# Enhancing Agricultural Productivity and Farmer Incomes in Bihar

Edited by

Sankar Kumar Bhaumik

Supported by

SAGE | spectrum

**SAGE** was founded in 1965 by Sara Miller McCune to support the dissemination of usable knowledge by publishing innovative and high-quality research and teaching content. Today, we publish over 900 journals, including those of more than 400 learned societies, more than 800 new books per year, and a growing range of library products including archives, data, case studies, reports, and video. SAGE remains majority-owned by our founder, and after Sara's lifetime will become owned by a charitable trust that secures our continued independence.

Los Angeles | London | New Delhi | Singapore | Washington DC | Melbourne

# Enhancing Agricultural Productivity and Farmer Incomes in Bihar

# Enhancing Agricultural Productivity and Farmer Incomes in Bihar

Edited by
Sankar Kumar Bhaumik

SAGE | spectrum
spectrum.sagepub.in

*First published in 2023 by*

SAGE | spectrum

**SAGE Publications India Pvt Ltd**
B1/I-1 Mohan Cooperative Industrial Area
Mathura Road, New Delhi 110 044, India
*www.sagepub.in*

Typeset in 9.5/13 pt Century Schoolbook by Zaza Eunice, Hosur, Tamil Nadu, India.

**Library of Congress Control Number: 2022947650**

**DOI:** https://doi.org/10.4135/978-93-5479-559-6

**ISBN:** 978-93-5479-542-8 (PB)
**ISBN:** 978-93-5479-564-0 (e-book)

**Dedicated to all toiling farmers of Bihar. Jai Kisan!**

# CONTENTS

## PART III: INSURANCE AND MARKETS FOR AGRICULTURE



## PART IV: CLIMATE CHANGE AND AGRICULTURE



## PART V: CREDIT AND TECHNOLOGY FOR AGRICULTURE

## PART VI: INCOME DIVERSIFICATION OF RURAL HOUSEHOLDS

# LIST OF FIGURES

# LIST OF TABLES

# ACKNOWLEDGEMENTS

The Patliputra School of Economics (PSE) has been established recently as a Centre of Excellence under the Aryabhatta Knowledge University in Patna, Bihar. It is the first-ever School of Economics in Eastern India that was envisioned by Shri Nitish Kumar, Hon'ble Chief Minister and the architect of 'The New Bihar' (this term was coined by N. K. Singh and Nicholas Stern while documenting the developments that have taken place in Bihar since 2005). Carrying forward his vision, the PSE is beginning to focus on research and teaching of the highest possible order in the fields of economics and economic policymaking. The PSE fraternity takes this opportunity to convey its deep sense of gratitude and respect to the Hon'ble Chief Minister for establishing this wonderful institution for the benefit of the students and researchers, especially those living in our part of the country.

The first significant academic event at the PSE happened in the form of a 'non-ritualistic' national seminar on the theme *Raising Agricultural Productivity and Farmers' Incomes in Bihar*, organised in Patna during 17–18 December 2021. Although as many as 40 research-based papers were presented in the seminar, this book contains only 18 of those as we were unable to accommodate all the papers in a single volume due to reasons beyond our control. Given an opportunity, we shall plan to publish another volume using some or all of the remaining papers. However, we are immensely grateful to all the paper-presenters in the seminar who, besides presenting their own papers, took part in discussions and provided critical comments on other's papers. The editor also conveys his thankfulness to the authors of 18 chapters to this volume for revising and updating their papers within a short span of time keeping in view the comments and suggestions received during the seminar.

While the seminar was inaugurated by Shri Vijay Kumar Choudhary, Hon'ble Education Minister, Government of Bihar, the keynote address was given by Dr Ramesh Chand, Hon'ble Member, NITI Aayog, New Delhi. The editor is highly grateful to both of them for throwing useful insights on the subject through their addresses in the seminar and encouraging us to bring out a publication. The editor is also immensely grateful to Amir Subhani, Chief Secretary, Government of Bihar, for his invaluable help and constant encouragement without which it would not have been possible to organise the seminar and bring out this volume. The editor received enormous help and encouragement from Tripurari Sharan (former Chief Secretary and present Information Commissioner of Bihar), N. Saravana Kumar (Secretary, Department of Agriculture, Bihar Government), Sanjay Kumar (former Additional Chief Secretary, Department of Education, Bihar Government), Sunil Kumar (Chief General Manager, NABARD, Patna), Prabhat P. Ghosh (Professor, Asian Development Research Institute, Patna) and the Officers and Staff of Agriculture and Planning & Development Departments of Bihar Government. The editor conveys his sincere gratitude to all of them.

The editor is highly grateful to Shambhu Nath Guha (Founder Vice-Chancellor, Aryabhatta Knowledge University) and Surendra Pratap Singh (Vice-Chancellor, Aryabhatta Knowledge University) for their constant help and blessings. Thanks are also due to the Officers and Staff of Aryabhatta Knowledge University for their help and encouragement to organise the seminar at the PSE.

The editor received help and encouragement from many other people, especially from his colleagues Poornima Sekhar Singh (Director, Centre for Geographical Studies, Aryabhatta Knowledge University), Iftekhar Ahmed (Director, School of Journalism & Mass Communication, Aryabhatta Knowledge University), Rakesh Kumar Singh, Manisha Prakash, Manish Parashar, Saad Asghar Moeeni, friends Saibal Kar, D. M. Diwakar, Panchanan Das, Surya Bhushan, Sudhanshu Kumar, Aditya Mohanty, Kumar Kaushal and past students of Central University of South Bihar, Gaya. Neha Kumari provided excellent secretarial assistance that at times eased the pressure of work on the part of the editor. The editor is grateful to all of them.

The publication of this book both under the 'Open Access' and 'Print' modes has become possible due to generous publication grants extended by NABARD (Bihar Regional Office, Patna), ICSSR (Eastern Regional Centre, Kolkata) and Department of Agriculture, Government of Bihar. The editor is thankful to them for their support.

The editor is thankful to the publisher's referee for helpful comments and suggestions over the manuscript. Special thanks are due to Amrita Dutta, Associate Commissioning Editor, and the entire production team of SAGE Publications for excellent support services that only enabled quick publication of this work.

Last but not least, the editor would like to record his thankfulness to his wife Bidisha and daughter Jayini who bore all the sufferings inflicted upon them as a result of his long absence from the family domain while staying in Patna.

The editor would consider his labour rewarded if this book provokes younger scholars to undertake more in-depth research, especially by using primary data, on some of the issues thrown bare in this book, which indeed is a necessity to revise and redesign the developmental policies and priorities with changing time. After all, research is a continuous process and no work in social sciences is free from limitations!

# INTRODUCTION

*Sankar Kumar Bhaumik*

Bihar's remarkable turnaround in economic performance during the past 15 years or so, as revealed by very high growth rates of both the Net State Domestic Product (NSDP) and per capita NSDP, has deservedly received wide attention and acclaim of the researchers and policy-makers. Nevertheless, Bihar continues as one of the poorest states of India. The available data show that the per capita NSDP in Bihar in 2018–19 remained not only just about one-third of the per capita net national product at the all-India level but also the lowest among all major states. Similarly, in the same year, as per the Periodic Labour Force Survey, Bihar recorded the highest rates of both rural and total (rural plus urban) unemployment rates among 22 major states of India. It is thus quite natural that Bihar continues to be clubbed with the group of states that have relatively high incidence and depth of poverty. However, the poverty in Bihar has been a rural phenomenon with more than 80 per cent of the poor in the state living in the rural areas.

In the above scenario, development of rural areas in general, and that of agriculture and its allied sectors in particular, holds the key towards attainment of inclusive economic growth in an otherwise fast-developing state such as Bihar. Given the fact that, as elsewhere, both the manufacturing and high-end services sectors have not been able to generate enough jobs for the unemployed persons in Bihar, the development of agriculture and its allied sectors received due attention in recent years from the state government. An important testimony towards the state government's initiatives in this direction is the implementation of three 'Agriculture

Roadmaps' since 2008. The thrusts of these roadmaps have been to attain a 'rainbow revolution' with simultaneous development of the crop and non-crop sectors besides giving emphasis towards attainment of food and nutrition security, increasing farmers' incomes, and promoting organic farming.

Following the implementation of the roadmaps, agricultural performance in Bihar has revealed signs of improvement (Hoda et al., 2021; Kannan, & Pohit, 2019; NCAER, 2019). While annual growth of NSDP accruing from agriculture and allied sectors during the pre-agriculture roadmap period (2001–08) has been about 2.0 per cent, the same during the First Agriculture Roadmap period (2008–12) increased to 3.1 per cent. However, such a growth momentum could not be sustained post-2012 thereby raising the question of stability of agricultural growth in the state. Further, Bihar lagged far behind with regard to the yield levels of its most important crops (rice and wheat) compared to the major states of India producing those crops. This is not unusual given the fact that almost three-fourths of the areas of North Bihar are flood-affected, while about one-third of areas in South Bihar is drought-prone that necessitated more vigorous intervention by the government for establishment of sound infrastructure in the rural areas as well as adoption of the Climate Resilient Agriculture (CRA) programme since 2018–19 for the benefit of the farmers.

Some recent studies have shown that although the farmers in Bihar have been dynamic enough towards adoption of modern agricultural inputs and technologies and there has been an appreciable rise in private investment in agriculture in recent years, yet they have suffered on multiple fronts (Hoda et al., 2017). For instance, the crop sector in Bihar is not yet diversified with nearly 80 per cent or more of the gross cropped areas being occupied by three crops that are rice, wheat and maize. Another important problem towards development of agriculture and raising farmers' income in Bihar is almost complete absence of insurance mechanisms to protect them from weather and price risks and uncertainties of agricultural production. The vast majority of the farmers couldn't avail the benefit of minimum support prices (MSP) because of inadequate procurement operations, and there existed a large gap between the price at which farmers sell their crop immediately after harvest and the MSP. The same story continues with regard to implementation of the crop-insurance schemes. There are also imperfections in the functioning of land and credit markets. With more than 90 per cent of operational holdings in the state falling under the 'marginal' category and the average size of holding being a meagre 0.39 ha (in 2015–16), the viability of the small-farming regime in Bihar becomes a serious issue that could not be addressed by the market forces alone. Of course, this fact is recognised by the state government as evident from various policy interventions, especially in recent years. But then to what extent the agricultural sector in the state has been responding to such initiatives to raise agriculture productivity and farmer incomes becomes an issue that deserves serious research scrutiny.

As against the above backdrop, this book seeks to understand the performance of the agriculture sector in Bihar in recent times, the multifarious challenges faced and its future possibilities from the perspective of raising agricultural productivity and farmer incomes so as to attain an inclusive economic growth of the state. Some of the questions addressed by this book are: What has been the performance of the agriculture sector in Bihar in recent decades? What have been the sources (drivers) of agricultural growth? How far the development of the agriculture sector is important for an inclusive growth of the state? What has been the pattern of agrarian transformation in the state in recent years? What has been the functioning of agricultural markets? What is the potentiality of the Farmer Producer Organisations (FPOs) to mitigate the problems faced by the farmers to market their outputs? To what extent contract farming is beneficial to the farmers? How far is the crop-insurance programme effective as a mechanism for mitigation of risk in agriculture? What has been the impact of climatic factors such as drought on agricultural production? Does the CRA programme help to protect agricultural production and productivity? How does climate change affect human development, and what are the coping strategies adopted by the people following climatic shocks? What has been the flow of institutional credit to the agricultural sector, and what steps should be taken to remove credit bottlenecks faced by the farmers? How far are the farmers responsive towards adoption of new techniques of cultivation? What has been the extent, patterns and determinants of income diversification among the rural households and how important are the off-farm sources of income to them? What has been the pattern of development of the livestock sector that happens to be the second most important sector after crop-cultivation to the rural people for livelihoods and income? What has been the impact of out-migration from rural areas on agricultural productivity?

Given the fact that raising agricultural productivity and the farmer incomes is in the agenda of the present policy dispensations both at the levels of central and state governments, the insights to be gained from this book would be specifically useful for the researchers and policymakers to understand the developmental challenges both in Bihar and other agriculturally backward regions that are largely dominated by the small and marginal farmers the majority of whom are dependent on this sector for their livelihoods. It will also help future researchers to locate some issues on which more research may be undertaken to formulate evidence-based policies to attain accelerated growth of the agriculture sector as also to improve the income levels of the farmers on a sustainable basis.

The 18 chapters of this book are divided into 6 parts, each representing an important area of research, in its own right, in the context of agriculture in Bihar, as elsewhere. Instead of attempting any value judgement on the chapters, the editor merely summarises further the main issues covered and the conclusions drawn by the contributors of those chapters.

## PART I: AGRICULTURAL GROWTH TRAJECTORIES

This part is devoted to understanding the growth dynamics of the agriculture sector in Bihar in the recent decades. Ramesh Chand sets the tone and tenor of the whole book in the first chapter. To begin with, he traces the paths of development followed by different states in India since Independence. He observes that agricultural development is a *sine qua non* for attainment of inclusive growth as it helps to reduce poverty at a faster rate compared to development of other sectors of the economy. This is, however, not to say that industry is unimportant. Referring to the works of John W. Mellor, he views that the objectives of both growth and development are best fulfilled by establishing strong forward and backward linkages between the farm and non-farm sectors of the economy. Moving the discussion to Bihar, he highlights both the challenges and opportunities for future development of agriculture in the state. On the policy front, he emphasised on making efforts to increase the yield levels of the cereals which dominate the cropping pattern of the state, increasing cultivation of fruits and vegetables, promotion of agro-based industries and development of the non-crop sector like fishing. On the problems the farmers face in marketing their products, his view is that while the Agricultural Produce Marketing Committee (APMC) option could have continued, the private sector should be freed from restrictive regulations of the APMC. His overall suggestion is that Bihar should follow an 'agri-centric growth model' involving the private corporate sector and inviting the agri-tech firms and start-ups to promote food value chains and value addition, and market its products in best-paying domestic and export markets.

What has been the growth performance of the agriculture sector in the state of Bihar, especially after implementation of three 'roadmaps' since 2008, has been the prime focus of three other chapters in this section. Elumalai Kannan and Sanjib Pohit specifically analyse the drivers of agricultural growth with a special focus on the crop sector. They applied the 'resource decomposition method' to identify the drivers of crop output growth and their relative contributions. Their main observation is that, except paddy, net income obtained from the cultivation of other crops was positive during the pre-agriculture road map period. However, the average net income increased considerably, though with higher levels of volatility, for most crops following implementation of the roadmaps. Further, their decomposition analysis suggests that total factor productivity (TFP) growth had significantly contributed to crop output growth and the contributions of the area effect and input intensification effect on crop output growth were lower than the TFP effect. They conclude that although output growth led by improvement in TFP is sustainable in the long run, the state should work on improving the market infrastructure, increase public spending on agricultural research (to generate area-specific crop technology) and extension services (to disseminate the new technology effectively among the farmers), and improve rural infrastructures, to sustain the present growth momentum and enhance the net income of the farmers in the years to come.

The chapter by Sankar Kumar Bhaumik and Sk. Abdul Rashid also provides a detailed analysis of the performance of the crop production sector in Bihar following implementation of various roadmaps. The analysis here is different from that of previous chapter in that the authors constructed the time series for values of output separately for foodgrains, non-foodgrains and all crops to identify the break-point(s) in such series before computing the growth rates of values of agricultural output in different sub-periods by estimating the 'two-kink exponential model'. The most striking conclusion of this chapter is that the growth rates of agricultural production of foodgrains, non-foodgrains, as well as all-crops witnessed a significant turnaround following implementation of various roadmaps and agricultural development programmes by the state government, and the break-point seems to be lying between 2009–10 to 2010–11. The individual crops enjoying significant growth of production in the post-roadmap period compared to pre-roadmap period are rice, maize and wheat among the foodgrains crops and chillies, sugarcane, groundnuts and potato among the non-foodgrains crops. In the cases of foodgrains crops like rice, maize and wheat, almost 90 per cent of growth of production has been contributed by expansion of their yield level, post-2009–10. For the non-foodgrains crops such as chillies, sugarcane and groundnuts, contribution of area growth has been more compared to the contribution of yield growth towards their production growth. However, yield growth contributed much more than area growth towards higher production growth of potato during the post-roadmap period. Analysing the changes in the cropping pattern, the authors noted that agriculture in Bihar is characterised by 'specialisation' with continuance of a three-crop regime (rice, wheat and maize). The value of crop diversification index has remained more or less stagnant during the past 20 years or so despite the per hectare value of output for the non-foodgrains crops being much higher compared to the same for foodgrains crops. On the basis of this finding, the authors suggest that the farmers be encouraged to diversify their cropping pattern to gain the benefit of higher productivity from crop cultivation. Further, estimating a panel regression model, the authors identified adoption of modern agricultural technology (especially irrigation) and climate (indexed by rainfall instability) as important determinants of agricultural productivity in Bihar. Thus, the authors support the adoption of the Climate Resilient Agriculture (CRA) programme by the state government to protect the farmers from the disturbances caused by climatic factors.

A significant event in the context of agriculture in Bihar in the recent past is that it witnessed a 'maize revolution'. Although maize is an all-season crop, it is cultivated more in the flood-prone areas of North Bihar in the rabi season to get protection from the vagaries of weather in the heavy-rainfall monsoon months. Bihar today is one of the largest producers of maize and it acts as the main supplier of maize to other states. Tulika Kumari and K. M. Singh examined the growth of area, production and yield of rabi maize in the recent past and estimated the TFP of maize. They found that the growth rates of area, production and yield of rabi maize have been positive. The yield of rabi maize has been increasing over the years due to improved input use efficiency and technological improvement. The TFP has been positive, and it is directly correlated with the yield, indicating that technological advancement has been responsible for high growth of yield and production of maize in the state. On this basis, the authors recommend for greater adoption of the technology to improve the farmers' condition for which necessary awareness-building and provision of quality extension services would be required.

## PART II: STRUCTURAL TRANSFORMATION IN THE AGRICULTURAL SECTOR

Bihar has a long tradition of political economy analysis of the state's agrarian structure and its implication for the development trajectory of the state. The two chapters in this part discuss the dynamics of agrarian transformation witnessed over the years in the state. Anirban Dasgupta and Binoy Goswami use a political-economic framework to interpret the development trajectory of the state as also to find out whether or not there has been capitalist penetration in the agriculture sector. They reviewed the recent literature on agrarian political economy and considered some 'input-oriented' as well as 'output-oriented' indicators to understand the nature of agrarian transition that has happened in Bihar. In their view, agriculture in Bihar is far from capitalist despite the crop cultivation sector making substantial progress in the last two decades using modern inputs, wage labour and substantial production for the market. This conclusion follows from the facts that the scale of cultivation has been low (as more than 90 per cent of the farmers belong to the marginal category) and there is absence of any substantial surplus from agriculture for reinvestment, which prevented this sector to follow the capitalist path of accumulation and expansion. However, recognising the critical role of the agriculture sector in absorbing the large pool of surplus labour, they argue that the objective of state planners should be to devise policies for the 'non-capitalist livelihood provisioning' rather than expecting capitalist transformation of agriculture. The livelihood and earnings outcomes in the rural areas could be improved by exploiting agriculture sector's potential backward and forward linkages with the small-scale rural enterprises as well as by ensuring an 'income floor' per unit of land under cultivation. Innovative policymaking that builds on a clear understanding of the livelihood function of agriculture becomes imperative in this regard.

Santosh Verma examines the agricultural scenario in the wake of land distribution inequality, higher landlessness and incidence of tenancy that resulted in a low-income trap in agricultural activities in Bihar. He argues that not-so-successful or failed land reforms have resulted into historically iniquitous distribution of land in Bihar. The successive state governments neglected the land reforms programme in the pressure of landed influential classes leading to marginalisation of a large proportion of households, land struggles and mass massacres in the past, and high-end seasonal migration from rural Bihar for work and livelihood purposes. The landlessness among the SC and OBC households has been extremely high in Bihar which resulted in higher incidence of tenancy, discouraging the private investment in agriculture. Although the public expenditure on agriculture and allied sectors has improved in recent years, it is still insufficient to provide the much needed support to all the agricultural communities in the state. The increase in nominal income of the agricultural households during 2013–2019 has been merely 3 per cent per annum in

Bihar which is far less than 10 per cent annual increase advocated by the Ashok Dalwai Committee (2016–17) to double the farmers' income. The author's overall conclusion is that the persistent structural inequality in agriculture has created barriers in achieving the desired goals, and the current neoliberal economic policy regime together with the bureaucratic apathy and biases caused an unending agrarian distress in Bihar.

## PART III: INSURANCE AND MARKETS FOR AGRICULTURE

The four chapters in this part deal with issues relating to crop insurance and agricultural marketing in Bihar. Subhankar Mukherjee analyses the status of crop insurance programmes in India in general, and in Bihar in particular. Analysing the extent of coverage of crop insurance programmes, he observes that this has been much lower in Bihar compared to the all-India level. Moreover, almost 60 per cent of the farmers both in India and Bihar are found to be unaware about crop insurance schemes even in 2018–19. The author identified three problems each from the 'design' as well as 'implementation' sides that impede higher penetration of crop insurance. In the design side, the main barriers are estimation of loss from crop damage in an approximate manner, credit-linking of crop insurance and information asymmetry related problems. On the other hand, lack of awareness, delay in claim settlement and farm loan waiver are the main culprits on the implementation side. Thus, the policies towards easier and better understanding of operating procedures of crop insurance schemes built through awareness improvement programmes and/or agricultural extension services might be effective in improving its take-up, especially among the poorer farmers.

The Government of Bihar repealed the APMC Act in 2006 to encourage private parties in agricultural marketing, which was supposed to provide more options to farmers to sell their produce. However, the reality is that repealing this Act did not persuade private entities to set up agricultural markets. On the other hand, this resulted in large numbers of mandis becoming stagnant and poor agricultural market density that, coupled with negligible public procurement, led to a lower price realisation by the farmers in the state. In these circumstances, the role of Primary Agricultural Credit Societies (PACS) becomes important concerning trade in agricultural commodities at remunerative prices. Manish Kumar uses the framework of the Agricultural Value System, which focuses on backward and forward linkages of agriculture, to understand the agricultural economy in Bihar. He also discusses the constraints of PACS in the context of agricultural marketing. He observes that Bihar has the potential to increase farmers' income through interventions in backward linkages that face constraints of peculiar land relations and inadequate infrastructure and investment. In forward linkages, so far public procurement has proved to be the only way to increase farmers' income, where PACS can be used more effectively. However, despite having a large membership base, the PACS do not cover more than seven per cent of the total agricultural households in Bihar as far as procurement of crops is concerned. In any case, the number of beneficiaries of public procurement in Bihar has been meagre, and the farmers depend on local private traders to sell their crops. The author's overall conclusion is that the existing policy framework has not benefited the farmers; on the contrary, it has increased their hardships and has created a vacuum, especially in the marketing structure that may be bridged by strengthening the PACS.

One of the reasons for agrarian distress all over the country is the declining average size of land holdings. At the all-India level, the average size of land holdings is barely 1.08 ha, which in Bihar is a paltry 0.39 ha. Resultantly, the size of marketable surplus is very low. This leads to poor bargaining power for the small and marginal farmers in fetching favourable price for their produce as well as in procurement of inputs at a reasonable cost. The problem is further aggravated due to a long marketing chain and presence of a large number of middlemen between the producers and consumers. To overcome these problems, the Farmer Producer Organisations (FPOs) have been established in recent years to organise the farmers into a collective to facilitate aggregation of their produce for collective marketing and better price realisation. Sunil Kumar discusses alternative institutional models of the FPOs and looks into the present status of FPOs in Bihar. He observes that the FPOs in Bihar have made a modest beginning with formation of 728 FPOs till 31st March 2021 with the institutional support of NABARD, SFAC, Agriculture

Department of Bihar, NAFED, etc. Briefly reviewing the existing literature on the FPOs, he observes that the majority of the farmers joining FPOs enjoyed improvement of their income levels. Thus, to promote formation of more FPOs in Bihar, his suggestions to the state government are: (i) providing seed capital support to the FPOs in the initial stages; (ii) establishing a dedicated nodal agency at the state level for FPO promotion, capacity building, technical training, grievance redressal, etc.; (iii) introducing a scheme for FPOs for facilitation in input license, agri exports, infrastructure creation for processing and value addition, and procurement of paddy/wheat through FPOs and (iv) declaring FPOs at par with the PACS.

Contract farming has been another institutional mechanism to overcome the problems faced by small farmers in accessing modern inputs and technology and marketing their produce. Recognising its potential benefits, the Bihar government encouraged contract farming in recent years. Deepak Kumar Behera and Maryam Sabreen discuss the determinants of participation in contract farming arrangements by the farmers using field data collected from four villages in Nalanda district of Bihar. They also examine the technical efficiency of contract farmers. Their main observation is that the contract farmers are more productive and efficient compared to the non-contract farmers. They also found that the farmers having better access to technology are technically more efficient and the distance to market place creates a negative impact on their technical efficiency level. On this basis, they suggest that the government should invest more in extension services and infrastructure development. Further, to promote contract farming, information regarding the benefits of contract farming should be disseminated.

## PART IV: CLIMATE CHANGE AND AGRICULTURE

Bihar is one of those states of India where agriculture is affected most by climate change. Frequent rise in temperature and change in rainfall distribution, especially during the summer monsoon months, lead to crop loss and enhanced vulnerability of the poor households depending on agriculture. In fact, much of the instability in agricultural production in the state is attributed to the climate-induced disturbances. The three chapters included in this section respectively discuss issues relating to the effect of drought on agricultural production, the impact of CRA programme of Bihar government on productivity and profitability of alternative cropping systems, and the degree of climate change vulnerabilities of the districts as also the coping strategies adopted by the people in the event of climatic shocks.

Using the high-resolution gridded rainfall data for the period 1961–2018, P. Parth Sarthi and Sunny Kumar examine the spatial and temporal variation in the summer monsoon rainfall in four agro-climatic zones of Bihar that triggers the meteorological drought and affects agricultural production. Their finding is that although there is frequent occurrence of mild droughts over each agro-climatic zone, the frequency of occurrence of severe drought is more over zone 3B (South-West Alluvial Plain). As regards the relation between the standardised precipitation index and volume of rice production, their observation is that such relation was direct (positive) during 1971–2010 but turned indirect (negative) during 2010–18, implying that rice production was adversely affected in the state due to droughts prior to 2010 but increased after 2010 (during the phase of implementation of agriculture roadmaps) despite droughts possibly because of better irrigation facility and other supports provided to the farmers by the government.

As already mentioned, climate change is a harsh reality in Bihar. The terminal heat is adversely affecting wheat productivity. Water related stress situations in kharif season and short winter for rabi season are doubly affecting the income of the farmers. Adoption of a climate resilient cropping system becomes very important in a situation where climatic disturbances occur frequently. Recognising this fact, the Bihar government launched the CRA programme from 2018–19. This intervention mainly focuses on demonstration of climate-resilient agricultural technologies in the farmers' fields and in Krishi Vigyan Kendras. Suitable cropping systems have also been identified for all the districts and the farmers are encouraged to adopt the most productive/profitable cropping system in their respective areas. N. Saravana Kumar discusses the methods of implementation of the CRA programme as also the gains of such a programme in terms of improved levels of productivity and profitability through adoption of appropriate cropping systems. His main conclusion is that the CRA programme is helping the farmers to raise their income levels through gains in productivity and profitability. He identified the rice-maize cropping system as the most viable cropping system in terms of productivity and profitability in the state among eight different cropping systems studied. However, given the fact that there is wide variation among the districts with regard to productivity and profitability of different cropping systems, one important implication of this study is that the farmers should be encouraged to adopt the cropping system that provides the maximum productivity and profitability in their respective areas.

The issue of climate change from the perspective of its impact on vulnerability level and human development is discussed by Sibananda Senapati. Using the secondary information on flood-related loss and damage and the indicators of climate change and human development, he computed the values of vulnerability index for 38 districts of Bihar. He also used primary data collected from 700 households spread over 7 vulnerable districts to understand the households' coping strategies at times of natural calamities such as flood. The district-level vulnerability mapping for Bihar revealed that flood and drought are the main factors increasing the vulnerability of the people majority of whom live in the rural areas. The districts of Bihar varied widely in terms of vulnerability scores. However, districts such as Sheohar, Kishanganj and Arwal are identified as high-vulnerability districts, and Patna, Nalanda and Vaishali as low-vulnerability districts. As regards the coping strategies adopted by the people in the event of floods, his econometric analysis revealed that the relief received, loans and borrowings and, to some extent, financial transfers are the coping instruments adopted by the flood-affected households. On the other hand, migration as a coping strategy is adopted by relatively few people to overcome the adverse effect of flood. To reduce the vulnerability of the people, the author's recommendations are improved planning for rainwater management, urban planning, better health facilities, education and some schemes to improve the income of the poor.

## PART V: CREDIT AND TECHNOLOGY FOR AGRICULTURE

Agricultural credit plays a vital role in farm sector development and adoption of new technologies. Availability of adequate and timely credit at reasonable cost enables farmers to purchase inputs, build up capital assets in form of farm implements, irrigation infrastructure, etc., and adoption of new and sustainable technology to boost agricultural production. Farming as a business requires constant flow of credit so that farmers are able to fulfil their working and fixed capital requirements. Unfortunately, the Situation Assessment Survey of the NSS for 2019 shows that only 30 per cent of the cultivators are indebted to the institutional credit agencies at the all-India level, which is even lower at 21 per cent in Bihar. In this context, Bibhudatta Nayak discusses the status of institutional credit flow to the agriculture sector in Bihar and examines the demand and supply-side factors responsible for low credit offtake in the farm sector. He also suggests some policies for 'horizontal' and 'vertical' expansion in institutional credit flow to the agriculture sector in Bihar. As regards the low credit offtake from institutional agencies in Bihar, the demand-side factors are identified as low KCC coverage, small-ticket loans (low demand for credit in a situation where 91 per cent of the holdings belong to the marginal category) and borrowers' attitude towards the public sector banks (wilful default of loan in anticipation of announcement of loan waivers by the government). On the other hand, the supply-side factors constraining the flow of institutional credit in Bihar are high non-performing assets of the banks, weak financial health of the regional rural banks and cooperatives, and low capital formation in agriculture through government support due to weak budgetary allocation for agriculture. Of course, some initiatives have been taken to improve institutional credit flow in the state in recent years by the RBI, state government and NABARD. To what extent such initiatives are being effective to enhance institutional credit flow for agriculture would become clear through future investigation. However, the author presents two sets of suggestions for consideration of the institutional credit agencies and the state government to change the agricultural credit scenario to boost agricultural performance and farmer incomes.

In developing countries, where the agricultural technology is predominantly traditional and there is high concentration of people in the agricultural sector, adoption of new methods of cultivation (technology) becomes necessary as it helps the farmers to enhance their income and livelihood. The adoption of new technology might happen through individual initiatives of the farmers as well as due to intervention by some local-level organisations in the form of training, for instance, by organising ‘farmers’ field-schools’. In a situation dominated by the poor and uneducated farmers, the usefulness of the second approach could not be undermined. Debabrata Samanta analysed field data to evaluate the effect on incomes and expenditures of the farmers following the intervention by a local-level organisation to provide training on improved farming technique and practices for onion cultivation in the villages of Gaya district of Bihar. He identified the factors that influence the farmers to self-select themselves for the training programme and assessed the counterfactual impact of such a programme as reflected through their incomes and expenditure patterns. The results show that the farmers with higher education level, better economic conditions and higher possession of land and assets are more likely to participate in the training programme and adopt the new cultivation technique. Further, the intervention of this kind created a positive impact on agricultural income of participant-farmers, which in turn led to higher spending on education and healthcare by them. Thus, he concludes that the new technique provided through training helps to enhance both the skills about improved cultivation practices and income of the farmers as well as to enhance their standard of living. On this basis, he recommends the organisation of more training camps for all categories of farmers to train and educate them about modern cultivation practices to raise their incomes from cultivation. However, for large-scale participation of the farmers in such programmes, efforts should be made to raise their educational base as well as the level of awareness so that they can comprehend the usefulness of application of new and more scientific methods of cultivation.

## PART VI: INCOME DIVERSIFICATION OF RURAL HOUSEHOLDS

The lack of growth of agricultural production and productivity results in low surplus generation forcing the large working population either to supplement their income from crop production by getting involved in non-farm activities within the village production systems or resort to migration to distant locations in search of more remunerative occupations. In this situation, an understanding of the extent and determinants of income diversification by the rural households becomes important. Meghna Dutta and Niladri Sekhar Dhar analyse primary data collected from eight villages spread across two agro-ecological zones of Bihar to understand the patterns of income diversification of the rural households. They also examine different aspects of the agrarian production process, compute the income diversification index of rural households and estimate an equilibrium model to identify the determinants of their income diversification index. Their observation is that, considering all categories of households, the extent of income diversification has been about 50 per cent. Further, the diversification behaviour of the households seems to be driven by the motive of accumulation as the households with larger operational holdings tend to diversify more. This points to the lack of opportunity available to poorer households in their study areas to supplement their already falling income from crop cultivation. As regards the determinants of income diversification, they observed that increased size of operational holding, amount of debt, number of workers in the family and availability of irrigation facilities enhance the value of income diversification index. On the other hand, weaker educational base of the head of household, higher distance from the nearest town and belonging to the ST social group reduce the value of the diversification index. One important policy suggestion emerging from this study is generation of more non-farm income opportunities, especially during the lean season and for lower social groups to lift them above the poverty line. Further, as the intricate intertwining of social and economic factors dampen the diversification opportunities, land reforms are of utmost importance in increasing agricultural income of rural households along with increase in investment in rural development projects.

The rising importance of the livestock sector in the agricultural economy has been one of the most important features of India's agricultural transformation. This is even more apparent in Bihar where the livestock sector has emerged as the most important driver of agricultural growth. Its contribution to agricultural households' income in Bihar increased steadily from 13 per cent in 2002–03 to about 23 per cent in 2018–19. The production of milk, meat, eggs and other livestock products has grown at more than

5 per cent per annum, contributing significantly to households' income and nutrition. Using secondary data drawn from multiple sources, Anjani Kumar, Seema Bathla and Vinay K. Sonkar provide a detailed analysis of the potential of the livestock sector in enabling higher income and promoting inclusive growth in Bihar, the challenges towards that goal and the way forward. They found that the livestock population in Bihar has increased from 30.3 million in 2007 to 36.4 million in 2019. Most importantly, the distribution of livestock resources favoured households at the lower end of land distribution where poverty is acute. However, they have lower yield both from crop and livestock activities and meagre capital for investment. Some other challenges faced are lower adoption of improved technologies, scarcity of feed and fodder for animals and their poor health besides inadequate institutional and policy support in terms of investment, finance, insurance and extension services. In this scenario, the extent to which the pro-poor growth opportunities offered by the livestock sector could be harnessed would depend on how the government addresses the challenges that the livestock sector faces. Some of their suggestions are strengthening the existing organised dairy cooperative societies, facilitating the linkage of farmers (upstream actors) with downstream actors (processors/poultry firms) preferably through FPOs/cooperative societies and self-help groups, providing app-based digital farm services for livestock and also disseminating knowledge about food safety and quality norms.

While India is known for an incommensurate transition of the economy between workforce and income, the states are positioned at different stages of transition. While less than one-third of rural people are dependent on agriculture in a state like Kerala, more than two-thirds of them are dependent on it in Rajasthan, Madhya Pradesh and Uttar Pradesh. Further, agriculture is by and large dominated by the small and unviable holdings. Therefore, income diversification to off-farm sources has been a way of life for many of the landholders. However, in dearth of sufficient off-farm opportunities, many landholders migrate for work at distant places. In the backdrop of increasing trend of rural–urban migration of interstate type, Brajesh Jha discusses the issues relating to the impact of migration on agricultural productivity. His main conclusion is that the migration of landowners from the hinterland where the rigid farm laws prohibit the tenancy of agricultural land is hurting productivity in agriculture. He is of the opinion that significant improvement of productivity in agriculture is difficult to infuse in a system that is dominated by small landholders, farmers are engaged in multiple activities and the farms are managed by the 'absent landowners' and informal lessees of land. Therefore, he suggests legalisation of tenancy that would protect the interest of lessors and lessees, increase the productivity of agriculture and encourage the transition of the rural economy to a higher growth path. Apart from this, development of a robust non-farm sector would be necessary which would require decentralisation of development as well as development of rural infrastructures.

## REFERENCES


Hoda, A., Rajkhowa P., & Gulati, A. (2017). *Unleashing Bihar's agriculture potential and drivers of agricultural growth*. ICRIER.

Hoda, A., Gulati, A., Jose, S., & Rajkhowa, P. (2021). Sources and drivers of agricultural growth in Bihar. In A. Gulati, R. Roy & S. Saini (Eds.), *Revitalizing Indian agriculture and boosting farmer incomes*. Springer.

Kannan, E., & Pohit, S. (2019). *Growth and structural transformation of agriculture in Bihar* (Policy Brief No. 1). NCAER.

NCAER. (2019). *Study on agricultural diagnostics for the State of Bihar in India*. NCAER.

# PART I

# AGRICULTURAL GROWTH TRAJECTORIES

CHAPTER 1

# ENABLING AGRICULTURE TO DRIVE FASTER AND INCLUSIVE GROWTH

*Ramesh Chand*

## 1.1 BACKGROUND

The subject matter of this book assumes special significance for two important reasons: (a) We are at the stage of finding out the ways and means to promote growth and inclusive development in a backward state like Bihar; and (b) We strongly believe that agriculture has advantage over other sectors of the economy in driving the socio-economic transformation of Bihar as also of other predominantly agrarian states in their early stages of development. We are saying so based on the experience of some of the present-day developed states in India and some countries.

It is well-known that the first major wave of growth and development in India came with the green revolution technology. Punjab, Haryana, Western Uttar Pradesh, deltaic regions of Andhra Pradesh, Tamil Nadu, Telangana and some other pockets witnessed transformation using this technology. This is very nicely documented in the literature, especially by some of the publications of the International Food Policy Research Institute for the states

**Disclaimer**: Views expressed here are personal.

of Punjab and Tamil Nadu. How agricultural growth led to overall transformation is explained through the backward and forward linkages and rural farm and non-farm linkages (Mellor, 1976, 2017).

The second wave of growth in India was, of course, led by industrialisation. This was mainly experienced in Maharashtra, Gujarat, Tamil Nadu – the coastal states. This was followed by the third wave that resulted from the services sector which was much more pronounced in Bengaluru (Karnataka) and Hyderabad (Telangana), and the rest of the country just caught up with them.

A comparison of these three models (waves) reveals an interesting fact. It is that the agri-led growth kept the state of Punjab at the top among major states of the country in terms of per capita income for several years. In the mid-1990s, Maharashtra, without much achievement in agriculture, overtook Punjab in per capita income at current prices. However, Maharashtra could not stay at the top for long as the state of Haryana overtook it by the end of the 1990s. There are some important messages from the rise/decline of Punjab, Maharashtra and Haryana.

High level of per capita income in Maharashtra was due to the very high level of industrialisation in a narrow industrial belt of Mumbai–Pune. If this belt is excluded, the per capita income in Maharashtra turns out to be lower than many states. Second, despite a much higher level of per capita income, poverty remained very high in Maharashtra. Thus, Maharashtra's growth model cannot be considered as inclusive. The state is now turning to the agriculture sector. Almost the same is the story of Karnataka. Its per capita income at current prices increased by 3.5 times in less than a decade after 2010–11 and crossed Punjab in per capita income. However, if the information technology hub of Bengaluru and Mysore is excluded, the situation turns totally different. Incidence of poverty in Karnataka at 20.91 per cent is much higher than poverty in Punjab (8.26 per cent) as per the 2011–12 data (Government of India, 2013).

Maharashtra, Karnataka and Gujarat skipped agriculture or did not attain prosperity through agricultural development to reach a particular level of income from where industry would take over. On the other hand, Tamil Nadu and Andhra Pradesh first exploited the green revolution and then, or simultaneously, started industrialisation. They show much less poverty compared to Maharashtra and Gujarat. Haryana, which first experienced agri-led growth followed by industry in the second stage, experienced growth that is inclusive and also sustained over a longer period. Thus, poverty in Haryana declined from 25 per cent to 11 per cent between 1993–94 and 2011–12. On the other hand, Punjab which ruled at top in per capita income for a very long time, kept sliding to a lower rank and many states crossed it in per capita income. The reason for this is that as the potential of agriculture in Punjab got almost exploited by the early 1990s, the state did not shift its focus towards growth of industry. The obvious lesson one could gather from the experiences of various states in the country is that to ignore agriculture in the growth process is detrimental to inclusive growth, and to remain stuck with agriculture ignoring industry is disastrous for economic development.

In fact, the confusion about the growth model in India stems from the Lewis (1954) model which has been very widely accepted. It assigned a very passive role to agriculture. The model represented agriculture as a dull sector, and thus advocated industrialisation for economic development. As the economy matured, it would move towards services. Many countries and states in India show it can be: the development path being 'agriculture → industry → services'; in no case agriculture development is skipped to avoid problems.

## 1.2 BIHAR SCENARIO

Since 1991, the per capita income in the state of Bihar has remained around one-third of per capita income for the country as a whole. This is partly due to lower growth of the state economy and partly due to higher growth in population compared to all other major states. In the recent years, Bihar economy has shown better performance compared to the past as well as compared to the rest of the country. But this has not changed its status in terms of per capita income because of higher growth in population. What is the best way to change this? To find an answer to this question we need to look at the specificities of Bihar and development experience of other states.

The moot question is: Will the agriculture-centric strategy be more effective than the service sector and/or the manufacturing sector for the state of Bihar in changing the dubious distinction of having just one-third of per capita income of India as a whole? We would view that though all states worked to develop all three sectors of the economy simultaneously, special focus or targeting sectors in a planned way has paid better dividends in most cases. The same is true of Bihar. It needs to develop all three sectors of the economy but if there is proper sequencing and priority in doing so, it will achieve a better and quick outcome. For that we need to look at some features of each of these three sectors in Bihar.

Let us begin by considering the manufacturing sector. Its growth rate in Bihar after 2011–12 has been 7.51 per cent per annum while the services sector has grown by 7.54 per cent per annum. Because of somewhat higher growth in services, the share of industry in the state economy has declined. Two other characteristics of contemporary industrial growth are also important to mention. The first is preferences for capital-intensive production and the option of labour displacing modern innovations. Though labour is cheap, industries are still going for capital-intensive production in India. Such a strategy of production generates output growth but not job growth. The second is the requirement of land for industry. This is a very serious constraint in the case of Bihar. Within industry, micro, small and medium enterprises have large scope because of traditional skills of artisans, craftsmen, and already well-established products like Mahbubani sarees and the likes.

The next is the services sector that involves two types of services. One is highly skilled services and the second is semi-skilled and moderately skilled services. Here, public sector services like health, education and other services delivery have a case for public sector delivery which is more in the nature of inclusiveness than having a growth push.

Now, we consider the agriculture sector, the largest sector of Bihar economy, that provides employment to 55 per cent of total workers (principal plus subsidiary) in the state (Government of India, 2022). Bihar is ahead of the all-India average in many areas in agriculture, has some advantages over other states and has many success stories in agriculture. Some of these are mentioned hereunder:

- Bihar has 72 per cent of the gross cropped areas under irrigation at present. It is endowed with water resources which are becoming a critical constraint for agricultural growth elsewhere.

- The wage rate in Bihar is the lowest among the major states of India.
- Fertilizer use in agriculture is reported to be the highest in Bihar among all major states.
- Bihar topped in the yield of potato in some years among all states.
- Maize production in Bihar has shown very impressive growth but yield of rice in the state is below two tons per hectare. The state has vast potential to raise paddy output because of high rainfall and abundant groundwater resources.
- With 40 per cent area under paddy, and 80 per cent under the cereals (wheat, rice and maize together), the state can do wonders if it catches up in yield of these three crops.
- Similarly, maize story can be further scaled up. Maize has put Bihar on national and international maps. Goods trains carrying maize from Bihar to Punjab and some South-east Asian countries are well-known. One can imagine how much value addition and jobs can be created in the supply chain based on maize cultivation in the state. However, right now, maize is grown only on 9 per cent of gross cropped areas, and it can be taken to much higher levels.
- Bihar has a very ideal climate for production of a variety of fruits and vegetables. Litchi and *Jardalu* mangoes (a unique mango variety from Bhagalpur) are two examples for the brand of Bihar.
- Fishing is another potential activity. Bihar has a lot of water bodies and the annual growth rate of fish production in the state has crossed 8 per cent since 2011–12. It is remarkable. Bihar can supply fish to the entire northeast India.
- There can be a lot of value addition activities in the case of potato as well.

## 1.3 FUTURE STRATEGY TO ATTAIN INCLUSIVE GROWTH

One approach to implement agriculture-led growth in Bihar is to identify activities for each district and push it aggressively. While diversity is good for ecology, specialization is good for growth.

Aggressive push, especially to high potential crops and products will create demand for inputs and also create a lot of post-harvest opportunities, popularly known as the rural farm and non-farm linkages. So far, such linkages remained very weak in Bihar as is evident from very large distress migration of labour from the state to every other state in India. We should think of creating an enabling environment for creating and harnessing forward and backward linkages through agricultural growth. The important elements of this strategy might be the following:

- The first one is greater role of farmers' organisations like *Jeevika* and many others who have shown that Bihar can transform its economy through agriculture.
- The second is the role of the private corporate sector through contract farming, taking technology to the field. One good example to emulate here is that of Jain Irrigation for banana revolution in Jalgaon district of Maharashtra. The state should encourage such investors.
- The third is improving the role of markets. Bihar repealed the APMC Act way back in 2006 and this is quoted as a market reform, which, in fact, it is not. It is now 16 years since the abolition of this Act, and we have some evidence of the consequences. It is to be noted that the Model APMC Act did not ask for abolition of the Act as such. Without the APMC Act in place, the option to farmers to sell their produce using public infrastructure and institutions has vanished. This was a move from one extreme to another extreme whereas the need of the hour is to have both – APMC option and freedom to private sector from restrictive APMC regulations.
- Farm harvest prices in Bihar are lowest for major crops. The state should give a big push to three crops, wheat–maize–rice that account for 80 per cent or more of the gross cropped area. It should promote the pockets of high value crops as specialization pockets.
- Promotion of agro-based industry based on maize, potato, mango and litchi is another important area for intervention.
- Bihar would also do better by reviving the status of sugarcane, especially in flood-prone areas as sugarcane is affected least by floods.

In conclusion, we would emphasize that Bihar should follow an ‘agri-centric growth model’. It should involve the private corporate sector and invite agri-tech firms and start-ups to promote food value chains and value addition, and market its products in better paying domestic and export markets.

## REFERENCES


Government of India. (2013). *Press note on poverty estimates, 2011–12*. Planning Commission.

Government of India. (2022). *Periodic labour force survey* (*July 2020 – June 2021*). Ministry of Statistics & Programme Implementation, National Statistical Office.

Lewis, W. A. (1954). Economic development with unlimited supplies of labour. *The Manchester School*, *22*, 2.

Mellor, J. W. (1976). *The new economics of growth*: *A strategy for India and the developing world*. Cornell University Press.

Mellor, J. W. (2017). *Agricultural development and economic transformation*: *Promoting growth with poverty reduction*. Cornell University Press.

# CHAPTER 2

# SOURCES OF AGRICULTURAL GROWTH

## Implications for Policy Interventions

*Elumalai Kannan and Sanjib Pohit*

## 2.1 BACKGROUND

The economy of Bihar has undergone a structural shift from the primary sector to the services sector in terms of income share since 2000–01. The share of agriculture in the state income has declined from 44.6 per cent in 2000–01 to 19.3 per cent in 2018–19, while the share of industry has increased from 12.8 per cent to 19.5 per cent and the share of services has risen from 42.6 per cent to 61.2 per cent (Government of India, 2019). Despite a fall in the income share, about 70 per cent of the total workforce is still employed in the agricultural sector. This has led to widening of income disparity between the agricultural and non-agricultural workers overtime. In fact, our estimates show that the ratio of non-agricultural to agricultural worker productivity has increased from 4.7 to 7.7 between 2001 and 2011. It is discomforting to observe that agricultural worker productivity has remained more or less stagnant between these periods. Regional disparity in economic and social development within the state is quite startling with skewed distribution of public expenditure on developmental programmes (Ghosh & Gupta, 2009; Tsujita et al., 2010) and lopsided diffusion of agricultural technology (Thakur et al., 2001).

These issues underline the need for achieving a robust growth of the agricultural sector for the economic and social development of the state. Keeping this in view, the Government of Bihar has launched many initiatives for improving crop productivity growth and farmers' income. These include the development of irrigation, strengthening the input supply and extension programmes, and the introduction of market reforms and farm mechanisation, among others. These initiatives are being implemented under different phases of the agriculture road maps as follows (Pohit et al., 2019): the first agriculture road map (2008–09 to 2011–12); the second agriculture road map (2012–13 to 2016–17) and the third agriculture road map (2017–18 to 2022–23). Road maps set production targets to be achieved through adoption of technologies, and implementation of various agricultural programmes in a time-bound manner.

The policy initiatives under agricultural road maps seem to have helped in accelerating Bihar's agricultural growth. Our estimates show that the agricultural sector has registered an annual growth of 2.0 per cent during the period from 2000–01 to 2007–08, though with a low base. During the subsequent period from 2008–09 to 2011–12, agricultural growth increased considerably to 3.1 per cent, which led to the achievement of a very high growth rate of 10.9 per cent in Gross State Domestic Product (GSDP). However, during the subsequent period of five years (2012–13 to 2016–17), agricultural growth decelerated to 1.3 per cent, which also pulled down the GSDP growth to 6.6 per cent. The volatility in agricultural growth has also increased. It is in this context the present chapter analyses the nature and pattern of agricultural growth in Bihar. More specifically, the study analyses the drivers of agricultural growth with a specific focus on the crop sector. The chapter is organised in six sections. The second section provides data sources and analytical tools used in the study. The third section analyses changes in crop output and land productivity. While the fourth section presents trends in cost and income from crop cultivation, the fifth section analyses the drivers of crop output growth in Bihar. The final section provides conclusions.

## 2.2 DATA SOURCES AND METHODOLOGY

In this study, we use secondary data compiled from various published sources. The data analysis pertains to the period 2000–01 to

2018–19. For analytical purposes, this period is sub-divided into the pre-agriculture road map period (2000–01 to 2007–08) and the post-agriculture road map period (2008–09 to 2018–19). For identifying the drivers of agricultural growth and their relative contribution, the 'resource decomposition method' proposed by Fuglie (2012, 2015) is used. This method involves, first, estimation of the total factor productivity (TFP), and then computes the contribution of TFP and other inputs to output growth. The present study uses the Tornqvist-Theil index to estimate the TFP growth. This index is widely used in the literature (Capalbo & Antle, 1988; Coelli et al., 2005; Diewert, 1976, 1978) and it can be expressed in logarithmic form as follows:

$$\ln\left(\frac{\mathrm{TFP}_t}{\mathrm{TFP}_{t-1}}\right)=\sum_j R_j \ln\left(\frac{Y_{jt}}{Y_{jt-1}}\right)-\sum_i S_i \ln\left(\frac{X_{it}}{X_{it-1}}\right) \tag{2.1}$$

where $\mathrm{R}_{\mathrm{j}}$ is the revenue share of $\mathrm{j}^{\mathrm{th}}$ output, $\mathrm{S}_{\mathrm{i}}$ is cost share of $\mathrm{i}^{\mathrm{th}}$ input, $Y_{\mathrm{jt}}$ is output and $X_{it}$ is input measured, all in period *t*.

Here, the total output growth is estimated by summing up the growth of each output weighted by its revenue share while the input growth is estimated by summing up the growth of each input weighted by the cost share. The difference between the growth of the total output and the growth of the total input is called TFP growth.

The output growth can be decomposed into different components. If we consider a particular input, for example, land, then the output growth can be written as the growth in the land (area) and growth in yield of this particular resource. This can be written as follows:

$$\dot{Y} = \dot{X}_1 + \left(\frac{\dot{Y}}{X}\right) \tag{2.2}$$

The dot above the variable refers to the annual growth rate. Following Fuglie (2012), the yield growth can be decomposed into the growth due to TFP and other inputs used per unit of land. This can be written as:

$$\dot{Y} = \dot{X}_1 + \dot{\mathrm{TFP}} + \sum_{i=2}^{I} S_i \left( \frac{X_i}{X_1} \right) \tag{2.3}$$

The above equation provides a resource decomposition of output growth as it focuses on quantity changes in physical resources such as land.

## 2.3 CHANGES IN AGRICULTURAL OUTPUT AND CROP PRODUCTIVITY

The changes in composition of agricultural output reveal the broad pattern of structural changes in the sector over time (Table 2.1). The contribution of crop agriculture to overall output has declined, from 66.3 per cent in 2002–03 to 52.0 per cent in 2018–19. Within agriculture, horticulture accounted for one-fifth of output in 2018–19, while field crops constituted roughly one-third of the agricultural output. The output from field crops and horticulture registered splendid growth during the period of agriculture road maps (2008–09 to

Table 2.1 Changes in Composition of Agriculture and Allied Activities

| | *% Share* | | | *Trend Growth Rate (%)* | | |
|---|---|---|---|---|---|---|
| *Item* | *TE 2002–03* | *TE 2007–08* | *TE 2018–19* | *2000–01 to 2007–08* | *2008–09 to 2018–19* | *2000–01 to 2018–19* |
| Agriculture | 66.3 | 56.4 | 52.0 | −0.69 | 3.81 | 3.34 |
| Field crops | 34.7 | 32.4 | 31.1 | 1.53 | 4.49 | 4.23 |
| Horticulture | 31.6 | 24.0 | 20.9 | −3.51 | 2.30 | 0.69 |
| Livestock | 25.4 | 30.3 | 34.6 | 6.39 | 6.65 | 6.35 |
| Forestry | 4.4 | 9.5 | 6.7 | 18.99 | 4.26 | 5.63 |
| Fishery | 4.0 | 3.8 | 6.7 | 2.43 | 9.39 | 8.55 |
| Overall | 100.0 | 100.0 | 100.0 | 2.57 | 5.07 | 4.58 |

*Source:* Authors' estimation.

*Note:* TE, triennium ending.

2018–19) as compared to the pre-agriculture road map period. Trend growth in output from the field crops was 4.49 per cent per annum, and it was 2.30 per cent from horticultural crops. For the entire period of 2000–01 to 2018–19, trend annual growth in output from the crop sector was appreciable at 3.34 per cent though its share in the overall output has come down overtime.

Interestingly, the decline in the share of crop output has been offset by a considerable rise in the contribution of the livestock sector. Livestock rearing has emerged as an important activity, accounting for about 34.6 per cent of total output during triennium ending (TE) 2018–19. Increase in its contribution was concomitant with a sustained growth of livestock output by over 6.0 per cent in different periods. Fishery and forestry activity have also registered commendable growth during the entire period of analysis. Growth in output from fishery was much higher than that of all other sub-sectors during the agriculture road map period. This implies that fishery is emerging as another important economic activity in rural Bihar.

Within the crop sector, farmers in Bihar have mostly used cultivable land to grow cereals, which constituted about 80 per cent of total cropped area (Table 2.2). Three crops namely, paddy, wheat and maize, account for most of the area under cereals and 80 per cent of total cropped area in the state. These crops also contributed about 40 per cent of the total value of crop output. With a more or less constant area share, there is a substitution of area among the cereals, particularly between paddy, wheat and maize. The importance of paddy among the farmers has come down marginally, which is evident from a decline in its area from 45.3 per cent in TE 2002–03 to 43.4 per cent in TE 2018–19. The area under paddy is being shifted to the cultivation of maize, which farmers prefer to grow due to its commercial importance. There is a growing demand for maize in the food processing industry and as poultry feed. Similarly, the area under wheat has increased and it constituted over a quarter of the total cropped area. Expansion of area under wheat can be attributed to availability of improved

Table 2.2 Share of Crop Area and Value of Output (%)

| Crop | % Share of Crop Area | | | % Share of Value of Output | | |
|---|---|---|---|---|---|---|
| | TE 2002–03 | TE 2007–08 | TE 2018–19 | TE 2002–03 | TE 2007–08 | TE 2018–19 |
| Paddy | 45.3 | 44.5 | 43.4 | 20.4 | 19.7 | 22.8 |
| Wheat | 26.5 | 27.2 | 28.2 | 13.7 | 16.1 | 15.5 |
| Maize | 7.6 | 8.4 | 9.2 | 3.6 | 4.5 | 6.2 |
| Total cereals | 80.1 | 80.7 | 81.1 | 37.9 | 40.3 | 44.5 |
| Moong | 2.4 | 2.3 | 2.3 | 1.1 | 0.8 | 1.1 |
| Lentil | 2.2 | 2.1 | 1.9 | 1.2 | 1.1 | 1.1 |
| Khesari | 1.9 | 1.3 | 0.7 | 0.4 | 0.3 | 0.2 |
| Total pulses | 8.8 | 7.9 | 6.4 | 4.3 | 3.6 | 3.5 |
| Total food grains | 88.9 | 88.6 | 87.5 | 42.2 | 43.9 | 48.1 |
| Jute | 1.8 | 1.7 | 1.1 | 0.8 | 1.1 | 1.3 |
| Total fibres | 2.2 | 2.0 | 1.3 | 0.9 | 1.2 | 1.4 |
| Rapeseed & mustard | 1.2 | 1.1 | 1.1 | 0.6 | 0.7 | 0.8 |
| Total oilseeds | 1.8 | 1.8 | 1.4 | 1.0 | 1.2 | 0.9 |
| Sugarcane | 1.3 | 1.5 | 3.1 | 2.1 | 1.6 | 3.9 |
| Potato | 1.8 | 1.9 | 4.2 | 2.1 | 2.7 | 2.6 |
| Fruits & vegetables | 5.1 | 5.4 | 5.9 | 44.8 | 39.4 | 31.2 |
| Horticulture | 5.2 | 5.6 | 6.1 | 47.7 | 42.5 | 40.2 |
| Others | 0.5 | 0.4 | 0.6 | 6.1 | 9.6 | 5.4 |
| Overall | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

*Source:* DES, Ministry of Agriculture and Farmers' Welfare.

new varieties and assured procurement of grains by primary agricultural credit societies at a minimum support price.

The area under pulses has declined by over 20 per cent between TE 2002–03 and TE 2018–19. Green gram (moong), lentil, lathyrus (khesari) and gram are the important pulses grown in Bihar. Despite a significant rise in minimum support prices of pulses in the past few years, the decline in their area and value of output is worrisome. Unlike cereals and pulses, oilseeds are not major crops cultivated by farmers in Bihar. In fact, the area under oilseeds has more or less remained stagnant over time. Jute is grown in the heavy rainfall regions of northern Bihar. But the area under jute has declined considerably from 1.35 lakh hectares to 0.71 lakh hectares between TE 2002–03 and TE 2018–19. Lack of a proper policy and institutional support, and weak markets are responsible for the decline in jute cultivation (Sarkar, 1986).

Interestingly, the area under sugarcane has increased considerably during recent years. The share of sugarcane in total cropped area has risen from 1.3 per cent to 3.1 per cent between TE 2002–03 and TE 2018–19. Most of the sugarcane area is concentrated in the north-western region. Availability of groundwater and an increase in the number of sugar mills are partly responsible for the increase in the area under sugarcane. With favourable climatic conditions and natural resources, Bihar is highly suitable for the cultivation of fruits and vegetables. Although the area under fruits and vegetables constituted about 6.0 per cent of total cropped area, they contributed about one-third of total value of output. Potato is the major vegetable grown in 4.2 per cent of area. However, lack of proper marketing arrangements, poor infrastructure and inadequate institutional support appear as deterrents for increased diversification towards cultivation of fruits and vegetables.

A comparison of actual yield of major crops grown in Bihar with the yield of the same crops at the national level reveals a very interesting picture about the performance of crop economy (Table 2.3). The yield of crops under consideration has shown an increasing trend over time. The yield of rice and wheat in Bihar was slightly lower than their yield at the national level. But with annual growth of about 3.7 per cent in rice and 2.1 per cent in wheat between 2000–01 and 2018–19, the yield of these crops will certainly surpass

Table 2.3 Changes in Yield of Major Crops in Bihar and India (t/ha)

| Crop | Bihar | | India | | Trend Growth Rate (%) (2000–01 to 2018–19) | |
|---|---|---|---|---|---|---|
| | TE 2002–03 | TE 2018–19 | TE 2002–03 | TE 2018–19 | Bihar | India |
| Rice | 1.46 | 2.29 | 1.91 | 2.57 | 3.72 | 1.80 |
| Wheat | 2.04 | 2.78 | 2.69 | 3.37 | 2.11 | 1.38 |
| Maize | 2.38 | 3.64 | 1.83 | 2.94 | 2.89 | 2.98 |
| Green gram | 0.59 | 0.70 | 0.33 | 0.50 | 1.10 | 2.57 |
| Lentil | 0.88 | 1.02 | 0.64 | 0.93 | 1.63 | 1.92 |
| Rapeseed & mustard | 0.80 | 1.24 | 0.93 | 1.41 | 2.72 | 2.00 |

*Source:* DES, Government of India.

the national average in the short run. The yield of other crops such as maize, green gram and lentil in Bihar was well above the average yield obtained at the national level.

Growth in output and average land productivity by major crops are provided in Table 2.4. Land productivity is measured as the gross value of output per hectare of net sown area at 2011–12 prices. Land productivity is relatively high for horticultural crops compared to field crops. These crops have more or less registered higher growth in output during the period of agriculture road maps with the exception of sweet potato and turmeric. Dry ginger, garlic and potato registered higher growth in output. Land productivity was the highest for dry ginger followed by dry chillies, banana, sweet potato and turmeric. For most horticultural corps, the land productivity has shown an increasing trend over time. There is growing interest among farmers to expand the area under horticultural crops.

Land productivity of major field crops has also shown upward trend. The productivity of sugarcane was as high as Rs. 90,962/ha during the TE 2018–19 with a robust average output growth of 10.8 per cent during the period of agriculture road map.

Table 2.4 Growth in Crop Output and Average Productivity

| Crop | Growth Rate (%) | | Average Productivity (Rs/ha) | | |
|---|---|---|---|---|---|
| | 2000–01 to 2007–08 | 2008–09 to 2018–19 | TE 2002–03 | TE 2007–08 | TE 2018–19 |
| Paddy | −1.14 | 5.27 | 18,917 | 18,738 | 38,366 |
| Wheat | 3.03 | 3.87 | 21,712 | 25,042 | 38,149 |
| Jowar | 14.4 | −10.23 | 5,154 | 6,623 | 18,423 |
| Bajra | 30.31 | 3.65 | 5,285 | 4,590 | 21,647 |
| Barley | −2.8 | 6.61 | 10,467 | 11,438 | 30,210 |
| Maize | 3.15 | 8.75 | 20,040 | 22,543 | 48,016 |
| Ragi | −9.49 | −4.23 | 5,989 | 5,648 | 25,252 |
| Gram | −3.77 | 3.57 | 30,850 | 28,380 | 50,774 |
| Arhar | −2.33 | −2.51 | 35,692 | 37,839 | 73,269 |
| Urad | −2.34 | −3.34 | 18,673 | 19,573 | 71,050 |
| Moong | −5.18 | 7.37 | 19,240 | 14,679 | 34,718 |
| Lentil | −3.36 | −0.91 | 23,637 | 20,916 | 39,706 |
| Khesari | −3.61 | −5.16 | 8,571 | 10,723 | 24,843 |
| Linseed | −2.98 | −9.06 | 20,975 | 22,160 | 27,705 |
| Rapeseed & mustard | 1.64 | 4.84 | 23,030 | 28,244 | 50,573 |
| Sugarcane | −5.98 | 10.83 | 67,171 | 46,052 | 90,962 |
| Jute | 5.19 | 10.43 | 18,647 | 27,144 | 98,426 |
| Mesta | 1.69 | 7.04 | 16,913 | 23,637 | 43,679 |
| Dry chillies | −5.84 | 2.94 | 64,516 | 62,692 | 143,647 |
| Dry ginger | 15.03 | 10.66 | 35,581 | 53,755 | 229,639 |
| Turmeric | 8.26 | −1.11 | 40,362 | 58,049 | 70,082 |
| Coriander | 5.92 | 3.11 | 17,385 | 24,047 | 48,701 |
| Garlic | 2.21 | 8.4 | 34,030 | 32,096 | 36,092 |
| Potato | 4.67 | 5.26 | 49,578 | 59,720 | 43,370 |

| Crop | Growth Rate (%) 2000–01 to 2007–08 | 2008–09 to 2018–19 | Average Productivity (Rs/ha) TE 2002–03 | TE 2007–08 | TE 2018–19 |
|---|---|---|---|---|---|
| Sweet potato | 4.97 | −17.95 | 104,505 | 142,807 | 71,794 |
| Banana | −6.11 | 2.99 | 209,949 | 149,166 | 85,491 |
| Onion | 11.53 | 4.48 | 54,167 | 88,663 | 37,166 |
| Overall | −0.69 | 3.81 | 51,387 | 57,405 | 101,751 |

*Source:* Computed from *National Accounts Statistics (various years)*, DES, Ministry of Agriculture and Farmers' Welfare.

