

एक ओपन सोर्स, खुले मानक और इंटरऑपेरेबल सिस्टम के रूप में, कृषि के लिए डिजिटल सार्वजनिक बुनियादी ढाँचा, बाज़ार, कीमतों, तकनीकों, इनपुट, सेवाओं और सूचनाओं तक किसानों की पहुँच को बेहतर बनाने में मदद करेगा। डिजिटल सार्वजनिक बुनियादी ढाँचा, उत्पादन और लेन-देन की लागत को कम करने, कृषि की प्रतिस्पर्धात्मकता में सुधार करने, लाभकारी फसल स्वरुप को बढ़ावा देने और किसानों की आय को बढ़ाने में मदद करेगा। कृत्रिम बुद्धिमत्ता भी कृषि के सतत परिवर्तन में महत्वपूर्ण भूमिका निभाएगी। यह फसल की पैदावार और नुकसान के आकलन के प्रयासों को मजबूत करेगी और सटीक खेती और मौसम के पूर्वानुमान में सुधार करेगी।

♦♦♦

# Executive Summary

## *Achieving 4% agricultural growth*

Enhancing agricultural growth is crucial for achieving the Sustainable Development Goals of zero hunger, reducing poverty, improving nutrition, and reducing inequalities in India, where agriculture remains the main source of livelihood for majority of the population despite a rapid decline in its share in gross domestic product. The recent growth in agriculture has been driven by the livestock and fisheries sub-sectors, the gross value-added product of which grew at an annual rate of 7.7 and 8.8%, respectively, as compared to a growth of 1.7% in the crop sub-sector. If these trends were to continue, by 2037 the agricultural sector will grow at an annual rate of 2.7-2.9%. It is predicted that the agriculture sector can grow by 4% annually during 2021-37 with 8% growth in public investment and 5% growth in private investment.

## *Regional patterns of unsustainability are alarming*

Ensuring sustainability of natural resources without affecting welfare of the people is the main policy concern. In India, there are varied regional patterns of agricultural sustainability, indicating the need for distinct priorities for its improvement. Low soil organic carbon, low water productivity, large wastelands, low input-use efficiency and underinvestment are common concerns across Indian states. High input subsidies are linked to unfavourable soil pH, overuse of fertilizers, low soil organic carbon, and groundwater overexploitation. Practices like laser land leveling, zero tillage, direct/drill seeding, precise water management, and crop diversification can improve economic and environmental sustainability.

Region-specific policies and holistic approaches are the need of the hour. Eastern and north-eastern states have relatively better water sustainability, but underdeveloped groundwater resources and problematic soils impact the socio-economic sustainability. This region requires strategies for efficient conservation of resources focusing on diversification of cropping system and enterprises, harnessing irrigation potential, improving mechanization, and sustainable land management practices. Arid and semi-arid regions show resilience through crop and livestock diversification. Provision of support services and revival of common property resources are crucial for agricultural sustainability in these regions.

## *Budget 2023-24 lays foundation of sustainable and equitable development of agriculture*

The Union Budget, 2023-24 for the agricultural sector is futuristic in managing emerging challenges to the sustainable development of the agri-food production system. It consolidates the foundations for sustainable development of agriculture and allied activities laid out in the recent government's initiatives on the management of land and water resources and production risks, prevention and control of animal and plant diseases, strengthening of rural infrastructure, digitization of agriculture, and provision of agricultural services. While PM-PRANAM scheme will help restore the health of natural resources, GOBARdhan aims at converting agricultural waste into wealth. Importantly, PMVIKAS will ensure that no one is left behind in rural development.

## *Ensuring self-sufficiency in edible oils is a major concern*

Increasing edible oil imports are a major concern. Edible oil imports have risen sharply from 2.6 million tonnes in 1998-99 to over 13 million tonnes in 2020-21, surpassing their domestic production by 11 million tonnes. The country depends on Indonesia and Malaysia for palm oil, Argentina for soybean oil, and Ukraine and Russia for sunflower oil. In 2020-21, the country imported 7.5 million tonnes of crude palm oil, 2.9 tonnes of crude soybean oil, and 1.9 tonnes of crude sunflower oil. On the other hand, there is a yield gap of more than 50% in oilseeds, indicating a significant potential to enhance their domestic production through technological interventions.

Area expansion and adoption of technology on one side, and a rise in tariffs on edible oils on the other side, would help increase production of oilseeds and edible oils. And, unlike tariffs, which inflate prices when these are imposed without adequate capacity to increase oilseeds production, the technological change reduces prices even when the tariff hikes are maintained. The impact of removing tariffs on oilseeds works the opposite. It leads to a surge in edible oil imports and fails to increase oilseeds production. Although consumers benefit from the reduction in tariffs, the cost to the government inflates.

Thus, tariffs are an instrument for regulating edible oil imports but cannot incentivize oilseeds production. An improvement in technology together with incentives for area expansion under oilseeds will increase production and reduce import dependence. Policy should focus on understanding the comparative advantage of oilseeds vis-à-vis other crops at regional level. Policies such as the ban on blending edible oils with imported cheaper oils can incentivize their production.

## *Logistics and value-chain management critical*

Post-production management is becoming important to enhance the effectiveness of supply chains and farmers' share in consumer rupee. A new market architecture is required, and thus the reforms must focus on enhancing marketing efficiency. Food consumption patterns are changing in favour of high-value non-cereal food products such as fruits, vegetables and animal products. Agricultural diversification will, thus, be a major driver of growth. Nevertheless, agro-ecological endowments and market intelligence must serve as basis for crop planning. Additionally, there is enormous potential for agro-processing to improve efficiency of value chains from production clusters to terminal markets. Thus, policies are required to build a solid foundation for a productive, competitive, and diversified agricultural sector.

## *Post-pandemic response of agriculture is encouraging*

Although, the Covid-19 pandemic created short-term disturbances, the agricultural sector exhibited resilience. Nevertheless, the growth in agricultural GVA has slowed down in the post-pandemic period, which needs to be accelerated. The movement restrictions impacted the supply chains, no major changes were observed in the market arrival and prices of most of the commodities. The policy facilitation put India in an advantageous situation, and the exports crossed $50 billion in 2021. The country introduced export-enhancing measures such as (temporary) elimination of export duties, eliminating export prohibitions, and terminating prior export authorization. Given these, the performance of India's agricultural exports is laudable. However, post- pandemic, international markets are becoming stringent on food safety and quality requirements. Thus, there is a strong case for India to invest in infrastructure for food quality and safety, create awareness among supply chain actors on global best practices and develop resilient supply chains to improve trade competitiveness.

## *Russia-Ukraine war created short-term disruptions*

Supply chain disruptions due to geopolitical conflict impacted the trade and trade costs leading to higher inflation. Higher global prices of commodities transmitted to domestic prices. Cereal inflation has been the main cause of food price inflation. Uncertainties emerged since Russia invaded Ukraine, and social, economic, and political impacts of this were felt across the world. The conflict also altered India's economic and trade relations. Trade disruption and subsequent shock to food and energy supplies led to a sudden spike in food inflation. Prices kept on increasing for about four months after the beginning of the conflict. However, prices stabilized subsequently. Prices of oil & fat and vegetables have even fallen.

Government interventions had been laudable in ensuring supplies through new contracts and domestic policy interventions. It has explored new suppliers and import destinations and succeeded in averting the adverse effects of the conflict. Export restrictions in wheat, rice, and sugar have helped ease inflationary pressure. Still, global economic prospects remain uncertain with sanctions, embargos, and price caps in place, whose effects could be experienced in India in the near future, especially in the form of higher import and domestic prices of some commodities. Nevertheless, the conflict has opened avenues for new food trade, import substitution of edible oils, and innovations in fertilizer production and use.

## *Agricultural exports are expanding*

India's presence in the global agri-food market is increasing. The country is export competitive in commodities such as Basmati and non-Basmati rice, spices, and shrimp. Export potential of several commodities remains untapped indicating a scope to raise the share of agricultural exports. International markets are becoming more demanding in terms of food safety and quality standards. Food safety issues are ascribed to poor sanitary facilities, inadequate food safety practices and knowledge, and insufficient food safety management. Implementation of best practices along the export supply chains, such as good agricultural practices (GAP) at the production level, good manufacturing practices (GMP) at the processing level, and good handling practices (GHP) at all levels is critical to address these challenges. Enhancing comparative advantage requires a multi-faceted strategy encompassing investments in infrastructure and research, promotion of good agricultural practices, capacity building of farmers, branding and marketing, diversification of exports, and strengthening of certification and quality assurance systems.

## *Start-up ecosystem is essential for agribusiness orientation*

Effectiveness of FPOs can be seen through their efficiency, equity, environmental, financial and social aspects. To achieve these, lowering transaction costs through clarity of objectives, good interactions, adaptability, appropriate scale, and compliance, is necessary. The success of FPOs lies in their scale of operation, access to finance, information and technologies, effective market linkages, good leadership, participatory decision-making and inclusiveness. Coordinated efforts of all stakeholders are needed to make it happen. The establishment of the Agriculture Accelerator Fund is expected to stimulate the ecosystem for start-ups in agriculture to strengthen the existing efforts in the transfer of modern technologies, innovations, and services, and promote value-addition through entrepreneurship, and commercialization of agriculture.

## *Information and digitalization to induce growth*

Future agriculture will be knowledge and information-intensive. A robust agricultural extension system is crucial for agricultural development. The country's extension and advisory system needs to respond to emerging challenges and opportunities. Emphasis is warranted on the information needs of smallholders. The changing environment requires extensive thrust on market-led extension for improved connectivity to markets.

The digital public infrastructure for agriculture as an open source, open standard, and interoperable system would facilitate improving farmers' access to markets, prices, technologies, inputs, services, and information. The digital public infrastructure will help reduce production and transaction costs, improve the competitiveness of agriculture, promote remunerative crop patterns, and enhance farmers' income. Artificial intelligence will also play a crucial role in the sustainable transformation of agriculture. It will strengthen the efforts of estimating crop yields and losses, and improve precision farming and weather forecasts.

♦♦♦

1

# GROWTH PROSPECTS FOR INDIAN AGRICULTURE

*Raka Saxena and Balaji S J*

Enhancing agricultural growth is critical for achieving the Sustainable Development Goals of zero hunger, reducing poverty, improving nutrition, and reducing inequities, especially in developing countries where agriculture is the main source of livelihood for the majority of the population. The UN Food Summit 2021 observes that many of these goals are off track, and can be achieved through sustainable transformation of agri-food systems duly supported by investments in infrastructure, institutions, and agricultural research, suggesting the empirical evidence. For instance, the transformation of the food system through diversification in favour of high-value food commodities, including animal-source foods, has been identified as an important pathway for enhancing farm incomes and reducing poverty (Birthal & Negi, 2012; Birthal et al., 2015).

## 1.1 Performance of Agriculture

Agriculture is an important sector of the Indian economy, contributing about 16% to the gross domestic product and engaging about 44% of the workforce. In the recent past, the central and state government have taken several innovative steps for fostering the sustainable transformation of agri-food systems in order to meet the growing demand for diverse food and non-food commodities. Table 1.1 presents the performance of agriculture over the past seven decades. The gross value-added (GVA) from agriculture grew at an annual rate of 2.7% during the 1950s but decelerated significantly during the 1960s. It started recovering thereafter, reaching 3.3% during the 1990s, but again decelerated during the 2000s. It bounced back during the 2010s, reaching an all-time high of 3.9%. On the whole, the agricultural sector grew at an annual rate of 2.7% during the past seven decades. There are four sub-sectors of agriculture, namely crops, livestock, fisheries, and forestry. Notably, the growth has been higher in livestock and fisheries most of the time. In fact, in the recent decade, agricultural growth has been driven by livestock and fisheries, the GVA of which grew

**Table 1.1. Growth of GVA agriculture & allied sector (at 2011-12 prices)**

| Period | Agriculture, forestry, and fishing | Crops | Livestock | Forestry & logging | Fishing & aquaculture |
|---|---|---|---|---|---|
| 1950-59 | 2.71 | 2.93 | 2.91 | 0.29 | 5.79 |
| 1960-69 | 1.51 | 1.27 | 1.25 | 3.33 | 4.00 |
| 1970-79 | 1.74 | 1.94 | 1.88 | -0.62 | 2.90 |
| 1980-89 | 2.97 | 3.09 | 3.11 | -0.26 | 5.67 |
| 1990-99 | 3.34 | 3.36 | 3.40 | 0.95 | 5.36 |
| 2000-09 | 2.56 | 2.52 | 4.16 | -0.42 | 3.62 |
| 2010-22 | 3.91 | 1.74 | 7.73 | 4.28 | 8.80 |
| 1950-22 | 2.73 | 2.69 | 3.21 | 0.68 | 4.54 |

*Source: Authors' computations*

at an annual rate of 7.7 and 8.8%, respectively, as compared to a growth of 1.7% in the crop sub-sector.

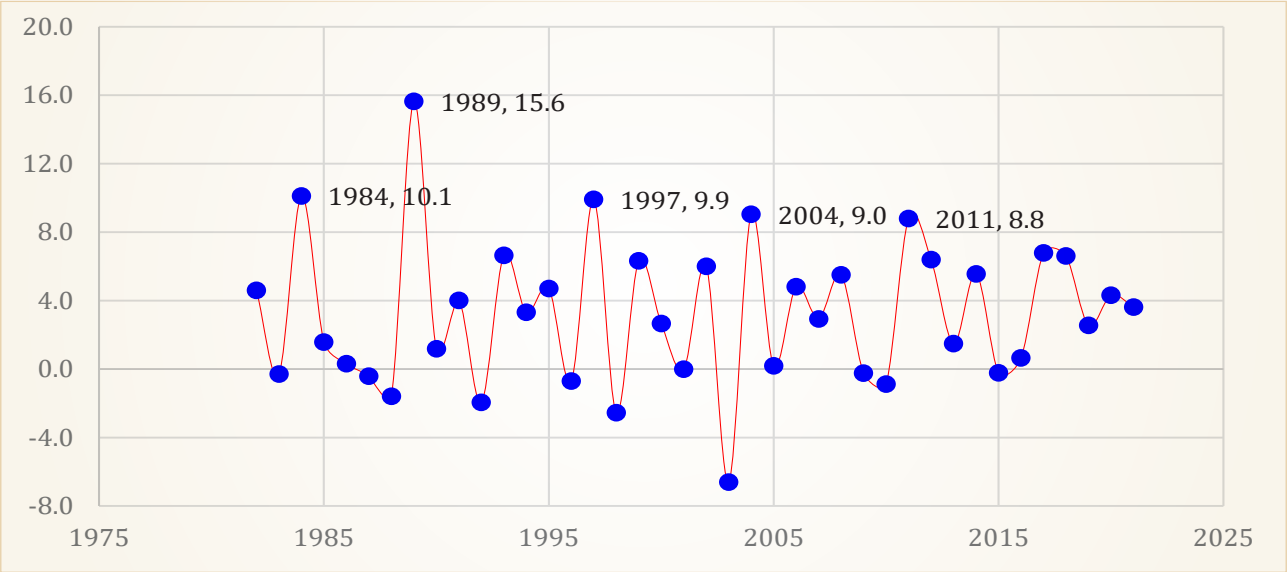
However, the overall growth of the agricultural sector has been quite volatile (Figure 1.1). The years 1983-84, 1988-89, 1996-1997, 2003-04, and 2010-11 are identified as the best years for agricultural performance. The growth in these years was 3 to 5 times more than the trend growth of about 3%. On the other hand, in several years, the growth had been negative. Such a disaggregated analysis of growth is essential to understand the causes of good and poor performance of agriculture or in other words the volatility in agricultural growth.

## 1.2 Forecasting Agricultural Growth

We have generated forecasts for agricultural gross domestic product (GDP) using the traditional econometric as well as modern machine learning (ML) approaches. To obtain forecasts in a business-as-usual scenario, the quarterly agricultural GDP series from 1996-97 to 2020-21 have been used. The actual series at different base periods have been converted at 2011-12 prices. The ML approach as prescribed by Taylor and Letham (2017) has been used. The autoregressive integrated moving average (ARIMA) model has been used as the baseline and its SARIMA version for adjusting seasonality in the series[1]. These models generate forecasts utilizing historical information contained in the series, and hence cannot be readily used for simulating the impacts of policy interventions. These models generate forecasts in a business-as-usual scenario. To allow for the change in decision behaviors of institutions, households, employment and terms of trade, a multiple-equation linkage model has been used as in Balaji (2017); Balaji and Pal (2021); Fan et al. (2008). Government interventions are inevitable for enhancing growth, and these are backed by economic factors such as investments in research and development, irrigation, and market infrastructure and incentives.

Institutional credit contributes to investment in

**Figure 1.1. Delineating the best and worst growth years in agriculture (Annual GVA growth, %)**




*Source: Authors' computations*

[1] The stationary of the series was tested using both graphical and standard unit root tests. For the latter, the first-generation tests namely Dickey-Fuller (DF) test, the Augmented Dickey-Fuller (ADF), and the Phillips-Perron (PP) unit root test were used. An alternative KPSS test as well was used for robustness check. The SARIMA, the extended version that takes into consideration the seasonality component was used in forecasting agricultural GDP in the business as usual scenario.

farm assets such as machinery and implements, irrigation, storage structures, and others. These along with technological change determine the level and growth of agricultural output (Balaji and Babu, 2020). Higher labor intensity in construction and employment guarantee programs (e.g., MGNREGS) creates a scarcity of farm labor, leading to an increase in farm wages. Table 1.2 displays the growth in selected macro-economic indicators.

**Table 1.2. Growth in selected macroeconomic indicators (CAGR*, % p.a.)**

| Indicators - Agri & allied sector | 1981-2020 | 1991-2020 | 2005-2020 | 2012-2020 |
|---|---|---|---|---|
| **GDP** | 3.0 | 3.0 | 3.5 | 3.5 |
| **GCF-Public sector** | 1.8 | 4.0 | 4.4 | 5.7 |
| **GCF-Private sector** | 4.7 | 4.8 | 3.8 | 0.8 |
| **Workforce (Farmers & agri laborers)#** | 0.1 | -0.5 | -2.1 | -2.1 |
| **Institutional credit** | 6.4 | 8.0 | 5.2 | 4.4 |
| **Fertilizer subsidy** | 6.6 | 5.6 | 2.6 | -2.0 |

** growth estimates are on constant 2011-12 (unsmoothed) series; #till 2019*

*Source: Authors' computations*

For forecasting agricultural growth both in the business-as-usual scenario with specific interventions the following simultaneous equation model is formulated;

AGLGDP = f {AGPUBINV, AGPVTINV} ---------- (1)
AGPUBINV = f {FERTSUB} ---------- (2)
AGPVTINV = f {CREDIT, LABSHR, PRICES} ---------- (3)
LABSHR = f {WAGERT} ---------- (4)

The simultaneous equation model has used the 3-stage least squares procedure (3SLS). Agricultural GDP (AGLGDP) is a function of public (AGPUBINV) and private (AGPVTIN) investment. Public investment is presumed to be conditioned by farm subsidy bill (FERTSUB), and private investment is an outcome of the credit supply (CREDIT), farm labor share (LABSHR), and terms of trade (PRICES). Further, farm labor supply is a function of difference in farm and non-farm wages ((WAGERT). Gross capital formation (GCF) in public and private sectors captures the investment levels.

The growth has been forecasted till 2036-37. The quarterly agricultural GDP series for 1996-67 to 2016-17 has been used as the training dataset (base period-1) before directly making the forecasts. The actual series for 2017-18 and 2020-21 are treated as the test data set. Using ML and SARIMA approaches the forecasts have been made for the latter period and validated by comparing these with the actual GDP estimates. Both 'additive' and 'multiplicative' versions of ML have been used. The forecasted values are closer to the observed GDP and have the least errors. The Mean Absolute Error (MAE), Mean Percent Error (MPE), Mean Absolute Percent (MAPE), and Root Mean Square Error (RMSE) were used to examine the forecast deviations.

Results show that if the trend since the mid-1990s were to continue, the agricultural sector will grow at an annual rate of 2.7 to 2.9%. If the trend follows the growth pattern since the mid-2000s, the growth will be slightly on the lower side. Projections from the econometric approach are slightly smaller in magnitude.

Shifting from univariate to simultaneous estimation, the interrelationships discussed earlier have been modeled for 1981-2019. As earlier, the model has been validated with existing growth rates of public and private investment. A three-year moving average for the series from 1983 to 2020 yields an annual growth of 1.9% in public investment and 4.8% in private investment. Assuming that this trend will continue, the agricultural GDP will grow by 3% annually.

The estimated coefficients are used to simulate the impacts of interventions. Three different scenarios have been developed– the best, the least, and the business-as-usual. In the

*best-growth scenario*, investments, credit, and subsidies are assumed to improve. The 'experience-in-past' provides guidance in this. Public sector capital formation had been stagnant during the 1990s and it began rising gradually afterward. After a temporary break in the late 2000s, it has sustained a growth of 5.9%. In the best-case scenario, the growth in capital formation is assumed to increase by 8% a year. Private investment has rather behaved the opposite, signaling a crowding-out effect in the post-reforms period.

Institutional credit outstanding has consistently grown at a rate of 7.8% throughout the early 2000s. But, fertilizer subsidy has dropped considerably (a non-agricultural GDP deflator was used to convert subsidy in real terms). In the best case, we presume no further hike in fertilizer subsidy. With given rates of public and private capital growth, it is predicted that the agriculture sector can grow 4% at the maximum during 2021-37 (Table 1.3). Note, private investment at present contributes more than 80% of total investment, and hence its GDP multiplier is assumed roughly 4 times of the public sector investment. However, a 5% growth in private investment will require substantial efforts in terms of conducive policy support, an inclusive financial sector, a shift in lending towards capital assets, and a preference for investment over short-run on-farm expenses at the farm level.

In the *least-growth scenario*, the public capital is presumed to grow slightly less that the existing rate. During the 2010s, it has grown at a rate of 5.9% a year. Still, the present environment demands MSP assurance and deficit payments through transfers, which will continue to exert pressure on financial resources.

## 1.3 Enablers of Future Growth

### *Bridge productivity gaps*

There is a huge potential to increase the yield of the majority of the crops. China produces over 7 tonnes of rice per hectare. India's yield is just

**Table 1.3. Simulation framework and predicted growth in agriculture**

| Indicator | Period | Growth (% p.a.) | Potential impact on agri & allied GDP growth (% p.a.) |
|---|---|---|---|
| **Business as usual scenario** | | | |
| **GCF-Public sector** | 1983-2020 | 1.9 | 3.0 |
| **GCF-Private sector** | | 4.8 | |
| **Institutional credit** | | 6.4 | 1.0 |
| **Fertilizer subsidy** | | 6.5 | |
| **Best-growth scenario** | | | |
| **GCF-Public sector** | - | 8.0 | 4.0 |
| **GCF-Private sector** | | 5.0 | |
| **Institutional credit** | | 8.0 | 1.0 |
| **Fertilizer subsidy** | | - | |
| **Least-growth scenario** | | | |
| **GCF-Public sector** | - | 5.0 | 2.7 |
| **GCF-Private sector** | | 3.5 | |
| **Institutional credit** | | 3.0 | 0.4 |
| **Fertilizer subsidy** | | 1.0 | |

*Source: Authors' computations*

57% of China's (Table 1.4). Even in Indonesia and Vietnam, the yield is relatively higher than in India. So is in the case of wheat. India's wheat yield is 3.5 tonnes/hectare, which is 46% of that in France and 63% in China. Sugarcane is the one crop in which India has a higher yield than most other countries. Understanding technological differences and production patterns and supportive policies shall help increase yield levels.

### *Enhance capital intensity and factor productivity*

The contribution of capital to agriculture has stalled since the mid-2000s (Figure 1.2). Such a trend implicitly signals a limited possibility of returns to higher capital investment in agriculture. Stagnancy in returns to investment in R&D adds further to this argument.

### *Reduce imports*

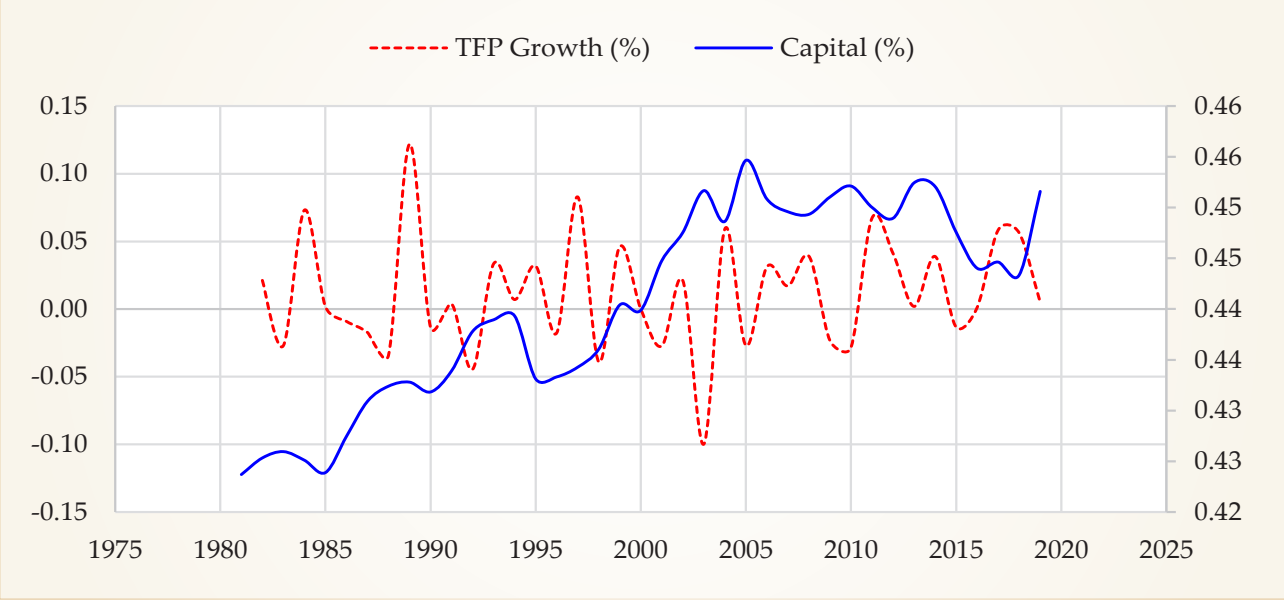
India is the largest producer of pulses and the second-largest producer of paddy, wheat, and sugarcane. It produces over 25% of pulses, 24% of paddy, 21% of sugarcane, and 14% of wheat. While the domestic demand falls behind the supply in the case of paddy and sugar, the dependence on imports remains in the case of pulses. In recent years, imports have declined considerably indicating significant scope to

**Table 1.4. Crop yields in selected countries (2019)**

| Crop | Yield (Kg/ha) | | | |
|---|---|---|---|---|
| | India | Other selected countries | | |
| **Paddy** | 4058 | 7060 (China) | 5114 (Indonesia) | 5837 (Vietnam) |
| **Wheat** | 3533 | 5630 (China) | 7743 (France) | 4157 (Ukraine) |
| **Maize** | 3070 | 10510 (USA) | 6317 (China) | 7862 (Argentina) |
| **Pulses** | 697 | 2050 (Canada) | 1793 (China) | 1610 (Russia) |
| **Sugarcane** | 80105 | 74657 (Brazil) | 78655 (China) | 81981 (Australia) |
| **Groundnut** | 1422 | 3781 (China) | 4409 (USA) | 3455 (Argentina) |

*Source: FAOSTAT*

**Figure 1.2. Trends in TFP growth and capital share in value-added (1981-2019)**




*Share of capital on the secondary axis*
*Source: Authors' computations*

further increase their production. Edible oil imports have risen sharply from just 2.6 million tonnes in 1998-99 to over 13 million tonnes in 2020-21, surpassing the domestic production of around 11 million tonnes (Figure 1.3). The country depends on Indonesia and Malaysia for palm oil, Argentina for soybean oil, and Ukraine and Russia for sunflower oil. In 2020-21, the country imported 7.5 million tonnes of crude palm oil, 2.9 tonnes of crude soybean oil, and 1.9 tonnes of crude sunflower oil. On the other hand, there is a yield gap of more than 50% in oilseeds, indicating a significant potential to enhance domestic oilseeds production through technological interventions.

### *Improve access to information*

A robust agricultural extension system is crucial for agricultural development. The country's extension and advisory system needs a revamp to respond to emerging challenges and opportunities. Emphasis is warranted on the information needs of smallholders. Figure 1.4 presents the percentage of agricultural households accessing technical advice from different sources. Progressive farmers, input dealers, and electronic & print media are the main sources of technical advice and information. The changing environment warrants extensive thrust on market-led extension for improved connectivity to markets.

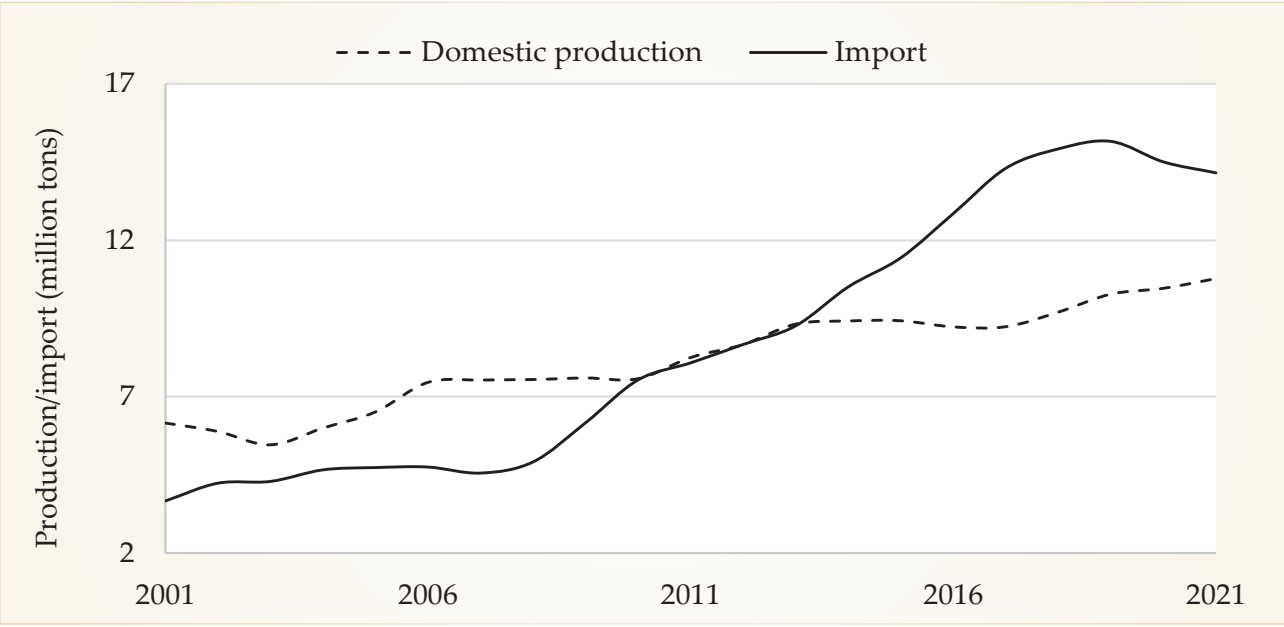
### *Transform institutions for technology upscaling*

Access to improved technologies will help bridge production gaps. With the opening of the economy, private sector-led innovation has started playing an important role. Start-ups have emerged in agriculture and allied activities, focusing on biotech, engineering, fintech, transport, environmental services, clean energy, logistics, IT services, marketplace, etc. Farmer Producer Organizations are supposed to improve efficiency and profitability in agriculture and overcome the constraints arising due to small landholdings.

### *Evolve efficient supply or value chains*

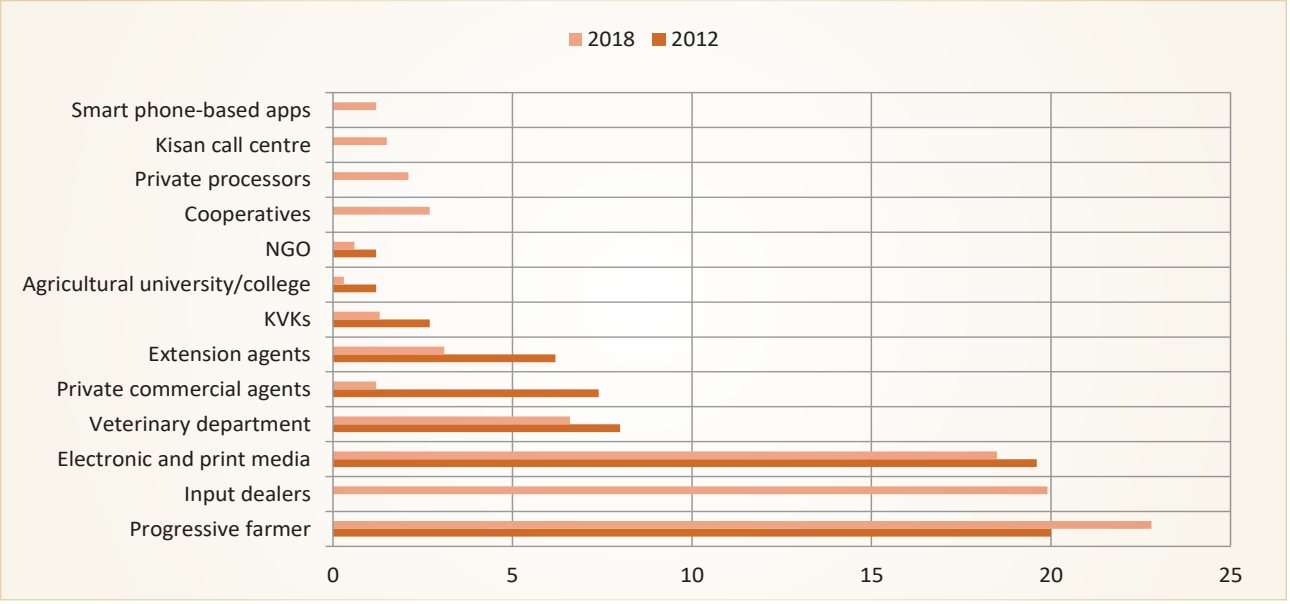
Emphasis on post-production is assuming importance. The transformation of agriculture has triggered the need for a new market architecture to improve supply chain efficiency and farmers' share in the consumer rupee. Reforms must aim at improving marketing efficiency by increasing competition, opening new markets,

**Figure 1.3. Trends in domestic production and import of edible oils (2001-21)**




*Source: Directorate of Economics and Statistics, MoA&FW*

**Figure 1.4. Agricultural households accessing technical advice from different sources (%)**




*Source: MoSPI, various reports*

and improvising innovative marketing channels. Currently, the bulk of transactions takes place in markets outside the APMCs, which are largely unregulated and non-competitive. Indian agriculture is dominated by informal value chain finance, with traders being the main source. However, the dependence on traders for financial requirements restricts farmers from benefiting from new marketing avenues. Therefore, interventions to increase access to formal finance will encourage farmers' participation in the new markets. There is a need to create an ecosystem for promoting efficient, transparent, competitive, barrier-free inter-state and intra-state trade in agriculture, and facilitate trade by integrating local markets with global markets.

### *Emphasize high-growth sectors*

Agricultural diversification towards higher-value commodities will be a significant factor in accelerating agricultural growth. The consumption patterns are shifting away from cereals to non-cereal food commodities. Policy reforms are continuously facilitating the growth of high-value agriculture. However, crop planning must be guided by market intelligence and agro-ecological endowments. Further, the immense potential exists for expanding agro-processing and building efficient value chains from production clusters to terminal markets, hence, efforts are needed to attract private investment in logistics and distribution. Policies and programmes must be able to build a solid foundation for a productive, competitive, and diversified agricultural sector.