The performance of pulses, particularly, red gram (arhar), black gram (urad) and gram has been very impressive in terms of land productivity. Among pulses, only gram and moong have registered positive growth in their output. A similar encouraging trend in land productivity is evident among cereals as well. Overall, the aggregate land productivity has almost doubled between TE 2002–03 and TE 2018–19 to reach ₹1,01,751/ha. The average growth in output was appreciable at 3.8 per cent during the period of agriculture road maps as compared to a negative growth in output during the period of pre-agricultural road map.

### 2.3.1. Irrigation and Cropping Intensity

The availability of irrigation facility augments the area under various crops through an increase in cropping intensity leading to higher land productivity. The proportion of gross irrigated area to total cropped area increased remarkably by 31 percentage points between 2000–01 and 2018–19. Gross irrigated area stood at 74.2 per cent during 2018–19. In correspondence with the increase in irrigated area, cropping intensity rose from 116 per cent to 143 per cent over this period. This trend in parallel movement of gross irrigated area and cropping intensity can be seen in Figure 2.1. The correlation between gross irrigated area and cropping intensity stands at 0.97 implying that there is a scope for increasing the cropping intensity to a higher level.

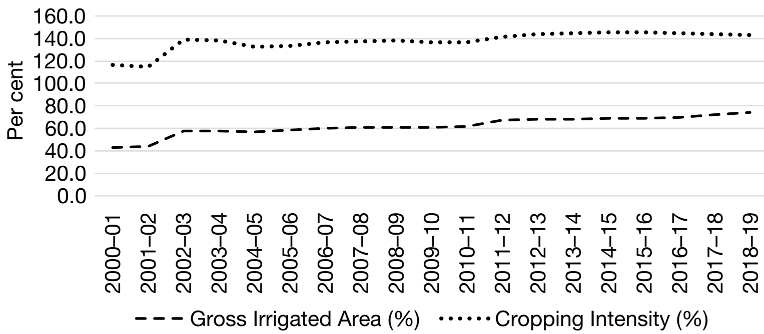



Figure 2.1 Trend in Gross Irrigated Area and Cropping Intensity (%)

*Source:* DES, Ministry of Agriculture and Farmers' Welfare.

## 2.3.2. Government Expenditure on Agriculture and Allied Activities

The improved performance of agriculture is important for achieving higher economic growth in Bihar. For this, a strong budgetary support is required to maintain a higher growth momentum in the long run. Although the amount of government spending on agriculture and irrigation has increased in absolute terms, its share in overall state budgetary outlay was less than 10 per cent (Government of Bihar, 2018). This is much lower than some of the recently fast-growing states such as Madhya Pradesh where agriculture and allied activities accounted for over 50 per cent of the total budgetary expenditure.

Notwithstanding the upward trend in revenue and capital expenditures in agriculture and irrigation sectors of Bihar since 2000–01 (Figure 2.2), there is a slump in both revenue and capital expenditure from 2014–15 onward. The average share of capital expenditure was 39.0 per cent during 2000–01 to 2007–08, which declined to 34.0 per cent during 2008–09 to 2017–18. The falling government expenditure, particularly, capital expenditure in agriculture and irrigation, is worrisome. Since capital expenditure creates permanent assets and infrastructure facilities to deliver agricultural services to farmers, its low and falling share in the total expenditure will hinder future growth potential.

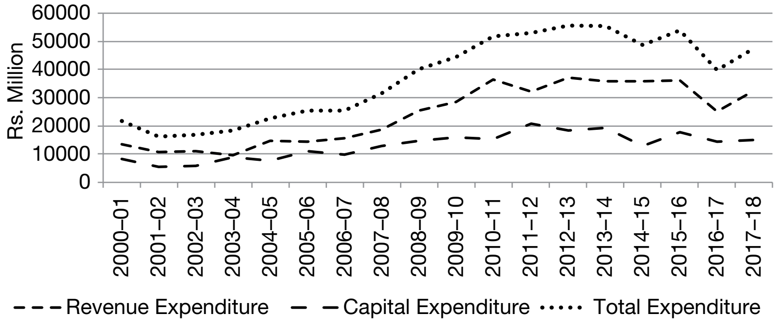



Figure 2.2 Government Spending on Agriculture, Irrigation and Flood Control (2011–12 Prices)

*Source:* CAGI (various years).

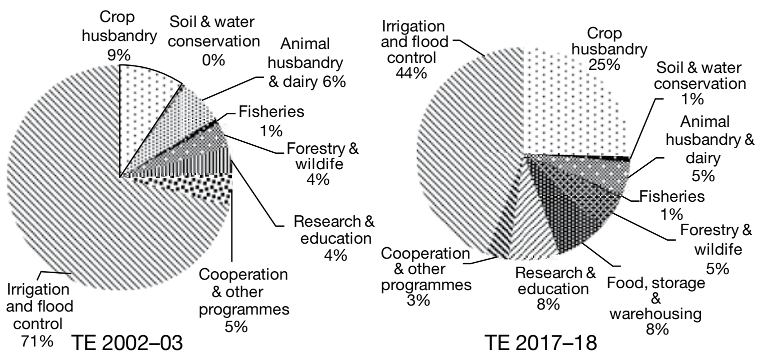



Figure 2.3 Composition of Government Expenditure (Revenue + Capital) on Agriculture and Irrigation TE 2002–03 TE 2017–18

*Source:* CAGI (various years).

The analysis of composition of government spending in agriculture and irrigation reveals that irrigation and flood control alone accounted for over 70 per cent of total expenditure during TE 2002–03 (Figure 2.3). Although resources were allocated for the development of other sub-sectors, given the problem of recurring floods, a major share of total expenditure (44 per cent) was devoted to irrigation and flood control in TE 2017–18. Crop husbandry accounted for a quarter of the total expenditure in TE 2017–18. There has been a significant rise in capital expenditure on construction of buildings for agricultural offices under different plan schemes since 2012–13. The rise in capital expenditure under this heading appears to have reduced considerably the spending on irrigation and flood control in the recent years. Agricultural research and education, and food, storage and warehousing each accounted for only 8.0 per cent of the total expenditure. Higher public investment on development of improved agricultural technologies will help the farmers to reduce the cost of cultivation and increase farm incomes.

## 2.4. CHANGES IN COST AND CROP INCOME

Analysis of trends in the cost of cultivation and net income from major crops provide an idea of the comparative performance of these crops. A higher agricultural income can be realised through reduction in the cost of cultivation and increase in the value of the output. The cost of cultivation survey conducted annually by the Ministry of Agriculture, Government of India, has been utilised for the estimation of cost and crop income. This survey collects detailed information on inputs, output and prices at the farm level for different crops across major states. In the case of Bihar, consistent information is available for six major crops: paddy, wheat, maize, gram, lentil and potato. These crops account for about 90 per cent of the total cropped area in the state.

The concept of net income is widely used as a measure of tracking the changes in farmers' welfare. Net income is calculated as the difference between total cost (Cost $C_2$) and gross value of output (only main product). Cost includes all the actual expenses incurred in cash and kind by cultivators, rent paid for leased in land, interest on value of own capital assets (excluding land), rental value of own land and imputed value of family labour. To compute per hectare net income, both inputs and output data were deflated by relevant price deflators at 2011–12 as the base year. The inputs considered include human labour, bullock labour, seeds, fertilisers, insecticides, irrigation, interest on working capital, rent paid for leased-in land, interest on value of own capital assets, land revenue, cesses and taxes and depreciation on implements and farm buildings. While agricultural labour wages were deflated by consumer price index for agricultural labourers, material inputs and other

Table 2.5 Changes in Average Real Cost, Output and Income of Major Crops in Bihar (Rs/ha)

| Crop | Gross Value of Output (Average) | | Total Cost (Average) | | Net Income (Average) | |
|---|---|---|---|---|---|---|
| | 2000N01 to 2007–08 | 2008–09 to 2017–18 | 2000–01 to 2007–08 | 2008–09 to 2017–18 | 2000–01 to 2007–08 | 2008–09 to 2017–18 |
| Maize | 36816 | 45218 | 24820 | 29975 | 11996 | 15243 |
| Paddy | 22863 | 26779 | 22994 | 28611 | –131 | –1833 |
| Gram | 31695 | 40629 | 17847 | 23492 | 13848 | 17138 |
| Lentil | 25754 | 26988 | 17221 | 19547 | 8533 | 7441 |
| Wheat | 28283 | 35847 | 25296 | 29587 | 2988 | 6260 |
| Potato | 65939 | 70499 | 55696 | 52639 | 10242 | 17859 |
| Overall (weighted) | 23091 | 29314 | 20807 | 26059 | 2284 | 3255 |
| Coefficient of variation (%) | 10.24 | 10.09 | 6.75 | 21.14 | 145.88 | 103.01 |

*Source:* CACP, Ministry of Agriculture and Farmers' Welfare.

items were deflated by the respective wholesale price indices. The value of output of different crops was deflated by using the respective wholesale price indices. The state-level income series was constructed by using the area share of crops in the total cropped area as the weight.

Details of average real cost, output and income of major crops in Bihar are given in Table 2.5. It is observed that, except for paddy, net income obtained for other crops was positive. There are considerable variations in the average value of output and cost among the crops, which affect the level of average income. Among crops, average net income was relatively high for gram with Rs. 17,138 per hectare and for maize with Rs. 15,243 per hectare during the period of agriculture road maps (2008–09 to 2017–18). In the case of paddy, the rate of increase in the total cost was much higher than the rise in the gross value of output. This has resulted in negative income in paddy cultivation not only during the pre-agriculture road map period but also in the periods of the agriculture road map.

There is considerable improvement in the value of output over total cost of cultivation of wheat. This has led to an increase in the average net income by 2.1 times between the pre-agriculture road map and the agriculture road map periods. In the case of lentil, the average net income has marginally declined. This was because the total cost increased more than a proportionate rise in the gross value of output. In contrast, net income from potato cultivation has increased considerably during the study periods with an increase in gross value of output and a marginal decline in the total cost. Overall, weighted average income from all the six crops has increased from Rs. 2,284 to Rs. 3,255 per hectare. Importantly, the coefficient of variation of net income has declined during the recent period even though it still remains high.

Figure 2.4 shows the trend in real output, cost and net crop income (2011–12 prices) at the aggregate level. The aggregate value of output showed a moderately increasing trend till 2005–06 and declined marginally thereafter. Since 2007–08, it has increased sharply though with some fluctuations in the series. Total cost has also shown an upward trend throughout the study period. A sharper rise in the total cost over the value output led to negative

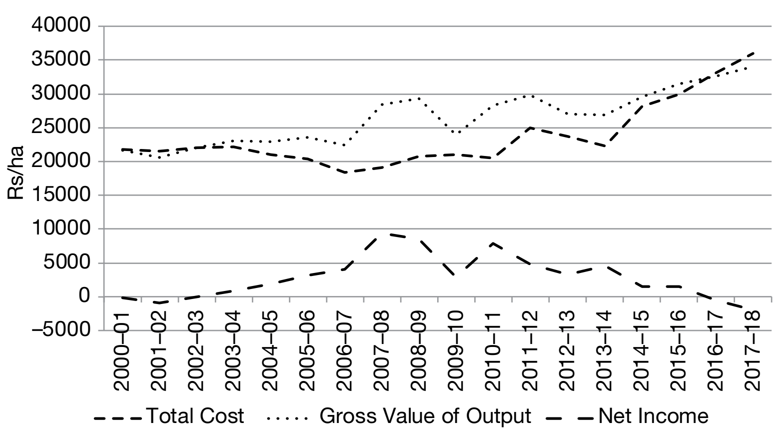



Figure 2.4 Trend in Overall Cost, Output and Crop Income

*Source:* CACP, Ministry of Agriculture and Farmers' Welfare.

net income during the initial and recent years of the study period. Although net income recovered from its negative trend in 2003–04, unfortunately it declined sharply since 2011–12 due to a sharp increase in aggregate cost of production. Perhaps a continuous rise in cost of material inputs, higher wages and high cost of finance contributed to a rise in cost of cultivation (Government of India, 2017; Kannan, 2015).

## 2.5 SOURCES OF CROP OUTPUT GROWTH

Our analysis has shown that the crop output has registered an appreciable growth over time. At the same time, cost of cultivation has also increased considerably. In this context, it is useful to examine whether input intensification or technological innovation is driving output growth. It is also important to analyse the sustainability of this higher growth in the long run.

As mentioned in section 2.2, the resource decomposition method proposed by Fuglie (2012, 2015) is useful to identify the extent of intensity of resource use and the role of technology in promoting output growth. Under this method, output growth is estimated as the sum of area growth and yield growth. Then, yield growth is decomposed to TFP growth and input growth. To accomplish the resource decomposition analysis, detailed information about inputs and output are required. Luckily, the cost of cultivation survey provides this information for six major crops, namely, paddy, wheat, maize, gram, lentil and potato, and the same has been utilised here.

Before discussing the results of the resource decomposition analysis, it is useful to present the trend in weighted indices of output, input and TFP for these six crops taken together. The aggregate output index has shown a gradual rising trend from 2000–01 to 2006–07 (Figure 2.5). It suddenly increased in subsequent years and then declined in 2009–10. There seems to be a structural break in the output series during 2009–10 and it was caused by widespread drought in different regions of Bihar (Government of Bihar, 2011). Encouragingly, the output index surged upward thereafter. The upward movement in the output index from 2010–11 onwards falls within the period of the second agriculture road map.

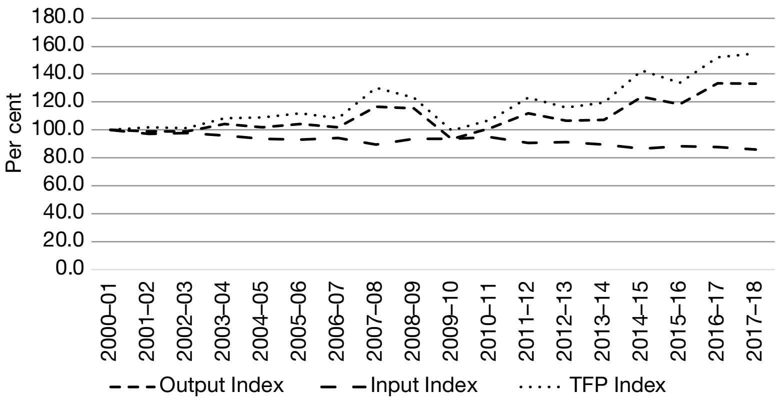



Figure 2.5 Trend in Output, Input and TFP Index

*Source:* Authors' estimation.

The aggregate input index has declined steadily during the study period. This indicates that input use in the cultivation of the crops is low and it has been declining over time. This also implies that output growth is largely driven by technological change and that the contribution of input intensification is limited. The aggregate TFP index, which is a measure of technological change, has moved closely with the movement of the aggregate output index. It is encouraging that the overall rise in TFP has led to an increase in the output index.

Looking at the relative contribution of inputs and TFP to output growth in different periods, the contribution of TFP stands out clearly (Figure 2.6). At the same time, the contribution of fertilisers and manure, area expansion and irrigation has improved during the period of the second agriculture road map. Among the inputs, contribution of irrigation stands out clearly. But effect of these inputs still remains low and hence their relative contribution to yield growth is also low compared to TFP growth. The fall in the contribution of human labour and bullock labour is not adequately offset by the positive contribution of mechanisation. There is a scope for increasing the level of mechanisation of agricultural operations in the backdrop of rising labour costs and labour out-migration.

The relative contribution of various material inputs, labour, TFP and natural resources such as land and irrigation water are

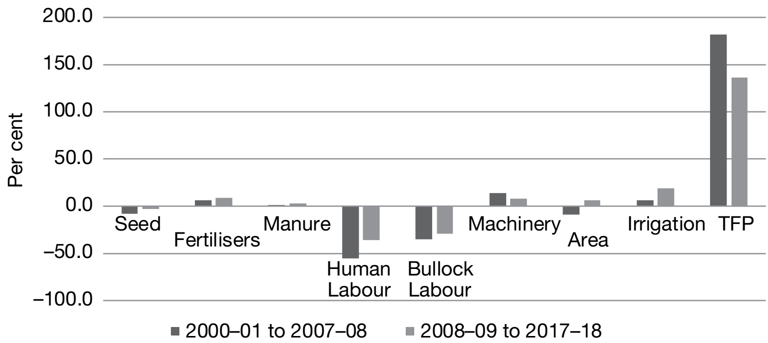



Figure 2.6 Contribution of Input Growth and TFP Growth by Different Periods

*Source:* Authors' estimation.

given in Table 2.6. Considering all six crops together, the aggregate TFP growth was 2.18 per cent during the period 2000–01 to 2017–18. Output growth was about 1.45 per cent, which was mainly contributed by TFP growth. Input growth was negative. This TFP growth in Bihar agriculture is much higher than the TFP growth of 1.6 per cent at the national level (Fuglie, 2018). This implies that Bihar agriculture tended to catch up with technological progress at the national level. At the aggregate level, only fertilisers and manure, machinery, area and irrigation have registered a positive average growth rate. Irrigation was the single most important input, contributing about 45 per cent of output growth, followed by mechanisation with 23 per cent.

The contribution of various inputs and technological change to output growth is varied across crops. Output growth was relatively high for gram and wheat with 3.20 per cent and 1.82 per cent, respectively (Table 2.6). Both TFP growth and input growth are responsible for output growth in gram, while TFP growth alone has contributed significantly to output growth in wheat. The TFP growth was appreciable at 2.57 per cent in gram, 2.37 per cent in paddy and 2.23 per cent in wheat during the study period. Output growth of potato was largely driven by its TFP growth. Except gram, input growth for other crops was negative. Contribution of fertilisers, machinery and irrigation to output growth was

Table 2.6 Relative Contribution of Input Growth and TFP Growth to Output Growth: 2000–01 to 2017–18

| *Crop* | *Output* | *Input* | *TFP* | *Seed* | *Fertilisers* | *Manure* | *Human Labour* | *Bullock Labour* | *Machinery* | *Crop Area* | *Irrigation* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Maize | 1.04 | –0.27 | 1.31 | –0.01 | 0.09 | 0.02 | –0.87 | –0.51 | 0.19 | 0.29 | 0.34 |
| Paddy | 1.28 | –1.09 | 2.37 | –0.14 | 0.16 | 0.04 | –0.95 | –1.15 | 0.19 | –0.16 | 0.41 |
| Gram | 3.20 | 0.63 | 2.57 | –0.03 | 0.30 | 0.08 | 0.33 | –0.22 | 0.26 | –0.63 | 0.10 |
| Lentil | 0.89 | –0.48 | 1.37 | –0.11 | 0.19 | 0.00 | –0.16 | –0.42 | 0.25 | –0.47 | –0.11 |
| Wheat | 1.82 | –0.41 | 2.23 | –0.02 | 0.09 | 0.00 | –0.39 | –1.04 | 0.33 | 0.03 | 0.06 |
| Potato | 1.54 | –1.06 | 2.60 | 0.26 | –0.20 | –0.23 | –1.42 | –0.47 | 0.07 | 1.26 | 0.07 |
| All crops | 1.45 | –0.73 | 2.18 | –0.09 | 0.14 | 0.05 | –0.73 | –0.75 | 0.23 | 0.09 | 0.45 |

*Source:* Authors' estimation.

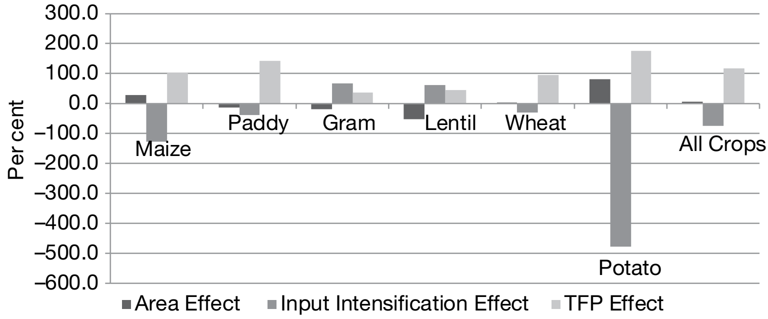



Figure 2.7 Contribution of Output Growth by Area Effect, Input Intensificationand TFP Effect: 2001–02 to 2017–18

*Source:* Authors' estimation.

appreciable for all the crops, except fertiliser use in the case of potato, and irrigation in the case of lentil.

Components of crop output growth can also be seen in terms of area effect, weighted input intensification effect and TFP effect (Figure 2.7). Contribution of area effect is positive only for maize and potato, which is consistent with the previous analysis on changes in cropping pattern. The input intensification effect was negative for maize, paddy, wheat and potato. Among these crops, contribution of inputs to output growth of potato was much lower than area effect and TFP effect. Interestingly, TFP effect dominates output growth of crops even though input intensification effect has slightly overshowed the TFP effect in the case of gram and lentil.

As evident from the analysis, the contribution of area growth to output growth was positive in maize, wheat and potato. However, a higher negative growth in human labour and animal labour outweighed the positive growth in material inputs, leading to overall negative growth in input of these crops. Interestingly, the contribution of fertilisers and manure, and machinery was positive in almost all the crops. This implies that increased use of fertilisers and mechanisation would emerge as the future source of agricultural growth in Bihar. At the same time, it is important to examine the constraints in using quality seeds and other inputs efficiently. Overall, it emerges that technological change has been the major driver of crop output growth. Input intensification is low and has worsened for some crops. Although TFP growth was very impressive, low input intensification is a concern as it affects yield growth.

## 2.6. CONCLUSION AND POLICY IMPLICATION

This chapter has analysed the sources of crop output growth in Bihar. Trend growth in output was appreciable at 4.49 per cent per annum from field crops and it was 2.30 per cent per annum from horticultural crops during the period of agriculture road maps. Within the crop sector, there is reallocation of area from low-value cereals and oilseeds to high-value commercial crops such as maize, sugarcane and vegetables. The area shift is prominent from paddy and pulses to maize. The weighted average income from cultivation of six major crops has increased from Rs. 2,284 per hectare during 2000–01 to 2007–08 to Rs. 3,255 per hectare during 2008–09 to 2018–19. Though volatility in net income has declined during the recent period, it still remains quite high. There is considerable variation in net income obtained from different crops; the highest net income is obtained from potato and the lowest and negative income from paddy.

Decomposition analysis has shown that aggregate output index has increased over time and the rate of increase in aggregate output was much higher during the second agriculture road map period. The aggregate input index has declined steadily during the study period implying that input use in the cultivation of the crops is low. This also indicates that output growth is largely driven by technological change and that the contribution of input intensification is limited. The aggregate TFP growth was 2.18 per cent between 2000–01 and 2017–18. Among the crops, TFP growth was over 2.0 per cent for potato, gram, paddy and wheat.

The output growth led by improvement in TFP is sustainable in the long run. However, higher output growth concomitant with better market price improves the net income of the farmers. Some studies have shown an increase in volatility of market prices in Bihar after the repeal of APMC Act in 2006. Volatility in prices of agricultural produce affects the farmers' decision to allocate area under different crops and invest on improved cultivation practices. Further, a rise in public spending on agricultural research and extension will help to generate area-specific crop technology and to disseminate it effectively among the farmers. Similarly, investment in rural infrastructure such as rural roads and markets will have significant effect on adoption of improved cultivation practices.

## ACKNOWLEDGEMENTS

This chapter has drawn inspiration from the 'Study on Agricultural Diagnostics for the State of Bihar in India', conducted by the authors at the National Council of Applied Economic Research (NCAER), New Delhi. The study was sponsored by the South Asia Research Hub, Department for International Development, Government of UK. The findings, interpretations and conclusions expressed in the paper are exclusively those of the authors and do not necessarily reflect views of the sponsoring organisation.

## REFERENCES

Capalbo, S. M., & Antle, J. M. (Eds.). (1988). *Agricultural productivity measurement and explanation*. Resources for the Future.

Coelli, T. J., Rao, D. S. P., Christopher, J. O'D., & Battese, G. E. (2005). *An introduction to productivity and efficiency analysis* (2nd ed.). Springer.

Diewert, W. E. (1976). Exact and superlative index numbers. *Journal of Econometrics, 4*, 115–145.

Diewert, W. E. (1978). Superlative index numbers and consistency in aggregation. *Econometrica, 46*(4), 883–900.

Fuglie, K. (2012). Productivity growth and technology capital in the global agricultural economy. In K. Fuglie, S. L. Wang, & V. E. Ball (Eds.), *Productivity growth in agriculture: An international perspective*. CAB International.

Fuglie, K. (2015). Accounting for growth in global agriculture. *Bio-based and Applied Economics, 4*(3), 201–234.

Fugli, K (2018). *Agricultural total productivity growth indices for individual countries, 1961–2015*, Economic Research Service, United States Department of Agriculture, Washington, D.C.

Government of Bihar. (2011). *Economic survey 2010–11*. Finance Department.

Government of Bihar. (2018). *Economic survey 2017–18*. Finance Department.

Government of India. (2017). *Report of the committee on doubling farmers' income, Volume II: status of farmers' income and strategies for accelerated growth*. Ministry of Agriculture and Farmers' Welfare.

Government of India. (2019). *National accounts statistics*. Ministry of Statistics and Programme Implementation.

Ghosh, P., & Gupta, S. (2009). *Economic growth and human development in Bihar* (Monograph No.: 03/2009). Asian Development Research Institute (ADRI).

Kannan, E. (2015). Trends in agricultural incomes: An analysis at the select crop and state levels in India. *Journal of Agrarian Change, 15*(2), 201–219.

Pohit, S., Kannan, E., Singh, R. K. P., Bandyopadhyay, S., Alawadhi, S., & Sayal, L. (2019). *Study on agricultural diagnostics for the state of Bihar in India*. NCAER.

Sarkar, G. K. (1986). The fading fabric I: raw jute scenario. *Economic and Political Weekly*, *21*(49), 2140–2146.

Thakur, J., Bose, M. L., Hossain, M., & Janaiah, A. (2001). Rural income distribution and poverty in Bihar: insights from village studies. *Economic and Political Weekly, 35*(52/53), 4657–4663.

Tsujita, Y., Oda, H., & Ghosh P. (2010). Development and intra-state disparities in Bihar. *Economic and Political Weekly, 45*(50), 13–15.

CHAPTER 3

# GROWTH PERFORMANCE OF AGRICULTURE DURING 2000–2020

*Sankar Kumar Bhaumik and Sk. Abdul Rashid*

## 3.1 INTRODUCTION

This chapter discusses the performance of the agriculture sector in Bihar during the period 1990–91 to 2019–20 with special focus on the period 2000–01 to 2019–20. As the state government laid special emphasis in recent years on development of the agricultural sector as also to improve the economic conditions of the farmers by undertaking various policy initiatives, most notably by implementing three ‘agriculture road maps’ since 2008, one of the questions that we address is to what extent the crop cultivation sector responded to such initiatives as may be revealed by enhanced growth rate of production, and the reasons thereof. Thus, we compare the growth rates of production of foodgrains, non-foodgrains, all crops, and individual crops for the pre- and post-road map periods as well as the contributions of area and yield expansions towards production growth during those periods. As agriculture in Bihar is adversely affected by the unpredictable climatic conditions,[1] and hence different regions vary widely in terms of agro-climatic conditions, we also examine the agricultural production performances of its different agro-climatic zones during the period of our study. Following this, we turn our attention towards understanding the pattern of diversification of crops in the state during the study period, and identifying the crops that are relatively more remunerative in the sense of reporting higher value of output per hectare of cropped area. The patterns of utilisation of various inputs during our study period is another aspect that we look into to understand possible contributions of agricultural technologies towards higher growth of agricultural production, if any, over time. We also seek to understand the effects of agricultural technologies and rainfall instability on agricultural productivity.

## 3.2 DATA AND METHODOLOGY

This study is based exclusively on the secondary data collected from the Centre for Monitoring Indian Economy (CMIE) reports on agriculture (various years), Bihar Statistical Handbooks (various years), Department of Agriculture (Government of Bihar), Development & Planning Department (Government of Bihar), Handbook of Statistics on Indian States (Reserve Bank of India, various years) and indiastat.com. To construct the series for values of output of foodgrains, non-foodgrains and all-crops, we have considered data on physical output of 26 crops for the period 1990–91 to 2019–20.[2] The physical output of such crops in these years have been converted into the values of output by using the average of farm-gate prices of such crops for the triennium ending (TE) 2019–20.

Before computing the growth rates of values of output to understand the effect of policy interventions as through implementation of the road maps and various other programmes, we have identified the break points in the series for values of output, both by visual inspection of the graphical plot of the data series as well as by applying the Quandt-Andrews breakpoint test (Andrews, 1993; Quandt, 1960) to reconfirm the break point as understood through visual inspection of data series.[3] Figure 3.1 provides a graphical presentation of data series relating to values of output for foodgrains, non-foodgrains and all crops in Bihar for the period 1990–91 to 2019–20. This figure seems to suggest two break points in the series (especially for foodgrains and all crops) – one between 1999–00 and 2000–01 and another between 2009–10 and 2010–11.

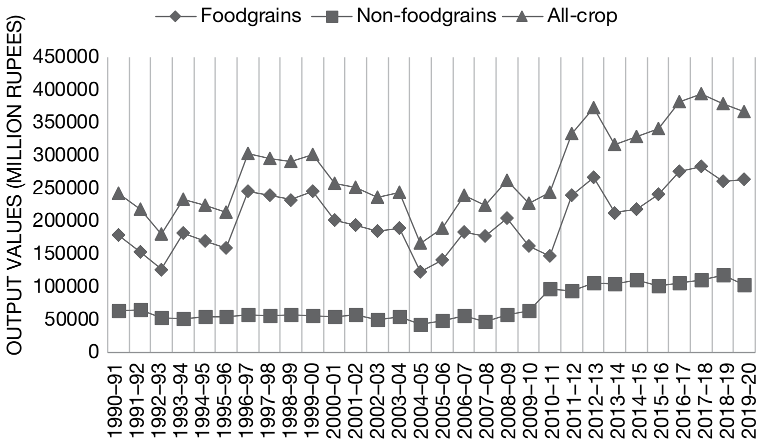



Figure 3.1 Values of Foodgrains, Non-foodgrains and All Crop Outputs in Bihar

*Source:* Authors' construction.

It is interesting to note that the second break point emerges with a lag, approximately after two years of the implementation of the first 'agriculture road map' in the state, which is understandable insofar as there is always a gap between formulation of a policy at the official level, its ground-level implementation, and the outcomes generated out of such a policy. Considering these break points, we have divided the whole study period into three sub-periods that are 1990–91 to 1999–00 (sub-period I), 2000–01 to 2009–10 (sub-period II), and 2010–11 to 2019–20 (sub-period III).

After identifying the break points, we have computed growth rates of values of output in different sub-periods and examined statistical significance of their difference, by estimating the 'two-kink' exponential model as suggested by Boyce (1987) to make growth rates between different sub-periods comparable.[4] To measure the degree of diversification of crops, we computed the value of the crop diversification index, which is one minus the Herfindahl index.[5] While examining the effects of technological factors and rainfall instability on agricultural productivity, we estimated a panel regression model using data for all 38 districts of Bihar for the period 2000–01 to 2019–20.

## 3.3 GROWTH OF AGRICULTURAL OUTPUT

### 3.3.1 Growth of Foodgrains, Non-foodgrains and All Crops Output

We examine the growth of agricultural output in the state of Bihar for the period 1990–91 to 2019–20[6] using the data series generated by us on the values of agricultural output for foodgrains, non-foodgrains and all crops, and estimating the 'two-kink' exponential model to understand the growth rates of output of various crop groups and individual crops during different sub-periods (1990–91 to 1999–00, 2000–01 to 2009–10, and 2010–11 to 2019–20). These three sub-periods capture the state of agriculture in Bihar in three different decades – the first one prior to separation of Jharkhand from Bihar, the second sub-period representing the decade following creation of the new Bihar state, and the third sub-period capturing the decade of the 2010s. A comparison of second and third sub-periods specifically reveals the effect of implementation of 'agricultural road maps' on the growth of agricultural output in Bihar.

The information on the growth rates of outputs of foodgrains, non-foodgrains and all crops for above-mentioned sub-periods for the state as a whole is presented in Table 3.1. It emerges that during the first sub-period (i.e., the decade of the 1990s), the growth rate of foodgrains was higher than the same during the second sub-period (decade of the 2000s). While the state recorded 3.05 per cent per annum growth of foodgrains output during sub-period I, the same not only got reduced but also turned negative during sub-period II.[7] A contrary picture is noticeable regarding growth of non-foodgrains output that was negative during sub-period I (–2.51 per cent) and turned quite high during sub-period II (3.78 per cent). As regards all crops, the growth rate was higher in the first sub-period (1.65 per cent) compared to the second sub-period (–0.57 per cent). Thus, it is clear that the crop-cultivation sector in Bihar recorded a better performance during the decade of the 1990s compared to the 2000s in terms of growth of agricultural outputs. The better output growth performance of the agriculture sector during the 1990s was contributed exclusively by the impressive growth of foodgrains output when the growth of non-foodgrains output was negative.

Table 3.1 Kinked Exponential Growth Rates (%) of Values of Foodgrains, Non-foodgrains and All-Crop Outputs in Bihar

| *Period* | *Growth Rates of* | | |
|---|---|---|---|
| | ***Foodgrains*** | ***Non-foodgrains*** | ***All-crop*** |
| 1990–91 to 1999–00 (Sub-period I) | 3.05 | −2.51 | 1.65 |
| | (92.03**) | (−1.86***) | −1.23 |
| 2000–01 to 2009–10 (Sub-period II) | −2.12 | 3.78 | −0.57 |
| | (−1.73***) | (3.43*) | (−0.52) |
| 2010–11 to 2019–20 (Sub-period III) | 6.11 | 6.16 | 6.06 |
| | (4.06*) | (4.57*) | (4.51*) |
| 1990–91 to 2019–20 (Whole period) | 1.35 | 2.77 | 1.72 |
| | (3.15*) | (6.09*) | (4.49*) |
| Difference in the growth rate between sub-periods I & II | −5.17 | 6.3 | −2.22 |
| | (−2.10**) | (2.86*) | (−1.01) |
| Difference in the growth rate between sub-periods II & III | 8.23 | 2.37 | 6.63 |
| | (3.35*) | (−1.08) | (3.02*) |

*Notes:* (i) Figures in brackets are computed t-values; and (ii) *, ** and *** imply significance at 1, 5 and 10 percent levels, respectively.

*Source:* Authors' computation.

However, the performance of the crop-cultivation sector in Bihar has been highly impressive during sub-period III (decade of the 2010s) when the state government started implementing the 'road maps' to improve agricultural performance. As shown in Table 3.1, the growth rates of both the foodgrains and non-foodgrains outputs were more than 6.0 per cent per annum during this sub-period, which were statistically significant. Moreover, the difference in growth rates between sub-periods II and III was statistically significant for foodgrains and all crops. In brief, it may be said that the agricultural road maps implemented so far by the government have brought out a dramatic turnaround as far as the growth of agricultural output in Bihar is concerned. However, it remains to be seen to what extent such a growth momentum could be sustained in the years to come in a state where the agriculture sector is plagued by adverse climatic conditions with frequent occurrence of floods and droughts.

### 3.3.2 Growth of Production of Individual Crops

We examined the growth rates of production of 18 crops[8] individually during three sub-periods in order to identify the crops that performed better in terms of growth rates of production in those sub-periods. The information presented in Table 3.2 shows that during the first sub-period (1990s), the crops to perform most significantly among the foodgrains crops are rice and maize (both recording more than 4.0 per cent growth of output per annum) that helped the group of foodgrains crops to attain more than 3.0 per cent annual growth of output during this period. On the other hand, barring some minor oilseeds like groundnuts, *til* and linseed, all other non-foodgrains crops recorded negative growth of output which is why the growth rate of non-foodgrains crops as a whole turned negative during this period.

The situation changed during the second sub-period (2000s) when the growth rate of output of the most important foodgrains crop, namely, rice, turned negative in Bihar (–2.52 per cent). Although maize (the third most important crop) continued to record an impressive growth of output during this sub-period (3.50 per cent per annum), almost all other foodgrains crops (except wheat) recorded negative growth of production as a result of which the growth rate of output for foodgrains crops became negative. In contrast, the growth rate of output for the non-foodgrains crops during the second sub-period was quite high and positive primarily because of impressive growth of output for the commercial crops like jute (2.01 per cent), mesta (4.04 per cent) and sugarcane (5.70 per cent).

The third sub-period (2010s) brought about a dramatic transformation in Bihar agriculture in so far as the growth of crop production is concerned. During this period, the most important foodgrains crops recorded quite impressive growth rate of production – while for rice and maize, the growth rate was close to 7.0 per cent, it was more than 3 per cent for wheat (3.07) and Barley (3.04). For the non-foodgrains crops like sugarcane and chillies, the per annum growth rate of production exceeded 10 per cent and that for

Table 3.2 Kinked Exponential Growth Rates of Production of Individual Crops in Bihar

| Crop | Growth rate (%) during | | | | Difference in growth rate between sub-periods | |
|---|---|---|---|---|---|---|
| | Sub-period I: 1990–91 to 1999–00 | Sub-period II: 2000–01 to 2009–10 | Sub-period III: 2010–11 to 2019–20 | Whole period: 1990–91 to 2019–20 | I & II | II & III |
| Rice | 4.31*** | −2.52 | 6.99* | 1.72** | −6.83*** | 9.51** |
| Wheat | 1.29 | 0.88 | 3.07*** | 1.55* | −0.41 | 2.2 |
| Maize | 4.19** | 3.50** | 6.87* | 4.55* | −0.69 | 3.37 |
| Barley | −0.13 | −9.97* | 3.04 | −4.05* | −9.84* | 13.01* |
| Gram | −6.01* | −2.13 | −0.94 | −2.83* | 3.89 | 1.19 |
| Arhar | 1.41 | −5.79* | −1.66 | −2.85* | −7.20** | 4.13 |
| Peas | −0.89 | −0.22 | −1.25 | −0.66* | 0.67 | −1.03 |
| Masoor | −0.12 | 0.95 | −2.12 | −0.13 | 1.07 | −3.07 |
| Khesari | −5.16* | −4.80* | −6.76* | −5.40* | 0.36 | −1.97 |
| Ground Nuts | 10.34 | −9.22 | 8.56 | 0.46 | −19.55 | 17.78 |
| Til | 16.56* | −9.52** | −2.31 | −0.89 | −26.09* | 7.22 |
| Rapeseed & Mustard | −0.76 | 0.42 | 1.8 | 0.47 | 1.18 | 1.38 |
| Linseed | 1.18 | −2.55** | −11.15* | −3.81* | −3.73 | −8.60* |
| Jute | −3.32 | 2.01 | 1.11 | 0.4 | 5.34 | −0.9 |
| Mesta | −2.08 | 4.04** | 0.78 | 1.61** | 6.11 | −3.25 |
| Potato | −1.09 | −0.24 | 6.13* | 1.19* | 0.86 | 6.37* |
| Sugarcane | −6.69* | 5.70* | 10.89* | 3.83* | 12.39* | 5.19 |
| Chillies | −7.32* | −6.49*** | 12.31* | −1.83 | 0.83 | 18.79* |

*Note:* *, ** and *** imply significance of growth rates at 1, 5 and 10 percent levels on the basis of computed t-ratios.

*Source:* Authors' computation.

potato exceeded 6.0 per cent. As a consequence, the overall growth rates of output for the groups of foodgrains and non-foodgrains crops were found to be quite high (more than 6.0 per cent per annum) during the decade of the 2010s, which coincided with the phase of implementation of 'agriculture road maps' by the government.

### 3.3.3 Decomposition of Growth of Production

Let us look at the contributions of area and yield growth towards growth of production to understand the sources of production growth (area and/or yield expansion) during the three sub-periods, following the decomposition method suggested by Boyce (1987). To begin with, we consider the three crop groups (foodgrains, non-foodgrains and all crops) the results of which are presented in Table 3.3. It is found that during the first sub-period, the growth rates of area and yield were almost identical thereby both the area and yield expansion contributing equally towards growth of foodgrains production during this period. During the second sub-period, as the growth rate of both the area and yield turned negative for the foodgrains, the growth of production too turned negative. However, the decline in the growth rate of foodgrains production during this period is driven more by decline in the area growth as compared to decline in the yield growth. During the third sub-period, although the growth rates of both area and yield turned positive for foodgrains, the growth rate of yield was much higher (5.73 per cent) compared to the growth rate of area (0.38 per cent). Therefore, the share of yield expansion in the growth of foodgrains production during this period is found to be as high as 94 per cent. An important implication of this observation is that as the scope of increasing area under the foodgrains crops is becoming limited with the passage of time with competition from non-foodgrains crops, any future policy for expansion of foodgrains output would have to emphasise on expansion of yield level which precisely seems to have happened in Bihar with implementation of the 'road maps' and other policies.

As regards non-foodgrains, during 1990–91 to 1999–00, both the growth rates of area and yield were negative, and the contributions of area and yield towards production growth were almost the same. In the next sub-period (2000–01 to 2009–10), the

Table 3.3 Decomposition of Growth Rates of Foodgrains, Non-foodgrains and All-Crops Production in Bihar

| | | ***Production*** | ***Area*** | | ***Yield*** | |
|---|---|---|---|---|---|---|
| ***Crop*** | ***Period*** | ***Gr. Rate*** | ***Gr. Rate*** | ***% Share in Prodn Growth*** | ***Gr. Rate*** | ***% Share in Prodn Growth*** |
| Foodgrains | 1990–91 to 1999–00 | 3.05** | 1.52*** | 49.85 | 1.53 | 50.15 |
| | 2000–01 to 2009–10 | −2.12*** | −2.03* | 95.84 | −0.09 | 4.16 |
| | 2010–11 to 2019–20 | 6.11* | 0.38 | 6.28 | 5.73* | 93.72 |
| | 1990–91 to 2019–20 | 1.35* | −0.49** | −35.86 | 1.84* | 135.86 |
| Non-foodgrains | 1990–91 to 1999–00 | −2.51*** | −1.2 | 47.64 | −1.32 | 52.36 |
| | 2000–01 to 2009–10 | 3.78* | 0.4 | 10.57 | 3.38* | 89.43 |
| | 2010–11 to 2019–20 | 6.16* | 1.48** | 24.12 | 4.67* | 75.88 |
| | 1990–91 to 2019–20 | 2.77* | 0.27 | 9.66 | 2.50* | 90.34 |
| All-crops | 1990–91 to 1999–00 | 1.65 | 1.29*** | 78.27 | 0.36 | 21.73 |
| | 2000–01 to 2009–10 | −0.57 | −1.82* | 319.51 | 1.2 | −219.51 |
| | 2010–11 to 2019–20 | 6.06* | 0.48 | 7.91 | 5.58* | 92.09 |
| | 1990–91 to 2019–20 | 1.72* | −0.42** | −24.26 | 2.14* | 124.26 |

*Source:* Authors' computation.

*Note:* *, ** and *** imply significance of growth rates at 1, 5 and 10 percent levels on the basis of computed t-ratios.

yield of non-foodgrains grew at a higher rate (3.38 per cent per annum) compared to the growth of area (0.40 per cent) which is why yield growth accounted for as high as 89 per cent of the growth of non-foodgrains production. In the final sub-period (2010–11 to 2019–20), while the yield of non-foodgrains grew at a very high rate of 4.67 per cent per annum, the growth of area for non-foodgrains continued to remain positive (1.48 per cent per annum). However, during this sub-period, the growth of yield accounted for almost 76 per cent of growth of production of the non-foodgrains crops.

Considering all crops together, it appears that during the first sub-period (1990s), area growth, rather than yield growth, played the dominating role towards growth of all-crops production in Bihar. However, during the second sub-period (2000s), while yield growth improved marginally, area under all-crops contracted significantly at the rate of 1.82 per cent per annum which is why the growth rate of all-crops production turned negative (–0.57 per cent). Such a trend got reversed during the third sub-period (2010s) when yield for all-crops grew at the rate of 5.58 per cent per annum as against a meagre growth of area at 0.48 per cent per annum. For this reason, the share of yield growth in growth of all-crop production turned out to be high at 94 per cent. It appears that the recent turnaround with regard to growth of agricultural production (considering all crops) in Bihar has happened primarily due to the high growth of yield. The yield of foodgrains in the state has been growing at a high rate during the past decade (2010s), and for non-foodgrains during the past two decades (2000s and 2010s).

We have also decomposed the growth of production of important individual crops to understand the shares of area and yield growth towards their production growth. As shown in Table 3.4, the area growth contributed more towards the growth of production of both rice and wheat during the first sub-period. During the second sub-period, area under rice declined sharply and significantly at the rate of 3.29 per cent per annum and yield growth was less than one per cent. Thus, the area component was mainly responsible for the negative growth rate of rice production during the second sub-period. In the case of wheat, sluggish growth of yield coupled with stagnating area under cultivation produced a slow growth rate of production during the second sub-period. For both of these crops

Table 3.4 Decomposition of Growth Rates of Production of Individual Crops in Bihar

| | | Production | Area | | Yield | |
|---|---|---|---|---|---|---|
| **Crop** | **Period** | **Gr. Rate** | **Gr. Rate** | **% share in Prodn Growth** | **Gr. Rate** | **% share in Prodn Growth** |
| Rice | 1990–91 to 1999–00 | 4.31*** | 2.59** | 60.06 | 1.72 | 39.94 |
| | 2000–01 to 2009–10 | −2.52 | −3.29* | 130.61 | 0.77 | −30.61 |
| | 2010–11 to 2019–20 | 6.99* | 0.7 | 10.04 | 6.29* | 89.96 |
| Wheat | 1990–91 to 1999–00 | 1.29 | 0.85* | 66.17 | 0.44 | 33.83 |
| | 2000–01 to 2009–10 | 0.88 | 0.05 | 5.81 | 0.83 | 94.19 |
| | 2010–11 to 2019–20 | 3.07* | 0.17 | 5.44 | 2.90** | 94.56 |
| Maize | 1990–91 to 1999–00 | 4.19** | 1.94 | 46.18 | 2.26** | 53.82 |
| | 2000–01 to 2009–10 | 3.50** | 0.38 | 10.94 | 3.12* | 89.06 |
| | 2010–11 to 2019–20 | 6.87 | 0.61 | 8.83 | 6.26* | 91.17 |
| Barley | 1990–91 to 1999–00 | −0.13 | 0.37 | −284.04 | −0.5 | 384.04 |
| | 2000–01 to 2009–10 | −9.97* | −13.04* | 130.76 | 3.07*** | −30.76 |
| | 2010–11 to 2019–20 | 3.04 | 1.08 | 35.44 | 1.96 | 64.56 |
| Gram | 1990–91 to 1999–00 | −6.01* | −5.05* | 83.91 | −0.97 | 16.09 |
| | 2000–01 to 2009–10 | −2.13 | −4.21* | 197.84 | 2.08*** | −97.84 |

*(Continued)*

Table 3.4 (Continued)

| | | Production | Area | | Yield | |
|---|---|---|---|---|---|---|
| **Crop** | **Period** | **Gr. Rate** | **Gr. Rate** | **% share in Prodn Growth** | **Gr. Rate** | **% share in Prodn Growth** |
| | 2010–11 to 2019–20 | −0.94 | −0.05 | 5.16 | −0.89 | 94.84 |
| Arhar | 1990–91 to 1999–00 | 1.41 | 2.36*** | 167.46 | −0.95 | −67.46 |
| | 2000–01 to 2009–10 | −5.79* | −8.72* | 150.79 | 2.94* | −50.79 |
| | 2010–11 to 2019–20 | −1.66 | −2.40*** | 144.45 | 0.74 | −44.45 |
| Peas | 1990–91 to 1999–00 | −0.89 | −3.03* | 341.4 | 2.14** | −241.4 |
| | 2000–01 to 2009–10 | −0.22 | −4.11* | 1853.07 | 3.89* | −1753.07 |
| | 2010–11 to 2019–20 | −1.25 | −0.06 | 5.13 | −1.19 | 94.87 |
| Masoor | 1990–91 to 1999–00 | −0.12 | −0.23 | 188.84 | 0.11 | −88.84 |
| | 2000–01 to 2009–10 | 0.95 | −0.33 | −34.59 | 1.27 | 134.59 |
| | 2010–11 to 2019–20 | −2.12 | −1.93* | 90.79 | −0.2 | 9.21 |
| Khesari | 1990–91 to 1999–00 | −5.16* | −5.10* | 98.82 | −0.06 | 1.18 |
| | 2000–01 to 2009–10 | −4.80* | −6.79* | 141.53 | 1.99*** | −41.53 |
| | 2010–11 to 2019–20 | −6.76* | −6.39* | 94.48 | −0.37 | 5.52 |
| Groundnuts | 1990–91 to 1999–00 | 10.34 | 10.08 | 97.55 | 0.25 | 2.45 |
| | 2000–01 to 2009–10 | −9.22 | −8.62 | 93.48 | −0.6 | 6.52 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 2010–11 to 2019–20 | 8.56 | 5.36 | 62.58 | 3.2 | 37.42 |
| Til | 1990–91 to 1999–00 | 16.56* | 9.26** | 55.9 | 7.30* | 44.1 |
| | 2000–01 to 2009–10 | −9.52** | −13.58* | 142.64 | 4.06* | −42.64 |
| | 2010–11 to 2019–20 | −2.31 | −2.44 | 105.57 | 0.13 | −5.57 |
| Rapeseed & Mustard | 1990–91 to 1999–00 | −0.76 | −0.89*** | 118.04 | 0.14 | −18.04 |
| | 2000–01 to 2009–10 | 0.42 | −1.55* | −370.66 | 1.97** | 470.66 |
| | 2010–11 to 2019–20 | 1.8 | −0.62 | −34.13 | 2.42* | 134.13 |
| Linseed | 1990–91 to 1999–00 | 1.18 | −3.47* | −294.61 | 4.65* | 394.61 |
| | 2000–01 to 2009–10 | −2.55** | −5.89* | 230.98 | 3.34* | −130.98 |
| | 2010–11 to 2019–20 | −11.15* | −10.04* | 89.99 | −1.12 | 10.01 |
| Jute | 1990–91 to 1999–00 | −3.32 | 1.31 | −39.34 | −4.63 | 139.34 |
| | 2000–01 to 2009–10 | 2.01 | −0.55 | −27.06 | 2.56 | 127.06 |
| | 2010–11 to 2019–20 | 1.11 | −8.09* | −727.91 | 9.2 | 827.91 |
| Mesta | 1990–91 to 1999–00 | −2.08 | −1.16 | 56.1 | −0.91 | 43.9 |
| | 2000–01 to 2009–10 | 4.04** | −1.37 | −33.91 | 5.40* | 133.91 |
| | 2010–11 to 2019–20 | 0.78 | −1.08 | −138.53 | 1.87 | 238.53 |

*(Continued)*

Table 3.4 (Continued)

| Crop | Period | Production | Area | | Yield | |
|---|---|---|---|---|---|---|
| | | Gr. Rate | Gr. Rate | % share in Prodn Growth | Gr. Rate | % share in Prodn Growth |
| Potato | 1990–91 to 1999–00 | −1.09 | −0.33 | 30.05 | −0.76 | 69.95 |
| | 2000–01 to 2009–10 | −0.24 | −0.92*** | 385.45 | 0.68 | −285.45 |
| | 2010–11 to 2019–20 | 6.13* | 1.37** | 22.4 | 4.76* | 77.6 |
| Sugarcane | 1990–91 to 1999–00 | −6.69* | −5.30* | 79.15 | −1.40*** | 20.85 |
| | 2000–01 to 2009–10 | 5.70* | 4.50* | 79.07 | 1.19*** | 20.93 |
| | 2010–11 to 2019–20 | 10.89* | 9.44* | 86.64 | 1.46** | 13.36 |
| Chillies | 1990–91 to 1999–00 | −7.32*** | −5.56** | 75.89 | −1.76 | 24.11 |
| | 2000–01 to 2009–10 | −6.49*** | −11.91* | 183.63 | 5.43* | −83.63 |
| | 2010–11 to 2019–20 | 12.31* | 8.15* | 66.21 | 4.16 | 33.79 |

*Note:* *, ** and *** imply significance of growth rates at 1, 5 and 10 percent levels on the basis of computed t-ratios.

*Source:* Computed by authors.

(rice and wheat), the situation changed completely in the decade of the 2010s when the share of yield growth played the dominating role towards growth of production of these crops. For maize, the third most important crop of the state in terms of its share in total cropped area, however, the shares of area and yield growth in the growth of production was by and large the same during the 1990s after which the share of yield in production growth increased to around 90 per cent. For barley, the yield growth contributed much more than area growth towards growth of production in the past decade. It is also found that, for different types of pulses, both the area and yield components are responsible for their negative growth rate of production during the 2010s. In the category of non-foodgrains crops, we find yield growth contributing highly significantly towards growth of production of rapeseed & mustard in the last two decades. The same observation can be made about two fibre crops like jute and mesta although growth of area of these crops has been negative in all the sub-periods (except jute in the first sub-period). In the case of commercial crops, however, we have a mixed picture. While yield growth contributed largely towards growth of production of potato during the decade of the 2010s, area growth contributed more towards the growth of production for sugarcane and chillies.

Overall, it appears that the crops that performed well in Bihar both in terms of growth of production and yield ever since the implementation of 'agriculture road maps' are rice, wheat, maize, barley, rapeseed and mustard, and potato. Although some other crops like groundnuts, sugarcane and chillies also displayed robust growth of production during this phase, the same has been contributed more by higher growth of area rather than yield for these crops.

## 3.4 GROWTH OF PRODUCTION, AREA AND YIELD IN DIFFERENT AGRO-CLIMATIC ZONES

Our discussion till now has provided an aggregative view of production performance of the crop-cultivation sector for the state of Bihar. However, as Bihar is one of those states of India where the performance of the agriculture sector is largely affected by the weather/climatic factors, we extend our discussion to the level of different agro-climatic zones.

Agro-climatically, Bihar is divided into four zones that are (i) North-West Alluvial Plain (Zone I) comprising the districts of Begusarai, Darbhanga, East Champaran, Gopalganj, Madhubani, Muzaffarpur, Samastipur, Saran, Sheohar, Sitamarhi, Siwan, Vaishali, and West Champaran; (ii) North-East Alluvial Plain (Zone II) comprising Araria, Katihar, Khagaria, Kishanganj, Madhepura, Purnia, Saharsha and Supaul; (iii) South-East Alluvial Plain (Zone IIIA) comprising Banka, Bhagalpur, Jamui, Lakhisarai, Munger, and Sheikhpura; and (iv) South-West Alluvial Plain (Zone IIIB) that includes Arwal, Aurangabad, Bhabhua, Bhojpur, Buxar, Gaya, Jehanabad, Nalanda, Nawada, Patna and Rohtas. The incidence of occurrence of floods is more in the first two zones which are in North Bihar although some districts in the other two zones from South Bihar also often get affected by floods.[9] Apart from floods, some districts of South Bihar are also plagued by occurrence of drought.

The information on the growth rates of production, area and yield of foodgrains, non-foodgrains and all crops for the two sub-periods (representing the decades of 2000s and 2010s) in different agro-climatic zones, obtained by estimating the kinked-exponential model, are presented in Table 3.5. A close perusal of the figures presented in this table lead to the conclusion that following the implementation of the 'agriculture road maps', while agro-climatic Zone II seems to have performed better compared to other zones in terms of growth of foodgrains production, Zone I seems to be doing better with regard to growth of non-foodgrains production as well as all-crops production. In the case of foodgrains, higher growth of production during the decade of 2010s is contributed more by yield growth compared to area growth in all the zones. In the case of non-foodgrains, while area growth seems to have contributed more than yield growth towards growth of production during this period in Zones I and IIIB, growth of both area and yield contributed towards higher growth of non-foodgrains production in Zones II and IIIB. However, when considered for all crops, the higher contributions of yield growth compared to area growth towards growth of production is clearly revealed in all the zones during 2000s and 2010s. Another point that needs to be noted is that the correlation between the growth rates of production in two periods seems to be weak, which indicates the uncertainty that the crop-cultivation sector

Table 3.5 Growth Rates (%) of Production, Area and Yield of Foodgrains, Non-foodgrains and All-Crops in Different Agro-Climatic Zones of Bihar

| | *Production Growth* | | | *Area Growth* | | | *Yield Growth* | | |
|---|---|---|---|---|---|---|---|---|---|
| *Zone* | *Period I* | *Period II* | *Difference* | *Period I* | *Period II* | *Difference* | *Period I* | *Period II* | *Difference* |
| ***Foodgrains*** | | | | | | | | | |
| Zone I | 1.53 | 3.56 | 2.03 | −0.07 | −0.42 | −0.35 | 1.61 | 3.98 | 2.38 |
| Zone II | 2.35 | 5.28 | 2.93 | −0.60 | −1.27 | −0.67 | 2.95 | 6.55 | 3.60 |
| Zone IIIA | 4.26 | 3.13 | −1.14 | −1.49 | 0.41 | 1.90 | 5.75 | 2.72 | −3.03 |
| Zone IIIB | 0.90 | 5.20 | 4.30 | −1.30 | 1.12 | 2.43 | 2.21 | 4.08 | 1.87 |
| ***Non-foodgrains*** | | | | | | | | | |
| Zone I | 5.63 | 10.07 | 4.44 | 3.88 | 6.57 | 2.69 | 1.75 | 3.50 | 1.75 |
| Zone II | 3.08 | 1.50 | −1.57 | −0.75 | −5.87 | −5.12 | 3.83 | 7.37 | 3.54 |
| Zone IIIA | 7.70 | 1.45 | −6.25 | 2.45 | 3.52 | 1.08 | 5.25 | −2.07 | −7.33 |
| Zone IIIB | 1.18 | 5.94 | 4.75 | 1.54 | −0.47 | −2.01 | −0.36 | 6.40 | 6.76 |
| ***All-Crops*** | | | | | | | | | |
| Zone I | 2.81 | 5.70 | 2.89 | 0.28 | −0.13 | −0.41 | 2.53 | 5.83 | 3.30 |
| Zone II | 2.49 | 4.50 | 2.00 | −0.63 | −1.71 | −1.08 | 3.13 | 6.21 | 3.08 |
| Zone IIIA | 5.04 | 2.54 | −2.50 | −1.35 | 0.39 | 1.74 | 6.39 | 2.16 | −4.24 |
| Zone IIIB | 0.94 | 5.20 | 4.26 | −1.25 | 1.05 | 2.29 | 2.19 | 4.16 | 1.97 |

*Source:* As in Table 3.1.

faces across different zones presumably because of unpredictable climatic disturbances.

## 3.5 SHARES OF DIFFERENT CROPS IN TOTAL CROPPED AREA AND TOTAL VALUE OF CROP OUTPUT

We have noted previously quite impressive growth of production of foodgrains crops like rice, wheat and maize and also the non-foodgrains crops like potato, sugarcane, and chillies during the recent decade of the 2010s, following implementation of the ‘agriculture road maps’. However, it may be interesting to look at the changes in the shares of different crops in total cropped area (cropping pattern), total value of output and the value of output per hectare at different points of time. Crop-wise and crop group-wise information on these aspects at four points of time (TE 1991–92, TE 1999–00, TE 2009–10 and TE 2019–20) for the state are presented in Table 3.6. The main observations are the following:

1. First, in terms of allocation of cropped area, the dominance of cereals crops like rice, wheat and maize continued in Bihar throughout the study period. Thus, the shares of these three crops in the total cropped area remained around 86 per cent during TE 1999–00, TE 2009–10 and TE 2019–20. However, some changes with regard to the share in the total cropped area are visible within the group of cereals. It is found that the shares of wheat and maize in the total cropped area increased and that of rice declined over time indicating thereby substitution of rice cultivation by cultivation of wheat and maize. It is also noticeable from Table 3.6 that the shares of all the pulses crops in the total cropped area declined gradually over time. Therefore, when considered for the group of foodgrains, only a nominal decline in the share of foodgrains is observed, declining from 91.34 per cent in TE 1991–92 to 90.31 per cent in TE 2019–20.
2. As regards the share of non-foodgrains crops in the total cropped area, a marginal improvement is visible, increasing from 8.66 per cent in TE 1991–92 to 9.69 per cent in TE 2019–20. Within this group, however, the percentage share in the total

Table 3.6 Shares of Different Crops in Total Cropped Area and Total Value of Crop-Output, and Per Hectare Value of Output in Bihar

| | *Percentage share in total cropped area* | | | | *Percentage share in total value of output* | | | | *Value of output per hectare (in thousand rupees)* | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Crop*** | ***TE 1991–92*** | ***TE 1999–00*** | ***TE 2009–10*** | ***TE 2019–20*** | ***TE 1991–92*** | ***TE 1999–00*** | ***TE 2009–10*** | ***TE 2019–20*** | ***TE 1991–92*** | ***TE 1999–00*** | ***TE 2009–10*** | ***TE 2019–20*** |
| Rice | 48.01 | 55.01 | 47.48 | 45.72 | 37.92 | 46.61 | 37.08 | 36.33 | 23.63 | 27.23 | 25.79 | 43.30 |
| Wheat | 25.58 | 22.95 | 30.12 | 30.64 | 21.11 | 22.22 | 26.61 | 22.53 | 24.60 | 31.13 | 29.01 | 40.09 |
| Maize | 7.47 | 7.79 | 8.84 | 9.66 | 5.54 | 5.93 | 7.78 | 9.53 | 21.97 | 24.42 | 29.05 | 53.54 |
| Barley | 0.54 | 0.45 | 0.19 | 0.15 | 0.19 | 0.19 | 0.08 | 0.06 | 10.88 | 13.77 | 13.86 | 20.02 |
| Other cereals | 0.60 | 0.87 | 0.27 | 0.11 | 0.17 | 0.26 | 0.08 | 0.02 | 8.56 | 9.55 | 9.52 | 11.62 |
| Gram | 1.81 | 1.19 | 0.87 | 0.80 | 2.25 | 1.36 | 1.01 | 0.60 | 37.16 | 36.96 | 38.20 | 40.45 |
| Arhar | 0.59 | 0.71 | 0.42 | 0.25 | 1.25 | 1.33 | 0.69 | 0.35 | 63.54 | 59.74 | 54.89 | 75.35 |
| Peas | 0.46 | 0.32 | 0.24 | 0.24 | 0.36 | 0.21 | 0.26 | 0.15 | 23.11 | 21.57 | 35.50 | 33.47 |
| Masoor | 2.40 | 1.93 | 2.32 | 2.05 | 2.20 | 1.81 | 2.05 | 1.11 | 27.33 | 30.12 | 29.14 | 29.73 |
| Khesari | 3.88 | 1.85 | 1.25 | 0.68 | 1.67 | 0.90 | 0.61 | 0.20 | 12.85 | 15.68 | 16.12 | 16.01 |
| Total Pulses | 9.14 | 5.68 | 5.09 | 4.02 | 7.72 | 5.61 | 4.62 | 2.40 | 25.24 | 31.79 | 29.85 | 32.59 |
| **Foodgrains** | **91.34** | **92.75** | **91.98** | **90.31** | **72.65** | **80.82** | **76.25** | **70.88** | **23.74** | **28.00** | **27.34** | **42.77** |

*(Continued)*

Table 3.6 (Continued)

| Crop | Percentage share in total cropped area | | | | Percentage share in total value of output | | | | Value of output per hectare (in thousand rupees) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TE 1991–92 | TE 1999–00 | TE 2009–10 | TE 2019–20 | TE 1991–92 | TE 1999–00 | TE 2009–10 | TE 2019–20 | TE 1991–92 | TE 1999–00 | TE 2009–10 | TE 2019–20 |
| Groundnuts | 0.01 | 0.06 | 0.01 | 0.01 | 0.01 | 0.14 | 0.02 | 0.01 | 59.01 | 80.50 | 76.11 | 68.85 |
| Sesamum (Til) | 0.05 | 0.20 | 0.04 | 0.02 | 0.03 | 0.17 | 0.04 | 0.02 | 16.55 | 27.61 | 40.08 | 44.74 |
| Rapeseed & Mustard | 1.36 | 1.14 | 1.20 | 1.12 | 5.39 | 4.43 | 4.76 | 3.42 | 117.20 | 124.60 | 129.78 | 165.79 |
| Linseed | 0.88 | 0.61 | 0.36 | 0.14 | 0.48 | 0.37 | 0.31 | 0.08 | 16.38 | 19.54 | 28.56 | 28.66 |
| Total Oilseeds | 2.30 | 2.01 | 1.61 | 1.30 | 5.91 | 5.12 | 5.14 | 3.53 | 76.41 | 81.86 | 104.65 | 147.85 |
| Jute | 1.78 | 1.62 | 1.78 | 0.97 | 2.68 | 2.02 | 2.83 | 1.35 | 44.57 | 40.15 | 51.91 | 76.55 |
| Mesta | 0.32 | 0.24 | 0.27 | 0.23 | 0.29 | 0.18 | 0.28 | 0.16 | 27.40 | 24.60 | 34.02 | 37.66 |
| Total Fibres | 2.11 | 1.85 | 2.05 | 1.20 | 2.98 | 2.20 | 3.11 | 1.51 | 41.95 | 38.16 | 49.52 | 68.91 |
| Sugarcane | 1.83 | 1.12 | 1.56 | 3.99 | 11.95 | 6.07 | 7.38 | 14.94 | 195.31 | 173.06 | 156.02 | 206.61 |
| Potatoes | 2.10 | 1.89 | 2.08 | 2.27 | 5.68 | 4.80 | 4.43 | 5.00 | 80.64 | 81.51 | 69.34 | 119.79 |
| Chillies | 0.06 | 0.06 | 0.04 | 0.03 | 0.11 | 0.11 | 0.08 | 0.07 | 60.82 | 54.56 | 67.76 | 113.62 |
| Misc. crops | 0.27 | 0.32 | 0.68 | 0.90 | 0.73 | 0.89 | 3.60 | 4.09 | 79.29 | 89.25 | 160.07 | 247.28 |
| **Non-foodgrains** | **8.66** | **7.25** | **8.02** | **9.69** | **27.35** | **19.18** | **23.75** | **29.12** | **94.02** | **84.91** | **97.23** | **163.71** |

*Notes:* (i) Total cropped area and total value of crop-output are computed considering 26 crops; (ii) Other cereals consists of jowar, bajra and ragi; (iii) Misc. crops include onion, ginger, turmeric, coriander and garlic; and (iv) The figures reported here are the averages for three years.

cropped area declined for all oilseeds and fibre crops. The increase in the percentage share in the total cropped area for the group of non-foodgrains crops has happened due to increase in area shares of sugarcane, potato and miscellaneous crops (onion, ginger, turmeric, coriander and garlic).