### *Prioritize agricultural investments*

There has been a constant debate regarding investments versus subsidies. There is a prerequisite to ensure that public investments are utilized in an efficient way to create multiplier effects. Looking from a broad policy spectrum, these investments are likely to assist in pushing Indian agriculture to a higher and more sustainable growth path. This raises the need for easing excessive regulations and control over private investment.

### *Emphasize agribusiness*

The current policy regime strongly emphasizes small-scale processing and value addition integrating supply chain activities for efficiency and quality. However, value addition to agricultural produce is estimated at about 10% (4% in fresh agri-produce to 50%

in milk), which is significantly less in several other countries. Inadequate post-harvest agri-logistics and processing facilities lead to huge losses (₹ 92000 crore in 2013 as per the ICAR-Central Institute of Post-Harvest Engineering and Technology) and price volatility. The challenges emanating from the current agribusiness environment lay the foundation of strong backward and forward linkages for optimal input use and effective monetization of agricultural output. This requires creation of a conducive business environment. The reforms must incentivize to diversify towards high-value commodities by reducing market and price risk and strengthening value chain linkages. Further, a favorable environment must be created to foster much-needed private investment in post-harvest infrastructure and food management.

## References


Balaji, SJ and SC Babu. 2020. Agricultural productivity, inter-sectoral labor shift, and economic growth in India, IFPRI Discussion Paper 01943, International Food Policy Research Institute, Washington DC, June.

Balaji, SJ and S Pal. 2021. Agricultural productivity, pay-gap, and non-farm development: contribution to structural transformation in India, Paper presented at the 31st Triennial International Conference of Agricultural Economists (ICAE), August 17-31 (Online).

Balaji, SJ. 2017. Agricultural growth, rural non-farm employment and poverty in India, Unpublished PhD Thesis, Indian Agricultural Research Institute, New Delhi.

Birthal, PS and DS Negi. 2012. Livestock for higher, sustainable and inclusive agricultural growth. *Economic & Political Weekly* 47(26-27): 89-99.

Birthal, PS, D Roy and DS, Negi. 2015. Agricultural diversification and poverty in India. IFPRI Discussion Paper No. 1446, International Food Policy Research Institute (IFPRI), Washington, D.C.

Fan, S, A Gulati and S Thorat. 2008. Investment, subsidies, and pro-poor growth in rural India, *Agricultural Economics* 39(2): 163–70. https://doi.org/10.1111/j.1574-0862.2008.00328.x

Taylor, SJ and B Letham. 2017. Forecasting at scale, PeerJ Preprints, 5:e3190v2 https://doi.org/10.7287/peerj.preprints.3190v2


♦♦♦

# 2

# BUDGET ANALYSIS, 2023-24

*Pratap S Birthal and P Kishore*

The 2023-24 budget of the Union Government for the agricultural sector is futuristic in managing the emerging challenges to the sustainable development of the agri-food production system. It consolidates the foundations for sustainable development of agriculture and allied activities laid out in the recent government's initiatives on the management of land and water resources and production risks, prevention and control of animal and plant diseases, strengthening of rural infrastructure, digitization of agriculture, and provision of agricultural services. Agriculture encompasses several activities from the farm, hence, the allocation of budgetary resources to agriculture needs to be looked into holistically. Besides the Ministry of Agriculture and Farmers Welfare and the Ministry of Fisheries, Animal Husbandry, and Dairying, several other Ministries including the Ministry of Jal Shakti, the Ministry of New and Renewable Energy, the Ministry of Chemicals and Fertilizers, the Ministry of Food Processing Industries, the Ministry of Consumer Affairs, Food and Public Distribution, and the Ministry of Rural Development also deal with agriculture and agri-based livelihoods. Hence, resources for agricultural development are scattered across Ministries. Table 2.1 provides a snapshot of budgetary allocations to activities related to agriculture and rural development.

## 2.1 Improving Health of Natural Resources

One of the biggest steps towards fostering sustainable development of agriculture is the announcement of the PM-PRANAM (Prime Minister Programme for Restoration, Awareness, Nourishment and Amelioration of Mother Earth) to rejuvenate soils, the very basis of agriculture. The main goal of the PM-PRANAM is to incentivize states to promote alternatives to chemical fertilizers and the balanced use of chemical fertilizers. The average use of fertilizers in agriculture in terms of nutrients, that is NPK, is 196 kg/ha of net sown area, but highly unequal across states. There is also a significant imbalance in the use of nutrients. At the national level, the NPK ratio stands at 6.3:2.5:1 as against the recommendation of 4:2:1. In Punjab and Haryana, fertilizer use is very high, i.e., 427 and 403 kg/ha of net sown area respectively, and highly skewed towards nitrogen. The NPK ratio is 26.8:7.1:1 in Punjab and 23.5:6.8:1 in Haryana. Excessive, indiscriminate, and unbalanced use of nutrients causes soil, water, and air pollution, affecting the long-term sustainability of agriculture. Besides, it is detrimental to human and animal health.

The budget also provides for the establishment of 10000 Bio-Input Resource Centres for the manufacturing and distribution of bio-fertilizers and bio-pesticides for use in natural farming. These initiatives can make immense contributions towards arresting the qualitative degradation of natural resources, reducing air pollution, and improving the quality of agricultural produce. Besides, these will gradually reduce the imports of agrochemicals and the subsidy burden. Notably, fertilizer subsidy has been reduced to ₹175100 crore from ₹225220 crore in 2022-23. The resultant savings can be invested in manufacturing and promotion of bio-alternatives to agrochemicals, and in research for improvements in the quality of fertilizers and fertilizer-use efficiency.

Nonetheless, the manufacturing and promotion of bio-based inputs are not free from problems.

## Table 2.1 Budgetary allocation to agriculture and related activities (₹crores)

| | Ministry/Department | Revised estimate, 2022-23 | Budget estimate, 2023-24 |
|---|---|---|---|
| 1 | **Ministry of Agriculture and Farmers Welfare** | 118913 | 125036 |
| 1a | Department of Agriculture and Farmers Welfare | 110255 | 115532 |
| | Pradhan Mantri Kisan Samman Nidhi (PM KISAN) | 60000 | 60000 |
| | Modified Interest Subvention Schemes (MISS) | 22000 | 23000 |
| | Crop Insurance Scheme (PM FBY) | 12376 | 13625 |
| 1b | Department of Agricultural Research and Education | 8659 | 9504 |
| 2 | **Ministry of Fisheries, Animal Husbandry, and Dairying** | 5065 | 6937 |
| 2a | Department of Fisheries | 1624 | 2249 |
| 2b | Department of Animal Husbandry and Dairying | 3441 | 4688 |
| | Livestock Health and Disease Control Programme | 1390 | 2350 |
| 3 | **Ministry of Jal Shakti** | 74088 | 97342 |
| 3a | Department of Water Resources, River Development and Ganga Rejuvenation | 14059 | 20119 |
| 4 | **Ministry of New and Renewable Energy** | 12571 | 17729 |
| | Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan (PM KUSUM ) | 1325 | 1996 |
| 5 | **Ministry of Chemicals and Fertilizers** | 230950 | 182462 |
| 5a | Department of Chemicals and Petrochemicals | 151 | 173 |
| 5b | Department of Fertilizers | 228531 | 179128 |
| | Urea subsidy | 154098 | 131100 |
| | Nutrient Based Subsidy | 71122 | 44000 |
| 6 | **Ministry and Food Processing Industries** | 1902 | 3288 |
| | Pradhan Mantri Kisan Sampada Yojana (PM KSY) | 673 | 923 |
| | Production-Linked Incentive Scheme for Food Processing Industry | 801 | 1530 |
| 7 | **Ministry of Consumer Affairs, Food, and Public Distribution** | 306560 | 230802 |
| 7a | Department of Food and Public Distribution | 306304 | 230514 |
| | Food Subsidy to Food Corporation of India under National Food Security Act (NFSA) | 214696 | 137207 |
| | Food Subsidy for Decentralized Procurement of Food grains under NFSA | 72283 | 59793 |
| | Sugar Subsidy payable under Public Distribution System | 216 | 350 |
| | Storage and Godowns | 38 | 104 |
| 8 | **Ministry of Rural Development** | 304819 | 238964 |
| 8a | Department of Rural Development | 303559 | 236545 |
| | Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS) | 89400 | 60000 |
| 8b | Department of Land Resources | 1260 | 2419 |

*Source: Union Budget-2023, GoI.*

The manufacturing of bio-pesticides is governed under the Insecticides (Amendment) Rules, 2022, and of bio-fertilizers under the Fertiliser (Inorganic, Organic or Mixed) Control Order, 2021. These inputs are of bio-origin, and should not be treated at par with agrochemicals. Besides, these have a short shelf life, which is a disincentive for private investment in their manufacturing.

Besides, the schemes on micro-irrigation and solar power use in agriculture continue to promote the efficient use of groundwater and renewable energy.

## 2.2 Harnessing Potential of Neglected Commodities for Human Health and Nutrition

The United Nations Organization, on India's initiative, declared 2023 as the International Year of Millets. Millets are rich in several nutrients, and are termed as nutri-cereals. These are also used as animal feed and fodder, and for the production of biofuel. Millets have low water and carbon footprints, hence thrive well in dry and rainfed regions and contribute towards reducing greenhouse gas emissions. India is the largest producer and second-largest consumer of millets. Unfortunately, the consumption, as well as production of millets, have declined considerably. To regain their lost glory and popularize as a superfood, the budget has provided for establishing a Centre of Excellence for Millets at the Indian Institute of Millets Research, Hyderabad to strengthen research on millets from upstream to downstream of their value chains.

Pulses are an indiscernible source of protein in Indian diets. Besides, by fixing atmospheric nitrogen in the soil these improve its fertility, and reduce dependence on imports of fertilizers. Pulses production, however, did not experience any significant growth until recently. In fact, for the past four decades, India has been a chronic importer of pulses. Nevertheless, during the past five years, pulses production increased considerably, leading to a significant decline in their imports. The NAFED on behalf of the Government procures pulses to encourage farmers to grow more pulses and channelize their distribution to the poor, who are often undernourished, through the public distribution system and other welfare schemes. A provision of ₹ 800 crores has been made in this budget for the distribution of pulses to the states for welfare schemes, which is almost five times more than the expenditure in 2022-23.

Fruits and vegetables are rich in several macro- and micro-nutrients, essential for human health and nutrition. Horticulture has been witnessing demand-driven growth, and of late it has emerged as an important source of agricultural growth. Horticultural crops, however, suffer heavy losses due to insect pests and diseases. The lack of availability of quality planting material, especially for fruits and plantation crops, discourages farmers to grow these crops. The budget has made a provision for ₹2.2 thousand crores for the production of disease-free quality planting material for high-value crops.

The livestock sector, including animal husbandry, dairying, and fisheries, has been an important source of agricultural growth in the past decade. Since 2011-12, it has been growing at an annual rate of about 8%. More importantly, these activities are concentrated among the small landholders and have a larger impact on the reduction of poverty and malnutrition. Their potential, however, cannot be harnessed in the absence of adequate investment and institutional support. The livestock sector has received a big thrust in this budget. A total of ₹6937 crores have been allocated to the Ministry of Fisheries, Animal Husbandry, and Dairy, almost 1.4 times the expenditure in 2022-23. Further, the animal health and disease control program has got a big boost with an allocation of ₹2350 crores as against ₹1390 crores in 2022-23. The program is likely to reduce morbidity and mortality losses, improve the quality of animal products, and increase farmers' income. Of the total allocation to the

Ministry, ₹2249 crores have been earmarked for the development of the fisheries sector.

Besides, the budget has provided enhanced credit to the agricultural sector to ₹20 lakh crores with an emphasis on meeting the capital requirements of animal husbandry, dairy, and fisheries, the share of which in the total agricultural credit has rarely exceeded 6%. Furthermore, the budget has provided for the development of dairy cooperatives in the regions that have little presence of dairy cooperatives. This is expected to improve dairy farmers' access to milk markets, inputs, services and information, essential for improving dairy productivity, and scaling up of dairy and dairy-based enterprises.

## 2.3 Promoting Clean Environment and Green Growth

To promote the circular economy, a scheme called 'GOBARdhan' (Galvanizing Organic Bio-Agro Resources Dhan) has been in progress since 2018. The focus of the scheme is on converting animal dung into biogas. This scheme has been further strengthened in this budget, which provides for the establishment of 500 new 'waste to wealth' plants, including 200 compressed biogas plants and 300 community or cluster-based plants with an investment of ₹10000 crores. The scheme provides for financial support for the collection of bio-mass and distribution of bio-manure. India has a bovine population of about 535 million, producing over 800 million tonnes of dung annually, which can be used for the manufacturing of biogas for domestic and commercial purposes. Besides, the monetary benefits to livestock farmers from the sale of dung, the conversion of dung into biogas and bio-manure will reduce methane emission and contribute to improving soil fertility, and reducing dependence on imports of natural gas and fertilizers.

Climate change is becoming a big threat to the sustainable development of agriculture. Agriculture also offers solutions to greenhouse gas emissions. The budget has provided an impetus for environmentally conscious lifestyle (LiFE- Lifestyle for Environment) to achieve the target of net zero carbon emission by 2070 for green growth. The National Green Hydrogen Mission will reduce imports of fossil fuels. Besides, the initiation of a program 'Amrit Dharohar' will encourage optimal use of wetlands, enhance biodiversity and carbon stock, encourage eco-tourism, and enhance income generation opportunities for local communities.

## 2.4 Funding Research and Innovations

Agricultural research has the potential to address multiple challenges, including that of climate change and undernutrition. Crop breeding is a more cost-effective and sustainable means of improving crops' resilience to climate change. So is the breeding for bio-fortification to combat undernutrition. Since 2014, the Indian Council of Agricultural Research (ICAR) has developed more than 1600 varieties of different crops that are resilient to different kinds of stresses, including droughts, floods, and heat waves; and over 100 nutrient bio-fortified varieties of several food crops. These efforts may get a setback in the absence of funds for research. In this budget, the Department of Agricultural Research and Education has been allocated ₹ 9504 crores, a 10% increase over the previous year's expenditure.

Future agriculture will be knowledge and information-intensive. The announcement of creating a digital public infrastructure for agriculture as an open source, open standard, and interoperable system is a step towards evolving a single window approach towards improving farmers' access to markets, prices, technologies, inputs, services, and information. Importantly, crop planning is an important component of this scheme. The digital public infrastructure will help reduce production and transaction costs, improve the competitiveness of agriculture, promote remunerative crop patterns, and enhance farmers' income. Another related announcement is the establishment

of three Centres of Excellence for Artificial Intelligence. Artificial intelligence will play a crucial role in the sustainable transformation of agriculture. It will strengthen the efforts of estimating crop yields and losses, and improve precision farming and weather forecasts. Besides, the budget provides for establishing 100 labs for developing different applications using 5G services including precision farming.

The establishment of the Agriculture Accelerator Fund is expected to stimulate the ecosystem for start-ups in agriculture to strengthen the existing efforts in the transfer of modern technologies, innovations, and services, and promote value-addition through entrepreneurship, and commercialization of agriculture.

## 2.5 Improving Inclusiveness

Landless and marginal farm households, which are often at the bottom of the socio-economic hierarchy and are engaged in traditional occupations, have been left behind in the development process. Besides, continuing with the two mega social safety nets, i.e., Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS), and Food Subsidy, this budget has announced a PM Vishwakarma Kaushal Samman (PMVIKAS) to improve income opportunities for traditional artisans and craftsmen. The scheme aims at reaching the unreached. The scheme provides financial support and access to advanced skill training, knowledge of modern digital techniques, efficient green technologies, and markets by integrating traditional products with the MSME value chains so as to improve the quality, scale, and reach of their products.

In nutshell, the announcement of the initiatives in the budget charter is a pathway for fostering efficient, sustainable, and inclusive development of agriculture and agriculture-based enterprises.

♦♦♦

3

# Russia-Ukraine War, and Implications for Indian Agriculture

*Balaji S J*

It has been more than a year since Russia invaded Ukraine. The social, economic, and political impacts of this conflict are being realized throughout the world, despite the sanctions, oil embargos, and price caps. Global food prices have worsened. Inflation remains over 5% in more than 83% of low-income countries and 90% of middle-income countries (World Bank, 2023). Prices of cereals, dairy products, and sugar remain higher than their pre-invasion levels, and fertilizer prices remain high with implications on crop economics (FAO, 2023). An extension of the Black Sea Grain Initiative has brought some relief.

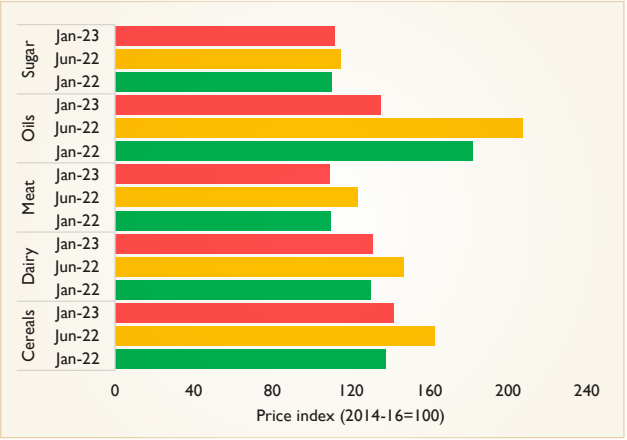
The conflict has altered India's economic and trade relations (Balaji & Babu, 2022). India, although not an importer of major foods, heavily depends on imports of fertilizers and edible oils to meet its domestic demand. In 2020-21, Ukraine contributed 10% of India's urea imports, and Russia contributed 5% of imports of DAP and 14% of MOP. Together, Ukraine and Russia contributed 86% of its sunflower oil imports. The conflict, hence, created disruption in the domestic economy directly. India experienced inflationary pressure in the short-run but managed with new trade relations and policy interventions. Russia has, now, turned the top supplier of oil and fertilizers to India. This chapter illustrates the global inflationary trend since the beginning of the Ukraine-Russia conflict and how it transmitted into India's import-sensitive commodities. It also looks into the government's efforts to ensure fertilizer and edible oil supplies to contain food price inflation.

## 3.1 Global Food Inflation

Toward the end of February 2022, Russia invaded Ukraine. A series of efforts are being made by the global stakeholders, including India, to bring down the fatal effects of the conflict as both Russia and Ukraine play a crucial role in global energy and food supplies. Russia is the world's largest exporter of oil and the second largest exporter of crude oil to the world (IEA, 2022). It is the largest exporter of nitrogenous fertilizers and the second and third largest exporter of potassic and phosphatic fertilizers (FAO, 2022). It also tops the list of global wheat exporters. Ukraine stands sixth in exports of wheat. Maize, barley, rapeseed, and sunflower oil are the other export commodities from these countries.

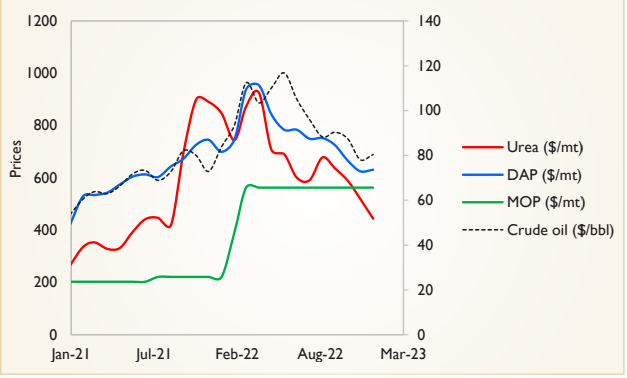
Trade disruption in the Black Sea region and the subsequent shock to food and energy supplies have led to a sudden spike in food inflation (Figure 3.1). Food prices in March 2022 witnessed the highest rise. The food price index spiked to 156 in March 2022, from 138 in February 2022. Prices kept on increasing for about four months. Prices of almost all major commodities increased, with cereals and vegetable oils recording a higher increase. Prices of Urea and DAP had been rising even before the start of the conflict but rose steeply after the conflict (Figure 3.2). In recent months, prices of both food commodities and fertilizers have dropped. Amongst foods, prices of vegetable oil have fallen substantially. Nevertheless, prices of several other commodities remain high compared to their pre-conflict levels.

### Figure 3.1. Trends in price index of major global commodities




*Source: FAO (2023)*

### Figure 3.2. Global oil and fertilizer price trends




*Source: World Bank (2023)*
*Note: secondary axis denotes crude oil prices.*

## 3.2 India's Trade Relations with Russia and Ukraine

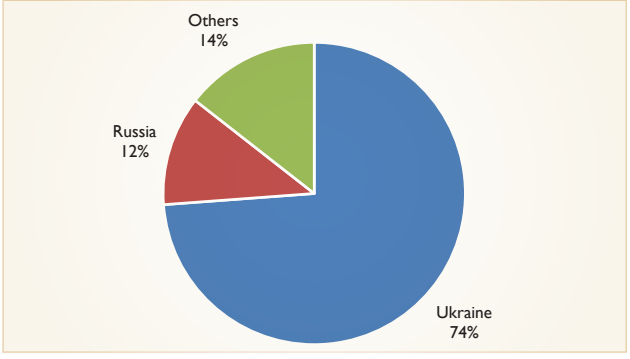
While India remains self-sufficient in food, it imports a sizeable proportion of fertilizer demand. In January-December 2022, India imported 26% of its Urea, 62% of its DAP, and 19% of its complex fertilizers demand. Its demand for phosphatic fertilizers is met through imports. China and Saudi Arabia are major suppliers of phosphatic fertilizers. Much of the import demand for Urea is sought from China, Oman, UAE, and Egypt; DAP from China, Saudi Arabia, and Morocco; and demand for MOP from Belarus, Canada, Israel, and Jordan. Still, a notable share of fertilizer imports is supplied by Russia and Ukraine (Table 3.1). In 2021-22, Russia was the fifth largest supplier, and Ukraine the ninth, and Belarus the tenth. Ukraine supplied over 10% of Urea, and Russia had about 14% of MOP. Belarus was the top supplier of MOP. Friction in the Black Sea transit was anticipated to cause uncertainties in their supplies, affecting the sowing of rainy season crops ensuing following the conflict.

### Table 3.1. Fertilizer imports from Russia and Ukraine ('000 tons)

| | Russia | Ukraine | Others | All |
|---|---|---|---|---|
| **Urea** | | | | |
| 2019-20 | 244 | 514 | 10,216 | 10,975 |
| 2020-21 | 95 | 1,038 | 9,164 | 10,296 |
| 2021-22 | 296 | 747 | 9,121 | 10,164 |
| **DAP** | | | | |
| 2019-20 | 148 | - | 5,399 | 5,547 |
| 2020-21 | 303 | - | 5,497 | 5,800 |
| 2021-22 | 197 | - | 5,664 | 5,860 |
| **MOP** | | | | |
| 2019-20 | 573 | - | 3,373 | 3,946 |
| 2020-21 | 715 | - | 4,379 | 5,094 |
| 2021-22 | 54 | - | 2,852 | 2,906 |

*Source: GoI (2022)*

### Figure 3.3. Sunflower oil imports of India (% to total imports)



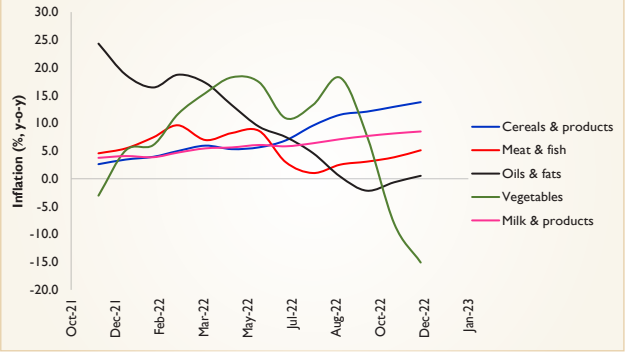

*Source: SEA (2021)*

So is the case of edible oil. In the oil year 2020-21 (November 2020 to October 2021), India imported over 131 lakh tons of edible oils spending ₹1.2 lakh crores. Palm oil contributed 63% to the total edible oil imports and much of this was imported from Indonesia and Malaysia. Sunflower oil contributed around 15%, of which three-fourths were supplied by Ukraine and 12% by Russia (Figure 3.3).

## 3.3 Domestic Inflation

Supply uncertainty due to the conflict created a hike in commodity prices in the domestic market (Figure 3.4). In January 2022, inflation was 6%, and it rose to 7.8% in April 2022, almost double of the target of maintaining inflation at 4%. Food inflation further worsened. Food inflation was on the rise but it was never ahead of the overall inflation. It was gradually converging. The war altered this relationship. Food inflation reached a high of 8.4% in April 2022 and has remained higher than the overall inflation. Prices of oil and fat rose by 18.7% in March 2022 and of vegetables by 18.3% in May 2022.

**Figure 3.4. Inflation rates in selected food articles (All-India, %)**




*Source: GoI (2023a)*

However, the prices stabilized in subsequent months. Prices of oil & fat and vegetables have even fallen significantly, and of meat and fish have stabilized. Still, cereal prices have continued to rise, especially since July 2022. In December 2022, cereal price inflation was 13.8%. Although not as equal in magnitude, the milk prices also rose. Edible oil prices have steeply declined as they did in the pre-conflict period. In fact, import volumes too have declined, from 15.1 million tons in 2016-17 to 13.1 million tons in 2020-21. The unit cost of their imports, which was ₹50/kg earlier, spiked at ₹89/kg, recording a 79% increase in just four years. The rise in import prices is partly due to the Ukraine-Russia conflict.

Notably, the conflict-induced rise in fertilizer prices has cost implications for agriculture. The price of Urea remains fixed (₹5,360/ton) in the retail market as per the government's policy. But, prices of phosphatic and potassic fertilizers have risen, as manufacturers and marketers are allowed to fix these. Price of DAP rose by 13% in just three months – from ₹24,000/ton in February 2022 to ₹27,000/ton in May 2022. It has remained at this level since then. The price of MOP rose by 9.2% during February-December 2022. Prices of key inputs such as phosphoric acid, rock phosphate, ammonia, and sulphur used in fertilizer manufacturing have increased appreciably.

## 3.4 Government Interventions

The government's efforts have been appreciable in containing inflation and ensuring adequate food and energy supplies. The rise in prices could have been more without the interventions as has been in several low-income and middle-income countries.

### *Ensuring fertilizer supplies*

After the beginning of the Ukraine-Russia conflict, the country entered into multiple agreements with countries to ensure adequate supplies of fertilizers. In early February 2020, even before the start of the conflict, India revived its Urea trade pact with Oman India Fertilizer Company after a lapse of a 15-years. It signed a three-year agreement to import about one million ton of Urea every year. The trade deal with the USA was to import an additional 47,000 tons of Urea. In mid-May 2022, it signed an MoU with Jordan to import 0.25 million tons of DAP, 3 million tons of rock phosphate, and 0.1 million tons of phosphoric acid. It also entered into an agreement with Jordan to import 0.27 million tons of MOP annually for 5 years. In March 2022, Indian Potash Limited signed a pact with Israel to import 0.60-0.65 million tons of MOP annually for five years. Also, it proposed to buy 1.2 million tons of MOP from Canada.

Further, India's turn towards Russia for fertilizers brought a dramatic change in its trade

relations. China and Saudi Arabia had been major suppliers of fertilizers. Surpassing both, Russia is now the major supplier. In 2022-23 (April-January), it supplied around one-fifth of India's total fertilizer imports. Statistics indicate adequate fertilizer availability in the country. During April-December 2022, it imported 4.6 million tons of Urea, 4.8 million tons of DAP, 1.5 million tons of MOP, and 1.9 million tons of NPK fertilizers. The domestic production was 18.7 million tons, 2.7 million tons, 6.7 million tons, and 3.9 million tons of urea, DAP, NPK, and SSP, respectively.

### *Protecting food security*

To ease out edible oil prices, the government in May 2022 exempted customs duty and agriculture infrastructure development cess on about 2 million tons (per year) of crude soybean and sunflower oil imports for 2022-23 and 2023-24. In August 2022, it extended the existing concessional import duties on specified edible oils up to March 31, 2023. One shall note that, currently, import duty on crudes of palm oil, soyabean oil, and sunflower oil is zero (the effective duty is 5.5% after taking into account 5% agri cess and 10% social welfare cess). Such interventions help in the short run, but evidence shows that tariffs have a limited impact on the domestic production of oilseeds and edible oils and the recourse has to be with improving their competitiveness through technological improvements (Balaji et al., 2021).

The government intervened in the paddy, wheat, and sugar trade to cool down their domestic prices. A ban was imposed on wheat exports on 13th May 2022 to ease the domestic supply following its concern over a sudden spurt in wheat exports. The ban is likely to continue in view of the reduction in domestic wheat production in 2022 due to terminal heat stress. Nonetheless, this led to a rise in exports of wheat flour, registering a 200% increase during April-July 2022 over the corresponding period in 2021, which in turn caused a surge in the price of flour in the domestic market. Following that, the Cabinet Committee on Economic Affairs (CCEA) restricted the export of wheat flour in August 2022.

The government also amended the policy of exporting broken rice by putting its export in the *prohibited* category in September 2022. It also imposed a 20% export duty on paddy, brown rice, and semi-milled/milled rice (other than par-boiled rice and basmati rice). The global demand for sugar surged following low production in Brazil and also its diversion to producing ethanol in some countries. India introduced regulations on sugar exports by restricting its exports up to 31st October 2023. However, it allowed sugar exports of up to 10 million tons in the sugar season 2021-22, and up to 6 million tons in the sugar season 2022-23.

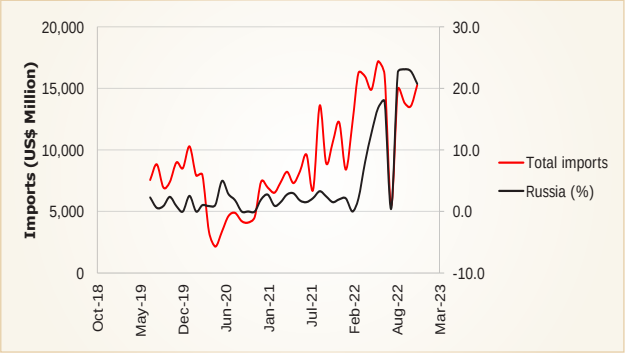
### *Shifting to new oil suppliers*

The expansion of crude oil trade with Russia helped bring down its domestic prices to some extent. In the past, India's oil imports from Russia hardly exceeded 2% of its total oil imports. Its share in January 2022 was just 2.1% (in value terms), a month before the start of the conflict. With sanctions on imports of oil from Russia, uncertainty loomed large regarding its adequate availability in the domestic market. Still, India opted for imports from Russia. This led to the import share of Russia in India's oil imports to 8% in April 2022. Russia emerged as the second-largest oil supplier to India in May 2022 (12.8%) and the largest supplier in October 2022. Russian oil prices were relatively lower, which helped ease its domestic prices. The trend in the oil import from Russia is displayed in Figure 3.5.

## 3.5 Trade expansion in the post-conflict period

The conflict, despite having inflationary effects in the short-run, opened ways for trade creation. It raised India's contribution to global food security. Despite the global shock, its agricultural and processed foods exports expanded by

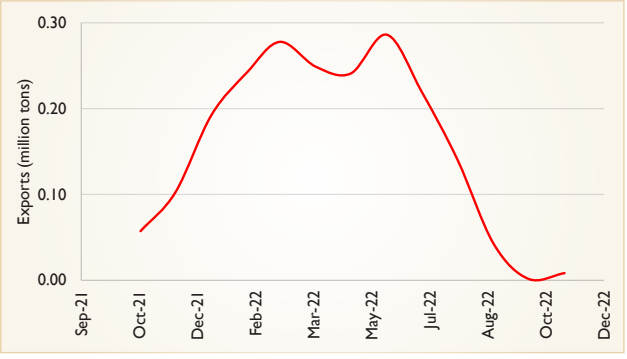
**Figure 3.5. Expansion of oil imports from Russia**




*Source: GoI (2023b)*

over 20% during April-December 2022 over the corresponding period in the previous year (APEDA, 2023). India's wheat exports, the ban on which triggered global criticism, continued following the government's agreement to export under G2G contracts benefitting several poor countries. India exported 5.1 million tons of wheat during April-December 2021. While it maintained its exports to traditional destinations, its exports expanded to new destinations considerably. Indonesia and Korea received 5% and 3% of Indian wheat in 2021-22. During April-November 2022, these have raised to 19% and 11%, respectively. One should remember that India allowed exports of wheat flour processed from imported grain in October 2022.

**Figure 3.6. India's broken rice exports to China**




*Source: GoI 2023b*

Unlike wheat, exports of basmati and non-basmati rice have expanded. Basmati rice exports have risen from 2.7 million tons to 3.2 million tons and non-basmati rice from 12.6 million tons to 13.2 million tons from April to December 2022. China emerged as a major buyer of broken rice, while it had not imported it from India in 2019-20. China imported broken rice worth US$ 84 million in 2020-21, which rose to US$480 in 2021-22. From April to November 2022, China imported around 1.2 million tons of broken rice. The decline in recent months is due to India's export curbs. Month-wise imports of broken rice by China are displayed in Figure 3.6.

## 3.6 Conclusions

The Russia-Ukraine war inflated global food and energy prices. India too experienced a rise in commodity prices, especially food, fertilizers, and edible oil. While in recent months, prices of most commodities have softened, prices of cereals remain high. Government interventions had been laudable in ensuring supplies through new contracts and domestic policy interventions. It has explored new suppliers and import destinations and succeeded in averting the adverse effects of the conflict. Export restrictions and regulations in commodities like wheat, rice, and sugar have helped ease inflationary pressure due to the conflict.

Still, global economic prospects remain uncertain with sanctions, embargos, and price caps in place, whose effects could be experienced in India in the near future, especially in the form of higher import and domestic prices. Even while supplies are ascertained, high prices of fertilizers may affect farmers' welfare, and put fiscal pressure on the government. A strong domestic food production and trade strategy is the key. While the conflict has opened avenues for new food trade, import substitution strategies for commodities like edible oils, and innovations in fertilizer production and usage presume utmost importance. This would require a vibrant ecosystem for research and development for higher crop yields.

## References

APEDA. 2023. Comparative statement for export of agricultural and processed food

products (April to December). Agricultural and Processed Food Products Exports Development Authority (APEDA), New Delhi. February.

Balaji, SJ and S Babu. 2022. The Ukraine war and its food security implications for India. *Policy Note 23*, International Food Policy Research Institute, Washington DC. September.

Balaji, SJ, M Umanath and G Arun. 2021. Welfare gains of inward-looking: an ex-ante assessment of general equilibrium impacts of protectionist tariffs on India's edible oil imports. *Agricultural Economics Research Review, 34 (Conference issue)*, 1-20.

FAO. 2022. The importance of Ukraine and the Russian Federation for global agricultural markets and the risks associated with the war in Ukraine. *Information Note*. Food and Agriculture Organization, Rome. June.

FAO. 2023. *FAO Food price index*. Food and Agriculture Organization, Rome. January.

GoI. 2022. *Trade statistics*. Ministry of Commerce and Industry, Government of India, New Delhi.

GoI. 2023a. *Press release on new CPI (various months)*. Ministry of Statistics and Programme Implementation, Government of India, New Delhi.

GoI. 2023b. *Trade statistics*. Ministry of Commerce and Industry, Government of India, New Delhi.

IEA. 2022. Russian supplies to global energy markets. International Energy Agency, Paris.

SEA. 2021. *Import of vegetable oil – 2020-21 (Nov.-Oct)*. The Solvent Extractor's Association of India, Mumbai. November.

World Bank. 2023. *Food security update*. World Bank, Washington DC. January.

♦♦♦

4

# FOOD INFLATION IN INDIA

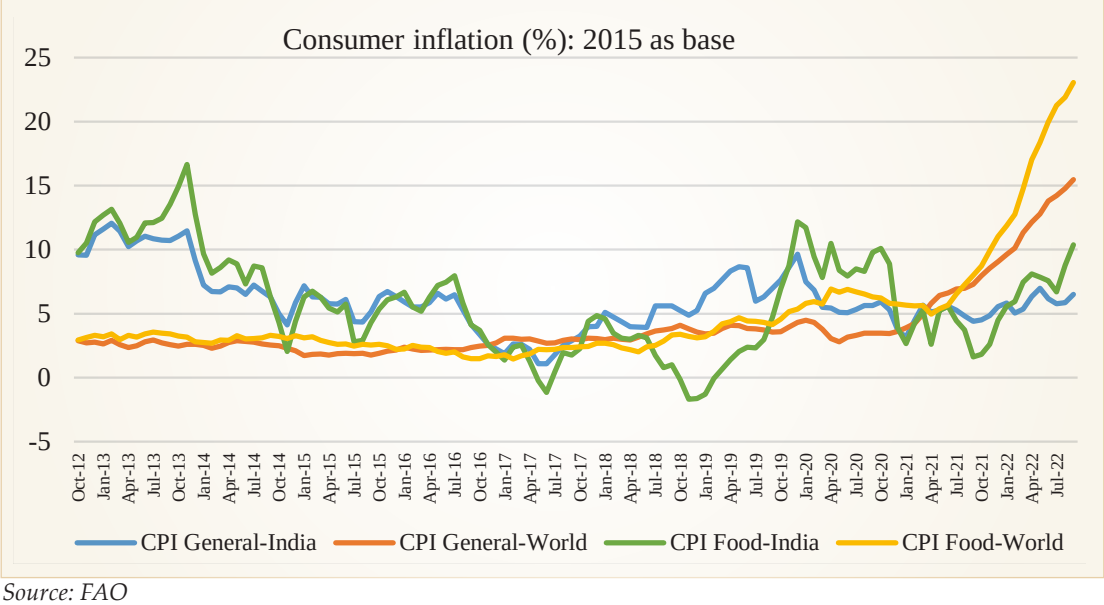
*Purushottam Sharma and Pratap S. Birthal*

Food inflation is rampant throughout the world, first triggered by disruptions in the global food supply chains due to the Covid-19 pandemic and then aggravated by the Ukraine-Russia war. According to the World Bank, food inflation has skyrocketed in most low- and middle-income countries. In South Asia, the year-on-year consumer price inflation for food in November 2022 was 73.7% in Sri Lanka, 31.2% in Pakistan, 8.1% in Bangladesh, 8.1% in Nepal, and 4.7% in India.

High food inflation is a concern for the governments because of its political sensitivity and being less responsive to monetary policy. In India, food and beverages have a weight of 45.86% in the consumer price index (CPI). High food inflation affects all of us, but the poor, who spend 56-60% of their household budget on food, are the most affected. Inflation reduces households' real income, especially for poor households. High inflation, particularly in food articles, affects the macroeconomic stability and purchasing power of small farmers and poor consumers.

Reserve Bank of India is tasked to maintain a medium-term retail inflation target of 4% with a band of +/-2%. Retail food inflation, after remaining below 4% from September 2016 to August 2019, reached an all-time high of 14.2% in December 2019 and remained above 6% until November 2020. Later on, after hovering around 4% for a few months, it started increasing and crossed 6% in March 2022 and remained above it until October 2022. After reaching a peak of 8.6% in September 2022, it softened to 7% in October 2022 and further to 4.2% in December 2022.

**Figure 4.1. Consumer inflation in India and World**




*Source: FAO*

Global consumer and food inflation has been at an all-time high in 2022 (Figure 4.1). Global consumer inflation is mainly driven by inflation in food and fuel items. Although global inflation moderated during the Covid-19 pandemic in 2020, it started surging towards the end of 2020, and the upsurge has continued. Supply chain disruptions post-Covid-19 and geopolitical conflict impacted trade and trade costs leading to higher inflation. The higher global prices of commodities transmitted to domestic prices.

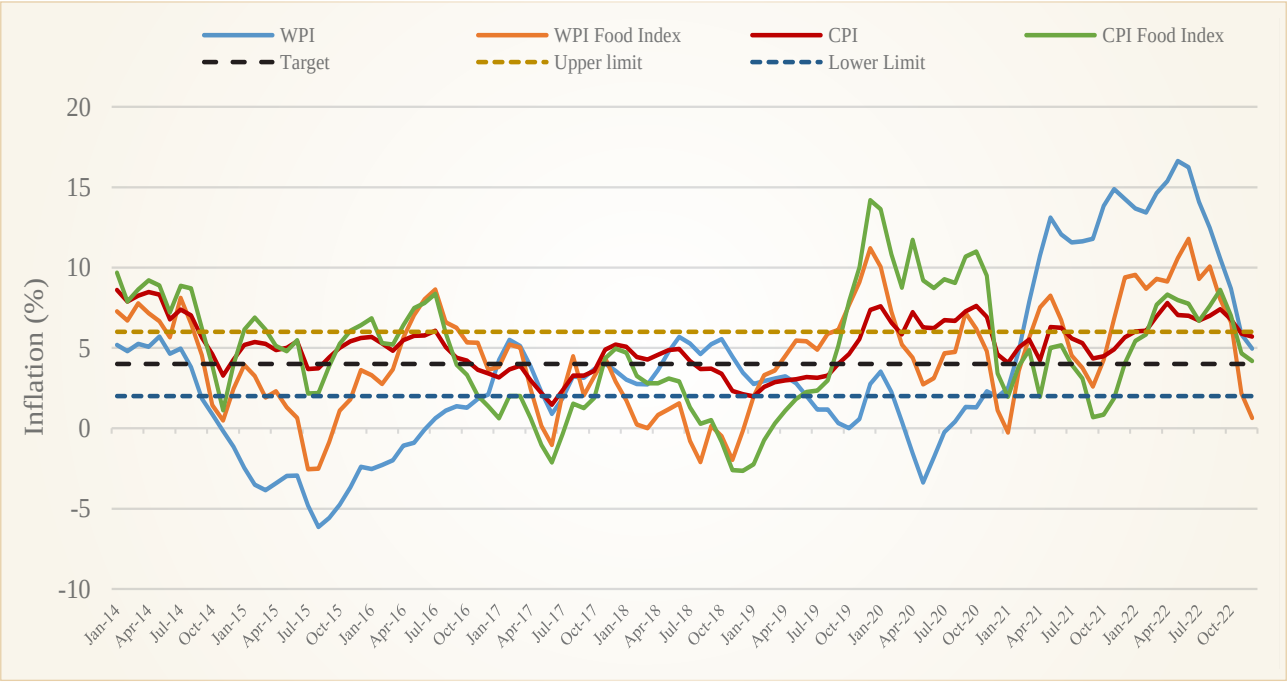
Retail inflation (CPI) peaked at 11.8% in October 2013, declined gradually but mostly above 4% until October 2016, dropped to 2% in January 2019, and started rising again mostly above the 4% level even above the upper bound of 6% continuously. In 2022, it remained above 6% in most months, peaking at 7.4% in October and declining to 5.9% in November, and further to 5.7% in December (Figure 4.2). Retail price inflation has been driven mainly by the rising prices of food & beverages, and fuel & light. Together these contributed more than 60% to the total retail inflation from May to October 2022, and 50% in December 2022.

Wholesale price inflation (WPI) was negative during the Covid-19 period (April to July 2020) mainly because of supply chain disruptions. It increased afterward but remained below 4% until January 2021. Later on, it continued increasing peaking at 16.6% in May 2022 but started declining afterward falling to 5% in December 2022 (Figure 4.2). Wholesale food price inflation was also above 6% from November 2021 to October 2022 and declined to 0.65% in December 2022. WPI inflation was far above the CPI inflation during 2021 and 2022.

## 4.1 Drivers of Food Inflation

By commodity, inflation in cereals remained below 5% from June to November 2021 but started increasing from January onwards reaching above 10% from September onwards. For most vegetables, except onion and garlic, it was above 20% between January to September 2022 but declined below 20% in October and November, and turned out negative in December except in the case of potato, ginger, and green chilies (Figures 4.3 and 4.4). Inflation in spices (i.e., dry chilies, coriander, and cumin) also increased significantly from less than 5% in January-February 2022 to

**Figure 4.2. Wholesale and retail inflation in India**




*Source: Office of Economic Advisor & MOSPI*

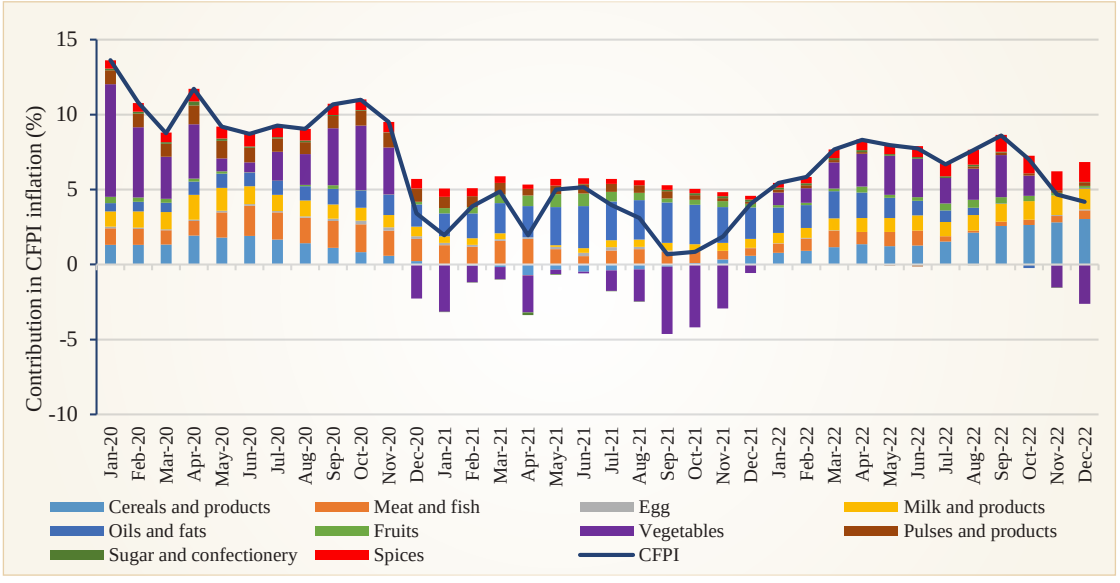
above 20% from September to December 2022. The inflation in edible oils and fats was in the range of 25-35% from June to October 2021 but started declining thereafter.

Cereal inflation has been the main cause of consumer food price inflation. Their share increased from 15% in December 2021 to 72% in December 2022. The contribution of vegetables turned out to be negative in December 2022 but the share of milk and milk products, and spices increased.

Further, a sharp increase in global prices due to the Russia-Ukraine war fueled record increase in prices of edible oils through import linkages, and of cereals through export linkages. The damage to wheat crop due to the intense heat wave adversely impacted production. Seasonality plays a crucial role in the supply of agricultural commodities, particularly perishables like fruits and vegetables; random shocks like untimely and high rainfall impact their supply.

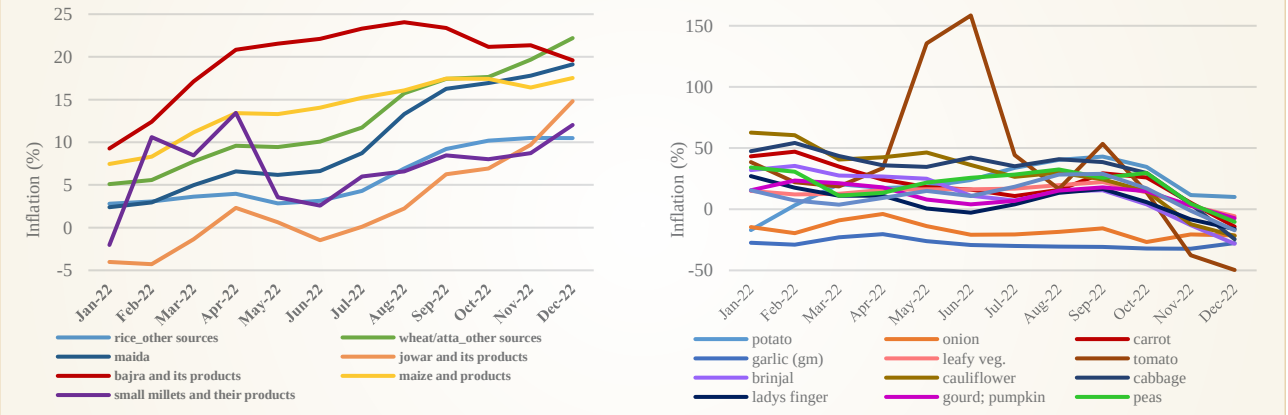
The main drivers of retail food inflation were oils and fats in 2021 and the first three months of 2022, while vegetables contributed more than 25% from April to October. The share of cereals and products, milk and milk products, and spices grew gradually and reached 72%, 33%, and 32%, respectively.

**Figure 4.3. Drivers of food inflation in India**




*Source: Authors' computations*

**Figure 4.4. Cereals and vegetable inflation in India**




Inflation- Cereals and products

Inflation- Vegetables

*Source: MOSPI*

Inflation in tomatoes contributed significantly to vegetable inflation in May (50%) and June (63.5%) months. The share of potato inflation was 6.6% in February, which increased to 60% in October and turned negative afterward (Figure 4.5). Similarly, the contribution of other vegetables increased from 28% in June to 75% in October. Although onion inflation momentum (m-o-m) increased in October and November, onion inflation (y-o-y) continued to be negative (-27% in October and -21% in November and December).

The supply of agricultural products is seasonal, particularly for perishables, and is inelastic in the short run. Varying production patterns of perishables lead to seasonality in prices, and the shocks mainly originate from uncertain weather conditions and other unpredictable events that lead to high price volatility. *Rabi* season contributes to 70% of the total tomato production (harvested during December-June). This phenomenon leads to upward pressure on tomato prices from July to November. Also, unexpected weather events exert upward shocks in tomato prices. Similarly, about 70% of onion production occurs in the *Rabi* season (harvested during March-May) and the rest in *Kharif* and late *Kharif* season. The keeping quality of *Rabi* onion is good and can be stored for 5-6 months. This puts downward pressure on onion prices coinciding with harvest season. Studies indicated that the high wholesale-retail markup in the case of perishables might also lead to high food inflation. Thus, agricultural prices exhibit a cobweb phenomenon based on supply response to price sentiments.

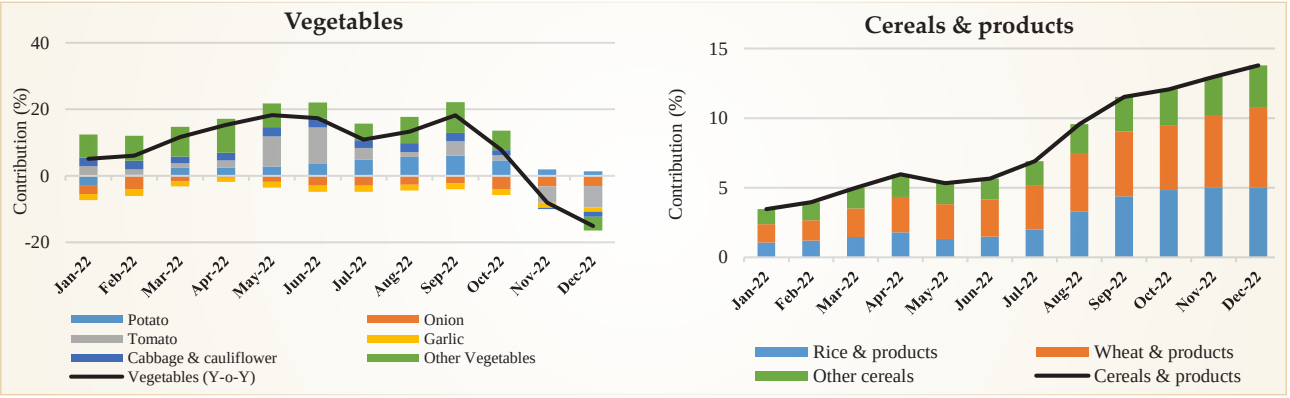
## 4.2 Food Inflation: Momentum and Base Effect

The strong momentum unleashed after the start of the Russia-Ukraine conflict offset the base effect and drove consumer and food price inflation up to April 2022, but the favorable base effect and declining momentum helped ease the food inflation. The easing of momentum and favorable base effect led to the decline in inflation from May 2022 onwards (Table 4.1). Strong momentum in the case of cereals and spices, overshadowed the favorable base effect, reflecting building up of price pressure. Vegetable inflation is declining recently due to both momentum and base effect.

## 4.3 Persistence of Food Inflation

To analyze the persistence of food inflation, we estimated a single autoregressive model using monthly data from January 2012 to November 2022, where commodity inflation was regressed on their lags. The optimal lag length was selected based on Akaike Information Criteria (AIC). The persistence of inflation is measured using the sum of autoregressive coefficients. The results indicated that food inflation (CFPI) exhibited less persistence than general inflation (CPI) (Table 4.2). The inflation in non-perishable commodities like cereals, pulses, and spices persists longer than in the perishables commodities including fruits, vegetables, and meat and fish.

**Figure 4.5. Drivers of vegetables and cereals inflation in India**




*Source: Authors' computations*

**Table 4.1. CFPI inflation: Base effect and momentum (%)**

| Category | Jan-22 | Feb-22 | Mar-22 | Apr-22 | May-22 | Jun-22 | Jul-22 | Aug-22 | Sep-22 | Oct-22 | Nov-22 | Dec-22 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Change in CPI inflation | 0.4 | 0.1 | 0.9 | 0.8 | -0.7 | 0.0 | -0.3 | 0.3 | 0.4 | -0.6 | -0.9 | -0.2 |
| i Momentum | -0.3 | 0.2 | 1.0 | 1.4 | 0.9 | 0.5 | 0.5 | 0.5 | 0.6 | 0.8 | -0.1 | -0.5 |
| ii Base effect | 0.6 | -0.2 | -0.1 | -0.6 | -1.6 | -0.6 | -0.7 | -0.2 | -0.2 | -1.4 | -0.7 | 0.3 |
| Change in CFPI inflation | 1.4 | 0.4 | 1.8 | 0.6 | -0.3 | -0.2 | -1.1 | 0.9 | 1.0 | -1.6 | -2.3 | -0.5 |
| i Momentum | -1.3 | -0.2 | 1.4 | 1.5 | 1.6 | 1.0 | 0.0 | 0.7 | 0.9 | 1.1 | -0.9 | -1.6 |
| ii Base effect | 2.6 | 0.6 | 0.3 | -0.9 | -1.9 | -1.2 | -1.0 | 0.1 | 0.0 | -2.6 | -1.3 | 1.2 |
| Change in cereals inflation | 0.8 | 0.5 | 1.0 | 1.0 | -0.6 | 0.3 | 1.2 | 2.7 | 2.0 | 0.5 | 0.9 | 0.8 |
| i Momentum | 0.5 | 0.3 | 0.9 | 1.1 | 0.8 | 0.6 | 1.0 | 2.4 | 2.0 | 1.0 | 1.3 | 1.1 |
| ii Base effect | 0.3 | 0.1 | 0.1 | -0.1 | -1.4 | -0.3 | 0.2 | 0.1 | -0.2 | -0.5 | -0.5 | -0.3 |
| Change in oil & fat inflation | -5.6 | -2.3 | 2.3 | -1.4 | -4.0 | -3.9 | -1.8 | -2.9 | -4.2 | -2.5 | 1.5 | 1.2 |
| i Momentum | -1.5 | 0.1 | 5.2 | 2.5 | 1.5 | -0.7 | -2.5 | -1.7 | -1.9 | -1.2 | 1.3 | -0.2 |
| ii Base effect | -3.1 | -2.1 | -3.2 | -3.8 | -5.1 | -2.8 | 0.9 | -1.0 | -2.2 | -1.4 | 0.3 | 1.3 |
| Change in vegetable inflation | 8.2 | 0.9 | 5.6 | 3.7 | 2.9 | -0.9 | -6.4 | 2.4 | 4.9 | -10.4 | -15.9 | -7.0 |
| i Momentum | -7.4 | -2.6 | -1.6 | -0.4 | 5.2 | 4.2 | -0.1 | 2.5 | 2.7 | 4.1 | -8.3 | -12.7 |
| ii Base effect | 14.6 | 3.5 | 6.6 | 3.6 | -2.6 | -5.1 | -5.7 | -0.4 | 1.5 | -14.2 | -7.5 | 5.5 |
| Change in spices inflation | 0.7 | 1.5 | 2.4 | 2.1 | -0.7 | 1.1 | 1.9 | 2.0 | 2.0 | 1.2 | 1.4 | 0.8 |
| i Momentum | 0.9 | 1.3 | 1.8 | 2.2 | 2.0 | 1.2 | 1.5 | 1.9 | 1.9 | 1.3 | 1.4 | 1.2 |
| ii Base effect | -0.2 | 0.1 | 0.4 | -0.2 | -2.6 | -0.2 | 0.1 | -0.1 | -0.2 | -0.3 | -0.2 | -0.5 |

*Source: Authors' computations*

**Table 4.2. Persistence of food inflation in India**

| Parameters | Cereals | Pulses | Meat & Fish | Fruits | Vegetables | Oils & fat | Spices | CPI | CFPI |
|---|---|---|---|---|---|---|---|---|---|
| 1-month lag | 1.540*** | 1.557*** | 1.191*** | 1.345*** | 1.268*** | 1.622*** | 1.494*** | 1.154*** | 1.246*** |
| 2-month lag | -0.564*** | -0.585*** | -0.655*** | -0.626*** | -0.461*** | -0.974*** | -0.509*** | -0.217** | -0.344*** |
| 3-month lag | - | - | 0.416*** | 0.200** | - | 0.706*** | - | - | - |
| 4-month lag | - | - | - | - | - | -0.390*** | - | - | - |
| Sum of AR Coefficients | 0.977** | 0.972** | 0.952** | 0.919** | 0.807** | 0.964** | 0.985** | 0.938** | 0.902** |
| R-squared | 0.974 | 0.977 | 0.884 | 0.881 | 0.800 | 0.981 | 0.968 | 0.910 | 0.875 |

*Source: Authors' computations*

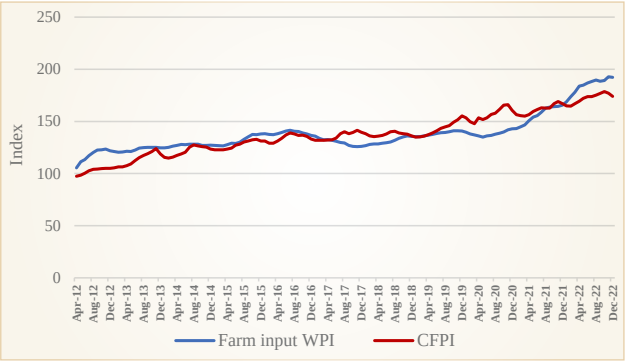
*Note: *** and ** represents significance at 1% and 5% level, respectively.*

## 4.4 Factors Responsible for High Food Inflation

What led to high food inflation? At the commodity level, inflation in cereals increased from 4% in February 2022 to 14% in December 2022, in milk from 3.9% to 8.5%, and in spices from 6.2% to 20.4%. Vegetable inflation tripled from 6.1% in February to 18.2% in September but softened subsequently due to higher market arrivals. India imports 56% of its edible oil requirement, and fueled by a sharp increase in international prices due to the Russia-Ukraine war, domestic prices of edible oils increased 16-19 % in May 2022 over February 2022, but subsequently, these have declined due to falling international prices and reduction in import duty.

The rise in production costs has also contributed to food inflation. India imports a large quantity of its input demand – 89% of crude oil, 27% of urea, 56% of di-ammonium phosphate (DAP), and the entire potash. The wholesale price index of farm inputs increased sharply from February onwards

**Figure 4.6. Wholesale price index for farm inputs**




*Source: Authors' computations*

(Figure 4.6) and farm input inflation was above 15%. International prices of these commodities increased sharply due to the Ukraine-Russia war. Although India could contain transmission of high global prices into domestic prices to a large extent, still these have increased. Between February and July 2022, the crude oil price increased by 39% but started declining after that. The price of urea is government-determined and has remained stable; prices of phosphatic and potassic fertilizers have increased by 12.5 and 7.6%, respectively, between February and October 2022.

Further, Indian agriculture, despite rapid progress in irrigation, remains rain-dependent; about half of the cropped area is rain-fed. Thus, agricultural commodities production and prices are closely associated with anomalies in rainfall and temperature. In the agricultural year 2021-22, the southwest monsoon rainfall (June-September) was normal but behaved erratically. Surplus rains in June prompted farmers sowing of Kharif crops, but a long dry spell from mid-July to third week of August and later excess rainfall in September adversely affected crop production. Besides, the abrupt rise in temperature in March 2022 adversely affected the production of several Rabi crops, especially wheat.

The production and supply of agricultural commodities are seasonal and inelastic in the short run. Thus, food inflation behaves cyclically, particularly in the case of perishable commodities such as vegetables. These are also highly vulnerable to insects, pests, and diseases, and suffer high post-harvest losses due to inadequate transportation, storage, and processing, leading to higher prices. Besides, perishables follow a price production cobweb; low price realization of a crop in a season forces farmers to allocate less area to it in the next season, lowers its availability, and consequently, higher price.

## 4.5 Efforts to Contain Food Inflation

During the Covid-19 pandemic (March 2020 to November 2020), retail food inflation was above 8%, but it fell afterward and rarely crossed 4% for about a year. The Government's minimum support price–based procurement of wheat and rice for public distribution (PDS) helped people easy access to staple food grains. Moreover, there was no adverse weather event in 2020-21, allowing a bumper harvest of both Kharif and Rabi crops and a record procurement of 60.17 million tons of rice and 38.99 million tons of wheat. The Government distributed 35.56 million tons of rice and 26.04 million tons of wheat through the PDS and other welfare schemes at a highly subsidized price of ₹ 3/kg for rice and ₹ 2/kg for wheat. In addition, for easing hardship to the poor due to the Covid-19 pandemic, the Government of India launched a scheme called Pradhan Mantri Garib Kalyan Anna Yojana (PMGKAY) in 2020-21 and distributed 20.77 million tons of rice and 10.75 million tons of wheat free of cost to about 800 million beneficiaries of the National Food Security Act, and the scheme has continued till date.

The Reserve Bank of India is taking the stance of monetary policy tightening to control inflation through hikes in the repo rate and cash reserve ratio. Also, supply-side measures such as restrictions on the export of wheat (since May 2022), wheat flour (August 27, 2022), broken rice (September 8, 2022), and imposition of a 20% export duty on rice except on par-boiled rice and basmati rice, cut in excise duties on

petrol and diesel. Other supply-side measures included allocation of tariff rate quota for import of 2 million tonnes each of crude sunflower and soybean oil for 2022-23 and 2023-24 with no basic customs duty (BCD) and cess, the extension of duty-free import of urad and tur up to March 2023 and no cess on lentil imports, and duty-free import of potatoes from Bhutan till June 2023.

The food inflation can be controlled through supply-side measures, including the cultivation of crops, especially vegetables, in non-traditional areas; creating post-harvest infrastructure for the storage and processing of perishable commodities; and strengthening market intelligence to guide the farmers and policymakers to make informed decisions on production, marketing, and trade.

♦♦♦

5

# TECHNOLOGY-POLICY TRADE-OFFS FOR SELF-SUFFICIENCY IN EDIBLE OILS

*Balaji S J and Purushottam Sharma*

Driven by a sustained rise in per capita income, urbanization, and changing lifestyles, India's demand for edible oils in the recent past has increased substantially, surpassing its population growth (GoI, 2022a). On the other hand, the growth in its domestic production capacity of oilseeds and edible oils has remained sluggish, compelling it to import huge quantities of edible oils to bridge the gap between domestic demand and production. In the oil year 2021-22 (November 2021 to October 2022), India imported over 14.03 million tons of edible oils, spending ₹1.57 lakh crores (SEA, 2022).

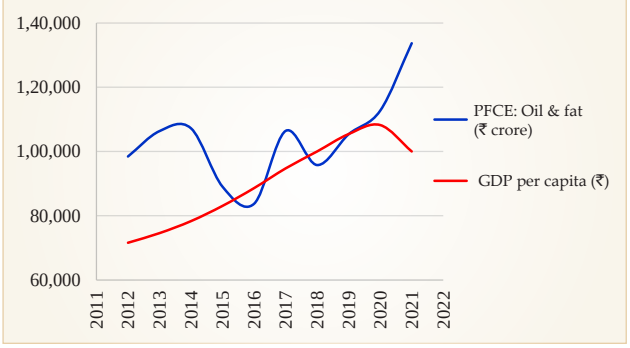
The government's efforts to improve domestic production have not yielded much. The oilseeds production increased from 29.8 million tons in 2011-12 to 37.7 million tons in 2021-22 (GoI, 2022b). This was driven by both the expansion in their area and an improvement in yields. For instance, between 2011-12 and 2020-21, the oilseeds area increased by 9.6%, and yield by 9.1%, leading to an increase in edible oil production from 9 million tons to 11.2 million tons (GoI, 2022c). But, this is not sufficient to meet even half of the total demand. About 55% of the edible oil demand is now met through imports. There exists a substantial potential to increase oilseeds production, especially by addressing the yield gap and investing in technologies. This chapter discusses, in brief, the composition of edible oil demand, trade dependencies and limitations, domestic production capacity, and the ways and means of increasing oilseeds and edible oil production in India.

## 5.1 Edible Oil Demand

India has turned as the most populous country in the world. Housing 1.42 billion people, half of them below the age of 30, it surpassed China in 2022. Alongside, its economy has grown consistently despite global headwinds such as the COVID pandemic and the global supply shock due to the Ukraine-Russian conflict. In 2021-22, its GDP increased by 8.7% and is expected to increase by 7% in 2022-23 (GoI, 2023a). Its economic growth is now the highest in the world and is projected to remain the highest in 2023-24 (IMF, 2022).

The size of the population on one side and steady income growth on the other side necessitates the need for a stable food policy, notably on commodities for which the country depends on imports. Edible oils are commodities for which there is a huge domestic demand. The household expenditure on oil and fat, measured in value terms (at 2011-12 prices) has risen from less than a rupees lakh crore in 2011-12 to ₹1.3 lakh crore in 2020-21, at an annual rate of 2.2% (Figure 5.1). The per capita income growth averaged 4.8% during this period. This translates that the demand for edible oils could grow around half

**Figure 5.1. Income growth and expenditure on oil and fat (All-India, 2011-12 to 2020-21)**




*Source: GoI (2022a)*

*Note: PFCE refers to private final consumption expenditure; PFCE and GDP per capita are at 2011-12 prices*

of the growth in income per capita in the coming years.

In physical terms, the demand for edible oils has doubled in the past fifteen years. The country demanded 126 lakh tons of edible oils in 2005-06, which increased to 246 lakh tons in 2020-21. Still, the country produces less than half of this demand. It produced 31 lakh tons of groundnut oil, 23 lakh tons of soybean oil, and 21 lakh tons of rapeseed & mustard oil in 2020-21. In fact, the share of domestically produced edible oils in the total demand has consistently declined, from 66% in 2005-06 to 57% in 2010-11 and further to 37% in 2015-16. It has increased slightly in recent years. The share of domestic production stands at 45% in 2020-21.

## 5.2 Trade Dependency and Limitations

Edible oil imports have more than tripled, from 43 lakh tons in 2005-06 to over 140.3 lakh tons in 2021-22. Palm oil comprises the major share of imports (Table 5.1). It comprised 56.4% of total edible oil imports. It was followed by soybean and sunflower oils. These are imported in crude form and processed domestically, and their import shares stand at 30% and 14%, respectively. Observing the pattern of trade, one shall notice a gradual diversification from palm oil to soybean and sunflower oils. In the past decade, the share of soybean oil has increased from 19% to 30%, and sunflower oil from 7% to 14%.

**Table 5.1. Composition of edible oil imports (lakh tons)**

| Edible oil | 2009-10 | 2020-21 | 2021-22 |
|---|---|---|---|
| Palm oil* | 64.99 (73.66) | 83.20 (63.36) | 79.15 (56.41) |
| Soybean oil | 16.67 (18.89) | 28.66 (21.82) | 41.71 (29.73) |
| Sunflower oil | 6.3 (7.14) | 18.94 (14.42) | 19.44 (13.86) |
| Others | 0.27 (0.31) | 0.52 (0.40) | - |
| All | 88.23 (100.00) | 131.32 (100.00) | 140.30 (100.00) |

** includes crude and refined palm oil, RBD palmolein, and palm kernel oil; 2010-11 estimates are as in its earlier releases; figures in parentheses are per cent of total imports*

*Source: SEA (2021)*

There has been a decline in import volume, but a steep rise in import prices. For instance, while the volume of imports has declined to 131 lakh tons in 2020-21 from 151 lakh tons in 2016-17, the unit price of their imports increased from ₹50/kg to ₹89/kg, a 79% increase in just four years. One shall hardly attribute this to inflation as the rise in cost rarely matches the overall inflation. It is depending on a few edible oil exporters that can partly explain this. India heavily depends on Malaysia and Indonesia for palm oil (94%), Argentina and Brazil for soybean oil (97%), and Ukraine, Russia, and Argentina for sunflower oil (97%). Such a concentration of imports creates supply and price risks, as observed during the Covid-19 pandemic and the Ukraine-Russia conflict.

Ironically, such dependence could rarely be avoided; these countries control a major share of global exports of these commodities. Indonesia and Malaysia together contribute 85% of the global palm oil exports, and Argentina and Brazil have 55% of the global soybean oil exports. So is the case with sunflower oil. Given that trade diversification possibilities are limited, enhancing domestic production could only be the key strategy to reduce imports.

## 5.3 Policies and Performance

The government of India has taken several initiatives to increase the domestic production of oilseeds to reduce import dependence on edible oils. In 1986, it launched a Technology Mission on Oilseeds (TMO) and brought palm into its ambit in 1992-93. In 2004, it launched an Integrated Scheme of Oilseeds, Pulses, Oil Palm, and Maize (ISOPOM), subsuming the Oilseeds Production Programme (OPP) and the Oil Palm Development Programme (OPDP). In 2014, it started a National Mission on Oilseeds and Oil Palm (NMOOP), and in 2021, a National Mission on Edible Oils–Oil Palm (NMEO-OP) was launched.