3. When we look at the shares of various crops in the total value of output, it appears that among the foodgrains crops, rice has been losing and maize has been gaining over time in terms of their respective shares in the total value of crop output. This is expected as the area share of the former in the total cropped area has been declining and that of the latter increasing over time. It, however, needs mention that the other important cereal crop of the state, namely wheat, did not enjoy any noticeable improvement in the total output share despite area share of the crop increasing. For total pulses, the decline in output share is clearly visible in consonance with decline in their area share. When considered for the group of foodgrains crops, the share in output is found to have declined rapidly since TE 1999–00, declining from almost 81 per cent to 71 per cent in TE 2019–20.
4. As regards non-foodgrains crops, it is found that most impressive improvement in the share of total value of crop output has happened for sugarcane, increasing from about 6 per cent in TE 1999–00 to 15 per cent in TE 2019–20. The other important non-foodgrains crops that improved its share a bit in the total value of crop output is potato. The share of potato in the total value of output stood at 5 per cent in TE 2019–20. For all non-foodgrains crops together, the share in the total value of crop output increased from about 19 per cent in TE 1999–00 to 29 per cent in TE 2019–20.
5. Among the cereal crops in Bihar, the most remunerative crop in terms of value of output per hectare appears to be maize that is followed by rice and wheat. As shown in Table 3.6, the per hectare value of output for maize in TE 2019–20 was nearly 54 thousand rupees, and the same for rice and wheat were 43 and 40 thousand rupees, respectively. Although arhar, among the pulses, enjoyed higher per hectare value of output compared to the three cereal crops, its share in total cropped area has been miniscule.

6. As we consider the non-foodgrains crops, it appears that per hectare value of output in TE 2019–20 was highest for sugarcane (207 thousand rupees)[10], which is followed by rapeseed & mustard (166 thousand rupees), potato (120 thousand rupees), chillies (114 thousand rupees), jute (77 thousand rupees) and groundnuts (69 thousand rupees). As all these crops have higher per hectare value of output compared to the cereals as well as total foodgrains, the value of output per hectare for total non-foodgrains in the state also appeared to be much higher. In fact, the per hectare value of total output was 3 to 4 times higher for the group of non-foodgrains crops compared to foodgrains at all the time points.

## 3.6 CROPPING INTENSITY AND CROP DIVERSIFICATION

In this section, we look at the change in cropping intensity and crop diversification pattern in Bihar during the period 1990–91 to 2019–20. Information on cropping intensity and the crop diversification index (CDI) are presented in Table 3.7, and graphically displayed in Figure 3.2. It is observed that the cropping intensity in the state improved over the past 30-year period at a very slow pace. Thus, while the value of cropping intensity in 1990–91 was 136, it improved to 141 in 2000–01. However, in the next 20 years, cropping intensity continued to improve slowly, reaching the level of 144 only in 2019–20.

As the change in cropping intensity was slow, there is not much change in the value of CDI. The value of CDI that was 0.693 in 1990–91 improved marginally to 0.708 in 2010–11 after which it is reduced to 0.687 in 2019–20. It is clear from rather stagnant value of CDI that the agriculture sector in Bihar is characterised for a long period more by 'specialisation' rather than 'diversification'. Specialisation, or the lack of diversification, has been continuing due to over-reliance of the farmers on foodgrains production (especially cereals).

If we look at the cropping pattern and the CDI values for different agro-climatic zones (Table 3.8), it becomes clear that the

Table 3.7 Cropping Intensity and Crop Diversification in Bihar

| *Year* | *CI* | *CDI* | *Year* | *CI* | *CDI* |
|---|---|---|---|---|---|
| 1990–91 | 136 | 0.693 | 2005–06 | 133 | 0.678 |
| 1991–92 | 132 | 0.693 | 2006–07 | 136 | 0.678 |
| 1992–93 | 131 | 0.704 | 2007–08 | 137 | 0.668 |
| 1993–94 | 134 | 0.700 | 2008–09 | 138 | 0.672 |
| 1994–95 | 134 | 0.711 | 2009–10 | 137 | 0.682 |
| 1995–96 | 137 | 0.683 | 2010–11 | 137 | 0.708 |
| 1996–97 | 138 | 0.647 | 2011–12 | 142 | 0.688 |
| 1997–98 | 135 | 0.634 | 2012–13 | 144 | 0.691 |
| 1998–99 | 135 | 0.636 | 2013–14 | 144 | 0.698 |
| 1999–00 | 134 | 0.640 | 2014–15 | 145 | 0.690 |
| 2000–01 | 141 | 0.676 | 2015–16 | 145 | 0.689 |
| 2001–02 | 139 | 0.675 | 2016–17 | 145 | 0.683 |
| 2002–03 | 139 | 0.673 | 2017–18 | 144 | 0.679 |
| 2003–04 | 138 | 0.673 | 2018–19 | 143 | 0.689 |
| 2004–05 | 135 | 0.687 | 2019–20 | 144 | 0.687 |

*Note:* CI represents cropping intensity and CDI represents the value of crop diversification index.

*Source:* Computed by authors.

degree of crop-diversification has been by and large low in all the zones. However, while Zone I seems to be moving along the path of higher diversification (with increase in the value of CDI), other zones seem to be moving towards specialisation (decreasing value of CDI). Increased crop-diversification in Zone I seems to have happened with decreasing share of rice and increasing share of commercial crops like sugarcane and potato in the total cropped area. Another point to note is that both cropping intensity and CDI values in Zones I and II (in North Bihar) are higher compared to Zones IIIA and IIIB (in South Bihar).

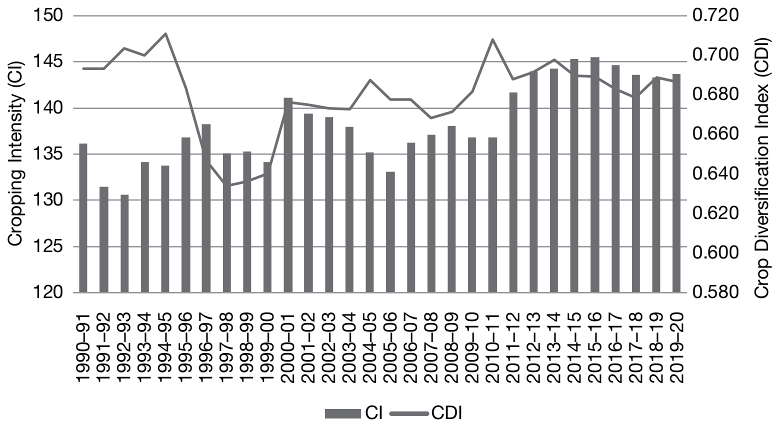



Figure 3.2 Cropping Intensity and Crop Diversification in Bihar

*Source:* Authors' construction.

## 3.7 PATTERNS OF UTILISATION OF SOME SELECTED AGRICULTURAL INPUTS

To understand the pattern of utilisation of inputs in agriculture in Bihar during our study period, we consider some selected indicators on which data are available. These are consumption of fertilisers per hectare (in kg) of gross cropped area (GCA), percentage of net cropped area irrigated, percentage of GCA irrigated, percentage of cropped area under the HYV seeds for three cereal crops (rice, wheat and maize), institutional credit to agriculture per hectare of GCA (in thousand rupees), storage capacity per hectare of GCA (in kg) and rural roads length per hectare of GCA. The information on these aspects for some selected time points are presented in Table 3.9.

It is observed that consumption of fertilisers for agricultural production in Bihar expanded at a steady rate during the past 30 years or so. The increase in the level of fertilisers use is especially noticeable since adoption of agriculture road maps. Thus, while the consumption of fertilisers per hectare of GCA was 94 kg in TE 2004–05, it increased to 173 kg in TE 2010–11 and further to 229 kg in TE 2019–20. As regards irrigation, it is found that while the percentage of GCA irrigated expanded quite appreciably during the past 15 years or so, especially after implementation of the road maps (increasing from 57 per cent in TE 2004–05 to 74 per cent in

Table 3.8 Cropping Intensity and Crop-Diversification in Different Agro-Climatic Zones in Bihar

| | | | *Percentage of cropped area under* | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Zone*** | ***Period*** | ***Cropping Intensity*** | ***Rice*** | ***Wheat*** | ***Maize*** | ***Barley*** | ***Gram*** | ***Arhar*** | ***Peas*** | ***Masoor*** | ***Khesari*** | ***Jute*** | ***Potato*** | ***Sugar-cane*** | ***Chillies*** | ***CDI*** | ***Rank in terms of CDI*** |
| Zone I | 2000–01 | 140 | 48.22 | 32.42 | 9.85 | 0.61 | 0.02 | 0.92 | 0.14 | 1.52 | 0.40 | 0.00 | 2.40 | 3.42 | 0.07 | 0.650 | 3 |
| | 2008–11 | 142 | 46.35 | 33.72 | 10.22 | 0.06 | 0.00 | 0.52 | 0.15 | 1.60 | 0.15 | 0.00 | 2.47 | 4.72 | 0.04 | 0.657 | 3 |
| | 2017–20 | 149 | 41.94 | 33.39 | 10.68 | 0.02 | 0.02 | 0.23 | 0.14 | 1.08 | 0.13 | 0.00 | 2.62 | 9.73 | 0.02 | 0.691 | 1 |
| Zone II | 2000–01 | 163 | 49.69 | 23.68 | 11.90 | 0.08 | 0.19 | 0.06 | 0.31 | 0.96 | 1.25 | 8.81 | 3.02 | 0.04 | 0.00 | 0.674 | 2 |
| | 2008–11 | 149 | 47.46 | 21.41 | 18.02 | 0.00 | 0.02 | 0.00 | 0.18 | 0.75 | 0.73 | 8.79 | 2.48 | 0.14 | 0.02 | 0.688 | 1 |
| | 2017–20 | 152 | 48.62 | 18.74 | 22.89 | 0.03 | 0.02 | 0.02 | 0.25 | 0.43 | 0.24 | 5.23 | 2.96 | 0.50 | 0.09 | 0.672 | 2 |
| Zone IIIA | 2000–01 | 125 | 47.99 | 26.05 | 15.46 | 0.57 | 2.39 | 0.22 | 0.28 | 2.96 | 2.06 | 0.00 | 1.29 | 0.73 | 0.00 | 0.675 | 1 |
| | 2008–11 | 128 | 46.82 | 30.05 | 12.13 | 0.51 | 2.32 | 0.33 | 0.34 | 2.92 | 2.01 | 0.00 | 1.16 | 1.41 | 0.00 | 0.670 | 2 |
| | 2017–20 | 133 | 50.08 | 30.55 | 9.73 | 0.28 | 2.32 | 0.63 | 0.50 | 2.15 | 0.84 | 0.00 | 2.29 | 0.64 | 0.01 | 0.644 | 3 |
| Zone IIIB | 2000–01 | 133 | 52.74 | 30.01 | 2.10 | 0.52 | 2.37 | 0.49 | 0.61 | 4.60 | 4.92 | 0.00 | 1.46 | 0.17 | 0.03 | 0.626 | 4 |
| | 2008–11 | 125 | 46.99 | 37.55 | 1.58 | 0.40 | 2.37 | 0.43 | 0.44 | 5.31 | 3.01 | 0.00 | 1.81 | 0.13 | 0.00 | 0.631 | 4 |
| | 2017–20 | 135 | 51.42 | 36.70 | 1.00 | 0.39 | 2.01 | 0.34 | 0.31 | 4.46 | 1.73 | 0.00 | 1.56 | 0.06 | 0.01 | 0.598 | 4 |

*Source:* Authors' computation.

*Notes:* (1) The figures reported here are averages for three-year period except for the first period (2000–01); and (ii) While for computation of cropping intensity, we have used information on gross cropped area and net cropped area for the districts in different zones, CDI has been computed by considering data on 13 crops only as data for all 26 crops for all the time points are not available at the district level.

Table 3.9 Utilisation Levels of Various Inputs in Agriculture in Bihar

| Item | Year/Period | | | | |
|---|---|---|---|---|---|
| | 1990–91 | TE 2000–01 | TE 2004–05 | TE 2010–11 | TE 2019–20 |
| Fertilisers consumption (N+P+K) [kg/ha] | 57 | 104 | 94 | 173 | 229 |
| Percentage of net cropped area irrigated | 43 | 53 | 59 | 60 | 60 |
| Percentage of gross cropped area irrigated | 40 | 51 | 57 | 62 | 74 |
| Irrigation intensity | 125 | 132 | 134 | 142 | 176 |
| Percentage of cropped area under HYV | | | | | |
| Rice | – | 48# | 51 | 59 | 64 |
| Wheat | – | 73# | 73 | 75 | 76 |
| Maize | – | 34# | 34 | 38 | 34 |
| Total | – | 55# | 58 | 62 | 65 |
| Institutional credit per hectare of GCA ('000 Rs.) | – | 0.76# | 1.72 | 10.17 | 58.79 |
| Storage capacity (kg/ha of gross cropped area) | – | – | 115 | 173 | 195 |
| Rural roads (km)/'000 ha of gross cropped area | 7 | 8# | 11 | 16 | 37$ |

*Source:* Computed by authors.

*Notes:* #data pertain to the year 2000–01 and $ data pertain to 2017–18.

TE 2019–20), the percentage of net cropped area remained more or less stagnant during this period (increasing insignificantly from 59 per cent in TE 2004–05 to 60 per cent in TE 2019–20). This implies that areas irrigated more than once have been growing in recent years, and the expansion of irrigation facilities in hitherto unirrigated areas has been limited. As regards the percentage of cropped areas under the HYV seeds for three cereal crops (rice, wheat and maize), it is found that the progress has been rather slow; increasing from 58 per cent in TE 2004–05 to 65 per cent only in TE 2019–20. However, some progress during the past decade is visible with regard to expansion of institutional credit to agriculture, storage capacity for crops and rural roads. Thus, while institutional credit per hectare of GCA was 10.17 thousand rupees only in TE 2010–11, it increased to as high as 58.79 thousand rupees in TE 2019–20. Similarly, the storage capacity increased from 173 kg/ha during TE 2010–11 to 195 kg/ha during TE 2019–20. Further, the length of rural roads measured as the percentage of thousand hectare of GCA more than doubled during these two time points.

As regards the pattern of utilisation of agricultural inputs in four agro-climatic regions, Table 3.10 reveals that in terms of percentage of cropped area irrigated, the two zones of South Bihar (Zones IIIA and IIIB) have been relatively better placed compared to the zones in North Bihar (Zones I and II) all through our study period. It, however, needs mention that all the zones have improved their percentages of GCA irrigated over time, especially during the decade of the 2010s. The progress with regard to utilisation of fertilisers is also clearly visible in all the agro-climatic zones. However, among all zones, fertiliser consumption increased at the fastest rate in Zone II compared to other zones. With regard to the percentage of area under HYV for the three cereal crops, all the zones recorded some improvement over time except Zone II.

## 3.8 DETERMINANTS OF AGRICULTURAL PRODUCTIVITY: RESULTS OF PANEL REGRESSION

In this section, we examine the roles of technology and weather instability to determine productivity of the crop-cultivation sector in Bihar. For this purpose, we have estimated a panel regression model using data for a period of 20 years (2000–01 to 2019–20) for all 38 districts of Bihar.[11] To capture the impact of technology on agricultural productivity (measured by value of foodgrains/total crop output per hectare), we have considered data on two variables: (i) percentage of area under high-yielding varieties of seeds to total cropped area (HYV), and (ii) percentage of GCA irrigated (IRRI). To examine the effect of weather on agricultural productivity, we constructed an index, called weather instability index (INST),[12] using the district-level rainfall data for the period 2000–01 to 2019–20.

Table 3.10 Levels of Inputs Utilisation in Different Agro-Climatic Zones of Bihar

| | % of Gross Cropped Area Irrigated | | | % of Areas of Rice, Wheat and Maize under HYV | | | Fertilisers Consumption (kg/ha) | | |
|---|---|---|---|---|---|---|---|---|---|
| Zone | 2000–01 | TE 2010–11 | TE 2019–20 | 2000–01 | TE 2010–11 | TE 2019–20 | 2000–01 | TE 2010–11 | TE 2019–20 |
| Zone I | 46 | 50 | 65 | 48 | 61 | 65 | – | 178 | 196 |
| Zone II | 47 | 55 | 68 | 50 | 55 | 53 | – | 157 | 321 |
| Zone IIIA | 57 | 61 | 74 | 44 | 47 | 49 | – | 206 | 272 |
| Zone IIIB | 81 | 84 | 89 | 70 | 74 | 75 | – | 199 | 219 |

*Source:* Computed by authors.

*Note:* The figures reported here (except for 2000–01) are averages for a three-year period.

Table 3.11 Results of Panel Regression (Fixed-Effects Model)

| *Explanatory variable* | *Dep. Variable: Value of Foodgrains Output Per Hectare* Est. Coeff. | t-value | *Dep. Variable: Value of All Crops Output Per Hectare* Est. Coeff. | t-value |
|---|---|---|---|---|
| Percentage of HYV area (HYV) | 103.56 | 2.47* | 103.73 | 2.19** |
| Percentage of irrigated area (IRRI) | 596.67 | 15.19* | 865.18 | 19.38* |
| Instability index (INST) | –1708.46 | –2.78* | –2212.64 | –3.19* |
| Intercept | –9230.96 | –3.14* | –21406.34 | –6.43* |
| No. of observations | 777 | | 777 | |
| $R^2$ | 0.31 | | 0.17 | |
| F-statistic | 98.76* | | 152.70* | |
| Hausman test-statistic ($\chi^2$) | 41.16* | | 98.69* | |

*Note:* * and ** imply significance at 1 and 5 per cent levels respectively.

*Source:* Estimated by the authors using STATA software package.

We hypothesise a positive relationship of HYV and IRRI with the value of output per hectare. However, the relation between the value of output per hectare and INST is hypothesised to be negative.

The results of panel regression are presented in Table 3.11.[13] It is found that for both the models (one considering per hectare value of foodgrains output as dependent variable, and other considering per hectare value of all-crop output as dependent variable), the results are the same. Consistent with our hypotheses, value of output per hectare increases with increase in the percentage of cropped area under HYV and the percentage of irrigated area to cropped area. Thus, the districts that have higher adoption of the new agricultural technology displayed higher productivity per hectare. On the other hand, the districts that are affected more by weather-induced instability are low on the productivity level. The estimated coefficients of two technological variables have expected positive signs and they are statistically significant. Similarly, the estimated coefficient of INST has a negative sign and is also statistically significant. Both the estimated models have overall statistical significance as the computed-$F$ values are statistically significant. Further, the choice of fixed-effects model over the random-effects model is justified by statistical significance of the Hausman ($\chi^2$) statistic.

## 3.9 CONCLUSION

On the basis of our discussion, it may be concluded that production performance of the crop-cultivation sector in Bihar improved significantly during the decade of the 2010s following active policy intervention by the state government through implementation of the 'agriculture road maps'. The turnaround in Bihar agriculture on the production front is clearly visible from much improved growth rates of production for the foodgrains and non-foodgrains crops during the 2010s compared to the two previous decades. During the decade of the 2010s, the most significant performance with regard to the growth of production (more than 6.0 per cent per annum) has been revealed by three cereal crops (rice, maize and wheat) and some non-foodgrains crops like groundnuts, potato, sugarcane and chillies. It is also observed that for the three cereal crops, the main driver of production growth during the 2010s was growth of yield, which accounted for 90 per cent or more of production growth for these crops (the remaining 10 per cent of production growth is accounted for by area growth). On the other hand, among the non-foodgrains crops, while yield growth has been the main driver of production growth for potato during the 2010s, area growth has been more important for groundnuts, sugarcane and chillies.

As Bihar is one of those states in India where performance of the crop-cultivation sector is largely affected by the weather/climatic factors, we looked into the production performance of this sector in four agro-climatic zones. We found that Zone II (North-East Alluvial Plain) and Zone IIIA (South-East Alluvial Plain) performed better with regard to the growth of foodgrains output during the decade of the 2010s compared to Zone I (North-West Alluvial Plain) and Zone IIIB (South-West Alluvial Plain). However, the picture is different with regard to the growth of non-foodgrains output during this period as Zone I turned out to be the best-performer, followed by Zones IIIB, II and IIIA, respectively. When we considered the growth of all-crops output during the decade of the 2010s, Zone I came first, followed by Zones IIIB, II and IIIA respectively. We also found that yield growth contributed much more than area growth towards bringing about higher growth of foodgrains output in all agro-climatic zones during the 2010s. On the other hand, for the growth of output of non-foodgrains, yield growth contributed more than area growth in two zones only – Zone II and IIIB. However, greater contributions of yield growth compared to area growth towards higher growth of all-crop output during this period are clearly observed in all the zones.

The dominance of three cereal crops, namely, rice, wheat and maize, in the cropping pattern of Bihar continued during the past 30 years or so. These crops together accounted for nearly 86 per cent of cropped area during this period. However, some substitution of rice area by maize area within this group is visible. Within non-foodgrains, some increase in area share is visible for sugarcane, potato and miscellaneous crops (onion, ginger, turmeric and garlic). With regard to share in the total crop output, maize in the case of foodgrains and sugarcane in the case of non-foodgrains have been the important gainers over time. Further, the non-foodgrains crops in general have been much more remunerative (on the basis of per hectare value of output) than the foodgrains crops in the state. In TE 2019–20, while maize among the foodgrains crops is found to have highest value of output per hectare, the same among the non-foodgrains crops is found for sugarcane (ignoring the misc. crops).

The cropping intensity in the state has moved upwards at a very slow pace during the past 30 years primarily because it followed the path of 'specialisation'. The cropping intensity that was 136 in 1990–91 in Bihar increased to 144 in 2019–20 (a meagre 8-point increase within a span of 30 years!). Thanks to the specialisation towards cultivation of cereals/foodgrains crops, the CDI in the state remained virtually stagnant during the past 30-year period. Notwithstanding continuation of dominance of cereals/foodgrains crops in the cropping patterns of different agro-climatic zones, some difference among them is noticed regarding the degree of crop-diversification. It seems that two zones in North Bihar have adopted a relatively more diversified cropping pattern compared to the South Bihar zones.

Analysing the pattern of utilisation of inputs in agriculture, we observed that per hectare consumption of fertilisers registered rapid expansion during past 30 years, more so during the decade of the 2010s when ‘agriculture road maps’ were implemented. Although the gross irrigated area as the percentage of GCA expanded appreciably during the 2010s (increasing from 62 per cent in TE 2010–11 to 74 per cent in TE 2019–20), the percentage of the net irrigated area to net cropped area remained unchanged (at 60 per cent), implying that expansion of irrigation facilities has happened more in already irrigated areas (expansion of area irrigated more than once). However, some progress over time regarding percentage of HYV area under the three cereal crops is visible. The same conclusion can be drawn about other input indicators like institutional credit per hectare of GCA, storage capacity (kg) per hectare of GCA and rural roads (km) per thousand hectare of GCA.

To analyse the effects of modern agricultural technologies and climate on agricultural productivity levels, we estimated a panel regression model considering two technological variables (percentage of HYV area and percentage of gross irrigated area) and one indicator of weather/climate (called ‘weather instability index’) as explanatory variables. It clearly appeared that while greater application of modern agricultural inputs helped to raise the productivity level in Bihar, instability of weather provided a dampening effect on it.

Our overall conclusion is that the turnaround in the agriculture sector in Bihar, as reflected by more than 6 per cent per annum growth of both foodgrains and non-foodgrains outputs, during the recent decade (2010s) has been driven by expansion of yield levels of the crops following greater application of modern agricultural inputs (especially irrigation and fertilisers) and improvement in rural infrastructure (e.g., roads). However, the crop sector pursued the path of ‘specialisation’ (with high concentration towards cultivation of crops like rice, wheat and maize) instead of ‘diversification’. This has happened despite the per hectare value of non-foodgrains output being 3 to 4 times higher than the same for foodgrains. Although cultivation of some commercial crops like sugarcane and potato expanded a bit in recent years, the expansion of cropping intensity and diversification of crops have been limited. This is possibly because of laxity towards the growth of net irrigated area and other supports such as institutional credit flow, marketing and storage capacities, and so on, that are required to induce diversification of crops. Above all, given that the uncertainty of agricultural production has been a perennial problem in Bihar, thanks to frequent occurrence of floods and droughts, the majority of the farmers in the state (especially the marginal farmers[14]) might be the risk-averters which is why they are unwilling to alter their foodgrains-dominated cropping pattern that also meets their basic requirements for food. Moreover, crop diversification might not be feasible under an uncertain agro-climatic conditions.

### 3.9.1 Policy Implications

The important policy suggestions emerging from this study to raise agricultural productivity and farmer incomes in the state are: (i) The agriculture sector in Bihar would have to diversify, moving away from foodgrains to non-foodgrains crops, as output per unit of land is much higher for the latter compared to the former; (ii) To hasten the pace of diversification as also to increase cropping intensity, it would be necessary to expand the net irrigated area and improve marketing and storage facilities; (iii) Although the most recent decade of the 2010s witnessed significant improvement in production and yield levels of important crops (both foodgrains and non-foodgrains), efforts should be made to further increase their yield levels as those remained substantially low compared to other major states producing those crops. For instance, the yield levels of two important cereal crops (namely, rice and wheat) in Bihar are much lower not only compared to the all-India yield levels but also the yield levels of other important states cultivating these crops (see Appendix Table 3.1A). The picture is the same for two important non-foodgrains crops like rapeseed and mustard and sugarcane; and (iv) As production performance of agriculture in Bihar is highly affected by weather-induced disturbances (floods and droughts), the Climate Resilient Agriculture programme adopted by the state government since 2018–19 is a welcome step that needs to be implemented with utmost sincerity. However, how far such a programme is becoming effective to prevent the damages being

Appendix Table 3.1A Percentage Shares of Important States in Total Production and Total Cropped Area of Some Crops and Their Yield Levels During TE 2017–18

| State | % share in | | Yield level (kg./ha) |
|---|---|---|---|
| | Total production in the country | Total cropped area in the country | |
| *Rice* | | | |
| West Bengal | 14 | 12 | 2926 |
| Uttar Pradesh | 13 | 13 | 2564 |
| Punjab | 11 | 7 | 4177 |
| Andhra Pradesh | 7 | 5 | 3761 |
| **Bihar** | **6** | **7** | **2192** |
| All-India | 100 | 100 | 2645 |
| *Wheat* | | | |
| Uttar Pradesh | 32 | 32 | 3378 |
| Madhya Pradesh | 17 | 19 | 2993 |
| Punjab | 17 | 12 | 5089 |
| Haryana | 11 | 8 | 4675 |
| Rajasthan | 10 | 10 | 3445 |
| **Bihar** | **6** | **7** | **2833** |
| All-India | 100 | 100 | 3447 |
| *Maize* | | | |
| Karnataka | 14 | 15 | 2914 |
| Madhya Pradesh | 14 | 14 | 2925 |
| Tamil Nadu | 9 | 4 | 7556 |
| Telangana | 9 | 6 | 4414 |
| **Bihar** | **8** | **7** | **3386** |
| All-India | 100 | 100 | 3047 |
| *Rapeseed & Mustard* | | | |
| Madhya Pradesh | 44 | 40 | 1559 |

| State | % share in Total production in the country | Total cropped area in the country | Yield level (kg./ha) |
|---|---|---|---|
| Gujarat | 13 | 9 | 1956 |
| Haryana | 11 | 11 | 1438 |
| Rajasthan | 11 | 12 | 1378 |
| West Bengal | 8 | 10 | 1185 |
| **Bihar** | **1** | **1** | **1241** |
| All-India | 100 | 100 | 1417 |
| *Sugarcane* | | | |
| Uttar Pradesh | 46 | 46 | 80455 |
| Maharashtra | 21 | 20 | 84493 |
| Karnataka | 10 | 9 | 87694 |
| **Bihar** | **4** | **5** | **69656** |
| Tamil Nadu | 4 | 3 | 103476 |
| India | 100 | 100 | 80267 |
| *Potato* | | | |
| Uttar Pradesh | 29 | 28 | 24054 |
| West Bengal | 25 | 21 | 29390 |
| **Bihar** | **15** | **13** | **27643** |
| Gujarat | 7 | 6 | 29602 |
| Madhya Pradesh | 7 | 7 | 22952 |
| All-India | 100 | 100 | 23815 |

*Sources:* Directorate of Economics & Statistics, Govt. of India, *Agricultural Statsitics at a Glance* (various years); Reserve Bank of India, *Handbook of Statistics on Indian States* (various years); and indiastat.com.

caused to agriculture production by weather-induced disturbances emerges as one of the issues for future research.

## NOTES

1. Almost three-fourths of the areas in North Bihar are flood-affected and about one-third of areas in South Bihar are drought-prone.

2. These crops are rice, wheat, maize, barley, jowar, bajra, ragi, gram, arhar, peas, masoor, khesari, groundnuts, sesamum (til), rapeseed & mustard, linseed, jute, mesta, sugarcane, potato, onions, chillies, ginger, turmeric, coriander and garlic. However, for the four agro-climatic zones and 38 districts, 13 crops have been considered (due to non-availability of data at the district level), which are rice, wheat, maize, barley, gram, arhar, peas, masoor, khesari, jute, sugarcane, potato and chillies.
3. We refrained from presenting the results of the Quandt-Andrews breakpoint test to save space. Further, the Bai-Perron test (Bai & Perron, 1998, 2003) that is more appropriate to test the presence of multiple breakpoints in data series could not be applied due to inadequate sample size.
4. Refer to Appendix of Boyce (1987) and Bhaumik and Rashid (2013) for discussion on the Double-Kink Exponential Model.
5. The Herfindahl Index (HI) is computed as: $HI = \sum_{i=1}^{n} C_i$ where $C_i$ is the proportion of area under the $i^{\text{th}}$ crop to total cropped area. Then, the crop diversification index (CDI) is: $\text{CDI} = 1 - HI$ The CDI has a direct relationship with diversification. The '0' value for it implies complete specialisation and moving towards '1' implies increasing diversification.
6. For the entire period of 1990–91 to 2019–20, data used are for Bihar only (i.e., excluding Jharkhand).
7. This might be due to the high incidence of natural disasters during this period. As reported by Gulati et al. (2021, p. 20), Bihar experienced floods in nine years and droughts in five years during 2000–2017.
8. These 18 crops together accounted for 93.14 percent of GCA in the state during the TE 2019–20.
9. In a recent study conducted by the National Remote Sensing Centre (2020), using historical satellite data on floods in Bihar for the period 1998–2019, 15 districts have been identified as 'worst flood-affected' of which 7 are from Zone I, 5 from Zone II, 1 from Zone IIIA and 2 from Zone IIIB. Further, according to an estimate of the Water Resources Department of Bihar Government, 73 per cent of geographical area of the state and 28 districts are flood-prone.
10. It is a long-duration crop that requires 10–15 months, and sometimes even 18 months, to mature depending upon the geographical conditions.
11. Separate data on the output level and technological variables are not available for Arwal district for initial three years when it was part of Jehanabad district. To fill this data gap, we applied linear interpolation technique using data for 17 years that are available.

12. To compute the index of weather instability for the districts, we used data on rainfall for 38 districts for the period 2000–01 to 2019–20. We divided this period into two sub-periods of equal size. For each district and each sub-period, we calculated the mean and standard deviation of actual rainfall, which are used to compute the value of the index for different years in a given sub-period. The formula used is as follows: $\text{INST} = \left|\dfrac{\text{Actual rainfall} - \text{average rainfall}}{\text{Standard deviation of rainfall}}\right|$
Thus, the weather instability index (INST) is the absolute value of the *z*-score statistic. Higher value of INST implies higher degree of instability and vice versa.
13. We estimated both the fixed-effects and random-effects models and chose the former model on the basis of the result of the Hausman test.
14. In the year 2018–19, the marginal farmers operated 58.62 per cent of the total operated area in Bihar. The corresponding figure for the small farmers is 23.15 per cent (MoSPI, 2021).

## REFERENCES


Andrews, D. W. K. (1993). Tests for parameter instability and structural change with unknown change point. *Econometrica, 61*(4), 821–856.

Boyce, J. K. (1987). *Agrarian impasse in Bengal: Agricultural growth in Bangladesh and West Bengal*. Oxford University Press.

Bai, J., & Perron, P. (1998). Estimating and testing linear models with multiple structural changes. *Econometrica, 66*, 47–78.

Bai, J., & Perron P. (2003). Computation and analysis of multiple structural change models. *Journal of Applied Econometrics, 6*, 72–78.

Bhaumik, S. K., & Rashid, S. K. A. (2013). Production performance of Indian agriculture in the era of economic reforms. In S. Banerjee & A Chakrabarti (Eds.). *Development and sustainability*, Springer, 125–154.

Gulati, A., Roy, R., & Saini, S. (2021). *Revitalizing Indian Agriculture and Boosting Farmer Incomes*. Springer.

MoSPI. (2021). *Situation assessment of agricultural households and land and livestock holdings of households in rural India, 2019*. Government of India.

National Remote Sensing Centre. (2020). *Flood hazard atlas of Bihar: A geospatial approach*. Indian Space Research Organisation, Department of Space, Government of India.

Quandt, R. E. (1960). Tests of the hypothesis that a linear regression obeys two separate regimes. *Journal of American Statistical Association, 55*, 324–330.

CHAPTER 4

# ENHANCING PRODUCTIVITY OF RABI MAIZE THROUGH TECHNOLOGICAL CHANGE

*Tulika Kumari and K. M. Singh*

## 4.1 INTRODUCTION

The state of Bihar witnessed the ‘Maize revolution’ courtesy the introduction of rabi maize. Being prominently a kharif crop, the production system of maize was constrained by heavy rainfall and the incidence of insects, pests and diseases during kharif months. As Northern Bihar is highly prone to floods and crop losses, the state introduced hybrid maize in the rabi of 1961 and the rest is history. The crop in rabi season became a grand success resulting in an increase in the area under rabi maize (Singh et al., 2012). With time, the intensification of rabi maize became an opportunity for flood-prone areas of the state to compensate for the loss of the kharif season. In 2019–20, rabi maize covered an area of 463.83 thousand hectares producing 1567.75 thousand tons of maize. Maize production has surged in the state due to increasing demand from the poultry industry. Approximately, 55 per cent of maize is used in the poultry industry as feed. Besides this, 25 per cent is utilised as human food and 16 per cent in industrial applications such as starch, pharmaceuticals and other industries (Kumari et al., 2015). The strong demand pulled by poultry and other industries for maize is enhancing the importance of the crop and attracts the producers to invest in the same. Today, Bihar acts as the main supplier of maize to the other states as it is one of the largest producers of maize.

Not only on the production front, but in terms of marketing too, Bihar has witnessed positive developments, even though there is no formal network of Agricultural Produce Market Committees (APMCs). There are Farmer Producers' Organizations whose primary activity is maize production and marketing. A cent per cent women farmer producer company, named Aranyak Agri Producer Company Ltd. (AAPC Ltd.), promoted by JEEVIKA is involved in maize marketing, which has empowered the status of women in the region. This producer company has a warehouse in the very popular Gulab Bagh mandi in Purnea. The mandi is the largest maize market in India, and about 125 feed companies in eastern India are engaged in maize procurement from this mandi trading in almost 2 million tons of maize annually (Sinha, 2018). In a way, there is a whole non-APMC market for maize in Bihar which has brought the buyers in the state who have established an efficient forward linkage for maize. These market opportunities have acted as a catalyst in the pushing of technological improvements in the production and marketing of maize, leading to a rise in area as well as production.

There is a vast improvement in maize yield in Bihar, increasing from 30.30 qt/ha in 2003–04 to 45.24 qt/ha in 2018–19 (GoI, 2019–2020). This growth could be attributed to technological changes such as the introduction of rabi maize, high-yielding varieties, mechanization, etc. However, very few studies analysed the nature of technological changes in maize production through the measurement of productivity difference between high-yielding varieties and local varieties (Badal & Singh, 2001). In this context, this chapter aims at estimating the total factor productivity (TFP) of maize and examining its correlation with the yield of the crop. In addition, we examine the trend in area, production and productivity of rabi maize.

## 4.2 DATA AND METHODOLOGY

The data on area, production and productivity of maize are collected from various reports published by the Directorate of Economics & Statistics, Department of Agriculture Cooperation and Farmers Welfare, Government of Bihar, for a period of 15 years between 2003–04 to 2017–18. The data on utilization of various inputs (seeds, fertilizers, manure, human labour, animal labour, machine labour, irrigation, insecticide, etc.) and their values have been obtained from the Comprehensive Cost of Cultivation Scheme of the Ministry of Agriculture & Farmers Welfare, running in the state. Additionally, the quantity of by-product is generated by using the 'grain-straw ratio'.

The data have been tabulated and analysed using suitable tools. The compound annual growth rates (CAGRs) of area, production and productivity have been computed by fitting the exponential function. We have analysed the TFP that measures the amount of increase in output which is not associated with the increase in inputs but with the improvement in technology, management, knowledge, infrastructure, and other factors. To estimate TFP, we have estimated input and output indices with the help of Tornqvist-Theil index. The output index includes the main products as well as by-products of rabi maize. The input index includes seeds, fertilisers, manure, human labour, animal labour, machinery, insecticide and irrigation. The output and input indices have been calculated as follows:

$$\text{Total Output Index (TOI): } \mathrm{TOI_t/TOI_{t-1}} = \frac{1}{2}\sum(R_{jt} + R_{jt-1})\,\mathrm{In}\,(Q_{jt}/Q_{jt-1})$$

$$\text{Total Input Index (TII): } \mathrm{TII_t/TII_{t-1}} = \frac{1}{2}\sum(S_{it} + S_{it-1})\,\mathrm{In}(X_{it}/X_{it-1})$$

where, $R_{jt}$ is the share of $j^{\text{th}}$ output in the total revenue in year $t$; $Q_{jt}$ is the output of $j^{\text{th}}$ crop in year $t$; $S_{it}$ is the share of input $i$ in the total input cost in year $t$; and $X_{it}$ is the quantity of input $i$ in year $t$.

As we have considered only one crop (rabi maize) for the study, the share refers to the share of the main product and by-product in the total revenue from the crop, and the output includes the main product and by-product.

The TFP index is calculated from TOI and TII as follows:

$$TFP_t = (TOI/TII).$$

## 4.3 RESULTS AND DISCUSSION

### 4.3.1 Growth Rates of Area, Production and Yield

Bihar is predominantly an agrarian economy; approximately 60 per cent of its geographical area is devoted to the cultivation of crops. Cereals dominate the cropping scenario in Bihar, and maize is one of the important cereals in the state, after rice and wheat. Maize is cultivated in all three seasons, that is, kharif, rabi and summer. However, rabi maize is most popular as its yield is higher compared to maize cultivated in two other seasons. The changes in the area, production and productivity of rabi maize in Bihar during 2003–04 to 2017–18 are displayed in Figure 4.1.

The area under the crop has increased from 196.3 thousand hectares in 2003–04 to 454.2 thousand hectares in 2017–18. The reason may be the increased demand for maize in the manufacturing of different processed products like poultry feed, starch, corn flakes, etc., and improvement in marketing facilities through farmer producer companies and establishment of Gulab Bagh mandi.

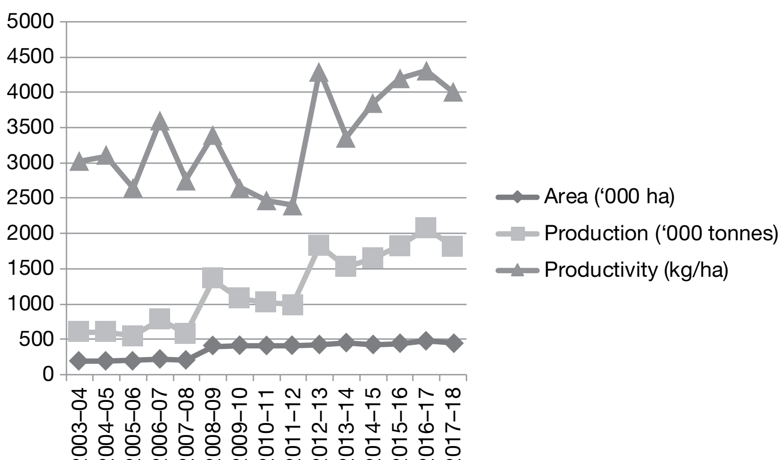



Figure 4.1 Area, Production and Productivity of Rabi Maize in Bihar

*Source:* Authors' construction.

Another reason might be the better return with the improvement in marketing facilities as indicated by the increase in the price of the commodity from Rs. 539.34 per quintal in 2003–04 to Rs. 1565.30 per quintal in 2017–18 (GoI, 2018–19). The productivity of the crop has increased from 3030 kg/ha in 2003–04 to 4005 kg/ha in 2017–18. This increase could be attributed to the adoption of high-yielding varieties like Shaktiman-1 and Shaktiman-2 as reported by Kumari et al. (2015) as well as a congenial weather. During the same time period, the production also increased from 594.7 thousand tonnes to 1819.09 thousand tonnes and it is very much evident that the increase is realised due to increase in both area and productivity. The growth in area, production and productivity as measured by CAGR is shown in Figure 4.2. The CAGR for the area, production and productivity between 2003–04 and 2017–18 was 7.5, 10.41 and 2.71 per cent, respectively. The positive growth rate indicates the improvement in the status of rabi maize in the state.

## 4.3.2 Total Factor Productivity

It is very much evident that the crop output has increased over the years. However, it is essential to understand if this rise is realised by increased utilisation of inputs or other factors than inputs. The

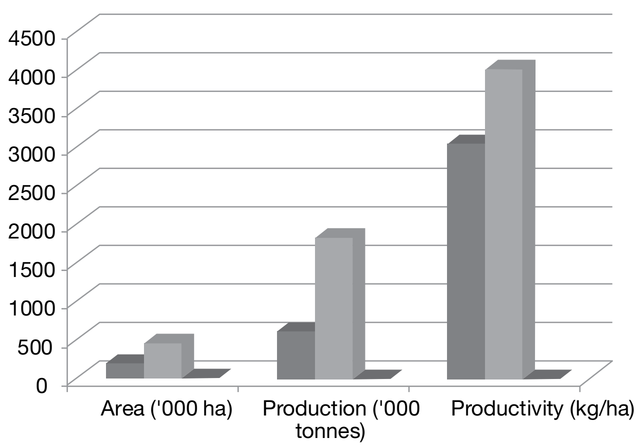



Figure 4.2 CAGR of Area, Production and Productivity of Rabi Maize in Bihar

*Source:* Authors' construction.

estimation of TFP helps in assessing if this rise is due to technological advancements or not. TFP explains the portion of output which is not explained by the amount of inputs used in production. In other words, it shows the effect of technological change on output. The output and input indices are calculated for estimation of TFP, and displayed in Figure 4.3.

It is clear that both output and input indices have shown an increasing trend but the output index is higher than the input index between 2012–13 and 2017–18 (Figure 4.3), which means that the pace of improvement in output is faster than the pace of improvement in inputs. The growth rate of TFP is also positive with a value of 0.93 per cent (Table 4.1). During the earlier period (1975–2005) also, the state of Bihar and Andhra Pradesh registered a positive TFP growth which indicated the gain due to technological advancements (Chand et al., 2012). Another study (Chaudhary, 2012) also reported the positive technical change during 1983–84 to 2005–06 in Bihar. The possible reason for the positive TFP growth could be the proper management of resources, use of high-yielding varieties (hybrids), use of machinery in place of animal labour and other technological advancements.

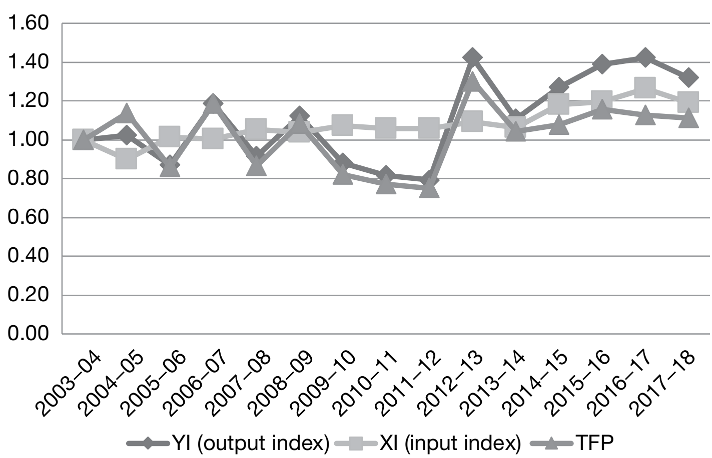



Figure 4.3 Output and Input Indices of Rabi Maize in Bihar

*Source:* Authors' construction.

Table 4.1 Total Factor Productivity (TFP) of Rabi Maize in Bihar

| *Year* | *Yield (ton/ha)* | *TFP* |
|---|---|---|
| 2003–04 | 3.03 | 1.00 |
| 2004–05 | 3.09 | 1.14 |
| 2005–06 | 2.64 | 0.86 |
| 2006–07 | 3.59 | 1.18 |
| 2007–08 | 2.76 | 0.86 |
| 2008–09 | 3.39 | 1.08 |
| 2009–10 | 2.66 | 0.82 |
| 2010–11 | 2.46 | 0.77 |
| 2011–12 | 2.40 | 0.75 |
| 2012–13 | 4.30 | 1.30 |
| 2013–14 | 3.35 | 1.04 |
| 2014–15 | 3.85 | 1.08 |
| 2015–16 | 4.20 | 1.16 |
| 2016–17 | 4.30 | 1.13 |
| 2017–18 | 4.01 | 1.11 |
| **TFP growth** | | 0.93 |

*Source:* Computed by the authors.

### 4.3.3 Correlation between Yield and TFP

The TFP growth in rabi maize is found to be positive in this study. The relation between yield and TFP is also positive as indicated in Figure 4.4. The value of correlation coefficient between the two is 0.89 indicating a strong relationship between TFP and yield.

## 4.4 CONCLUSION

In the state of Bihar, maize is cultivated in all three seasons. However, the highest yield is achieved during the rabi season. The area under the crop has increased in rabi season due to high demand for the same. The growth trend (CAGR) of area,

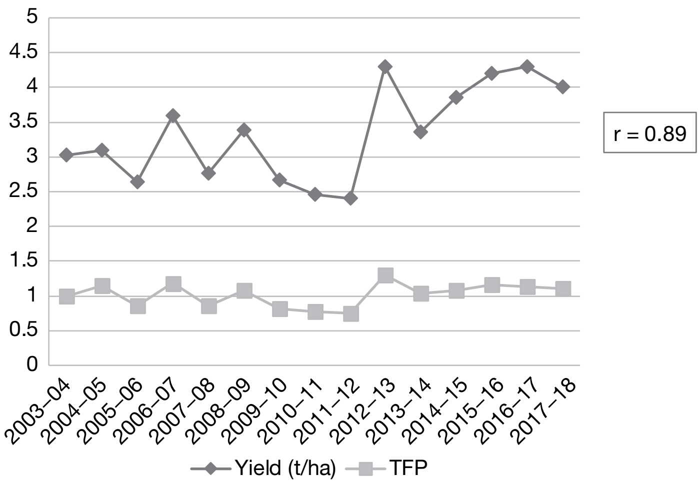



Figure 4.4 Correlation between TFP and Yield

*Source:* Authors' construction.

production and yield is positive. It is very much evident that the yield is increasing over the years and the effect of technology on this increase was captured by estimating TFP. Our analysis revealed positive TFP growth, which indicates the contribution of technological advancement in rabi maize. The technological advancement could be in terms of efficient utilisation of resources, use of hybrid maize, adoption of mechanisation in the crop and others. The relation between technology and yield was very strong as the value of the correlation coefficient was high for TFP and yield. With enhanced production due to technological improvement, the state is moving towards self-sufficiency and fulfilling the increased demand for maize. Based on our analysis, it is suggested to adopt the technology to improve the farm condition. For this, awareness among farmers to adopt the technology might be enhanced by providing quality extension services.

## REFERENCES

Badal, P. S. & Singh, R. P. (2001), Technological change in Maize production: A Case study of Bihar. *Indian Journal of Agricultural Economics*, *56*(2), 211–219.

Chand, R., Kumar, P., & Kumar, S. (2021) Total factor productivity and returns to public investment on agricultural research in India. *Agricultural Economics Research Review, 25*(2), 181–194.

Chaudhary, S. (2012). *Trends in total factor productivity in Indian agriculture: State-level evidence using non-parametric sequential Malmquist index* (Working Paper No. 215). Centre for Development Economics, Delhi School of Economics.

GoI. (2018–2019). *Current daily price of various commodities from various markets (Mandi).* Open Government Data (OGD) Platform, India (accessed November 26, 2021).

GoI. (2019–2020). *Directorate of economics and statistics*. https://view.officeapps.live.com/op/view.aspx?src=http%3A%2F%2Fdesagri.gov.in%2Fwp-content%2Fuploads%2F2021%2F05%2F5-Year-Foodgrain-2019-20.xlsx&wdOrigin=BROWSELINK (accessed November 22, 2021).

Kumari, M., Meena, L. K., & Singh, R. G. (2015). Problems and prospects of maize crop in eastern zone of Bihar. *International Journal of Agricultural Sciences, 5*(2), 137–146.

Singh, N., Rajendran, R. A., Shekhar, M., Jat, S. L., Kumar, R., & Kumar, R. S. (2012). *Rabi maize: Opportunities & challenges*. Directorate of Maize Research.

Sinha, R. K. (2018). *An analysis of supply chain of maize marketing and possibility of its value addition in Bihar*. Agro-Economic Research Centre of Bihar & Jharkhand, T M Bhagalpur University.

# PART II

# STRUCTURAL TRANSFORMATION IN THE AGRICULTURAL SECTOR

CHAPTER 5

# AGRARIAN TRANSFORMATION

## Prospects and Pitfalls

***Anirban Dasgupta and Binoy Goswami***

## 5.1 INTRODUCTION

Bihar's development experience in the last 15 years under the incumbent government has generated a lot of interest in academic and policy circles alike. One of the most backward states in India for many decades, an economic resurgence based on critical institutional reforms promised by the newly elected government in 2005 elicited the expectations of a *New Bihar* (Singh & Stern, 2013) opening up the possibility of rapid development to catch up with the advanced states in India.

Looking back at the broad contours of the development experience in Bihar since 2005, the recent *Bihar Economic Survey* (Government of Bihar, 2021) highlights an important aspect of the growth process. While growth has been led by the urban services sector similar to the larger Indian pattern, urbanisation has not progressed in a commensurate rate thereby increasing the burden on the rural economy to sustain a non-decreasing population.

This chapter examines the dynamics of agrarian transformation within this context of an overburdened rural economy in Bihar. In doing so, it attempts to use an explicit political economic framework based on the literature on the classical agrarian question and the potential of capitalist transformation in agriculture.

In the second section, the relevant theoretical framework is briefly discussed. The third and fourth sections review the recent performance of the agricultural sector and the alternative indicators of capitalist transition derived from the literature, respectively. The final section discusses the implications of agrarian change observed in Bihar and reflects on the constraints which impede a capitalist transformation in the state's agricultural sector.

## 5.2 THEORETICAL APPROACH

Bihar has a long tradition of political economy analysis of the state's agrarian structure (see, for example, Das, 1983; Prasad, 1975, 1979; Sharma, 2005; Wilson, 1999) and its implication for the development trajectory of the state. Without commenting on the detailed inferences drawn by the individual studies, done as they were at different points in time in the last five decades, a common point of concern has been the debilitating impact of unequal and exploitative production relations on the potential of agricultural growth in Bihar. Much of this inequality was operational along a rigid caste hierarchy in the countryside and can be traced back to colonial land revenue extraction practices which was accentuated by state policies of both omission and commission in the post-independence period. Another hallmark of these political economy studies has been their focus on the implications of agrarian change in Bihar for establishing a capitalist mode of production in cultivation with the assumption that widespread capitalist agriculture is necessary for long-term development. In this chapter, we revive this valuable tradition of political economic analysis for Bihar's agriculture[1] and, in turn, the overall development of the state by examining the different indicators of capitalist penetration in agriculture.

A key debate in recent literature on agrarian political economy has centred around the relevance of the classical agrarian question in the contemporary phase of globalised capitalism. Re-evaluating the original concerns in the works of Lenin and Kautsky (among other Marxist thinkers) around the role of agriculture in facilitating the development of capitalism, Bernstein (2006, 2009) has persistently argued that these questions are largely bypassed in current times. The near ubiquitous presence of 'generalised commodity production' in agriculture across the world and increasing global integration of markets over the last three decades, according to Bernstein, have made agricultural development less of a pre-condition for capital accumulation in the larger economy. In case of India, Lerche (2013) has provided an argument in line with Bernstein's about the agrarian question of capital being bypassed for Indian capitalism although an agrarian question of 'classes of labour' still remains valid.[2] While there have been questions raised by scholars like Moyo et al. (2013), Carlson (2018) and Dasgupta (2021) on Bernstein's fundamental position, it still remains dominant in agrarian studies.

Carlson's critique focuses on questioning the universal penetration of capitalist production relations in agriculture across the global south. Carlson identifies two indicators often used in the literature to characterise capitalist mode of production – the use of wage labour and market integration for individual agricultural producers. He concurs that based on either of these two indicators much of southern agriculture will appear to be capitalist, but it is incorrect to draw that conclusion simply because the indicators are not appropriate markers of capitalist production in the first place. Instead, capitalist production relations are identified by the exact nature of land possession by producers. Carlson writes:

> Where possession of the land is mediated by market competition, producers are compelled by market forces to engage in capital accumulation in order to systematically raise productivity and assure their economic survival. But where capitalist property relations are absent, agriculture will not be governed by market discipline, and these capitalist dynamics will not likely be present. (2018: 5–6)

In light of the above, Carlson argues that genuine capitalist production relations should inevitably lead to differentiation and concentration of land in agriculture and, therefore, increasing farm sizes and decreasing total number of farms are more accurate indicators of the spread of capitalism in agriculture.

We use the various indicators of capitalist production used in the agrarian political economy literature to understand the extent of capitalist production relations in Bihar's agricultural sector.

## 5.3 ROLE AND PERFORMANCE OF THE AGRICULTURE SECTOR

Similar to the national level, the contribution of the agriculture sector to Bihar's Gross State Domestic Product (GSDP) has declined over time (Table 5.1). The share of the agriculture and the allied sector declined from 45.27 per cent in 1993–94 to 34.01 per cent in 2004–05, and then further to 25.68 per cent and 19.40 per cent in 2011–12 and 2018–19, respectively[3].

While the share of the agriculture sector in GSDP declined remarkably over time, the decline in the employment share has not been so drastic. The sector continues to provide employment to almost half of the rural labour force (Table 5.2). In 1993–94, agriculture provided employment to 84 per cent of the rural work force that declined 68 per cent in 2011–12 and further to 49 per cent in 2017–18. Therefore, despite the sharp decline in the share of the sector in GSDP, the agriculture sector continues to play an important role in Bihar's economy as the primary source of employment, especially to the rural workforce. The sluggish decline in employment share accompanied by a drastic fall in income share over time implies the worsening of livelihood of those employed in the agriculture sector.

The worsening of livelihood has been further aggravated by the volatile growth performance of the agriculture sector.

Table 5.1 Sectoral Composition of Gross State Domestic Product and Per Capital Income in Bihar, 1993–94 to 2018–19 (in %)

| | *1993–94** | *2004–05* | *2011–12* | *2018–19* |
|---|---|---|---|---|
| Agri & allied | 45.27 | 34.01 | 25.68 | 19.40 |
| **Primary** | **48.78** | **34.15** | **25.76** | **19.61** |
| Manufacturing | NA | 7.02 | 6.07 | 8.22 |
| **Secondary** | **9.93** | **12.35** | **18.76** | **19.76** |
| **Tertiary** | **41.29** | **53.50** | **55.48** | **60.63** |

*Source:* ADRI, 2008 for the year 1993–94; authors' calculation based on data from Directorate of Economics and Statistics, Bihar.

*Notes:* NA means not available in the source.

* Figures for 1993–94 are in 1993–94 prices, and the rest are in 2011–12 prices.

Table 5.2 Sectoral Composition of Rural Employment in Bihar, 1993–94 to 2018–19 (in %)

| | ***1993–94*** | ***2004–05*** | ***2011–12*** | ***2017–18*** |
|---|---|---|---|---|
| Agriculture | 84 | 76 | 68 | 49 |
| Industry | 5 | 11 | 15 | 25 |
| Services | 10 | 14 | 17 | 26 |

*Source:* Singh (2020).

Kishore et al. (2014) shows the trend in the growth of real GSDP from Agriculture (GSDPA) between 1994–95 and 2008–09, and finds that there is not a single episode when growth is positive for two consecutive years. On the other hand, Hoda et al. (2021) presents an unstable trend of agricultural growth in the state over the period of 2001–02 to 2017–18. Barring two short episodes of continuous positive growth between 2010–11 to 2012–13 and 2015–16 to 2017–18, the performance of the sector during the rest of the period as observed by Hoda et al. (2021) is similar to what is found by Kishore et al. (2014). Even during 2015–16 to 2017–18, though the sector registered positive growth, the rates of growth fluctuated remarkably. While Kishore et al. (2014) attributes the volatility in the growth rates of agricultural GSDP to an underlying problem in the GSDPA data, especially after 2004–05, Hoda et al. (2021) attributed this volatility to extreme weather events. Agricultural growth was negative in those years during which the state experienced either drought or flood.

Another important development that deserves attention is the changes in the contributions of different sub-sectors within agriculture as shown in Figure 5.1. The noteworthy change that has happened is the fall in the share of crops and the increase in that of livestock within the agricultural GSDP. The share of crops in GSDPA declined from 68.65 per cent in 2011–12 to 48.70 per cent in 2020–21. On the other hand, the share of livestock increased from 19.38 to 34.68 per cent during the same time period. However, the shares of forestry and logging, and fishing and aquaculture increased only marginally in the last decade.

Within the crops sector, Bihar's agriculture predominantly produces foodgrains. In 2017–18, foodgrains constituted

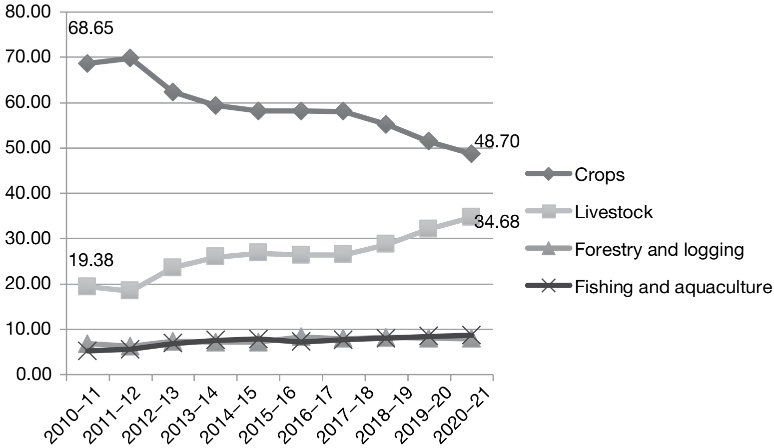



Figure 5.1 Trends in the Shares of Sub-sectors within Agriculture, 2011–12 to 2020–21

*Source:* Authors' construction using data from Directorate of Economics and Statistics, Bihar.

87.52 per cent of the gross cropped area (Table 5.3). Within foodgrains, cereals, especially rice (43.95 per cent) and wheat (27.93 per cent), are the most important crops. Cash crops were grown only on 7 per cent of the gross cropped area wherein sugarcane was the prominent crop. On the other hand, 1.37 per cent of the total cropped area was allocated to growing oilseeds in 2017–18.

## 5.4 TRANSITION IN AGRARIAN RELATION: INPUT VS OUTPUT BASED INDICATORS

In the light of the discussion in Section 5.2 above, we try to understand the nature of agrarian transition that has happened in Bihar over time based on input-oriented as well as output-based indicators. The objective is to explore if the process of capitalist development characterises the changes in the agrarian relations in the state.