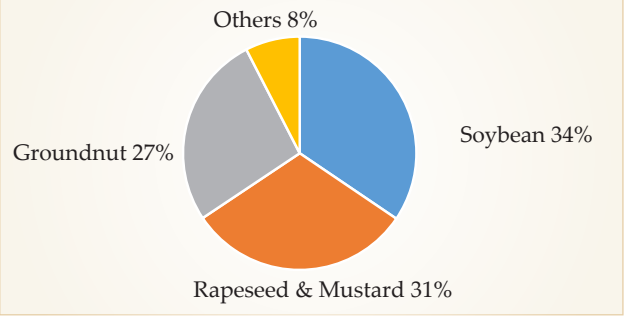
**Table 5.2. Recent estimates of area under oilseeds (Lakh Ha)**

| Crops | Rabi | | | Crops | Kharif | | |
|---|---|---|---|---|---|---|---|
| | 2022-23 | 2021-22 | % change | | 2022-23 | 2021-22 | % change |
| Rapeseed & mustard | 98.02 | 91.25 | 7.42 | Soybean | 120.83 | 120.86 | -0.02 |
| Groundnut | 5.67 | 5.23 | 8.41 | Groundnut | 45.53 | 49.15 | -7.37 |
| Linseed | 3.27 | 2.92 | 11.99 | Sesamum | 13.35 | 13.20 | 1.14 |
| Safflower | 0.87 | 0.75 | 16.00 | Castor | 8.81 | 7.40 | 19.05 |
| Sunflower | 0.91 | 1.17 | -22.22 | Sunflower | 2.02 | 1.53 | 32.03 |
| Sesamum | 0.51 | 0.53 | -3.77 | Niger | 1.10 | 1.02 | 4.78 |
| Other oilseeds | 0.59 | 0.50 | 18.00 | Other oilseeds | 0.12 | 0.13 | 7.84 |
| Rabi total | 109.84 | 102.36 | 7.31 | Kharif total | 191.75 | 193.28 | -0.7 |

*Source: GoI (2022d & 2023b)*

These efforts helped enhance the production of oilseeds as well as edible oils. The oilseeds production increased from 243 lakh tons in 2004-05 to 377 lakh tons in 2021-22. While the yields of oilseeds have improved, their area has declined, from 275 lakh hectares in 2004-05 to 245 lakh hectares in 2017-18. There has been an improvement in their cultivated area in recent years. The area under groundnut cultivation has remained almost stagnant, while under rapeseed & mustard, and soybean has shown a gradual improvement. Despite an increasing trend in sunflower oil imports, the area put to sunflower cultivation has dropped significantly from 22 lakh hectares in 2004-05 to 2.2 lakh hectares in 2020-21. So is the case with sesamum, niger, and safflower. The area sown under different oilseed crops is shown in Table 5.2 and their production shares in Figure 5.2.

**Figure 5.2. Oilseed production in India (%, 2021-22)**




*Source: GoI (2022b)*

## 5.4 Scope for Improving Production

Both area expansion and technology on one side and a rise in tariffs on edible oils on the other side shall help to increase both oilseeds and edible oil production in India. Arresting the declining trend in the area under crops like sunflower has to be prioritized. It is estimated that there exists the potential to grow oil palm on 28 lakh hectares. At present, it is grown on only 3.5 lakh hectares. The NMEO-OP targets to increase it to 10 lakh hectares, producing 11.2 lakh tons of edible oil by 2025-26.

**Table 5.3. Yield gap in oilseeds**

| Crop | Yield (kg/ha) | | Yield gap (%) |
|---|---|---|---|
| | National average* | Improved technology** | |
| Groundnut | 1703 | 2264 | 33 |
| Soybean | 976 | 1603 | 64 |
| Rapeseed & mustard | 1524 | 1692 | 11 |
| Sunflower | 1011 | 1742 | 72 |
| Sesame | 474 | 536 | 13 |
| Safflower | 640 | 1061 | 66 |
| Niger | 317 | 406 | 28 |
| Castor | 1856 | 2032 | 9 |
| Linseed | 637 | 1090 | 71 |

**2020-21; ** FLD average (2010-2015), accessed from https://www.nfsm.gov.in/StatusPaper/NMOOP2018.pdf*

*Source: GoI (2022c)*

Estimates show that the total factor productivity (TFP) growth in oilseeds had been much slower than in other crops. TFP growth was less than 1% from the early 1970s till the mid-2000s, and increasing marginally to 1.5% afterward. A rise in TFP growth of oilseeds since the mid-2000s correlates well with an improvement in oilseeds production, signaling the impact of technological change reflected in improvements in productivity and production and its spillover effects. A significant opportunity lies in addressing yield gaps, which range from 11% to 64% for major oilseeds, i.e., soybean, rapeseed & mustard, and groundnut (Table 5.3). It is as high as 72% in sunflower, which explicitly provides the country an opportunity to reduce imports. These crops are mostly grown under rainfed conditions on marginal lands and research shows that climate change is likely to have a negative impact on oilseed production (Birthal et al., 2021). Less than one-third of the oilseed area is irrigated, with significant inter-state disparities. An expansion in irrigation, accompanied by the supply of quality seeds, and management practices can help bridge the yield gaps.

## 5.5 Tariffs versus Technology

Traditionally, tariffs have been used as an instrument to regulate edible oil imports, and to serve as an incentive for the domestic oilseeds production. India has considerably reduced tariffs on edible oils through trade agreements. It brought down the tariffs on crude palm oil from 76% in 2010 to 37.5% in 2019 under the ASEAN-India Free Trade Agreement (AIFTA), Currently, the tariff on crude palm oil is 8.25%, and on soybean and sunflower oils 5.5%.

Higher tariffs, other than regulating imports, also protect the domestic edible oil industry, and farmers (Balaji et al., 2021). An empirical exercise designed to estimate the impacts of rising tariffs on edible oils and improving oilseeds production technology provides evidence. Balaji et al. (2022) estimated the impacts of tariffs and technology on production and imports in a general equilibrium framework applying to Social Accounting Matrix (SAM) for 2017-18[1] on the assumptions given in Table 5.4.

**Table 5.4. Presumed rates of technology growth and tariff hikes**

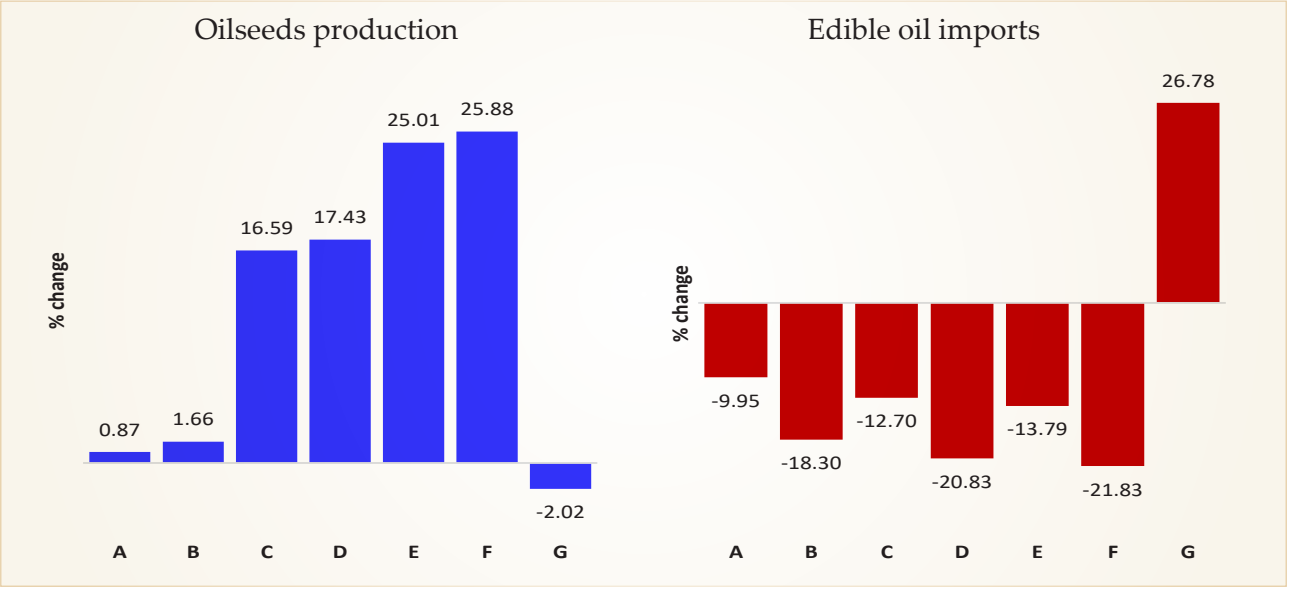
| Scenario | Tariff change on edible oil imports (%) | TFP change in oilseeds production (%) |
|---|---|---|
| A | +50% | - |
| B | +100% | - |
| C | +50% | +2% |
| D | +100% | +2% |
| E | +50% | +3% |
| F | +100% | +3% |
| G | Zero tariff | - |

Scenarios A and B provide the impacts of higher tariff rates. Scenario A presumes that the tariff is raised by 50% and it doubles in Scenario B with no growth in the total factor productivity (TFP). Scenarios C and D assume a moderate increase in TFP growth and the tariffs remain the same as in Scenarios A and B. The oilseeds production experienced a growth of 1.5% in TFP after the mid-2000s, and it is assumed it to grow at a rate of 2% or 3% until 2036-37. As a reference case, trade liberalization is also studied (Scenario G). The impacts of these changes in tariffs and TFP are presented in Figure 5.3.

When the existing tariff rate is doubled, edible oil imports decline by over 18% due to an increase in import prices. As it inflates edible oil prices, prices of oilseeds also increase through the demand effect. Still, the response of production of oilseeds is low, only 1.7%, which is much less than the required quantities to compensate for the demand for edible oils. This leads to an increase in the overall price levels by 10%. When TFP grows at an annual rate of 2%, the oilseed production increases by 17% even after

[1] For model closure, investment is presumed to drive savings; the Government's savings and foreign exchange are presumed to be flexible, and the producer prices are set to remain constant at the national level.

**Figure 5.3. Impacts of technology growth and tariff hike**




*Source: Authors' computations*

imposing higher tariffs. It also leads to a higher rate of reduction in edible oil imports.

A greater rate of response is observed in both the production of oilseeds and edible oils when TFP increases. And unlike tariffs, which inflate prices when these are imposed without adequate capacity to increase oilseeds production, TFP growth reduces prices even when tariff hikes are maintained. Rural income also rises with technological improvements despite a fall in the prices of oilseeds. The impact of removing tariffs on oilseeds works the opposite. It leads to a surge in edible oil imports and fails to increase oilseeds production. Although consumers benefit from the reduction in tariffs, the cost to the government inflates.

## 5.6 Policy Implications

The oilseeds production has been increasing gradually, and it has helped in arresting the rise in imports to an extent. Import dependence, especially on a few nations could challenge fiscal stability due to supply and price risks. However, import concentration in a few countries cannot be avoided because of these being major producers and suppliers of edible oils in the international market. Given this, enhancing domestic production of oilseeds should be the main strategy to reduce import dependence.

The evidence shows that tariffs are an instrument for regulating edible oil imports but cannot incentivize oilseeds production. To this end, an improvement in technology together with the incentives to bring the additional area under expansion in oilseeds will increase production and reduce import dependence. There exists the potential to expand oil palm in several regions. Existing TFP growth in oilseeds production is less than 1.5%, and the oilseeds including palm share only 2.2% of the total expenditure on agricultural research. Higher allocations, either through redistribution or addition, could bring innovations. Oilseed research needs a systematic prioritization for efficient resource allocation. Opportunities also lie in exploiting the yield gaps. Expansion of irrigation, accompanied by the provision of quality seeds and management practices can help bridge the yield gap. Research policy should focus on understanding the comparative advantage of oilseeds vis-à-vis other crops at the regional level for inclusive development of the oilseed sector. Policies such as the ban on blending edible oils with imported cheaper oils can incentivize their production.

## References


Balaji, SJ, P Sharma, P Venkatesh, and K Shreya. 2022. Technology and policy options for reducing India's import dependence on edible oils. *Policy Brief 49*, ICAR- National Institute of Agricultural Economics and Policy Research.

Balaji, SJ, M Umanath, and G Arun. 2021. Welfare gains of inward-looking: an ex-ante assessment of general equilibrium impacts of protectionist tariffs on India's edible oil imports. *Agricultural Economics Research Review, 34 (Conference issue)*, 1-20.

Birthal, PS, J Hazrana, DS Negi, and SC Bhan. 2021. Climate change and land-use in Indian agriculture. *Land Use Policy*, 109, 105652.

GoI. 2022a. *National accounts statistics 2022*. Ministry of Statistics and Programme Implementation.

GoI. 2022b. *Fourth advance estimates of production of oilseeds and commercial crops for 2022-23*. Ministry of Agriculture and Farmers Welfare.

GoI. 2022c. *Agricultural statistics at a glance 2021*. Ministry of Agriculture and Farmers Welfare.

GoI. 2022d. *Progress report of area coverage under kharif crops as on 23.09.2022*. Ministry of Agriculture and Farmers Welfare.

GoI. 2023a. *First advance estimates of national income 2022-23*. Ministry of Statistics and Programme Implementation.

GoI. 2023b. *Progress report of area coverage under rabi crops as on 03.02.2023*. Ministry of Agriculture and Farmers Welfare.

IMF. 2022. Latest World economic outlook growth projections. In *World Economic Outlook (October)*. International Monetary Fund.

SEA. 2022. *Import of vegetable oil –2021-22 (Nov.-Oct)*. The Solvent Extractor's Association of India, Mumbai.


♦♦♦

6

# Long-term facilitation of agricultural exports

*Raka Saxena, Purushottam Sharma, and Devesh K Pant*

Global trade in agricultural products tripled between 2001 to 2019 (UNCOMTRADE, 2020). And, such an expansion in trade has the potential to enhance agricultural growth and resource use efficiency, avert hunger and malnutrition, and reduce poverty (Birthal et al., 2008; Van den Broeck and Maertens, 2016; Martin, 2017). However, the realization of trade potential and its benefits vary across geographies and trade specializations (Santos-Paulino and Thornquist, 2015). Exports are one of the important factors in economic growth. In its Agricultural Export Policy 2018, the Government of India set the target of enhancing agricultural exports to US$ 60 billion by 2022 and to US$100 billion by 2025 by means of portfolio diversification in terms of commodities and destinations, and development of institutional mechanisms for enhanced access to global markets. This is expected to boost agricultural growth and farm incomes. In 2021, India's agricultural exports surpassed $50 billion, equaling 12% of the country's total merchandise exports.

Since the initiation of the economic reforms in 1991, India has remained a net exporter of agricultural products. The export mix, however, has changed, possibly due to a shift in global dietary patterns. For India, the main challenge in boosting agricultural exports is the lack of competitiveness in the global market (Chakraborty and Garg, 2020). Competitiveness is influenced by several internal factors such as the geography of agricultural production and government policies, and external factors including product quality, standardization, and phytosanitary requirements of the importing countries. This chapter looks into the evolving patterns of India's agricultural trade and examines the changes in trade competitiveness and barriers to exports.

## 6.1 Trends and Structural Breaks

India has showcased impressive growth in agriculture, from food scarcity to food sufficient or even a food surplus nation. Notably, during the Covid-19 pandemic, India's agricultural exports registered tremendous growth (Kumar, 2021). This study has identified phases in agricultural exports following the global information criterion suggested by Bai and Perron (2003)[1]. These phases are (i) 1990-91 to 2006–07; (ii) 2006–07 to 2011–12; (iii) 2011–12 to 2018–19; and (iv) 2018–19 to 2020–21 (Figure 6.1).

- In the first phase, exports increased slowly with low volatility.
- In the second phase, these grew rapidly but with volatility.
- Export growth continued in the subsequent phase, but in a cyclical pattern.
- In the fourth phase, agricultural exports witnessed a strong acceleration.

If the trend in exports as in phase I were to continue, India could have realized export earnings of only ₹1 lakh crores in 2020-21, much less than the actual realization of ₹3 lakh crores (Figure 6.1). The acceleration in exports can be attributed to the sustained efforts on the part of

[1] Schwarz and the LWZ information criterion recommended three breaks throughout the time frame (2006–07, 2011–12, and 2018–19).

export promotion agencies to facilitate supply chains and strengthen market linkages of farmers and farmers' associations. Notably, the outbreak of the COVID-19 pandemic provided an opportunity for increasing agricultural exports, especially rice. With effective institutional arrangements to overcome the pandemic-induced bottlenecks, India could emerge as a reliable supplier of food.

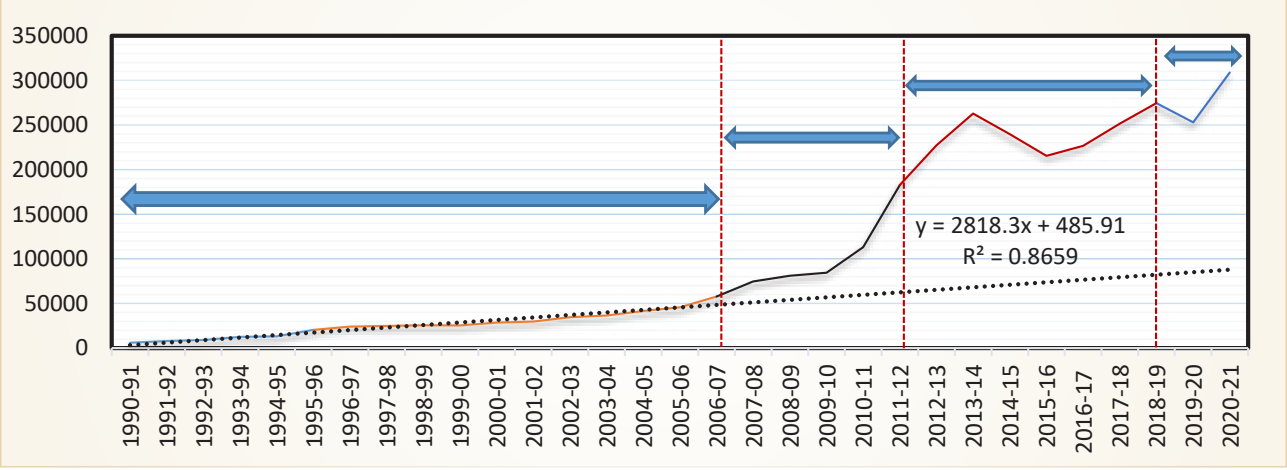
## 6.2 Composition of Agricultural Exports

Rice, marine products, buffalo meat, cotton, and spices comprise the bulk of the exports (Figure 6.2). In 2021, together these products accounted for more than 70% of the total agricultural exports. Sugar, coffee, tea, and vegetables are other important exported commodities. The export basket is a mix of commodities exhibiting varying patterns. One pattern characterizes consistent growth, and another shows a bulk share in exports but loses it over time. The third pattern includes commodities whose share in the export basket is low but growing. These patterns are shown in Figure 6.3.

### *Commodities with consistent export growth*

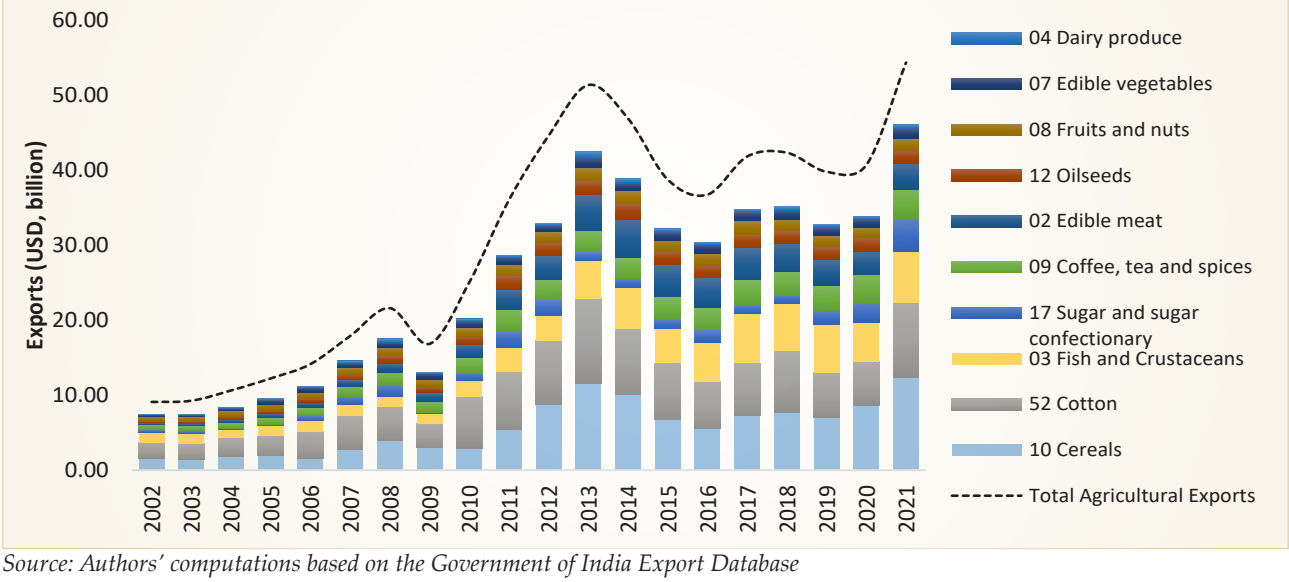
Rice, shrimps & prawns, cane sugar, cotton, capsicum, cumin seeds, and fresh grapes occupy a significant share of the total agricultural

**Figure 6.1. Structural breaks in agricultural exports (₹ Crore)**




*Source: Authors' computations based on the Government of India Export Database*

**Figure 6.2. Trend and composition of agricultural exports of India**




*Source: Authors' computations based on the Government of India Export Database*

exports and their exports have been growing consistently. A spike in rice exports is visible during the Covid-19 pandemic, government took prompt actions and set up a *Rice Export Promotion Forum* (REPF) in order to ensure smooth exports of rice and other cereals. India contributes about 5% to global fish export. Its vast coastline offers huge scope to expand fish exports. Crustaceans are the most exported, sharing around 75% of the total fish exports. India is one of the largest producers of cotton, and cotton is exported in different forms. Cotton exports declined from 2014 to 2016 mainly because of severe damage to cotton production by pink bollworms (Saxena et al., 2022). Nevertheless, cotton exports registered a positive growth of 67% from US$ 6 billion in 2019 to US$ 10.03 billion in 2021.

### *Historically important commodities, but losing exports*

Commodities in this category had a higher share in global exports in the past, but their exports have been declining. The major commodities are tea, bovine meat, sesamum seeds, coffee, cashew nuts, and fresh coconuts.

### *Emerging export commodities*

Majorly spices, cardamoms, cumin seeds, ginger, wheat, and skimmed milk powder fall in this category. Their share in global exports is not significant but their exports have been increasing. India's exports of spices such as cumin seeds, turmeric, dried capsicum/pimento, and coriander seeds are competitive in the global market. However, continuous research and development efforts are needed to sustain their competitive edge.

## 6.3 Dynamics of Comparative Advantage

The revealed comparative advantage (RCA) is a measure of a country's relative advantage or disadvantage in the export of a commodity. A value of RCA greater than unity indicates comparative advantage or vice versa.

Figure 6.4 shows RCA of major agricultural export commodities of India during 2001-2021. India has comparative advantage in exports of cereals, cotton, fish and spices. Exports of bovine meat have been competitive historically, but losing relative export advantage in recent years. Vietnam, Egypt, Malaysia, Hong Kong, Indonesia, Iraq, and Saudi Arabia are the main destinations for India's buffalo meat. Notably, India's exports are destined mainly to countries where sanitary regulations permit meat imports from countries classified as endemic for foot-and-mouth disease (FMD) by the World Organization for Animal Health (WOAH). India is classified as FMD endemic. On the other hand, fruits and dairy products have a comparative disadvantage, in general.

Enhancing comparative advantage requires a multi-faceted strategy encompassing investments in infrastructure and research, promotion of good agricultural practices, capacity building of farmers, branding and marketing, diversification of exports, and strengthening of certification and quality assurance systems.

## 6.4 Tapping Export Potential

Agricultural exports have accounted for 10-13% of the country's total merchandise exports in the past two decades. The export potential of several commodities remains untapped indicating a scope to raise the share of agricultural exports. For example, cotton can be raised by 60%[2] (Table 6.1). Cereals, fish, meat, vegetables, tea, coffee, and spices also possess significant untapped export potential. Agricultural exports face several challenges, from upstream to downstream of the export value chain. The agricultural export policy should address these challenges to harness the untapped potential emphasising diversification of the export basket, and alleviation of trade barriers.

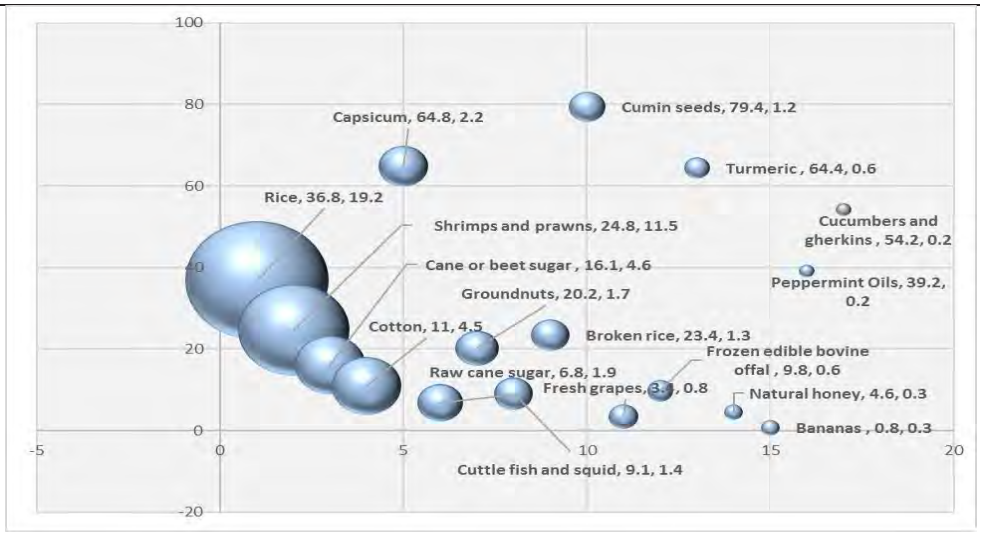
[2] Export potentials were drawn from the Export Potential Map of ITC. These assessments are based on an export potential assessment methodology developed by the ITC.

## Figure 6.3. Major segments in agricultural exports

**Consistently growing commodities**

*Occupying major share in exports*

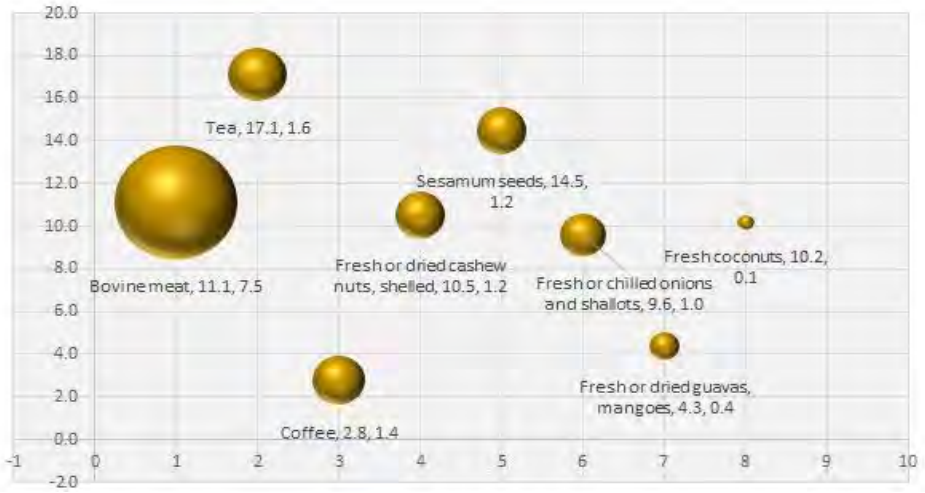
*Have positive growth*




**Historically significant, currently declining**

*Occupying major share in exports*

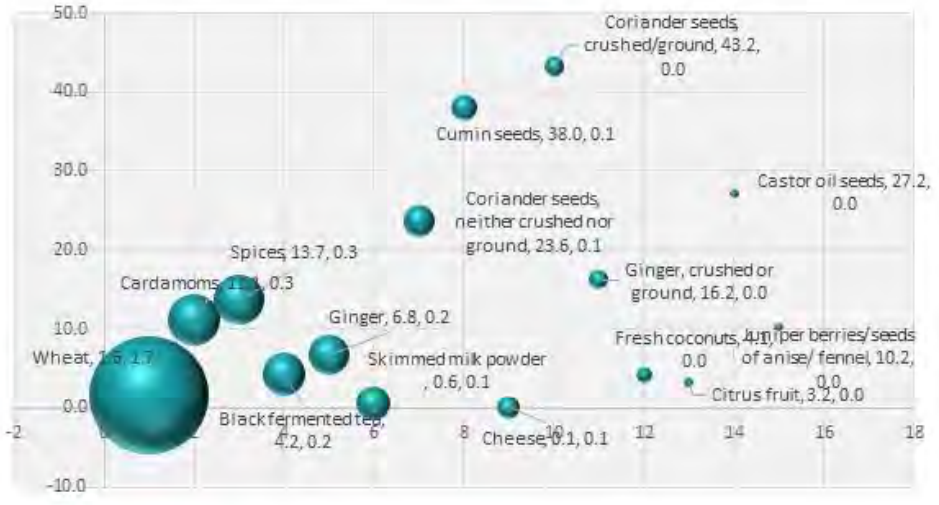
*Have negative growth*




**Emerging Commodities**

*Positive growth*

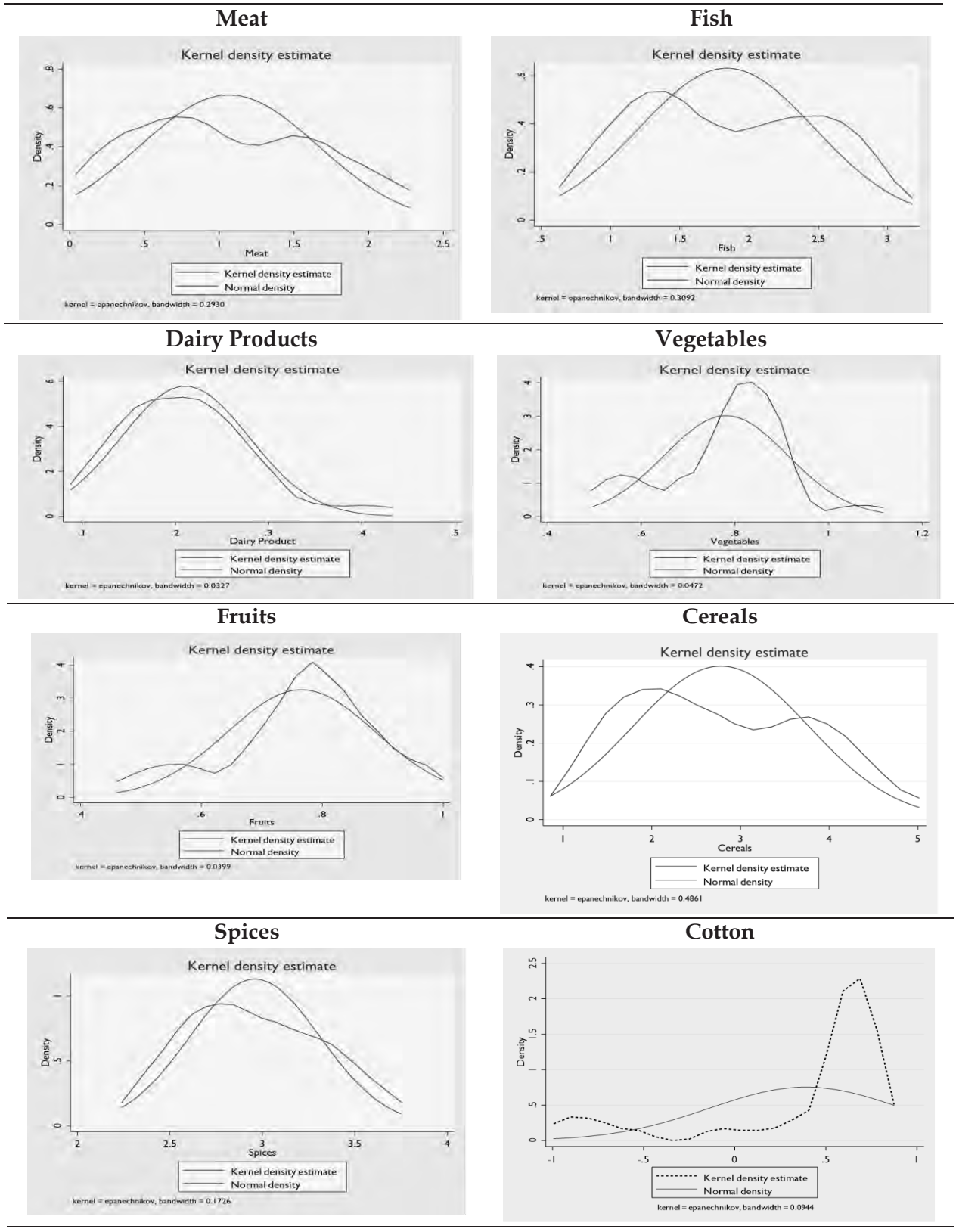
*Shares not significant*




*Note: The coordinates of the bubble represent the share in global exports and domestic agri-exports, respectively. X-axis represents the commodities; Y-axis represents the share in global exports. The size of the bubble represents the share in domestic agri-exports.*

*Source: Authors' computations*

## Figure 6.4. RCA of major agricultural commodities




*Source: Authors' computations*

**Table 6.1. Untapped potential in agricultural exports**

| HS Code | Products | TE 2021 (USD million) | Untapped export potential (% of commodity exports) |
|---|---|---|---|
| '10 | Cereals | 9363.0 | 56 |
| '02 | Meat | 3313.6 | 49 |
| '52 | Cotton | 7280.1 | 62 |
| '08 | Fruits | 1442.4 | 32 |
| '07 | Vegetables | 1237.9 | 44 |
| '03 | Fish | 6061.7 | 50 |
| '09 | Coffee, tea & spices | 3675.6 | 42 |
| '04 | Dairy Produce | 421.3 | 37 |

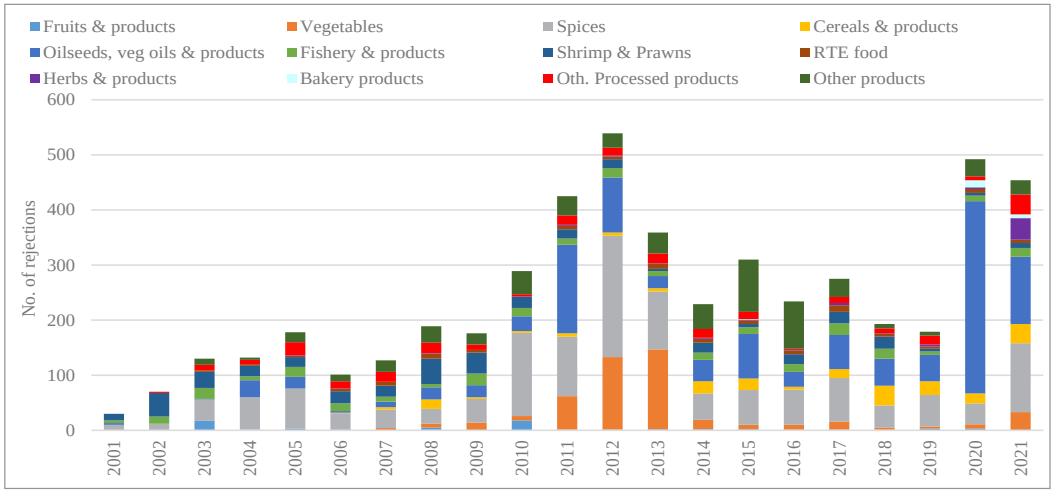
*Source: Authors' computations*

## 6.5 Export Rejections

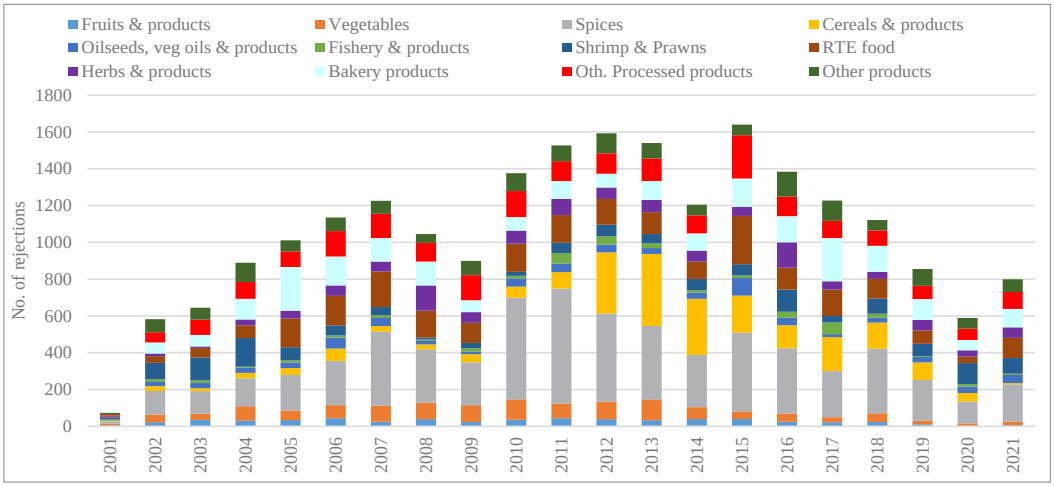
Food safety is a critical issue in international trade. The exporters are required to meet the food safety standards of the importing countries to prevent food waste and economic loss. Import refusals can discourage exports and diminish the value of exported products, leading to food loss. The rejection rates of India's exports of agricultural commodities and processed food products in the US and the EU show an upward trend, peaking in 2012 in the EU and in 2015 in the US. Export rejections are more in the US than in the EU. However, there was a resurgence in rejections in the EU in 2020 and 2021 (Figure 6.5) perhaps due to the greater safety protocols imposed during

**Figure 6.5. Indian export rejections by the EU and USA**

*Rejections by the EU*




*Rejections by the USA*




*Source: USFDA and RASSF*

the Covid-19 pandemic. The main exports rejected by the US include spices, cereals & products, ready-to-eat food items, bakery products, shrimp & prawns, and vegetables. Spices, oilseeds & products, vegetables, and shrimp & prawns are the main rejections in the EU. Spices have higher rejections than any other commodity. India is a significant player in the global spices trade. Spices like black pepper have been exported from India since time immemorial. Despite this, the country has been able to tap less than half of the export potential of most spices because of the issues related to import licensing, packaging, and labeling requirements, rules of origin, sanitary and phytosanitary rules, import quotas, and technical barriers (Deardorff, 2012; Thomas and Sanil, 2019). In addition, spices were among the commodities most affected due to non-compliance with required food safety parameters imposed by the US and the EU (Idris et al., 2015).