### 5.4.1 Input-Oriented Indicators

On the input side, we consider three indicators, namely, (i) proportion of hired labour in total labour used in cultivation,

Table 5.3 Percentage Shares of Gross Cropped Areas under Different Crops

| ***Crops*** | ***2003–04*** | ***2017–18*** |
|---|---|---|
| Rice | 45.2 | 43.95 |
| Wheat | 26.7 | 27.93 |
| Maize | 7.6 | 9.01 |
| Cereals | – | 81.13 |
| Pulse | 8.8 | 6.33 |
| Total food grains | – | 87.52 |
| Oil seeds | 1.8 | 1.37 |
| Sugarcane | 1.4 | 3.12 |
| Cash crops | – | 7.00 |
| Others | 8.5 | 4.11 |

*Source:* 2003–04: Hoda et al. (2021); 2017–18: authors' calculation based on data sourced from Government of Bihar (2019).

(ii) proliferation of the rental markets for agricultural machinery and equipment, and (iii) adoption of high yielding varieties.

A strand of literature suggests that the producers in Global South increasingly produced for the markets that are globally integrated; consequently, they operated under the logic of global capitalism. Even the ones who do not produce for markets are subjected to a capitalist logic of production as they rely on the selling of commoditised labour for survival (Akram-Lodhi & Kay, 2010a; Bernstein, 2004; Lerche, 2010). In this context, Akram-Lodhi and Kay (2010b) point out that a substantial part of income of the small farmers comes from wage labour. This implies that the agriculture sector that is characterised by capitalist development should show predominance of hired labour in agricultural operation as well. Figure 5.2 shows the distribution of hired and family labour in total labour used in the cultivation of two primary crops, namely paddy and wheat, in Bihar. The amount spent on hired labour is much higher (by Rs. 1,472) than that on family labour in case of paddy. On the other hand, in the case of wheat, the amount spent

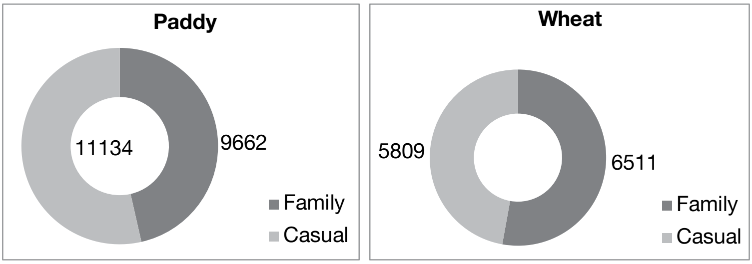



Figure 5.2 Distribution of Hired and Family Labour in Paddy and Wheat (Rs.)

*Source:* Directorate of Economics and Statistics, Government of India, 2018–19. Available at: https://eands.dacnet.nic.in/Cost_of_Cultivation.htm.

on hired labour is less by Rs. 702 than that on family labour. In any case, the preponderance of hired labour in agricultural operation is quite clear from Figure 5.2.

The compulsion of selling labour for wage has an implication for mechanisation of agriculture. In order to sell labour, farmers have to free labour from agricultural activities. Withdrawal of labour increases the dependence on agricultural machinery and equipment. Thus, as an outcome of the capitalist development process, the extent of mechanisation should increase.[4] In order to examine the extent of mechanisation, we look at the extent of the rental market for agricultural machinery and equipment rather than their ownership. It may not be possible for the marginal and small farmers, who are the predominant groups in Bihar (see Table 5.5), to own these capital goods owing to their poor resource conditions. Rental markets, by separating the flow of services from ownership, allow the small and marginal farmers to use the machinery without having to own them (Timmer, 1988).[5] Table 5.4 shows the extent of the proliferation of rental markets for tractor and power tiller in Bihar. In the absence of mechanisation, one of the most labour-intensive parts of the cultivation process is tilling and, therefore, we looked at the rental market for tractors and power tillers. On the whole, 85.38 per cent of the operational holdings used tractor and power tiller in Bihar for tilling activity in 2016–17. Out of this, 69.55 per cent of operational holdings used hired tractor and power tiller as opposed to only 15.83 per cent operational holdings that used their own tractor and power tiller. Thus, the extent of mechanisation as far as tilling activity is concerned is quite high.

Table 5.4 Percentage Shares of Operational Holdings in Bihar Using (Own and Hired) Tractor and Power Tiller across Size Classes in Bihar

| *Size Groups* | | *Power Tiller + Agricultural Tractor* |
|---|---|---|
| Marginal | Own | 14.67 |
| (Below 1.0 ha) | Hired | 70.38 |
| Small | Own | 23.70 |
| (1.0–2.0 ha) | Hired | 64.72 |
| Semi-medium | Own | 34.00 |
| (2.0–4.0 ha) | Hired | 57.55 |
| Medium | Own | 45.41 |
| (4.0–10.0 ha) | Hired | 47.02 |
| Large | Own | 41.38 |
| (10.0 ha & above) | Hired | 48.28 |
| All size groups | Own | 15.83 |
| | Hired | 69.55 |

*Source:* Computed from All India Report on Input Survey 2016–17, Government of India (2021a).

Table 5.4 also shows that the proportions of farmers that use hired tractors and power tillers are relatively higher in the marginal and small size classes categories. This may be due to the fact that these resource-poor farmers probably earn a substantial part of their income through wage labour and, therefore, in order to free their labour from agriculture, they depend more on hired machinery.

Another factor that can reflect the process of capitalist transformation in agriculture is the adoption of better-quality inputs, such as seeds, by farmers in order to realise higher production and productivity. The data available from the agriculture department of Bihar government show that the HYV seeds were adopted on 64.11 per cent and 76.40 per cent of the total acreage under rice and wheat respectively in 2017–18. The farmers who cultivate the primary crops in the state use HYVs on a substantial part of the cropped area.

Thus, the proliferation of market transactions in the input markets through wage labour and rental market of agricultural machinery, as well as the adoption of better-quality inputs, suggests that the process of capitalist transition may have made progress in Bihar's agriculture.

### 5.4.2 Output-Oriented Indicators

Citing the historical evidence from 17th century Spain and 19th century United States of America, Carlson (2018) asserts that use of wage labour or production for markets are not good indicators of capitalist development of agriculture. Instead, one has to analyse the nature of the transition process with respect to property relation. If a farmer produces under the capitalist logic, she/he should be able to reproduce the possession of land through accumulation. This in turn is possible through continuous innovation and investment on land, intensive cultivation and specialisation, all of which eventually lead to higher scale of operation. Table 5.5, however, shows that 84.18 per cent of the operational holdings in the state were marginal holdings in 2000–01, which further increased to 91.24 per cent in 2016–17. The average size of operational holding

Table 5.5 Distribution of Operational Holdings and Area Operated across Land Size Classes in Bihar

| | ***2000–01*** | | | ***2016–17*** | | |
|---|---|---|---|---|---|---|
| ***Size Classes*** | ***Holdings (%)*** | ***Area (%)*** | ***Average Area (ha)*** | ***Holdings (%)*** | ***Area (%)*** | ***Average Area (ha)*** |
| Marginal | 84.18 | 43.09 | 0.03 | 91.24 | 58.64 | 0.25 |
| Small | 9.23 | 19.20 | 1.21 | 5.74 | 17.98 | 1.24 |
| Semi-medium | 5.09 | 22.88 | 2.62 | 2.51 | 15.77 | 2.49 |
| Medium | 1.42 | 12.76 | 5.24 | 0.49 | 6.86 | 5.53 |
| Large | 0.08 | 2.07 | 15.50 | 0.02 | 0.75 | 17.05 |
| Overall | 100.00 | 100.00 | 0.58 | 100.00 | 100.00 | 0.40 |

*Source:* Agricultural Census 2000–01, authors' calculation based on data sourced from All India Report on Input Survey, 2016–17, Government of India (2021a).

declined from 0.58 hectare in 2000–01 to 0.40 hectare in 2016–17. Thus, the scale of operation in agriculture does not indicate a tendency towards capitalist development.[6]

Table 5.6 presents further evidence of non-capitalist characteristic of the agriculture sector in the state. The overall cropping intensity in the state is very low. In 2016–17, the value of the index of crop intensity was only 1.42. This implies that only less than half of the land is cultivated more than once despite having access to irrigation on 67.36 per cent of the gross cropped land. Cropping intensity is less than 2 for all size classes even on the irrigated land.

Evidence on market participation of Bihar farmers is ambiguous. Government data, based on the Cost of Cultivation surveys, reports Marketed Surplus Ratios (MSR) for the major food grains. For the period 2012–13 to 2014–15, the MSR ranges between 82 and 86 per cent for rice (approximately the all-India average) and between 80 and 82 per cent for wheat (higher than all-India average). Moreover, the MSR figures for rice in Bihar are significantly higher than the other rice growing states in eastern India. The data from a recent multi-state study of agricultural markets, however, present a different picture. The survey carried out, as part of this study, across three major agricultural districts in

Table 5.6 Cropping Intensity across Land Size Classes of Operational Holdings in Bihar

| ***Land Size Classes*** | ***Irrigated Land*** | ***Unirrigated Land*** | ***Overall*** | ***% Share of Irrigated Land in Gross Cropped Land*** |
|---|---|---|---|---|
| Marginal | 1.42 | 1.14 | 1.26 | 48.82 |
| Small | 1.74 | 1.38 | 1.70 | 90.08 |
| Semi-medium | 1.70 | 1.42 | 1.66 | 89.35 |
| Medium | 1.57 | 1.58 | 1.57 | 84.57 |
| Large | 1.66 | 1.77 | 1.66 | 84.05 |
| Overall | 1.58 | 1.17 | 1.42 | 67.36 |

*Source:* Authors' calculation based on data sourced from All India Report on Input Survey, 2016–17, Government of India (2021a).

Bihar in 2018 revealed that only 40 per cent of paddy farmers and less than 30 per cent of wheat farmers report selling any produce in the market (Chatterjee et al., 2020). The primary reason identified in this study for this low market participation is the very small farm sizes in Bihar which leave little scope for market sale after meeting family consumption needs. Although the sampling frames of the two sources of evidence reported above are not strictly comparable, they raise important questions which need attention of the researchers. It is possible that a disaggregated analysis of MSRs by land size would reveal that the relatively high market integration indicated by the Commission for Agricultural Costs & Prices (CACP) data is entirely driven by the small number of farmers with relatively larger scale of operations.

As discussed above, farmers producing under capitalist logic should be able to reproduce the possession of land through accumulation of surplus. Thus, the final indicator that we considered is the generation of income by a rural household in the state. Table 5.7 shows the average monthly income earned by a rural household in Bihar from different sources during July 2018 to June 2019. As per the 77th round of National Sample Survey data, while the average monthly income of agricultural households in India is a meagre amount of Rs. 10,218 only under the paid expenses approach, the

Table 5.7 Average Monthly Income from Different Sources Earned by an Average Agricultural Household during July 2018 to June 2019 in Bihar (in Rs.)

| *Income Sources* | *Paid out Expenses Approach* | *Paid out + Imputed Expenses Approach* |
|---|---|---|
| Wage | 2,503 | 2,503 |
| Leasing out of land | 82 | 82 |
| Crop production | 2,739 | 2,300 |
| Farming of animals | 1,739 | 914 |
| Non-farm business | 479 | 479 |
| Total | 7,542 | 6,278 |
| All India | 10,218 | 8,337 |

*Source:* NSS Reports No. 587, pp. 129–130, Government of India (2021b).

amount is even smaller for Bihar. An agricultural household earns Rs. 7,542 only during an agricultural year in Bihar. In fact, if the imputed costs of crop cultivation are also considered, it gets further reduced to Rs. 6,278 only. In terms of the components of income, crop cultivation constitutes only 36.64 per cent of the total income of an agricultural household under the paid out plus imputed costs approach. The inadequate amount of income earned from crop cultivation and other sources forces an agricultural household to sell labour in order to support its survival. In fact, the highest share of income (39.87 per cent) comes from labour wages. Another significant share of income is earned from animal farming.

The discussion in sections 5.4.1 and 5.4.2 presents contradictory evidence of capitalist transition in Bihar's agriculture. The input-oriented indicators clearly suggest that the agriculture sector in the state exhibits characteristics of a capitalist mode of production. On the other hand, the output-based indicators present a completely opposite picture. However, in the light of the discussion in Section 5.2 and the evidence presented in Section 5.4.2, we can conclude that Bihar's agriculture that is characterised by non-intensive and low-scale of operation at the household level, and low level of surplus generation, is yet to make a transition to a capitalist system of production.

## 5.5 NATURE OF CONSTRAINTS FOR AGRARIAN TRANSFORMATION

A quick summary of the results in the previous section may be made thus: even though crop cultivation in Bihar has made substantial progress in the last two decades in using modern inputs and even if the use of wage labour and production for market is substantial, agriculture in Bihar is far from capitalist. The key signs that bolster the latter conclusion include the low and declining scale of operations and the absence of any substantial surplus from agriculture (including livestock). In this section, we make some brief remarks on what this situation might mean for Bihar's economic future both pertaining to agriculture and more broadly.

In a recent study, using growth diagnostic techniques on Bihar's agriculture (Kannan & Pohit, 2021), the two main constraints on growth were identified as inefficient product markets and low levels of crop diversification. Earlier generation studies (Kishore, 2004) highlighted major deficiencies related to inadequate irrigation access and prohibitive cost of irrigation as central to the yield deficits in Bihar. It is safe to infer both from our discussion on input-based indicators and the reading of the recent literature that the input deficiencies have been largely overcome in Bihar in the last two decades at least partly due to the implementation of the three rounds of the Agriculture Roadmaps programmes since 2008. However, large yield deficits for wheat and rice (the major crops in Bihar) still exist relative to progressive states like Punjab and Haryana. While there may still be identifiable areas in which input intensification can be improved, clearly the emerging agrarian structure and particularly the sharply declining scale of operations poses a serious constraint in this regard. With more than 90 per cent of operational holdings in the marginal category (and average size of holding being only 1 acre), agriculture cannot even provide a subsistence livelihood for a family. This necessitates adopting a fractured livelihood strategy made of multiple sources (Akram Lodhi & Kay, 2010b) where agriculture provides an anchor but does not warrant serious effort or innovation.

A related question which comes up in assessing the presence (and even possibility) of capitalist transformation in Bihar agriculture is the meagre surplus generated from cultivation directly as well as from supplementary sources of income. While such numbers are low for most states in India, Bihar is significantly below the national average despite being one of the few states that showed high growth in income levels for farming households between the last two rounds of the NSS Situation Assessment Survey (Hussain & Bathla, 2021). It is true that policy interventions for providing better access to markets (including setting up appropriate infrastructure) and incentives towards crop diversification may have some scope for improving returns from agriculture. Access to credit via institutional sources is also essential to increase the scale of output and other associated activities. A capitalist farmer, who expands the scale of operation, innovates and specialises in production, would require funds for which she/he has to borrow. Table 5.8 shows that, overall, only 24.19 per cent of the operational holdings borrowed from institutional sources. Thus, non-intensive

Table 5.8 Proliferation of Institutional Credit in Bihar

| *Land Size Classes* | *% of Operational Holdings Accessing Institutional Credit* |
|---|---|
| Marginal | 25.32 |
| Small | 11.52 |
| Semi-medium | 13.75 |
| Medium | 17.00 |
| Large | 10.35 |
| Overall | 24.19 |

*Source:* Authors' calculation based on data sourced from All India Report on Input Survey, 2016–17, Government of India (2021a).

and low-scale of crop production gets reflected in lower access to institutional credit also.[7]

A similar argument can be made regarding the potential of expanding extension services for farmers in Bihar where the current uptake of such services is limited (see Table 9, NSSO Report 587, 77th Round). However, one just needs to look at figures from advanced states like Punjab to appreciate the limits of such strategies for generating adequate surplus for marginal farmers. In Bihar, like much of agrarian India, expanded capitalist reproduction through reinvestment of surplus seems infeasible in the foreseeable future.

Our final comment is on the central contradiction that plagues capitalist transformation in agriculture in most economies of the Global South – the continued presence of substantial surplus labour. It is precisely because of this fact that agriculture in these contexts cannot be equated with other economic activities. The burden of surplus labour shows up on the one hand in the abysmally low labour productivities in agriculture (even when yield increases) and in the declining size of holdings on the other. As Carlson (2018) correctly points out, in most developed countries the establishment of agrarian capitalism is witnessed in the gradual increase in farm sizes and consequent decline in the number of farms. However, this phenomenon is contingent on the successful progress and eventual completion of the process of structural transformation whereby labour productivity across sectors are nearly equalised. But this has not been the case with India and most other developing countries where the process of structural transformation has been found to have slowed down in recent years (Timmer & Ackus, 2008) or stunted (Binswanger-Mkhize, 2013). The consequence is a continued dependence on agriculture (and certain informal activities) of a large mass of people for subsistence, making it virtually impossible for the sector to function along a purely capitalist logic of accumulation and expansion. Acknowledging the critical role played by agriculture in accommodating and contributing (even partially) to the subsistence of the surplus population who cannot be absorbed in the high productivity sectors has important implications for policymaking. Conventionally, development policy had underscored the importance of generating productive employment outside agriculture and thus speeding up structural transformation while also trying to increase productivity in agriculture. We would argue that it is more pragmatic to accept that surplus labour will continue to exist in agriculture for the foreseeable future and, therefore, the objective cannot be one of capitalist transformation but non-capitalist livelihood provision. This realisation, however, should not lead to policy paralysis. There is significant scope for improving the livelihood outcomes in agriculture by exploiting its potential backward and forward linkages with the small-scale rural enterprises as well as ensuring an income floor per unit of land under cultivation. Innovative policymaking that builds on a clear understanding of the livelihood function of agriculture is imperative in this regard.

## NOTES

1. Since Sharma (2005), there has been little work on Bihar's agriculture using an explicitly political economy framework.
2. This raises concerns about the questions of subsistence of labour based on agriculture.
3. At the national level, the contribution of the agriculture and allied sectors to the total economy was 17.6 per cent in 2018–19.
4. Extent of mechanisation may increase as the scale of operation increases under the capitalist development process. However, in order to understand this phenomenon, one has to juxtapose the penetration of the use of machines with the scale of agricultural operation.

5. The cost of cultivation data for 2018–19 shows that the proportion of hired machine labour in total machine labour used in the cultivation of paddy and wheat in Bihar are 96.40 per cent and 96.95 per cent, respectively.
6. As discussed, distribution of ownership holdings would be a better indicator of capitalist development rather than operational holdings. However, given that the land sale market is very thin in India for varied reasons, we consider only operational holdings for our analysis.
7. For a complete picture with regard to the use of credit, one should consider the sources of informal credit as well. However, given the substantially higher rates of interest that are usually associated with informal credit, one would expect that a capitalist farmer would prefer to access institutional credit, at least a predominant part of it.

## REFERENCES


Akram-Lodhi, A. H., & Kay C. (2010a). Surveying the agrarian question (part 1): Unearthing foundations, exploring diversity. *Journal of Peasant Studies, 37*(1), 177–202.

Akram-Lodhi, A. H., & Kay, C. (2010b). Surveying the agrarian question (part 2): Current debates and beyond. *Journal of Peasant Studies, 37*(2), 255–284.

Bernstein, H. (2004). Considering Africa's agrarian questions. *Historical Materialism, 12*(4), 115–144.

Bernstein, H. (2006). Is there an agrarian question in the 21st Century? *Canadian Journal of Development Studies, 27*(4), 449–460.

Bernstein, H. (2009). Ten agrarian questions from transition to globalization. In A. H. Akram-Lodhi, J. Borras & C. Kay (Eds), *Peasants and globalization: Political economy, rural transformation and the agrarian question* (pp. 239–261). Routledge.

Binswanger-Mkhize, H. P. (2013). The stunted structural transformation of the Indian economy: Agriculture, manufacturing and the rural non-farm sector. *Economic and Political Weekly*, *48*(26/27) 5–13.

Carlson, C. (2018). Rethinking the agrarian question: Agriculture and underdevelopment in the global South. *Journal of Agrarian Change, 18*(4), 703–721

Chatterjee S., Krishnamurthy, M., Kapur, D., & Bouton, M. (2020). *A study of the agricultural markets of Bihar, Odisha and Punjab*. Center for the Advanced Study of India, University of Pennsylvania.

Das, A. N. (1983). *Agrarian unrest and socio-economic changes in Bihar, 1900–1980*. Manohar.

Dasgupta, A. (2021). Peasant production in India: How the 'Need Economy' facilitates accumulation. *Development and Change, 52*(2), 217–240.

Government of Bihar. (2019). *Bihar at a Glance, 2019*. Directorate of Economics and Statistics, Department of Planning and Development.

Government of Bihar. (2021). *Bihar economic survey 2020–21*. Finance Department.

Government of India. (2021a). *All India report on input survey 2016–17*. Agriculture Census Division, Department of Agriculture, Cooperation & Farmers' Welfare, Ministry of Agriculture & Farmers' Welfare.

Government of India. (2021b). *Situation assessment of agricultural households and land and livestock holdings of households in rural India, 2019*. National Sample Survey (Report No. 587).

Hoda, A., Gulati, A., Jose, S., & Rajkhowa, P. (2021). Sources and drivers of agricultural growth in Bihar. In A. Gulati, R. Roy & S. Saini (Eds.), *Revitalizing Indian agriculture and boosting farmer Incomes*. Springer.

Hussain, S., & Bathla, S. (2021). What the latest NSS survey tells us about the state of farmers in India. *The Wire*. https://thewire.in/agriculture/what-the-latest-nss-survey-tells-us-about-the-state-of-farmers-in-india

Kannan, E., & Pohit, S. (2021). *Agricultural growth diagnostics for Bihar (India): Identifying the binding constraints and policy remedies* (Working Paper). NCAER

Kishore, A. (2004). Understanding agrarian impasse in Bihar. *Economic and Political Weekly, 39*(31), 3484–3491.

Kishore, A., Sharma, B., & Joshi, P. K. (2014). *Putting agriculture on the takeoff trajectory: Nurturing the seeds of growth in Bihar, India*. International Food Policy Research Institute and International Water Management Institute.

Lerche, J. (2010). From 'Rural Labour' to 'Classes of Labour': Class fragmentation, caste and class struggle at the bottom of the Indian labour hierarchy. In B. Harriss-White & J. Heyer (Eds.), *The comparative political economy of development: Africa and South Asia*. Routledge.

Lerche, J. (2013). The agrarian question in neoliberal India: Agrarian transition bypassed? *Journal of Agrarian Change, 13*(3), 382–404.

Moyo, S., Jha, P., & Yeros, P. (2013). The classical agrarian question: Myth, reality and relevance today. *Agrarian South: Journal of Political Economy, 2*(1), 93–119.

Prasad, P. H. (1975). Agrarian unrest and economic change in rural Bihar: Three case studies. *Economic and Political Weekly, 10*(24), 931–937.

Prasad, P. H. (1979). Caste and class in Bihar. *Economic and Political Weekly, 7*(8), 481–484.

Sharma, A. N. (2005). Agrarian relations and socio-economic change in Bihar. *Economic and Political Weekly, 40*(10), 960–972.

Singh, G. (2020). Access to non-farm employment in contemporary India: A study of Bihar and Punjab. *Social Change, 50*(4), 532–547.

Singh, N. K., & Stern, N. (2013). *The new Bihar: Rekindling governance and development*. Harper Collins.

Timmer, C. P. (1988). The agricultural transformation. In H. Chenery & T.N. Srinivasan (Eds.), *Handbook of development economics* (Vol. I). Elsevier Science Publishers.

Timmer, C. P., & Akkus, S. (2008). *The structural transformation as a pathway out of poverty: Analytics, empirics and politics* (Working Page No. 150). Center for Global Development Working Paper.

Wilson, K. (1999). Patterns of accumulation and struggles of rural labour: Some aspects of agrarian change in central Bihar. *The Journal of Peasant Studies*, *26*(2–3), 316–354.

## CHAPTER 6

# AGRICULTURAL DEVELOPMENT AND SOME STRUCTURAL ISSUES

*Santosh Verma*

### 6.1 INTRODUCTION

Despite achieving impressive growth numbers over past 15 years or so, Bihar continues as one of the backward states of India in almost all economic and human development indicators. The Tendulkar Committee Poverty Estimates, which itself is criticised to be a line of destitution rather than a poverty line, established the fact that Bihar is one of Indian states where headcount poverty (33.7 per cent) is the highest (NITI Aayog, 2015). A recent report on National Multidimensional Poverty Index (MPI) by the NITI Aayog (2021) brings out the fact that Bihar has the highest percentage of poverty among all the Indian states. The report shows that the headcount ratio of poverty in Bihar was 51.91 per cent. The backwardness and higher poverty percentages in Bihar are due to long-drawn structural imbalances in the state's economy in which structural imbalances/deficiencies in agriculture, for example higher land inequality, lesser public investment in agriculture, under-performing/non-functional government agricultural marketing institutions, are among the prominent ones. Insufficient investment towards the manufacturing sector puts a barrier in absorbing the surplus labour from the rural areas in Bihar as the sector itself is languishing (Endow & Mishra, 2021). The rural–urban linkages reflect that the percentage share of hired workers in total workers in the urban manufacturing units of Bihar has declined from 57.5 per cent in 2005 to 46.7 per cent in 2013 (ibid.). There is also uneven distribution of public investment, and henceforth accruing development initiatives and benefits are also uneven that even widen the socio-economic disparities in Bihar (Tsujita et al., 2010). But lately, there had been signs of emergence from economic stagnation and backwardness — real wages have risen substantially, agricultural productivity has increased and remittances from migration have become one of the important contributors in the rural economy, but for this to continue in the longer term there is need for agrarian transformation (Sharma & Rodgers, 2015). Now, the question that remains to be answered is: What is this agrarian transformation and how far will the people of Bihar wait for it to happen?

Historically, Bihar has witnessed a very exploitative agrarian relation that caused rural stagnation and poverty. The agrarian system in Bihar was dominated by the relatively large landlords who generally controlled the rural labour through interlocking mechanisms of labour attachment, tenancy and indebtedness in a system that is well described as 'semi-feudal' (ibid., p. 46). These tendencies were not new and restricted to Bihar; they are carried forward from British India where massive ruralisation of the economy took place (Chandra, 1966) that pulled India into severe economic distress, famines, poverty, unemployment and various other dehumanising circumstances at the eve of India's independence. For rural and agrarian transformation, there was need of structural change in the land relations and Bihar was one of the states which adopted land reforms policy to redistribute the land to the real tillers, but couldn't actually implement it.

In view of the above, this chapter examines the agricultural scenario of Bihar in the wake of higher landlessness and incidence of tenancy and its impact that largely signifies a low/negative income trap in agricultural activities in Bihar. The chapter also discusses the recent public investment patterns in agriculture and allied activities, rural development, irrigation and public investment in village and small industries in Bihar. To understand the pattern of income generation in the agricultural households in Bihar, we have analysed the Situation Assessment of the Agricultural Household data for 2012–13 and 2018–19 provided by the National Sample Survey (NSS).

This chapter is divided into six sections: first being the introduction, second, a brief analysis of the political economy of Bihar, third, the investment pattern in agriculture and rural economy, fourth, the land distribution pattern in Bihar, fifth, analysis of agricultural households' income and the sixth, concluding remark.

## 6.2 BIHAR'S AGRARIAN POLITICAL ECONOMY

### 6.2.1 Land Reform Programmes

After Independence, Bihar was one of the first states to enact the land reform act when the Zamindari system was abolished in the state in 1952 through the legislation – the Bihar Land Reform Act, 1950. The next stage of land reform was to transform the semi-feudal agrarian relations through imposition of a ceiling on the ownership of land of the individuals and consolidating the surplus land above the ceiling by the state to distribute them among the real tillers of land. However, the imposition of the ceiling was a difficult task in Bihar as there were no proper land records with the state, so the first task was to prepare the land records and it took around 12 years to pass the Ceiling Act in 1962. Almost three decades after enactment of the ceiling legislation in Bihar, the government acquired 3.85 lakh acres of land (around 2.75 per cent of total arable land in Bihar) as 'surplus' up to November 1990. Of these acquired land, around 2.62 lakh acres were distributed, whereas 0.72 lakh acres were under 'disputed' area; 0.20 lakh acres were 'not fit for distribution' and 0.24 lakh acres stood as 'debarred' by appellate courts (Bharti, 1992). Although these numbers as claimed by the Bihar government put a rosy picture of land reform in the state, any such success would have changed the agrarian structure of the state to a more equitable pattern which in reality did not happen. Some scholars analysed the land reforms programme followed in Bihar and found it as a dismally failed one. Even after legislative efforts to change the land ownership pattern in the state, land remained in the control of dominant castes. The land reform legislation set a loose definition of 'personal cultivation' instead of taking 'cultivation by one's own labour' (Banerjea, 1993). Taking the benefit of the term 'personal cultivation', the landholders easily got recorded as cultivators by dispossessing the actual tillers. So, the dominant castes saved their landholding and a small proportion of upper layers of middle castes could acquire land mainly due to, first, they being tenants during the British rule and, second, due to selling and buying of land (functioning of land market) (Prasad, 1979, 1980). Thus, the only importance of the land reforms programme was that it broadened the land control base to include along with the dominant (upper) castes, a very small proportion of upper layers of the middle castes. In any case, the land reforms programme in Bihar failed to give any relief to the actual tillers who toiled on land as insecure tenants-at-will (Chakravarti, 2001).

The Task Force on Agrarian Relations constituted under the aegis of the erstwhile Planning Commission of India reported that the inherent interests of India's political and administrative classes who were at the helm of governance in the early years of independence and were also enjoying the status of landed class altogether were hardly open to compromise their influential positions of a politician, administrator and the landlord at the same point of time. So, the very structure of the land reform process was the victim of 'weakness of political will' (Planning Commission of India, 1973). The result of not so successful or failed land reforms has been, first, iniquitous distribution of land, the most productive resource in Bihar, increasing landlessness among the rural households, high incidence of tenancy, and usurious exploitation of the real tillers of the land. The lack of commitment towards the land reforms in Bihar led to violent struggles for land and caste massacres in large numbers since the decade of the 1970s (Kumar, 2009). But these land struggles and massacres couldn't force successive governments to implement the land reforms programme.

In 2005, with the change in government in the state and Nitish Kumar being the new Chief Minister, there was much pressure on him to implement the land reforms programme. The government constituted the Bihar Land Reforms Commission (LRC), 2006–08, to recommend the ways to redistribute land in the state. The commission was headed by D. Bandyopadhyay, the key architect of the successful land reforms programme in West

Bengal. The commission submitted its report to the government in April 2008. The Commission made three main recommendations: first, to abolish the distinction between agricultural and non-agricultural land and fix an upper ceiling of 15 acres; second, to allot land in quantum of one to 0.66 acre of the ceiling surplus land to the lowest quintile of agricultural labourers who constitute around 16.68 lakh households and to assign at least 10 decimals of land to the shelter-less households who constituted 5.48 lakh non-farm rural workers; and third, to legislate a Bataidari Act to secure a heritable right of cultivation to all the sharecroppers/tenants with 60 per cent of the produce if the landowner bears the cost of production and 70–75 per cent of the produce if the sharecropper/tenant bears the cost of production (ibid.). But, in October 2009, the government decided not to implement these recommendations (Mainstream Weekly, 2009). On the decision to not implement LRC's recommendations, Bandyopadhyay (2009, p. 14) commented, 'The government of Bihar has lost yet another opportunity of reordering production relations in agriculture through legal means. Perhaps, land reforms in Bihar will have to wait for a violent and massive social upheaval in future.'

### 6.2.2 Technological Route to Transform Agriculture

The agrarian transformation programmes such as land reforms programme and the cooperative movement introduced in the early decades after Independence were largely ineffective in attaining their objectives. So, they could not remove the spectre of rural poverty, unemployment and the ever-growing socio-economic inequality (Dhanagare, 1984). By the mid-1960s, the agricultural development bureaucracy, accepting the status quo of land ownership inequality, shifted their goals to reforming agriculture through adoption of Green Revolution strategy, i.e., large-scale application of modern science and technology to agriculture. The strategy involved use of a high yielding variety of seeds, mechanisation of farming (extensive use of labour-saving devices), use of chemical fertilisers and pesticides and promotion to irrigation facilities (ibid.). The aim of the Green Revolution technology was to enhance agricultural productivity, achieve food self-sufficiency, increase rural income and generate employment in the rural areas. However, it favoured large landowners (those having land more than 5 acres) and mostly the irrigated areas thereby creating inter-regional inequality; and in states like Bihar where there was large presence of marginal and small farmers, it created rural inequality. Further, the Green Revolution strategy made the conditions of tenant farmers/sharecroppers worse off as with the use of new technology the cost of cultivation increased and the price (rent) of leased-in land went up (ibid.). On the state-wise effects of the Green Revolution strategy, it is widely accepted that at the one extreme there are states such as Punjab and Haryana which experienced a wide-ranging impact of economic transformation, and on the second, there were states such as Bihar and Odisha where the strategy had limited impact (Chadha & Khurana, 1989).

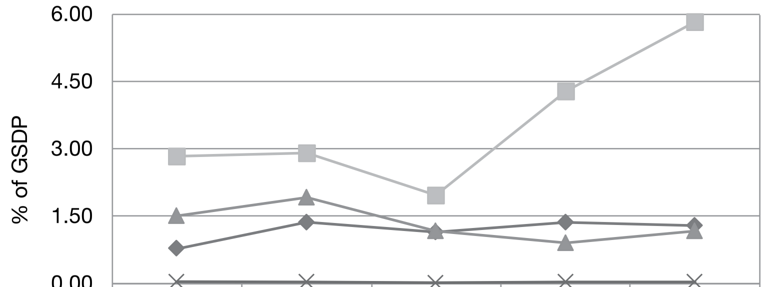
### 6.2.3 Agriculture in Bihar in the Era of Neoliberal Reforms

So, the land reforms could not bring the much-needed structural change in Bihar's agriculture and the Green Revolution strategy was having a limited effect with its regional and scale (large farmer) bias. This was despite the fact that a large part of the labour force and population in Bihar depended upon agriculture for income and livelihoods. By the beginning of the decade of the 1990s, the Union Government, started to do away with the 'dirigisme' policies and initiated the economic reforms and restructuring of the economy in the form of liberalisation, privatisation and globalisation (LPG). The imminent effect of the LPG programme was reduction in development expenditures to contain budget deficits forcing states to borrow (Patnaik, 2003). The share of expenditure on agriculture and allied sector out of total public sector plan expenditure in India declined from 6.1 per cent in the Sixth Plan (1980–85) to 5.2 per cent in the Eighth Plan (1992–97) and further to 3.7 per cent in the Eleventh Plan (2007–12) (Jha & Acharya, 2011). In the case of Bihar, in the Seventh Plan (1985–90), the average annual public expenditure to gross state domestic product (GSDP) was 7.57 per cent, but with the adoption of economic reforms, this expenditure was brought down to 4.16 per cent of the GSDP in 1992–93 (i.e., a decline of around 45 per cent) (ibid.).

## 6.3 INVESTMENT IN AGRICULTURE AND OTHER SUB-SECTORS

Agricultural development in any state or country depends largely on the public investment over a period of time. Figures 6.1 and 6.2 show the direction and magnitude of public investment in agriculture in Bihar. A large section of Bihar's population depends directly or indirectly on agriculture and allied activities for employment and livelihoods. So, the public investment in sectors like agriculture and allied activities, rural development, major, medium and minor irrigation projects and flood control and village and small industries largely determine the growth of agriculture, rural employment and earnings. The combined average revenue and capital expenditure on agriculture and allied activities in Bihar for the period 2005–06 to 2007–08 was 0.77 per cent of the GSDP which increased to 1.37 per cent in the period 2008–09 to 2011–12, and declined to 1.30 per cent in 2017–18 to 2019–20. The combined average revenue and capital expenditure on rural development for the period 2005–06 to 2007–08 was 2.85 per cent of the GSDP which declined to 1.97 per cent in the period 2011–12 to 2013–14 and increased to 5.83 per cent in 2017–18 to 2019–20. The expenditure on major, medium and minor irrigation and flood control had a declining trend over the period in Bihar. It is a well-known fact that if there is a higher proportion of population that depends on agriculture for livelihood, there is a need to invest in village and small industries so that employment can be generated in the non-farm sector. However, when we look at the public investment in the village and small industries, we find that the public investment in this sector is the least. Not having enough investment in these industries and henceforth no substantial employment generation in this very sector force a large proportion of the labour force to migrate from rural areas to other nearby cities and to other metro cities and states for employment and work purposes.

All the above-mentioned sub-sectors also create infrastructure for economic development that directly or indirectly generate employment in the economy, but having lesser public investment pushes the economy into sluggish development. Figure 6.2 represents the combined revenue and capital expenditure on agriculture and allied activities as a percentage of agricultural GSDP




| | 2005–06 to 2007–08 | 2008–09 to 2010–11 | 2011–12 to 2013–14 | 20014–15 to 2016–17 | 2017–18 to 2019–20 |
|---|---|---|---|---|---|
| Agriculture and Allied Activities | 0.77 | 1.37 | 1.15 | 1.36 | 1.30 |
| Rural Development | 2.85 | 2.91 | 1.97 | 4.29 | 5.83 |
| Major, Medium and Minor Irrigation & Flood Control | 1.52 | 1.92 | 1.16 | 0.91 | 1.17 |
| Village and Small Industries | 0.04 | 0.03 | 0.02 | 0.04 | 0.03 |

Figure 6.1 Combined Revenue and Capital Expenditure as Percentage of GSDP in Different Sub-sectors of the Rural Economy of Bihar

*Source:* Author’s calculation; RBI Handbook of Indian States.

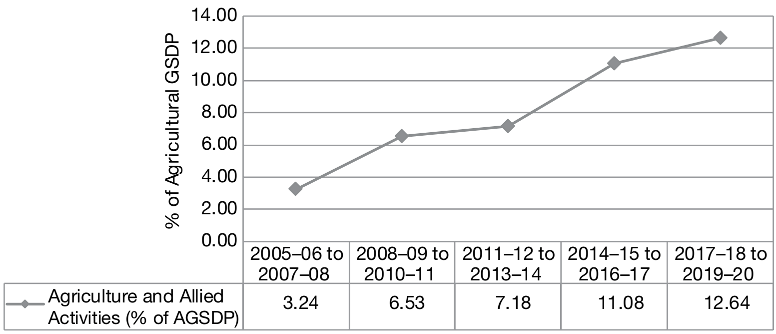



Figure 6.2 Combined Revenue and Capital Expenditure on Agricultural and Allied Activities as Percentage of Agricultural GSDP

*Source:* Author's calculation; RBI Handbook of Indian States.

(AGSDP). This expenditure, though, had increased over the period (Figure 6.2), the overall agricultural performance is still marred by the structural bottlenecks – such as landlessness, higher proportion of tenancy and almost non-functional agricultural marketing in Bihar.

## 6.4 OWNERSHIP DISTRIBUTION OF LAND

The two latest rounds of NSS reports on landholdings reveal the fact that land fragmentation as well as land concentration have increased in Bihar. In this section, we discuss the present scenario of land distribution and persisting land ownership inequality among different classes, social categories and various religious groups in Bihar using the unit-level data available for the 70th (reference year 2012–13) and 77th (reference year 2018–19) rounds of Land and Livestock Survey conducted by the NSS.

### 6.4.1 Measure of Landlessness

The Land and Livestock Surveys collect information on operational and ownership holdings of the households. Plots of households listed in the process are categorised into four factions: (i) owned and possessed, (ii) leased-in, (iii) otherwise possessed and (iv) leased out. Ownership holding is calculated by summing up 'owned and possessed' and 'leased out' plots of land. Even though the official definition of landlessness includes households with landholding less than 0.002 hectares including homestead land, we have estimated landlessness without taking into account the homestead part of land. Many other studies have also questioned the structure of land ownership and its distribution in rural India as well as on the basis of its accuracy, reliability of data estimation and extent of landlessness described by various NSSO surveys (Rawal, 2008). Several scholars have found higher incidence of landlessness in rural India than what the NSSO shows in its analysis (Bakshi, 2008; Mohanty et al., 2010; Ramakumar, 2000; Ramchandran, 1980; Rawal, 2008, 2013). The other size classes, in our estimates, are: 0.002–0.5 hectares (semi-marginal); 0.5–1 hectares (marginal); 1–2 hectares (small); 2–4 hectares (semi-medium); 4–10 hectares (medium), and more than 10 hectares (large farmers).

### 6.4.2 Land Distribution Pattern

The 70th round data (reference year 2012–13) show that there was massive landlessness in rural Bihar (Table 6.1). Around 48.6 per cent rural households were landless which, in 77th round (reference year 2018–19), has further increased and more than half of the rural households (51.01 per cent) in Bihar were landless. The proportion of semi-marginal, marginal and small farmer households taken together declined slightly from 49.7 per cent in 2012–13 to 47.9 per cent in 2018–19, whereas their share in land increased from 76.04 per cent to 83.84 in the same period. Proportion of semi-medium and medium farmer households considered together declined from 1.73 per cent in 2012–13 to 1.0 per cent in 2018–19. Likewise, their share of land also declined from 23.52 per cent to 12.90 per cent in the same period. The land ownership data also show that the proportion of large farmers had increased from 0.01 per cent in 2012–13 to 0.04 per cent in 2018–19 and their share of land increased from 0.44 per cent to a higher 3.27 per cent in the same period. It is clear that while there was an increase in landlessness in Bihar, there was an increase in land concentration at the higher end as well.

### 6.4.3 Land Ownership among the Different Social Categories

Social category-wise land ownership reflects that, in 2018–19, there was massive landlessness among the scheduled tribes (STs)

Table 6.1 Distribution of Ownership of Land in Bihar (2012–13 and 2018–19)

| | % of Households | | % of Owned Land | |
|---|---|---|---|---|
| **Category** | **NSS 70th Round (2012–13)** | **NSS 77th Round (2018–19)** | **NSS 70th Round (2012–13)** | **NSS 77th Round (2018–19)** |
| Landless | 48.57 | 51.01 | 0.00 | 0.00 |
| Semi-marginal | 37.36 | 36.43 | 24.34 | 34.24 |
| Marginal | 8.95 | 8.31 | 30.75 | 28.97 |
| Small | 3.38 | 3.19 | 20.95 | 20.63 |
| Semi-medium | 1.39 | 0.94 | 15.26 | 11.40 |
| Medium | 0.34 | 0.06 | 8.26 | 1.50 |
| Large | 0.01 | 0.04 | 0.44 | 3.27 |

*Source:* Author's calculation.

and scheduled castes (SCs) rural households in Bihar (Table 6.2). Around 46.6 per cent rural households from the other backward castes (OBCs) and 28.24 per cent of the other category rural households were landless in 2018–19. The large landholders (more than 10 hectares) were around 0.04 per cent and all of them belonged to other category rural households (mostly belonging to upper caste households) only. Bihar's agricultural scenario is such that more than 99 per cent of rural households belonging to STs, SCs and OBCs are landless, semi-marginal, marginal and small farmers. Such a high incidence of landlessness and marginality in Bihar leads to high rate of tenancy in the state. An analysis of NSS's Land and Livestock Surveys by Bansal et al. (2018) shows that there was rampant rise in tenant cultivators as well as rise in leased-in land in the total operated area in Bihar (Table 6.3). The proportion of tenants among the cultivator households increased from 9.4 per cent in 1991–92 to 17.2 per cent in 2002–03; it further increased to 29.9 per cent in 2011–12 and again it had risen to 37.2 per cent in 2018–19. The increase in tenancy is accompanied by increase in landlessness and marginalisation of farmers in Bihar.

Table 6.2 Distribution of Ownership of Land in Bihar by Social Category, 2018–19

| | % of households | | | | | | | % of area | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Social category*** | ***Landless*** | ***Semi-marginal*** | ***Marginal*** | ***Small*** | ***Semi-medium*** | ***Medium*** | ***Large*** | ***Landless*** | ***Semi-marginal*** | ***Marginal*** | ***Small*** | ***Semi-medium*** | ***Medium*** | ***Large*** |
| STs | 70.66 | 18.68 | 3.80 | 6.33 | 0.53 | 0.00 | 0.00 | 0.00 | 0.48 | 0.28 | 0.86 | 0.13 | 0.00 | 0.00 |
| SCs | 69.36 | 27.37 | 2.80 | 0.41 | 0.07 | 0.00 | 0.00 | 0.00 | 5.35 | 2.65 | 0.67 | 0.21 | 0.00 | 0.00 |
| OBCs | 46.60 | 40.23 | 9.21 | 3.18 | 0.74 | 0.04 | 0.00 | 0.00 | 23.05 | 18.36 | 12.03 | 5.14 | 0.54 | 0.00 |
| Others | 28.24 | 41.59 | 16.93 | 8.75 | 3.82 | 0.32 | 0.35 | 0.00 | 5.36 | 7.67 | 7.07 | 5.91 | 0.96 | 3.27 |
| All | 51.01 | 36.43 | 8.31 | 3.19 | 0.94 | 0.06 | 0.04 | 0.00 | 34.24 | 28.97 | 20.63 | 11.40 | 1.50 | 3.27 |

*Source:* Author's calculation.

Table 6.3 Incidence of Tenancy in Bihar

| State/ Country | % of Tenants among Cultivator Households | | | | % of Leased in Area to Total Operated Area | | | |
|---|---|---|---|---|---|---|---|---|
| | 1991–92 | 2002–03 | 2011–12 | 2018–19* | 1991–92 | 2002–03 | 2011–12 | 2018–19* |
| Bihar | 9.4 | 17.2 | 29.9 | 37.2 | 5.5 | 12.0 | 22.5 | 32.1 |
| India | 12.8 | 11.4 | 15.0 | 18.6 | 8.7 | 6.7 | 11.1 | 15.3 |

*Source:* Bansal et al. (2018).

*Note:* *Author's calculation.

It also amplifies the fact that there is either an increasing land hunger in rural Bihar for cultivation or there is relatively lesser employment generation in the non-farm sector which is pushing people to lease land for earnings and to feed themselves and their families. It is a matter of further investigation whether cultivators in Bihar are having decent net returns. For this purpose, the data provided by the NSS on Situation Assessment of the Agricultural Households are analysed in the upcoming section.

### 6.4.4 Land Inequality

Using the two rounds of NSS data on land-ownership, we have tried to understand the extent of land inequality in Bihar. For this purpose, we have used the Gini-coefficient which is a measure of distribution of income/wealth/asset across the population. The Gini-coefficient ranges from zero (0) to one (1) where '0' represents perfect equality and '1' represents perfect inequality. This does mean a higher value of Gini-coefficient represents higher inequality among the population. The Gini-coefficient of land ownership for the year 2012–13 was 0.715 which slightly increased to 0.719 in 2018–19 in Bihar. So, the measure of inequality reflects that within five years, the land inequality has increased in the state, though marginally. In any case, a Gini-coefficient value of more than 0.70 in both the years reveals very high land inequality persisting in the state.

## 6.3 INCOME OF AGRICULTURAL HOUSEHOLDS

Six years ago, in February 2016, Hon'ble Prime Minister of India, Narendra Modi, in his speech pitched to double the income of farmers by the year 2022 in a rally at Bareilly in Uttar Pradesh. In the process, the Government of India formed an Inter-Ministerial Committee headed by Ashok Dalwai to prepare a roadmap for doubling the income of farmers. The committee submitted its report in 14 volumes in 2017 and recommended various steps such as improvement in crop productivity, improvement in livestock productivity, resource-use efficiency, increasing crop-intensity, diversification towards high value crops, improvement in real prices received by the farmers, shift from farm to non-farm occupations, improved market linkages, optimal monetisation of crops produced, sustainability of production, risk management, and so on.

In his presidential address at the annual conference of Indian Economic Association in December 2019, Ramesh Chand, the member of NITI Aayog, had outlined that to double the farmers' income by 2022, a multi-pronged strategy that includes increase in productivity, reduction in the average cost of cultivation, better price realisation of the farm produce, expansion of allied activities and shift from farm to non-farm occupations would be required (Chand, 2019).

It is high time now to look back and find out whether the farmers' incomes has increased, and if it has, to what extent. To assess the farmers' income, we have taken data from two rounds (70th & 77th) of Situation Assessment Surveys of Agricultural Households (July to June 2012–13 and July to June 2018–19). In these surveys, the total nominal income of the agricultural households is provided. The total nominal income of a farmer includes income from various sources, which are, net receipt from wages, net receipt from leasing in land, net receipt from cultivation, net receipt from farming of animals and net receipt from farm business. The average nominal monthly income from all the sources to all the size classes of farmers in Bihar was Rs. 5,485 in 2012–13 and it increased to Rs. 6,278 in 2018–19. This shows that average monthly nominal income of a farmer household in Bihar increased only 14.5 per cent within a span of five years, i.e., almost 3 per cent per annum, whereas the Ashok Dalwai Committee had recommended that to double the farmers' income there is need to increase their income by 10 per cent annually (MoA & FW, 2018). Clearly, achieving a 10 per cent increase in nominal income of farmers in Bihar is still a distant dream.

The nominal income does not show the real picture unless the inflation is adjusted to it. To calculate the real incomes of the agricultural households (farmers), we have deflated the nominal incomes with the Consumer Price Indices Combined (base year 2012). The real incomes of farmers of Bihar for different size classes are shown in Table 6.4. The size classes in our analysis include landless (less than 0.1 ha), semi-marginal (0.1–0.4 ha), marginal (0.41–1 ha), small (1.01–2.0 ha), semi-medium (2.1–4.0 ha), medium (4.01–10.0 ha) and large (more than 10.0 ha).

It is found that the monthly real income of the landless class (Rs. 4,525.0) is higher than the monthly real incomes of semi-marginal, marginal and small farmer households in Bihar. This is because the landless class is mostly dependent upon the wage incomes and farming of animals. The wage component contributes almost 73 per cent to the total real income of the landless class and if the income from farming of animals is included, both the components together contribute almost 95.8 per cent to the total real income of this class. However, the real income of the landless class in Bihar has declined from Rs. 4,525.0 in 2012–13 to Rs. 3,693.1 in 2018–19, a decline of almost (–) 18.4 per cent. This decline in income of the landless class is because the income from wages and farming of animals as also from farm business has witnessed significant decline in 2018–19 in comparison to 2012–13. All other size class of farmers, except the medium size class farmers, have witnessed an increase in monthly real incomes in 2018–19 compared to 2012–13. It is worth noting that the average monthly real income of the large farmers had increased from Rs. 31,319.8 in 2012–13 to Rs. 59,191.0 in 2018–19, an increase of almost 89 per cent. This shows two extremes happening in Bihar's agriculture: first, the large farmers who are very less in proportion (refer Table 6.1) are witnessing higher increase in real incomes, whereas, the second,

Table 6.4 Average Monthly Real Income of Agricultural Households in Bihar in 2012–13 and 2018–19 (in Rs.)

| Size Class | Wages | Cultivation | Farming of Animals | Non-Farm Business | Total Income |
|---|---|---|---|---|---|
| **2012–13** | | | | | |
| Landless | 3299.9 | 8.2 | 1036.1 | 180.9 | 4525.0 |
| Semi-marginal | 1646.8 | 489.9 | 307.2 | 229.0 | 2673.7 |
| Marginal | 532.6 | 1673.1 | 418.1 | 107.2 | 2731.0 |
| Small | 697.1 | 3270.8 | –779.8 | 523.5 | 3711.6 |
| Semi-medium | 2431.1 | 6747.1 | 683.4 | 309.9 | 10171.5 |
| Medium | 452.6 | 22322.4 | –358.1 | 169.0 | 22586.0 |
| Large | 0.0 | 31838.6 | –519.8 | 0.0 | 31318.8 |
| All size classes | 1202.4 | 1558.6 | 253.6 | 218.1 | 3233.6 |
| **2018–19** | | | | | |
| Landless | 3017.8 | 21.3 | 654.0 | 0.0 | 3693.1 |
| Semi-marginal | 2091.5 | 574.4 | 645.5 | 301.4 | 3612.8 |
| Marginal | 1366.4 | 1947.2 | 518.2 | 270.1 | 4101.9 |
| Small | 1491.5 | 3552.4 | 895.0 | 645.5 | 6584.4 |
| Semi-medium | 1841.9 | 7451.7 | 1283.9 | 826.1 | 11402.8 |
| Medium | 3919.9 | 13685.5 | 2579.9 | 28.4 | 20214.5 |
| Large | 0.0 | 59665.2 | –474.2 | 0.0 | 59191.0 |
| All size classes | 1779.4 | 1635.1 | 649.8 | 340.5 | 4404.7 |

*Source:* Author's calculation.

landless farmers who are slightly more than half of the total rural households are witnessing decline in real income. Among the other categories, the semi-marginal, marginal, small and semi-medium farmers, have witnessed 35.1 per cent, 50.2 per cent, 77.4 per cent and 12.1 per cent rise in average monthly real income respectively in 2018–19 in comparison to 2012–13. For the medium farmers, the real income has declined by (–) 10.5 per cent in the same period. It indicates that for different size classes of farmers, scenarios have been different in terms of increase/decrease in real income. The difference in increase in real incomes of different size class of farmers also reflects that the income inequality within the agricultural community has widened.

### 6.3.1 Real Incomes of Agricultural Households from Different Social Groups

Table 6.5 shows that the average monthly real income of the landless class from all the social groups of farmers has declined in 2018–19 in comparison to 2012–13. Among the SC farmers, the real incomes of small, semi-medium and medium farmers have declined in 2018–19 in comparison to 2012–-13. There are no large farmers in the SC category in Bihar. Overall, the real income of the SC farmers has increased from Rs. 2,476.5 to Rs. 3,646.2 in 2018–19, an increase of almost 47.2 per cent. This increase in real income for this group of farmers is due to the overall increase in the real income of semi-marginal and marginal farmers as their proportion is the highest (refer Tables 6.5 and 6.2).

Among the OBC farmers, except the landless and large farmers, all other size class of farmers have witnessed increase in the average monthly real income. According to the Situation Assessment Round (2018–19) of the NSS, there is no large farmer left in the OBC category. Overall, the real income of the OBC farmers increased from Rs. 3,117.2 in 2012–13 to Rs. 4,158.8 in 2018–19, an increase of almost 33.4 per cent.

Among the 'others' category farmer households (those belonging to upper-caste category) in Bihar, the real income of semi-marginal, marginal and small categories increased in 2018–19 in comparison to 2012–13, but the real income of landless, semi-medium, medium and large categories declined significantly in the same period. Overall, the real income of 'others' category farmers increased from Rs. 4,124.2 in 2012–13 to Rs. 6,364.0 in 2018–19 which is an increase of 54.3 per cent. This analysis reflects that among the different social groups and even within particular social groups, the real income has not increased smoothly for all the size classes.

There is an interesting trend that among the SC and 'others' category farmers, the real income of small, semi-medium and

Table 6.5 Real Income of Agricultural Households of Different Social Groups in 2012–13 and 2018–19 (in Rs.)

| Social Group | Size Class | Real Income (Rs.) in 2012–13 | 2018–19 |
|---|---|---|---|
| SC | Landless | 3,692 | 3,425 |
| | Semi-marginal | 2,075 | 3,290 |
| | Marginal | 2,457 | 3,892 |
| | Small | 9,928 | 6,602 |
| | Semi-medium | 10,988 | 6,289 |
| | Medium | 13,291 | 8,237 |
| | Large | 0 | 0 |
| | All size classes | 2,477 | 3,646 |
| OBC | Landless | 4,524 | 4,105 |
| | Semi-marginal | 2,982 | 3,312 |
| | Marginal | 2,555 | 4,030 |
| | Small | 2,599 | 6,461 |
| | Semi-medium | 9,674 | 12,499 |
| | Medium | 20,355 | 28,952 |
| | Large | 1,19,426 | 0 |
| | All size classes | 3,117 | 4,159 |
| Others | Landless | 7,129 | 560 |
| | Semi-marginal | 1,801 | 6,029 |
| | Marginal | 3,527 | 4,703 |
| | Small | 6,458 | 6,424 |
| | Semi-medium | 11,315 | 10,445 |
| | Medium | 25,158 | 14,871 |
| | Large | 29,718 | 523 |
| | All size classes | 4,124 | 6,364 |

*Source:* Author's calculation.

medium farmers has significantly declined, whereas among the OBC farmers the real income in the same categories has increased over the period of our study. The reason behind this is a matter of further investigation. It is indicative from Table 6.5 that among the social groups, SC farmer households have the least monthly real income, followed by the OBC farmer households who have higher income than SC farmer households and the 'others' category farmer households that have higher income than the previous two social groups. The lesser income of the farmers belonging to the SC and OBC groups, who constitute larger proportions than the 'others' category farmers, might be due to various reasons. Proportionately, among the SC and OBC, farmer households have lesser land, higher landlessness (refer Table 6.2), lesser capital formation – both public and private (Bathla, 2014), lesser availability of formal credit (there is a substantial credit gap between the forward caste and other social groups [SC, ST and OBC] in Bihar) (Karthick & Madheswaran, 2018) and either no surplus produce to sell or if there is small surplus, it is being sold at distress prices due to non-functional/unavailable procurement agencies who could pay better prices fixed by the government (MoSPI, 2021). Further, there is severe land inequality in rural Bihar and, high incidence of tenancy that normally demotivates the private investment in agriculture and does not get benefits from the government policies/expenditure to attain the desired income.

## 7.4 CONCLUSION

The not so successful or failed land reforms have resulted in historically iniquitous distribution of land in Bihar. Successive state governments neglected the land reforms programme under the pressure of landed influential classes leading to marginalisation of a large proportion of households that culminated into land struggles and mass massacres, and high-end seasonal migration from the rural Bihar for work and livelihood purposes. The landlessness among the SC and OBC households has been extremely high in Bihar which promotes higher incidence of tenancy in the state. It is a well-established fact that the high rates of tenancy demotivate private investment in agriculture. There is persisting land inequality in the state. This study shows that the Gini-coefficient, a measure of inequality, of land ownership has been quite high during 2012–13 to 2018–19. Though, in the recent past, the public expenditure on agriculture and allied sector has marginally increased, it is still insufficient to provide the much needed support to all the agricultural communities in the state. An analysis of Situation Assessment Rounds of the NSS shows that although the nominal and real incomes of the agricultural households have increased in the period of 2012–13 to 2018–19, the yearly increase in their nominal income has been merely 3 per cent, which is less than one-third of the desired 10 per cent yearly increase in nominal income advocated by the Ashok Dalwai Committee (2016–17) to double the farmers' income. Overall, the real income of the agricultural households has increased, but when we consider various size classes and social groups separately, it appears that the increase in the real incomes has not been smooth for all categories. For the landless class, the biggest component of income has been the wages, and for the relatively larger farmers, the biggest contributor of income has been the income from crop cultivation. The allied sector, which is supposed to contribute larger in income, has not performed well, as the income from farming of animals has been very low or has even been negative to some size class of farmers. Overall, the persistent structural inequality in agriculture has created barriers in achieving desired goals in Bihar and the current neo-liberal economic policy regime in consonance with the bureaucratic apathy and biasedness has pushed the sector into an unending agrarian distress.

## REFERENCES

Bakshi, A. (2008). Social inequality and land ownership in India: A study with particular reference to West Bengal. *Social Scientist, 39*(9–10), 95–116.

Bandyopadhyay, D. (2009, November 21). Lost opportunity in Bihar. *Economic and Political Weekly, 44*(47), 12–14.

Banerjea, D. (1993). Personal cultivation: The crucial issue in land Reforms. In B. N. Yugandhar & K. Gopal Iyer (Eds.), *Land reforms in India: Bihar-institutional constraints*. Sage Publications.

Bansal, V., Usami, Y., & Rawal, V. (2018). *Agricultural tenancy in India: An analytical report and a compendium of statistical tables based on NSSO surveys of land and livestock holdings*, Society for Social and Economic Research Monograph No. 18/1, SSER, New Delhi.

Bathla, S. (2014). Public and private capital formation and agricultural growth in India: State level analysis of inter-linkages during Pre- and Post-reform periods. *Agricultural Economics Research Review, 27*(1), 19–36.

Bharti, I. (1992): Bihar's bane. Slow progress on land reforms. *Economic and Political Weekly, 27*(13), 628–630.

Chadha, G. K., & Khurana, M. R. (1989). Backward agriculture, unrewarded labour and economic deprivation: Bihar's contrast with Punjab. *Economic and Political Weekly, 24*(47), 2617–2623.

Chakravarti, A. (2001). Caste and agrarian class: A view from Bihar. *Economic and Political Weekly, 36*(17), 1449–1462.

Chand, R. (2019). *Transforming agriculture of challenges of 21st century*. Indian Economic Association (Presidential Address, 102 Annual Conference), AURO University, Surat (Gujarat).

Chandra, B. (1966). *The rise and growth of economic nationalism in India*. People's Publishing House.

Dhanagare, D N. (1984). Agrarian reforms and rural development in India: Some observations, research in social movements. *Conflict and Change, 7*, 177–201.

Endow, T., & Mishra, S. K. (2021). Rural urban linkages in Bihar: Manufacturing sector and jobs for unskilled labour. *Economic and Political Weekly, 56*(45–46). https://www.epw.in/journal/2021/45-46/special-articles/rural-urban-linkages-bihar.html

Jha, P., & Acharya, N. (2011, July–December). Expenditure on the rural economy in India's budgets since the 1950s: An assessment. *Review of Agrarian Studies, 1*(2). http://www.ras.org.in/m/expenditure_on_the_rural_economy_in_indias_budgets_since_the_1950s.

Karthick, V., & Madheswaran, S. (2018). Access to formal credit in the Indian agriculture: Does caste matter? *Journal of Social Inclusion Studies, 4*(2), 169–195.

Kumar, A. (2009, October 31). Illegitimacy of the State in Bihar. *Economic and Political Weekly, 44*(44), 8–11.

Mainstream Weekly. (2009, August 1). Bihar: implement Bandyopadhyay Commission's recommendations for land reforms. *46*(33). https://www.mainstreamweekly.net/article1547.html

MoA & FW. (2018). *Report of the committee on doubling farmers' income* (Vol.14). Government of India.

Mohanty, M., Ray, S., Trivedi, G. N., & Sukumar, N (2010). Landlessness and the marginalized: A study of Kalahandi, Bhojpur, and Chittoor in India, in Manoranjan Mohanty (Ed.), *2010 Social development report, The land question and the marginalised*. Council for Social Development, Oxford University Press, New Delhi.

MoSPI. (2021). *Situation assessment of agricultural households and land and livestock holdings of households in rural India* (NSS 77th Round, Report No. 587). Government of India.

Niti Aayog. (2015). *State statistics: Tendulkar poverty estimates (combined)*. https://www.niti.gov.in/state-statistics (accessed November 16, 2021).

Niti Aayog. (2021). *National multidimensional poverty index: Baseline report*. Government of India.

Patnaik, U. (2003, October). *Global capitalism, deflation and agrarian crisis in developing countries. Social Policy and Development Programme* (Paper No. 15). United Nations Research Institute.

Planning Commission of India. (1973). *Report of the task force on agrarian relations*. Government of India.

Prasad, P. H. (1979). Caste and Class in Bihar. *Economic and Political Weekly, 14*(7–8), 481–484.

Prasad, P. H. (1980). Rising middle peasantry in North India. *Economic and Political Weekly, 15*(5–7), 215–219.

Ramachandran, V. K. (1980). *A note on the sources of official data on landholdings in Tamil Nadu*. (Data Series No. 1). Madras Institute of Development Studies.

Ramakumar, R. (2000). Magnitude and terms of agricultural tenancy in India: A state-wise analysis of changes in 1980s. *Indian Journal of Agricultural Economics, 55*(3), 337.

Rawal, V. (2008, March 8). Ownership holdings of land in rural India: Putting the record straight. *Economic and Political Weekly, 43*(10), 43–47.

Rawal, V. (2013). Changes in the distribution of operational landholdings in rural India: A study of national sample survey data. *Review of Agrarian Studies, 3*(2).

Sharma, A. N., & Rodgers, G. (2015, December 26). Findings from a longitudinal study: Structural change in Bihar's rural economy. *Economic and Political Weekly, 50*(52).

Tsujita, Y., Hisaya, O. and P. Ghosh (2010): Development and intra-state disparities in Bihar, *Economic and Political Weekly*, *45*(50), 13–15.

# PART III

# INSURANCE AND MARKETS FOR AGRICULTURE

CHAPTER 7

# CROP INSURANCE AND RISK MITIGATION IN AGRICULTURE

*Subhankar Mukherjee*

## 7.1 INTRODUCTION

Even though the share of the agriculture sector in India's gross domestic product (GDP) has declined from over 50 per cent in 1950–51 to about 16 per cent in 2016–17, approximately 50 per cent of the country's workforce is still employed in this sector (Economic Survey, 2018). The numbers are on the similar lines for the state of Bihar as close to 54 per cent of the workforce is employed in agriculture, while the sector contributes around 20 per cent to the state's GDP (Hoda et al., 2021). Moreover, agriculture in India and Bihar faces substantial risk both in the production as well as marketing processes. Yet, formal risk mitigation mechanism like agricultural insurance has not really taken off in the country as well as in Bihar.

This chapter discusses the state of crop insurance in India with special focus on the state of Bihar. Specifically, the following set of questions will guide this chapter's discussion: What has been the performance of crop insurance in India and Bihar over the years? Can crop insurance be a good tool for mitigating farm households' risk, and do farmers actually adopt it? What are the constraints towards higher coverage of crop insurance? Finally, what are the design and implementation boundaries that limit its adoption?

The rest of the chapter is organised as follows. The second section provides a brief overview of the definition, concept and importance of agricultural insurance as a risk mitigation mechanism for farm households. The third section discusses the importance of agricultural insurance as a formal risk mitigation mechanism. The fourth section briefly describes the evolution of crop insurance schemes in India. The fifth section discusses the extent of coverage of crop insurance both in Bihar and all-India. The reasons behind low coverage of crop insurance in Bihar and all-India are explored in the sixth section. The seventh section concludes.

## 7.2 DEFINITION AND FEATURES OF CROP INSURANCE

Agricultural insurance is a special type of property insurance for crop, livestock, bloodstock, forestry, aquaculture and greenhouses (Iturrioz, 2009). Crop insurance is the major component of agricultural insurance, accounting for 90 per cent of the total premium collected for combined agricultural insurance. We concentrate only on crop insurance programmes, since presence of other forms of insurance under the umbrella of agricultural insurance is negligible. Also, we use the term agricultural insurance and crop insurance interchangeably to mean insurance for crops only.

Crop insurance products can be classified into two main types depending upon the coverage and method of indemnity calculation. The groups and their subgroups are displayed in Figure 7.1.

The individual-based approach to crop insurance is operationally similar to life insurance. Under this approach, premium as well as claim amount is calculated for each individual farmer. On the other hand, under the index-based approach, sum insured amount, premium amount and claim amount calculations are done based on an 'index' which mirrors the yield/crop loss in each individual field. Two types of indices are prevalent: (i) area-based index and (ii) weather-based index. Under the area indexed approach, average crop yield for a large area, which is considered homogeneous in terms of crop productivity, is estimated considering a representative sample of plots. The area can be as small as a village, or as large as a district. This average yield is considered as the

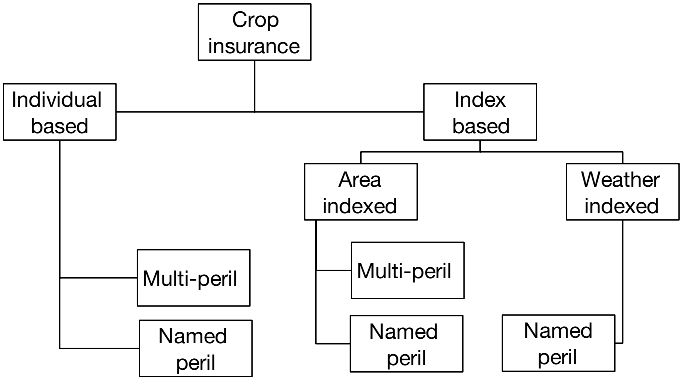



Figure 7.1 Type of Crop Insurance Products by Claim Calculation Method

*Source:* Author's preparation from various sources.

proxy for crop yield attained by each farmer within the area. The assumption here is that yield of each individual plot is highly correlated with the average yield of the homogeneous area. Further, depending upon the riskiness of the area, a 'guaranteed yield' is calculated, which is a fraction (usually varies from 0.6 to 0.9 in India) of the average yield. If the yield of the area for a particular crop in a cropping season falls below this guaranteed yield, each insurance holder is paid indemnity for the difference between guaranteed yield and actual yield, proportional to sum insured amount. Equation (7.1) shows the formula for computing the claim amount for an index-based crop insurance scheme:

$$Claim\ amount = \frac{Guaranteed\ yield - Actual\ yield}{Guaranteed\ yield} * Sum\ Insured \quad (7.1)$$

The weather-index based insurance works in a similar fashion. Under this approach, however, instead of the average yield of an area, a weather index over the homogeneous area is taken as the proxy for crop yield. The weather-index is constructed using information on rainfall, temperature and humidity, and considered to be similar over a large area.

There are some advantages of index-based approach. First, it reduces the cost of estimating the crop loss drastically. Given the fragmented nature of land holdings in India, estimating crop yield for each insured plot may lead to very high administrative cost. In India, presently, the ministry of agriculture of every state government conducts crop-cutting experiments (CCEs) to estimate crop production. The agricultural insurance implementing agency uses this data for crop damage estimation, thus reducing cost of loss measurement further. Second, index-based insurance reduces the information asymmetry issues related to the insurance products. Crop insurance might attract only those farmers who *ex-ante* have private information of facing crop loss at a higher probability (adverse selection). Also, farmers may change their behaviour and take less care to protect their crops from losses after insuring their crops, knowing that crop damages will be covered (moral hazard problem). Since crop loss estimation under index-based schemes depends upon crop yield over many plots, it becomes impossible for one atomistic farmer to take advantage of the private information they possess. Third, farmers do not need to file a claim in case of index-based schemes. If the crop loss is recognised, all insured farmers within the area receive indemnity payment automatically, following Equation (7.1).

However, the main disadvantage of index-based approach is that it may not cover the full extent of loss faced by each farmer. Since the index is only a proxy for actual loss, it covers the covariate portion of risk for an individual farmer, and not the idiosyncratic portion of the risk, i.e., the portion of risk not correlated with other farmers within the homogeneous area. This can give rise to a gap between actual yield for each farmer and the loss estimated through the common index. This is termed as the basis risk, and it is one of the major reasons for low demand for indexed insurance (Clarke, 2011; Mobarak & Rosenzweig, 2012). Basis risk can be brought down by reducing the size of the homogeneous area, increasing the number of plots sampled for CCEs (for area-index based crop insurance), and increasing density of weather stations (for weather-index based crop insurance).

Named periled crop insurance provides protection from a specific cause (sometimes a set of causes) of crop loss that is mentioned in the policy document. For example, hail insurance is a type of named peril insurance. Multi-peril crop insurance covers production loss from all causes, unless some causes are specifically excluded from the coverage. For example, crop insurance schemes in India cover crop loss from almost all causes except for losses due to attacks from wild animals, war or nuclear risks (Ministry of Agriculture, 2016).

Crop insurance programmes generally cover losses arising from production losses only. However, farmers face risk not only from low production but also from higher production. There have been some attempts to design crop insurance schemes that protect farmers' income, instead of only crop damage, e.g., Farm Income Insurance Scheme (FIIS) in India. However, this scheme was discontinued after running on a pilot basis for one rabi season and one kharif season.

## 7.3 AGRICULTURAL INSURANCE AS A RISK MITIGATION MECHANISM

In India, income from agriculture is not only low but also volatile. A comparison of variability of sectoral GDP of India over the last three decades shows that agricultural GDP experienced substantially higher volatility than from industry and services sectors. Volatility in agricultural GDP can broadly be ascribed both to the uncertainty in agricultural production as well as in agricultural commodity prices. The over-dependence of agriculture on rainfall is the primary factor behind production volatility. On the other hand, volatility in prices can arise from the transmission of volatility of agricultural prices from the international market to the domestic market, caused by increased integration with the international market due to trade liberalisation (Nayyar & Sen, 1994).

Volatility in agriculture can have adverse impacts on farmers' welfare through several ways. There is strong evidence that rainfall fluctuation directly translates into consumption fluctuation (Kazianga & Udry, 2006). Presence of risk discourages farmers from adopting newer technologies (Dercon & Christiaensen, 2011). Farmers use less fertilisers (Lamb, 2003) and cultivate safer crops with lower returns (Dercon, 1996). Poorer farmers deplete their productive assets in order to maintain consumption levels (Morduch, 1995). There are other far-reaching impacts of agricultural volatility. Rose (1999) reports that the girl child's mortality rate in rural

India is higher in years of adverse rainfall shock. Farmers' suicide is sometimes related to uncertainty of income from agriculture and their indebtedness (Mishra, 2006, 2014). Further, death related to dowry also increases during drought years (Sekhri & Storeygard, 2014).

Farming households adopt various mechanisms to cope with uncertainties in the agricultural production process. Working for longer hours, taking employment in non-farm sector, borrowing from formal or informal sources, keeping buffer stock of grain, buying and selling of bullocks, engaging in land-leasing, participating in informal insurance through cash transfer with relatives/ other villagers, receiving remittances from migrants, engaging in marital relationship, ritualised gift giving, etc., are some of the informal risk sharing mechanisms farmers adopt to mitigate such risks (Dercon, 2002; Fafchamps, 1999; Morduch, 1999). However, many of these informal mechanisms are *ex-post* risk coping, rather than *ex-ante* risk managing strategies, and have been found incomplete or absent in many societies. Moreover, a large part of the risk that farmers face is covariate in nature. Flood or drought generally affects a large number of farmers in an area, making risk mitigation through the local asset market difficult. Townsend (1994), in his seminal contribution on rural households' risk coping strategies in India, shows that even though individual household's consumption does co-move with aggregate consumption within a village, which is indicative of presence of informal insurance arrangements among rural households, this insurance is only partial, i.e., it is unable to completely smoothen individual household's consumption. In a relatively recent study, Gaurav (2015) shows that villagers in India are significantly exposed to both idiosyncratic as well as covariate risks. Coate and Ravallion (1993) show that informal insurance arrangements in village societies can be unstable under various circumstances. Mobarak and Rosenzweig (2012) show that informal insurance works best within the same *jati* (caste)-based community.

Given these insufficiencies of informal risk sharing mechanisms in mitigating income volatility, policymakers across the world have devised formal interventions through government support and/or market-based mechanisms. Examples of such formal mechanisms include providing credit to farmers, ensuring guaranteed price of the output, encouraging farmers to participate in contract farming and futures market, etc. Agricultural insurance is one such important mechanism that can complement both informal risk-sharing mechanisms as well as other formal risk mitigation tools to address farmers' risk.

Formal agricultural insurance has several advantages over traditional and informal insurance practices. First, a formal market-based mechanism has the potential of spreading (i.e., distributing) the risk spatially. For a large country like India, it is unlikely that rainfall will show a similar pattern across different regions, and so the conventional theory of insurance of risk pooling can be applied easily. Second, a market-based insurance can spread risk temporarily as well. This is especially important for smaller countries where weather variation may not be significant across regions. Third, crop insurance can help maintain farmers' credit worthiness. Fourth, access to crop insurance encourages farmers to shift investment on inputs away from low-yield and low-volatility crops to riskier crops which give higher profitability. Fifth, formal mechanisms to cope with risks are considered to be better for economic growth and social mobility (Morduch, 1999; Munshi & Rosenzweig, 2009). Finally, crop insurance may be an effective tool in managing production shocks related to climate change (Falco et al., 2014; Rao, 2010).

## 7.4 EVOLUTION OF AGRICULTURAL INSURANCE IN INDIA

Provision of agricultural insurance is a challenging task in developing countries. Yet as early as in 1920, an agricultural insurance scheme based on rainfall was developed for the State of Mysore in Southern India (Mishra, 1995). Even though this scheme was never implemented, it remains one of the first agricultural insurance schemes in a developing country.

Soon after independence, the first independent government of India had set up a commission in 1950 to study the feasibility of crop insurance schemes for the entire country. This commission recommended implementing crop insurance in India following the 'homogeneous area approach'. About a decade and a half later, the

Government of India developed a model scheme of crop insurance, and circulated among the states. The scheme required some portion of the expenditure to be shared by the states. However, none of the states wanted to implement the scheme citing lack of funds as the reason.

The first crop insurance scheme in independent India was finally launched in 1972. This scheme was based on 'individual approach', and was underwritten by the General Insurance Corporation of India Limited (GIC). The scheme was launched in six states (Andhra Pradesh, Gujarat, Karnataka, Maharashtra, Tamil Nadu and West Bengal) and initially covered only H-4 cotton, but later expanded to cover groundnut, wheat and potato. However, as the scheme was making huge losses, a commission headed by Dandekar (1976) proposed changing the crop insurance schemes from individual approach to 'area approach'. In 1979, GIC discontinued the individual-based scheme, and launched an area approach-based scheme on a pilot basis. There were several features introduced in this Pilot Crop Insurance Scheme (PCIS) (apart from calculating loss based on area approach), some of which continue till now, either unchanged or in slightly modified forms. First, this scheme was available only to the farmers who availed working capital loans. Second, farmers could either insure 100 per cent, or up to 150 per cent of the crop loan. Third, premium payable by small/marginal farmers was subsidised, and the subsidy was divided equally between the central and the state governments. This scheme continued till 1984–85, when the Comprehensive Crop Insurance Scheme (CCIS) replaced it.

The primary changes in the CCIS over PCIS are the following. While under PCIS, farmers could choose whether to buy insurance along with loan or not, crop insurance under CCIS was made mandatory for all loanee farmers. The premium amount was substantially reduced, from around 5 to 10 per cent under PCIS to around 1 to 2 per cent under CCIS. This scheme continued till 1999, when it was replaced by the National Agricultural Insurance Scheme (NAIS).

In 1999, the Government of India instituted a dedicated insurance company, named Agricultural Insurance Company of India (AIC), and simultaneously introduced the NAIS scheme, which was in operation till 2015–16 cropping year. This scheme was not only mandatory for all loanee farmers but also available for voluntary purchase by all other farmers. Also, this scheme was operational on both homogeneous area approach basis as well as individual basis.

Along with the above schemes, the Government of India attempted a few other crop insurance schemes on a pilot basis, such as the Experimental Crop Insurance Scheme (Economic Survey, 1999) and Farm Income Insurance Scheme (Economic Survey, 2005). While the full premium was subsidised under the former, the latter provided insurance to a minimum guaranteed income. These schemes were financially non-viable and discontinued soon after introduction.

All the indexed crop insurance schemes discussed so far were area index-based schemes, which covered crop losses from multiple causes (multi-periled). A major change in crop insurance scheme design happened when the Government of India introduced a weather index-based scheme in 2003–04 whose large-scale rollout started in 2007–08 (Cole & Xiong, 2017). Under this scheme, each homogeneous area (called Reference Unit Area or RUA) is attached to a Reference Weather Station (RWS). Loss of crop is estimated through rainfall and temperature measurement gathered through these weather stations.

Even after continuous modifications, coverage of crop insurance schemes remained very low in India. Delay in claim payment persisted, and presence of basis risk was identified as another major reason for low take-up. In 2011, to address the problems of multi-periled area index-based insurance schemes, a Modified National Agricultural Insurance Scheme (MNAIS) was introduced. To address the issue of basis risk, this scheme proposed reducing the unit area size to a village panchayat level. To reduce the delay in claim payment, it proposed two solutions. First, the total subsidy spending was recommended to be spent only on premiums, rather than both on premium and claim amount. Second, 25 per cent of the likely claims was proposed to be disbursed as immediate relief if catastrophic loss is reported. Another major change in this scheme was to allow private sector insurance companies to offer crop insurance schemes to the farmers.

The latest modification in crop insurance schemes took place in 2016 January, when the present central government announced the Pradhan Mantri Fasal Bima Yojana (PMFBY), replacing both NAIS and MNAIS. This scheme introduced the one-season one-premium policy, under which the premium price to be paid by farmers was fixed at 1.5 per cent of sum insured for all kharif season crops, 2 per cent for all rabi season crops, and 5 per cent for the commercial/horticultural crops. Along with PMFBY, the Weather Based Crop Insurance Scheme (WBCIS) scheme was also modified to bring in Restructured WBCIS. The purpose was to include losses due to hailstorm, cloudburst and wind speed apart from deviation of rainfall, temperature and humidity.

## 7.5. ESTIMATING CROP INSURANCE COVERAGE IN INDIA AND BIHAR

Subscription to crop insurance programmes in India, in terms of absolute number of farmers insured, is one of the highest in the world (Mahul et al., 2012). However, given the large population involved in cultivation of crops, penetration of crop insurance remains low. In this section, we discuss the coverage of crop insurance using three indicators – number of farmers insured, units of cultivation insured and cultivated area insured.

For coverage by units of cultivation insured, we use the data available from two rounds of the Situation Assessment Survey (SAS) of Agricultural Households, conducted by the NSSO, during 2012–13 and 2018–19. For coverage estimation by proportion of area insured, we rely on the Agricultural Statistics, published by the Ministry of Agriculture and Farmers Welfare, Government of India. To estimate coverage by proportion of farmers insured, we count a farm household as 'insured' if the household insured at least one crop among the set of crops it cultivated. We consider the household as 'not insured', if it did not insure any of the crops it cultivated. Dividing the number of farm households that insured at least one crop by the total number of households surveyed, gives the proportion of farmers insured. We carry out this exercise separately for both the kharif and rabi seasons.

Table 7.1 shows estimates of crop insurance coverage by proportion of farmers and units of cultivation insured at the all-India level. The following facts stand out. First, the coverage shares are very low. Just over 10 per cent farmers in India insured their crops

Table 7.1 Coverage by Farmers Insured and Units of Cultivation

| | 2012–13 | | | | 2018–19 | | | |
|---|---|---|---|---|---|---|---|---|
| | India | | Bihar | | India | | Bihar | |
| Indicator | Kharif | Rabi | Kharif | Rabi | Kharif | Rabi | Kharif | Rabi |
| Proportion of Farmers Insured (per cent) | 6.14 | 3.8 | 1.24 | 0.3 | 10.47 | 8.34 | 2.37 | 1.36 |
| Proportion of Units of Cultivation Insured (per cent) | 5.61 | 4.17 | 1.13 | 0.23 | 9.57 | 7.43 | 2.27 | 1.08 |

*Source:* Situation Assessment Survey, 70th and 77th rounds.

in the kharif season in 2018–19. The figures are even lower for rabi cropping season. This is, however, understandable, given kharif crops are more sensitive to rainfall than rabi crops. A simple addition of these numbers will give us the upper bound of yearly coverage, at around 19 per cent. Second, coverage measured by units of cultivations covered is lower than coverage by proportion of farmers insured. This implies that many farmers cultivated more than one crop, and that they did not formally insure all of their crops. Third, coverage has increased considerably during 2018–19 compared to 2012–13. For example, for the kharif season, coverage by proportion of farmers insured showed an increase by 70 per cent. Given the low base and the policy push in 2016–17 through the introduction of new schemes, these increases are in the expected lines. Finally, estimation of coverage by area covered (Table 7.2) shows substantially larger numbers. This probably implies that large farmers are buying more insurance compared to small/marginal farmers.

Table 7.1 also reports corresponding coverage numbers for Bihar. The coverage by number of farmers as well as by units of cultivation insured in Bihar are far lower than that for all-India. In the Kharif season of 2018–19, only 2.37 per cent farmers insured their crops. This number went down further to 1.36 per cent in the rabi season. This pattern is similar to what we witness for the

Table 7.2  Coverage of Crop Insurance by Gross Cropped Area

| | 2014–15 | | 2015–16 | | 2016–17 | | 2017–18 | | 2018–19 | |
|---|---|---|---|---|---|---|---|---|---|---|
| ***Indicator*** | ***India*** | ***Bihar*** | ***India*** | ***Bihar*** | ***India*** | ***Bihar*** | ***India*** | ***Bihar*** | ***India*** | ***Bihar*** |
| Proportion of Cropped Area Insured (per cent) | 19.80 | 48.65 | 26.58 | 37.06 | 28.97 | 32.81 | 26.13 | 28.07 | 26.35 | N.A. |

*Source:* Agricultural Statistics (2017, 2019).

*Note:* Figure for Bihar for 2018–19 is not reported.

country as a whole. Further, a similar pattern can be noticed in terms of coverage by units of cultivation – the numbers are slightly lower, indicating prevalence of multi-cropping by farmers. Also, as in the case for all-India, there has been substantial increase in terms of proportion of coverage. Most striking numbers for Bihar, however, are the coverage by percentage of cultivated area. It is found that the proportion of gross cropped area covered in Bihar has been higher than that for all-India, and consistently so over the years (Table 7.2).

## 7.6 REASONS FOR LOW TAKE-UP OF CROP INSURANCE

On the basis of the above discussion, it would not be an exaggeration to call the coverage of crop insurance in India as modest. The coverage is even lower for the state of Bihar – by proportion of farmers insured and by proportion of units of cultivation insured.[1] In this section, therefore, we seek to identify the constraints that impede take-up of crop insurance both in India and Bihar. We divide our discussion in two parts. In the first part, we focus on the design-related problems of the schemes. In the second part, we focus on the implementation-related issues. Following Sharan (n.d.), we name these as 'boundaries in design' and 'boundaries in implementation', respectively.

### 7.6.1 Boundaries in Design

#### *7.6.1.1 Approximate Loss Estimation*

All the major crop insurance programmes in India are index based. For the area indexed schemes such as NAIS or MNAIS, and for the latest PMFBY, loss is estimated through CCEs. The CCEs are conducted by the state governments, under the guidance of NSSO. The problem here is that there is no upper bound of the number of CCEs that may be conducted and, due to constraint of budget and staff, most of the times the number of CCEs conducted can only meet the minimum number criteria (World Bank, 2011). This may not always be sufficient for crop loss estimation. The other problem is the lack of expertise of the field staff. Given the level of skill required for conducting CCEs properly, lack of training and/

or supervision of the process can produce erroneous loss estimation, possibly resulting in higher basis risk experienced by farmers.

Loss measurement for weather-indexed schemes is based on the deviation of rainfall in a homogeneous area from the long period average of that area. Such a scheme is supposed to reduce the scale of error in loss measurement because rainfall is measured through automated rain gauges as a result of which human intervention is more or less eliminated. However, lack of density of weather stations posits a barrier in reducing basis risk (Clarke et al., 2012).

The primary reason for relying on index-based insurance, instead of individual insurance, is the highly fragmented nature of agricultural land ownership in India. Due to this, measuring crop loss for each and every insured plot is not cost-effective. There is a trade-off between the basis risk that the farmers face and the administrative cost that insurance companies need to bear. Use of modern technology can be a possible solution to this trade-off, by reducing both basis risk as well as overhead cost at the same time.

#### *7.6.1.2 Credit-linking of Crop Insurance*

Since the introduction of the CCIS in 1986, crop insurance was made mandatory for farmers taking short-term agricultural loans. The reasons for linking crop credit to crop insurance are two-fold. First, since more farmers take loans from institutional sources than they buy insurance, tying loans with insurance will improve its take-up among farmers, and will generate interest among them once they get acquainted with the schemes. Second, attaching insurance to crop loans may help reduce the rate of default of institutional credit. This would also help maintain credit worthiness of farmers and work as an incentive for banks to provide advances to the agricultural sector (Hazell et al., 1986).

We showed in Tables 7.1 and 7.2 that even with provision of credit-linking, crop insurance coverage has remained modest. There are reports that farmers do not prefer linking crop loan to crop insurance[2] and perceive that the banks gain more from the insurance schemes which is also substantiated by the erstwhile Planning Commission in its 12th Five Year Plan document (Planning Commission, 2013). On the other hand, banks may

Table 7.3 Proportion of Non-Loanee Farmers among All Farmers Insured

| Data Source and Year | Per cent of Non-Loanee Farmers among Insured in | |
|---|---|---|
| | India | Bihar |
| SAS 70th Round (2012–13) | 12.02 | 24.78 |
| AIC Business Statistics (2016–17) | 20.62 | 1.25 |
| SAS 77th Round (2018–19) | 28.89 | 52.56 |

*Sources:* (i) Situation Assessment Survey, 70th and 77th rounds (Visit 1), and (ii) Business Statistics published by the Agricultural Insurance Company of India.

*Note:* Sample weights have been used while arriving at the estimates.

also lack incentives to implement credit-linked crop insurance if it reduces credit offtake as they have to meet their priority sector lending target. Further, due to the policy emphasis of mandatory insurance for loanee farmers, almost no other channel for selling pure insurance to farmers has developed.

Table 7.3 corroborates our above arguments. The share of non-loanee farmers in all insured farmers has never been above 30 per cent in India. In 2012–13, only 12 per cent farmers insured their crop without taking a crop loan. This share increased to 20 per cent in 2016–17, and further to around 29 per cent in the 2018–19 agricultural year. For the state of Bihar, there is noticeable peculiarity in take-up of insurance by the non-loanee farmers. According to the data published by the AIC,[3] merely 1.25 per cent farmers in Bihar insured their crops without loan in 2016–17. However, this share is substantially large (at 25 and 52 per cent for 2012–13 and 2018–19, respectively) according to the SAS data. One possible reason for this anomaly may be due to the relatively small sample size of insured farmers in Bihar.

### *7.6.1.3 Information Asymmetry*

One of the boundaries of providing insurance comes from the economic theory itself. According to the standard theory of insurance, there are possibilities of adverse selection and moral hazard in the insurance market. Adverse selection refers to the fact that crop insurance would attract farmers who have private information that they might face a crop loss in the upcoming cropping season, whereas moral hazard refers to the fact that farmers may increase the probability of crop loss by changing their behaviour after purchasing insurance. Gunnsteinsson (2020) finds experimental evidence in support of both adverse selection and moral hazard-related problems amongst farmers in the Philippines. One reason for relying on index-based insurance, as opposed to individual-based insurance in India (and many other developing countries), is to address these issues. There is evidence that crop insurance schemes in India might not be suffering at least from the moral hazard-related problems. Ranganathan et al. (2019) observed from a survey of farm households in six Indian states (including Bihar) that subscription to crop insurance actually increases rice yield by 47 per cent.

However, an analysis of the SAS data, interestingly, shows that farmers who insured their crops are substantially more likely to report crop loss. Figure 7.2 shows the picture for India in 2018–19. There is approximately a 10-percentage point difference in reporting of crop loss between insured and non-insured farmers. Further, among the insured farmers, propensity to report crop

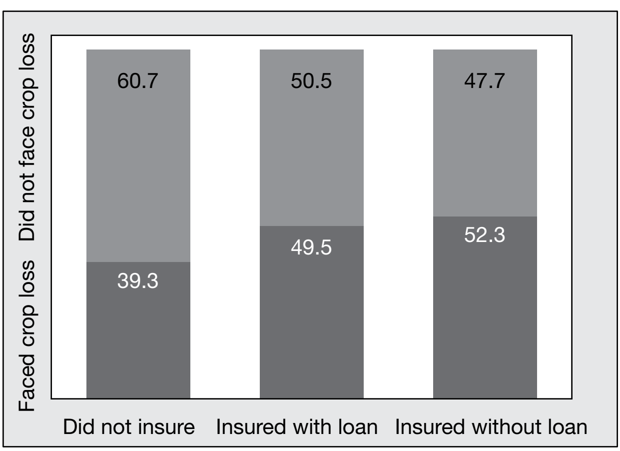



Figure 7.2 Distribution of Farmers Reporting Crop Loss by Insurance Status (India, 2018–19)

*Source:* NSSO 77th round, Visit 1.

*Note:* Sample weights have been used while arriving at the estimates.

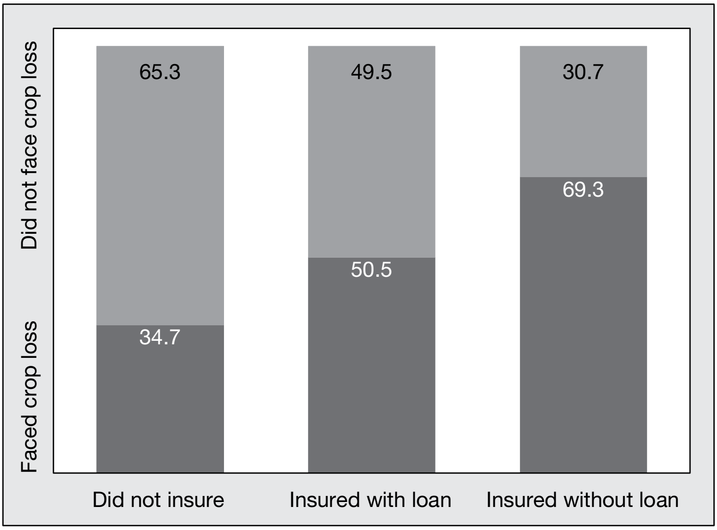



Figure 7.3 Distribution of Farmers Reporting Crop Loss According to Insurance Status (India, 2012–13)

*Source:* NSSO 70th round, Visit 1.

*Note:* Sample weights have been used while arriving at the estimates.

loss is higher for non-loanee farmers compared to loanee farmers, reinforcing the plausibility of information asymmetry-related problems. One silver lining in this finding is that the problem may have reduced over the years. As Figures 7.2 and 7.3 show, the difference in reporting crop loss was substantially higher between the insured and the non-insured farmers during 2012–13 as compared to 2018–19, especially for the non-loanee farmers.

For the state of Bihar, the patterns are not only similar but also more pronounced. While the proportion of farmers reporting crop loss by non-insured farmers (39.5 per cent) is similar to that for the country, the share increases substantially, to over 75 per cent, when the farmers are insured (Figure 7.4).[4]

There are a few other weaknesses in the design of crop insurance schemes. For example, the schemes do not cover losses from all types of exogenous shocks. Second, the requirement of proof of ownership prevents many farmers from procuring insurance. In some cases, the cultivable land is divided among heirs of the family without formal transfer of ownership in each of the heirs' names. In

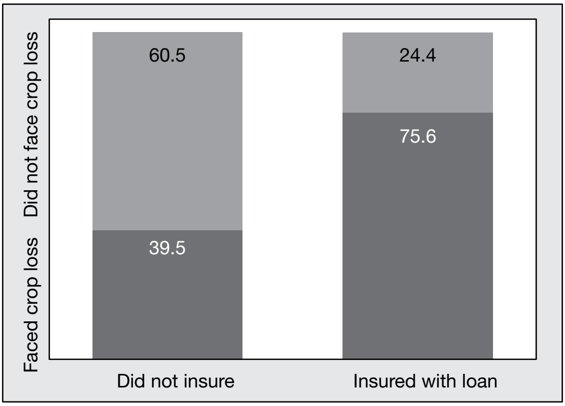



Figure 7.4 Distribution of Farmers Reporting Crop Loss According to Insurance Status (Bihar, 2018–19)

*Source:* NSSO 77th round, Visit 1.

*Note:* Sample weights have been used while arriving at the estimates.

that case, if one member from the family is interested to insure their land while others are not, they cannot do so due to lack of formal ownership. Similarly, sharecroppers and tenants find it difficult to insure crops, even though there is provision of providing insurance to such farmers as well in the schemes.

## 7.6.2 Boundaries in Implementation

### *7.6.2.1 Lack of Awareness*

Possibly the most important reason for low take-up of crop insurance among farmers is their lack of awareness about it. Since insurance is a sophisticated financial product, improving awareness about its functionality can help improve its coverage, especially among small and marginal farmers. However, till recently, improving awareness was not listed as a responsibility of the state-level committees overseeing implementation of crop insurance schemes. It was only since rabi season of 2018–19 that the guideline was amended to include a mandatory expenditure of the order of 0.5 per cent of the gross premium per insuring company per season towards awareness building.

An analysis of the latest SAS data shows that even in 2018–19, close to 58 per cent farmers across states and union territories

(UTs) in India reported either being 'not aware' or being 'not aware about availability of facility' as the reason for not insuring their crops (Table 7.4). The share is even higher for the state of Bihar, at 62 per cent. Therefore, addressing this issue remains a binding constraint towards higher penetration of crop insurance. Mukherjee and Pal (2019) noted that there is a positive association between access to technical advice and awareness about crop insurance and its take-up.

The percentage distribution of reasons for not insuring crops, shown in Table 7.4, also reveals a few other patterns for the state of Bihar vis-à-vis India. While the responses are similar across most dimensions, fewer farmers from Bihar expressed 'not interested' as a reason for not insuring their crops. Also, more farmers from Bihar reported unavailability of crop insurance as a reason for not insuring. These findings reinforce the need to provide a supply side push to improve crop insurance coverage in the state.

Table 7.4 Reasons for Not Insuring Crops

| | *Per cent of Farmers in* | |
|---|---|---|
| ***Reason for Not Insuring*** | ***India*** | ***Bihar*** |
| not aware | 42.77 | 44.96 |
| not aware about availability of facility | 15.06 | 16.94 |
| not interested | 20.34 | 14.12 |
| no need | 4.74 | 3.53 |
| insurance facility not available | 4.4 | 9.62 |
| lack of resources for premium payment | 2.48 | 2.7 |
| not satisfied with terms & conditions | 2.29 | 1.03 |
| nearest bank at a long distance | 0.17 | 0.02 |
| complex procedures | 4.12 | 2.32 |
| delay in claim payment | 2.68 | 4.18 |
| others | 0.95 | 0.58 |

*Source:* SAS, 77th round.

### *7.6.2.2 Claim Settlement*

One of the reasons farmers want to insure their crops is to avoid a liquidity crunch in the post-harvest season if there is any crop loss. Therefore, faster claim settlement is a critical component for any successful crop insurance scheme. However, this appears to be a bottleneck in the case of Indian crop insurance programmes. Cole and Xiong (2017) observed that the delay in settlement of crop insurance claims in India ranges between 9 and 12 months. Nair (2010) points out bureaucratic lags as the main reason behind inordinate delay in payment of claim amount to farmers. However, as far as we know, there has not been any systematic study of this problem so far. Here we try to provide some quantitative measures to throw some light on this issue.

First, we consider one of Lok Sabha question and answer sessions (Lok Sabha, unstarred question no. 972, 2018) in which the Ministry of Agriculture and Farmers' Welfare reported the status of claim payment (among other details) for almost all states of India for the cropping years 2016–17 and 2017–18. It is reported that out of the 25 states and UTs, 22 states approved claims and paid at least some amount of it to farmers till July 2018. But for 2017–18 rabi season, the situation is reversed; only three states paid and approved some claim amount out of those states.

Second, on delay in claim settlement, we consider the latest SAS data. In the SAS, the farmers who bought crop insurance voluntarily, i.e., even without taking crop loans, were asked whether they received claim payment (either fully or partially), and if yes, time taken to receive the claim amount. The responses for this question were recorded under three categories: received claim amount within 6 months, within 6 to 12 months and after 12 months. It is found that about 80 per cent farmers reported that they did not receive any claim amount. The numbers are lower for the state of Bihar (46 per cent), but given that only 38 farmers in the SAS survey for Bihar reported facing crop loss when insured without loan, they may not be representative of the population. Further, less than half of the farmers (45 per cent) reported receiving claim amounts within 6 months when they did receive any claim amount.

Third, we consider the data published by the AIC. The company provided state-wise and season-wise data on crop

Table 7.5 Claim to Premium (Loss) Ratio for India and Bihar (in per cent)

| Year | Season | All India Average | All India Median | Bihar |
|---|---|---|---|---|
| 2016 | Kharif | 72.75 | 61.53 | 20.95 |
| 2017 | Kharif | 92.57 | 90.78 | 66.73 |
| 2017 | Rabi | 72.69 | 45.55 | 16.68 |

*Source:* Business Statistics, Agricultural Insurance Company of India.

insurance coverage from 2016 kharif season till 2020 kharif season. Considering that Bihar moved out of the PMFBY scheme from the 2018 kharif season, we estimate the loss ratio for Bihar as well as the country as a whole, for the years 2016 and 2017. The analysis reveals that claim as a percentage of premium was considerably lower for Bihar for all seasons (Table 7.5). Thus, low loss ratio appears as one of the major reasons for opting out of the central crop insurance schemes by Bihar.

In this context, it needs mention that the MNAIS tried to address the problem of delayed claim settlement through an arrangement of on account payment of 25 per cent of expected loss in case of a catastrophic disaster. This provision has been continued under the PMFBY. Further, from the 2018–19 rabi season, a penalty of 12 per cent interest rate per annum has been levied on the insurance companies for delay in claim settlement beyond 10 days of the prescribed cut-off date of claim payment.

#### *7.6.2.3 Farm Loan Waiver*

Farm loan waivers by the states, especially before elections, may also cause low take-up of crop insurance. Empirical evidence on association between loan waiver announcement and drop in crop insurance take-up can be found in the same Lok Sabha question and answer data referred above. The data show that four major states, namely Karnataka, Rajasthan, Maharashtra and Uttar Pradesh, were responsible for almost all of the drop in crop insurance take-up between 2016–17 and 2017–18. Notably, just before the commencement of the kharif season in 2017, three among these states (Karnataka, Maharashtra and Uttar Pradesh) announced farm loan waiver. Before the start of the rabi season for 2017–18,

Table 7.6 Decrease in Number of Farmers Availing Crop Insurance in Four Loan-Waiver States

| | Decrease in Number of Farmers between 2016–17 and 2017–18 | |
|---|---|---|
| ***State*** | ***Kharif Season*** | ***Rabi Season*** |
| Karnataka | 219,215 | 1,361,694 |
| Maharashtra | 2,274,091 | 326,626 |
| Rajasthan | 894,694 | 2,241,989 |
| Uttar Pradesh | 1,220,830 | 256,262 |

*Source:* Lok Sabha unstarred question no. 972, 2018.

Rajasthan too announced waiver of farm loans. Table 7.6 shows a comparison of the drop in crop insurance coverage for these four states in those two years.

## 7.7 CONCLUSION

In this chapter, we discussed agricultural insurance both in Bihar and all-India. We observed that the crop insurance schemes are primarily index-based – either area-indexed or weather-indexed. We noted the importance of formal risk mitigation mechanisms such as crop insurance towards smoothing of farm households' income. Since the risks farmers face are covariate across a large geographical area, informal risk coping mechanisms become unsuitable to eliminate risks due to crop failure. For diverse agro-climatic regions in a large country like India, crop insurance can be suitable in tackling such risks. While discussing the evolution of crop insurance schemes in India, we noted that although the initial schemes were financially unsustainable, their performance has improved over the years.

Moving on, we analysed the extent of crop insurance coverage in India and compared the same with the state of Bihar. We found that the coverage for the country as a whole is, at best, modest. Further, it is generally lower for Bihar compared to the all-India average. We identified three constraints each from the design as well as implementation sides that might impede higher penetration of crop insurance both in India and Bihar. In the design side, we find approximate loss estimation, credit linking of crop insurance and information asymmetry-related problems as the main barriers. On the other hand, lack of awareness, delay in claim settlement and farm loan waiver are the main implementation side constraints. We identified lack of awareness as the binding constraint towards higher penetration of crop insurance for India as well as Bihar. Even in 2018, almost 60 per cent of the farmers both in India and Bihar are reported to be unaware about crop insurance schemes.

The poor in the villages lack the resources to adopt modern technology. They also lack understanding the intricacies of an insurance product. So, policies towards easier and better understanding of operating procedures of crop insurance schemes, through awareness improvement programmes and/or agricultural extension services, can be effective in improving its take-up, especially among the poorer farmers. Further studies are required for designing the appropriate policy measures towards this end.

## NOTES

1. Bihar stopped subscribing to the national crop insurance programme PMFBY. However, the state continues to offer its own scheme to its farmers.
2. It is reported that the farmers term the mandatory premium for crop insurance attached with crop loan as 'lagaan', a heavy tax levied during the British rule. See https://www.hindustantimes.com/punjab/lagaan-crop-insurance-scheme-draws-farmers-flak/story-NM3im4x9WZQqvrKWInUj7J.html.
   Since Kharif season of 2020–21 agricultural year, crop insurance has been made voluntary for all farmers.
3. https://www.aicofindia.com/AICEng/General_Documents/Business_Statistics/PMFBY.pdf
4. We do not report the proportion by loanee and non-loanee farmers separately for Bihar as the number of insured farmers is very low.

## REFERENCES

Clarke, D. (2011). *A theory of rational demand for index insurance.* Department of Economics (Discussion Paper 572), University of Oxford.

Clarke, D., Mahul, O., Rao, K. N., & Verma, N. (2012). Weather based crop insurance in India. *World Bank Policy Research* (Working Paper No. 5985). https://openknowledge.worldbank.org/bitstream/handle/10986/3270/WPS5985.pdf?sequence=1&isAllowed=y

Coate, S., & Ravallion, M. (1993). Reciprocity without commitment. Characterization and performance of informal insurance arrangements. *Journal of Development Economics, 40*(1), 1–24.

Cole, S., & Xiong, W. (2017). Agricultural insurance and economic development. *Annual Review of Economics, 9*, 235–262.

Dandekar, V. M. (1976). Crop insurance in India. *Economic & Political Weekly, 11*(26), A61–A80.

Dercon, S. (1996). Risk, crop choice, and savings: Evidence from Tanzania. *Economic Development and Cultural Change, 44*(3), 485–513.

Dercon, S. (2002). Income, risk coping strategies, and safety nets. *The World Bank Research Observer, 17*(2), 141–166.

Dercon, S., & Christiaensen, L. (2011). Consumption risk, technology adoption and poverty traps: Evidence from Ethiopia. *Journal of Development Economics, 96*(2), 159–173.

Economic Survey. (1999). *Economic Survey 1998–99*. Ministry of Finance, Government of India.

Economic Survey. (2005). *Economic Survey 2004–05*. Ministry of Finance, Government of India.

Economic Survey. (2018). *Economic survey 2017–18*, Chapter 06. Ministry of Finance, Government of India. http://mofapp.nic.in:8080/economicsurvey/pdf/082101_Chapter_06_ENGLISH_Vol_01_2017-18.pdf

Fafchamps, M. (1999). *Rural poverty, risk and development*. Cheltenham, Edward Elgar.

Falco, S. D., Adinolfi, F., Bozzola, M., & Capitanio, F. (2014). Crop insurance as a strategy for adapting to climate change. *Journal of Agricultural Economics, 65*(2), 485–504.

Gaurav, S. (2015). Are rainfed agricultural households insured? Evidence from five villages in Vidarbha, India. *World Development, 66*, 719–736.

Gunnsteinsson, S. (2020). Experimental identification of asymmetric information: Evidence on crop insurance in the Philippines. *Journal of Development Economics, 144*, 102414.

Hazell. P., Bassoco, L. M., & Arcia, G. (1986). A model for evaluating farmers' demand for insurance: Applications in Mexico and Panama. In P. B. R. Hazell, C. Pomareda & A. Valdes (Eds.), *Crop Insurance for Agricultural Development: Issues and Experience*. The Johns Hopkins University Press.

Hoda, A., Gulati, A., Jose, S., & Rajkhowa P. (2021). Sources and drivers of agricultural growth in Bihar. In Ashok Gulati *et al.* (Eds.), *Revitalizing Indian Agriculture and Boosting Farmer Incomes*. Springer.

Iturrioz, R. (2009). *Agricultural Insurance* (Issue 12). World Bank.

Kazianga, H., & Udry, C. (2006). Consumption smoothing? Livestock, insurance and drought in rural Burkina Faso. *Journal of Development Economics, 79*(2), 413–446.

Lamb, R. (2003). Fertilizer use, risk and off-farm labour markets in the semi-arid tropics of India. *American Journal of Agricultural Economics, 85*(2), 359–371.

Lok Sabha unstarred question no. 972. (2018). *Ministry of Agriculture and Farmers Welfare*. Government of India.

Mahul, O., Verma, N., & Clarke, D. J. (2012). *Improving farmers' access to agricultural insurance in India* (Working Paper No. 5987). World Bank Policy Research.

Ministry of Agriculture. (2016). *Operational guidelines: Pradhan Mantri Fasal Bima Yojana.* Department of Agriculture, Cooperation and Farmers Welfare, Government of India.

Mishra, P. K. (1995). Is rainfall insurance a new idea? Pioneering work revisited. *Economic & Political Weekly, 30*(25), 84–88.

Mishra, S. (2006). Farmers' suicides in Maharashtra. *Economic and Political Weekly, 41*(16), 1538–1545.

Mishra, S. (2014). *Farmers' suicides in India, 1995–2012: Measurement and interpretation* (Working Paper No. 62). London School of Economics Asia Research Centre.

Mobarak, A. M., & Rosenzweig, M. (2012). *Selling formal insurance to the informally insured. Economic Growth Centre Discussion* (Paper, No. 1007). Yale University.

Morduch, J. (1995). Income smoothing and consumption smoothing. *Journal of Economic Perspectives*, *9*(3), 103–114.

Morduch, J. (1999). Between the market and state: Can informal insurance patch the safety net ?. *The World Bank Research Observer, 14*(2), 187–207.

Mukherjee, S., & Pal, P. (2017). Impediments to the spread of crop insurance in India. *Economic and Political Weekly*, *52*(35), 16–19.

Mukherjee, S., & Pal, P. (2019). On improving awareness about crop insurance in India. *Review of Agrarian Studies*, *9*(1), 46–68.

Munshi, K., & Rosenzweig. M. (2009). *Why is mobility in India so low? Social insurance, inequality and growth* (Working Paper No. 14850). NBER.

Nair, R (2010): Crop insurance in India: Changes and challenges, *Economic & Political Weekly*, *45*(6), 19–22.

Nayyar, D., & Sen, A. (1994). International trade and the agricultural sector in India. *Economic and Political Weekly, 29*(20), 1187–1203.

Planning Commission. (2013). *Twelfth five year plan (2012–2017): Economic sectors*, Volume II. Sage Publications.

Ranganathan, T., Mishra, A. K., & Kumar, A. (2019, January 4–6). *Crop insurance and food security: evidence from rice farmers in eastern India*. Invited Paper Presented at the 2019 Annual Meeting of the Allied Social Sciences Association (ASSA), Atlanta, GA.

Rao, K. N. (2010). Index based crop insurance. *Agriculture and Agricultural Science Procedia, 1*, 193–203.

Rose, E. (1999). Consumption smoothing and excess female mortality in rural India. *Review of Economics and Statistics, 81*(1), 41–49.

Sekhri, S., & Storeygard, A. (2014). Dowry deaths: Response to weather variability in India. *Journal of Development Economics, 111*, 212–223.

Sharan, M. R. (n.d.). RSBY in the context of universalizing healthcare in India. http://www.academia.edu/10735990/RSBY_in_the_context_of_universalizing_healthcare_in_India

Townsend, R. (1994). Risk and insurance in village India. *Econometrica, 62*(3), 539–591.

World Bank (2011). *Enhancing crop insurance in India*. https://docplayer.net/2851523-Enhancing-crop-insurance-in-india-report-no-61491-in.html

# CHAPTER 8

# AGRICULTURAL MARKETS

## Constraints and Opportunities

***Manish Kumar***

### 8.1 INTRODUCTION

Agriculture in Bihar occupies an important place in various aspects including its employability and overall share in the economy. With respect to these two factors, on an average, agriculture is more important for Bihar than for the average of India. While agriculture in India contributes about 17 per cent to the Gross Domestic Product (GDP) and employs about half the workforce, it accounts for 25 per cent of the State-GDP and is the source of livelihood for about 70 per cent of the workforce in Bihar.

Despite its important position in the state's economy, the agriculture sector in Bihar is in dire straits. One of the factors responsible for the severe crisis in agriculture is floods in a large part of the state. Almost every year, floods in Bihar destroy a significant part of the total cropped area. Therefore, a strong policy for flood management in Bihar can be an important step in addressing agrarian distress. However, the major problems of Bihar agriculture are rooted in a wider policy framework.

In an era of the neoliberal economic structure, there is an ideological shift from a state-led support system to market-driven management in the decisions of governments for the economy, including agriculture. This resulted in a decline in public investment in agriculture (Himanshu, 2019; Jha et al., 2021), a reduction in public procurement of food grains (Kumar, 2019; Rawal et al., 2020b) and several policies launched by the central and state governments aimed at giving a free hand to the corporates (Kumar, 2021; Rawal et al., 2020a).

The Bihar government repealed the Agricultural Produce Market Committee (APMC) Act in 2006 with an aim to encourage private parties in agricultural marketing, which was supposed to provide farmers with more options to sell their produce. However, experience of the state shows that the repeal of the APMC Act did not persuade private entities to set up agricultural markets (Kumar, 2021). This resulted in stagnation in the number of mandis, poor agricultural market density and negligible public procurement, leading to lower prices for farmers in the state. This policy retreat also had a massive impact on other public policies, such as non-participation in an online platform called 'eNAM' or the National Agricultural Market. In these circumstances, the role of Primary Agricultural Credit Societies (PACSs) becomes important with regard to trade in agricultural commodities at remunerative prices for farmers. The present chapter discusses the constraints of PACS in the context of agricultural marketing, and the way forward.

## 8.2 EXPLANATIONS OF AGRICULTURAL BACKWARDNESS IN BIHAR

The 'technocratic' explanation for the backwardness of agriculture in Bihar focuses on poor irrigation, low level of input use, land fragmentation, lack of credit and extension services (Jha, 1997). Referring to the poor irrigation base of the state as the main reason for the backwardness of Bihar agriculture, policymakers encouraged groundwater irrigation through increasing tube-well density during the 1980s. It resulted in a high yield of output during 1981–82 to 1991–92 (Kishore, 2004). However, it was also observed that the increase in yield was accompanied by an increase in the use of fertilisers. The impressive expansion of the yield during the mentioned period could not sustain despite increased tube-well density. Even if the major technocratic efforts are required for the growth of agricultural output, it may not result in the improvement of livelihood of the actors of agricultural value systems (AVSs), which suggests the limitations of technocratic efforts to overcome agricultural backwardness of Bihar (Jha, 1997). For the period between 1981–82 and 2009–10, the yield of paddy and wheat increased by 99 per cent (2.5 per cent per year) and 91 per cent (2.3 per cent per year), respectively. However, because of the continuing dependence of the population on agriculture, the growth did not translate into increase in productivity of the workforce (Sharma & Rodgers, 2015). Further, using secondary data, Shah (2016) contradicted the claim that the agriculture sector in Bihar is growing. He finds that the Gross State Domestic Product (GSDP) in agriculture (at constant price) in Bihar did not have two consecutive years of growth since 1993–94. This argument is consistent with the finding that Bihar is among the states where the yield of major foodgrains is lowest in India.

The other explanations of the backwardness of agriculture in Bihar include poor public provisioning, as argued by Amartya Sen, and the 'semi-feudal' hypothesis put forward by Amit Bhaduri. In Bihar, in the post-1960s, substantial land was sold by privileged castes (Brahmins, Bhumihars, Rajputs and Kayasthas) to middle castes (Yadavs, Koeris and Kurmis). The reason behind the transfers was disinterest of the privileged caste in agriculture because of the non-agricultural sources of income and their bulky expenditures. The land helped the middle castes to challenge the social and political supremacy of the privileged castes. This change led to the weakening of the 'semi-feudal relations of production' (Jha, 1997). Despite such transfer of the land, the land reforms launched in 1962 remained incomplete to date. The Commission, formed under the chairmanship of D. Bandyopadhyay, observed:

> There is a structural bottleneck in Bihar agriculture due to very queer pattern of land ownership and very extortionate system of tenancy-at-will which are causing a great impediment to an accelerated rate of agricultural growth. (Bandyopadhyay, 2009).

The Commission also observed the skewed land ownership pattern in favour of middle and large landowning classes. The commission highlighted that 96.5 per cent of the landowning classes are small and marginal agricultural households that owns 66 per cent of the total agricultural land and the remaining 3.5 per cent of the landowning class, which are large and middle agricultural households, own 33 per cent of the total land (ibid.). The commission made several recommendations, but the subsequent governments of Bihar avoided implementing those because of electoral gains (Thakur, 2013).

## 8.3 AGRICULTURAL VALUE SYSTEM IN BIHAR

In line with the ideas under alternative explanations, we consider the framework of the AVS to understand the agricultural economy in Bihar. The AVS consists of agricultural and non-agricultural segments, with various actors in the backward and forward linkages. These AVS actors interact with each other in the presence of embedded power positions. The agricultural segment faces relative structural constraints in AVS and, therefore, the non-farm segment appropriates a significant portion of the surplus generated in agriculture (Kumar, 2019).

As discussed in an earlier work (Kumar, 2021), the absence of substantial public intervention in Bihar's AVS reinforces the power of the non-farm segment. In most cases, the risk of AVS is entirely borne by the farmers, while the profit is earned by the actors from the non-farm segments. In this situation, the land/tenancy relationship, input supply, market, time of sale, etc., become the defining characteristics for the distribution of created value in AVS. In other words, the factor endowments of farmers are responsible for their specific backward and forward linkages, which further guide the different earnings from the identical product. This is why the price received by small landholders is relatively lower than that received by big landholders in Bihar[1] (Kumar, 2021).

### 8.3.1 Backward Linkages

#### *8.3.1.1 Land Distribution*

As pointed out above, marginal and small land size groups constitute the majority of the agricultural community of rural Bihar. As per the latest agricultural census of India (2015–16)[2], almost 97 per cent of total land holdings in Bihar are under marginal and small size groups, which include 76 per cent of the total operational

Table 8.1 Number and Area of Holding by Size Groups in Bihar

| *Size Groups* | *Number in '000 Units* | *Area in '000 Hectares* |
|---|---|---|
| Marginal (less than 1 ha) | 14970 [91.21] | 3727 [57.73] |
| Small (1 – 2 ha) | 943 [5.75] | 1178 [18.25] |
| Semi-medium (2 – 4 ha) | 414 [2.52] | 1075 [16.66] |
| Medium (4 – 10 ha) | 81 [0.5] | 430 [6.67] |
| Large (more than 10 ha) | 3 [0.02] | 44 [0.69] |
| All Classes | 16412 [100] | 6457 [100] |

*Note:* Figures in square brackets are percentages to all classes.

*Source:* Agricultural Census, 2015–16.

agricultural area in the state (Table 8.1). The share of other size groups (semi-medium, medium and large) is close to three per cent of total landholdings, but they occupy almost 24 per cent of the agricultural operational area in Bihar. Although there has been a significant decline in the agricultural area concentrated in large and medium-sized groups in the last decade, the heterogeneous land ownership in Bihar's AVS is still undeniable. Therefore, the combination of facts that Bihar has a large number of agriculturally dependent population and skewed land ownership becomes important in defining the tenancy relationship in the state. Unfortunately, tenancy data is grossly underreported across all states for a variety of reasons, including legal issues concerning state-specific land ceiling mandates. The agricultural census (2015–16) reports that the share of leased-in/out land in Bihar is negligible.

In contrast to the agriculture census, the latest National Sample Survey (NSS) data shows that 16 per cent of the total agricultural households in Bihar had leased-in land for agriculture in 2018–19 (NSS, 2021), which was higher than the national average. Further, the share of tenant holdings in the total operational holdings in the state is 28 per cent, which is close to 25 per cent of the total operational agricultural area in Bihar. Given the widespread tenancy in the state, access to land is a significant feature in the backward linkages. Therefore, the rent, paid on leased-in land in

Bihar is more critical than officially envisioned. A significant part of the surplus value in agriculture goes to the owner of the land in the form of rent, which is an obstacle to investment in agriculture and a hindrance to its development (Patnaik, 1999).

### *8.3.1.2 Cost of Cultivation*

Table 8.2 presents the latest available data on cost of cultivation and cost of production of three major agricultural products of Bihar: paddy, wheat and maize. As per the calculation of the Commission for Agricultural Costs and Prices (CACP), the rental value of land in Bihar is 22 per cent of the total cost of cultivation for paddy, 27 per cent in case of wheat and 30 per cent in case of maize. In

Table 8.2 Cost of Cultivation and Cost of Production of Paddy, Wheat and Maize in Bihar, 2018–19

| | *Cost of Cultivation (Rs./Ha)* | | | *Cost of Production (Rs./Qtl)* | | |
|---|---|---|---|---|---|---|
| *Particulars* | *Paddy* | *Wheat* | *Maize* | *Paddy* | *Wheat* | *Maize* |
| **Operational Cost** | **37617** | **33113** | **35033** | **1039** | **889** | **775** |
| Human Labour | 20801 | 12325 | 15917 | 574 | 331 | 352 |
| Machine Labour | 4641 | 6488 | 5631 | 128 | 174 | 125 |
| Seed, Fertilisers, Manure, Insecticides | 6265 | 8409 | 6963 | 173 | 226 | 154 |
| Irrigation Charges | 5044 | 5064 | 5654 | 139 | 136 | 125 |
| Other Operational Costs | 865 | 826 | 870 | 25 | 23 | 19 |
| **Fixed Costs** | **13654** | **15404** | **17481** | **377** | **413** | **387** |
| Rental Value of Land | 11518 | 13072 | 15647 | 318 | 351 | 346 |
| Other Fixed Costs | 2136 | 2332 | 1834 | 59 | 63 | 41 |
| **Total Cost [C2]** | **51271** | **48518** | **52514** | **1416** | **1302** | **1161** |
| **Value of Main Product** | 40420 | 47705 | 58408 | 1116 | 1280 | 1292 |

*Source:* Directorate of Economics and Statistics, Government of India.

other words, close to 30 per cent of the total value of the main product is going into the hands of landowners as rent.

### *8.3.1.3 Irrigation*

In Bihar, as per the Agricultural Census 2011, the net irrigated area is just 48 per cent of the total operational land, which is among the lowest in India. The coverage of large and medium sources of irrigation is very less even for the net irrigated area. Canal is the source of irrigation for only 28 per cent of the total net irrigated land in Bihar. The coverage of the tank is negligible for the state (Table 8.3). Therefore, the tube wells become a significant source of irrigation for farmers in Bihar, for which diesel operated engines are the source of energy. Since farmers in Bihar do not have any major state support for irrigation, its cost is a significant component in the total cost of cultivation. Moreover, irrigation charges in Bihar are the highest among all Indian states. As shown in Figure 8.1, the operational cost of paddy cultivation in Bihar in 2018–19 is close to the Indian average, while the irrigation cost is third highest, next to Haryana and Uttar Pradesh. Since the yield rate of paddy

Table 8.3 Sources of Irrigation in Bihar (Area in ha), 2011

| *Size Groups* | *Total Area* | *Canals* | *Tanks* | *Wells* | *Tube-wells* | *Other Sources* | *Net Irrigated Area* |
|---|---|---|---|---|---|---|---|
| Marginal | 3669 | 494 | 40 | 22 | 1122 | 55 | 1734 |
| Small | 1186 | 154 | 12 | 8 | 378 | 19 | 572 |
| Semi-medium | 1073 | 151 | 9 | 7 | 344 | 20 | 530 |
| Medium | 415 | 64 | 4 | 1 | 124 | 8 | 200 |
| Large | 45 | 6 | – | – | 10 | – | 16 |
| All Classes | 6388 | 869 | 65 | 39 | 1979 | 102 | 3053 |

*Note:* Agricultural Census 2015–16 doesn't provide data on sources of irrigation. Hence we used data for 2011.

*Source:* Agricultural Census, 2011.

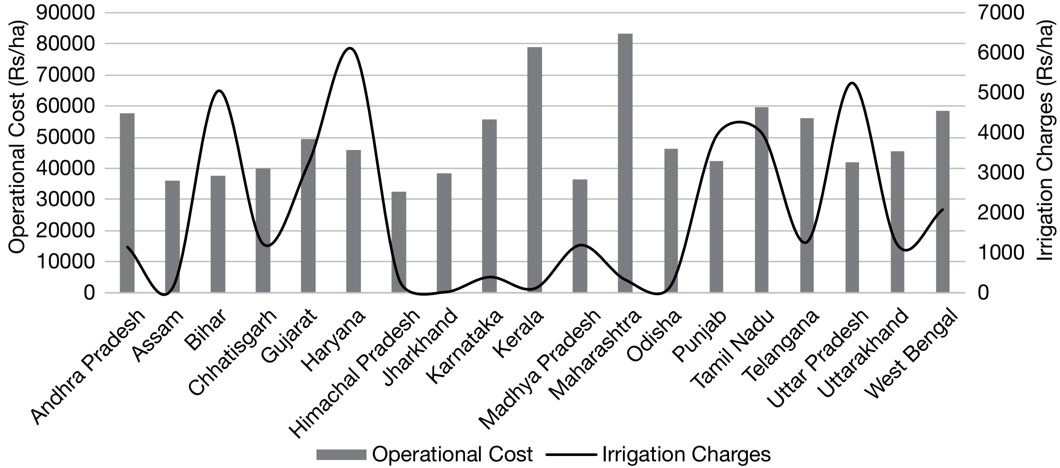



Figure 8.1 Operational Cost of Cultivation and Irrigation Charges for Paddy, 2018–19

*Source:* Directorate of Economics and Statistics, GoI.

in Haryana is higher than that of Bihar, the cost of irrigation per quintal is obviously highest in later.

#### *8.3.1.4 Other Inputs*

In the total cost of cultivation in Bihar, the shares of operational and fixed costs are 70 and 30 per cent, respectively. Human labour cost is the largest portion of the operational costs as well as total costs; it constitutes, on average, 43 per cent in the total cost and 60 per cent in the operational costs. Within the human labour cost, the share of family labour is 44 per cent on average, which is among the highest across Indian states. Considering the fact that the majority of Bihar's agricultural households are small and marginal, a significant share of family labour is not surprising. The share of attached labour is negligible and that of hired casual labour is 56 per cent. The share of animal labour cost in the total cost is just 2 per cent. The machine labour cost is the second-largest component of the operational costs on average. However, the expenditure on machine labour in Bihar is lower than many prominent agriculture dependent states. Within the machine labour cost, the share of the hired machine is between 96 and 97 per cent, which reflects that a significant portion of earning is going out of the farmers' hands as rent for hired machines. Among the major states, Bihar has the lowest share of expenditure on seeds, fertilisers, chemicals, etc. This reflects the technological backwardness of Bihar's agriculture, possibly due to agricultural losses or negligible earnings.

### 8.3.2 Forward Linkages

After harvesting, farmers have multiple options for disposing off agricultural products. The Situation Assessment Surveys of agricultural households by NSS are the main data source for analysis in this section. The NSS 70th round had considered five major options for farmers to sell their produce: local private traders, mandi, cooperative societies or government agencies, input suppliers and private processors. The NSS 77th round made some changes in these options and inquired about eight options that are local market (including local private traders), APMC market (non-existent in Bihar), input dealer, private processor, contract farming, farmer producer organisations (FPOs), cooperative societies and government agencies. Tables 8.4A and 8.4B depict the share of farmers who accessed different agencies to sell crops in two different years. As shown in the Table 8.4A, in 2012–13, for all major crops in Bihar, local private traders are the main agencies for the procurement of crops. The local traders procured from 75 per cent of maize farmers, 78 per cent of wheat farmers and 51 per cent of paddy farmers. In terms of quantity, local traders procured almost 87 per cent of maize, 72 per cent of wheat and 61 per cent of paddy outputs sold to different agencies. Access to public agencies, such

Table 8.4A Share of Farmers Who Reported Sale of Crops to Different Agencies and Share of Quantity Sold to Different Agencies, 2012–13

| ***Agency*** | ***Maize*** | ***Wheat*** | ***Paddy*** |
|---|---|---|---|
| | ***% share of farmers who reported the sale of crops*** | | |
| Local Traders | 75 | 78 | 51 |
| Mandi | 17 | 7 | 6 |
| Input Dealers | 8 | 12 | 11 |
| Cooperative & Govt. Agency | 0 | 0 | 2 |
| Processors | 0 | 0 | 0 |
| Others | 0 | 2 | 29 |
| Number of agri-households reported sale (in '00) | 7661 | 21824 | 23708 |
| ***% share of quantity sold*** | | | |
| Local Traders | 87 | 72 | 61 |
| Mandi | 11 | 7 | 9 |
| Input Dealers | 2 | 19 | 10 |
| Cooperative & Govt. Agency | 0 | 0 | 8 |
| Processors | 0 | 0 | 0 |
| Others | 0 | 2 | 12 |
| Estimated quantity sold ('000 tonne) | 1699 | 2447 | 3080 |

*Source:* NSS 70$^{th}$ Round.