Pesticide residues comprise the major reason for the rejection of export consignments of rice, seed spices, including other spices and mixtures, vegetables, fruits and their products, oilseeds and their products, and herbs in the US as well EU (Table 6.2). Use of non-recommended or excessive amounts of pesticides leads to pesticide residues in food products. Similarly, the presence of veterinary drug residues is found the main cause for the rejection of export consignments of shrimp and prawns. Veterinary drugs are typically used for the treatment and prevention of parasitic and microbial diseases in fishery and aquaculture. Misuse or overuse of these drugs can result in high levels of residues in fishery products, leading to export rejections.

**Table 6.2. Commodity-wise rejections and reasons (2011-2021)**

| Commodity/ Product | Rejections by the US | | EU | |
|---|---|---|---|---|
| | Number | Reasons[1] | Number | Reasons[1] |
| **Basmati rice** | 1368 | Pesticide residue (75%), filthy (22%) | 119 | Pesticide residue (83%), mycotoxins (8%) |
| **Rice** | 379 | Pesticide residue (82%), filthy (9%) | 38 | Pesticide residue (79%), mycotoxins (13%) |
| **Shrimp & prawn** | 798 | Microbial (42%), filthy (21%), vet. drug residue (17%) | 141 | Vet. drug residue (62%), microbial (13%) |
| **Fish & aqua** | 299 | Filthy (58%), Salmonella (23%), insanitary control (11%) | 147 | Heavy metals (46), insanitary control (24%), microbial (14%) |
| **Seed spices** | 697 | Salmonella (57%), unsafe substance (17%), labeling (13%) | 41 | Pesticide residue (63%), Salmonella (27%) |
| **Other spices** | 3016 | Salmonella (54%), filthy (13%), pesticide residue (11%), labeling (9%) | 906 | Pesticide residue (51%), mycotoxin (27), adulteration (12%) |
| **Vegetables** | 565 | Pesticide residue (50%), labeling (15%), insanitary control (14%) | 436 | Pesticide residue (94%) |
| **Fruits & products** | 287 | Insanitary control (28%), labeling (25%), pesticide residue (15%) | 17 | Pesticide residue (82%) |
| **Oilseeds, oil & products** | 440 | Unsafe additive (30%), pesticide residue (27%), Salmonella (23%) | 1060 | Pesticide residue (39%), mycotoxin (32%), Salmonella (22%) |
| **Herbs & products** | 695 | Poisonous substance (38%), unsafe substance (38%), pesticide residue (7%) | 61 | Pesticide residue (51%), Salmonella (33%) |
| **RTE foods** | 1351 | Labeling (40%), pesticide residue (13%), filthy (12%), Salmonella (11%), | 74 | Aflatoxin (42%), adulteration (38%) |

*Note: [1]. Rejection reasons may be more than one for a consignment.*
*Source: Authors' computations*

Salmonella is one of the major causes of export rejections. The most important product categories with Salmonella, mycotoxins, and other pathogenic microbial contamination are fishery products, shrimp and prawns, rice, seed spices, oilseeds, herbs and products, and ready-to-eat foods. The most prominent source of exposure to pathogens is the contaminated soil and irrigation water at the pre-harvest level, and unhygienic practices during harvest and pre-processing and transportation at the post-harvest level. The growing concerns about pathogenic contamination in food highlight the need for improvements in food safety management practices all along the supply chain. Here, is the role of R&D institutions in strengthening the capacity of value chain participants. Trade-facilitating institutions like APEDA and EIC need to play an effective role in handling quality issues and SPS compliances.

Insanitary control or conditions during packing, transportation, and processing is another cause of rejections of fishery products, vegetables, and fruits and products. Rejections of herbs and products, and oilseeds and products relate to the use of unsafe substances or additives, or colors. Inappropriate labeling or misbranding, packaging, and lack of documents are also important reasons for the rejection of spices and mixtures, vegetables, fruits, and products. Actors at different segments of the food supply chain need to follow good handling and food safety management practices. Sensitization of food supply chain actors for proper export documentation and labeling is also called for.

Food safety issues are ascribed to poor sanitary facilities, inadequate food safety practices and knowledge, and insufficient food safety management system implementation. The ability to implement best practices at various levels of the food product export supply chains, such as good agricultural practices (GAP) at the production level, good manufacturing practices (GMP) at the processing level, and good handling practices (GHP) at all levels, must be improved in order to address these challenges. It is also necessary to improve infrastructure such as cold chain management systems, pre-processing and processing facilities, and laboratories in order to improve quality control and food safety handling by domestic supply chain actors.

## 6.6 Way Forward

India's presence in the global agri-food market is increasing. The country is export competitive in specialized commodities such as Basmati and non-Basmati rice, spices, and shrimp. International markets are becoming more demanding in terms of food safety and quality standards. It is, therefore, necessary to assess the cost-effectiveness, logistics, and traceability of products. Value chain actors must constantly develop their capacities in order to better manage product quality and export compliances. Developing an international market intelligence system holds the key to market surveillance and monitoring, including trade agreements, demand patterns, export regulations, and certifications. It will facilitate market linkages and optimal regional crop planning.

India's trade policy is currently driven by contingency needs, mainly for domestic price stabilization. To improve and sustain India's exports, there is a need for consistent efforts. For Indian agriculture exports to remain in line with the shifting international market requirements, knowledge upgradation through technical and practical training is essential. It is necessary to build the needed infrastructure to address food safety and traceability issues. Blockchain technology and the Internet of Things can be quite useful in this.

## References

Bai, J and P Perron. 2003. Computation and analysis of multiple structural change models. *Journal of Applied Econometrics*, 18(1): 1-22.

Birthal, PS, PK Joshi, S Chauhan, and H Singh. 2008. Can horticulture revitalize agricultural

growth? *Indian Journal of Agricultural Economics*, 63(3): 310-321.

Chakraborty, M, and A Garg. (2020). Competitiveness in Indian agricultural exports. *Journal of Accounting and Finance*, 34(2): 12-21.

Chand R. 2020. New farm acts: understanding the implications, NITI Aayog, Government of India, New Delhi

Deardorff, A. 2012. Easing the burden of non-tariff barriers. *International Trade Forum*, 3: 26-27.

Idris, S, A Singh, and KV Praveen. 2015. Trade competitiveness and impact of food safety regulations on market access of India's horticultural trade. *Agricultural Economics Research Review*, 28: 301-309, doi: 10.5958/0974-0279.2016.00009.4.

Kumar, V. 2021. Trends and performance of India's agricultural trade in the midst of COVID-19 pandemic. *Indian Journal of Agricultural Economics*, 76 (3): 352-370.

Martin, W. 2017. *Agricultural trade and food security.* ADBI Working Paper (No. 664), Asian Development Bank Institute, Tokyo.

Santos-Paulino, AU and D Thornquist. 2015. *Estimating the impact of trade specialization and trade policy on poverty in developing countries.* United Nations Conference on Trade and Development, Geneva, pp. 1-23.

Saxena, R, R Kumar, S Chauhan and MS Raman. 2022. Trajectory of Indian agricultural exports: competitiveness, diversification and growth linkages. In *India's Agriculture and Food Exports: Opportunities and Challenge,* Bloomsbury India. (NABARD)

Thomas, L and PC Sanil. 2019. Competitiveness in spice export trade from India: a review. *Journal of Spices and Aromatic Crops*, 28(1): 1-19.

UNCOMTRADE. 2020. Monthly trade data, available at: https://comtrade.un.org/

Van den Broeck, G and M Maertens. 2016. Horticultural exports and food security in developing countries. *Global Food Security*, 10: 11-20. doi: 10.1016/j.foodpol.2016.12.003.

♦♦♦

7

# IMPACT OF COVID-19 ON AGRICULTURE

*S.K. Srivastava, Raka Saxena, D. C. Meena, and Purushottam Sharma*

## 7.1 Rationale

The COVID-19 pandemic adversely affected almost all economies. In India, the first case of COVID was reported on January 30, 2020, from Kerala, and subsequently, its infection spread throughout the country. The Government of India, in order to check its spread, imposed a nationwide lockdown on March 24, 2020, for 21 days, which extended further keeping in view the increasing infection due to the virus. The lockdown disrupted several economic activities – a 23.9% contraction in the real gross domestic product (GDP) in the first quarter (April-June) of 2020-21 as compared to a 5.2 % growth in the corresponding period of 2019-20. The adverse effects of the COVID-led lockdown were supposed to affect all sectors.

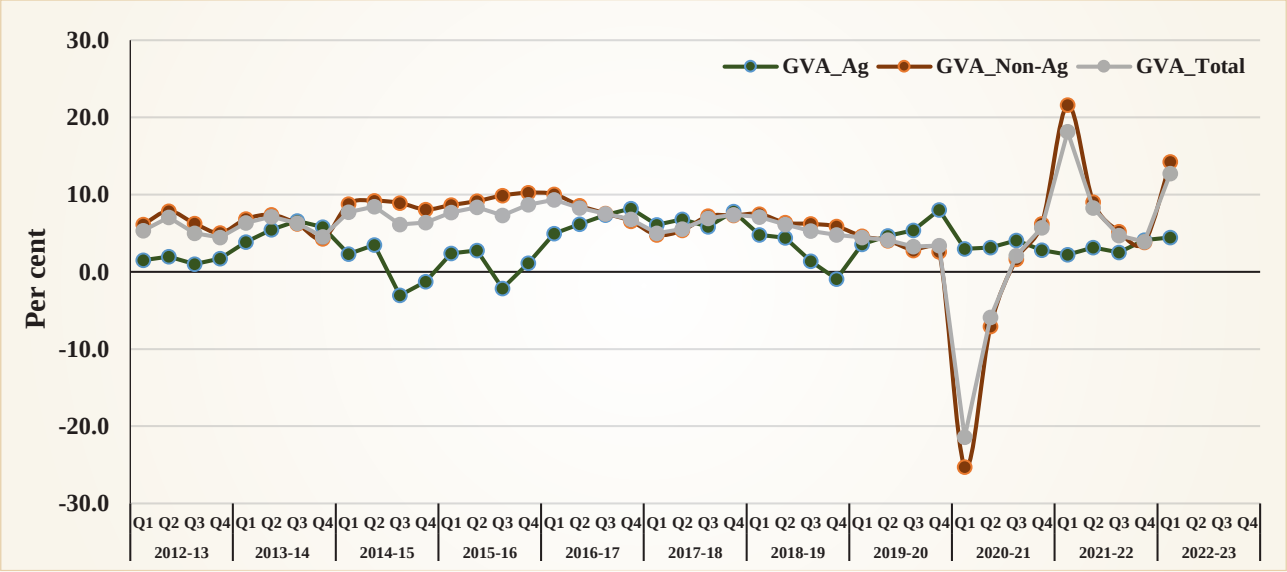
Agriculture is the most important sector of the Indian economy. As a source of food, it has the prime function of producing an adequate amount of food. Besides, agriculture is also an important source of income for a large population. According to the Periodic Labour Force Survey (2021-22) of the National Sample Survey Office (NSSO), 45.5% of the workforce is engaged in agriculture. The other sectors are also dependent on agriculture for their raw material requirements. Further, agriculture is also a major source of foreign revenue through exports. Therefore, any adverse effect on the production and supply of agricultural commodities is expected to have a detrimental impact on food and nutritional security and overall economic growth. It is, therefore, essential to assess the possible effects of COVID-led disruptions on different aspects of the agricultural economy, including production, market arrival, prices, and trade. This chapter briefly provides the effects of lockdown on these aspects. This provides useful insights into the resilience of Indian agriculture to such shocks and the likely prescriptions to minimize their adverse effects.

## 7.2 Performance of Agricultural Production

The government imposed a complete lockdown on March 24, 2020, for a period of three weeks, which was further extended until May 31, 2020, but with some relaxations at the local level depending on the level of infection. The lockdown was lifted in a phased manner. Nonetheless, all economic activities were completely disrupted during the lockdown period. At the macro level, the adverse effect of such disruptions can be gauged from changes in the gross value added (GVA). Figure 7.1 presents the quarterly growth in the GVA of agriculture and non-agriculture sectors. The GVA of non-agricultural sectors (at constant prices) grew at an annual rate of 7.2% between 2011-12 and 2019-20, which can be construed as a "pre-pandemic" period. Due to the lockdown, economic activities were adversely affected in the 2$^{nd}$ and 3$^{rd}$ quarters (construed as a "pandemic period") of 2020-21. This is reflected in a 16.2% decline in the GVA of the non-agricultural sector over the previous period (Table 7.1).

The output growth in agriculture decelerated from 4.1% during the "pre-pandemic period" to 3.1% during "pandemic period". However, as compared to non-agricultural sectors, the growth in the agriculture sector remained positive and agricultural output did not decline during the lockdown. On account of relatively better resilience and performance, the share of agriculture in the total GVA increased from 13.5% (quarterly average) during the pre-lockdown period (2011-12 to 2019-20) to 15.1% during

Figure 7.1. Quarterly growth in GVA (at 2011-12 prices)




*Source: Authors' computations based on data form MOSPI*

the lockdown period (2020-21, Q1:Q2). In other words, the agriculture sector succored the Indian economy during the pandemic. Nevertheless, despite positive growth in agriculture, the overall economic growth declined by 13.6% due to a significant decline in the growth of non-agricultural output.

The economy started a revival in "post-pandemic period" (2021-22, Q1:Q2). The non-agricultural sector grew at an annual rate of 15.3% over the lockdown period (2020-21, Q1:Q2). This along with a 2.7% growth in the agricultural sector prompted the growth of 13.2% in the economy during the post-lockdown period. It is to be noted that the adverse effect of the lockdown on output was limited to only 1st and 2nd quarters of 2020-21 and the economy recovered thereafter. During the 3rd and 4th quarters of 2020-21, the output of the non-agricultural sector was 3.99% more than the previous period (2019-20, Q3:Q4). Although agricultural output did not decline during the lockdown, its growth slowed down and could not attain its previous level.

## 7.3 Market Arrivals and Prices of Agricultural Commodities

The evidence reveals no adverse effect of the pandemic on the production of agricultural commodities. But, their distribution could have been affected due to the supply chain disruptions. We examine this by analyzing monthly market arrivals, and daily prices of important agricultural commodities from 2017 to 2021 using interrupted time series analysis (ITSA). Results show a decline in market arrivals of most commodities during the lockdown period as compared to the corresponding months' of 2017 to 2019. The

Table 7.1. Sector-wise growth and composition of the gross value of output

| Period | Growth rate (%) | | | Share in total GVA (%) | |
|---|---|---|---|---|---|
| | Agriculture & allied | Non-agriculture | Total | Agriculture & allied | Non-agriculture |
| 2011-12 to 2019-20 (Q1:Q2): Pre-lockdown | 4.1 | 7.2 | 6.8 | 13.5 | 86.5 |
| 2020-21 (Q1:Q2): Lockdown | 3.1 | -16.2 | -13.6 | 15.1 | 84.9 |
| 2021-22 (Q1:Q2): Post lockdown | 2.7 | 15.3 | 13.2 | 13.8 | 86.2 |

*Source: Authors' computations*

lockdown coincided with the *Rabi* season harvest, hence the impact of the lockdown was higher. There was a decline in market arrivals in the initial phase of the lockdown due to restrictions on movement. However, with the easing of restrictions on agriculture, market arrivals of most commodities started recovering.

Interrupted time series analysis treats lockdown as a policy intervention (lockdown of 2020, and 2021) and shows no significant impact on the wholesale prices of rice, wheat, gram dal, and tomato immediately after the lockdown (column labeled as 'level_20' in Table 7.2). However, there was a significant increase in wholesale prices of masoor dal, while the prices of mustard oil and onions declined significantly immediately after the lockdown. The 'time' column reveals the price trend before the lockdown and the 'trend' column shows the price trend after the lockdown, and similarly, the 'level' column indicates the lockdown effects immediately after the lockdown.

Significant trend reversal happened post-lockdown for rice, wheat, gram dal, and masoor dal, while an increasing trend continued in the case of mustard oil. Free distribution of food grains to the poor under the Pradhan Mantri Garib Kalyan Anna Yojana (PMGKAY) was a significant contributor to the negative price trend for rice and wheat during the lockdown. Also, the lockdown period coincided with the *Rabi* harvest, the higher market arrivals depressed market prices of *Rabi* crops.

There was no significant change in the wholesale prices of most commodities immediately after the lockdown (as revealed from the coefficient for level_21) except for mustard and tomato which declined. Similarly, there was no significant trend change in the wholesale prices of major food commodities post-lockdown in 2021, except for masoor dal and mustard oil. The retail prices of rice, wheat, mustard oil, and onion declined significantly after the lockdown in 2020 (level change in 2020) while the price of

**Table 7.2. ITSA estimates of lockdown impact on wholesale & retail prices of major agricultural commodities**

| Commodity | Wholesale price (₹/qtl) | | | | | |
|---|---|---|---|---|---|---|
| | Time | Level_20 | Trend_20 | Level_21 | Trend_21 | Intercept |
| Rice | 0.856** | 8.949 | -0.790** | -2.277 | -0.182 | 2812.28** |
| Wheat | 0.985** | -9.81 | -1.61** | -101.76** | 0.618 | 2324.86** |
| Gram dal | -0.065 | 59.86 | 1.695** | 97.64 | 0.836 | 5962.94** |
| Masoor dal | 2.217** | 688.36** | -1.193* | 60.10 | 7.13** | 5502.87** |
| Mustard oil | 3.84** | -568.17** | 5.54** | 476.50 | 15.63** | 9774.77** |
| Tomato | -6.03** | 1126.46 | 5.04 | -1188.27* | 4.61 | 3401.82** |
| Onion | 10.65 | -3390.87* | -7.68 | -1429.40 | 2.31 | 2277.96** |
| Potato | 2.47** | 588.12 | -3.62 | -624.49 | -2.07 | 1317.86** |
| | Retail prices (₹/kg) | | | | | |
| Rice | 0.008** | -0.921* | 0.002 | -0.639 | -0.023** | 31.53** |
| Wheat | 0.010** | -0.509* | -0.012** | -0.833** | -0.007 | 26.31** |
| Gram dal | -0.002 | 0.405 | 0.025** | 0.471 | 0.005 | 66.22** |
| Masoor dal | 0.020** | 6.37** | 0.001 | -0.063 | 0.048** | 61.26** |
| Mustard oil | 0.039** | -6.23** | 0.059** | 4.51 | 0.150** | 106.66** |
| Tomato | -0.063** | 12.29 | 0.055 | -14.33* | 0.054 | 41.10** |
| Onion | 0.134 | -42.36* | -0.067 | -24.52** | -0.013 | 25.24** |
| Potato | 0.026** | 6.21 | -0.034 | -11.59* | 0.045* | 17.75** |

*** and * indicate the statistical significance at 1 and 5% probability levels, respectively*
*Source: Authors' computations*

masoor dal increased but marginally. The trend change in retail prices post-lockdown in 2020 was non-significant for most food commodities, except for wheat, gram dal, and mustard oil. The level change immediately after the lockdown in 2021 was significant in the case of wheat, and vegetables with a marginal decline. Post-lockdown 2021 trend was found to be significant and negative for rice and positive for masoor dal, mustard oil, and potato. Although, the magnitude of change was marginal. All other food commodities witnessed no significant change post-lockdown 2021.

Overall, no major change (either level change or trend change) in the wholesale and retail prices of most of the food commodities was observed post-lockdown 2020 and 2021, except the level change in the case of wheat and tomato and trend change in the case of masoor dal and mustard oil.

## 7.4 Performance of Agricultural Trade

The COVID-19 pandemic disrupted the global supply chains and changed the landscape of economic activities, including food production, processing, distribution, consumption, and trade. The Government of India took several measures (e.g., investments in supply chains and agro-processing) to minimize the impact of such shocks on rural livelihoods and improve the resilience of agriculture and agricultural supply chains. Despite the pandemic, a noticeable spurt occurred in India's agricultural exports, reaching US$41.32 billion in 2020-21 and crossing US$50 billion in 2021-22. This section analyzes the performance of some important export-oriented commodities using the monthly export data from January 2011 to December 2021 and projects how the exports would have behaved had the historical trends prevailed (Figure 7.2).[1]

Rice has always been the most important exported commodity from India. It exports Basmati and non-Basmati rice. However, the exports of non-basmati rice have picked up in recent years. Rice exports during the COVID-19 pandemic witnessed a remarkable increase of 24.4% during the biennium ending (BE) 2021 from US$ 7.07 billion over the pre-COVID period, i.e., BE 2019. The actual exports exceeded the projections. This spurt in India's rice exports has been attributed to the Indian government's measures to ensure exports of rice and other cereals while taking COVID-19-appropriate safety precautions. The Agricultural and Processed Food Export Development Authority (APEDA) promoted rice exports through collaborations with various stakeholders. The Government set up a Rice Export Promotion Forum (REPF) involving representatives from the industry, exporters, the Ministry of Commerce, APEDA, and directors of agricultural departments of major rice-producing states.

Crustaceans are the most exported fish from India, accounting for 75% of the total exports of fish products. Exports of crustaceans declined in 2020. However, the country recovered from the crisis, leading to an 11% increase in their exports in 2021. Overall, crustacean exports experienced a decline, and the actual exports remained below the projected exports. Bovine meat exports have dwindled in recent years due to global competitiveness and quality issues. Similar trends continued even during the COVID-19 pandemic, and bovine meat exports declined by about 11% during the COVID pandemic. The export decline exceeded projected trends. Spice exports during the pandemic witnessed a significant jump, the increase in actual exports was much higher than the projection. Spices like ginger, pepper, cinnamon, cardamom, turmeric, and saffron have known therapeutic qualities, hence their exports increased substantially.

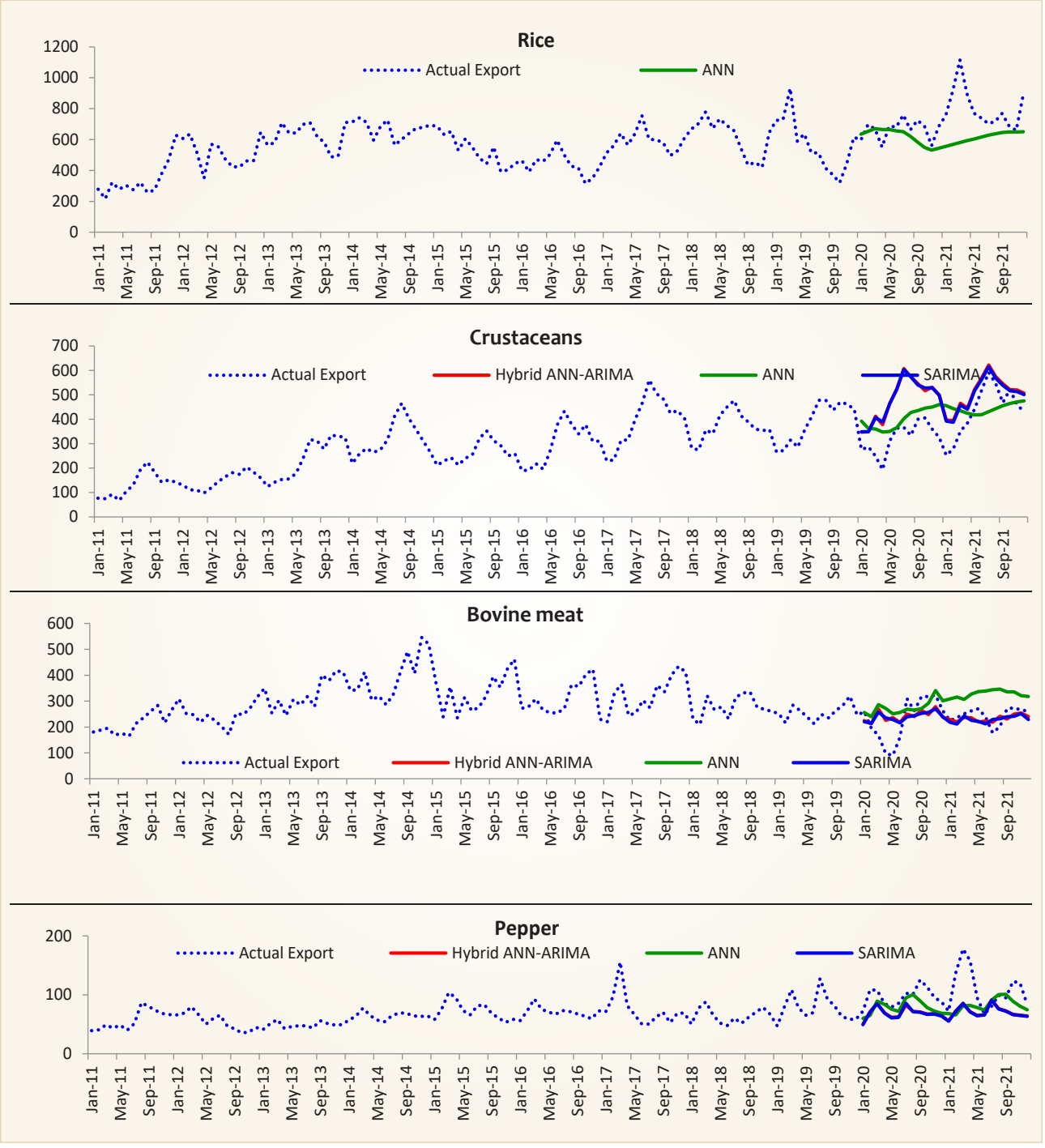
Exports of cotton products exhibited an increasing trend during the last three decades but with some extreme aberrations. Cotton yarn exports dipped to the lowest levels during the decade due to the Covid-19 pandemic across

[1] We applied autoregressive integrated moving average (ARIMA), seasonal ARIMA (SARIMA), artificial neural network (ANN), and hybrid models (ANN-ARIMA) after validation

the globe. A similar decline was noticed in India too. However, the country improved its global trade share gradually. As a result, India's cotton exports increased tremendously in 2021, much higher than in the pre-COVID period.

The country introduced export-enhancing measures such as (temporary) elimination of export duties, eliminating export prohibitions, and terminating prior export authorization. Given these, the performance of India's agricultural exports is laudable. The country stepped in through its missions abroad, interacted through buyer-seller meets, coordinated with the authorities at different levels, and removed the bottlenecks when surfaced.

**Figure 7.2. Trends in exports of major commodities during Covid-19 (US$ million)**




*Source: Authors' computations*

As rice remains the staple crop in many Asian countries, its exports witnessed a remarkable jump during the Covid-19 pandemic due to food security concerns. A significant quantum of rice is also exported to middle-east countries. At the same time, other major trading nations like Thailand, Pakistan, and China lost their shares during the Covid-19 pandemic, creating greater scope for India's rice exports. The occurrence of the Covid-19 pandemic worldwide created a lot of health concerns and reliance on herb-based Ayurvedic medicines. This led to a global upsurge in the demand for spices. Thus, a strong positive impact was noticed on the export of spices from India. Livestock and fisheries products faced many stringent import requirements from importing countries, particularly during the initial phase of the pandemic, when apprehensions existed about the animal-to-human transmission of the virus. Thus, animal-based exports suffered in 2020, however, the crustaceans' exports recovered in 2021.

## 7.5 Conclusions

The lockdown to curb COVID infection adversely affected the output from the non-agricultural sectors. But the agricultural sector exhibited resilience and positive growth. Nevertheless, the growth in agricultural GVA has slowed down during the post-pandemic period which needs to be accelerated. As expected, the movement restrictions affected the supply chain but except few no major changes have been observed in the market arrival and prices of most of the commodities. The policy facilitation put India in an advantageous situation, and the exports crossed US$50 billion. Post-Covid pandemic, international markets are becoming stringent on food safety and quality requirements. Thus, there is a strong case for India to invest in infrastructure for food quality and safety, create awareness among supply chain actors on the global best practices and develop resilient supply chains to improve the competitiveness of its exports and consolidate its share in the global market.

♦♦♦

8

# SUSTAINABILITY IN INDIAN AGRICULTURE

*Prem Chand and Kiran Kumara T M*

Evaluating sustainability aids decision-makers in taking informed decisions to improve the performance of an enterprise, sector, or society (Devuyst, 2001). Sustainability assessment has become crucial since the late 1980s when the World Commission on Environment and Development was tasked with creating a global plan for sustainable development. While various sustainability assessment methodologies exist, concerns over their effectiveness in capturing real issues and getting desirable results persist in academic and policy circles (OECD, 2003; Binder et al., 2010; Magrini & Giambona, 2022). The key questions relate to: (i) making assessments comprehensive, (ii) avoiding capital substitutability (natural vs. manmade), and (iii) ensuring that results are comparable in space and time.

Agriculture is central to achieving Sustainable Development Goals, as it links people, the planet, and sustainability. The goal of eliminating hunger and poverty hinges on the sustainability of agriculture. Assessing agricultural sustainability in India is crucial on account of multiple reasons, including ensuring the availability of food to all at all times, maintaining long-term productivity, and reducing biotic and abiotic stresses. Assessment of agricultural sustainability is also important for ensuring the efficient utilization of natural resources such as land, water, and soil. Agricultural practices such as the use of pesticides and agrochemicals often involve trade-offs, for example, between maximizing yields and ensuring environmental health. Such a complex interplay of social, economic, and environmental factors that impact agriculture has not been adequately represented in the current agricultural sustainability assessments. This chapter assesses the agricultural sustainability across Indian states by applying composite indicators to identify priorities for sustainable and inclusive development of agriculture.

## 8.1 Indicators of Sustainability

We have used several indicators of sustainability for the triennium ending 2019-20. A longer time frame has been considered for indicators such as rainfall and temperature, and groundwater depletion. Indices and composite indicators are simple and effective means of summarizing various aspects of sustainability and evaluating the index against high standards. A Composite Index of Agricultural Sustainability (CIAS) was constructed using standard sustainability indexing procedures such as selecting indicators, normalizing data, and aggregating indicators into a composite index. A total of 51 indicators listed in Table 8.1 have been used and the raw scores have been normalized using the benchmark method, which measures sustainability by comparing performance with a desired value, not among assessment units. Normalized values are aggregated into four component indices, then into a composite index by giving equal weight to all the indicators and dimensions. Equal weights were chosen because when there are a large number of indicators, the weight remains rather small to affect the composite index (Pal et al., 2022).

## 8.2 Agricultural Sustainability Indices

The CIAS score at the all-India level is estimated at 0.50 (Table 8.2), which indicates the moderate sustainability of Indian agriculture. Agriculture in Rajasthan in the arid region is the least sustainable (CIAS 0.40), while it is the most sustainable in Mizoram, Kerala, Andhra Pradesh, Madhya Pradesh, and West Bengal. Agriculture

## Table 8.1. Sustainability dimensions and indicators

| Dimensions | Indicators | Unit of measurement |
|---|---|---|
| Soil health | Area under land degradation [ADL$^-$], area under soils with poor water holding capacity [SPWHC$^-$], area under unfavorable soil pH [USPH$^-$] | ADL & SPWHC: % of geographical area (GA); USPH: % of soil samples with pH >=8.5 & <5.5 |
| | Deficiency of primary soil nutrients [SNFDPRIMARY$^-$], deficiency of secondary and micro soil nutrients [SNDMICRO$^-$] | SNPRIMARY & SNSECONDARY: % of nutrient deficit soil samples |
| | Deficiency of soil organic carbon [DOC$^-$], crop residue burning [CRB$^-$] | DOC: % of SOC deficit soil samples; CRB: % of residue generated |
| | Chemical pesticides use intensity [CPUI$^-$], fertilizer use deviation [FUD$^-$] | CPUI: kg/ha of NSA; FUD: % of recommended |
| | Adoption of resource conservation technology [RCT$^+$], organic manuring [OM$^+$] | RCT: %; OM: tons/ha; |
| Water resource | Rainfall anomalies [RAI$^-$], dry spell incidences [DOI$^-$], days with temperature extremes [TEI$^-$] | Frequency of events (numbers/years) (average of 1965-2016) |
| | Groundwater extraction vis-à-vis recharge [GE$^-$], annual net groundwater recharge rate [RGD$^+$], water productivity index [WPI$^+$], water quality index [WQI$^+$] | GE: % of recharge; RGD: meters/year; WPI: crop produce/$m^3$ expressed in index terms comparing with the best case; WQI: Index was computed using methodology suggested by Yıldız and Karakuş (2018). |
| | Irrigation potential utilized [IPU$^+$], investment on soil and water conservation [ISWC$^+$], area under micro-irrigation [MI$^+$] | IPU: % of potential created; ISWC: ₹/ha of degraded lands; MI: area under MI as % of gross irrigated area excluding paddy (GIA) |
| Biodiversity and ecology | Area under forest [FOREST$^+$], area under agro-forestry [AGF$^+$], pastures and grazing lands [PGL$^+$] | FOREST: % of GA; AGF & PGL: % of NSA |
| | Crop diversification index [CDI$^+$], varietal diversification index [VDI$^+$], livestock diversity index [LDI$^+$], fish diversity index [FDI$^+$] | Index computed using Simpson's formula (Simpson 1976) |
| | Area under organic farming [NF$^+$], area under legume crops [LC$^+$], honey production [HP$^+$], ex-situ germplasm conservation [EGC$^+$] | NF: % of NSA; LC: % of gross cropped area (GCA); HP: kg/1000 ha GA; EGC: number of accessions in gene banks/1000 ha of NSA |
| | Waste lands [WL$^-$], GHG emission [GHGE$^-$] | WL% of GA; GHGE (kg/ha) |
| Socio-economic | Land productivity [LP$^+$], Labour productivity [LABP$^+$], Fertilizers productivity [FP$^+$], Livestock productivity [LSP$^+$], Fish productivity [FI$^+$] | LP: ₹ lakh/ha of net sown area (NSA); LABP: ₹ lakh/worker; FP: ₹ lakh/ ton of nutrient used; LSP: ₹ lakh/ per Standard Animal Unit; FI: tons/ha; |
| | Food calories self-sufficiency [CALORIES$^+$], Protein self-sufficiency [PROTEIN$^+$], green fodder self-sufficiency [FODDER$^+$] | CALORIES: kcal Per capita per day; PROTEIN: g/person/day; FODDER: area in cultivated fodder (% to NSA) |
| | Land-man ratio [LMR$^+$], land fragmentation [PPH$^-$], Terms of trade (agriculture to non-agriculture) [TOT$^+$] | LMR: ha/person; PPH: number of parcels per holding; TOT: ratio |
| | Input subsidies in agriculture [ISA$^+$] | ₹/ha of NSA |
| | Farmers Producer Organisations [FPO$^+$], Self Help Groups [SHG$^+$], co-operatives [COOP$^+$] | FPO: Numbers/100000 holdings; SHG: Number of members/1000 holdings; COOP: Number of members/holdings |
| | Investment in agriculture at current prices [AGINVEST$^+$], Investment in agriculture R&D at current prices [R&DINVEST$^+$] | ₹/per ha of NSA |

*Note: '+' and '-' sign in superscripts indicate "higher value is better" or "lower value is better, respectively; Information in the square bracket is the abbreviated name of the indicator.*

*Source: Authors' computations*

in these states experienced growth due to factors such as infrastructural development, farm credit, input use, and crop diversification (GoI, 2017). Madhya Pradesh excelled in organic farming. However, more than half the states score below 0.5, indicating sustainability risks at one or another dimension. The risk to sustainability is greater in the states in the Indo-Gangetic Plains (i.e., Uttar Pradesh, Punjab, Bihar, and Haryana), and also in the rice-dominant Jharkhand and Assam. These states produce much of India's staple food, putting food security at risk if sustainability is threatened.