Table 8.4B Share of Farmers Who Reported Sale of Crops to Different Agencies and Share of Quantity Sold to Different Agencies, 2018–19

| ***Agency*** | ***Maize*** | ***Wheat*** | ***Paddy*** |
|---|---|---|---|
| | ***% share of farmers who reported the sale of crops*** | | |
| Local Market | 95 | 87 | 91 |
| Input Dealers | 0 | 1 | 1 |
| Cooperative & Govt. Agency | 0 | 1 | 2 |
| FPOs or Contract Farming | 0 | 0 | 0 |
| Processor | 1 | 5 | 3 |
| Others | 4 | 6 | 3 |
| Number of agri-households reported sale (in '00) | 11816 | 39567 | 41908 |
| ***% share of quantity sold*** | | | |
| Local Market | 99 | 90 | 90 |
| Input Dealers | 0 | 1 | 1 |
| Cooperative & Govt. Agency | 0 | 2 | 4 |
| FPOs or Contract Farming | 0 | 0 | 0 |
| Processor | 0 | 5 | 3 |
| Others | 1 | 3 | 1 |
| Estimated quantity sold ('000 tonne) | 2839 | 4042 | 5097 |

*Source:* NSS 77$^{th}$ Round.

as cooperative society and government agencies were negligible in the state in 2012–13.

The situation with regard to forward linkages remains more or less the same in 2018–19 as well (Table 8.4B). The local market, which includes local private traders is the dominant agency to procure crops from farmers in Bihar. The share of new entrants in the list of procurement agencies like FPOs or contract farming is negligible in Bihar and that is why their impact on AVS and subsequent earnings of farmers are yet to be analysed. However, the existence of procurement agencies in the state and their functioning

Table 8.5 Farmers' Satisfaction Level After Selling Crops (% of total farmers who reported sale or respective crop)

| Crop | 2012–13 | | | 2018–19 | | |
|---|---|---|---|---|---|---|
| | Satisfied | Not Satisfied because price received was lower than market price | Not Satisfied due to Other Reasons | Satisfied | Not Satisfied because price received was lower than market price | Not Satisfied due to Other Reasons |
| Maize | 82 | 18 | 0 | 59 | 31 | 10 |
| Wheat | 85 | 15 | 0 | 51 | 42 | 8 |
| Paddy | 80 | 17 | 3 | 41 | 51 | 7 |

*Source:* NSS 70th and 77th Rounds.

or non-functioning has a direct impact on the price received by the farmers.

Table 8.5 helps us to look at the farmers' satisfaction level after selling crops. It is found that, in 2012–13, 82 per cent of maize farmers, 85 per cent of wheat farmers and 80 per cent of paddy farmers, who sold crops to various agencies, reported being satisfied with the sales, and the remaining farmers were primarily not satisfied, because they got a price less than the market price. The proportion of farmers not satisfied with the sale rose sharply in 2018–19.

Since most of the sales were with local traders or in the local markets, the increase in dissatisfaction reflects price suppression by the actors in the forward linkage. The other reason for dissatisfaction includes delay in payment, which is mainly a dominant concern in the case of procurement of crops by public agencies.

Although the level of dissatisfaction is an indicator of understanding agrarian distress, it is conceptually a vague term. Hence, it is important to look at the average price accessible for farmers. For Bihar, the cost of production of paddy, wheat and maize in 2018–19, as per the calculation of CACP, were 1116, 1280, 1292 rupees per quintal, respectively,[3] whereas the minimum support price (MSP) for the same year was 1750, 1735 and 1700 rupees per quintal for the three crops[4]. In this regard, public procurement is the only formal arrangement of linkages between farmers and buyers in the state. It is a 'formal' arrangement because of the guaranteed MSP. However, it is found that the access to public procurement agencies is higher for larger land size groups (Kumar, 2021). The access to public procurement agencies in a setup of mostly informal output linkages is a reflection of relative power position. The larger land size appears as a major factor, which enables the farmers to access a secured price. The lesser coverage of formal linkages also gets reflected in the prices received by the farmers for paddy. Thus, as high as 96 per cent paddy growers in Bihar got less than the MSP. In the price band of less than MSP, the farmers of lesser land size group are more compared to larger land size group. Selling at price less than MSP reflects the inability of Bihar's farmers to retain surplus or profit from the paddy cultivation. This inability increases with the decreasing landholding of the farmers. Table 8.6 shows that 97 per cent of the small and marginal farmers and 90 per cent of the medium farmers received a price less than the MSP in 2012–13. Only one per cent of the marginal and small farmers and 5 per cent of the semi-medium farmers received a price more than MSP.

The proportion of the paddy farmers in Bihar who accessed public procurement agencies in different land size groups is consistent with the share of farmers in respective land size groups, who

Table 8.6 Percentage Distribution of the Different Size Groups of Paddy Farmers According to Price Received

| *Price received* | *Marginal* | *Small* | *Semi-Med* | *Medium* | *Large* | *Total* |
|---|---|---|---|---|---|---|
| Less than MSP | 97 | 97 | 90 | 82 | 100 | 96 |
| Equal to MSP | 2 | 2 | 6 | 12 | 0 | 3 |
| More than MSP | 1 | 1 | 4 | 5 | 0 | 1 |

*Source:* NSS 70th Round.

could get a price either equal to or more than the MSP. The MSP is the minimum level of price and any price less than the MSP results in a deficit for the farmers. Hence, the fact that 96 per cent of the paddy farmers in Bihar receive a price less than MSP, indicates a shift of surplus through the output linkages under the framework of value networks. The capacity of the entire farming community in Bihar to retain surplus is limited as compared to the other processes in the paddy value networks. First, the power position of the farmers to hold the surplus generated in agriculture is weaker than the actors of other production processes in the AVS of paddy. Second, the power position of the smaller landholders is relatively weaker with reference to network than the larger landholders.

## 8.4 CONSTRAINTS IN THE AGRICULTURAL VALUE SYSTEM

To understand the situation of AVS in Bihar, a primary survey of paddy farmers in two districts was conducted. The regions in Bihar, specifically the south and north of the Ganga River, are very different regarding paddy value system (Figure 8.2). Irrigation channels, soil fertility and the yield of paddy are better in the southern part than in the northern part of the state. For the primary survey, two villages have been selected: one from the southern part, namely, Kharbhaiya from Katihar district and Kuraitha from the northern part and in Patna district. Floods are frequent in the northern part that affects the paddy value system in the region (Figure 8.2).

In the period between 2010 and 2017, except for two years, Katihar district witnessed floods every year.[5] Since flood has become a regular disturbing factor for paddy cultivation, selection of Kuraitha helped to understand flood's impact on AVS. The yield of paddy in the Patna district, in which Kharbhaiya is located, is close to the average yield of southern Bihar. The number of rice mills in Patna district also makes it a representative of the rice mill density of south Bihar.

In 2017–18, the surveyed farmers in Kuraitha village had planted Swarna and BB11 varieties of paddy; both varieties are short size non-Basmati. All farmers had sowed paddy in the month of June. As a result of the flood, farmers faced a complete loss of crop on 76 per cent of the total surveyed area under paddy cultivation.

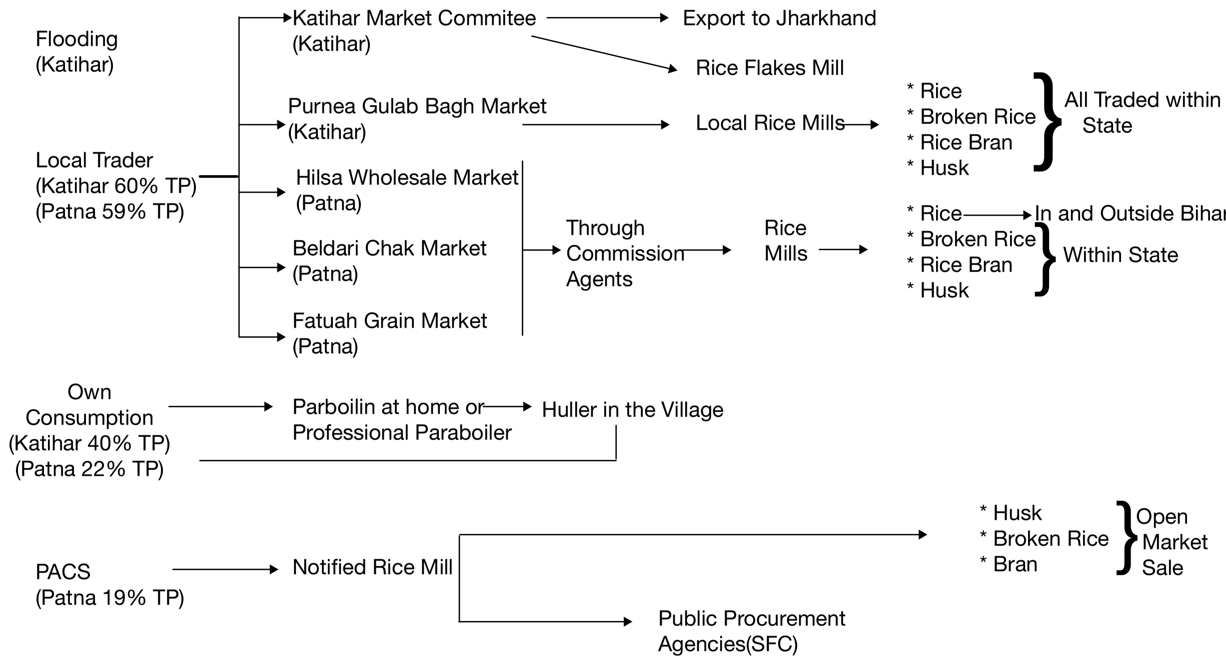



Figure 8.2 Paddy Value System in Kuraitha (Katihar) and Kharbhaiya (Patna), Bihar

*Source:* Primary Survey by author (2017–18).

The yield of paddy on the remaining 24 per cent of the total cropped area was 1,364 kg/ha, which is less than half of the state's average. The Bihar Government did provide some compensation against the loss of the farmers – just a fraction of the total loss incurred by farmers. The surveyed smallholder households in this village produced a total of 69 quintals of paddy and 6,200 bundles of paddy-straw. Forty per cent of paddy straw was kept for household use, the rest of it was sold, and 60 per cent of paddy was traded with the local traders. The local traders procured paddy from the field and bore all expenditure on transportation, loading/unloading and packing.

Fifteen smallholder agricultural households were interviewed in Kharbhaiya village, who cultivated 16.3 ha land for paddy during the 2017–18 season. They all used tube-well and pit-water for irrigation using diesel operated engines. Almost every agricultural plot has a nearby pit that collects rainwater, which is the main source for irrigation in the village. In the absence of rain, households use tube-well. Only 27 per cent of the surveyed smallholder agricultural households could access the public procurement agencies in the village, which was the PACS. The surveyed households cultivated long and short grain non-Basmati varieties. In this village, 56 per cent of the total surveyed area was leased-in land. They sold 59 per cent of total paddy to the local traders. The local traders procured paddy from the field. After that they packed and transported paddy to different wholesale markets. The rice millers do not procure directly from the wholesalers but through agents. The agents fix a deal between wholesalers and rice millers; in return, the they get half per cent of the value of trade from the rice millers and the same amount from the wholesalers.

## 8.5 OPERATIONS OF THE PACS IN BIHAR

It is difficult to negate the importance of public institutional support in ensuring remunerative prices for agricultural produce. According to the Bihar government, the channel of the PACS is a better alternative for public procurement than APMC. The PACS are primarily village level cooperative credit institutions in India. The marketing of agricultural products is one of the important functions of PACS in the case of Bihar. The PACS has the right to collect food grains from the members of the society from where

Table 8.7 Production and Public Procurement of Rice in Bihar

| Year | Production ('000 tons) | Public Procurement ('000 ton) |
|---|---|---|
| 2012–13 | 7529 | 682 |
| 2013–14 | 5506 | 942 |
| 2014–15 | 6357 | 1614 |
| 2015–16 | 6802 | 1223 |
| 2016–17 | 8239 | 1234 |
| 2017–18 | 8039 | 793 |
| 2018–19 | 6156 | 949 |
| 2019–20 | 7129 | 1182 |

*Source:* Directorate of Economics and Statistics, Department of Food and Public Distribution, Govt. of India (https://bit.ly/35Iludm)

the state and central agencies procure and pay. The PACS has its own drawbacks, with delayed payments, slow procurement and a severe scarcity of readily available storage facilities (Singh, 2015). Moreover, a significant portion of households dependent on agriculture in Bihar, who are landless, cannot be members of PACS and there is a limited possibility for them to sell their produce to PACS (Government of Bihar, 2017–2018). Even with the presence of PACS, public procurement of agricultural produce is quite negligible in the state. As Table 8.7 indicates, between 2012–13 and 2019–20, the procurement by the public agencies in the State was not more than 15 per cent of the total production. This is in stark contrast to states like Punjab and Haryana, where the share in public procurement is at least 70–80 per cent (Kumar, 2021).

Given the limited public procurement, small and marginal landholders are on the receiving end. Sales options are very limited for the vast majority of farmers, who hold 97 per cent of the total landholdings in Bihar, mainly because of the inaccessible formal market system or negligible public procurement. Under various compulsions and urgent need of cash money, farmers in general, and small-marginal farmers in particular, sell their produce at less than remunerative price to nearest available traders. In this situation, a well-functioning PACS can help farmers to get the

Table 8.8 Number of Societies and Farmers Selected for Public Procurement in Bihar

| Year | Crop | No. of Societies (PACS + Vyapar Mandal) | No. of Farmers |
|---|---|---|---|
| 2019–20 | Paddy | 6221 | 279440 |
| 2020–21 | Wheat | 4391 | 980 |

*Source:* Cooperative Department, Government of Bihar, http://epacs.bih.nic.in/MIS/Default.aspx.

remunerative price. According to the cooperative department of Bihar Government, in 2019–20, paddy was procured from 2.8 lakh farmers in Bihar through 6,221 PACS and Vyapar Mandals (Table 8.8). The situation of wheat procurement is worse than that for paddy; in 2020–21, public agencies procured wheat from 980 farmers through 4,391 societies. Considering the fact that the total number of PACS in Bihar is 8,463,[6] the number of societies selected for public procurement is not sufficient to cover all villages in the state.

The Food Corporation of India provides information on the number of farmers who benefited from public procurement. It is found that the total number of farmers in Bihar who benefited from public procurement of paddy is between two and four per cent of the total beneficiary at all-India level. In the case of wheat, the share of Bihar farmers is close to zero in most years or 0.1 per cent of the total beneficiary in India. It is noteworthy that between 2019–20 and 2020–21, the number of farmers benefiting from paddy procurement increased in Bihar from 2.8 lakh to 5 lakh (Table 8.9). However, the increased numbers are still very small and account for close to 7 per cent of Bihar's total 70 lakh agricultural households. In contrast, the number of beneficiary farmers from paddy procurement at the all-India level is close to 14 per cent of total agricultural households. This is also consistent with the satisfaction level discussed earlier in this chapter. Across India, 59 per cent of paddy farmers and 66 per cent of wheat farmers who reported the sale of the crop said they were satisfied with the sale, while in Bihar's case the share was 41 and 51 per cent, respectively.

Table 8.9 Number of Farmers who Benefited from Public Procurement in Bihar and All India

| Year | Bihar | | All India | |
|---|---|---|---|---|
| | Paddy | Wheat | Paddy | Wheat |
| 2016–17 | 287830 | 0 | 7685168 | 2046766 |
| 2017–18 | 163425 | 0 | 7230859 | 3187229 |
| 2018–19 | 210028 | 3128 | 9693641 | 4033463 |
| 2019–20 | 279402 | 554 | 12459354 | 3557080 |
| 2020–21 | 497097 | 1002 | 13112282 | 4335972 |

*Source:* Food Corporation of India, http://fci.gov.in/app/webroot/upload/Procurement/No%20of%20farmers%20benfited_7.pdf

Table 8.10 Share of Farmers who Sold Crops to Public Procurement Agencies in Bihar (%)

| Year | Satisfied | Not Satisfied Due to Delayed Paymenta | Not Satisfied Due to Other Reasons |
|---|---|---|---|
| 2012–13 | 79.5 | 18.4 | 2.1 |
| 2018–19 | 51.3 | 48 | 0.7 |

*Source:* NSS 70th and 77th Rounds.

Apart from very small coverage of public procurement in Bihar, the delay in payment is another concern associated with it. Of the total number of farmers who sold crops to public procurement agencies, the majority were satisfied and those who were dissatisfied cited delay in payment as the main reason. Between 2012–13 and 2018–19, the proportion of dissatisfied farmers increased from 18 per cent to 48 per cent (Table 8.10), indicating the severity of delays in payments.

## 8.6 WAY FORWARD

The possibility to increase the farmers' earnings in Bihar through intervention in the backward linkages faces constraints of peculiar land relations, infrastructure and inadequate investment. A significant portion of agricultural land in Bihar is under tenancy agreements, which, being a politically sensitive matter, remains invisible in official records. However, the invisibility of an important land relation in the state is not enough to hide the fact that a part of the earnings from agriculture goes to the owner of the land, which inhibits the development of agriculture. Therefore, recognising the existence of tenancy in Bihar can be a small step towards solving the continuing agricultural crisis in the state.

In addition, some components of the cost of production in Bihar are higher than in any other state in India, such as irrigation charges, rent of hired machines, etc. The cost of irrigation alone accounts for about ten per cent of the total cost in Bihar, which is clearly a major consequence of the extinction of the public irrigation system in the state, to a great extent. Above all, withdrawal of subsidy from diesel, non-availability of other state support for irrigation, etc., are other contributing factors, due to which irrigation charges are burdened on farmers' income in Bihar. Moreover, due to low income from agriculture, most of the farmers in Bihar compromise with the quantity or quality of other inputs used in cultivation, such as fertilisers, seed varieties, agro-chemicals, updated technical support, etc., which, on the one hand, reduces the total cost but, on the other hand, decreases the total yield of the crop.

In the AVS of Bihar, though farmers have many options to sell their crops, in recent years, most of the farmers are dependent on local private traders. This is in line with the fact that after the repeal of the APMC Act in Bihar, the expected private investment in building market infrastructure did not materialise. Moreover, public procurement of crops in Bihar remained negligible as compared to the national average. The combination of these facts led to a situation where prices realised by farmers in Bihar were mostly less than the remunerative price or national average price. Primary investigations revealed that the farmers' per-unit earnings for a crop are lower than other actors of the value system or, in some cases, farmers suffer losses while other actors make profits (Kumar, 2021).

In the prevailing situation, PACS can be considered as affirmative action in the AVS of Bihar. However, despite having a large membership base, PACS do not cover more than seven per cent of the total agricultural households in Bihar, as far as procurement of crops is concerned. Even the maximum coverage of seven per cent is only for paddy and that too for one year in the last five years; otherwise, the number of the beneficiaries of public procurement in Bihar is very less. Farmers who sell crops to government procurement agencies in Bihar are generally satisfied with the price and the only reason for their discontent is the delay in payment. In sum, the existing policy framework has not benefited the farmers; on the contrary, it has increased their hardships and has created a vacuum, especially in the marketing structure. Nevertheless, the PACS in Bihar has the potential to bridge this gap, but that would require overhauling to address the above-mentioned shortcomings.

## NOTES

1. This is discussed in detail in the next part of this chapter.
2. https://agcensus.dacnet.nic.in/
3. https://eands.dacnet.nic.in/Cost_of_Cultivation.htm
4. https://fci.gov.in/procurements.php?view=89
5. https://www.hindustantimes.com/interactives/bihar-floods-2017/
6. https://www.rbi.org.in/scripts/PublicationsView.aspx?id=20968

## REFERENCES


Bandyopadhyay, D. (2009). Lost opportunity in Bihar. *Economic and Political Weekly, 44*(47), 12–14.

Government of Bihar. (2017–2018). *पैक्सों में ऑनलाइन सदस्य बनाने हेतु प्रक्रिया का प्रस्तुतीकरण*. Cooperative Department.

Himanshu. (2019, April 12). *India's farm crisis: Decades old and with deep roots*. Ideas for India. https://www.ideasforindia.in/topics/agriculture/indias-farm-crisis-decades-old-and-with-deep-roots.html

Jha, P. (1997). *Changing conditions of agricultural labourers in post-independent India: A case study from Bihar*. Jawaharlal Nehru University.

Jha, P., Verma, S., & Kumar, M. (2021). Contours of food security challenges in neo-liberal India, in Lima Thiago & Agostina Costantino (Eds.). *Food security and international relations: Critical perspectives from the global south*, ibidem-Verlag, Stuttgart, 27–59.

Kishore, A. (2004). Understanding agrarian impasse in Bihar. *Economic and Political Weekly, 39*(31), 3484–3491.

Kumar, M. (2019). India's rice export: What is in it for farmers? *Agrarian South: Journal of Political Economy, 8*(1/2), 136–171.

Kumar, M. (2021). Experiences from Bihar: The government's retreat from agricultural policy. *Economic and Political Weekly, 56*(4), 17–19.

NSS, 2021. *Situation assessment of agricultural households and land and livestock holdings of households in rural India*, 2019. Report No. 587. Ministry of Statistics and Programme Implementation, National Statistical Office, Government of India.

Patnaik, U. (1999). EMS on the agrarian question: Ground rent and its implications. *Social Scientist, 27*(9/10), 51–64.

Rawal, V., Patel S., & Pais J. P. (2020a). The political economy of agricultural market reforms: An analysis of the farmers' produce trade and commerce (Promotion and Facilitation) Act, 2020 (SSER Monograph 20/4), Society for Social and Economic Research, New Delhi.

Rawal, V., Kumar, M., Verma, A., & Pais, J. (2020b). COVID-19 lock-down: Impact on agriculture and rural economy. *Social Scientist, 48*(3–6), 67–82.

Shah, M. (2016). Eliminating poverty in Bihar: Paradoxes, bottlenecks and solutions. *Economic and Political Weekly, 51*(6), 56–65.

Sharma, A. N., & Rodgers, G. (2015). Structural change in Bihar's rural economy findings from a longitudinal study. *Economic and Political Weekly, 50*(52), 45–53

Singh, S. (2015, February 8). APMCs: The other side of the story. *Hindu Business Line*.

Thakur, M. (2013). Land question in Bihar: Madhubani as a metaphor. *Economic and Political Weekly*, *48*(19), 19–21.

CHAPTER 9

# FARMER PRODUCER ORGANISATIONS FOR TRANSFORMING AGRICULTURAL MARKETING

*Sunil Kumar*

## 9.1 BACKGROUND

The declining average size of land holdings and low business participation of the producers in the prevailing agriculture value chain are the main reasons for agrarian distress all over the country in general and Bihar in particular. It is expected that the average size of land holdings will reduce further with time. The average size of land holdings at the all-India level is barely 1.08 ha, which in Bihar is a paltry 0.39 ha and it has been reducing further in case of small and marginal farmers who account for about 97 per cent of all farmers in Bihar. Such farmers face difficulty in adoption of modern farming methods due to lack of viability. Further, they are unable to hold produce to take advantage of price movements due to lack of farm-level storage infrastructure. Resultantly, the volume of marketable surplus is very low. This leads to poor or no bargaining power with small and marginal farmers in fetching favourable prices for their produce as well as in procurement of inputs at a reasonable cost. In this situation, the farm gate prices received by the farmers range between one-fourth to one-third of the prices paid by the end-consumers. Manipulated price, default payment, unscientific weighing technique by the organised value chain actors further deepened the reduction of economic rent of the producers. The problem gets magnified further due to the presence of a long marketing chain as also a large number of middlemen between the producer and the end-consumer.

Now, the challenge before the small holders is how the economic rent can be enhanced through development of an institutional model that reduces their marketing cost and enhances marketing margins across the agricultural value chains. This necessitated organising the farmers into a collective institutional arrangement, namely, a Farmer Producer Organisation (FPO) to facilitate aggregation of their produce for collective marketing. It is expected that collectivisation will help in improving the scale of operation through collectivisation/aggregation leading to improved access to the market for better price realisation for outputs. It will also enhance the bargaining power of the small farmers to negotiate for better prices for their inputs.

Various organisational forms of collective enterprises have been promoted at different times in India, the oldest formal collectives being credit and non-credit cooperatives. Based on the recommendations of the 'High Powered Committee' under the Chairmanship of Dr Y. K. Alagh, the concept of Producer Companies (PCs) was adopted in 2002, and the Companies Act of 1956 was amended allowing for a new form of corporate entity, namely, PCs having features of both cooperatives and corporates.

## 9.2 INSTITUTIONAL DEVELOPMENT MODEL OF FARMER PRODUCER ORGANISATIONS/FARMER PRODUCER COMPANIES

A farmer producer company (FPC) is a hybrid between cooperative societies and private limited companies having desirable aspects of both cooperatives and corporates, namely, equal rights to members irrespective of the number of shares held, professionalism and governance standard of corporates, etc. The main objective of the FPOs/FPCs is to organize primary producers/farmers into a collective to improve their bargaining strength in the market.

As regards the organisational structure and functioning of the FPCs, the following points may be noted: (i) An FPC can be formed by any 10 or more primary producers or by two or more producer institutions, or by a combination of both; (ii) FPC can undertake activities related to production, harvesting, procurement, grading, pooling, marketing, processing, etc., of agricultural produce; (iii) It has democratic governance set up with each producer or member having equal voting rights irrespective of the number of shares held; (iv) The board of directors having 5–15 directors are responsible for running the FPC, and expert directors can be co-opted for professional guidance; (v) The FPC is managed by a professional CEO and is expected to operate purely as a business entity; (vi) Apart from being a producer company, an FPO can also be registered as a cooperative, society or a trust; (vii) Non-producers seeking to invest in these companies as shareholders are precluded under the statute concerned and (viii) Profit is largely distributed on the basis of 'patronage', which acts as a reward for members contributing to the business of the producer company.

## 9.3 BUSINESS MODELS OF FPOs

Analysis of the prevailing agri and agri-allied value chains of major commodities/sectors revealed that there is ample scope, potential, prospects and opportunities in agri-value chains. Enhancement of production and productivity of major agricultural produce is warranted to fulfil increasing demand. However, farmers are not getting a respectable amount of share in sale proceeds despite bearing maximum risk and incremental input cost. To protect the interest of the farmers, there is a need for the welfare state to create a facilitating institutional framework and appropriate business environment. In this process, the farmers would undertake business participation as agri-value chain actors in the existing agri-value chain through establishment of commercial agri-business enterprises.

The basic strategies for commercial agri-business model evolved around aggregation of three components, namely, agri-input, agri-support and agri-sale. A graphical display of such a model is provided in Figure 9.1.

Enhancement of 'economic rent' may be possible through more and more business participation of the producers in

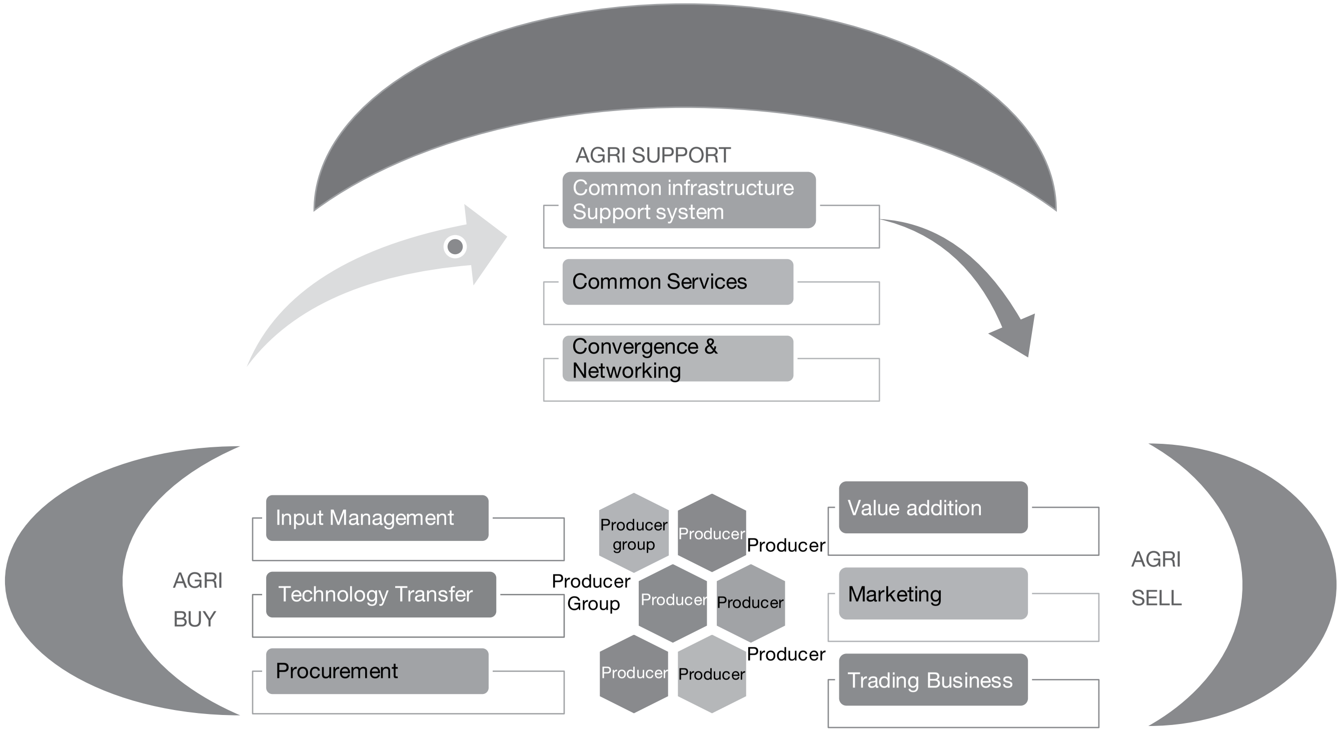



Figure 9.1 Commercial Agri-business Model

*Source:* Model conceptualised by Shri Rajesh Yadav, Faculty Member, Bankers' Institute of Rural Development, Lucknow.

aggregation and collectivisation of the individual resources, production and marketing in a given institutional framework. One or multiple approaches of aggregations, depending upon the available resources, potential and prospects and enabling environment, can be undertaken by FPO which are: (i) participation to fulfil technological gap (to enhance production and productivity); (b) business participation in input management (aggregation of inputs); (iii) business participation in primary/secondary processing (value addition); (iv) business participation in marketing (collective marketing); (v) business participation in trading business during the lean period of the agricultural operation and (vi) export business.

### 9.3.1 Scope of Business for FPOs

More and more resources and capability of the FPO are required to initiate participation on the downstream of the agri-value chains along with increasing risk. Hence, the FPO is often suggested to undertake stepping in business participation gradually. Illustrative steeping business operation is as follows:

- Aggregation of inputs (input business)
- Collective marketing (procurement and marketing on MSP/ tie-up with retail chain)
- Value addition (primary/secondary/tertiary—processing)
- Collective marketing (open market operation)
- Trading (buying and selling of agri-produce of non-producer member)
- Export (supplying to an exporting agency/tie-up with an importer from foreign country)
- Future trading (participation through commodity exchange like NCDEX for risk management and taking benefit of price movements)

It is observed that the FPO is the *Growth Engine of Indian Agriculture System* and economic rent of the producer can be enhanced by establishment and sustainable operations of this hybrid cooperative system in a given environment framework.

### 9.3.2 Benefits Envisaged from FPOs

Some of the important benefits of collectivisation of farmers into FPOs are: (i) Increased scale of operation by bringing together the business activities of small-scale producers/farmers; (ii) Improved access to market through collectivisation/aggregation of agricultural produce. Also, processing of large quantity of produce enables the FPO to access higher value markets and realise better price at a later stage; (iii) Increased bargaining power by collective action of small/marginal producers enabling them to negotiate better price and (iv) Improved access to services by means of dealing with a bigger group which reduces transaction costs.

Above all, it is expected that the FPCs would enable small producers to pool their resources and establish inclusive businesses benefiting small farmers in enhancing their incomes and reducing risks. As member-based institutions, they would be inherently embedded in local communities and have the potential to become strong local institutions of marginalized producers (Govil et al., 2020).

## 9.4 STATUS OF FPOs IN BIHAR

Recognizing the strength of producer organisations, NABARD decided to support these organisations and created a dedicated Producers Organization Development Fund (PODF) in 2011, followed by creation of 'Producers Organization Development and Upliftment Corpus' (PRODUCE) by the Government of India (GoI) in 2014 for which the NABARD was entrusted to promote 2,000 FPOs all over the country. As a result of promotional assistance from NABARD as well as other organisations such as SFAC, NCDC, NAFED, state government departments, etc., approximately 7,500 FPOs in the country (of which 728 are in Bihar) have been established till 31st March 2021. At present, these FPOs are at various stages of evolution and engaged in a wide range of activities such as bulk procurement of inputs, aggregation of farm produce, value-addition, collective marketing and so on.

Of the FPOs formed in Bihar, about 95 per cent are engaged in agriculture-related activities and 62 per cent of them have registered during the last three years. It is interesting to note that almost 40 per cent of these FPCs are concentrated in 6 districts, namely Patna, Vaishali, Samastipur, Muzaffarpur, Nalanda and East Champaran.

Having observed the benefits accrued from these institutional arrangements and changes brought about in the life of primary producers, the GoI launched a dedicated Central Sector Scheme, namely, 'Formation and Promotion of 10,000 FPOs', in 2020 with the aim of supporting 10,000 FPOs in the country in next five years.

As far as NABARD's contribution towards promotion of FPOs in Bihar is concerned, it may be noted that it has so far promoted 353 FPOs in Bihar, out of which 235 FPOs are registered as Producer Company and 2 are registered under State Cooperative Society Act. Some information relating to the present status of 205 FPOs in Bihar that registered till 31 March 2021 is presented in Table 9.1.

It may further be noted that 24 FPOs in Bihar have obtained Equity Grant Support from SFAC so far. Eleven FPOs have been credit-linked. Six FPOs have been extended credit by NABKISAN, a subsidiary of NABARD. Twenty FPOs have obtained licenses for selling seeds, pesticides and fertilizers

Table 9.1 Status of FPOs formed by NABARD in Bihar (as on 31 March 2021)

| *Particulars* | *PODF* | *PRODUCE* | *Total* |
|---|---|---|---|
| No. of FPOs registered | 84 | 121 | 205 |
| No. of districts covered | 27 | 32 | 32 |
| No. of villages covered | 702 | 1943 | 2645 |
| Total membership | 15408 | 42431 | 57839 |
| No. of female members | 4151 | 20965 | 25116 |
| No. of small & marginal farmers | 12264 | 42328 | 54592 |
| No. of SC/ST members | 3963 | 13265 | 17228 |

*Note:* PODF = Producers Organisation Development Fund and PRODUCE = Producers Organisation Development and Upliftment Corpus

*Source:* NABARD, Patna

from the concerned departments. The average number of shareholders per FPO has been 295, and the number of memberships exceeded 500 for 40 FPOs. The average share capital of the FPOs stands at Rs 2.48 lakh, and 12 FPOs have share capital of more than Rs. 10 lakh, this has been between Rs. 5 and 10 lakhs for 25 FPOs and for remaining it is less than Rs. 5 lakh. The average turnover is found to be Rs 4.46 lakh; for 3 FPOs, this was more than Rs. 1 crore; for 11 FPOs between Rs 25 and 50 lakh; for 12 between Rs 11 and 25 lakh; and for remaining between Rs 01 and 10 lakh. Ten FPOs have obtained licenses from the state government for marketing certified seeds.

## 9.5 ISSUES AND CHALLENGES FACED BY THE FPOs

A significant number of FPOs seem to have provided benefit to their member-producers in real terms by facilitating better than market prices for commodities, inputs at reduced costs and reduced transaction costs, etc. A recent study conducted by Tata Cornell Institute (Roy & Joshi, 2020) on FPOs in Bihar observed a difference of almost 14 per cent in the average monthly incomes of the FPO members and non-FPO members.

A research study sponsored by NABARD and conducted by Centre for Research in Rural and Industrial Development (CRRID), Chandigarh (Verma, 2018), on the benefits of FPOs in Punjab and Madhya Pradesh shows that in nascent FPOs, the proportion of farmer members contributing to FPOs activities is 20–30 per cent while for the emerging and mature FPOs it is higher at about 40–50 per cent. An evaluation study conducted by NABARD to understand the economic and social impact of FPO membership on farmers in the four states, namely, Kerala, Madhya Pradesh, Odisha and Rajasthan (NABARD, 2021) found that the average price received by the farmers who are members of FPO has increased in the range of 7.5–45 per cent and their incomes increased in the range of 13.5–25 per cent. Further, such farmers reported a reduction in dependence on informal sources of credit.

Another recent study conducted by the Bankers' Institute of Rural Development (BIRD), Lucknow (Pande et al., 2021), on FPOs in Uttar Pradesh and Bihar pointed out that though the FPOs themselves operated on a thin margin, their business interventions generated substantial net incremental financial benefits for their farmer-members due to saving in input cost, gains in productivity due to better quality inputs and scientific production practices, minimizing losses due to transparent marketing practices with FPOs acting as market aggregators, processors of produce, discoverers of better price in local markets for aggregated produce, etc. The extent of financial gains accrued to farmer-members due to FPO interventions ranged from the modest level of 7.5 per cent to as high as 23.4 percent. Overall, the study validated that the concept of FPO is a potentially vibrant umbrella business organisation for the small and marginal farmers.

However, the FPOs in Bihar are facing many challenges: (i) The FPO ecosystem in the state is in a very nascent stage; (ii) Disaggregated efforts put in by different agencies and lack of coordination among them to promote in the state; (iii) Inadequate enrolment of members and access to capital that have constrained their business volumes; (iv) Inadequacy of professional management and quality manpower; (v) Weak financial base; (vi) Inadequate access to credit from institutional sources; (vii) Absence of a clear business plan; (viii) Lack of technical skills; (ix) Lack of risk mitigation mechanism; and (x) Inadequate access to market and infrastructure. It is necessary to address all these challenges for development of a robust FPO ecosystem in Bihar.

## 9.6 WAY FORWARD

The FPOs need to adopt a combination of strategies for increasing membership, generating business volumes, expanding its marketing activities beyond local markets, dealing in multiple commodities and allied produce, planning interventions at different stages of commodity value chains, encouraging adoption of better technologies, accessing capital and financial resources for business expansion, undertaking primary/secondary processing of local produce, manufacturing key farm-related inputs locally, enhancing their role in agri-markets for preventing exploitative marketing practices, etc., for better price discovery/realisation to member-farmers for improving financial viability of FPO operations.

Different FPOs participated at different stages of the supply/value chains and their business activities covered agri-input marketing, technology improvement, aggregated marketing of produce, contract marketing with vendors, agency for government procurement at MSP, etc. These FPOs, however, need to upscale the size and area of their operations for profit maximization.

The FPOs have so far not been able to play an effective role as secondary processors, where the operating margins are generally high. They have restricted themselves to the role of primary processor, and mostly aggregators. Therefore, FPOs were operating with modest turnovers on thin margins, underlining the need to expand the operations, improve efficiency, adopt technology and access finance. The banks/financial institutions also need to design suitable products for lending to the FPOs as getting credit remained as one of the challenges before the FPOs.

Some studies have pointed out that more than one lakh FPOs are needed for a large country like India while we currently have less than 10,000. Similarly, there is a requirement of about 10,000 FPOs in Bihar keeping in view the preponderance of small and marginal farmers in Bihar. The formation of new FPOs needs to be supplemented with the removal of the existing bottlenecks in the transition of FPOs from the nascent stage to a mature one. The issues such as working capital, marketing and infrastructure need to be addressed while scaling up FPOs.

The FPOs need to chalk out business strategies to address the problems faced by the members and maximise net financial returns to them by taking up wide range of pre-harvest activities (e.g., farm inputs supply, variety/breed/technology up-gradation, feed/seed supply, etc.) and/or post-harvest operations (aggregation of produce, processing and marketing, pre-contract pricing with local traders, transparent market practices to prevent exploitation of farmers, etc.). It is necessary that the government considers FPOs as agri start-ups as defined in Startup India Scheme and all the benefits provided to agri start-ups need to extend to FPOs also.

## 9.7 CONCLUSION AND SUGGESTION

In conclusion, it can be said that FPOs have emerged as an important institutional mechanism to organise small and marginal farmers. The aggregation of small and marginal farmers helps to overcome the constraint of small size. The small and marginal farmers gain greater bargaining power through FPOs in relation to the purchase of inputs, obtaining credit and selling the produce which will help in improving their incomes. To promote formation of more FPOs, the state government may consider extending revolving seed capital support in the initial phase of FPO, especially for input business, and subsequently support credit access through credit guarantee, interest subvention, etc. It is estimated that nearly 25–30 per cent of farmers in Bihar are sharecroppers. A special initiative may be taken by the state government to form Joint Liability Groups of these sharecroppers and then federate them into FPOs.

There is a need for an institutional mechanism with a dedicated nodal agency at the state level for FPO promotion, capacity building, technical training, grievance redressal, etc. It is also necessary to extend/introduce a scheme for FPOs for facilitation in input license, agri exports, infrastructure creation for processing and value addition, and procurement of paddy/wheat through FPOs at par with Primary Agricultural Credit Society (PACS). Past experience of implementing various developmental initiatives underlines that participation and patronage of the state government is of utmost importance for success of the development initiative. For instance, the success of JEEVIKA in Bihar is largely attributed to the patronage from the state government. So, there is a need for a state FPO policy to provide broad direction for emergence of a robust FPO ecosystem in Bihar. This will lead to holistic development of FPOs not only in their initial stages of life cycle but also when they graduate into full-fledged business organisations.

The state government may issue notification declaring FPOs at par with cooperatives. There should be enabling provisions for engagement of FPOs as procurement units (at par with PACS) so that FPOs get an additional source of income. As lack of proper business plan emphasising the business potential is a hindrance in mobilisation of members of FPOs, the state government may rope in management institutes operating in the state and offering rural management course to prepare the business plan for FPOs, which will not only help the management of the FPOs but also help farmers in taking informed decision to become shareholders of FPOs. A focused approach is required for development of the FPO ecosystem, and identification of clusters is an important task. Cluster identification will help in promoting specific products, branding and generating enough marketable surplus for marketing. Further, a dedicated digital platform for networking of existing/newly formed FPOs, may be developed for exchange of market information, innovation, best practices intra-marketing of each other's produce, etc. It is suggested that the state government promotes 'FPO federation' at the state level for this purpose.

It is hoped that with implementation of some of these suggestions, the FPOs will be able to bring a transformative effect on the agriculture sector in Bihar and it will be possible to achieve a significant increase in farmers' income in the state.

## REFERENCES


Govil, R., Neti, A., & Rao, M. R. (2020). *Farmer producer companies: Past, present and future*. Project Report, Azim Premji University.

NABARD. (2021). *Annual report 2020–21*. National Bank for Agriculture and Rural Development.

Pande, S. A., Arya, V., Kumar, N., & Yadav, R. (2021). *Study on farmer producer organisation: Empirical evidence for business opportunities, sustainability and value proposition for members in Eastern Uttar Pradesh and Bihar*. Bankers' Institute of Rural Development (BIRD).

Roy, D., & Joshi P. K. (2020). *Comparative study of farmer producer organisations of Bihar and Maharashtra*. Tata Cornell Institute.

Verma, S. (2018). *Farmer producer organisation and agri-marketing: Experience, relevance and their performance in Punjab*. Centre for Research in Rural and Industrial Development.

# CHAPTER 10

# CONTRACT FARMING AND AGRICULTURAL PRODUCTIVITY

*Deepak Kumar Behera and Maryam Sabreen*

## 10.1 INTRODUCTION

Contract farming (CF), an institutional arrangement between different actors (farmers, firms, consumers and others) involved in agricultural sector, has been seen to increase productivity, particularly for the small farmers. It organizes the agricultural production in such a way that farmers are obliged to supply their produce to the agro-enterprises through a forward contract, resolve the problems caused by market failures and thereby increase the agricultural productivity and profits (Key & Rusten, 1999; Eaton & Shepperd, 2001; Singh, 2002; Simmons et al., 2005; Mishra et al., 2018). Recognizing its potential benefits, both the central and state governments in India have undertaken different policy measures to promote CF to enhance agricultural productivity and farmers' income. As a sizable part of the farming community falls in the small and marginal farmers category in India, CF, therefore, becomes important as it allows their agricultural produce to be purchased by agro-processing firms. CF suggests that agro-processing firms provide inputs, improved technology, better methods of cultivation and management practices to procure desired quality and quantity of products for meeting the consumers' choice and demand.

In the literature, it has been observed that CF would increase farmers' efficiency either through exploiting economies of scale or providing better knowledge and inputs that would not be otherwise available in the open market. The contract production turns efficient when the farmer's costs of production are reduced or when the maximum output is produced with limited resources. The efficiency of the CF could be evaluated by comparing the production costs or outputs of the contract and non-contract farmers. Costs in contract production could be lower than in non-contract production in two ways. First, because of better technology and management practices brought in by the firm, the production cost is reduced and efficiency increases compared to the non-contact mode. Secondly, the processing firms buy inputs in large quantities at a lower cost and transfer those to the farmers. Contract production becomes cheaper than non-contract production, even if production efficiency is unchanged. Ramaswami et al. (2005) observed that contract production is more efficient than non-contract production due to the lower cost paid for inputs by the contract farmers. In the contract mode of production, the contractor facilitates production by providing credit, better technology and inputs, thus reducing the risks of market imperfection. Thus, CF relieves farmers from input constraints and enables them to apply inputs at an optimal level.

Some empirical studies examined the farm productivity and efficiency of a farmer under contract production. While some studies observed a close link (positive impact) between CF and farm productivity, others did not find any such link. Kumar (2006) found no difference in farm productivity between contract and non-contract farmers while studying the CF of tomatoes and potatoes in Punjab. On the other hand, Ramaswami et al. (2005) found that the contract farmers were more productive and efficient than their non-contract counterparts due to the lower feed conservation ratio. Chang et al. (2006) found a positive relationship between farm size and profit among contract farmers while studying rice contract production in Taiwan, implying that the profit of a contract farmer is highly correlated with the acreage devoted to the contract.

In the study of hog farming in the USA, Key and William (2003) found that contract farmers were more productive compared to non-contract farmers even after correcting for sample selection bias. They explained this productivity difference in terms of the better technology and management used by contract farmers. Further, by estimating the marginal value of the product and marginal factor cost (MFC), Dileep et al. (2002) observed that tomato contract farmers used resources more efficiently than non-contract ones. By comparing the technical efficiency of contract and non-contract cultivators of HYV paddy and ginger in Nepal, Mishra et al. (2018) observed that entering into the contract mode of production helped farmers to achieve higher technical efficiency by a 7-point level in the case of HYV paddy and 8-point level in case of ginger cultivation. The survey by Nguyen et al. (2018) on CF of tea production in Vietnam revealed that technical efficiency among contract farmers is higher by 5 per cent compared to non-contract farmers. The study of Khan et al. (2019) on the land productivity of potato and maize growers in Pakistan revealed the productivity differences between contract and non-contract farmers. They found that land productivity has increased due to CF and encouraged the farmers to shift from low to high-value-added crop varieties. Dubbert's (2019) study on labour productivity under contract mode of production revealed that participation in CF significantly increases the labour productivity and price margin of growing cashew in Ghana.

The study on farmers' efficiency under CF has not received much research attention in India, especially in the case of Bihar. Further, most studies conducted elsewhere didn't pointedly examine the allocative and technical efficiencies across different farmer groups. Hence, an inquiry into whether CF increases farm-level efficiency that may help raise the incomes of the farmers in a state like Bihar, which is plagued with problems relating to the marketing of crops following the repeal of the APMC Act in 2006, becomes essential. To be more specific, we focus on Bihar for the reasons that the state government has been promoting CF for the last decade or so to improve the plight of the farmers, and although the contract mode of production has spread in some regions of the state,[1] enough research attention has not been paid to examine its efficacy.

In the above context, this chapter addresses the following questions: (i) What are the determinants of farmers' participation in CF? (ii) Does CF improve the productivity and efficiency (technical and allocative) of contract farmers? and (iii) If it does, what are the factors that encourage the farmers to attain higher efficiency under CF?

## 10.2 DATA AND METHODOLOGY

This study is based on the primary data collected during 2017–18 from the Nalanda district of Bihar, located in the eastern part of India. Nalanda district was selected because of the high prevalence of CF in vegetable cultivation, particularly green chilli. The data were collected from 600 farm households (contract plus non-contract). We used a well-structured questionnaire to collect information on farmers' characteristics, cropping patterns, market linkages, price, inputs used, output level and socio-economic variables of both contract and non-contract farmers, etc. Out of the 600 households, 350 households are involved in CF, and 250 households are not in CF. However, 320 contract farm households and 250 non-contract farm households were taken into consideration for the efficiency analysis. The rest of the farming households were not considered due to poor data quality.

Multistage sampling techniques like purposive and stratified random sampling methods were adopted to identify the contract and non-contract farmers. At the first stage, we identified a Farmer Producer Organisation (FPO). The second stage involved a stratified random sampling method to select villages where CF is being practiced based on the prior information provided by the FPO. The list of farmers engaged in the contract production of green chilli in the villages has been collected from FPO's record. Then, both the contract and non-contract farmers were selected randomly from four villages. These farmers possess similar cropping patterns. In our study areas, there was a tri-tripartite contract among the farmers, FPO and an agro-processing firm (named Khistiz Agro Tech). The agro-processing firm and FPO are engaged in a formal written contract with farmers to supply green chilli. The NABARD facilitates farmers with credit through FPO to grow green chilli. The processing firm provides inputs such as improved seeds, pesticides and the method of cultivation for production to the farmers. Therefore, the CF in our study areas involved vertical integration within the agricultural commodity chain, wherein the processing firm enjoyed greater control over the production process and final product. The farmers sell their output to the processing firm through FPO. The details about the contract between the contract farmers and the processing firm are provided in Table 10.1.

### 10.2.1 Variables Construction

The output is taken as the total output (in quintal) produced in the reporting season. Labour is measured as the number of man-days (family plus hired) used for growing the crop. Power is the total amount (in ₹) spent for both animal and mechanical power (tractor) for land preparation and other activities. Chemicals and manures include the total value (in ₹) of fertilizers, pesticides and manures. The seed includes the total seed cost (in ₹). Table 10.2 reports the mean levels of inputs and output from green chilli production by the contract and non-contract farmers. It is observed that there is some difference in utilisation of chemical inputs and labour between contract and non-contract farmers. While the former has been spending more on chemical inputs, the latter has been using more labour. Further, the non-contract farmers are spending more on land preparation compared to contract farmers. It is also found

Table 10.1 Terms of Contract Between Farmers and Processing Firm

| *Input Supply Mechanism* | *Output Procurement Mechanism* |
|---|---|
| i. Supply of improved variety of seeds on credit | i. Price of the output is based on the market price |
| ii. Extension service on improved cultivation practice and post-harvest management | ii. Farmer has to bring the output to the selling point |
| | iii. No procurement of substandard product |
| iii. No supply of fertilizers | iv. The cost of pesticides and others is adjusted in the final price received by the farmers |
| iv. Supply of pesticides on credit | |
| v. Credit facilities through NABARD | v. Farmer has to sort/grade the green chilli before supplying |
| | vi. Payment made after seven days through their bank account |

*Source:* Field Survey.

Table 10.2 Mean Levels of Inputs Used and Output for Contract and Non-contract Farmers

| *Variables* | *Contract Farmers* | *Non-contract Farmers* |
|---|---|---|
| Area under green chilli (in acre) | 0.25 | 0.15 |
| Production (quintal/acre) | 230.68 | 226.36 |
| Land preparation cost (₹/acre) | 3835.48 | 5121.2 |
| Seed cost (₹/acre) | 9422.01 | 9248.17 |
| Chemicals (fertilizers, pesticides, and manures) cost (₹/acre) | 9998 | 6907.71 |
| Labour (man-days/acre) | 56.62 | 59.53 |

*Source:* Field Survey

that the yield level is higher for the contract farmers compared to the non-contract ones.

Using the primary data, we estimated a probit model to identify some determinants of the probability of participation in CF against non-participation. We have also estimated the stochastic frontier model to measure the technical efficiency of the two sets of farmers.

## 10.3 DETERMINANTS OF FARMERS' PARTICIPATION IN CONTRACT FARMING

As mentioned above, we have estimated a probit model to identify some possible determinants of the farmers' decision to enter into CF. In this model, the dependent variable is a binary variable that is assigned value '1' for contract farmers and '0' for non-contract farmers. The explanatory variables are land area under chilli cultivation, access to credit (a dummy variable that is assigned value '1' if the farmer had access to credit from institutional agencies and '0' otherwise), access to technology (dummy variable that is assigned value '1' if the farmer had access to technology and '0' otherwise), the age of household head, number of female workers in the family, and access to output market as through the FPO under the contract

Table 10.3 Results of Estimated Probit Model to Identify Determinants of Participation in Contract Farming in Green Chilli

| ***Explanatory Variables*** | | |
|---|---|---|
| ***Constant*** | ***Est. Coefficient*** | ***t-Statistics*** |
| Total land | –2.12 | –5.63** |
| Access to credit | –0.21 | –4.37*** |
| Access to technology | 0.82 | 1.96** |
| Household head age | 2.4 | 11.96*** |
| Female working population | –0.21 | –1.98* |
| Access to output market | 0.31 | 1.91* |
| Number of observations | 0.33 | –0.79 |
| Number of observations | 557 | |
| Contract farming participation correctly predicted | 79 per cent | |
| Contract farming non-participation correctly predicted | 72 per cent | |

*Note:* *, ** and *** imply significance at 1, 5 and 10 per cent levels, respectively.

*Source:* Calculated by the authors.

system (dummy variable that is assigned value '1' if the farmer had access to market and '0' otherwise).

The estimation results are presented in Table 10.3. It is found that the estimated coefficients of all the variables are statistically significant. The signs of the estimated coefficients indicate that households with more women workers in the family and access to credit and technology (improved cultivation practices) have a higher probability of going in for CF. On the other hand, the probability of participation in CF reduces with the increasing age of the household head and total land area of the household. These results could be explained in the line of risk minimization strategy of the contract farmer – as the firms provide basic inputs like seeds, chemicals, improved method of cultivation and assured price, it reduces the risk of growing the contracted crop. On the other hand, labour surplus households (especially female labour) will have a higher incentive to join CF. MaCulloc and Ota (2002) also found in the context of Africa that the households possessing surplus family labour had a higher probability of participation in the contract production of horticultural crops. Our study corroborates the view that the availability of women's labour has a significant influence on CF participation, whereas households having older heads are less likely to participate in CF, particularly in the production of green chilli, which is a labour-intensive crop.

## 10.4 TECHNICAL EFFICIENCY OF CONTRACT AND NON-CONTRACT FARMERS

The literature on the measurement of technical efficiency is quite extensive. Measurement of efficiency brought forward by Farrell (1957) defines efficiency as the architecture of a firm; its function could be measured when it produces a large quantity of output from a given set of inputs. Before Farrell's work, Koopmans (1951) suggested that a producer is technically efficient (TE) when an increase in any output requires an increase in at least one input or if a reduction in any input requires a reduction in at least one output. Therefore, a technically efficient producer will produce the same outputs with less of at least one input or could use the same inputs to produce more of at least one output. Kumbhakar and Lovell (2000) measured efficiency by comparing observed optimum cost, revenue or profit, subject to the appropriate constraints on quantities and prices. We have estimated the stochastic frontier production model to measure the technical efficiency of the two sets of farmers.

Table 10.4 indicates that contract participation has a negative impact on technical inefficiency. Put differently, contract participation leads to the attainment of higher technical efficiency. For example, as per our results, compared to non-contract farmers, the technical efficiency among contract farmers increased by 3.01 per cent after joining CF. This finding is similar to the findings of some other studies (see, for example, Mishra et al., 2018; Ramaswami et al., 2005; Swain, 2016). The estimated coefficient of access to technology indicated that farmers having better access to technology have a negative impact on technical inefficiency (i.e.,

Table 10.4 Results Relating to Technical Efficiency of Green Chilli Cultivation

| *Variables* | *Coefficient* | *P-value* |
|---|---|---|
| Constant | 5.85 | 20.64* |
| Ln Land | 1.03 | 24.53* |
| Ln Seed | 0.10 | 2.38** |
| Ln Chemicals | –0.20 | –3.49* |
| Ln Labour | 0.17 | 0.43 |
| **Determinants of Technical Efficiency** | | |
| Contract participation | –3.01 | –13.02* |
| Access to technology (1 = Yes, 0 = No) | –0.52 | –2.42** |
| Household head age | –0.29 | –1.54 |
| Access to output market (Yes = 1, No = 0) | 0.40 | 2.40** |
| No. of female workers | 0.27 | 1.42 |
| Constant | –4.41 | –12.38* |
| σv | –5.34 | –47.87* |
| *Wald Chi-square* (5) | 2148.55* | |
| *Log-likelihood* | 182.12 | |
| *No. of observations* | 512 | |

*Note:* * and ** imply significance at 1 and 5 per cent levels.

*Source:* Calculated by authors using primary data.

positive impact on technical efficiency) of growing green chilli. It is also found that farmers who lack access to the output market tend to be inefficient. Further, a higher distance from the marketplace leads to high transaction costs (more time required to carry output to the market) that reduce the efficiency level of a farmer. This finding is also consistent with the findings of Mishra et al. (2018) and Adduali and Huffman (2000). Obviously, to enhance the farmers' technical efficiency level, the government should invest more in extension services and infrastructure development. Investing in roads, establishing regulated markets, etc. would enhance the efficiency level of farmers.

Table 10.5 Frequency Distribution of Farm-specific Technical Efficiency in Stochastic Production Frontier Model

| *Technical Efficiency (per cent)* | *Contract Farmers* | *Non-contract Farmers* |
|---|---|---|
| ≤70.00 | 30 (10.00) | 8 (3.3) |
| 70.01–75.00 | 1 (0.3) | 1 (0.4) |
| 75.01–80.00 | 47 (15.7) | 2 (0.8) |
| 80.01–85.00 | 11 (3.7) | 6 (2.5) |
| 85.01–90.00 | 85 (28.3) | 121 (50.0) |
| 90.01–95.00 | 112 (37.3) | 84 (34.7) |
| 95.01–100 | 14 (4.7) | 20 (8.3) |
| Total | 300 (100) | 242 (100.0) |
| Average | 92.84 | 91.43 |
| Minimum | 60.00 | 66.91 |
| Maximum | 99.42 | 99.34 |

*Source:* Calculated by authors.

Table 10.5 reveals wide intra-group variation in the level of technical efficiency both for contract and non-contract farmers growing green chilli. For the contract farmers, the mean efficiency is computed to be 92.84 per cent, while for non-contract farmers it is found to be 91.43 per cent. This implies that the contract farmers are relatively more efficient than the non-contract farmers by 1.41 points (1.54 per cent). Further, 37.4 per cent of contract farmers were able to achieve 90.01 to 95.00 per cent of the output in the most technically efficient manner as against 34.7 per cent in the case of non-contract farmers.

## 10.5 CONCLUSION

The main objective of promoting CF in developing countries is to enhance farm productivity and efficiency as well as the income of farmers by linking the input and output markets. In this regard, the theory, as well as empirical evidence, suggest that the crops grown under the contract mode of production have better productivity, and contract farmers are more efficient compared to non-contract farmers. Further, the past literature emphasized the importance of a steady supply of inputs, better technology and assurance to procure output for the success of CF. Although a good number of studies examined the impact of CF on income, employment, yield, etc., adequate attention has not been provided to measure the technical efficiency of the contract mode of cultivation. This study attempted to fill this research gap using primary data collected from four villages in the Nalanda district of Bihar. We estimated the stochastic frontier production model to measure the technical efficiency of contract farmers engaged in green chilli cultivation.

We found that contract farmers are more efficient in growing the contracted crop (green chilli) compared to non-contract farmers growing the same crop. We also found that factors like land and seeds significantly contribute to the total output of green chilli. The contract farmers are found to be more productive than non-contract ones. As regards the determinants of technical efficiency, our finding is that the farmers having better access to technology are technically more efficient. However, distance to the marketplace has a negative impact on their technical efficiency level. Thus, to enhance the farmers' technical efficiency level, the government should invest more in extension services and infrastructure development. Investing in roads and establishing regulated markets would contribute towards enhancing the efficiency level of farmers. The results on technical efficiency revealed wide variation in efficiency levels of two groups of farmers – contract and non-contract. The mean efficiency level of contract farmers is higher than the same for non-contract farmers. Thus, joining contract production would help the farmers to attain a higher level of technical efficiency.

To promote CF, the government may consider freeing the land lease market so that the marginal and small farmers can expand their operational landholdings. However, as the contracts are essentially private, the issue of contract enforcement becomes important for which the government should act as an effective regulator so that the contractors (firms) do not abuse their market power on small and petty cultivators. Information regarding the benefits and problems of CF should also be disseminated.

## NOTE

1. Some examples are milk production and marketing by COMFED, vegetable procurement and marketing by Kaushalya Foundation in Nalanda district, seed production in Ara district, Basmati rice cultivation in Munger, potato cultivation by PepsiCo and chilli cultivation by Khistiz Agro Tech in Nalanda district.

## REFERENCES


Abdulai, A., & Huffman, W. (2000). Structural adjustment and economic efficiency of rice farmers in Northern Ghana. *Economic Development and Cultural Change, 48*(3), 503–520.

Chang, C. C., Chi-Chung, C., Min-Ching, C., & Wei-Chun, T. (2006). Is contract farming more profitable and efficient than non-contract farming: A survey study of rice farms in Taiwan. Paper presented at the *American Agricultural Economics Association Annual Meeting*, Long Beach, California, July 23–26.

Dileep, B. K., Glover, R. K., & Rai, K. N. (2002). Contract farming in tomato: An economic analysis. *Indian Journal of Agricultural Economics*, *57*(2), 197–210.

Dubbert, C. (2019). Participation in contract farming and farm performance: Insights from cashew farmers in Ghana. *Agricultural Economics*, *50*(6), 749–763.

Eaton, C., & Andrew, S. (2001). Contract farming: Partnership for growth. *FAO Agricultural Services Bulletin 145*. Food and Agricultural Organisation.

Farrell, M. J. (1957). The measurement of productive efficiency. *Journal of the Royal Statistical Society*, *120*(3), 253–281.

Key, N., & William, M. (2003). Production contracts and productivity in the U.S Hog Sector. *American Journal of Agricultural Economics*, *85*(1), 121–133.

Key, N., & Rusten, D. (1999). Contract farming smallholders, and rural development in Latin America: The organization of agro-processing firms and the scale of out grower Production. *World Development*, *27*(2), 381–401.

Khan M, F., Nakano, Y., & Kurosaki, T. (2019). Impact of contract farming on land productivity and income of maize and potato growers in Pakistan. *Food Policy*, *85*, 28–39.

Koopmans, T. C. (1951). Efficient resource allocation. *Econometrica*, *19*(4), 555–565.

Kumar, P. (2006). Contract farming through agribusiness firms and state corporation: A case study in Punjab. *Economic and Political Weekly*, *41*(52), 5367–5375.

Kumbhakar, S. C., & Knox Lovell, C. A. (2000). *Stochastic frontier analysis*. Cambridge University Press.

McCulloch, N., & Ota, M (2002). Export horticulture and poverty in Kenya (Working paper series, 174). IDS.

Mishra, A. K., Shaik, S., Khanal, A. R., & Bairagi, S. (2018). Contract farming and technical efficiency: Evidence from low-value and high-value crops in Nepal, *Agribusiness: An International Journal*, *34*(2), 426–440.