The socio-economic dimension is the primary concern for ensuring the sustainability of agriculture. Except for Haryana and Punjab, none of the states scores more than 0.5 on the socio-economic sustainability index (Table 8.2). Nevertheless, the other three dimensions are also inconsistent across states. Bihar, Karnataka, Maharashtra, Assam, and Chhattisgarh rank low on socio-economic sustainability. The mean value of WSI is below the half mark for nine states. Similarly, the soil health index (SHI), which is relatively better (SHI 0.59) than the other dimensions at the all-India level,

**Table 8.2. Agricultural sustainability indices by states and four dimensions**

| States | SHI | WSI | ESI | SESI | CIAS |
|---|---|---|---|---|---|
| Andhra Pradesh | 0.69 | 0.57 | 0.45 | 0.44 | 0.53 |
| Arunachal Pradesh | 0.58 | 0.47 | 0.45 | 0.47 | 0.49 |
| Assam | 0.54 | 0.62 | 0.37 | 0.32 | 0.46 |
| Bihar | 0.60 | 0.53 | 0.43 | 0.24 | 0.45 |
| Chhattisgarh | 0.63 | 0.57 | 0.47 | 0.33 | 0.50 |
| Gujarat | 0.70 | 0.37 | 0.43 | 0.37 | 0.47 |
| Haryana | 0.56 | 0.28 | 0.40 | 0.61 | 0.46 |
| Himachal Pradesh | 0.72 | 0.37 | 0.47 | 0.46 | 0.50 |
| Jharkhand | 0.46 | 0.58 | 0.41 | 0.35 | 0.45 |
| Karnataka | 0.62 | 0.66 | 0.53 | 0.26 | 0.52 |
| Kerala | 0.66 | 0.59 | 0.43 | 0.46 | 0.54 |
| Madhya Pradesh | 0.71 | 0.50 | 0.50 | 0.38 | 0.53 |
| Maharashtra | 0.58 | 0.59 | 0.52 | 0.31 | 0.50 |
| Manipur | 0.65 | 0.63 | 0.40 | 0.41 | 0.52 |
| Meghalaya | 0.63 | 0.52 | 0.48 | 0.37 | 0.50 |
| Mizoram | 0.55 | 0.62 | 0.51 | 0.47 | 0.54 |
| Odisha | 0.63 | 0.53 | 0.45 | 0.35 | 0.49 |
| Punjab | 0.59 | 0.28 | 0.38 | 0.63 | 0.47 |
| Rajasthan | 0.56 | 0.20 | 0.45 | 0.39 | 0.40 |
| Tamil Nadu | 0.59 | 0.51 | 0.48 | 0.35 | 0.48 |
| Telangana | 0.55 | 0.48 | 0.41 | 0.35 | 0.45 |
| Uttar Pradesh | 0.52 | 0.43 | 0.43 | 0.36 | 0.44 |
| Uttarakhand | 0.69 | 0.38 | 0.51 | 0.46 | 0.51 |
| West Bengal | 0.63 | 0.64 | 0.42 | 0.41 | 0.52 |
| All India | 0.59 | 0.49 | 0.50 | 0.40 | 0.50 |

*Note: SHI–Soil Health Index; WSI–Water Resource Sustainability Index (WSI); ESI–Environmental Sustainability Index; SESI–Socio-economic Sustainability Index; CASI–Composite Index of Agricultural Sustainability.*

*Source: Authors' computations*

shows significant inter-state variation, ranging from 0.46 in Jharkhand to 0.72 in Himachal Pradesh. States in the rice-wheat-dominated Indo-Gangetic Plains generally rank low SHI due to low organic carbon and micronutrient deficiencies, and high use of agrochemicals. Several studies have highlighted concerns about deteriorating soil health in the region due to such factors (Sharma et al., 2012; Shukla et al., 2016; Subash et al., 2017).

## 8.3 Sustainable Agricultural Development Priorities

The priority areas and states for sustainable agricultural development are presented in Table 8.3. The normalized score for an indicator lies between zero and one, with zero representing the least sustainable and one the highly sustainable. The states with a score below 0.33 are shown in Table 8.3. In other words, that indicator needs to be addressed on priority. Major soil health priorities across states include reducing soil organic carbon deficiency and increasing the adoption of resource conservation technologies. Overuse of chemical fertilizers and crop residue burning are limited to the rice-wheat cropping systems of IGP. Some states such as Bihar, Assam, and West Bengal need attention towards minimizing secondary and micronutrient deficiencies, and Andhra Pradesh and Telangana towards improving balanced fertilizer use. Jharkhand and Assam score the lowest on most soil health indicators.

Insufficient investment in soil and water conservation, low micro-irrigation coverage, and poor water productivity drag down the water sustainability index (Table 8.3). Immediate attention is required in the states of Rajasthan, Punjab, and Haryana where groundwater extraction is higher than its annual recharge. The long-term groundwater depletion rate is alarming in three-fourths of the states, covering more than three-fourths of the cropped area. The annual depletion rate is more than 40 cm in Telangana, Andhra Pradesh, Punjab, and Haryana. Despite the high depletion rate, these states have higher micro-irrigation coverage and invest more in water conservation and recharge structures. Irrigation water quality (measured by the water quality as in Yıldız and Karakuş (2020) is satisfactory. However, water is unsuitable for irrigation in Arunachal Pradesh, Meghalaya, and Rajasthan, and of poor quality in Andhra Pradesh, Gujarat, Haryana, Tamil Nadu, Karnataka, and Uttarakhand.

The key priorities for environmental sustainability should be the management of wastelands, preservation of quality and quantity of pastures and grazing lands, conservation of plant species both in their natural habitat and in controlled environments, and expanding areas under natural or organic farming. The Environmental Sustainability Index (ESI) is one of the lowest in Assam, Manipur, Jharkhand, Punjab, and Telangana, which are characterized by cereal-based monoculture, declining acreage of leguminous crops, the limited area under organic farming, and high greenhouse gas emissions from agriculture. In contrast, arid and semi-arid states like Rajasthan, Maharashtra, Karnataka, Gujarat, and Tamil Nadu have more diversity in crops, livestock, and fish, which makes them more resilient to environmental stresses. Although the government focuses on preserving plant diversity in ex-situ environments through the National Bureau of Plant Genetic Resources (NBPGR), most of these efforts are concentrated in the Northern and North-Eastern hill states. Over 50% of the NBPGR's collections for ex-situ management of plant genetic resources for food are from these regions. The increasing area under agroforestry, although a medium priority, can effectively manage wastelands, reduce pressure on forests, pastures, and grazing lands, and promote self-sufficiency in fodder production.

The socio-economic sustainability problems affecting states include lack of availability of labor and fertilizers, insufficient investment, lack of availability of protein, and farmers' poor bargaining power (evidenced by farmer producer

## Table 8.3. Priority indicators and states for sustainable agriculture

| Priority area | States securing <0.33 score and arranged according to severity |
|---|---|
| **Soil health** | |
| Minimizing land degradation | JH>RJ>GJ |
| Improving water holding capacity | RJ |
| Management of soil pH | AR>MZ |
| Minimizing deficiency of primary soil nutrients | MZ>AR>AS>UP>HR>MG>OD>JH |
| Minimizing deficiency of secondary and micro soil nutrients | BR>AS>WB |
| Minimizing deficiency of soil organic carbon | HR>UP>RJ>TN>PB |
| Reducing chemical pesticides use intensity | PB>HR>TS>HP |
| Balanced use of fertilizers | TS>AP |
| Crop residue management | PB>UP>HR>JH>UK |
| Adoption of resource conservation technology | MG>MZ>AR>MN>KL>BR>JH>CG>AS>TN>OD>MH>UP |
| Use of organic manure | MZ>AR>MN>CG>MG>JH>AS>BR>KL>MH |
| **Water resources** | |
| Management against rainfall anomalies (Drought/flood) | GJ>MG>RJ>MZ>HR>PB>UP |
| Management against dry-spells | RJ>GJ>HR>PB>UP>TN>MP |
| Management against temperature extremes | HP |
| Increasing water productivity | CG>MP>RJ>MH>OD>HP>KR>UP>JH |
| Improving irrigation water quality | RJ>MG>AR>GJ>HR>KR>AP>UK>TN |
| Groundwater management | PB>RJ>HR |
| Groundwater recharge | TS>AP>PB>HR |
| Utilization of irrigation potential created | MZ>OD>GJ>AS |
| Investment in soil and water conservation | JH>WB>HP>TS>CG>MG>GJ>RJ>MH>UK>BR>MH>HR>OD>KL>PB>KR>UP>MP>AS>AP>TN |
| Increasing micro-irrigation coverage | MG>MN>PB>AS>UP>WB>AR>BR>UK>HP>MP>KL>OD>HR>TS>JH>MZ |
| **Environment** | |
| Increasing area under forest | HR>PB>RJ>UP>GJ>BR |
| Waste lands management | HP>MN>UK>RJ>MZ>MG>AR>JH>AP>MP>TS>OD>MH>AS |
| Checking degradation of pastures and grazing lands | MG>KR>WB>MN>PB>BR>AR>UP>MZ>HR>TN>AP>JH>AS>TS>OD>UK>MH>MP |
| Increasing area under agro-forestry | MZ>KL>MG>HP>MN>WB>AR>MP>AS>HR>PB>UK>GJ>MH |
| Crop diversification | AS>CG>OD>PB>WB |
| Varietal diversification | KL>HP>KR |
| Livestock diversity | MZ>AS |
| Fish diversity | UK>HP>JH>UP |
| Conservation of faunal diversity | RJ>WB>KR>GJ>UP>MH>MP>BR>PB>TN>TS>AP>HR>KL>AS>OD>JH>CG>MN |
| Increasing diversity of pollinators | AP>TS>GJ>MN>MH>CG>MP>OD>MZ>KR>AP |
| Reducing GHG emission | JH |
| Increasing area under legume crops | KL>PB>HR>HP>MZ>MG>WB>AS>AR>UK>BR>UP>MN>JH |
| Increasing area under natural/organic farming | WB>HR>TS>PB>UP>BR>CG>TN>AP>KR>GS>GJ>MH>JH>AS>KL>OD>HP>MN |
| **Socio-economic** | |
| Enhancing land productivity | CG>MN>KR>RJ>MH>MP>OD>MG>MZ |
| Increasing labour productivity | All except PB, KL, HR, GJ |
| Improving fertilizers productivity | TS>BR>PB>HR>UP>KR>AP>UK>MH>CG>TN>WB>MP |
| Increasing livestock productivity | MG>AS>JH>CG>AR>MN>OD>KR>HP>MZ |
| Increasing fish productivity | All except PB, HR, AP, WB |
| Food calories self-sufficiency | KL>MZ>MG>MH>TN>JH>AS>BR>GJ>MN>OD>KR |
| Protein self-sufficiency | All except GJ, HR, MH, PB, RJ, UP, UK, MP |
| Green fodder self-sufficiency | All except GJ, HR, MH, PB, RJ, UP, UK, MP |
| Improving land-man ratio | WB>BR>KL>UP>AS>TN>HP>JH>HR>PB>UK |
| Enhancing investment in agriculture | RJ>BR>GJ>MP>AS>WB>MN>HR>UP>AP>MH |
| Land consolidation | HP>RJ>WB>AS>MP>CG>UK |
| Improving terms of trade (agriculture to non-agriculture) | MG>RJ>KL>GJ>HP>PB>UK |
| Rationalizing agricultural input subsidies | TN>TS>KR>PB |
| Investment in agricultural research and development | All except WB< MN |
| Increasing and strengthening farmers' producer organizations | UP>BR>KL>CG>MS>RJ>AP>TN>MP>WB>KR>GJ>AS>TS>OD>JH>MG |
| Self-help groups | MN>UP>HP>PB>AR>RJ>HR>UK>MH>KR>MP>TN>KL>GJ |
| Co-operatives | JH>MZ>AR>UP>MG>MN>MP>BR>TS>RJ>CG |

*Note: AP – Andhra Pradesh; AR – Arunachal Pradesh; AS – Assam; BR–Bihar; CG – Chhattisgarh; GJ – Gujarat; HR – Haryana; HP – Himachal Pradesh; JH – Jharkhand; KR – Karnataka; KL – Kerala; MP – Madhya Pradesh; MH – Maharashtra; MN – Manipur; MG – Meghalaya; MZ – Mizoram; OD – Odisha; PB – Punjab; RJ – Rajasthan; TN – Tamil Nadu; TS – Telangana; UP – Uttar Pradesh; UK – Uttarakhand; WB – West Bengal.*

*Source: Authors' computations*

companies, self-help groups, and co-operatives). However, there are variations across states even for better-rated indicators. Although the area under fodder crops is substantial at the national level, it is concentrated in Rajasthan, Haryana, Punjab, and Gujarat. Tamil Nadu, Telangana, Karnataka, and Punjab can improve agricultural sustainability by rationalizing and repurposing input subsidies, while Himachal, Rajasthan, West Bengal, Assam, Madhya Pradesh, Chhattisgarh, and Uttarakhand can improve it by focusing on land consolidation. The terms of trade are not in favour of agriculture in the states of Meghalaya, Rajasthan, Kerala, Gujarat, Himachal Pradesh, Punjab, and Uttarakhand. Better infrastructure for storage, transport, and marketing can help farmers to access wider markets, reduce post-harvest losses, and negotiate better prices.

## 8.4 Implications

Agriculture in India is identified as moderately sustainable. The sustainability of water resources and socio-economic dimensions is the main concern. The states show varied patterns of agricultural sustainability, with a distinct set of priorities for its improvement. For example, low soil organic carbon, low water productivity, underinvestment in agriculture, large wastelands, low input productivity, and weak bargaining power are common concerns across states. High input subsidies are linked to unfavorable soil pH, overuse of fertilizers, low soil organic carbon, groundwater overexploitation, and poor natural and organic farming practices. A change in agricultural policies is necessary, from high input subsidies to a system that rewards multiple ecosystem services. Practices like laser-aided land levelling, reduced/zero tillage, direct/drill seeding, precise water management, and crop diversification can provide economic and environmental benefits, but their adoption is limited.

One size does not fit all. Hence, region or state-specific policies and holistic approaches are needed to improve the overall sustainability of agriculture. For example, eastern and north-eastern states have relatively better water sustainability but underdeveloped groundwater resources and problematic soils impact socio-economic sustainability. Strategies for resource-efficient conservation are needed to enhance agricultural sustainability in these regions. Policies should focus on cropping systems and enterprise diversification, harnessing irrigation potential, improving mechanization, and sustainable land management practices. Incentives need to be given for preserving climate-resilient indigenous breeds of livestock. Livestock insurance has not picked up at the desirable speed because of high premiums and a lack of awareness among the farmers. There is a need to revamp existing livestock insurance schemes and make them user-friendly. Comprehensive rural development is also important for the revival of the agriculture sector.

Arid and semi-arid regions show resilience through crop and enterprise diversification. Most of these states score high on indicators like livestock productivity and crop diversification. Agricultural support services and reviving traditional common property resources are crucial for sustaining the diversified production systems and farmers' livelihoods in arid and semi-arid regions. Promoting an agroforestry-based production system may strengthen crop-livestock linkages in these states.

## References


Binder, CR, G Feola and JK Steinberger. 2009. Considering the normative, systemic and procedural dimensions in indicator-based sustainability assessments in agriculture. *Environmental Impact Assessment Review* 30(2):71-81.

Devuyst, D. 2001. How green is the city? Sustainability assessment and the management of urban environments. Columbia University Press, New York.

GoI. 2017. Report of the committee on doubling farmers' income volume I "March of

Agriculture since Independence and Growth Trends". Department of Agriculture, Cooperation and Farmers' Welfare, Ministry of Agriculture & Farmers' Welfare, Government of India, New Delhi.

Magrini, A and FA Giambona. 2022. Composite indicator to assess sustainability of agriculture in European Union countries. *Social Indicator Research* 163:1003–1036.

OECD. 2003. Composite indicators of country performance: a critical assessment, DST/IND(2003)5, Organisation for Economic Co-operation and Development, Paris, France.

Pal, S, P Chand, C Roul and T Mohapatra. 2022. Assessment of agricultural sustainability in the Indo-Gangetic Plains of India: An application of the indicator framework. *Agricultural Research* https://doi.org/10.1007/s40003-022-00621-y

Sharma, BD, GS Sidhu, D Sarkar and SS Kukal. 2012. Soil organic carbon, phosphorous, and potassium status in rice-wheat soils of different agro-climatic zones in Indo-Gangetic plains of India. *Communications in Soil Science Plant Analysis* 43(10):1449-67.

Shukla, AK, SK Behera, NK Lenka, PK Tiwari, C Prakash, RS Malik, NK Sinha, VK Singh, AK Patra and SK Chaudhary. 2016. Spatial variability of soil micronutrients in the intensively cultivated Trans-Gangetic Plains of India. *Soil and Tillage Research* 163:282-289.

Simpson, E. 1949. Measurement of diversity. *Nature* 163:688.

Subash, SP, P Chand, S Pavithra and S Pal. 2017. Pesticide use in Indian agriculture: trends, market structure, and policy issues. Policy Brief 43, ICAR-National Institute of Agricultural Economics and Policy Research, New Delhi.

Yıldız, S and CB Karakuş. 2020. Estimation of irrigation water quality index with development of an optimum model: a case study. *Environment, Development and Sustainability* 22:4771–4786.

♦♦♦

9

# IMPROVING EFFECTIVENESS OF FARMER PRODUCER ORGANIZATIONS

*Vinayak R Nikam*

Farmer Producer Organizations (FPOs) are claimed to be one of the effective institutional mechanisms to foster agricultural growth and rural development in developing countries which are dominated by smallholders. FPOs enhance farmers' access to improved technologies, quality inputs, information, credit, and markets in a cost-effective manner and improve their bargaining power in the marketplace. In India, small landholdings of less than or equal to two hectares comprise over 86% of the total holdings (GoI, 2019), and the operators of such tiny pieces of land, in the absence of alternative income opportunities, often lag in development. Therefore, their collectivization through Farmer Producer Organizations (FPOs) is an option to improve their economic status.

FPO is a type of producer organization where its members are primarily the farmers (NABARD, 2015). In India, FPOs can be registered either under the Cooperative Society Act, the Indian Companies Act, the Indian Trust Act, or the Society Registration Act. Several government and non-government organizations, including the Small Farmers Agribusiness Consortium (SFAC) of the Ministry of Agriculture and Farmers Welfare, National Bank for Agriculture and Rural Development (NABARD), National Cooperative Development Corporation (NCDC), and Krishi Vgyan Kendras (KVKs) facilitate and support FPOs as an agribusiness entity. Recognizing the power of collectives in agricultural transformation, the Government of India has launched the Central Sector Scheme of "Formation and Promotion of 10,000 Farmer Producer Organizations(FPOs)" by 2027-28. There are several ways through which FPOs can improve farmers' income and foster agricultural growth and rural development.

- FPOs improve scale economies and bargaining power of their members
- Member-farmers have better access to domestic and international markets.
- FPOs facilitate enhanced access to credit from financial institutions
- FPOs help reduce production and transaction costs
- Farmers have an augmented flow of information, technologies and services
- FPOs help improve value chain efficiency
- FPOs enable farmers to benefit from collective market infrastructure

## 9.1 FPOs: Evolution and Status

Cooperatives, a form of FPO, have existed in India since the beginning of the twentieth century. Examples of these include dairy and sugar cooperatives, which succeeded in some regions, but not everywhere. To overcome the limitations of the cooperatives, the Government of India constituted Prof. Y.K. Alagh Committee in 2000, which suggested the formation of FPOs as new-generation cooperatives or a hybrid between cooperatives and corporates. In 2003, the Government of India introduced the concept of Farmer Producer Companies (FPCs) by amending the Companies Act 1956, and a national policy for the promotion of FPOs was formulated in 2013.

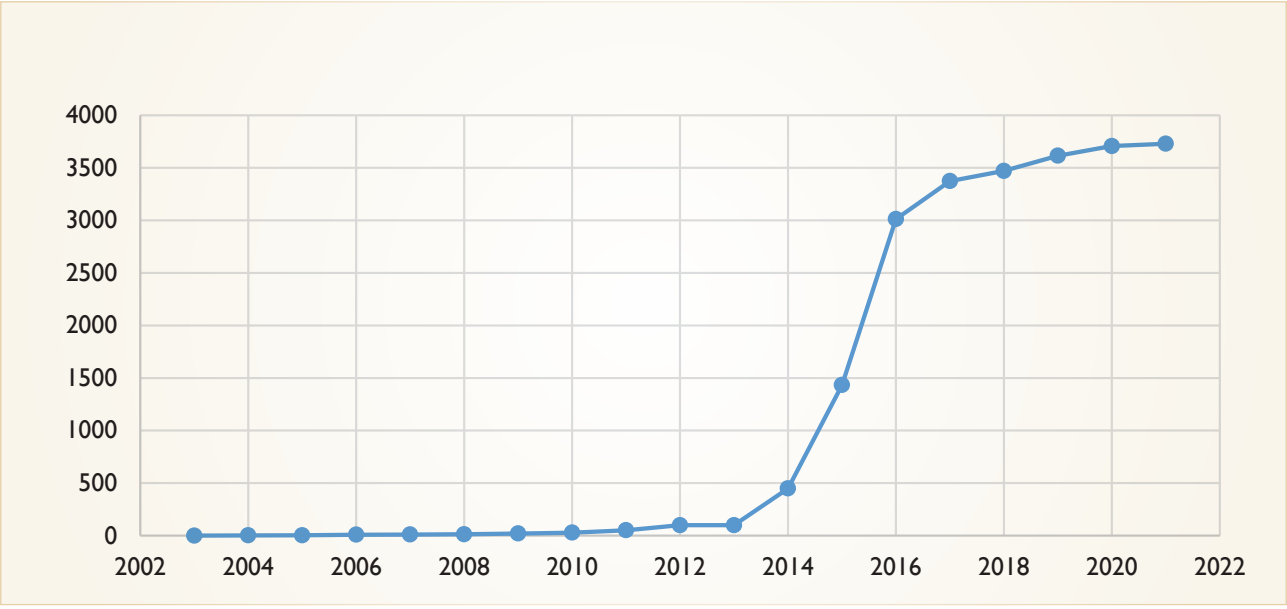
In a press release by the Government of India in March 2022, it was suggested there are 7059 FPOs in the country. Most of these (3904) have been promoted by NABARD, and SFAC (898). However, there are reports of more FPOs. Neti *et*

*al.* (2022) reported 15948 Producers Companies in 2021, and the National Association of Farmer Producer Organizations (NAFPO) puts their number at 9153.

The SFAC mobilized 8.46 lakh farmers to be engaged in 853 FPOs, an average 992 members per FPO (SFAC annual report, 2019-20). About 13.8 lakh farmers were mobilized by NABARD in 3721 FPOs, an average of 371 farmers per FPO (NABARD annual report 2020-21).

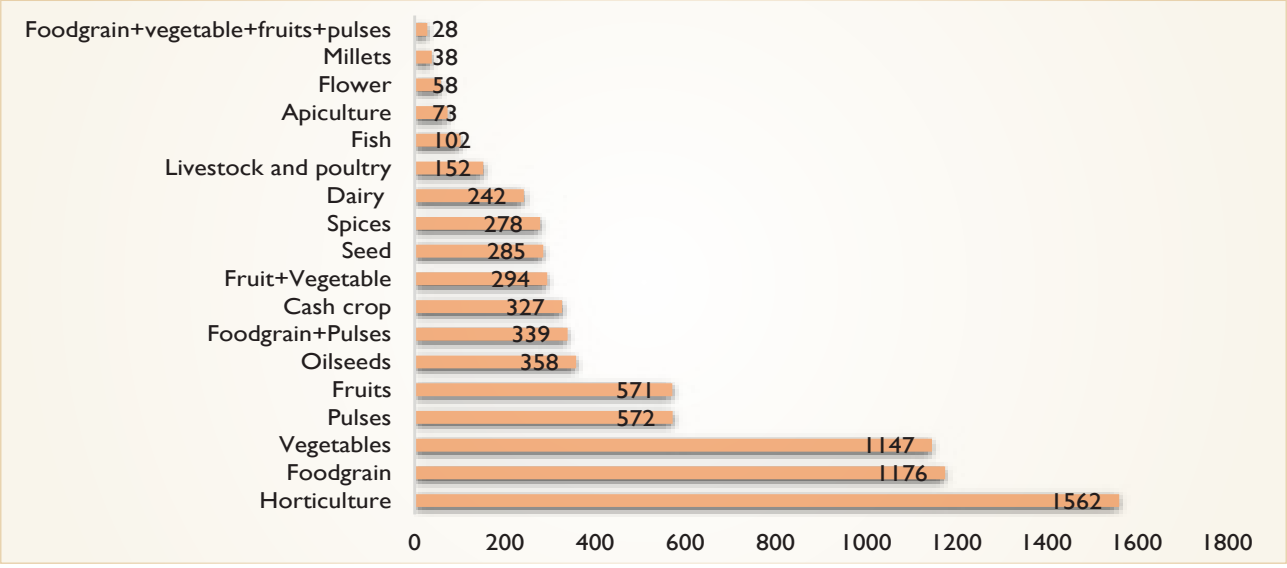
Horticulture and foodgrain crops are the primary focus of the FPOs, with some also engaged in apiculture, seed production, spices and millets. While most FPOs have a single commodity focus, some are involved in multiple commodities. Additionally, marketing is the dominant activity of most FPOs, followed by the provision of inputs and services. Many of them undertake several activities simultaneously.

**Figure 9.1. The trend in the number of FPOs promoted by the Government agencies**




*Source: https://nabfpo.in/images/staticFPO.html and http://sfacindia.com/List-of-FPO-Statewise.aspx , n=3729*

**Figure 9.2. Major crops/business activities of the FPOs (numbers)**




*Source: https://nabfpo.in/images/staticFPO.html and http://sfacindia.com/List-of-FPO-Statewise.aspx , n=1967*

## 9.2 Government Incentives

The Government of India has set a target of forming 10,000 FPOs by 2027-28, following the produce cluster area approach. NABARD, SFAC, NCDC, and NAFED will be among the implementing agencies. FPOs will receive financial assistance of up to ₹18 lakh for three years, a matching equity grant of up to ₹2,000 per farmer-member, limited to ₹15 lakh, and a credit guarantee facility of up to ₹2 crores from eligible lending institutions. At the district level, a District Level Monitoring Committee (D-MC) is proposed to be chaired by the District Collector/ CEO/ Zilla Parishad. At the national level, a National Project Management Agency (NPMA) is proposed to provide guidance, coordination, compile information relating to FPOs, maintain MIS, and monitor. Additionally, there are other central government schemes promoting the formation of FPOs and their activities.

## 9.3 Problems and Challenges

FPOs face several challenges in the process of their establishment and implementation of the proposed activities. Some of the important challenges include:

### *Inadequate infrastructure*

Lack of marketing infrastructure such as pre-cooling, cooling, and cold storage facilities at the FPO level is a major challenge. The availability of such infrastructure helps in reducing post-harvest losses and increasing exports. Most of the FPOs also lack processing facilities and are involved in marketing activities only. The lack of transport facilities is another constraint faced by FPOs. This was very prominently felt during the Covid-19 pandemic (Nikam and Kale, 2020). Most of the FPOs lack an office building, essential for efficient management.

### *Marketing*

Lack of assistance in post-harvest activities and marketing is also reported by many FPOs. Poor or absence of market linkages is a major constraint. During peak season, there is pressure on the available infrastructure. Lack of market information and intelligence is also felt. Proper market assessment in terms of consumer preferences and demand is rarely taken into account by FPOs while selecting products. Some FPOs start operations in niche areas with innovative products like Neera drink, but because of a lack of market demand and competition from the big players they are forced to stop production.

### *Group dynamics*

India is a diverse country, in terms of castes, religions, and political affiliations. Bringing people from different backgrounds together is a big challenge. Poor participation of members in FPO activities is also a constraint. The dominance of some members/castes/groups affects the functioning and participation of all members. Lack of team spirit and conflict resolution mechanisms/skills are also important constraints.

### *Inadequate access to finance*

Constrained by certain terms and conditions, for example, a minimum number of members in FPO, small-sized FPOs are not able to access finance for investment in processing and value addition. In cases of losses in previous years, FPOs face difficulty in obtaining credit. Inadequate working capital affects their business performance.

### *Problems during incubation phase*

Complex registration procedures, high fees/ charges, insufficient training, lack of support, and handholding in the initial stages are also reported by FPOs. In the initial stages of business

Figure 9.3. Major challenges faced by FPOs


planning and development, FPOs require information and handholding in technical and procedural aspects, which is lacking or not accessible to them. Disengagement of promoting agencies after formation and initial activities makes them difficult to sustain business in absence of guidance and marketing information and linkages.

### *Technical services and capacity building*

Inadequate availability of inputs and their poor quality are some technical problems faced by the FPOs. Lack of advisory services is a limitation. Further, there is a lack of capacity-building programs for office-bearers and members of FPOs. Farmers lack awareness and technical skills for cleaner production. There is also a lack of technical and legal knowledge to comply with various provisions/regulations of the government.

### *Management and organizational constraints*

There is a lack of experienced and qualified CEOs, and directors to manage FPOs professionally and efficiently. Lack of communication between office-bearers and farmers, linkages with other organizations, and transparency are major organizational and management-related constraints.

Owing to these and other circumstantial challenges, the viability of the FPOs are not similar. About 30% of these are operating viably while 20% are struggling to survive and the remaining 50% are still in the phase of mobilization, equity collection, and business planning, among others (Business Standard, 2020). Similar findings have been reported in a survey conducted by the Maharashtra Agriculture Department—only 16% FPCs were active and the rest existed only on paper (Indian Express, 2022).

## 9.4 Improving Effectiveness of FPOs

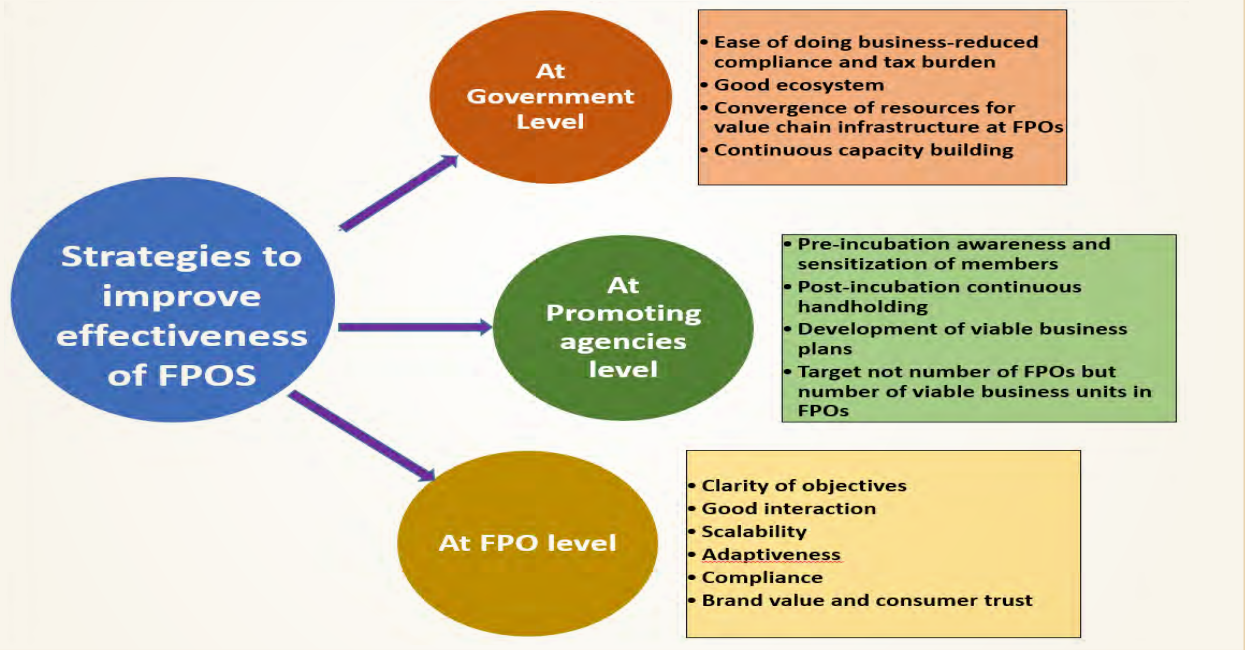
The effectiveness of FPOs can be studied by analyzing their efficiency, equity, and environmental, financial, and social aspects. To achieve these, lowering transaction costs through clarity of objectives, good interactions, adaptability, appropriate scale, and compliance is necessary (Pagan, 2003). Some measures along

these lines are suggested below to improve the performance of FPOs.

- ***Clarity of objectives*:** At the time of establishment, FPOs should have clear objectives and all the members should be aware of these. This will ensure business and financial planning. When there is clarity of objectives among board of directors, members, and promoting institutions, there are fewer chances of conflicts and of a viable business.
- ***Good interaction*:** Efforts are needed to increase interaction among members, between members and the board of directors, and among members and staff. Good interaction should reflect in fruitful discussions in FPOs meetings, members' participation in meetings, and decision-making. This will ensure the merging of formal and informal rules, promote cooperation, and reduction in transaction costs. Pre-establishment support and activities are needed for the awareness and sensitization of members on various aspects of FPOs to ensure group cohesiveness. Alignment of shareholders and promoting the institute's interest are needed for proper business establishment and sustenance of FPOs.
- ***Scalability*:** Optimum range of membership, landholdings, commodities, and turnover is required to reduce transaction costs to FPOs. This can also be related to a number of operations and activities of FPOs. Most FPOs are engaged in marketing. They also need to focus on the provision of quality inputs. This can be an effective means of attracting members and building their trust. However, FPOs need to gradually increase their scale by increasing their capacities of procurement, storage, processing, transport, and marketing, as to cope with price and market risks.
- ***Adaptability*:** Considering uncertainties due to climate change, pandemics, and markets, FPOs need to have flexibility in their scale of operation. This will help to reduce transaction costs. Continuous capacity building of FPOs, board of directors, and members are needed to ensure high adaptability and better compliance to quality standards imposed in domestic and international markets. Based on the capacity need of FPOs their members may be linked to KVKs/SAUs/ ATMAs/ICAR institutes or private training centers in the district for continuous capacity building. Digitization of the database is needed to improve its adaptability. This will help manage demand, supply, storage, and processing in an efficient way, besides improving the traceability of the product to gain the trust of the consumers. A well-established infrastructure, including pre-cooling, cooling, cold storage, and transport facilities, will enable better adaptability of FPOs, and improve value addition.
- ***Compliance*:** Greater compliance of FPOs with agreements of Promoting Institution (PI) and Federation, and provisions of the Company Act; compliance of members with rules of FPOs and standards of production will ensure less transaction cost. At the same time, the government also needs to be ensured that the cost of compliance is not too high for FPOs. FPOs have to bear the cost of compliance and also non-compliance activities. They have to comply with GST every month, failing which attracts penalties. There is some annual compliance also in terms of filling out various forms. Therefore, there is a need to reduce the number of forms, compliance, and late penalties.
- ***Tax streamlining*:** Although FPCs are exempted from income tax for up to a turnover of ₹100 crore, these have to pay the Minimum Alternative Tax. Some state governments levy their own taxes, increasing the multiplicity of taxes. This process needs to be streamlined by restructuring the taxes for FPOs.

- ***Post-incubation support*:** Promoting Institutions should continue with their roles ever after the establishment and incubation of FPOs. Continuous handholding for arranging working capital, building capacities, and improving market access is needed.
- ***Convergence of resources for basic infrastructure*:** Basic market infrastructure like pre-cooling and cooling units, storage, processing, and transport needs to be created. During the COVID-19 pandemic, it was observed that FPOs with such facilities could cope with the adverse effects of the pandemic. This can be achieved through funding from the schemes like Agricultural Infrastructure Fund.
- ***Business acumen and business plans*:** A viable business plan is necessary for the success of a FPO. Business acumen needs to be developed in FPOs. For this purpose, at the district level, mechanisms need to be evolved.
- ***Brand value and consumer trust*:** FPOs need to focus on creating brand value and earning the trust of consumers. This requires following of the Good Agricultural Practices, and food standards of India as well as importing countries.
- ***Consumer research*:** FPOs need to identify the domestic market demand, and manufacture products as per the requirements of different domestic segments. Market strategies of FPOs should be based on the assessment of consumer demand, preferences, perception, changes in lifestyle, urbanization, etc. For export, FPOs need constant innovations in production, processing, and marketing to comply with international standards.
- ***Success cannot always be judged through the prism of profit*:** The purpose of an FPO is different from that of a corporate entity. FPOs cannot be judged through the prism of financial measures applied as in the case of corporates. They serve several intangible functions of empowering people and connecting them among themselves, and improving social capital, which is not reflected in financial measures of their performance.
- ***Good ecosystem*:** The government's priority should be to promote a good ecosystem for

**Figure 9.4. Strategies to improve the performance of FPOs**



the growth of FPOs and not of an individual FPO. A good ecosystem will create FPOs spontaneously, and provide better opportunities for their growth. At the same time, in a target-based approach, rather than the establishment of FPO as the target, the establishment of a viable business unit at the FPO should be the target of the promoting institutions.

Hence, there are pre-requites for realizing the objectives and impacts of FPOs. The success of FPOs lies in their scale of operation, access to finance, information and technologies, effective market linkages, good leadership, participatory decision-making, and inclusiveness. Coordinated efforts of all stakeholders are needed to make it happen.

## References


Business Standard. 2020. Centre plans to promote 250 new farmer-producer bodies in FY 2020-21. Authored by Sanjeeb Mukherjee, date 29th Feb, 2020. Available At: https://www.business-standard.com/article/economy-policy/centre-plans-to-promote-250-new-farmer-producer-bodies-in-fy-2020-21-120022801196_1.html

GoI. 2019. *Agriculture Census. 2015-16: All India report on number and area of operational holdings.* Department of Agriculture, Co-operation & Farmers' Welfare, Ministry of Agriculture & Farmers' Welfare, Government of India.

Indian Express. 2022. Only 16% of registered Farmers Producers Companies active in Maharashtra, reveals survey. Authored by Parthasarathi Biswas, Pune, date December 6, 2022. Available at https://indianexpress.com/article/cities/pune/only-16-of-registered-farmers-producers-companies-active-in-state-reveals-survey-8307830/

NABARD. 2015. Farmers Producer Organizations. Frequently asked questions. Farm Sector Policy Department & Farm Sector Development Department. National Bank for Agricultural and Rural Development (NABARD), Mumbai, India. (Available at: https://www.nabard.org/demo/auth/writereaddata/File/FARMER%20PRODUCER%20ORGANISATIONS.pdf)

NABARD. 2021. Annual Report 2020-21. National Bank for Agriculture and Rural Development, Mumbai.

Neti, A and R Govil. 2022. *Farmer producer companies: Report II, inclusion, capitalisation and incubation.* Azim Premji University, Bangalore.

Nikam, V and R Kale. 2020. Unshackling FPOs from Covid-19 lockdown. Agriculture Extension in South Asia (AESA) blog 110, April 2020.

Pagan, P. 2003. Laws, customs, and rules: identifying the characteristics of successful water management institutions, Presentation at a Workshop on Institutional Issues in Water Resources Allocation: Lessons from Australia and Implications for India, July 16-18, Beechworth, Victoria, Australia.


♦♦♦

# 10

# ICAR-NIAP RESEARCH HIGHLIGHTS, 2022-23

*Khem Chand, Arathy Ashok, Vikas Kumar, Subhash Chand, Rajni Jain, and Nalini Ranjan Kumar*

The mandate of ICAR-NIAP is to conduct policy studies on contemporary issues in agricultural development. The studies are undertaken under three core themes: technology and sustainable agriculture; agricultural growth and development; and markets, trade, and institutions. During this period, the Institute tried to address key policy issues, including agricultural growth forecasts, enhancing farmers' income, the impact of the COVID-19 pandemic on Indian agriculture, the impact of agricultural technologies and innovations, sustainability of agricultural production systems, price forecasts, and volatilities. Studies were also undertaken on the economic valuation of ecosystem services from sustainable agricultural production practices in India, repurposing agricultural subsidies, market crop insurance, climate change adaptations, and reforms for remunerative price realization.

## 10.1 Agricultural Growth and Development

### *Growth performance and forecasts*

Between 1991 and 2021, the agricultural Gross Value Added (GVA) more than doubled, from ₹787 thousand crores to ₹1817 thousand crores at 2011-12 prices. Yet the share of agriculture in GDP declined, but the momentum of growth picked up. In the most recent decade, the agricultural sector grew at an annual rate of 3.5%, with impressive growth of 7.64% and 8.99% in livestock and fisherie, respectively. Further, the performance of agriculture was found better in 1983-84, 1988-89, 1996-1997, 2003-04, and 2010-11.

Using quarterly data series of agricultural GDP, growth was predicted from 2020-21 to 2036-37. The sector is expected to grow not more than 4% a year at 8% growth in public investment and 5% growth in private investment.

### *Dynamics of farmers' income*

A comparative assessment of farmers' income across three rounds of the Situation Assessment Survey of Agricultural Households for 2002-03, 2012-13, and 2018-19 was done, and the results reveal that in nominal terms, the average monthly income of agricultural households in 2018-19 was ₹10,218, compared to ₹6426 in 2012-13 and ₹2115 in 2002-03. The share of income from crops declined. Much of the increase in income resulted from an increase in wages and income from animal farming. Between 2002-03 and 2012-13, farmers' real income grew at an annual rate of 2.47%. The real income growth, however, decelerated to 1.5% during 2012-13 and 2018-19. The income from animal farming has grown at an accelerated rate. Providing remunerative prices for agricultural commodities has remained a major concern for increasing income. Marketing reforms and price support are needed to enhance farmers' income. Furthermore, linking agro-processing with production via efficient value chains and contract farming is necessary to enhance farmers' income. Promoting innovative technologies for increasing productivity and reducing costs should be prioritized. Finally, fostering a rural non-farm economy will have a multiplier income effect on farmers' income by creating opportunities in auxiliary enterprises.

### *Trade for enhancing farmers' income*

A modeling exercise was done to ascertain the potential impacts of an increase in agricultural exports on farmers' income. From 2015 to 2020, agricultural exports increased by 3.2% a year and it is predicted that this growth would continue through 2024–25. The results show that if agricultural exports continued to rise at their current rate, farmers will gain to the extent of ₹1.6 thousand crores. At 4% export growth, the gains will be about ₹2 thousand crores.

An analysis of the export potential of different commodities shows rising demand for Indian Basmati rice, non-Basmati rice, spices, and sugar in the international market. Exports of commodities like onions, pepper, rice, fennel, coriander, cumin, and tea will contribute to agricultural growth. Cucumbers/gherkins, onions, preserved vegetables, fresh grapes, shelled cashew nuts, guavas, mangoes, and spices emerged as the most important export commodities. India has a strong seasonal advantage in dried onions, cucumber/gherkins, shelled cashew nuts, dried capsicum, coriander, cumin, and turmeric. The potential of horticultural exports can be tapped by addressing trade barriers affecting the exports, particularly sanitary and phytosanitary issues. Proper policies must be enacted to facilitate investment in advanced agricultural technologies and logistics to ensure the desired quality and cost-effectiveness.

### *COVID led changes in the agri-food sector*

During the COVID-19 lockdown period agricultural sector grew at a rate of 3.1% (first and second quartile of 2020-21) as compared to a negative growth of -16.1% in the non-agricultural sector. Gross Value Added (GVA) from agriculture increased with 8.8% growth in the post-lockdown period (2020-21 Q3:Q4 to 2022-23 Q1). Macro-level evidence shows no increase in the unemployment rate (based on usual status) during 2020-21 over the pre-COVID period. The unemployment rate (based on current weekly status) in urban areas increased from 9.1% during Jan-March, 2020 to 20.9% during April-June, 2020 whereas in rural areas it declined. It unravels the fact that the rural areas of the agricultural sector supported employment during the pandemic period.

Agri-food supply chains were affected by the lockdown, negatively impacting the market arrival of several agricultural commodities. However, no major change was observed in the wholesale prices of most agricultural commodities. Retail prices of rice declined, while that of masoor dal, mustard oil, and potato increased marginally. The export of agricultural commodities picked up during the lockdown.

On the consumption front, private final consumption expenditure (at constant prices) declined by 16% during the lockdown, which is expected to reduce both food and non-food expenditure. However, actual expenditure on food did not decline because of the reallocation of expenditure from non-food to food commodities. Overall, the effect of COVID-19 was short-lived and the Indian economy is, now, fully recovered from the pandemic effects.

## 10.2 Technology and Sustainable Agriculture

Technologies play a crucial role in improving productivity and growth in Indian agriculture. Achieving sustainability in terms of profitability, environmental health, and equity is essential for accomplishing Sustainable Development Goals (SDGs). Institute's research activities during the period include R&D investment and innovation outcomes, impacts of agricultural technologies, institutions for water management, economic evaluation of ecosystem services, the impact of Minimum Support Prices (MSP), performance and impacts of Farmer Producer Organizations (FPOs) and use of Artificial Intelligence (AI) and machine learning for supply forecast.

### *R & D investment and innovation outcomes*

Analysis of agricultural R&D outputs in terms of patent grants and plant varieties notified/

registered in PPV&FRA reveal that from 2005 to 2021, 1675 patents were granted in agriculture, 438 in food, and 335 to ICAR Institutes. The value of public vis-à-vis private, and Indian vis-à-vis foreign patents were compared in terms of grant lag, renewal term, claims granted, patent class size, and patent family size. Private patents appear to be more valuable than public patents, and foreign patents than Indian patents in all the parameters. ICAR filed a maximum number of patents in agrochemicals (21%) followed by biotechnology (20%) and engineering (19%). A dominant share of the private sector is also seen in plant varieties registered under PPV&FRA, except for a few crops like wheat, chickpea, and sugarcane.

### *Farm mechanization and its impacts*

The farm mechanization index for paddy was constructed for the Indo-Gangetic Plain (IGP) of India. The mechanization index was the highest for Punjab (0.28), followed by Haryana (0.22), Bihar (0.20), Uttar Pradesh (0.20), and West Bengal (0.14). However, considering the scale of farming, the mechanization level is higher for larger farms in general but varies across states in the IGP (Figure 10.1).

Based on mechanization indices (MI), farms were categorised into: low (MI ≤ 0.2**)**; medium (0.2 < MI ≤ 0.4) and high (MI>0.4) mechanization levels. The use of human and animal labour is negatively associated with mechanization. Mechanization has been found to reduce the cost of production and increase crop yield. Gross income was higher in the case of highly mechanized farms. A significant and positive relationship between mechanization and farm efficiencies has been established.

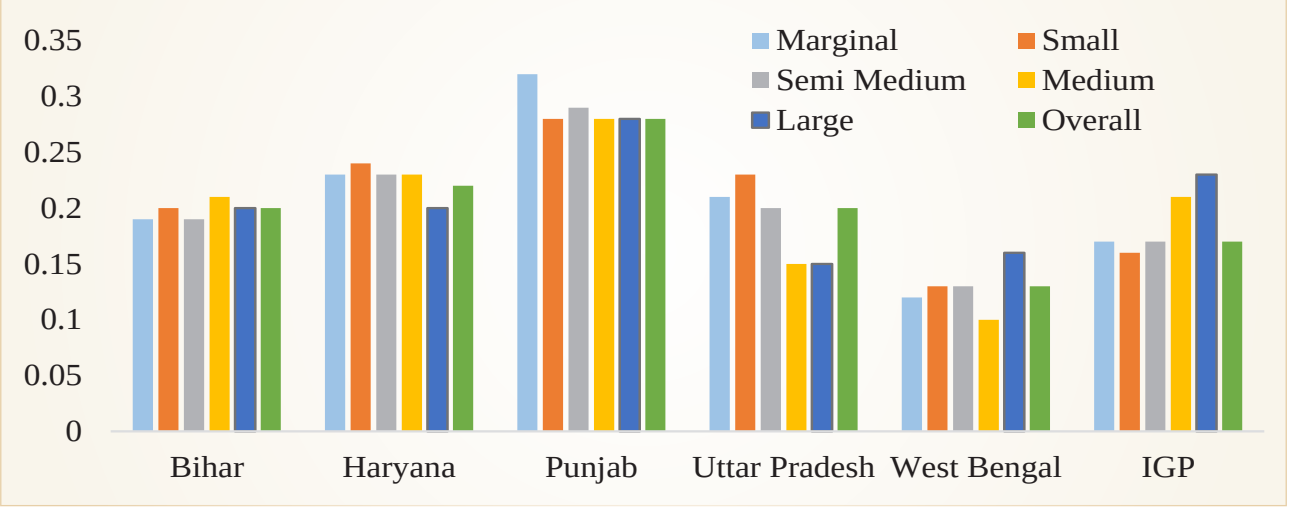
### *Impact assessment of technologies under farmer FIRST project*

The impact of different interventions such as breed improvement in local goat breeds using Sirohi buck, and the upgradation of the non-descriptive sheep population with pure breed of Marwari sheep in Rajasthan were undertaken as a part of Farmer FIRST project. Breed improvement in local goat showed a weight gain of 27.3% in bucks (one year old), fetching an additional net return of ₹1350/ buck/year. Similarly, the breed improvement in the case of non-descriptive sheep breeds of Rajasthan also showed weight gain in ram after the intervention, enabling farmers to earn 40 percent more. The impact of another intervention 'MEMNAPRASH', a reconstituted milk powder for lamb indicated a 3-4 kg weight gain, fetching a net profit of ₹ 316/lamb.

### *Improving groundwater sustainability*

Increasing groundwater depletion and water use in agriculture is a matter of concern. The

**Figure 10.1. Mechanization index for paddy by farm size in states in IGP**



analysis of the data on observation wells by the Central Groundwater Board (CGWB) reveals considerable spatial heterogeneity in groundwater levels in the country. More than 50% of the observation wells in Rajasthan, Punjab, Haryana, and Gujarat have a water level of more than 10-meter depth during the pre-monsoon season in 2019, whereas in Odisha, Bihar, Chhattisgarh, Jharkhand, West Bengal, and Andhra Pradesh, only less than 25% wells have a water level of more than 10-meter depth. From 2008 to 2019, 23% of wells witnessed a declining trend in water level and 11% of wells had the opposite trend. Studies on groundwater energy nexus using district-level data show a positive association between electricity supply and groundwater use, though energy is not the only factor behind the level of groundwater use. The well density, composition, aquifer type, dependency on groundwater, cropping pattern, price policy, etc. are other important factors influencing the extent of groundwater use for agriculture. In 2019-20, state governments paid ₹80,777 crore subsidy to power utilities for supplying subsidized electricity for groundwater irrigation. There exists a wide inter-state variation in power subsidy, varying from ₹16,893 per hectare of net sown area in Punjab to a mere ₹233 per ha of net sown area in West Bengal. The power subsidy has a positive association with groundwater depletion, and thus rationalizing subsidy is essential for sustainable groundwater use. A regional approach along with an optimum mix of technological and policy measures are required for the sustainable use of groundwater in agriculture.

### *Institutions and technology for agricultural water management*

Given a limit to the large-scale augmentation of water supply, rising water scarcity can be addressed through the management of water in agriculture. This requires wide-ranging changes in water institutions, i.e., water-related legal, policy, and organizational arrangements that govern the water resources, their allocation, and management. Institutions consist of institutional structure (interactive effect of the policy, laws, and administrative aspects) and institutional environment (overall historic, socio-economic, cultural, and political setting of a country or region). The structural framework of the existing water management institutions at the national and sub-national levels has been constructed and the roles of the various institutions have been analyzed. Further, a Water Institution Index (WII) consisting of 12 indicators of institutional structure has been constructed for the ranking of states. There is a large inter-state variation in water management institutions, which affects the outcome of the water management efforts being extended at the sub-national level.

### *Institutions and people's participation in watershed management*

The study of the Institutional arrangement of watershed management programs indicated that the focus and approach of the watershed have been evolving over generations of watersheds. The approach of the management has been shifted from top-down to bottom-up from less participatory to more participatory and from unconnected to an integrated approach. The focus has been shifted towards water conservation to the sustainable development of the watersheds. The review of the studies on participation showed that watersheds generated more benefits where people's participation was higher. However, there is a need to establish effective linkages of watershed institutions with other institutions, particularly with the resource agencies (credit institutions and markets).

### *Economic valuation of ecosystem service*

Agriculture provides a huge opportunity to enhance ecosystem services (ES) through sustainable agricultural management practices. However, its contribution to ecosystem services is undervalued or not estimated. Therefore, the economic valuation of key ecosystem services, viz., yield, carbon

sequestration, soil fertility, water saving, and biological nitrogen fixation (BNF) of Direct Seeded Rice (DSR) and legumes, was carried out using direct and indirect valuation methods in a meta-analysis framework. The results indicate a mixed response of ecosystem services under direct seeded rice. The farm-level impacts indicate a reduction in yield (-10.80%) under DSR compared to transplanted rice. However, significant environmental benefits such as less water consumption (-334mm/ha), higher carbon sequestration (1.20/ton/ha/year), lower GHG emission(-170kg/ha/year), and improvement in additional nutrient availability (80kg of NPK/ha/year) were observed. The total economic value of ecosystem services under DSR was estimated at ₹1,80,291/ha/year, which is very high compared to any other crops. The economic value of non-marketed services from DSR, viz., climate regulation, water regulation, soil fertility, and nitrogen fixation are estimated as ₹ 82,575/ha/year, which is 47% of the total value of ES. Therefore, the social benefits of DSR are significantly higher compared to the transplanted paddy. Hence, payments for incentivizing ES of direct seeded rice should consider the value of services provided by the ecosystem.

### *Carbon sequestration potential of agroforestry*

A meta-analysis was done to assess the carbon sequestration potential of agroforestry. Findings are based on 423 observations collected from 46 studies (28 agri-silvi-culture, 8 agri-horti-culture, 4 agri-horti-silvi-culture, and 11 silvi-pasture). These indicated that agri-horti-culture is the most effective system in improving soil organic carbon (SOC). The change in the SOC due to the transition from different types of cropping systems (from agriculture, forestry, grasslands, pastures, and uncultivated lands) to agroforestry was also studied. Findings show that shifting from grasslands to agroforestry is most effective in increasing carbon sequestration. On the other hand, converting forestry to agroforestry is not advisable to enhance carbon sequestration. Across major agro-climatic zones, the Indo-Gangetic plains and Southern Plateau and Hill zones have relatively higher potential carbon sequestration from agroforestry.

### Economic valuation, and governance and management of common property resources

Common property resources (CPRs) have been playing a crucial role in sustaining livelihood and maintaining ecosystem health. Hill states occupy 18% of the geographical area, 13% of the reported area, and only 4.6% of the agricultural lands of the country. The arid state of Rajasthan occupies 10.41% of the geographical area, 31% of cultivable wasteland, and 16% of pastures and grazing lands. CPRs are more common for supporting livelihood and sustainable development in these regions (forest, pasture and grazing lands, etc.). A conducted on the economic evaluation of pasture and grazing lands in the Bikaner district of Rajasthan shows returns of ₹ 9904/ha.

### Performance and impact of FPOs

A mixed-method research synthesis approach was used to assess the situation of FPOs in the country, wherein both quantitative and qualitative findings are combined. A significant impact of FPOs was observed on member farmers' crop and livestock yield, income, and technical efficiency. FPOs have more impact on income per unit area than on output, indicating a greater role of FPOs in marketing. In dairy and livestock, a higher impact was observed on the output which is not reflected in the value of output. The results of three different types of liquidity test ratios show that a number of FPOs start with a good current ratio, but it turns out unfavorable within a short period of three years. For 36% of the FPOs, the debt-equity ratio was more than two, suggesting that they were facing significant financial distress and unable to pay their debt. Therefore, more emphasis is needed on strengthening the existing FPOs by providing financial support

and building their business acumen to raise and manage the funds. Education and extension contact (awareness) are important determinants of farmers' participation in FPOs.

### Progress of crop insurance and farmers' willingness to pay

This study examined the performance of the PMFBY scheme and analyzed the crop yield variability in different states of India. Since its inception in 2016-17, the percentage share of benefitted farmers has also increased from 24.73 to 34.27% in 2020-21 The share of non-loanee farmers increased from 23.99% to 35.66%. The registration of marginal and small farmers under the scheme has increased leading to a reduction of area insured per farmer from 0.98 hectares to 0.72 hectares. With the progress of the scheme, the sum insured per farmer has increased from ₹35096.79 to ₹43510.92, while the per-farmer premium has reduced from ₹646.48 to ₹611.20. The farmer-based claim ratio has increased from 4.15 in 2016-17 to 5.84 in 2019-20. The claim received per farmer has also increased from ₹2683.21 to ₹3810.46.

To understand farmers' views about PMFBY, primary data were collected from farmers of UP and Rajasthan for 2020-21. About 24% of non-beneficiaries have not heard of the PMFBY and 89% of them do not know the processes to avail of scheme benefits. A majority of non-beneficiary as well as beneficiary farmers responded that the promotion of the scheme is not sufficient, and suggested that there should be at least two meetings per year for the promotion of the scheme. The majority of benefitted farmers have responded that payment of claims is delayed and given in 3-5 months, and 44% of non-benefitted farmers have asked for claims settlement within two months. The incorporation of farmers' and other stakeholders' views and a decentralized complaint resolution mechanism is necessary for the success of the crop insurance scheme.

### *Artificial intelligence based model for area estimation*

An attempt was made to develop an inexpensive methodological framework to predict crop yields from publicly available satellite imagery using Artificial Intelligence (AI) and Machine Learning (ML) approaches. AI approach will implicitly model the relevance of the different steps in the growing season *via* various bands in the satellite imagery. The framework was experimented with for predicting wheat and mustard area in Hisar district, Haryana. The procedure involved (i) extraction of satellite data for Hisar and calculating the Normalized Difference Vegetation Index (NDVI). NDVI profile difference for the growing season across cultivable land in Hisar, was used to apply AI-based K-means clustering algorithm (Figure 10.2). More than 30 types of clusters were identified. Visualization of these clusters led to the identification of wheat and mustard clusters. The area under wheat (230.33 thousand ha) and mustard (76.91 thousand ha) were predicted using satellite images.

## 10.3 Agricultural Markets and Trade

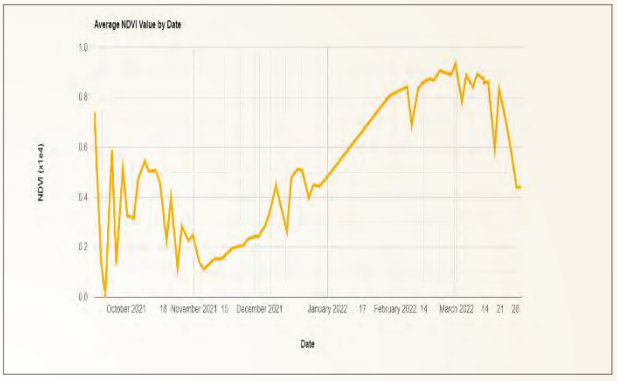
The thrust is on studies related to agriculture price analysis and forecasts, market reforms, commodity outlook, agricultural trade patterns and international agreements. The following policy studies were undertaken under the theme.

### *Ensemble forecast modeling for perishables*

Different models (time series, machine learning, and deep learning) were tested by applying the ensemble framework using daily wholesale prices of Tomato, Onion, and Potato (TOP) for two major markets for each commodity using data from the AGMARKNET portal from January 2010 to December 2021. MCS algorithm has been implemented for six error functions and developed a PCA-based error index. The developed PCA-based error index has demonstrated consistency in selection by providing the fewest and justified number of

**Figure 10.2. NDVI pattern and corresponding area estimates of mustard and wheat using the remote sensing data**


NDVI pattern of Mustard




NDVI pattern of Wheat

Area under mustard in Hisar district: 76.908 th Ha

Area under wheat in Hisar district: 230.329 th ha

models in the superior class, with the majority of them being deep learning models as these have been found to perform better. Following the selection of the superior set of models using the MCS algorithm and the PCA-based error-index, the forecasts of the selected models' ensemble using a weighted linear combination approach. These weights have been optimized using 20 optimization techniques. Based on the combined insight of RMSE and MAPE, the Bi-LSTM model outperforms all other models in every data series. The Ensemble model is found to be superior followed by the deep learning models.

### *Effects of rainfall shocks on potato production and prices*

The effect of rainfall-induced shocks on the production and prices of potato was worked out using panel data on monthly wholesale prices, monthly cumulative rainfall, and annual potato production (rabi) collected from 8 districts from 2010-11 to 2020-21. The study estimated the fixed effects panel regression. The results indicate that positive rainfall shocks during the growing season have a significant negative impact on production while the negative shocks do not. The occurrence of positive shock led to an approximately 18.5% reduction in rabi season production. The visible impact of rainfall-induced production shocks transmitted to prices. Wholesale prices were found to be highly sensitive to positive rainfall shocks, resulting in 20% increase in wholesale prices.

### *Effect of monetary policy on agricultural prices*

The study examines the effect of monetary policy on food prices in India employing the factor augmented vector auto-regression (FAVAR) model. The Wholesale Price Index (WPI) (107 food commodities), Retail Price Index (RPI) (144 food commodities), and macro-economic data

for the period from April 2012 to Sept 2022 were used for the analysis and used 25 basis point positive repo rate shock to examine the response of WPI, WFPI, IIP food, and CPI. The results indicate that WPI, WFPI, and IIP food start declining with a lag of 2 months and the declining response of CPI starts from the next month, and the decline persists. The disaggregated response of commodity prices (WPI as well as RPI) exhibits a heterogeneous response to the 25 basis points positive repo rate shock. The majority of the commodity prices responded with a lag of 1-9 months, with few exceptions, confirming the negative response of commodity prices to the contractionary monetary policy changes.

### *Trend and pattern of agricultural price volatility*

Volatility in prices of agricultural commodities was analysed using data from January 2010 to October 2022 for major markets of cereals, pulses, oilseeds, and major vegetables. The unconditional and conditional volatility of returns series generated as logged differences in prices were compared for periods with the breakpoint. The results indicate an increase in volatility in the case of rice, wheat, mustard, soybean, sunflower, groundnut, potato, onion, and tomato.

### *Welfare gains of minimum support prices*

The price and procurement policy has been at the center stage of policy debates. A study was undertaken to assess the impacts of MSP on farm incomes and crop yields. The procurement of paddy and wheat has shifted to new states (e.g., Odisha and Chhattisgarh in the case of paddy, and Madhya Pradesh in the case of wheat). MSP benefits farmers. Farmers selling paddy to procurement agencies realize 10.3% higher price over the prevailing market price. The difference in the case of wheat was 3.8%. However, it is the large farmers who have a larger marketable surplus, that benefit more.

### *Consumer behavior toward millets consumption*

In view of the *International Year of Millets*, a study was undertaken to analyze consumer behavior towards four millet crops (pearl millet, finger millet, barnyard millet, and amaranths). Findings show that although consumers are aware of the health and environmental benefits of millet, they do not consume these regularly. Healthiness and taste are the major traits that attract consumers towards millet, while their unavailability and complex cooking are the major reasons for not eating millet.

♦♦♦

# 11

# AGRICULTURAL DEVELOPMENT INDICATORS

*Sant Kumar, Ankita Kandpal, S.V. Bangaraju, and Dilip Kumar*

This chapter provides key indicators of agricultural development both at all-India and state levels, reflecting the performance of the agriculture sector on various aspects. These aspects include the global ranking of India in terms of nutritional status, export performance, and output and input indicators. The output indicators include the value of production from agriculture, land productivity, and agricultural growth. The input indicators encompass certified/ quality seeds availability, fertilizer and pesticide use, irrigated area, electricity consumption in agriculture, and extent of crop diversification. The chapter also highlights environmental indicators related to agriculture and crop residue/biomass burning. The food security issues are also reflected through the amount of stock handled (procurement and offtake) through PDS. The service and infrastructure development in the agriculture sector are presented through indicators such as rural road density, market density, R&D intensity, number of Primary Agricultural Credit Societies (PACS), and branches of scheduled commercial banks. The chapter also includes major dimensions hindering the growth of the sector like groundwater depletion, land holding size, and wasteland area.