Nguyen, A. T., Dzator, J., & Nadolny, A. (2018). Contract farming, agriculture productivity and poverty reduction: Evidence from tea estates in Vietnam. *Asia-Pacific Sustainable Development Journal*, *25*(1), 109–145.

Ramaswami, B., Birthal, P. S., & Joshi, P. K. (2005). *Efficiency and distribution in contract farming: The case of Indian poultry growers* (ISI Discussion Paper). ISI.

Simmons, P., Winters, P., & Patrick, I. (2005). An analysis of contract farming in East Java, Bali, and Lombok, Indonesia. *Agricultural Economics*, *33*(3), 513–525.

Singh, S. (2002). Contracting out solutions: Political economy of contract farming in Indian Punjab. *World Development*, *30*(9), 621–1638.

Swain, B. B. (2016). Contract farming and Indian agriculture: Can agribusiness help the small farmer? *Indian Journal of Agricultural Economics*, *71*(3), 285–296.

# PART IV

# CLIMATE CHANGE AND AGRICULTURE

## CHAPTER 11

# METEOROLOGICAL DROUGHT AS A PRECURSOR OF CLIMATE CHANGE AND AGRICULTURAL PRODUCTION

*P. Parth Sarthi and Sunny Kumar*

## 11.1 INTRODUCTION

The Indian summer monsoon season (June to September) receives almost 80 per cent of the total rainfall. The changes in the surface temperature in recent decades due to various anthropogenic activities or global warming is the cause of change in the rainfall pattern that has been influencing agriculture and the economy. The observed variability of annual and seasonal rainfall over India has been studied extensively over different time periods and spatial scales (Hastenrath & Rosen, 1983; Kripalani et al., 1991; Sontakke et al., 2008). The variability of summer monsoon rainfall over the Indo-Gangetic Plain (IGP) is very crucial owing to its linkage with flood and drought (Parth Sarthi et al., 2015). Over the middle and lower Gangetic plains of India, such variability of Indian summer monsoon rainfall produces conducive conditions for meteorological flood or drought. In India, the meteorological drought is a condition when an area receives less than half the amount of normal rainfall (Indian Meteorological Department, 1971) and it happens due to variation in onset, magnitude and intensity of rainfall (Agnew & Chappell, 2000; Okpara & Tarhule, 2015; Paulo & Pereira, 2006). The intensity and frequency of drought is generally studied by quantifying drought indices in terms of precipitation, evapotranspiration, soil moisture, surface temperature, surface water and groundwater and is necessary for assessment of agricultural production, crop insurance policy and economy.

The drought indices are used to monitor the drought events on multi-temporal scales (1-month, 2-month,…, *n*-month) by inculcating the values into a single numerical value. These indices are the Palmer Drought Severity Index (Palmer, 1965), the Z index (Palmer, 1968), the Crop Moisture Index (Dai, 2011; Palmer, 1968), the Standardized Precipitation Index (SPI) (McKee et al., 1995), the Reconnaissance Drought Index (Tsakiris & Vangelis, 2005), etc. However, The World Meteorological Organization (WMO) advises to use the SPI in all the national meteorological and hydrological services as it is considered to be the most efficient tool to assess the meteorological drought (Okpara & Tarhule, 2015). The researchers have carried out drought studies using SPI over the IGP of India and observed a significant increasing trend of meteorological droughts over the middle part of the Gangetic plain (Jha et al., 2013).

The Seasonality Index (SI) is another tool to determine the seasonal monthly distribution of precipitation (Walsh & Lawler, 1981). The SI provides an assessment of the precipitation regime in the region of interest. It is the sum of the absolute deviations of the monthly rainfall from the mean monthly rainfall, divided by the total seasonal rainfall of the given year. The different SI values represent the degree of variability in monthly rainfall throughout the year. The higher SI values indicate the occurrence of rainfall either in a single month or may be spread in two months.

This chapter looks into the temporal changes in meteorological drought over different agro-climatic zones of Bihar and its impact on the production of rice, the most important crop of the state.

## 11.2 STUDY AREA AND DATA

The study area, i.e., the densely populated state of Bihar, located over the Eastern Gangetic Plain, depends heavily on agriculture for livelihoods of the people. The analysis is carried out over the four agro-climatic zones of Bihar, namely zone 1 (North-West Alluvial Plain), zone 2 (North-East Alluvial Plain), zone 3A (South-East Alluvial Plain) and zone 3B (South-West Alluvial Plain).[1]

The gridded daily rainfall data for the period 1961–2018 at a resolution of 0.25×0.25 is taken from the Indian Meteorological Department. The area-averaged rainfall for each agro-climatic zone of Bihar is estimated, and June-July-August-September (JJAS) rainfall is used for the calculation of SPI-4 (four months SPI) for analysing the meteorological drought intensity over the agro-climatic zones. The data of rice production in Bihar is taken for the period 1971–2018 from the Agriculture Department, Government of Bihar.

## 11.3 RESULTS AND DISCUSSION

### 11.3.1 Standardized Precipitation Index

The intensity of meteorological drought is estimated through SPI as recommended by the WMO. Although SPI uses the Gamma and Pearson Type III distributions, gamma distribution is widely used for SPI calculation. The steps involved in its calculation are as follows: (i) Fit a gamma distribution to the time series of rainfall values for timescale four months and then compute the parameters of the gamma distribution[2]; (ii) Compute the value of the cumulative distribution function (CDF) corresponding to each value of the precipitation and (iii) The value of the standard normal deviate corresponding to the value of CDF is calculated, which will be the SPI value for the rainfall. These values correspond to dry and wet events of rainfall. Table 11.1 shows the SPI values and corresponding intensity of drought.

The temporal variation of JJAS rainfall and SPI-4 values are graphically displayed in Figures 11.1a and 11.1b. The JJAS rainfall shows a sharp decline since 1998/1999 in each agro-climatic

Table 11.1 Standardized Precipitation Index (SPI) and Respective Conditions

| *SPI Index* | *Conditions* |
|---|---|
| ≥2.0 | Extremely wet |
| 1.5 to 1.99 | Very wet |
| 1.0 to 1.49 | Moderately wet |
| –0.99 to 0.99 | Near normal |
| –1.0 to –1.49 | Moderately dry |
| –1.5 to –1.99 | Severely dry |

*Source:* Computed by the authors.

zone of the state (Figure 11.1a). Based on SPI, the years 1965, 1966, 1972, 1979, 1992, 2002, 2005, 2006, 2009, 2010, 2013, 2015 and 2018 are identified as intense drought years (Figure 11.1b). The years in which SPI lies between –1.0 and 0.0 are marked as moderate to mild drought years. During these periods, regions of Bihar were more prone to the aforesaid category of droughts. Since 1990 onwards, the occurrence of drought events has become more frequent in almost every agro-climatic zone. However, zone 3B is shown as the hotspot for the occurrence of droughts. The meteorological drought of the mild intensity has been observed in many years throughout the period of 1961–2018, with increased frequency in recent years.

## 11.3.2 Seasonality Index

The SI is another tool for the study of spatial and temporal variation in seasonality of rainfall and is expressed as follows:

$$SI = \frac{1}{R}\sum_{n=1}^{12}\left|\overline{X_n} - \frac{\bar{R}}{12}\right|$$

SI index values represent the spread of rainfall within a year. The higher values of SI correspond to the occurrence of rainfall within one/two months while the lower values suggest spread of rainfall throughout the season/months and, therefore, the variation of

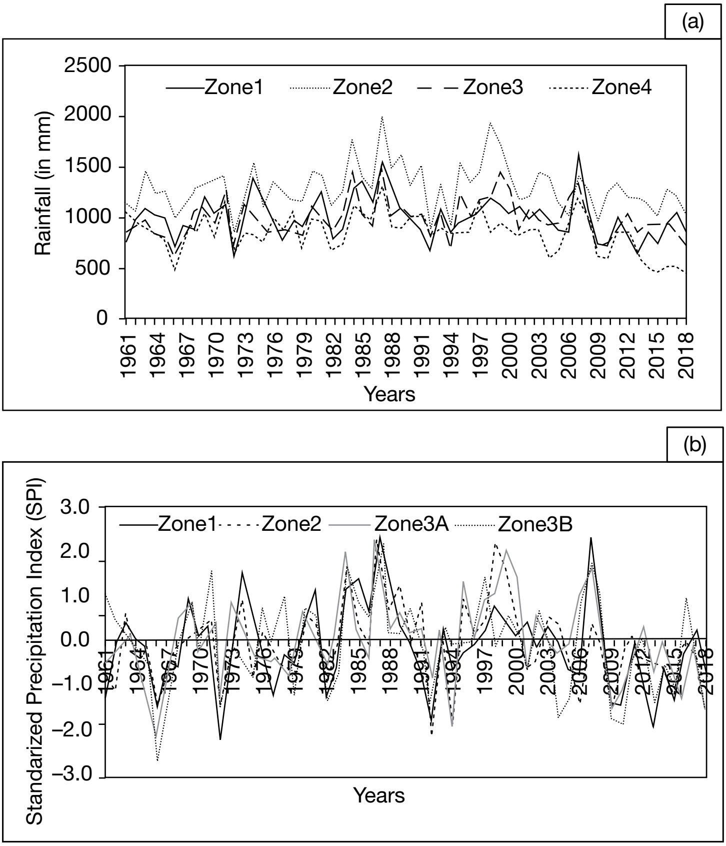



Figure 11.1 Year-to-Year (1961–2018) Variations of (a) JJAS Rainfall and (b) SPI over Different Agro-Climatic Zones of Bihar

*Source:* Authors' construction.

SI on a regional level plays an important role to understand the occurrence of drought. The SI and respective rainfall regimes are given in Table 11.2.

A Box or Whisker Plot is used to display the information through their quartiles. Figure 11.2 shows the box plot of SI for each agro-climatic zone. The SI is varying from 0.86 to 1.20 in zone 1, from 0.80 to 1.17 in zone 2, 0.77 to 1.35 in zone 3A and from 0.85 to 1.29 in zone 3B. The higher value of SI (1.1–1.5) over agro-climatic zones implies occurrence of most of the rainfall in less than three months, keeping other months dry. SI values of more than 1.0 over

Table 11.2 Seasonality Index (SI) and Respective Regimes

| *SI Class Limits* | *Rainfall Regime* |
|---|---|
| ≥1.20 | Extreme, almost all rain in 1–2 months |
| 1.00–1.19 | Most of the rainfall in 3 months or less |
| 0.80–0.99 | Markedly seasonal with a long drier season |
| 0.60–0.79 | Seasonal |
| 0.40–0.59 | Rather seasonal with a long drier season |
| 0.20–0.39 | Equable with a definite wetter season |
| ≤0.19 | Very equable, rainfall spread throughout years |

*Source:* Computed by the authors.

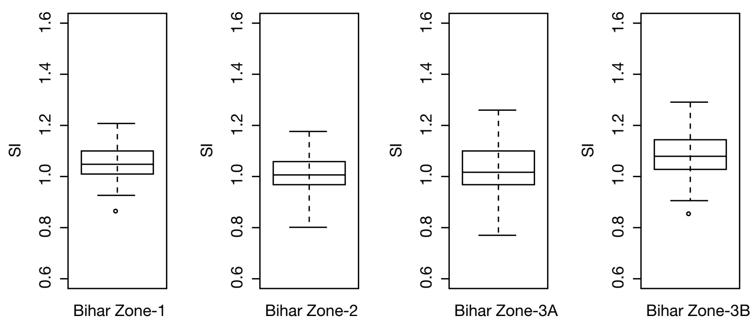



Figure 11.2 Box Plot of SI over Agro-Climatic Zones of Bihar

*Source:* Authors' construction.

a number of years correspond to the greater likelihood of drought. It is to be noted that the JJAS rainfall over each agro-climatic zone of Bihar has shown a significant decreasing trend (at 95 per cent confidence level in Mann-Kendall test) since the year of 1990 onwards.[3]

### 11.3.3 Relation between Rice Production and SPI

In general, it is assumed that the crop production will be reduced when the SPI gets a negative (or decreased) value and, therefore, a direct relationship between crop production and SPI may exist. Figure 11.3 shows the time series of rice crop production and

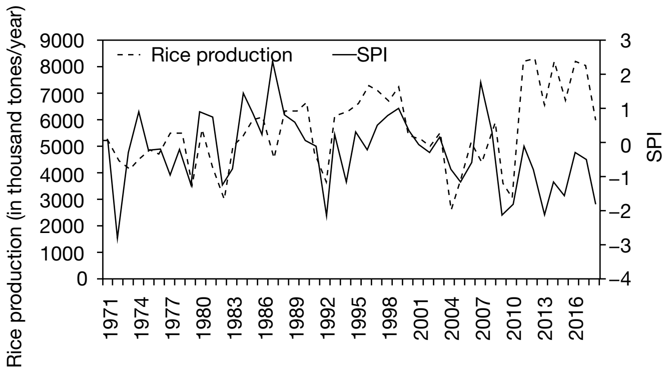



Figure 11.3 Year-to-Year Variation of Rice Crop Production and SPI during 1971–2018

*Source:* Authors' construction.

SPI for the period 1971–2018 for Bihar. It seems there existed a direct relationship between the two during the period 1971–2010. However, during 2011–18, in spite of decreased or negative values of SPI, the rice production increased and attained the maximum values ranging between 6,000 and 8,000 tons per year. In the state, the rice crop production depends on rainfall and irrigation as well as tube wells which provide water to around 62 per cent of the total irrigated area. It seems that the area-irrigated schemes by the Government of Bihar after 2010 have helped in improving the rice production in spite of meteorological drought-like conditions. In a recent study, it has been pointed out that the availability of irrigation facilities and cropping intensity had significant influence on rice production in Bihar (Najmuddin et al., 2018). Therefore, the high production of rice in spite of negative values of SPI is interesting and indeed encouraging.

## 11.4 CONCLUSION

The large variability of JJAS rainfall on spatial and temporal scale over the four agro-climatic zones of Bihar has been examined for meteorological drought conditions. To assess the spread of rainfall, the value of SI is estimated. Large values of SI (>1.0) suggest that out of four months (JJAS), a couple of months is remaining dry in a number of years in Bihar leading to the meteorological drought. The temporal distribution of SPI-4 suggests the frequent occurrence of mild droughts over each agro-climatic zone, while the frequency of occurrence of severe drought is found more over zone 3B. Greater than 50 per cent probability of occurrence of drought is found over agro-climatic zones 1, 2 and 3B of Bihar. There existed a direct relationship between the SPI and volume of rice production during the period 1971–2010. However, during 2011–18, an inverse relation is found implying that despite decreased or negative values of SPI, the rice production increased. It seems that better irrigation facility and other supportive schemes for farmers provided by the government helped to increase rice production in Bihar during 2011–18 in spite of negative values of SPI (or a significant decreasing trend in JJAS rainfall from 2010 to 2018).

## NOTES

1. The districts under these zones are mentioned in Section 3.4 of Chapter 3.
2. The gamma distribution function is expressed as $g(x) = \frac{1}{\beta^{\alpha} T(\alpha)} x^{\alpha-1} e^{-\alpha/\beta} \quad \text{for} \quad x > 0,$

   Where, $\alpha > 0$, $\alpha$ is a shape parameter; $\beta > 0$ , $\beta$ is a scale parameter; $x > 0, x$ is a precipitation constant and $\Gamma(\alpha) = \int_0^{\infty} y^{\alpha-1} e^{-y} dy$ , where $\Gamma(\alpha)$ is a gamma parameter.
3. We have not presented the figures to save space.

## REFERENCES


Agnew, C. T., & Chappell, A. (2000). *Desiccation in the Sahel linking climate change to land surface change*. Springer.

Dai, A. (2011). Characteristics and trends in various forms of the Palmer drought severity index during 1900–2008. *Journal of Geophysical Research: Atmospheres, 7, 116*(D12). https://doi.org/10.1029/2010JD015541

India Meteorological Department (IMD) (1971). *Climate diagnostic bulletin of India*, June, July, August. Rep. Nos. 88, 89 and 90. National Climate Center, IMD, Pune.

Jha, S., Sehgal, V. K., Raghava, R., & Sinha, M. (2013). Trend of standardized precipitation index during Indian summer monsoon season in agroclimatic zones of India. *Earth System Dynamics Discussions, 4*, 429–449.

Hastenrath, S., & Rosen, A. (1983) Patterns of Indian monsoon rainfall anomalies, *Tellus*, *35A*(4), 324–331.

Kripalani, R., Singh, S. V., & Arkin, P. A. (1991). Large scale features of rainfall and outgoing longwave radiation over Indian and adjoining regions. *Contribution to Atmospheric Physics, 64*, 159–168.

McKee, T. B., Doesken, N. J., & Kleist, J. (1995). Drought monitoring with multiple time scales. *Proceedings of the Ninth Conference on Applied Climatology*, *Dallas, Boston, MA*.

Najmuddin, O. et al. (2018). Low water productivity for rice in Bihar, India: A critical analysis. *Water, 10*(8).

Okpara, J. N., & Tarhule, A. (2015). Evaluation of drought indices in the Niger Basin. *West African Journal of Geography, 3*(2), 1–32

Palmer, W. C., (1965). *Meteorological drought* (Research Paper No 45). US Weather Bureau, Washington, DC.

Palmer, W. C. (1968). Keeping track of crop moisture conditions, nationwide: The new crop moisture index. *Weatherwise, 21*, 156–161.

Parth Sarthi, P., Ghosh, S., & Kumar, P. (2015). Possible future projection of Indian summer monsoon rainfall with the evaluation of model performance in coupled model inter-comparison project phase 5. *Global and Planetary Change, 129*, 92–106.

Paulo, A. A., & Pereira, L. S. (2006). Drought concepts and characterization: Comparing drought indices applied at local and regional scales. *Water International, 31*(1), 37–49

Stefan, H., & Rosen, A. (2010). Patterns of Indian monsoon rainfall anomalies. *Tellus, 35A*(4), 324–331.

Sontakke, N. A., Singh, N., & Singh, H. N. (2008). Instrumental period rainfall series of the Indian region (1813–2005): Revised reconstruction, update and analysis. *The Holocene, 18*(7), 1055–1066.

Tsakiris, G., & Vangelis, H. (2005). Establishing a drought index incorporating evapotranspiration. *European Water Journal, 9*(10), 3–11.

Walsh, R. P. D., & Lawer, D. M. (1981). Rainfall seasonality: Description, spatial patterns and change through time. *Weather, 36*, 201–208.

CHAPTER 12

# CLIMATE RESILIENT AGRICULTURE PROGRAMME AND ITS EFFECT ON PRODUCTIVITY AND PROFITABILITY

*N. Saravana Kumar*

## 12.1 INTRODUCTION

As South Asia may face great challenges in achieving food security in the coming decades, there is a need to double the foodgrains production by 2050 by using resources more efficiently while minimising environmental problems (Ladha et al., 2016). In many regions, with growing population, the demand for food is increasing, and the dietary changes are causing increased competition for inputs used in production of food. (Garnett et al., 2013). Moreover, climate change poses additional challenges to agricultural development in developing countries such as India with food security, economic and political ramifications (Dagar et al., 2012; Dubash, 2013). In many regions and countries, current farming practices are not sustainable and turned out to be the major source of greenhouse gas (GHG) emissions (Ladha et al., 2016; Tongwane et al., 2016).

Agriculture is one of the most climate-vulnerable sectors of the Indian economy. The agricultural production system is highly sensitive to extreme events such as floods and drought, as well as long-term changes in climatic conditions such as rainfall and temperature that can lead to a reduction in yields and shifts in cropping patterns. This is particularly problematic for small and marginal farmers who face the brunt of climate change impacts more than economically better-off farmers. The ecosystems on which they rely are increasingly degraded, and their access to suitable agricultural land is declining. In such a situation, we require a 'multiple-benefit approach' to build climate resilience along with other benefits, contributing to poverty reduction, enhancement of biodiversity, increased agricultural productivity and lowering of GHG emissions from the agricultural sector. The climate resilient cultivation approach is often implemented as packages at the farm level.

Agriculture in the Eastern Indo-Gangetic Plains (EIGP) of South Asia is dominated by Rice–Wheat (R–W) cropping system with mixed productivity and sustainability problems (Ladha et al., 2016), including deteriorating crop yields, lower input use efficiency and high production costs (Keil et al., 2015; Singh et al., 2015). Therefore, there is a need to enhance the sustainability of the current strained production systems of the EIGP into more lively production systems, while climate change calls for making them more climate resilient.

The temperature in the EIGP has been rising over the last few decades as a result of which the environments for cultivation of crops have been disturbed. The agricultural water demand is estimated to increase, whereas the availability of water is decreasing, though the number of rainy days showed a significant increasing trend. Increasing trends of minimum temperature in the EIGP have also been observed. There is evidence of the negative impact of changing climate on the yield of wheat, rice and other crops with variable magnitude in diverse ecologies of Bihar. The climate projections of Bihar for 2050 have further revealed increasing trends in both maximum and minimum temperatures (2–4°C), coupled with much more variability (± 25 per cent) in monthly rainfall patterns, that are bound to have large implications on agriculture, food security and livelihoods of the rural masses. This situation in Bihar points to the need for a call to action to counter adversities of climate change in a proactive and preemptive manner.

Bihar, a very populous eastern state of India, is described as the home of marginal farmers. Around 91 per cent of farmers belong to the marginal category with land holdings of less than one hectare. Apart from this, there is a large prevalence of tenant farmers who remain the most vulnerable to climate change impacts. Cropping system is dominated by R–W. Rice is grown almost as the sole crop in the kharif season and is most vulnerable to weather variations. Crop losses due to climatic changes affect livelihoods and farmers' incomes. As the farmers adopted cereal-based cropping systems, the degree of crop diversification has been low. Adoption of a climate-resilient cropping system becomes necessary in a situation where climatic disturbances are becoming more frequent. Farmers need to diversify the kharif crop spectrum by substituting rice with better-suited crops, particularly uplands. These challenges vary by geographic location and are particularly challenging in the EIGP, especially in the state of Bihar, which urgently needs to strengthen its agricultural potential to ensure food and nutritional security (Erenstein & Thorpe, 2011; GoB, 2015).

The Climate Resilient Agriculture (CRA) is a multi-benefit approach for transforming and reorienting agricultural development under the new realisms of climate change. It may be defined as agriculture that increases productivity on a sustainable basis, enhances resilience (adaptation), reduces/removes GHGs (mitigation) where possible and enhances the achievement of national food security and development goals. The CRA seeks to transform the prevailing systems and has a wider perspective than just increasing production alone. It has the objectives of enhancing the resilience of agriculture covering crops, livestock and fisheries to climatic variability and climate change through development and application of improved production and risk management technologies; demonstrating site-specific technology packages on farmers' fields for adapting to current climate risks; building up the capacity of scientists/researchers and other stakeholders in climate resilient agricultural research and its applications. Several interventions are made to build soil carbon, control soil loss due to erosion and enhance water holding capacity of soils, all of which build resilience in soil.

Under the Bihar government's initiative of Agriculture Road Maps, climate change is identified as one of the major challenges for sustainable agricultural growth in the state. Accordingly, the

State Government has started a series of initiatives such as Jal-Jivan-Hariyali, Organic Agriculture Mission, Hariyali Mission, Crop Residue Management, and the CRA Programme. The main goals of the CRA programme of Bihar government are: (i) conducting baseline survey for identifying the suitable climate resilient technologies and impact assessment; (ii) development of on-farm innovation clusters of suitable climate resilient and futuristic cropping system (crop cycle) modules in climate resilient villages for technology evaluation, co-learning and capacity development and (iii) to enhance farm productivity and profitability by adopting climate resilient technologies.

As against the above background, this chapter discusses the methods of implementation of the CRA programme in Bihar. It also looks into the impact of such a programme on productivity and profitability of some important cropping systems.

## 12.2 IMPLEMENTATION METHOD OF CRA PROGRAMME IN BIHAR

The CRA Programme is fully funded by the Government of Bihar, which is a collaborative project of the Borlaug Institute for South Asia (BISA), Pusa, Samastipur, Dr Rajendra Prasad Central Agricultural University (RPCAU), Pusa, Bihar Agricultural University (BAU), Sabour and ICAR-Research Complex for Eastern Region (RCER), Patna.

Under this programme, CRA practices of a new futuristic cropping system (crop cycle) relevant to needs of resource-poor farmers that can address climatic risks are being developed, validated and deployed through a community-led approach to make farming relevant, remunerative and stable. The engagement model that is being followed works around principles of convergence with multi-stakeholders, multi-disciplinary and multi-institutional teams for innovation and knowledge generation. Each CRA village adopts an integrated social, biophysical and economic approach to understand the factors influencing the adoption and impact of climate smart interventions. Once the dynamics stabilised in the local context, the CRA village model is progressively rolled out in other villages. To begin with, one CRA village was established in a district as a 'project hub'. Subsequently, the programme is upscaled in 190 villages of 38 districts (five villages in each district). This upscaling will not only cover more farmers but also help optimise the cost and efficiency of service delivery.

Out of 38 project district hubs, 18 are being managed by BAU (these are Bhagalpur, Banka, Araria, Arwal, Aurangabad, Khagaria, Bhojpur, Jahanabad, Jamui, Kaimur, Kishanganj, Lakhisarai, Madhepura, Patna, Rohtas, Saharsa, Sheikhpura and Supaul), 11 are managed by RPCAU (these are Madhubani, Begusarai, Darbhanga, E Champaran, W Champaran, Gopalganj, Muzaffarpur, Saran, Sheohar, Sitamarhi and Siwan), seven by BISA (these are Nawada, Nalanda, Munger, Katihar, Purnea, Samastipur and Vaishali) and two by ICAR-RCER (these are Gaya and Buxar).

Based on the existing climatic situations, different ecologies (low, mid and upland soils) and available resources, 14 different cropping systems have been identified (these are Rice–Wheat–Mung bean; R–W; Rice–Potato–Maize; Rice–Winter maize; Rice–Mustard–Mung bean; Rice–Lentil; Maize–Wheat–Mung bean; Maize–Mustard–Mung bean; Maize–Lentil–Mung bean; Soybean–Winter maize; Soybean–Wheat–Mung bean; Pearl millet–Mustard–Mung bean; Pearl millet–Lentil–Mung bean and Pearl millet–Wheat–Mung bean) to demonstrate in the 38 project district-hubs of Bihar. In each district, one long-term field experiment having 8–10 combinations of suitable different cropping systems has been established at the Krishi Vigyan Kendra (KVK) farm and five villages are selected to demonstrate the suitable climate resilient cropping systems.

### 12.2.1 Adopted Technologies

In recent years, several technologies that enhance the sustainability of different production systems, such as minimum or zero tillage (ZT), seeding using a drill, crop residue retention, crop rotation with legumes and laser land levelling, have been evaluated in the EIGP. To effectively utilise the 365 days of a year, different components of the technologies are implemented to save time and effectively fit two or more crops in a year. Further, there is increased interest in direct seeded rice (DSR) under non-puddled/non-ponded conditions due to increasing labour scarcity, energy constraints and rising input costs.

Early planting of short to medium-duration rice varieties help in the early planting of succeeding wheat crops. Planting rice by direct seeding helps to promote water use efficiency and is time-saving. Stress tolerant crop cultivars help to tackle adverse climatic situations. Adopting improved planting/seeding methods enhances water use efficiency and crop productivity under changing climatic scenarios. It improves the resilience of poor farmers by reclaiming cultivable wastelands.

Farmers in the villages traditionally grow local varieties of different crops resulting in poor crop productivity. Under the CRA programme, improved, early duration, drought, heat and flood tolerant varieties are being introduced to achieve optimum yields despite climatic stresses.

### 12.2.2 Planting Method

Zero tillage planted wheat crops mature 7–10 days earlier than the conventional planted wheat. Conventional tillage requires one week for land preparation. Raised bed planting helps reduce the high rain risk to non-rice kharif crops. Small and manually operated paddy drum seeders and R–W seeders are getting wider acceptance for saving the cost of cultivation with increased production and income. Community paddy nursery as a contingency measure is helping farmers with delayed planting.

### 12.2.3 Water Management

Since climate variability causes deficit or excess water in crop fields, water-saving technologies like DSR, zero tillage and other resource conservation methods, which also reduce GHG emissions apart from saving water, are being adopted in many areas. Laser land-levelling helps uniform water and nutrients application and saves about 20–30 per cent of irrigation water and nutrients. Alternate wetting and drying, field bunding and raised-bed planting systems avoid temporary water logging, which helps grow the soybean and maize during the rainy season and save 20–30 per cent of irrigation water during the dry season (winter).

### 12.2.4 Nutrient Management

In the EIGP, inefficient management of fertilisers affect yield and income of farmers. So, balanced use of fertiliser and real-time nutrient management is done using Nutrient Expert (NE), Green seeker and leaf colour chart (LCC).

### 12.2.5 Crop Residue Management

Both in situ and ex situ crop residue management interventions are implemented under the CRA programme. Besides the mass awareness campaign launched to make farmers aware of the ill-effects of crop residue burning, several initiatives are put in place to transform waste (straw) into wealth, like the aggregation of straw through straw baler for the use as animal fodder and the making of bio-char from the crop residue. Happy Seeder, Super Straw Management System, etc. help to manage the crop residue in situ. Happy Seeder is a tractor-mounted machine that cuts and lifts straw, sows wheat seeds into the soil and deposits the straw over the sown area as mulch. This option also has the largest potential to reduce the environmental footprint of on-farm activities.

### 12.2.6 Farm Machinery

Providing access to farm machinery for timely sowing/planting and other agricultural operations is important to deal with a variable climate, like delays in monsoon and inadequate rains needing replanting of crops. However, the potential of farm machinery-based climate resilient agricultural technologies and practices to adapt to climate change have not been explored in depth in the current literature. In the era of climate change and declining water resources, optimising crop distribution could bring both cropping system and nutrition benefits to conventional systems in many areas, including the EIGP.

## 12.3 PRODUCTIVITY AND PROFITABILITY GAINS FROM THE CRA PROGRAMME

Since the start of the CRA programme in Bihar in the rabi season of 2019–20, six cropping seasons have been completed up to December 2021, and rabi 2021–22 is in progress (Table 12.1). In rabi 2019–20, against the target of 1200 demonstrations covering eight districts (150 demonstrations per district), 1430 demonstrations have been conducted (achievement of 119 per cent). Summer 2020s target was

400 demonstrations covering eight districts (50 demonstrations per district), against which 375 demonstrations (93.75 per cent) were conducted. In kharif 2020, against the target of 2400 demonstrations covering eight districts (300 demonstrations per district), 2996 demonstrations (125 per cent) were conducted. In the case of rabi 2020–21, the target was 23,674 demonstrations covering all 38 districts (623 demonstrations per district) against which 23,710 demonstrations (100.15 per cent) were conducted. Summer 2021s target was 13,300 demonstrations covering 38 districts (250 demonstrations per district), against which 13,045 demonstrations (98 per cent) were conducted. In kharif 2021, against the target of 22,610 demonstrations (595 demonstrations per district) 22,975 demonstrations (101 per cent) were achieved. However, in the case of rabi 2021–22, the target was 23,674 demonstrations (623 demonstrations per district), against which 20,843 demonstrations (88 per cent) were achieved.

### 12.3.1 Impact of Adopted Technologies on Productivity and Profitability

Out of 14 cropping systems under the project, we have so far analysed eight prominent cropping systems (Rice–Wheat–Mung

Table 12.1 Cropping Season-based Targets and Achievements of Demonstrations Under the CRA Programme in Bihar

| *Cropping Seasons* | *Target* | *Achievement* | *Per cent of Achievement to Target* |
|---|---|---|---|
| Rabi 2019–20 | 1200 | 1430 | 119.17 |
| Summer 2020 | 400 | 375 | 93.75 |
| Kharif 2020 | 2400 | 2996 | 124.81 |
| Rabi 2020–21 | 23,674 | 23,710 | 100.15 |
| Summer 2021 | 13,300 | 13,045 | 98.08 |
| Kharif 2021 | 22,610 | 22,975 | 101.61 |
| Rabi 2021–22 (till 10 Dec.) | 23,674 | 20,843 | 88.04 |
| Total | 87,258 | 85,374 | 97.84 |

*Source:* CRA Programme, Government of Bihar.

bean; Rice–Lentil–Mung bean; Maize–Wheat–Mung bean; Rice–Chickpea–Mung bean; Rice–Mustard–Mung bean; Pearl millet–Wheat–Mung bean; Soybean–Wheat–Mung bean and Rice–Maize) considering all 38 districts of the state together. The results show that the highest productivity is achieved in Rice–Maize cropping system (137.62 q/ha) (Figure 12.1) that is followed by Rice–Wheat–Mung bean (97.31 q/ha), Maize–Wheat–Mung bean (95.65 q/ha), Pearl millet–Wheat–Mung bean (76.55 q/ha), Rice–Mustard–Mung bean (69.99 q/ha), Rice–Lentil–Mung bean (69.40 q/ha), Rice–Chickpea–Mung bean (69.18 q/ha) and Soybean–Wheat–Mung bean (68.83 q/ha) cropping systems. This is in contrast to the conventional cropping systems of Bihar, as the average productivity for Rice and Wheat for the state, is only 26 and 27 q/ha, respectively.

As regards the profitability of above-mentioned eight cropping systems, we found that the profitability is also highest for Rice–Maize cropping system (1,87,055 Rs./ha) that is followed by Rice–Wheat–Mung bean (1,51,188 Rs./ha), Soybean–Wheat–Mung bean (1,47,954 Rs./ha), Rice–Chickpea–Mung bean (1,45,733 Rs./ha), Rice–Mustard–Mung bean (1,45,445 Rs./ha), Rice–Lentil–Mung bean (1,41,683 Rs./ha), Pearl Millet–Wheat–Mung bean

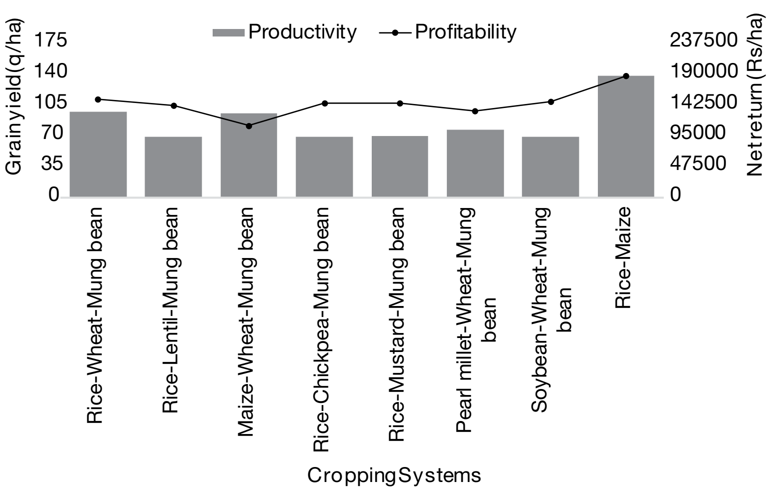



Figure 12.1 Productivity and Profitability of Different Cropping Systems (Considering mean of 38 project

*Source:* CRA Programme, Government of Bihar.

(1,33,071 Rs./ha) and Maize–Wheat–Mung bean (1,11,042 Rs./ha) systems.

### 12.3.2 Productivity and Profitability of Different Cropping Systems in the Districts

To understand the inter-district variation in the productivity and profitability, we have so far analysed four cropping systems that are Rice–Maize, Rice–Wheat-Mung bean, Rice–Mustard–Mung bean and Rice–Lentil–Mung bean. The district or project-level information on the productivity and profitability of these cropping systems is presented in Table 12.2. The following observations can be made here:

1. For the Rice–Maize cropping system, the productivity was highest in Bhagalpur (162 q/ha) and lowest in Sitamarhi (74.5 q/ha). For the Rice–Wheat–Mung bean system, the highest and lowest productivity are recorded by Nalanda (121.7 q/ha) and Kishanganj (64.4 q/ha), respectively. The productivity varied between 107.68 q/ha in Buxar to 43.7 q/ha in Kishanganj for the Rice–Mustard–Mung bean cropping system. As regards Rice–Lentil–Mung bean system, the highest and lowest productivities are found in Patna (87.09 q/ha) and Kishanganj (35.8 q/ha), respectively.
2. The Rice–Maize cropping system is rapidly expanding in South Asia as also in the Indian state of Bihar, Telangana and Andhra Pradesh due to the higher yield and profit potential from rabi (winter) maize, its reduced water requirement compared to Rice–Rice system, and ever-increasing demand for maize from poultry and fish feed industries. In Bihar, the profitability of Rice–Maize cropping system ranged from ₹2.41 lakh/ha in Bhagalpur to ₹0.45 lakh/ha in Sheikhpura. On the other hand, for the Rice–Wheat–Mung bean system, the profitability was highest in Araria (₹2.12 lakh/ha) and lowest in Darbhanga (₹0.59 lakh/ha). The Rice–Mustard–Mung bean system recorded the highest profitability in Buxar (₹2.05 lakh/ha) and the lowest in Darbhanga (₹0.63 lakh/ha). In the case of the Rice–Lentil–Mung bean cropping system, the highest and lowest profitability are found in Saran (₹1.92 lakh/ha) and Darbhanga (₹0.59 lakh/ha), respectively.

Table 12.2 Productivity and Profitability of Four Important Cropping Systems in the Districts

| District | Productivity (q/ha) | | | | Profitability (lakh ₹/ha) | | | |
|---|---|---|---|---|---|---|---|---|
| | ***Rice–Maize*** | ***Rice–Wheat–Mung bean*** | ***Rice–Mustard–Mung bean*** | ***Rice–Lentil–Mung bean*** | ***Rice–Maize*** | ***Rice–Wheat–Mung bean*** | ***Rice–Mustard–Mung bean*** | ***Rice–Lentil–Mung bean*** |
| Araria | 123.3 | 83.3 | 58.3 | 61.3 | 1.93 | **2.12**$^{H}$ | 1.56 | 1.82 |
| Arwal | 50.2 | 102.0 | 69.7 | 71.1 | 0.61 | 1.37 | 1.22 | 1.31 |
| Aurangabad | 48.5 | 86.8 | 59.3 | 69.3 | 0.65 | 1.47 | 1.12 | 1.49 |
| Banka | 140.1 | 99.6 | 69.3 | 65.4 | 1.27 | 1.12 | 1.25 | 1.03 |
| Begusarai | 123.6 | 103.9 | 61.5 | 63.9 | 1.60 | 1.51 | 1.39 | 1.51 |
| Bhagalpur | **162.0**$^{H}$ | 91.9 | 60.7 | 63.5 | **2.41**$^{H}$ | 1.99 | 1.77 | 1.91 |
| Bhojpur | 117.8 | 114.8 | 66.3 | 78.5 | 1.64 | 1.63 | 1.43 | 1.76 |
| Buxar | 51.4 | 107.7 | **107.7**$^{H}$ | 71.7 | 0.81 | 1.79 | **2.05**$^{H}$ | 1.54 |
| Darbhanga | 79.3 | 73.8 | 49.8 | 46.8 | 0.68 | **0.59**$^{L}$ | **0.63**$^{L}$ | **0.59**$^{L}$ |
| East Champaran | 126.6 | 93.7 | 71.8 | 70.0 | 1.41 | 1.29 | 1.70 | 1.67 |
| Gaya | 45.8 | 72.8 | 53.8 | 56.8 | 0.67 | 1.03 | 0.92 | 1.03 |
| Gopalganj | 145.6 | 83.4 | 65.4 | 63.4 | 1.91 | 1.07 | 1.19 | 1.07 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Jamui | 91.4 | 96.6 | 67.3 | 68.6 | 1.26 | 1.64 | 1.52 | 1.68 |
| Jehanabad | 143.6 | 89.0 | 52.4 | 68.0 | 1.56 | 1.31 | 0.74 | 1.24 |
| Kaimur | 101.3 | 90.3 | 69.8 | 53.1 | 1.13 | 1.15 | 1.20 | 0.65 |
| Katihar | 156.5 | 116.2 | 73.7 | 71.8 | 1.62 | 1.63 | 1.59 | 1.32 |
| Khagaria | 133.4 | 88.2 | 63.3 | 62.9 | 1.28 | 0.81 | 0.95 | 1.14 |
| Kishanganj | 121.0 | **64.4**[L] | **43.7**[L] | **35.8**[L] | 1.18 | 0.71 | 0.89 | 0.71 |
| Lakhisarai | 121.0 | 97.2 | 66.9 | 55.4 | 1.45 | 1.31 | 1.18 | 0.83 |
| Madhepura | 140.3 | 89.0 | 64.0 | 65.1 | 1.77 | 0.93 | 1.33 | 1.30 |
| Madhubani | 114.0 | 85.0 | 56.0 | 53.5 | 1.19 | 0.84 | 0.91 | 0.84 |
| Munger | 127.0 | 105.9 | 76.2 | 74.7 | 1.49 | 1.67 | 1.76 | 1.76 |
| Nalanda | 147.4 | **121.7**[H] | 83.5 | 81.6 | 1.66 | 1.64 | 1.78 | 1.63 |
| Nawada | 115.2 | 106.9 | 76.3 | 68.6 | 1.30 | 1.12 | 1.54 | 1.14 |
| Patna | 119.4 | 87.1 | 61.0 | **87.1**[H] | 1.34 | 1.05 | 1.12 | 0.98 |
| Purnea | 140.0 | 121.2 | 83.0 | 79.1 | 1.68 | 1.91 | 1.95 | 1.74 |
| Rohtas | 155.1 | 110.1 | 81.4 | 79.4 | 1.88 | 1.63 | 1.60 | 1.60 |

*(Continued)*

Table 12.2 (Continued)

| District | Productivity (q/ha) | | | | Profitability (lakh ₹/ha) | | | |
|---|---|---|---|---|---|---|---|---|
| | Rice–Maize | Rice–Wheat–Mung bean | Rice–Mustard–Mung bean | Rice–Lentil–Mung bean | Rice–Maize | Rice–Wheat–Mung bean | Rice–Mustard–Mung bean | Rice–Lentil–Mung bean |
| Saharsa | 139.5 | 83.6 | 61.2 | 65.4 | 1.50 | 0.75 | 0.96 | 1.01 |
| Samastipur | 153.8 | 115.5 | 88.3 | 86.8 | 1.59 | 0.93 | 1.67 | 1.45 |
| Saraiya | 102.3 | 88.2 | 76.2 | 70.7 | 1.06 | 1.15 | 1.29 | 1.15 |
| Saran | 119.2 | 112.0 | 81.2 | 84.2 | 1.57 | 1.24 | 1.75 | **1.92**$^{H}$ |
| Sheikhpura | **40.9**$^{L}$ | 93.1 | 52.9 | 68.6 | **0.45**$^{L}$ | 1.62 | 1.17 | 1.78 |
| Sheohar | 44.7 | 97.8 | 67.2 | 67.3 | 0.55 | 1.09 | 1.51 | 1.51 |
| Sitamarhi | 74.5 | 88.2 | 63.6 | 64.9 | 1.15 | 1.46 | 1.46 | 1.46 |
| Siwan | 145.1 | 89.8 | 62.6 | 61.6 | 0.88 | 0.71 | 1.04 | 1.15 |
| Supaul | 124.0 | 90.0 | 58.4 | 47.5 | 1.57 | 0.78 | 1.24 | 0.78 |
| Vaishali | 130.2 | 117.6 | 73.6 | 71.9 | 1.23 | 1.68 | 1.85 | 1.68 |
| West Champaran | 151.8 | 91.0 | 56.3 | 58.2 | 1.43 | 0.91 | 1.12 | 0.91 |

*Note:* 'H' and 'L' stand for highest and lowest values.

*Source:* CRA Programme, Government of Bihar.

## 12.4 CONCLUSION

Climate change repercussions on agricultural systems in the EIGP differ due to different characteristics of agro-ecological zones and socio-economic aspects. The farmers in different parts of Bihar get adversely affected owing to abiotic (rainfall and temperature) variations. In this situation, the implementation of the CRA Programme is helping the farmers to raise their income levels through gains in productivity and profitability. Our analysis of alternative cropping systems, considering all districts (project sites) together, revealed that productivity varies from 69.40 q/ha under the Rice–Lentil–Mung bean cropping system to 137.62 q/ha under the Rice–Maize cropping system. It is also observed that the Rice–Maize cropping system recorded the highest profitability (1,87,055 Rs./ha), which was the lowest (1,11,042 Rs./ha) for Maize–Wheat–Mung bean cropping system. These results suggest that the Rice–Maize cropping system is the most viable cropping system (in terms of productivity and profitability) when considered for the state as a whole. However, given the fact that there is wide variation among the districts with regard to the productivity and profitability of different cropping systems, the farmers should be encouraged to adopt the cropping system that provides the maximum productivity and profitability in their respective districts.

It is indeed encouraging to note that the state government is mobilizing the farmers in large numbers (1.5 lakh farmers per year) to acquaint and train them for adoption of climate resilient technologies. The limited research conducted so far in the context of Bihar clearly revealed that adopting CRA technologies in different cropping systems can ensure food security and enhance the profitability and income of the farmers from crop cultivation.

## ACKNOWLEDGEMENT

This study was initiated under the "Climate Change Adaptation in Bihar" project, implemented by the BAU (Sabour), RPCAU (Pusa-Samastipur), ICAR-RCER (Patna) and BISA under the aegis of Bihar Government. The contribution by the scientists and research teams of all implementing partners is duly acknowledged. The author is thankful to Anil Kumar Jha for his help. The financial support of Bihar Government is highly acknowledged.

## REFERENCES


Dagar, J.C., Singh, A. K., Singh, R & Arunachalum, A. (2012). Climate change vis-a-vis Indian agriculture. *Annals of Agricultural Research* (New Series), *33*, 189–203.

Dubash, N. K. (2013). The politics of climate change in India: narratives of equity and co benefits. *WIREs Climate Change, 4*, 191–201.

Erenstein, O., & Thorpe, W. (2011). Livelihoods and agro-ecological gradients: A meso-level analysis in the Indo-Gangetic plains, India. *Agricultural Systems, 104*, 42–53

Garnett, T., Appleby, M. C., Balmford, A., Bateman, I. J., Benton, T. G., Bloomer, P., Burlingame, B., Dawkins, M., Dolan, L., Fraser, D., Herrero, M., Hoffmann, I., Smith, P., Thornton, P. K., Toulmin, C., Vermeulen, S. J., & Godfray, H. C. J. (2013). Sustainable intensification in agriculture: premises and policies. *Science, 341*, 33–34.

GoB. (2015). *Bihar state action plan on climate change: Building resilience through development*. Government of Bihar.

GoB. (n.d.) *Agricultural road maps 2008–12, 2012–17 & 2017–22*. Department of Agriculture.

Keil, A., D'Souza, A., & McDonald, A. (2015). Zero-tillage as a pathway for sustainable wheat intensification in the Eastern Indo-Gangetic plains: Does it work in farmers' fields? *Food Security, 7*, 983–1001.

Ladha, J. K., Rao, A. N., Raman, A. K., Padre, A. T., Dobermann, A., Gathala, M., Kumar, V., Sharawat, Y., Sharma, S., Piepho, H. P., Alam, M. M., Liak, R., Rajendran, R., Reddy, C. K., Parsad, R., Sharma, P. C., Singh, S. S., Saha, A., & Noor, S. (2016). Agronomic improvements can make future cereal systems in South Asia far more productive and result in a lower environmental footprint. *Global Change Biology, 22*, 1054–1074.

Singh, B., Humphreys, E., Gaydon, D. S., & Yadav, S. (2015). Options for increasing the productivity of the rice-wheat system of northwest India while reducing groundwater depletion. Part 2. Is conservation agriculture the answer? *Field Crops Research, 173*, 81–94.

Tongwane, M., Mdlambuzi, T., Moeletsi, M., Tsubo, M., Mliswa, V., & Grootboom, L. (2016). Greenhouse gas emissions from different crop production and management practices in South Africa. *Environmental Development, 19*, 23–35.

CHAPTER 13

# CLIMATE CHANGE, VULNERABILITY, AND HUMAN DEVELOPMENT

*Sibananda Senapati*

## 13.1 INTRODUCTION

India's agriculture sector is highly sensitive to weather patterns, particularly variability in rainfall. Eighty per cent of the total rainfall over the Indian sub-continent occurs during June–September as a result of the South-West monsoon. Although drought is a recurring problem in some areas, floods cause serious damage to livelihoods and agriculture in other areas (e.g., Coastal Odisha, Andhra Pradesh, Bihar and Uttar Pradesh). One-third of the average flood-prone area in the country is agricultural land. Climate variability has considerable social and economic consequences in India, where almost three-quarters of the population relies directly or indirectly on agriculture for their livelihoods. Long-term climate change is likely to exacerbate these consequences, as patterns of temperature, rainfall, and other variables shift due to increased atmospheric concentrations of greenhouse gases and global warming (Aandahal & O'Brien, 2001).

O'Brien et al. (2004) conducted a vulnerability study for India's agriculture sector and identified various factors (biophysical, socio-economic and technological) affecting the capacity to adapt. The biophysical factors include soil quality and depth and groundwater availability, whereas socio-economic factors are the measures of literacy, gender equity, and the percentage of farmers and agricultural wage labourers in a district. Technological factors comprise the availability of irrigation and the quality of infrastructure. Together, these factors provide an indication of which districts are most and least able to adapt to drier conditions and variability in the Indian monsoons, as well as to respond to import competition resulting from liberalised agricultural trade. The results of this vulnerability mapping show that the districts located along the Indo-Gangetic plains (IGP) (except Bihar) have higher degrees of adaptive capacity, and lower adaptive capacity is found in the interior portions of the country, particularly in the States of Bihar, Rajasthan, Madhya Pradesh, Maharashtra, Andhra Pradesh, and Karnataka.

In a study by Sehgal et al. (2013), the vulnerability of agriculture in the districts of the IGP is determined by using the following three core components of vulnerability: exposure to natural hazards (temperature and rainfall), sensitivity to climate change (i.e., the amount of damage expected to be caused by a particular event), and adaptive capacity to recover from stress. A total of eight indicators have been computed using gridded meteorological data for the period 1951–2009 for exposure. Sensitivity has been computed from six indicators based on crop and soil characteristics. The computation of adaptive capacity has been based on socio-economic indicators of agricultural technology, infrastructure and human development. These spatial data sets of the key indicators contributing to agricultural vulnerability have been generated for the 161 districts in the IGP. These indicators were ranked; the weight of each factor was estimated using multi-criteria decision-making techniques, such as the analytic hierarchical process; and finally, the vulnerability maps of agriculture to climate change in the IGP districts were developed. These districts have been tabulated as per the vulnerability rank based on which highly vulnerable, medium-vulnerable and less-vulnerable districts have been identified. It has been found that the districts located in the eastern and southern parts of Uttar Pradesh and Bihar are the most vulnerable, whereas the districts in Punjab and Haryana have low vulnerability due to their higher adaptive capacity to recover from climatic stresses.

This chapter discusses climate change vulnerability in the context of Bihar based on both secondary and primary information. The secondary information on flood-related loss and damage for the districts of the State is analysed, and the values of a vulnerability index are computed, including both climate change and human development indicators. Furthermore, data collected through a primary survey of 700 households from 7 vulnerable districts of Bihar have been analysed to understand households' coping strategies following floods.

## 13.2 THE CONTEXT OF BIHAR

A systematic study on climate change impacts and vulnerability for Bihar has not yet been conducted. However, Bihar is one of the few States preparing a State-level action plan on climate change (BAPCC). The geographical location of the State and the existence of the river Ganga in the middle increase the vulnerability of the State. Bihar is highly vulnerable, especially to hydro-meteorological natural disasters, with North Bihar, in general, being highly flood-prone and South Bihar being highly drought-prone. Bihar is the 12th largest State in terms of geographical size (94,163 $km^2$) and the 3rd largest in the country in terms of population (10.38 crores population as per Census 2011). Nearly 88 per cent of the population in the State lives in villages. Bihar is also a densely populated region, with no less than 1102 persons living per $km^2$ of its area. As per the Planning Commission, in the year 2004–05, 41.4 per cent of the population lived below poverty line (BPL) in Bihar. As nine out of ten people on average live in the villages, poverty is more visible in rural areas. With the bifurcation of the State in November 2000, the newly created Jharkhand state inherited the mineral-rich and forest-rich parts of the State, and the present Bihar was left with its largely agro-based economy (Government of Bihar, 2012).

According to Singh et al. (2014), out of 38 districts, 27 districts in Bihar are found fully affected by high-speed winds of 47 m/s intensity. In districts including Banka, Jahanabad, Arwal, and Nalanda, nearly 90 per cent of the area is affected by this. Other districts of South Bihar (except Nawada) are partly affected by high-speed winds of 44 m/s. In all, 86 per cent of the total area of Bihar is prone to high-speed winds of 47 m/s intensity, and only 14 per cent of the area is prone to high-speed winds of lesser intensity. The study suggests mitigating the high-wind disasters by focusing on the factors causing climate change.

Chakraborty and Joshi (2016) in a study on mapping disaster vulnerability in India using the analytical hierarchical process observed that the districts in the States of Arunachal Pradesh, Assam, Bihar, Himachal Pradesh, Jharkhand, Manipur, Meghalaya, Mizoram, Uttar Pradesh, Uttarakhand, and West Bengal are the most vulnerable regions, whereas the districts in the States of Punjab, Haryana, Gujarat, Tamil Nadu, Maharashtra, Goa, Andhra Pradesh, Kerala, and Karnataka are among the least vulnerable regions. This study, based on the Intergovernmental Panel on Climate Change (IPCC) framework of measuring vulnerability to natural and climate-induced disasters, suggests that prior knowledge of the vulnerability of the system and ways to increase its adaptive capacity would help in reducing the adverse risks due to disasters. This study also noted that long-term developmental processes in India would be greatly influenced by the frequency and magnitude of the occurrence of natural and climate-induced disasters.

According to Madhuri et al. (2014) floods exaggerate the distressed conditions of the poor and vulnerable people in Bihar and floods have a differential impact on households depending on differences in their livelihood choices. Based on an the Livelihood Vulnerability Index, the study found that the absence of the basic livelihood assets like irrigation facilities, underdeveloped infrastructure, non-availability of agricultural inputs, and small and fragmented land holdings cause agriculture-dependent households in Bihar to suffer even more poverty and vulnerability. The study also revealed that better access to resources does not necessarily mean that households are adapting to climate change as the households' attitude and apathy also affect their adaptive capacity.

In an interesting study, Jha and Gundimeda (2019) studied vulnerability to flood hazards in Bihar and concluded that (i) Bihar is highly vulnerable to floods, and north Bihar is more vulnerable due to recurrent floods; and (ii) there is a strong spatial pattern among the vulnerable districts. They found that biophysical and social factors dominate and determine the varying degrees of vulnerability among the districts of Bihar. This study is based on a geo-hazard vulnerability index where multi-temporal remote sensing data are incorporated to evaluate the area statistics and dynamics of floods and waterlogging in shaping the vulnerability of the north Bihar districts. This study clearly observes that north

Bihar is more vulnerable than the south due to high exposure to floods based on their relative positions in sensitivity and adaptive capacity groups.

Giri (2015) analysed rainfall data for Bihar for 30 years from four stations and found that the frequency of extreme temperature events is increasing in Bihar. The frequency of rainfall events is classified into six classes (light, moderate, rather heavy, heavy, very heavy, and exceptionally heavy). The number of 'moderate' rainfall days (7.6–14.4 mm) decreased, whereas that of 'light rainfall' days increased in all the stations, except in Gaya. Similarly, the 'heavy rainfall' days (64.5–124.4 mm) decreased for three stations, except for Gaya. The number of rainy days for 'rather heavy' rainfall days (35.6–64.4 mm) increased for all the stations, except Bhagalpur, and the number of rainfall days for the 'heavy' rainfall category increased in three stations (the exception being Purnea). No case has been reported for the 'exceptionally heavy' category (> 244.5 mm) in those stations for about two decades. The frequency of extreme temperature events shows an increasing trend for the >35°C category for all the stations except Bhagalpur. The frequency in the >40°C category shows an increasing trend except for Gaya. The frequency of the >30°C category shows an increasing trend in all the stations, except Gaya and Bhagalpur.

### 13.2.1 Rainfall Trend in Bihar

Bihar's average rainfall is around 1000–1200 mm per year. The rainfall pattern for the State as a whole is displayed in Figure 13.1.

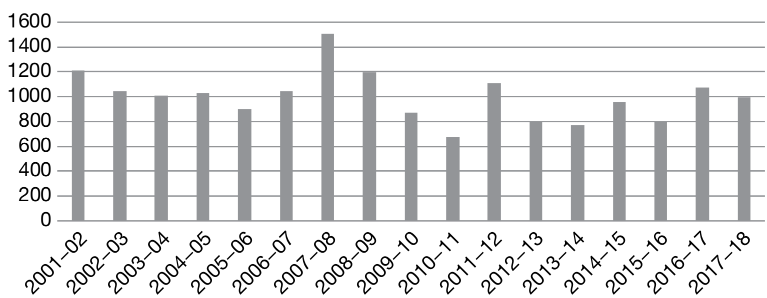



Figure 13.1 Yearly Trend in Annual Rainfall (mm) in Bihar

*Source:* Author's construction.

However, districts such as Saran, Kishanganj, Araria, and Madhepura recorded higher rainfall than the average rainfall frequently between the period 2001–02 and 2017–18.

### 13.2.2 Loss and Damage Due to Floods during the Period 2001–02 to 2018–19

District-level loss and damage information are collected from the Disaster Management Department of the Government of Bihar for the period 2001–02 to 2018–19[1]. We found that, on average, the highest number of people affected due to floods are from Darbhanga, followed by Sitamarhi and Muzaffarpur. As regards the number of animals affected due to floods, East Champaran comes first, followed by West Champaran and Sitamarhi. When we consider the average agricultural area/land affected due to floods during this period, West Champaran comes first. However, the maximum impact of floods in terms of crop loss (in lakh rupees) is observed in Sitamarhi, which is followed by Muzaffarpur, Madhubani, Darbhanga and Samastipur. Furthermore, the value of public properties lost during this period was highest in Madhepura. As regards the number of houses damaged over the period due to floods, Araria comes first, which is followed by Saharsha, Sitamarhi, Katihar and Kishanganj. In terms of human lives lost, the highest number of deaths occurred between 2001 and 2018 in Muzaffarpur, followed by Araria, Darbhanga, and Katihar. Finally, the average loss of animals during this period appeared to be highest in the Madhubani district.

It is clear that many districts in Bihar are highly vulnerable in terms of one parameter and/or the other. Overall, it may be said that the frequencies of high rainfall events are increasing in Bihar, and in terms of indicators like humans affected, livestock lost, and crop loss, districts like Muzaffarpur, Araria, Darbhanga, Sitamarhi have been at the receiving end during 2001–2018.

## 13.3 VULNERABILITY LEVELS OF THE DISTRICTS

Considering the speed at which climate change is happening due to the rise in global temperature, there is an urgent need that the vulnerability of developing countries to climate change must be reduced and their capacity to adapt must be increased. In a country like India, enhancing adaptive capacity is a necessary condition for reducing vulnerability, which can be achieved through the implementation of national adaptation plans or by linking these plans along with economic development programmes. Furthermore, future vulnerability depends not only on climate change but also on the type of development path that is pursued today. The vulnerability of human populations varies with economic, social, and institutional conditions. For example, in a study by O'Brien et al. (2004), it has been observed that the districts of southern Bihar have a higher adaptive capacity than those of northern Bihar. However, more detailed studies on this area are needed to have proper planning towards improving adaptive capacity and reducing vulnerability.

In the following, we seek to construct vulnerability indices for the districts of Bihar. The indicators chosen for this purpose belonged to the following five categories: income, demographics, health, education, and climate change (see Figure 13.2). The income indicator includes district-wise data on per capita Gross Domestic Product (GDP) and small savings; demographic indicators include the population, number of BPL families, marginal workers and children below 7 years; health indicators include infant mortality rate (IMR) and the number of population per health institution; education indicators are literacy rate and the number of primary and upper primary schools in the districts; and climate change indicators are rainfall, temperature, number of rainy days, and waterlogged areas. The data on these indicators have been collected from various secondary sources like the Economic Review of Bihar, Census 2011, and the Indian Meteorological Department.

The method followed to compute vulnerability indices is the same as the process followed for deriving the human development index. Thus, after selecting appropriate indicator variables, the next step is to bring all the variables into a standardised or normalised form. The most commonly used normalisation procedure is one that adjusts the variables to take a value between 0 and 1, by using the following formula (Downing & Patwardhan, 2003):

$$Vij = \frac{(Xij - \min Xi)}{\max Xi - \min Xi}$$

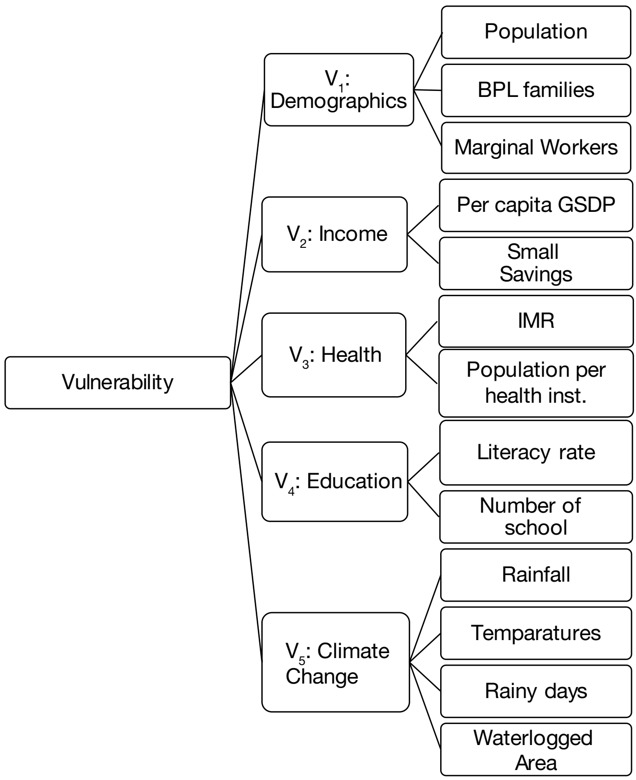



Figure 13.2 Indicators of Socio-economic Vulnerability

*Source:* Constructed by author.

where *Vij* stands for the standardised variables associated with *i*th component for district *j*; *Xij* is the value of the *i*th indicator in the vulnerability index for district *j*; and max *Xi* and min *Xi* are the maximum and minimum values of the *i*th indicator considering all districts, respectively.

Once the normalisation is done with the help of the above-mentioned formula, the next step is to assign appropriate weights (equal or varying) to the average value in order to derive the aggregate value. To assign the weights to the indicators, we have applied the Principal Component Analysis. In the next step, the aggregate values for the indicators are derived, and based on those aggregate values, the districts are ranked to identify the most vulnerable districts in the State (having the highest rank is more vulnerable).

The indicator scores and corresponding ranks for 38 districts of Bihar are presented in Table 13.1. It is found that there is significant variation in income and other indicators among the districts. In terms of demographic indicators ($V_1$), East Champaran ranks first among 38 districts, and Sheikhpura ranks the lowest. The size of the population and the number of BPL families are high in the Sheikhpura district. In the case of the income index ($V_2$), Patna tops the list of districts, and Sheohar comes last, meaning that economic vulnerability is least in Patna and highest in Sheohar. One of the interesting facts noticed during the analysis is that per capita GSDP in Patna district is ₹63,063 only, whereas the same in Munger district (second-ranked on this basis) is ₹22,051 only, and for Sheohar district (lowest-ranked), it is ₹7092 only. In the case of health ($V_3$) and education ($V_4$) indicators, the highest rank is obtained by Nawada and Patna districts, respectively. The lowest-ranked districts on the basis of health and education indicators are Sitamarhi and Sheohar, respectively. In the case of $V_5$, which represents the climate change index, Patna is having rank one, which means that it is facing issues of high rainfall, more waterlogging and high temperature. The lowest rank in this regard is obtained by the Jamui district.