**Table 11.1. Agricultural development indicators**

| S.N. | Indicator | Value | Reference year |
|---|---|---|---|
| 1. | Global Food Security Index (Rank)<br>1. Affordability<br>2. Availability<br>3. Quality and safety<br>4. Sustainability and adaptation | 68<br>59.3<br>62.3<br>62.1<br>51.2 | 2022 |
| 2. | Global Hunger Index (Rank) | 107 | 2022 |
| 3. | Global Multidimensional Poverty Index (Rank) | 66 | 2019-21 |
| 4. | Prevalence of undernourishment (%) | 16.3 | 2020 |
| 5. | Children affected by wasting (%) | 19.3 | 2020 |
| 6. | Stunted children (%) | 35.3 | 2020 |
| 7. | Child mortality (%) | 3.3 | 2020 |
| 8. | Emissions from agriculture (million tonnes)<br>• $CO_2$<br>• $N_2O$<br>• $CH_4$ | <br>10.86<br>0.81<br>20.11 | 2020 |
| 9. | Biomass burned (million tonnes)<br>• Maize<br>• Rice<br>• Sugarcane<br>• Wheat<br>• All crops | <br>9.86<br>24.75<br>3.11<br>12.54<br>50.26 | 2020 |

| S.N. | Indicator | Value | Reference year |
|---|---|---|---|
| 10. | Work force employed in agriculture (million persons)<br>• Male (%)<br>• Female (%) | 208.9<br>38.1<br>62.9 | 2021-22 |
| 11. | Agricultural exports<br>• Value (billion US $)<br>• Share in total exports (%) | <br>50.27<br>11.92 | 2021 |
| 12. | GVA Agriculture & allied at 2011-12 prices (Rs. lakh crore)<br>Percentage share in AgGVA<br>• Crops<br>• Livestock<br>• Fisheries<br>• Forestry and logging | <br>21.49<br>53.9<br>30.5<br>6.9<br>8.8 | 2021-22 |
| 13. | Agricultural growth (%) | 3.81 | 2011-12 to 2021-22 |
| 14. | Land productivity (GVA/GCA), ₹ lakh /ha | 1.10 | 2021-22 |
| 15. | Foodgrain yield (kg/ha) | 2394.0 | 2020-21 |
| 16. | Certified/quality seed availability (lakh quintal)<br>Share (%)<br>• Public sector<br>• Private sector | 483.66<br><br>35.5<br>64.5 | 2020-21 |
| 17. | Net sown area (Mha) | 139.9 | 2019-20 |
| 18. | Gross cropped area (Mha) | 211.36 | 2019-20 |
| 19. | NPK use (kg/ ha) | 164.89 | 2020-21 |
| 20. | Pesticide use (kg/ha) | 0.294 | 2020-21 |
| 21. | Irrigated area (% of GCA) | 53.09 | 2019-20 |
| 22. | Area under micro-irrigation ('000 ha) | 14,123.32 | 2021-22 |
| 23. | Extent of crop diversification (0 to 1 scale, 1-complete diversification) | 0.884 | 2020-21 |
| 24. | Research & education intensity in agriculture (%) | 0.43 | 2021-22 |
| 25. | Procurement of rice and wheat (million tonnes) | 100.93 | 2021-22 |
| 26. | Total offtake for PDS (million tonnes) | 93.09 | 2021-22 |
| 27. | Share of GCF in agriculture & allied in GCF of India (%) | 7.05 | 2021-22 |
| 28. | Disbursement of Rural Infrastructure Development Fund (₹ crore) | 30,200 | 2020-21 |
| 29. | Agricultural credit (₹ lakh crore)<br>• Short-term loans<br>• Medium-term/ long-term loans | 15.75<br>8.94<br>6.81 | 2020-21 |
| 30. | Scheduled commercial banks density (Branches/'000 sq km) | 47 | 2021 |
| 31. | Rural road density (length in km /km$^2$ of geographical area) | 1.65 | 2018-19 |
| 32. | Market density (number of agricultural markets/000 sq km.) | 2.11 | 2017-18 |
| 33. | Livestock density (number/km$^2$) | 163 | 2019 |
| 34. | Farmer's income (₹/ month/household) | 10,218 | 2018-19 |
| 35. | Primary Agricultural Cooperative Societies (number) | 95,509 | 2019-20 |

| S.N. | Indicator | Value | | Reference year |
|---|---|---|---|---|
| 36. | Consumption (kg/month/person) | Rural | Urban | |
| | • Cereals<br>• Pulses<br>• Edible oil<br>• Fish<br>• Milk (litres)<br>• Eggs (No.) | 11.22<br>0.78<br>0.67<br>0.27<br>4.33<br>1.94 | 9.28<br>0.90<br>0.85<br>0.25<br>5.42<br>3.18 | 2011-12 |
| 37. | Poverty (Number in millions)<br>Headcount ratio | | 228.9<br>25.01 | 2022 |
| 38. | Total wastelands area (% of total geographical area) | | 16.96 | 2015-16 |

*Source*:

*1. Global Food Security Index report, 2022*
*2. Global Hunger Index report, 2022*
*3. Multidimensional Poverty Index report,2022, UNDP & OPHI*
*4 to 10. FAOSTAT*
*11. Directorate General of Commercial Intelligence and Statistics, Ministry of Commerce and Industry, GoI*
*12 to 14. National Account Statistics*
*15 to 23. Directorate of Economics and Statistics, Ministry of Agriculture and Farmer's Welfare, GoI*
*24. Combined Finance and Revenue Accounts*
*25 to 29. Handbook of Statistics on Indian Economy, RBI*
*30. Bank Branch Statistics, RBI*
*31. Basic Road Statistics of India, Ministry of Road Transport and Highways*
*32. http://dmi.gov.in/Documents/agmstat_2017-18.pdf*
*33. Livestock Census*
*34. NSSO data as stated in NSS Report 587.*
*35.National Federation of State Cooperative Banks Ltd. (NAFSCOB)*
*36. NSSO 68th round*
*37. Global Multidimensional Poverty Index Report, 2022, UNDP & OPHI*
*38. NRSC-Wasteland atlas of India*

## Table 11.2. Agricultural development indicators of states, 2021-22

| State/ Union Territory | GSVA (agri & allied activities) ₹ '000 crore | Foodgrains yield (kg/ha) | Share of agriculture in state GVA (%) | Land productivity (₹ lakh /ha) | Agricultural growth (% growth in GSVA) |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| Andhra Pradesh | 206.86 | 2763 | 32.61 | 2.84 | 8.87 |
| Assam | 46.10 | 2145 | 19.66 | 1.16 | 3.96 |
| Bihar | 85.42 | 2419 | 21.09 | 1.17 | 2.99 |
| Chhattisgarh | 43.53 | 1712 | 17.23 | 0.76 | 4.90 |
| Gujarat | 156.17 | 2121 | 13.45 | 1.13 | 4.55 |
| Haryana | 88.20 | 3985 | 17.67 | 1.33 | 4.08 |
| Himachal Pradesh | 15.39 | 2112 | 13.08 | 1.73 | 2.24 |
| Jammu & Kashmir | 16.96 | 1894 | 15.09 | 1.56 | 3.53 |
| Jharkhand | 31.11 | 1733 | 14.65 | 1.77 | 2.21 |
| Karnataka | 129.69 | 1767 | 11.89 | 0.94 | 5.05 |
| Kerala | 44.30 | 3064 | 8.80 | 1.71 | -1.25 |
| Madhya Pradesh | 189.70 | 2188 | 33.10 | 0.67 | 7.00 |
| Maharashtra | 231.01 | 1390 | 12.74 | 0.97 | 3.87 |
| Odisha | 58.98 | 1913 | 15.72 | 1.26 | 3.43 |
| Punjab | 94.18 | 4606 | 24.13 | 1.20 | 2.20 |
| Rajasthan | 198.61 | 1561 | 29.22 | 0.72 | 5.03 |
| Tamil Nadu | 140.31 | 2834 | 11.72 | 2.36 | 5.59 |
| Telangana | 88.51 | 3075 | 15.08 | 1.18 | 5.21 |
| Uttar Pradesh | 260.34 | 2915 | 23.17 | 0.96 | 3.19 |
| Uttarakhand | 15.33 | 2474 | 8.53 | 1.50 | 1.45 |
| West Bengal | 148.97 | 3025 | 19.16 | 1.47 | 2.50 |
| All-India | 2149.12 | 2394 | 15.57 | 1.10 | 3.81 |

***Source:*** *Column 2, 4 and 6. National Account Statistics (http://www.mospi.nic.in/); Column 3: Directorate of Economics and Statistics, Ministry of Agriculture & Farmer's Welfare, Government of India (dacnet.nic.in); Column 5. National Account Statistics (http://www.mospi.nic.in/); Directorate of Economics and Statistics, Ministry of Agriculture & Farmer's Welfare, Government of India (dacnet.nic.in)*

*Note: GSVA estimates are at 2011-12 prices, growth estimates pertain to the period 2011-12 to 2021-22 and foodgrain yield pertains to 2020-21.*

## Table 11.3. Agricultural input use indicators of states

| State | Consumption of NPK (kg/ha) | Consumption of pesticides (kg/ha) | Irrigated area (% of GCA) | Area under micro-irrigation ('000 ha) | Electricity use in agriculture (% of total) | Extent of crop diversification (0 to 1) | Rural road density (per km2) | Agri R&E intensity (% of GSVA) | PACS (Number) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| | 2020-21 | 2020-21 | 2019-20 | 2020-21 | 2019-20 | 2020-21 | 2018-19 | 2021-22 | 2019-20 |
| Andhra Pradesh | 278.02 | 0.214 | 52.3 | 1907.29 | 26.85 | 0.81 | 1.08 | 0.19 | 1992 |
| Assam | 70.34 | 0.106 | 13.7 | 20.42 | 0.52 | 0.52 | 5.09 | 0.49 | 766 |
| Bihar | 261.88 | 0.136 | 74.5 | 120.74 | 4.11 | 0.74 | 3.17 | 0.32 | 8463 |
| Chhattisgarh | 151.98 | 0.286 | 35.3 | 362.59 | 22.30 | 0.52 | 0.78 | 0.31 | 1617 |
| Gujarat | 141.68 | 0.114 | 61.0 | 1630.89 | 13.00 | 0.88 | 1.27 | 0.27 | 8823 |
| Haryana | 221.35 | 0.612 | 94.9 | 640.48 | 23.91 | 0.77 | 1.14 | 0.44 | 769 |
| Himachal Pradesh | 66.40 | 0.063 | 22.9 | 14.34 | 0.62 | 0.72 | 1.31 | 1.19 | 2175 |
| Jammu & Kashmir | 165.58 | 3.075 | 40.8 | 2.06 | 3.46 | 0.77 | 0.54 | 1.36 | 620 |
| Jharkhand | 118.27 | 0.660 | 15.3 | 43.40 | 0.88 | 0.80 | 1.02 | 0.23 | NA |
| Karnataka | 160.69 | 0.140 | 36.4 | 2093.26 | 35.70 | 0.88 | 1.87 | 0.26 | 5481 |
| Kerala | 77.77 | 0.226 | 19.9 | 33.26 | 1.56 | 0.20 | 6.69 | 0.66 | 1643 |
| Madhya Pradesh | 102.33 | 0.024 | 52.0 | 588.93 | 39.26 | 0.85 | 1.18 | 0.03 | 4457 |
| Maharashtra | 143.09 | 0.555 | 20.3 | 1926.30 | 23.31 | 0.89 | 2.07 | 0.37 | 20151 |
| Odisha | 130.88 | 0.248 | 29.2 | 144.82 | 2.80 | 0.55 | 1.96 | 0.26 | 2701 |
| Punjab | 246.65 | 0.665 | 98.6 | 50.47 | 23.56 | 0.61 | 2.93 | 0.27 | 3922 |
| Rajasthan | 64.58 | 0.085 | 42.8 | 2018.49 | 41.43 | 0.89 | 0.92 | 0.09 | 6569 |
| Tamil Nadu | 188.64 | 0.309 | 57.4 | 1153.29 | 14.42 | 0.79 | 2.08 | 0.39 | 4525 |
| Telangana | 243.02 | 0.667 | 61.3 | 278.15 | 35.07 | 0.69 | 1.25 | 0.26 | 799 |
| Uttar Pradesh | 207.64 | 0.426 | 84.8 | 269.17 | 19.17 | 0.77 | 1.84 | 0.06 | 8929 |
| Uttarakhand | 154.34 | 0.132 | 52.6 | 23.04 | 1.59 | 0.76 | 1.28 | 0.84 | 706 |
| West Bengal | 172.04 | 0.359 | 65.7 | 103.33 | 2.77 | 0.63 | 3.20 | 0.09 | 7405 |
| All-India | 153.95 | 0.294 | 53.1 | 13,476.80 | 20.08 | 0.88 | 1.65 | 0.43 | 95,509 |

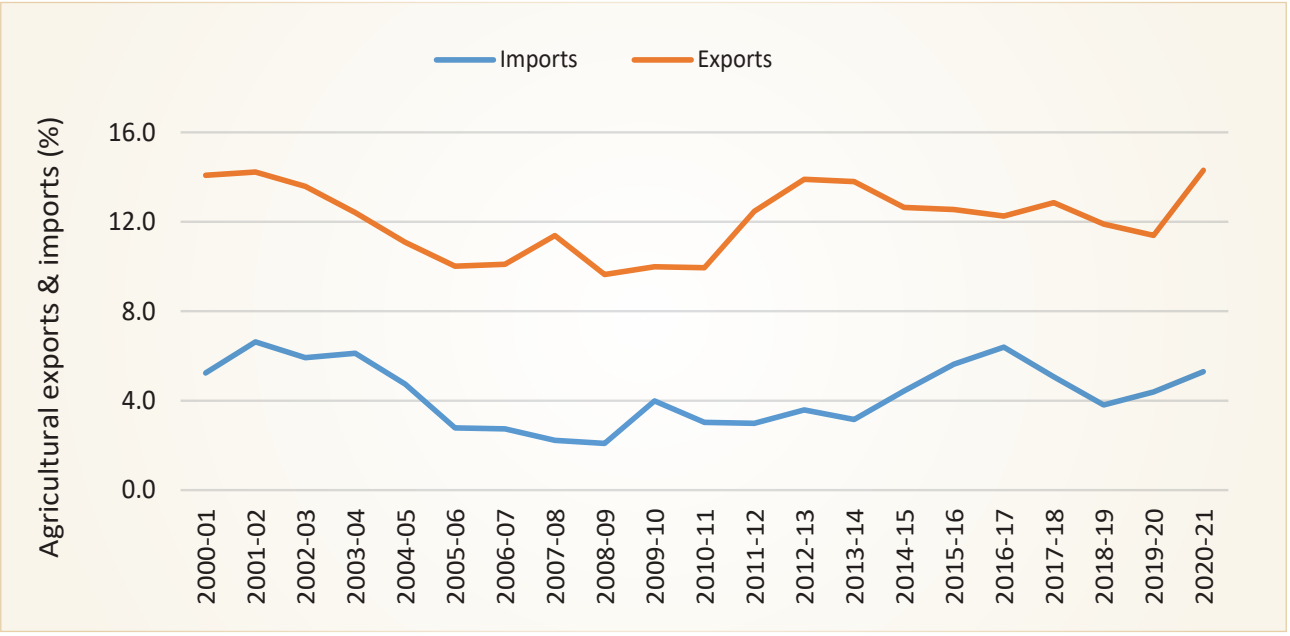
## Table 11.3. ---- Contd….

| State | Agricultural wages (₹./day) | | Livestock density (number/ km2 | Market density (number/ 000 km2 | Depth of water level (meters below ground level) | Scheduled commercial banks (branches/ 000 km2) | Agricultural credit (₹ crore) | Farmer's income (monthly average per hh) | Average size of land holdings (ha) | Total wastelands (% of total area) |
|---|---|---|---|---|---|---|---|---|---|---|
| | Male | Female | | | | | | | | |
| Year | 2020-21 | | 2019 | 2017-18 | 2021 | 2021 | 2021 | 2018-19 | 2015-16 | 2015-16 |
| | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| Andhra Pradesh | 416 | 266 | 209 | 2.14 | 9.86 | 46 | 85797.60 | 10480 | 0.94 | 14.71 |
| Assam | 331 | 254 | 230 | 2.88 | 3.78 | 39 | 4847.94 | 10675 | 1.09 | 11.48 |
| Bihar | 284 | 260 | 387 | NA | 4.22 | 81 | 16812.07 | 7542 | 0.39 | 8.16 |
| Chhattisgarh | 260 | 202 | 117 | 1.38 | 5.73 | 21 | 7494.28 | 9677 | 1.24 | 8.04 |
| Gujarat | 291 | 223 | 137 | 2.04 | 12.72 | 44 | 59519.79 | 12631 | 1.88 | 11.09 |
| Haryana | 442 | 377 | 157 | 6.36 | 17.08 | 118 | 28118.19 | 22841 | 2.22 | 3.75 |
| Himachal Pradesh | 490 | 419 | 79 | 1.01 | 6.54 | 30 | 3496.54 | 12153 | 0.95 | 41.01 |
| Jammu & Kashmir | 470 | 503 | 37 | 0.11 | 2.14 | 8 | 6177.57 | 18918 | 0.59 | 79.06 |
| Jharkhand | 284 | 260 | 296 | 2.38 | 5.37 | 40 | 2668.02 | 4895 | 1.10 | 14.76 |
| Karnataka | 440 | 242 | 151 | 2.68 | 6.27 | 57 | 49077.41 | 13441 | 1.36 | 6.9 |
| Kerala | 628 | 517 | 75 | NA | 6.08 | 177 | 41303.45 | 17915 | 0.18 | 5.89 |
| Madhya Pradesh | 260 | 202 | 132 | 1.80 | 7.96 | 24 | 37636.43 | 8339 | 1.57 | 12.83 |
| Maharashtra | 334 | 220 | 107 | 2.94 | 5.88 | 44 | 51887.26 | 11492 | 1.34 | 11.72 |
| Odisha | 250 | 216 | 117 | 3.11 | 3.91 | 34 | 17148.66 | 5112 | 0.95 | 11.83 |
| Punjab | 373 | 343 | 139 | 8.58 | 17.76 | 133 | 25406.12 | 26701 | 3.62 | 0.92 |
| Rajasthan | 314 | 290 | 166 | 1.34 | 26.01 | 23 | 55106.98 | 12520 | 2.73 | 23.04 |
| Tamil Nadu | 549 | 293 | 188 | 2.21 | 5.19 | 92 | 114596.51 | 11924 | 0.75 | 6.32 |
| Telangana | 416 | 266 | 291 | 2.47 | 5.61 | 50 | 36710.44 | 9403 | 1.00 | 12.71 |
| Uttar Pradesh | 303 | 245 | 281 | 2.59 | 7.25 | 75 | 46092.81 | 8061 | 0.73 | 3.54 |
| Uttarakhand | 490 | 419 | 83 | 1.33 | 19.51 | 42 | 3669.54 | 13552 | 0.85 | 23.79 |
| West Bengal | 336 | 268 | 422 | 6.03 | 6.85 | 106 | 29795.41 | 6762 | 0.76 | 1.86 |
| All-India | 341 | 258 | 163 | 2.11 | 17.24 | 47 | 7,36,589.1 | 10,2018 | 1.08 | 16.96 |

*Source:*

*Column 2,3,4,5,6,7,11,12 &17; Directorate of Economics and Statistics, Ministry of Agriculture & Farmer's Welfare, Government of India (dacnet.nic.in)*
*Column 8. Basic Road Statistics of India 2018-19, Ministry of Road Transport and Highways, GoI*
*Column 9. Combined Finance and Revenue Accounts, Comptroller and Auditor General of India*
*Column 10. National Federation of State Cooperative Banks Ltd. (NAFSCOB)*
*Column 13. Livestock census, 2019*
*Column 14. http://dmi.gov.in/Documents/agmstat_2017-18.pdf*
*Column 15. Water Resources Information System, Ministry of Jal Shakti, GoI, (https://indiawris.gov.in/wris/#/DataDownload)*
*Column 16. Bank Branch Statistics, RBI*
*Column 18. NSSO data as stated in NSS Report 587.*
*Column 19. Agriculture Census, 2015-16*
*Column 20. NRSC-Wasteland atlas of India 2019 (https://dolr.gov.in/documents/wasteland-atlas-of-india)*

## Figure 11.1. Share of agricultural exports and imports to national trade (2000/01 to 2020/21)

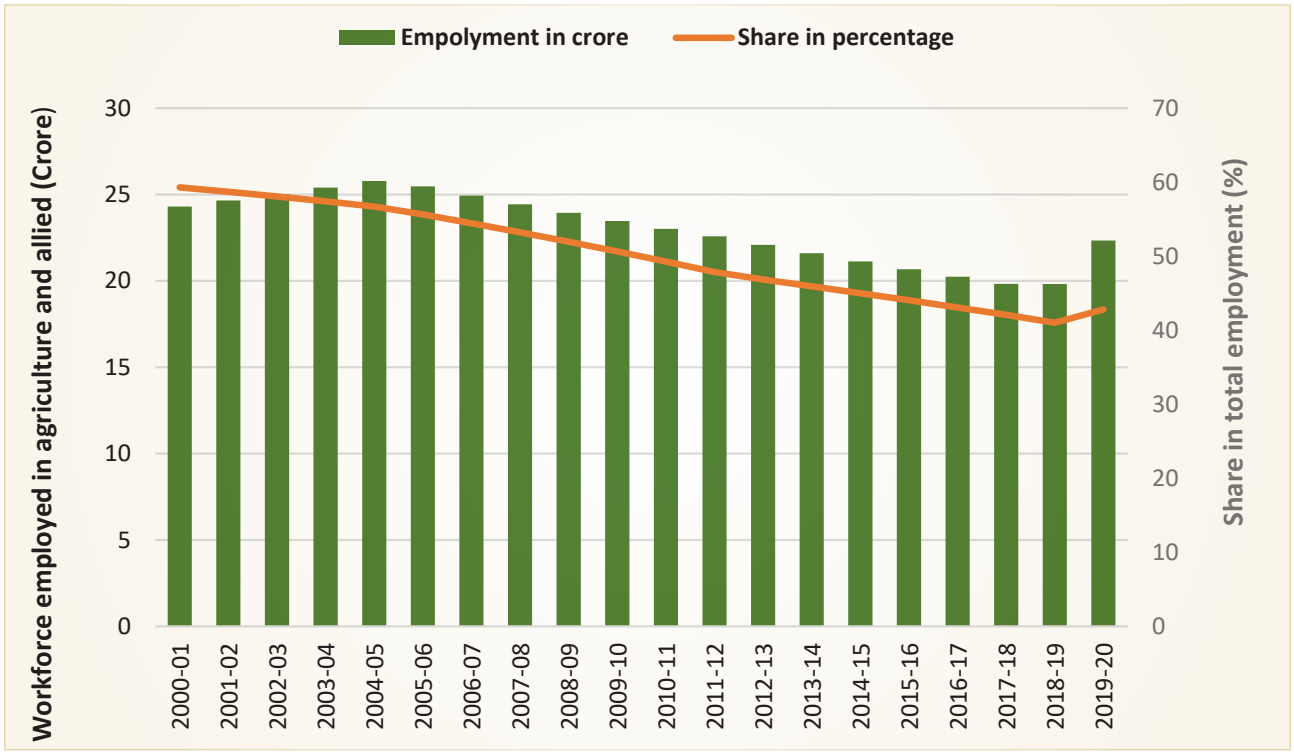



*Source: Directorate General of Commercial Intelligence and Statistics*

## Figure 11.2. Institutional credit to agriculture and allied sectors (2000/01 to 2021/22)

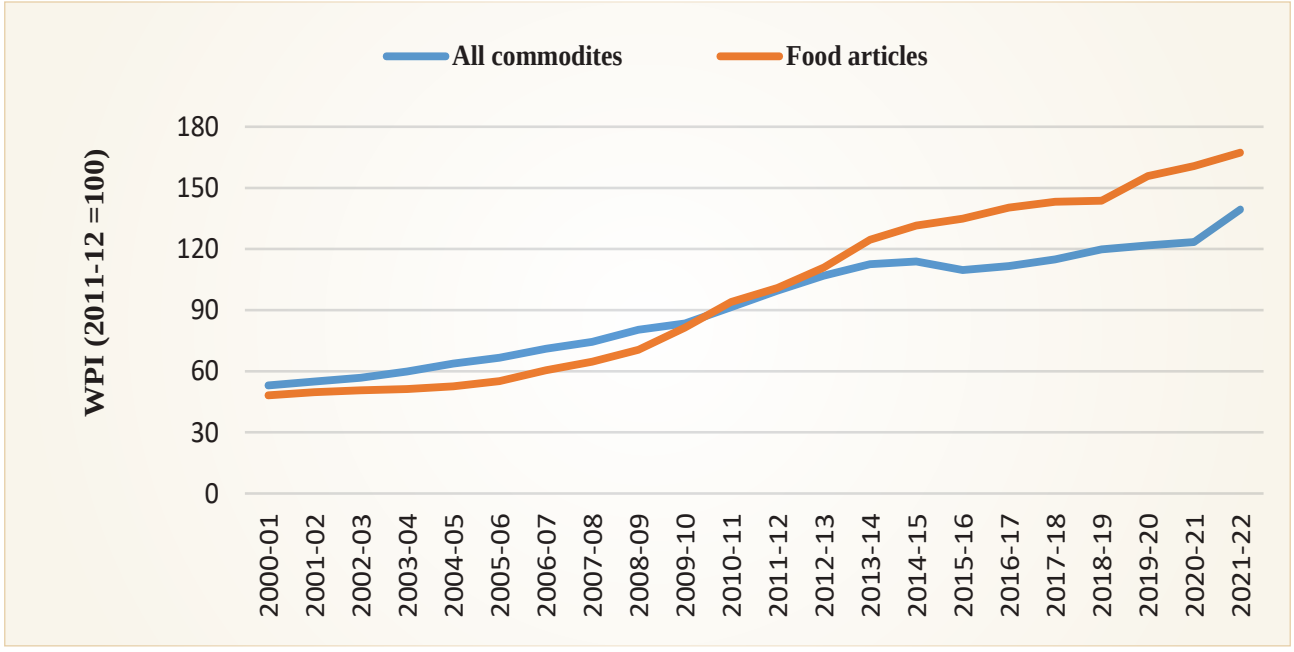

*Source: RBI*

## Figure 11.3. Employment in agriculture and allied sectors (2000/01 to 2019/20)



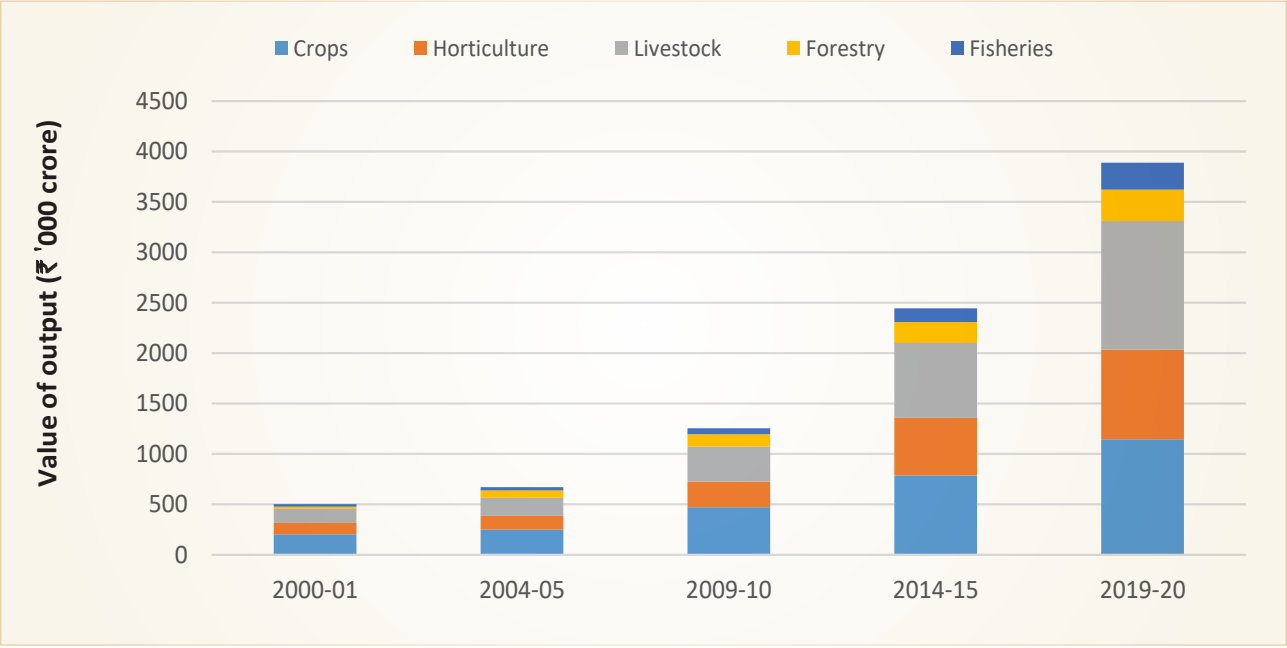

*Source: Ministry of Statistics and Programme Implementation*

## Figure 11.4. Trend in wholesale price indices (annual average, 2000/01 to 2021/22)



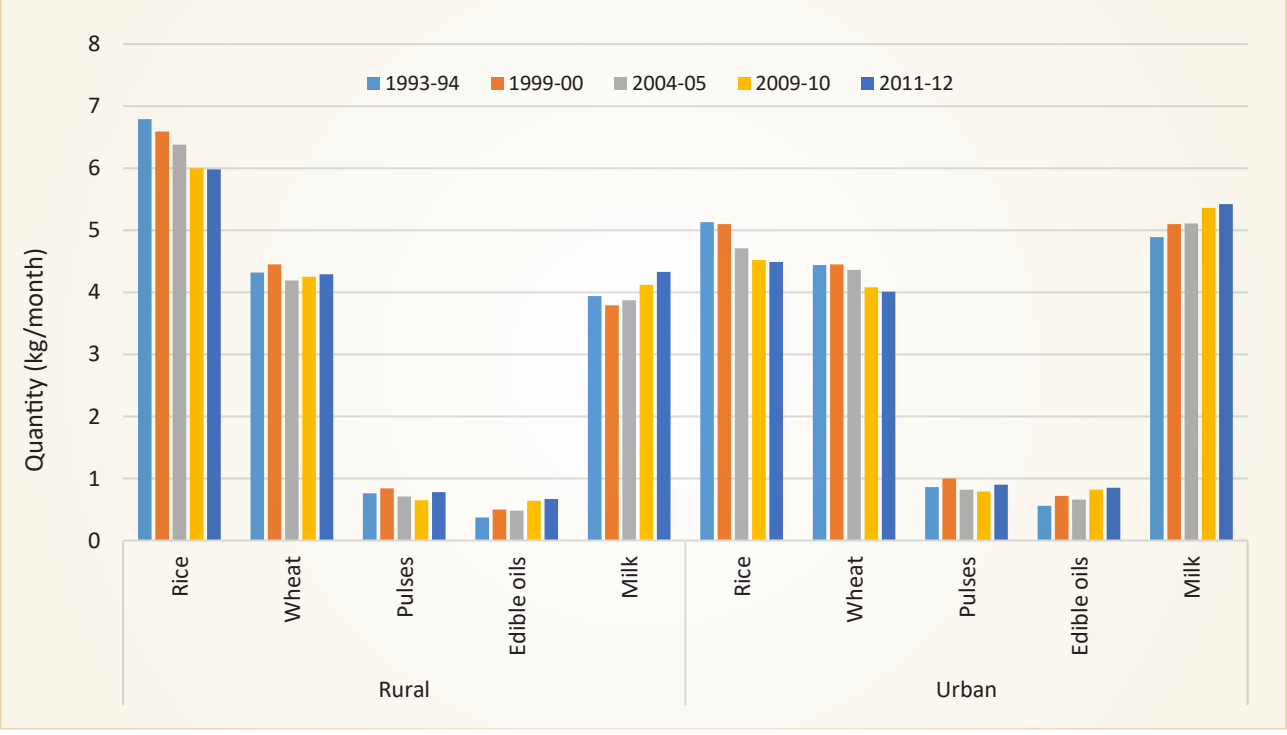

*Source: Ministry of Commerce and Industry*

## Figure 11.5. Value of output of agriculture and allied sector (2000/01 to 2019/20)



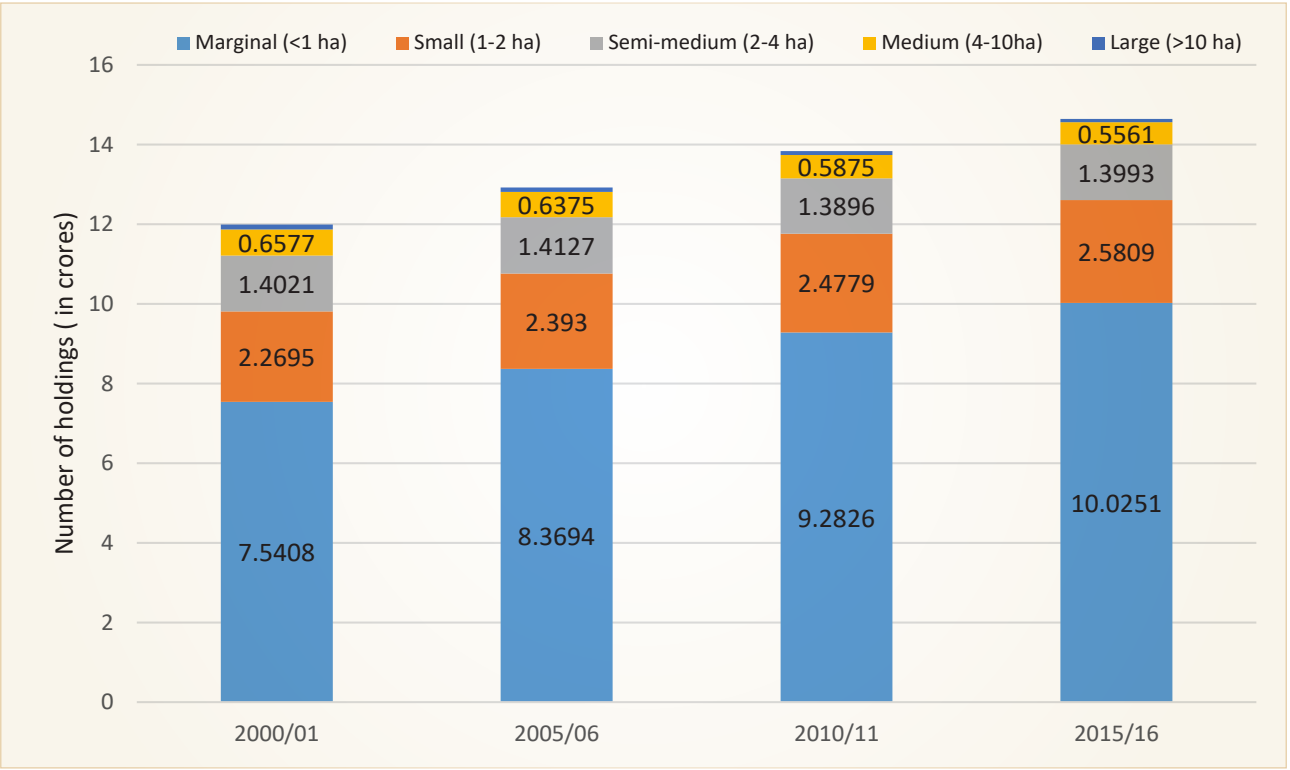

*Source: Ministry of Statistics and Programme Implementation*

## Figure 11.6. Changing per capita food consumption pattern (kg/month, 1993/94 to 2011/12)




*Source: Ministry of Statistics and Programme Implementation*
*Note: Milk consumption is in litres*

## Figure 11.7. Number of operational holdings in agriculture (2000/01 to 2015/16)




*Source: MoA&FW*

# NIAP Policy Papers

37. Subhash SP, A Jhajhria & S Pal. 2020. Trade and investment policy for overseas acquisition of fertilizers and raw materials.
36. Chand S, P Kishore, S Kumar & SK Srivastava. 2020. Potential, adoption and impact of micro irrigation in Indian agriculture.
35. Singh NP, B Anand & S Singh. 2020. Impact of climate change on agriculture in India: assessment for agro-climatic zones.
34. Saxena R, RK Paul, S Pavithra, NP Singh & R Kumar. 2019. Market intelligence in India: price linkages and forecasts
33. Saxena R & R Chand. 2017. Understanding the recurring onion price shocks: revelations from production–trade–price linkages
32. Singh NP, A Ashok, S Pavithra, SJ Balaji, B Anand & MA Khan. 2017. Mainstreaming climate change adaptation into development planning.
31. Saxena R, NP Singh, SJ Balaji, UR Ahuja & D Joshi. 2017. Strategy for doubling income of farmers in India.
30. Birthal PS, DS Negi & D Roy. 2017. Enhancing farmers income: who to target and how?
29. Birthal PS, S Kumar, DS Negi & D Roy. 2015. The Impact of information on returns from farming.
28. Shinoj P, A Kumar, S Kumar & R Jain. 2014. Commodity outlook on major cereals in India.
27. Raju SS, P Shinoj, R Chand, PK Joshi, P Kumar & S Msangi. 2012. Biofuels in India: potential, policy and emerging paradigms.
26. Chand R, SS Raju, S Garg & LM Pandey. 2011. Instability and regional variation in Indian agriculture.
25. Chand R, P Kumar & S Kumar. 2011. Total factor productivity and contribution of research investment to agricultural growth in India.
24. Kumar A. 2009. India's livestock sector trade: opportunities and challenges.
23. Jha D & S Kumar. 2006. Research resource allocation in Indian agriculture.
22. Bhowmick BC, BC Barah, S Pandey & N Barthakur. 2005. Changing pattern of rice production systems and technology in Assam.
21. Dastagiri MB. 2004. Demand and supply projections for livestock products in India.
20. Mruthyunjaya, S Pal & R Saxena. 2003. Agricultural research priorities for South Asia.
19. Chand R. 2003. Government intervention in foodgrain markets in the new context.
18. Birthal PS. 2003. Economic potential of biological substitutes for agrochemicals.
17. Adhiguru P & C Ramasamy. 2003. Agricultural-based interventions for sustainable nutritional security.
16. Pal S & D Byerlee. 2003. The funding and organization of agricultural research in India: evolution and emerging policy issues.
15. Birthal PS, PK Joshi & A Kumar. 2002. Assessment of research priorities for livestock sector in India.
14. Selvarajan S, A Ravi Shankar & PA Lakshmi Prasannna. 2001. Irrigation development and equity impacts in India.
13. Haque T. 2001. Impact of tenancy reforms on productivity improvement and socio-economic status of poor tenants.
12. Pal S, R Tripp & A Janiah. 2000. Public-private interface and information flow in the rice-seed system of Andhra Pradesh (India).
11. Chand R. 2000. Emerging trends and regional variations in agricultural investments and their implications for growth and equity.
10. Rasheed SV & VV Sadamate. 2000. Privatising agricultural extension in India.
9. Birthal PS, A Kumar, A Ravishankar & UK Pandey. 1999. Sources of growth in the livestock sector.
8. John F, SV Rasheed & S Pal. 1998. Improving the effectiveness of agricultural research and extension in India: an analysis of institutional and socio-economic issues in rainfed areas.
7. Pal S & A Singh. 1997. Agricultural research and extension in India: institutional structure and investments.
6. Chand R. 1997. Import liberalization and Indian agriculture: the challenge and strategy.
5. Maji CC, T Haque & A Bhattacharya. 1995. Small farms, employment and surplus generation: a case of West Bengal.
4. Maji CC & A Bhattacharya. 1995. GATT and agricultural exports: hopes and realities.
3. Jha D, P Kumar, Mruthyunjaya, S Pal, S Selvarajan & A Singh. 1995. Research priorities in Indian agriculture.
2. Pant SP. 1995. Production prospects and constraints to higher productivity of pulses in Madhya Pradesh (Eds. Maji CC & Rasheed SV).
1. Pal SS. 1995. Impact of tenancy reforms on production and income distribution - a case study of Operation Barga in West Bengal (Eds. Maji CC & Rasheed SV).

भाकृअनुप
ICAR

# ICAR–NIAP

भाकृअनुप
ICAR

भाकृअनुप–राष्ट्रीय कृषि आर्थिकी एवम् नीति अनुसंधान संस्थान
**ICAR - NATIONAL INSTITUTE OF AGRICULTURAL ECONOMICS AND POLICY RESEARCH**
(Indian Council of Agricultural Research)
Dev Prakash Shastri Marg, Pusa, New Delhi - 110 012, INDIA
Ph: +91(11) 2584 7628, 2584 8731 Fax: +91 (11) 2594 2684
Email : director.niap@icar.gov.in, Website : www.niap.icar.gov.in