## 13.4 COPING STRATEGY OF THE HOUSEHOLDS

Various risk-coping strategies are adopted by households to overcome disaster-related outcomes. These strategies include reduction of consumption expenditure, using credit to smooth consumption by reallocating future resources to today's consumption, accumulating financial and physical assets as a precautionary device against unexpected income shortfalls, and so on. In addition, the households receiving remittances in an emergency is a kind of risk-coping behaviour (Sawada, 2006). Swada and Shimizutani (2007) investigated the responses of the three risk-coping strategies, i.e., borrowing, receiving transfer income, and dissaving against various negative shocks caused by the earthquake following the approach of Flavin (1999). Jha et al. (2017) also studied migration as a coping strategy and found that livelihood risk factors are major drivers of farmers' migration. According to Patnaik and Narayanan (2015), households develop a variety of risk-coping mechanisms to hedge

Table 13.1 Indicator Scores and Ranks for the Districts in Bihar

| ***District*** | ***$V_1$*** | ***Rank*** | ***$V_2$*** | ***Rank*** | ***$V_3$*** | ***Rank*** | ***$V_4$*** | ***Rank*** | ***$V_5$*** | ***Rank*** |
|---|---|---|---|---|---|---|---|---|---|---|
| Araria | 0.527 | 17 | 0.033 | 35 | 0.723 | 35 | 0.270 | 30 | 0.845 | 6 |
| Arwal | 0.034 | 36 | 0.043 | 33 | 0.255 | 12 | 0.368 | 26 | 0.572 | 10 |
| Aurangabad | 0.428 | 22 | 0.178 | 16 | 0.160 | 8 | 0.714 | 8 | 0.332 | 26 |
| Banka | 0.395 | 24 | 0.023 | 37 | 0.020 | 2 | 0.402 | 24 | 0.293 | 30 |
| Begusarai | 0.513 | 18 | 0.222 | 13 | 0.153 | 7 | 0.477 | 19 | 0.163 | 35 |
| Bhagalpur | 0.583 | 13 | 0.227 | 11 | 0.373 | 20 | 0.516 | 18 | 0.392 | 21 |
| Bhojpur | 0.427 | 23 | 0.312 | 5 | 0.094 | 3 | 0.744 | 5 | 0.500 | 13 |
| Buxar | 0.225 | 32 | 0.145 | 18 | 0.443 | 24 | 0.567 | 14 | 0.289 | 31 |
| Darbhanga | 0.730 | 8 | 0.231 | 10 | 0.551 | 28 | 0.436 | 21 | 0.367 | 24 |
| Gaya | 0.786 | 7 | 0.257 | 8 | 0.358 | 19 | 0.761 | 3 | 0.465 | 14 |
| Gopalganj | 0.432 | 21 | 0.191 | 15 | 0.437 | 22 | 0.542 | 17 | 0.510 | 11 |
| Jamui | 0.334 | 28 | 0.063 | 29 | 0.152 | 6 | 0.406 | 23 | 0.000 | 38 |
| Jehanabad | 0.115 | 34 | 0.076 | 27 | 0.313 | 17 | 0.424 | 22 | 0.437 | 16 |
| Kaimur (Bhabua) | 0.253 | 30 | 0.087 | 25 | 0.308 | 16 | 0.545 | 16 | 0.211 | 33 |
| Katihar | 0.582 | 14 | 0.098 | 23 | 0.377 | 21 | 0.227 | 32 | 0.435 | 18 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Khagaria | 0.299 | 29 | 0.054 | 32 | 0.631 | 32 | 0.226 | 33 | 0.065 | 37 |
| Kishanganj | 0.248 | 31 | 0.032 | 37 | 0.705 | 34 | 0.190 | 35 | 0.824 | 7 |
| Lakhisarai | 0.071 | 35 | 0.071 | 28 | 0.262 | 13 | 0.285 | 28 | 0.437 | 17 |
| Madhepura | 0.380 | 25 | 0.056 | 30 | 0.615 | 30 | 0.154 | 36 | 0.198 | 34 |
| Madhubani | 0.999 | 2 | 0.141 | 19 | 0.355 | 18 | 0.634 | 10 | 0.127 | 36 |
| Munger | 0.161 | 33 | 0.223 | 12 | 0.170 | 9 | 0.549 | 15 | 0.351 | 25 |
| Muzaffarpur | 0.909 | 4 | 0.317 | 4 | 0.472 | 26 | 0.760 | 4 | 0.903 | 4 |
| Nalanda | 0.527 | 16 | 0.385 | 3 | 0.120 | 4 | 0.615 | 11 | 0.503 | 12 |
| Nawada | 0.346 | 27 | 0.265 | 7 | 0.000 | 1 | 0.381 | 25 | 0.370 | 22 |
| West Champaran | 0.839 | 5 | 0.169 | 17 | 0.438 | 23 | 0.448 | 20 | 0.940 | 3 |
| Patna | 0.921 | 3 | 1.000 | 1 | 0.238 | 10 | 1.000 | 1 | 1.000 | 1 |
| East Champaran | 1.000 | 1 | 0.125 | 21 | 0.698 | 33 | 0.573 | 13 | 0.846 | 5 |
| Purnia | 0.651 | 10 | 0.091 | 24 | 0.517 | 27 | 0.221 | 34 | 0.990 | 2 |
| Rohtas | 0.503 | 19 | 0.214 | 14 | 0.568 | 29 | 0.818 | 2 | 0.369 | 23 |
| Saharsa | 0.350 | 26 | 0.110 | 22 | 0.631 | 31 | 0.145 | 37 | 0.314 | 27 |
| Samastipur | 0.788 | 6 | 0.140 | 20 | 0.459 | 25 | 0.610 | 12 | 0.425 | 19 |

*(Continued)*

Table 12.2 (Continued)

| ***District*** | ***$V_1$*** | ***Rank*** | ***$V_2$*** | ***Rank*** | ***$V_3$*** | ***Rank*** | ***$V_4$*** | ***Rank*** | ***$V_5$*** | ***Rank*** |
|---|---|---|---|---|---|---|---|---|---|---|
| Saran | 0.690 | 9 | 0.478 | 2 | 0.307 | 15 | 0.724 | 7 | 0.616 | 9 |
| Sheikhpura | 0.000 | 38 | 0.037 | 34 | 0.251 | 11 | 0.263 | 31 | 0.401 | 20 |
| Sheohar | 0.002 | 37 | 0.000 | 38 | 0.778 | 37 | 0.000 | 38 | 0.302 | 29 |
| Sitamarhi | 0.611 | 12 | 0.079 | 26 | 1.000 | 38 | 0.282 | 29 | 0.302 | 28 |
| Siwan | 0.570 | 15 | 0.282 | 6 | 0.136 | 5 | 0.730 | 6 | 0.438 | 15 |
| Supaul | 0.450 | 20 | 0.055 | 31 | 0.743 | 36 | 0.349 | 27 | 0.222 | 32 |
| Vaishali | 0.624 | 11 | 0.238 | 9 | 0.267 | 14 | 0.643 | 9 | 0.673 | 8 |

*Source:* Computed by author.

against the impacts of shocks (both ex-ante and ex-post). The ex-ante measures are crop and asset diversification, migration, and specialisation into low-risk activities, whereas ex-post measures include dissaving, insurance, borrowings, monetary transfer from relatives, etc. Their study also explores whether the informal coping mechanisms are helpful in covering the fluctuations in consumption faced by households following an extreme weather event.

We have undertaken a study on coping strategies adopted by 700 households in Bihar. The prevailing coping strategies are migration, financial transfer, loans/borrowings, and relief. These households are randomly selected from a total of 19 villages spread over 7 flood-affected districts of Bihar. The survey data were collected during April–June 2021. The following four binary-dependent variable models are estimated using the multivariate probability approach outlined by Cappellari and Jenkins (2013). The dependent variables are four coping strategies following the flood-related shock, which are migration, finance transfer, loan and relief. The independent variables include household-specific shock variables, i.e., if there is damage to the house, damage to crops, livestock loss, the prevalence of diseases and loss of livelihood in the family due to the recent flood as well as other household characteristics, including the age of the family head, type of household (above poverty line (APL)/BPL), education level of the head of household, if the family has children below 14 years of age, type of roofing, including katcha and pucca and if there is a saving account in the family.

$$\Delta Mgi = Si\theta_1 + Hi\beta_1 + \varepsilon_{1i} \tag{13.1}$$

$$\Delta TYi = Si\theta_2 + Hi\beta_2 + \varepsilon_{2i} \tag{13.2}$$

$$\Delta Lni = Si\theta_3 + Hi\beta_3 + \varepsilon_{3i} \tag{13.3}$$

$$\Delta Bri = Si\theta_4 + Hi\beta_4 + \varepsilon_{4i} \tag{13.4}$$

$p1i = 1$ if $\Delta Mgi > 0$ and 0 otherwise
$p2i = 1$ if $\Delta Tyi > 0$ and 0 otherwise
$p3i = 1$ if $\Delta Lni > 0$ and 0 otherwise
$p4i = 1$ if $\Delta Bri > 0$ and 0 otherwise

In equations 13.1–13.4, $S$ represents a matrix of household-specific shock variables generated by the flood and $H$ is a matrix of household characteristics and other control variables. Instead of the intensities of the risk-coping strategy, dependent variables in equations express whether a household adopted a particular risk-coping strategy against the flood-induced shock, which can be represented by a discrete variable, $p_m$, $m = 1, 2, 3$, and 4. The variance–covariance matrix of $\varepsilon_{mi}$ is symmetric, and the covariances are assumed to be non-zero. The dependent variables are in the binary form, assuming value '1' if the household is adopting a particular coping strategy, and '0' otherwise.

The results presented in Table 13.2 show that there is a positive and statistically significant relation between migration as a coping strategy and only one shock variable, which is the prevalence of disease; age of the household head and savings in the family also show a significant relationship with migration. On the other hand, the relation between migration as a coping strategy and the education level of the household head is negative and statistically significant. This means that a household plagued by a disease of one or more of its members that involve expenditures for medical treatment prefers migration as the option to cope with the crisis. It is also found that while the heads of households with higher age adopt migration as a coping strategy, more educated household heads do not prefer this mode of coping mechanism.

It is also evident from Table 13.2 that financial transfer as a coping strategy helps to deal with crop loss and livestock loss, and these are immediate losses due to flood. Financial transfer as a coping strategy is also adopted by more aged and educated household heads. However, disease and house damage are negatively related to the financial transfer. This might be both because the households suffering from such shocks are the poorer ones and the focus of financial transfer is to cope with the shocks obtained due to crops and/or livestock loss. Loans or borrowing is used as a coping strategy to overcome various shocks. Crops and livestock loss, as well as house damage, compel households to adopt borrowing as a coping strategy. However, livelihood loss and age of the household have a negative relation with borrowing. The results suggest that it is difficult to rebuild livelihood loss on borrowing. On the other

Table 13.2 Estimation Results of Coping Strategies

| Independent Variables/ Shock and Household Characteristics Variables | Dependent Variable/Coping Strategy | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Migration | | Finance Transfer | | Loan | | Relief | |
| | Est. Coeff. | S.E. | Est. Coeff. | S.E. | Est. Coeff. | S.E. | Est. Coeff. | S.E. |
| House damage | – 0.13 | 0.12 | –0.4 | 0.13*** | 0.73 | 0.13*** | 0.26 | 0.13** |
| Crops damage | –0.17 | 0.11 | 0.37 | 0.12*** | 0.23 | 0.11** | 0.17 | 0.11 |
| Livestock loss | –0.04 | 0.18 | 0.56 | 0.19*** | 0.43 | 0.19** | 0.15 | 0.2 |
| Disease | 0.51 | 0.19*** | –0.73 | 0.19*** | 0.18 | 0.19 | –0.23 | 0.21 |
| Livelihood loss | –0.05 | 0.09 | –0.15 | 0.1 | –0.34 | 0.1*** | –0.33 | 0.1*** |
| Age | 0.007 | 0.003** | 0.01 | 0.003*** | –0.01 | 0.003*** | 0.01 | 0.003*** |
| Household type | –0.09 | 0.12 | 0.15 | 0.12 | 0.17 | 0.12 | 0.45 | 0.13*** |
| Education level | –0.05 | 0.03** | 0.07 | 0.03** | –0.05 | 0.03 | 0.005 | 0.03 |
| Children below 14 years | 0.03 | 0.02 | –0.0004 | 0.02 | 0.03 | 0.02 | –0.04 | 0.02* |
| Type of roofing | –0.03 | 0.03 | 0.04 | 0.03 | –0.08 | 0.03** | –0.05 | 0.03* |
| Saving account in the family | 0.54 | 0.33*** | 0.12 | 0.32 | 0.79 | 0.34** | –0.05 | 0.33 |
| Constant | –0.97 | 0.41* | –0.56 | 0.41 | –0.96 | 0.44** | 0.38 | 0.41 |
| Log-likelihood | –1624.81 | | | | | | | |
| Wald-stat | 255.91 | | | | | | | |
| Chi-square | 17 | | | | | | | |

*Source:* Computed by author.

*Notes:* (i) We have considered robust standard errors here; and (ii) *, ** and *** imply significance at 1, 5 and 10 per cent levels, respectively.

hand, relief appears to be the coping mechanism in the event of house damage. Again, livelihood loss shows a significant negative relation with relief as a coping strategy, reflecting that relief is not used as a coping strategy for livelihood loss, and a similar result is also derived in the case of borrowings. Furthermore, while the age of the household head and type of household show significant positive relation with relief, this suggests that the relief provided by the State Government is reaching needy families; similarly children below 14, type of roofing and having a savings account show significant negative relation with relief received.

## 13.5 CONCLUSION

This chapter discussed some issues related to climate change in the context of Bihar. Agriculture in Bihar is affected most by climate change. A rise in temperature and change in rainfall increase the vulnerability of large poor communities depending on agriculture. Bihar is one of the poorest states in India and is exposed to many natural hazards. Ganga and many other rivers, especially the Koshi, enhance the vulnerability of the State.

Vulnerability to climate change is a multidisciplinary concept. There are many issues related to vulnerability, like its definition, measurement and the availability of data. There are few studies available measuring vulnerability at the community level (Senapati & Gupta, 2017). The district-level vulnerability mapping for Bihar reveals that flood and drought are the main factors increasing the vulnerability of the people, the majority of whom live in rural areas. We observed that districts of Bihar vary widely in terms of indicator scores of vulnerabilities. However, there are a few districts that consistently get low rank in most of the indicators and, therefore, are designated as high-vulnerability districts (examples, Sheohar, Kishanganj and Arwal). Similarly, districts like Patna, Nalanda, and Vaishali are getting a high rank in most of the indicators (indicating low vulnerability level), although Patna is highly vulnerable to climate change indicators.

Furthermore, we observed that the frequency of high-rainfall events is increasing across Bihar, thereby affecting the people apart from resulting in livestock and crop losses. Among the districts, Muzaffarpur, Araria, Darbhanga and Sitamarhi are the most flood-affected districts. Analysing the coping strategies adopted by the people in the event of floods, we found that the relief received, loans and borrowings and, to some extent, financial transfers are the coping instruments adopted by the households affected by the floods. On the other hand, migration is adopted relatively less as a coping instrument to deal with the impact of flood.

To end, we would like to mention that human development is linked significantly to climate change and the action to deal with climate change also deals with human development. Improved planning for rainwater management, urban planning, better health facilities, education, and the scheme to improve the income of the poor would reduce the vulnerability of poor people living in Bihar. This study, being dependent on the limited indicators of vulnerability on which secondary data are available, needs to be expanded further using primary data that could provide a much better understanding of the vulnerability levels of different segments of the population as well as the coping strategies adopted by them. This is surely an area for future research.

## NOTE

1. The detailed data tables have not been presented due to limitations of space.

## REFERENCES

Aandahal, G., & O'Brien, K., (2001). *Vulnerability to climate changes and economic changes in Indian agriculture*. Centre for Climate and Environmental Research.

Cappellari, L., & Jenkins, P. (2003). Multivariate probit regression using simulated maximum likelihood. *STATA Journal*, *3*(3), 278–294.

Chakraborty, A., & Joshi, P. K. (2016). Mapping disaster vulnerability in India using analytical hierarchy process. *Geomatics, Natural Hazards and Risk, 7*(1), 308–325.

Downing, T. E., & Patwardhan, A., (2003). *Vulnerability assessment for climate adaptation* (APF Technical Paper, 3). United Nations Development Programme, New York.

Flavin, M. (1999). *Robust estimation of the joint consumption/asset demand decision*. (Working Paper Number 7011). NBER.

Giri, R. K., (2015). The study of temperature and rainfall over Bihar Region. *International Journal of Applied Engineering and Technology, 5*(2), 67–84.

Government of Bihar. (2012). Bihar action plan for climate change, building resilience through development. Draft on State Action Plan on Climate Change. https://ncdc.gov.in/WriteReadData/l892s/6345664691632304060.pdf

Jha, C. K., Gupta, V., Chottopadhayay, U., & Sreeraman, B. K., (2017). Migration as adaptation strategy to cope with climate change: A study of farmers' migration in rural India. *International Journal of Climate Change Strategies and Management, 10*(1), 121–141

Jha, R., & Gundimeda, H., (2019). An integrated assessment of vulnerability to floods using composite index: A district level analysis for Bihar, India. *International Journal of Disaster Risk Reduction*. doi: https://doi.org/10.1016/j.ijdrr.2019.101074.

Madhuri, Tewari, H. R., & Bhowmik, P. K. (2014). Livelihood vulnerability index analysis: An approach to study vulnerability in the context of Bihar. *Original Research*, *6*(1), 1–13.

O'Brien, K. L. et al. (2004). Mapping vulnerability to multiple stressors: Climate change and globalization in India. *Global Environmental Change, 14*, 303–313.

Patnaik, U., & Narayanan, K., (2015). Are traditional coping mechanisms effective in managing the risk against extreme events? Evidences from flood-prone region in rural India. *Water Policy, 17*, 724–741.

Sawada, Y., (2006). The impact of natural and manmade disasters on household welfare, paper presented at *International Association of Agricultural Economists Conference*, Gold Coast, Australia, 12–18 August.

Sawada, Y., & Shimizutani, S. (2007). Consumption insurance against natural disasters: Evidence from the great Hanshin-Awaji (Kobe) earthquake. *Applied Economics Letters, 14*(4), 303–306.

Sehgal, V. K. et al. (2013). *Vulnerability of agriculture to climate change: District level assessment in the Indo-Gangetic plains*. Indian Agricultural Research Institute, New Delhi.

Senapati, S., & Gupta, V. (2017). Socio-economic vulnerability due to climate change: Deriving indicators for fishing communities in Mumbai. *Marine Policy, 76*, 90–97.

Singh, C. S. et al. (2014). Disastrous challenge due to climate change in Bihar, developing State of India. *International Journal of Scientific & Engineering Research*, *5*(6), 1038–1041.

# PART V

# CREDIT AND TECHNOLOGY FOR AGRICULTURE

# CHAPTER 14

# INSTITUTIONAL CREDIT FLOW TO AGRICULTURE SECTOR

## Issues and Prospects

***Bibhudatta Nayak***

## 14.1 INTRODUCTION

The importance of credit for the development of an economy cannot be undermined. A study to assess the impact of agricultural credit on agricultural production observed a credit elasticity of 0.574 to agriculture GDP during the period 2004–05 to 2011–12 in Bihar (Narayanan, 2015), which means that a 1 per cent increase in institutional credit flow to agriculture was associated with a 0.574 per cent increase in agricultural GDP of the State during this period. Institutional credit is one of the basic and crucial inputs in agriculture as it enables farmers to procure various inputs adequately and on time for agricultural operations. Due to various reforms in the banking sector and also the policies of the Government, institutional credit has become available to the farmers at a very low rate of interest, both for crop husbandry and investment in capital formation. The relevance of institutional credit to the agriculture sector becomes significant where the financial health of the farmers is weak and the agrarian scenario is predominated by the marginal and small farmers, as is the scenario in Bihar. These

**Disclaimer**: Views expressed here are personal.

farmers need to adopt intensive farming, even if it is farming for subsistence, as the yield per unit of land has to improve substantially.

Bihar is predominantly an agrarian state that accounts for 11.2 per cent of agricultural landholdings and 4.1 per cent of the agricultural land of the country (GoI, 2020). Around 91.2 per cent of landholdings in Bihar belong to the 'marginal' category with the average size of holding for this category being 0.25 ha. The average annual income from all sources of farmer households in Bihar was about ₹90,500, which is 26 per cent less than the national average income (SAS, 2021). In such a situation, institutional credit becomes vital to facilitate the farmers to source low-cost funds to procure their inputs and undertake capital investments. However, hardly 19 per cent of farmers in rural Bihar avail credit support either from institutional sources or both from institutional and non-institutional sources, as against 30 per cent at the all-India level (AIDIS, 2021). A host of factors cause low institutional credit flow in the State.

As against the above background, this chapter examines the status of institutional credit flow to the agriculture sector in Bihar and looks at the demand- and supply-side factors that are responsible for low credit offtake in the farm sector. This chapter also provides some recommendations for the horizontal and vertical expansion of institutional credit flow to the agriculture sector in Bihar.

## 14.2 STATE OF AGRICULTURE IN BIHAR

The economy of Bihar has been growing at a faster pace since 2017–18 as compared to the rate of growth at the national level (Figure 14.1). The agriculture sector contributed significantly to the economy of the State, accounting for 20 per cent of Gross State Value Added, even though it encountered pitfalls of an uncertain climate. Although Bihar occupies 3.8 per cent of the geographical area and 3.7 per cent of the Net Sown Area of India, it accommodates 8.6 per cent of the country's population, making it one of the most densely populated states of the country. About 56 per cent of the geographic area of the State is put under cultivation, with a cropping intensity of about 145 per cent. Cereals, like paddy, wheat, and maize, account for 87 per cent of the total cropped area, whereas pulses account for 7 per cent. The State accounts for 5.5 per cent of foodgrains production, 9.0 per cent of vegetables production, and 4.4 per cent of fruits production of the country.

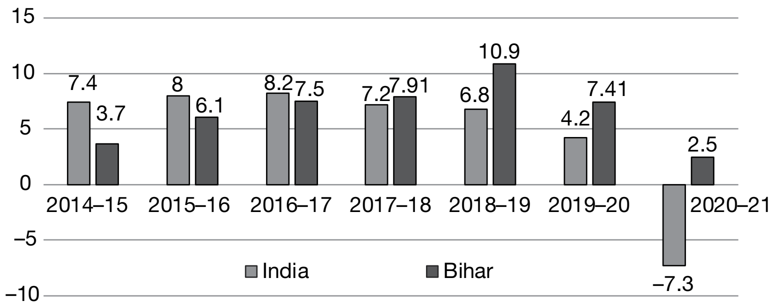



Figure 14.1 Annual GDP/GSDP Growth Rate in India and Bihar (per cent) (at Constant Prices)

*Source:* Handbook of Statistics of the Indian Economy 2020–21 (RBI, 2021).

Allied activities, like milk production, poultry, sheep and goat-rearing, and fish production, are also gaining prominence in the State.

Cultivation in Bihar is undertaken in all the three cropping seasons. Although irrigation potential has been created for about 71 per cent of the gross cropped area (GCA), agriculture in the State is still sensitive to the vagaries of rainfall. However, agricultural output in the State has witnessed an upward trend in recent years on the strength of increased productivity. Between 2014–15 and 2019–20, even though the volume of paddy production declined by 16 per cent, production of total foodgrains, total cereals, wheat, and maize increased by 11 per cent, 12 per cent, 56 per cent and 61 per cent, respectively (Table 14.1). Of late, the area and production under *Rabi* crops, like maize, pulses, barley, and ground nut, have been increasing, whereas the production of *Kharif* crops got affected due to floods in North Bihar and droughts in south Bihar. The cropping pattern has made a shift towards high-value crops like vegetables, fruits and millet in recent years (BES, 2021). Following the package of improved cultivation practices, farm mechanisation and judicious application of inputs, the farm yield increased. Credit flow from institutional sources has contributed to enhancing farming activities in the State.

## 14.3 STATUS OF INSTITUTIONAL CREDIT FLOW TO AGRICULTURE SECTOR IN BIHAR

The incidence of indebtedness from institutional sources among the cultivators has been second-lowest in Bihar among the major

Table 14.1 Production of Major Crops in Bihar (Thousand Tons)

| Major Crops | 2014–15 | 2015–16 | 2016–17 | 2017–18 | 2018–19 | 2019–20 | CAGR |
|---|---|---|---|---|---|---|---|
| Total foodgrains | 14,750 | 14,508 | 18,560 | 17,802 | 16,311 | 16,380 | 2.41 |
| Total cereals | 14,321 | 14,087 | 18,099 | 17,348 | 15,858 | 16,045 | 2.55 |
| Total paddy | 8241 | 6802 | 8238 | 8093 | 6155 | 6953 | –3.28 |
| Wheat | 3570 | 4736 | 5985 | 6104 | 6465 | 5579 | 9.53 |
| Total maize | 2478 | 2517 | 3845 | 3120 | 3193 | 3995 | 8.62 |
| Total pulses | 429 | 421 | 462 | 454 | 453 | 334 | –2.95 |
| Kharif pulses | 34 | 29 | 29 | 22 | 23 | 20 | –9.84 |
| Rabi pulses | 395 | 392 | 332 | 432 | 430 | 315 | –1.67 |
| Total oilseeds | 127 | 126 | 126 | 124 | 125 | 130 | 0.22 |
| Total fibre crops | 1637 | 1630 | 1571 | 1280 | 1085 | 802 | –13.30 |

*Source:* Bihar Economic Survey, 2020–21.

states of India, next to Jharkhand (Table 14.2). Furthermore, Bihar is the only State where the incidence of indebtedness from non-institutional sources is more than the institutional sources. The average outstanding debt of a cultivator household in Bihar is nearly 41 per cent of the national average, and it is about one-sixth of Kerala, one-fifth of Haryana and Punjab, and one-third of Andhra Pradesh and Rajasthan.

The ratio of institutional credit to gross value added in agriculture (at current prices) in Bihar has remained lower than the same for the all-India level for most of the years during 2011–12 to 2020–21 (Table 14.3). This indicates a situation of relatively low productivity in the agriculture sector to bank credit in Bihar. Although the compound annual growth rate (CAGR) of institutional credit to agriculture is found to be higher than the CAGR for the value added in agriculture during the period 2011–2021, the situation got reversed in recent years (2015–2021) when the CAGR for

Table 14.2 Incidence of Indebtedness in Major States of India

| States | Average Outstanding Debt (Thousand Rupees) | | | Incidence of Indebtedness of Cultivators (per cent) | | | |
|---|---|---|---|---|---|---|---|
| | Rural House-hold | Cultiva-tor House-hold | Indeb-ted Cultiv-ator House-hold | Institu-tional only | Non-institu-tional only | Both | All |
| Andhra Pradesh | 127 | 207 | 275 | 26.7 | 16.5 | 31.9 | 75.1 |
| Assam | 16 | 18 | 80 | 17.5 | 3.9 | 1.1 | 22.5 |
| **Bihar** | **19** | **26** | **77** | **12.8** | **13.9** | **6.8** | **33.5** |
| Chhattisgarh | 13 | 14 | 66 | 16 | 3.9 | 1.1 | 21.0 |
| Gujarat | 50 | 66 | 181 | 24.8 | 7.0 | 4.6 | 36.4 |
| Haryana | 94 | 159 | 402 | 19.4 | 8.3 | 12.0 | 39.7 |
| Jharkhand | 10 | 11 | 41 | 10.9 | 8.4 | 3.2 | 22.5 |
| Karnataka | 90 | 110 | 180 | 29 | 10.8 | 19.4 | 59.2 |
| Kerala | 241 | 260 | 450 | 39.4 | 5.4 | 12.9 | 57.7 |
| Madhya Pradesh | 62 | 77 | 177 | 22.3 | 14.0 | 7.4 | 43.7 |
| Maharashtra | 89 | 125 | 275 | 33 | 5.6 | 6.9 | 45.5 |
| Odisha | 31 | 34 | 74 | 24.2 | 10.1 | 12.1 | 46.4 |
| Punjab | 98 | 198 | 388 | 26.2 | 12.7 | 12.1 | 51.0 |
| Rajasthan | 104 | 125 | 258 | 20.1 | 18.2 | 10.2 | 48.5 |
| Tamil Nadu | 53 | 90 | 184 | 28.4 | 7.9 | 12.7 | 49.0 |
| Telangana | 98 | 128 | 153 | 32.7 | 15.4 | 35.6 | 83.7 |
| Uttar Pradesh | 40 | 48 | 140 | 16.7 | 11.3 | 6.0 | 34.0 |
| West Bengal | 18 | 21 | 81 | 17.4 | 5.7 | 3.1 | 26.2 |
| **All India** | **60** | **74** | **185** | **21.2** | **10.3** | **8.8** | **40.3** |

*Source:* AIDIS 2019, 77th Round of NSSO.

Table 14.3 Institutional Credit and Gross Value Added in Agriculture (at Current Prices) in Bihar and India

| Year | Bihar | | | India | | |
|---|---|---|---|---|---|---|
| | Gross Value Added in Agrl. (Rs. Crore) | Agrl. Credit (Rs. Crore) | Ratio of Agrl. Credit to Agrl. GVA (per cent) | Gross Value Added in Agrl. (Rs. Crore) | Agrl. Credit (Rs. Crore) | Ratio of Agrl. Credit to Agrl. GVA (per cent) |
| 2011–12 | 62,067 | 14,958 | 24.1 | 15,01,947 | 5,11,029 | 34.02 |
| 2012–13 | 76,700 | 21,566 | 28.12 | 16,75,107 | 6,07,375 | 36.26 |
| 2013–14 | 73,719 | 28,770 | 39.03 | 19,26,372 | 7,30,122 | 37.9 |
| 2014–15 | 78,632 | 34,680 | 44.1 | 20,93,612 | 8,45,328 | 40.38 |
| 2015–16 | 84,284 | 41,348 | 49.06 | 22,27,533 | 9,15,509 | 41.1 |
| 2016–17 | 98,559 | 41,076 | 41.68 | 25,18,662 | 10,65,755 | 42.31 |
| 2017–18 | 1,12,153 | 42,161 | 37.59 | 28,29,826 | 11,62,617 | 41.08 |
| 2018–19 | 1,12,153 | 43,621 | 38.89 | 30,16,277 | 12,56,830 | 41.67 |
| 2019–20 | 1,17,196 | 41,449 | 35.37 | 33,94,033 | 13,92,729 | 41.03 |
| 2020–21 | 1,29,852 | 48,695 | 37.5 | 35,87,986 | 15,60,000 | 43.48 |
| CAGR: 2011–2021 | 8.2 | 11.4 | | 10.2 | 12.7 | |
| CAGR: 2015–2021 | 8.0 | 2.5 | | 10.0 | 10.7 | |

*Source:* GoI (2021).

institutional credit to agriculture (2.5 per cent) fell far short of the CAGR for value added in agriculture (8.0 per cent).

The ground-level credit flow (GLC) from institutional sources to the agriculture sector in Bihar in 2020–21 was ₹48,695 crores only, out of which 28 per cent went to the self-help groups (SHGs) and joint liability groups (JLGs). During the past six years (2015–16 to 2020–21), the CAGR of the total institutional credit flow to the agriculture sector in the State was only 2.5 per cent, even after taking the credit flow to SHGs, JLGs and others into account (Table 14.4). On the other hand, during the said period, the CAGR of crop loans, which is the short-term credit provided to farmers through Kisan Credit Cards (KCC) for meeting the financial needs for procuring inputs, was negative. In absolute terms, the quantum of crop loans disbursed has declined by 30 per cent between 2016–17 and 2020–21. The share of total agricultural loans in total priority sector (TPS) loans has registered a decline from 68 per cent in 2015–16 to 56 per cent in 2020–21.

The GLC for the agriculture sector includes short-term credit, which is known as crop loan, advanced by banks to the farmers through KCC. Crop loan is crucial for enabling the farmers to carry out agricultural operations as it enables them to purchase various inputs as required. On the other hand, medium- and long-term credit (Agri Term Loan) is meant for investments in agriculture and allied activities, leading to capital formation in the agriculture sector. Out of the total agricultural credit disbursement in Bihar, the share of crop loans was about 41 per cent in 2020–21, which has been steadily coming down from 59 per cent in 2016–17, the corresponding figures for the national level remained at 57 per cent and 65 per cent, respectively. Low crop loan disbursement deprives a majority of farmers from availing low-cost institutional loan support for the procurement of inputs for crop husbandry.

The average per account crop loan amount in Bihar is about 6 per cent less than that of the national average (Table 14.5). However, the point to be noted is that the number of loan accounts availing crop loan is only 13 per cent of agricultural landholdings in Bihar as compared to 65 per cent across the country. It is quite probable that in Bihar, large landholders avail crop loans from banks in bigger amounts, which is why the average crop loan nears the national average. A majority of the marginal farmers, on the other hand, might be meeting their credit requirements from informal sources. The scenario with regard to disbursement of agricultural term loan in the State is not bright either, even though a major part of agricultural credit in the State goes as term loan. The average per account term loan disbursement in Bihar is 45 per cent of the national average (Table 14.5). On the other hand, the average crop

Table 14.4 Institutional Credit Flow in Bihar (in Crore)

| Particulars | 2015–16 | 2016–17 | 2017–18 | 2018–19 | 2019–20 | 2020–21 | CAGR (%) |
|---|---|---|---|---|---|---|---|
| 1.Crop loan | 23,506 | 24,458 | 21,900 | 19,446 | 17,695 | 17,094 | –7.4 |
| 2. Agri. Term loan | 17,844 | 13973 | 13547 | 17218 | 16148 | 18,143 | 2.2 |
| 3. Others (SHG, JLG, etc.) | – | 2646 | 6714 | 6957 | 7606 | 13,458 | 40.2 |
| **4.Total Agri Loan (1+2+3)** | **41350** | **41077** | **42161** | **43621** | **41449** | **48,695** | **2.5** |
| 5.MSME | 13097 | 14862 | 18985 | 23601 | 25209 | 30,786 | 19 |
| 6.OPS | 6399 | 8968 | 9781 | 8672 | 5969 | 6,784 | –3 |
| 7.TPS (4+5+6) | 60846 | 64907 | 70927 | 75894 | 72627 | 86,266 | 6.3 |
| 8.NPS | 19238 | 23002 | 29007 | 33688 | 32773 | 41,596 | 15.6 |
| 9.Total GLC (7+8) | 80084 | 87909 | 99934 | 109582 | 105400 | 1,27,861 | 8.9 |
| Total Agri Loan y-o-y Growth Rate (%) | 19.23 | –0.66 | 2.64 | 3.46 | –4.98 | 17.48 | |
| Total GLC y-o-y Growth Rate (%) | 16.4 | 9.8 | 13.7 | 9.7 | –3.8 | 21.31 | |

*Source:* SLBC, Bihar

Table 14.5 Status of Disbursement of Institutional Credit for Agriculture during 2019–20: A Comparison of Bihar with Major States of India

| States | Average Loan Disbursed per Account (Rs.) | | | No of Loan Accounts to No of Land holdings (per cent) | | Average Crop loan per ha of GCA (Rs.) |
|---|---|---|---|---|---|---|
| | Crop Loan | Term Loan | Agri Loan | Crop Loan | Term Loan | |
| Andhra Pradesh | 86,929 | 1,61,446 | 1,01,843 | 126 | 32 | 1,25,883 |
| **Bihar** | **80,882** | **63,748** | **69,979** | **13** | **23** | **22,424** |
| Chhattisgarh | 51,286 | 1,60,607 | 67,322 | 48 | 8 | 17,331 |
| Gujarat | 1,38,902 | 2,62,488 | 1,71,094 | 59 | 21 | 36,656 |
| Haryana | 1,50,094 | 2,99,902 | 1,79,431 | 177 | 43 | 67,034 |
| Jharkhand | 36,423 | 55,288 | 47,318 | 17 | 24 | 8,646 |
| Karnataka | 85,372 | 82,618 | 83,982 | 60 | 61 | 37,759 |
| Kerala | 86,856 | 1,47,706 | 1,02,043 | 94 | 31 | 2,40,807 |
| Madhya Pradesh | 66,629 | 1,39,357 | 80,493 | 63 | 15 | 17,292 |
| Maharashtra | 79,988 | 2,37,602 | 1,35,042 | 26 | 14 | 13,174 |
| Odisha | 42,609 | 72,656 | 51,270 | 87 | 35 | 36,817 |
| Punjab | 1,92,168 | 2,96,675 | 2,13,693 | 274 | 71 | 73,609 |
| Rajasthan | 98,896 | 1,46,834 | 1,09,397 | 89 | 25 | 25,774 |
| Tamil Nadu | 78,426 | 1,28,616 | 90,753 | 233 | 76 | 2,83,122 |
| Telangana | 70,911 | 3,27,706 | 1,13,729 | 78 | 16 | 55,160 |
| Uttar Pradesh | 81,579 | 1,39,232 | 93,906 | 38 | 10 | 27,596 |
| West Bengal | 48,639 | 99,782 | 79,123 | 39 | 57 | 14,161 |
| **All India** | **86,164** | **1,41,428** | **1,02,484** | **65** | **27** | **41,216** |

*Source:* GoI (2021).

loan per hectare of GCA in the State is almost half of the national average and much lower compared to States like Tamil Nadu, Kerala and Andhra Pradesh.

As per the Reserve Bank of India (RBI) directives, all crop loans are to be channelised through KCC, but the coverage of KCC in the State is very low. As on 31 March 2021, nearly 39 lakh KCC were reported to have credit outstanding, although the State has 164 lakh operational holdings that are *prima facie* eligible for KCC, apart from sharecroppers, oral lessees and other landless farmers who are also eligible.

During 2020–21, about 19.64 lakh farmers had availed institutional credit through their KCC in Bihar. This indicates that only about 12 per cent farmers had availed crop loans from institutional sources. As shown in Table 14.6, the number of farmers availing crop loans through their KCC declined from nearly 22 per cent in 2015–16 and 12 per cent in 2020–21. The farmers brought under institutional credit linkage afresh have also been declining over the years, indicating a saturation in institutional credit linkage. The Regional Rural Banks (RRBs) that accounted for about 56 per cent of KCC loan accounts are the major lenders of crop loans. The role of Cooperative Banks in Bihar, unlike many other States of India, is not so significant in agriculture credit linkage. Coverage of KCC loans by Commercial Banks, however, has declined fast, from 18.57 lakh KCC loans in 2016–16 to only 7.88 lakh in 2020–21. There is a significant fall in the average credit limit sanctioned per KCC by Commercial Banks as well (Figure 14.2) during 2020–21 compared to the previous year. The average credit disbursement per KCC was the highest by RRBs in the State.

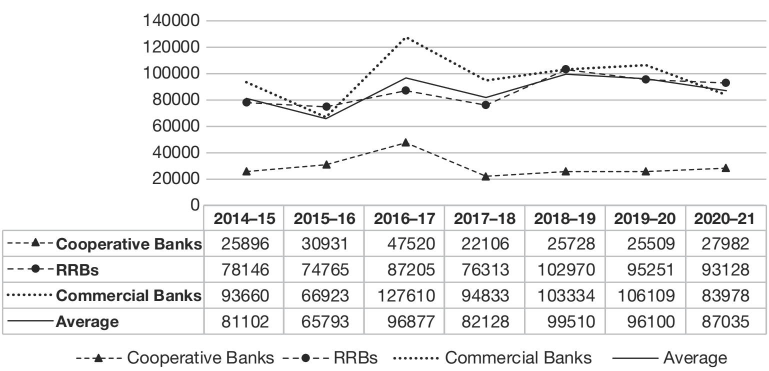
Although the Commercial Banks are the leaders in total credit flow to the agriculture sector in Bihar, their share has been declining steadily over time, declining from 69 per cent in 2009–10 to 53 per cent in 2019–20. A significant part of the lending by Commercial Banks goes to agricultural term loans, as term lending is done either by Commercial Banks or RRBs since the cooperatives do not lend for agricultural term loans. However, the share of Commercial Banks in agriculture credit in the State has gone down steadily from two-thirds of total agricultural credit from all institutional sources in 2010–11 to a little less than one-half in 2020–21

Table 14.6 Credit Provided through KCC in Bihar (number, in lakh)

| Year | Commercial Banks | | RRBs | | Cooperatives | | All Sources | | % to Total Land Holdings |
|---|---|---|---|---|---|---|---|---|---|
| | New | Total | New | Total | New | Total | New | Total | |
| 2015–16 | 12.82 | 18.57 | 2.68 | 13.44 | 0.10 | 4.06 | 15.60 | 36.08 | 21.98 |
| 2016–17 | 4.07 | 10.14 | 1.62 | 11.26 | 0.07 | 3.84 | 5.76 | 25.25 | 15.38 |
| 2017–18 | 4.05 | 12.57 | 1.19 | 12.65 | 0.04 | 1.43 | 5.29 | 26.67 | 16.25 |
| 2018–19 | 1.55 | 7.25 | 0.62 | 11.40 | 0.02 | 0.90 | 2.19 | 19.56 | 11.92 |
| 2019–20 | 1.33 | 6.33 | 0.32 | 11.55 | 0.01 | 0.78 | 1.66 | 18.66 | 11.37 |
| 2020–21 | 2.24 | 7.88 | 0.25 | 11.03 | 0.02 | 0.73 | 2.51 | 19.64 | 11.97 |

*Note:* Total number of landholdings in Bihar is 164.13 lakh

*Source:* SLBC, Bihar.




| | 2014–15 | 2015–16 | 2016–17 | 2017–18 | 2018–19 | 2019–20 | 2020–21 |
|---|---|---|---|---|---|---|---|
| Cooperative Banks | 25896 | 30931 | 47520 | 22106 | 25728 | 25509 | 27982 |
| RRBs | 78146 | 74765 | 87205 | 76313 | 102970 | 95251 | 93128 |
| Commercial Banks | 93660 | 66923 | 127610 | 94833 | 103334 | 106109 | 83978 |
| Average | 81102 | 65793 | 96877 | 82128 | 99510 | 96100 | 87035 |

Figure 14.2 Average Credit Limit Sanctioned per KCC (in ₹)

*Source:* SLBC, Bihar.

(Table 14.7). The share of Cooperatives in agricultural lending in the State also came down from 13 per cent in 2004–05 to 1 per cent in 2013–14 after which it started improving to reach 9 per cent in 2020–21. Crop procurement activities by primary agricultural credit societies (PACS) and refinance support from the National Bank for Agriculture and Rural Development (NABARD) enabled

Table 14.7 Agency–wise Institutional Credit Flow to Agriculture Sector in Bihar

| Year | Commercial Banks | | RRBs | | Cooperatives | | Total |
|---|---|---|---|---|---|---|---|
| | Rs. Crore | % share | Rs. Crore | % share | Rs. Crore | % share | Rs. Crore |
| 2004–05 | 1,325 | 65 | 431 | 21 | 274 | 13 | 2,030 |
| 2005–06 | 1,489 | 68 | 450 | 21 | 235 | 11 | 2,174 |
| 2006–07 | 1,916 | 64 | 797 | 27 | 272 | 9 | 2,985 |
| 2007–08 | 2,447 | 65 | 952 | 25 | 356 | 9 | 3,755 |
| 2008–09 | 3,943 | 69 | 1,438 | 25 | 317 | 6 | 5,698 |
| 2009–10 | 4,960 | 69 | 1,851 | 26 | 353 | 5 | 7,164 |
| 2010–11 | 7,058 | 66 | 3,188 | 30 | 422 | 4 | 10,668 |
| 2011–12 | 9,689 | 65 | 4,882 | 33 | 387 | 3 | 14,958 |
| 2012–13 | 13,203 | 61 | 8,035 | 37 | 328 | 2 | 21,566 |
| 2013–14 | 17,786 | 62 | 10,676 | 37 | 307 | 1 | 28,769 |
| 2014–15 | 21,260 | 61 | 13,058 | 38 | 362 | 1 | 34,680 |
| 2015–16 | 24,957 | 60 | 15,135 | 37 | 1,258 | 3 | 41,350 |
| 2016–17 | 25,004 | 61 | 14,247 | 35 | 1,825 | 4 | 41,076 |
| 2017–18 | 24,734 | 59 | 14,879 | 35 | 2,548 | 6 | 42,161 |
| 2018–19 | 23,556 | 54 | 17,264 | 40 | 2,800 | 6 | 43,620 |
| 2019–20 | 21,913 | 53 | 16,332 | 39 | 3,204 | 8 | 41,449 |
| 2020–21 | 26,386 | 57 | 16,205 | 35 | 4,104 | 9 | 46,695 |
| CAGR | 23.0 | | 29.5 | | 19.9 | | 24.7 |

*Source:* Economic Survey of Bihar, various issues

the Cooperatives in the State to enhance their role in agriculture credit. The RRBs, on the other hand, have steadily improved their share in total institutional credit from 21 per cent in 2004–05 to 37 per cent by 2012–13, and thereafter maintained their share between 35 and 40 per cent.

## 14.4. EXPLANATION OF LOW CREDIT OFFTAKE IN BIHAR FOR THE FARM SECTOR

We can explain the low credit offtake for the farm sector in Bihar both in terms of demand-side and supply-side factors.

### 14.4.1 Demand-Side Factors

Some of the demand-side factors responsible for low credit offtake in Bihar are the following.

1. *Low KCC Coverage*: KCC is the sole instrument for the farmers to avail crop loans from a bank. Every eligible farmer, landless farmer, sharecropper, and oral lessee farmer is eligible to have a KCC, provided one is not a defaulter of any loan from the bank. The Government, with a view to making more farmers eligible to avail institutional credit for agriculture, has implemented debt-waiver schemes, introduced new KCC guidelines, and revamped the existing loan policies from time to time. However, in Bihar, only 24 per cent farmers had KCC loans outstanding, and hardly 12 per cent of farmers availed bank loans through KCC during 2020–21. The low coverage of KCC is the major deterrent to the horizontal expansion of institutional credit flow to the agriculture sector in the State.
2. *Small Ticket Loans:* The predominance of small and marginal landholdings makes the demand for agricultural credit low. Of 164 lakh landholdings in the State, 91 per cent are marginal farmers (less than one ha), and another 6 per cent are small landholders (between 1 and 2 ha). The average loan requirement for agricultural purposes is low for these landholders. Furthermore, about 28 per cent of the land in Bihar is cultivated by sharecroppers (SAS, 2021). The report on the Status of Tenant farmers/Sharecroppers (*Bataidars*) and Marginal Farmers in Bihar (Action Aid, 2016) reveals that as there is no proper documentation of land-leasing arrangements, the tenants could not avail bank credit.

   It is also to be noted that about one-half of rural households in Bihar are economically backward. About one-fourth of the total workforce in the State are marginal workers (work for less than 6 months in a year). Such households have low credit potential.

Furthermore, rural borrowers, especially marginal, small and landless farmers, hesitate to approach banks for small credits, whereas it is easier for them to avail credit from non-banking financial companies/micro-finance institutions (NBFCs/MFIs), as these institutions provide credit and recovery services at the doorstep. Bihar is the third largest state in terms of credit portfolio by NBFCs and MFIs. As of 31 March 2021, Bihar had a credit portfolio of about ₹29,429 crore only for about 1.4 crore borrowing accounts by the NBFCs and MFIs (Micrometer, 2021, April).

3. *Borrowers' Attitude towards Public Sector Banks*: In most cases, the borrowers from public sector banks in the State wilfully default on the repayment of loans in anticipation of the announcement of a loan waiver by the Government. However, they make regular repayment of the loans availed from NBFCs/MFIs even though their rate of interest is higher than the interest charged by public sector banks. The repayment environment for public sector bank loans is quite vitiated, which has resulted in an non-performing asset (NPA) level of as high as more than 20 per cent for many public sector banks. This creates a disincentive for public sector banks to advance credit to the agriculture sector.

### 14.4.2 Supply-Side Factors

The supply-side factors causing low offtake of credit in Bihar are the following.

1. *High NPA:* High NPA is the biggest deterrent for large-scale financing in the agriculture sector for the banks in Bihar, especially for the Public Sector Commercial Banks and the RRBs. Overall NPA of bank loans in Bihar as on 31 March 2021 was 11.85 per cent. NPA has been on the rise for the past few years, with a respite in 2020–21 over the previous year. Five Public Sector Commercial banks in Bihar are reported to have an NPA of between 15 and 27 per cent. The NPA of RRBs was 28.11 per cent. The agriculture sector, accounting for about one-third of total

outstanding bank loans, has a 23.59 per cent NPA. The NPA in agriculture advances by Public Sector Commercial banks was 33 per cent, and that for RRBs was 27 per cent. As on 31 March 2021, 13.3 lakh KCC loans, which account for 35 per cent outstanding KCC loan accounts, were NPA. NPA in KCC was 47 per cent for Public Sector Commercial Banks, and seven out of ten major public sector banks have NPA of lending under KCC to the extent of more than 40 per cent. The NPA in KCC of Cooperative Banks was 41 per cent. RRBs, the largest lender of KCC loans, in the State had a 28 per cent NPA in KCC.

2. *Weak Financial Health of RRBs*: Both the RRBs (Uttar Bihar Gramin Bank (UBGB) and Dakshin Bihar Gramin Bank (DBGB)) have a Gross Non-performing Asset (GNPA) higher than 15 per cent, and their return on assets is negative. Hence, they are in the 'RRB in Focus' category and under Prompt Corrective Action of RBI. The capital to risk (weighted) asset ratio (CRAR) of UBGB and DBGB was (–) 2.33 per cent and 5.66 per cent, respectively, as on 31 March 2021. Thus, both RRBs could not maintain the stipulated RBI norm of 9 per cent CRAR during 2020–21. Both the RRBs have accumulated losses.
3. *Weak Financial Health of Cooperatives:* There are only 23 District Central Cooperative Banks (DCCBs) operating in the State that has 38 districts. All DCCBs have a gross NPA of over 5 per cent, 17 DCCBs have accumulated losses, 9 DCCBs are not complying with the CRAR norm as prescribed by RBI, and 4 DCCBs are under Section 11 of B R Act 1949. Cooperative Banks are the major purveyors of short-term agricultural loans to farmers. However, in Bihar, their exposure to disbursement of term loans is very meagre. A major part of their business activities is limited to the procurement of foodgrains.
4. *Low Capital Formation in Agriculture*: Capital formation in agriculture in India takes place through public and private investments, with private investments (household + corporate) accounting for around 85 per cent of total capital formation in agriculture, and around 90 per cent of the private investment comes from the household sector. There is an element of complementarity between public investment and private investment. Therefore, boosting investment credit for agriculture, which is the main source of private investment in agriculture, along with

increasing the level of public investment in agriculture, is necessary for increasing capital formation in the agriculture sector.

Budgetary allocation for capital expenditure is important from the point of view of encouraging and providing an enabling environment for private investment in the sector. The share of budgetary allocation for agriculture and allied sectors and the share of capital outlay in it in various State budgets during 2019–20 give a picture of the support to the sector. In Bihar, the budgetary support for the agriculture sector was the lowest among all major States in 2019–20 (Figure 14.3).

## 14.5 MAJOR INITIATIVES FOR AUGMENTING INSTITUTIONAL CREDIT FLOW IN BIHAR

### 14.5.1 Initiatives by RBI

In order to address regional disparities in the flow of priority sector credit at the district level, the RBI has ranked districts on the basis of per capita credit flow to the priority sector. From financial year (FY) 2021–22 onwards, a higher weight (125 per cent) is assigned to the incremental priority sector credit in the comparatively low credit flow districts (having per capita priority sector lending less than ₹6000 only). Accordingly, 28 districts in Bihar have been identified as credit-deficient districts. The banks have been advised to enhance their credit delivery in credit-starved districts.

In order to ensure the continuous flow of credit to the priority sector, the RBI also monitors the compliance of banks on a 'quarterly' basis. The banks are required to furnish data on their priority sector advances in prescribed formats to the RBI. In addition, the progress of priority sector lending is regularly monitored by the State Level Bankers' Committee (SLBC) at the State level and by the District Consultative Committee (DCC) at the district level on a quarterly basis.

### 14.5.2 Initiatives by State Government

In order to incentivise the farmers to avail credit for seasonal agricultural operations and make prompt repayment by farmers, the Bihar Government has been providing 1 per cent additional

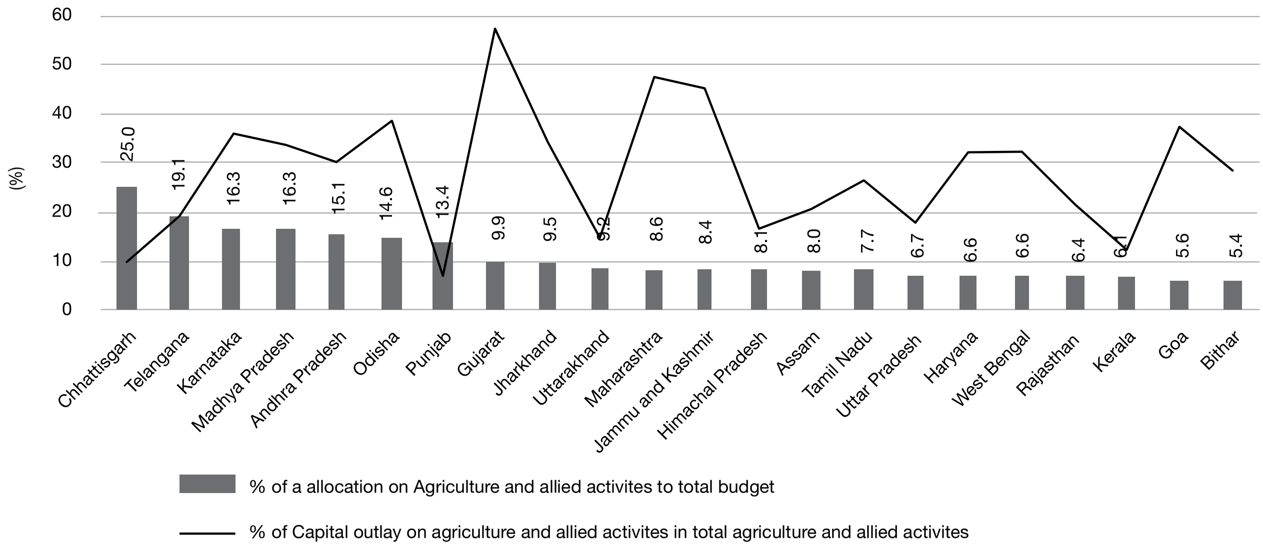



Figure 14.3 Budgetary Allocation in Various States to Agriculture and Allied Activities

*Source:* RBI (2020).

interest subvention to farmers availing crop loans and repaying those on time.

To encourage and promote the agribusiness sector in Bihar through the creation of an enabling environment and enhancing the level of processing, storage, waste reduction, value addition and export promotion, the State Government introduced the Bihar Agri Investment Promotion Policy (BAIPP) in 2020 wherein a credit-linked capital subsidy of 15–30 per cent is provided to establish agro-processing units in focused sectors like makhana, honey, fruits and vegetables, maize, seeds, medicinal and aromatic plants and tea (BAIPP, 2021).

Most importantly, Bihar has more than 10 lakh SHGs functioning under the *Jeevika*, a World-Bank-supported poverty alleviation programme operational in the State since 2007 to empower women and make them self-reliant. Under the Jeevika, rural women are being supported to enhance their skills and entrepreneurial abilities so as to involve them in various livelihood-promoting activities. The banks in the State have been financing the SHGs promoted under the *Jeevika*. It is indeed heartening to note that the repayment of bank loans advanced to SHGs and JLGs is very good as compared to other sectors of bank loans.

### 14.5.3 Initiatives by NABARD

NABARD estimates credit potential for the State by aggregating grassroots-level assessments given in district-wise potential linked credit plans. Credit potential estimates of various priority sectors are shared with the respective lead banks to prepare the Annual Credit Plan for every district as well as for the State. The aggregate priority sector credit potential estimated for Bihar revealed adequate scope for bank credit flow in the State. The credit flow from institutional sources to the priority sector has been increasing at a CAGR of 14 per cent during 2013–2021.

NABARD has been providing short-term, medium-term (18 months to 5 years) and long-term (more than five years) refinance assistance to eligible rural financial institutions, namely Cooperative Banks, RRBs, Commercial Banks, Small Finance Banks, NBFC and MFIs. Furthermore, keeping in view the national goal of doubling farmers' income and the need for institutional credit support for recovering the economy from the slowdown owing to the COVID-19 pandemic, NABARD introduced a few Special Refinance Assistance schemes, especially for channelling credit in wadi and watershed project areas, for converting PACS to multi-service centres, for investment in water, sanitation and hygiene amenities at residential houses, for the development of micro-food processing sector, etc. During the past few years, NABARD's refinance support to eligible rural financial institutions in Bihar has been in the range of around 6–15.5 per cent of the TPS lending in the State.

### 14.5.4 Creation of Rural Infrastructure Development Fund

Rural infrastructure is crucial for the development of the State, especially when almost 90 per cent of the geography is rural. Infrastructure development supports the enhancement of GLC. Thus, NABARD has been providing loans to State Governments under the Rural Infrastructure Development Fund (RIDF) since its inception in 1995–96 for the development of a variety of economic and social infrastructures. About a quarter of the total RIDF support availed by Bihar has been allocated for the creation of agri-infrastructure, like irrigation and warehouses. Two-thirds of the RIDF loans have been allocated for the improvement of rural connectivity, facilitating the rural hinterland to get connected with market centres for better price realisation by the farmers. It may also be noted that NABARD has introduced RIAS, a dedicated fund for Eastern India with a corpus of ₹15,000 crore only, with the aim to provide financial assistance to State Governments for the creation of livelihood infrastructure, mitigate the problems of reverse migration and reduce further migration. Rural Infrastructure Assistance to State Governments (RIAS) would fund any activity that promotes a circular economy, and such activity pivots around livelihood generation activity.

In addition to the above, NABARD provides promotional grant support to banks for spreading financial literacy, technical and capacity building, thus facilitating financial inclusion so that Rural Financial Institutions (RFIS) can expand their credit outreach. Grant support is provided for organising financial literacy programmes, demonstration of banking technology through Mobile

Vans, support kiosks in unbanked villages, deployment of point of sale (PoS) terminals, support for onboarding of BHIM and UPI platforms, etc.

## 14.6 SUGGESTIONS FOR ENHANCING CREDIT FLOW TO AGRICULTURE SECTOR

### 14.6.1 Suggestions for Banks

- In order to enhance the flow of credit to the agriculture sector in Bihar, the banks need to explore extending credit to individual farmers and farmer collectives, like SHGs, JLGs, farmers' clubs, and FPOs, which may be a suitable model for financing to the agriculture sector, keeping in view the predominance of marginal and small farmers and poor households in rural areas.
- At present, only about 4 per cent members of Cooperative Banks in Bihar are borrowing members. Therefore, the DCCBs need to design specific action plans for enhancing the number of borrowing members.
- Banks may prioritise lending to allied activities, like dairy, poultry, goat rearing, piggery, and in-land fisheries. These sectors have immense potential in Bihar.
- Horticulture is a promising sector, and Bihar has certain unique products like makhana, litchi, *jardalu* mango, and banana. Banks may draw Area Development Plans to extend credit for production, processing and marketing of horticultural crops both for improving flow of institutional credit and employment promotion.

### 14.6.2 Suggestions for the Government

- The RRBs and Cooperative Banks in Bihar need to be strengthened to extend credit to promote capital investment in agriculture and allied activities. The State Government needs to extend capital support to the Cooperative Banks in general and the weak DCCBs in particular.
- Public sector investments in infrastructure building can enhance institutional credit flow for capital formation in agriculture and allied sectors in the State. The State Government

may consider enhancing budgetary allocation for agriculture and allied activities.

- The public sector banks are the trustees of public money. The State Government needs to act to improve the credit environment and repayment culture of the general public by organising programmes to raise awareness of prospective borrowers. This would provide the necessary confidence to the public sector banks for enhancing the quantum of lending in the State.

## REFERENCES


ActionAid. (2016). *The status of tenant farmers/sharecroppers (Bataidars) and marginal farmers in Bihar*. Fourth Dimension and ActionAid India, New Delhi.

AIDIS. (2021). *All India debt & investment survey 201 (NSS 77th Round)*. National Statistical Office, Government of India.

BAIPP. (2021). *Bihar agri investment promotion ecosystem: Creating an enabling ecosystem for agri investors*. Department of Agriculture, Directorate of Horticulture, Bihar.

BES. (2021). *Bihar economic survey 2020–21*. Finance Department, Government of Bihar.

GoI. (2020). *All India Report on agriculture census 2015–16*. Department of Agriculture, Cooperation & Farmers' Welfare, Government of India.

GoI. (2021). *Agricultural statistics at a glance 2020*. Department of Agriculture, Cooperation & Farmers Welfare, Government of India.

Micrometer. (2021). *Synopsis* (Issue 37). Micrometer, Mfin, New Delhi.

Narayanan, S. (2015). *The productivity of agricultural credit in India* (WP-2015-01). Indira Gandhi Institute of Development Research, Mumbai.

RBI. (2020). *State finances: A study of budgets of 2019–20*. Reserve Bank of India.

RBI. (2021). *Handbook of statistics of the Indian economy 2020–21*. Reserve Bank of India.

SAS. (2021). *Situation assessment of agricultural households and land and holdings of households in rural India, 2019* (NSS 77th Round). National Statistical Office, Government of India.

CHAPTER 15

# ADOPTION OF NEW CULTIVATION TECHNIQUE AND FARMERS' INCOME

*Debabrata Samanta*

## 15.1 INTRODUCTION

In developing countries, where agricultural technology is predominantly traditional and there is a high concentration of people in the agricultural sector, the adoption of new methods of cultivation (technology) becomes necessary as it helps the farmers to enhance their income and livelihood. One of the objectives of technological change is to raise agricultural productivity. The adoption of new techniques in the agricultural sector may take place at an aggregate level (by a group of farmers) or at the level of an individual farmer. It has been observed that the adoption of technology depends upon the land size, costs and benefits of new technology and other economic factors. Although the adoption of new technology provides a scale effect to the large farmers, small farmers often face both internal and external challenges to adopt modern agricultural technology. Technological adoption at the individual farmer level is defined as the degree of use of the new technology in the long run when the farmer has full information about the technology and its potential (Feder et al., 1985). In spite of the new innovation in agriculture opening up new opportunities, farmers in developing countries are often slow in its adoption, mainly because of their risk-aversion behaviour (Pannell et al., 2006).

One of the most unique features of Indian agriculture is the predominance of small and marginal landholders. Here, the fragmented farm areas reduce the benefit of scale effect and cause an investment disincentive for large-scale adoption of improved techniques. Although the number of total operational holdings in India increased from 138 million in 2011–12 to 146 million in 2015–16, the average size of operational holdings has revealed a declining trend – declining from 1.15 ha. in 2011–12 to 1.08 ha. in 2015–16. According to the Agriculture Census 2015–16, the proportion of small and marginal farmers in India increased from 84.97 per cent in 2010–11 to 86.21 per cent in 2015–16 (Government of India, 2019). The same pattern is observed in Bihar, where the operational holdings are fragmented and mostly cultivated by small and marginal farmers. The available data show that the proportion of marginal and small holdings in Bihar stood at 96.96 per cent in 2015–16 (*Ibid.*). It is also noticeable that the share of Bihar in total operational holdings of the country has been the highest among all states (16.41 million, which is 11.2 per cent of total operational holdings in India). Furthermore, the distribution of land in Bihar is highly skewed, and the inequality of landholdings in rural areas is increasing over time.

However, the agriculture sector has always been an important component of Bihar's economy. Although the contribution of the primary sector in Bihar's GSDP has decreased from 23.4 per cent in 2013–14 to 19.5 per cent in 2019–20, the primary sector (comprising agriculture, forestry and fishing) is still the biggest employment provider, with 48.9 per cent of total workers in Bihar being engaged in this sector (Government of Bihar, 2021). Hence, several initiatives, such as infrastructure development and credit and training support, are being taken by the state government to boost the performance of the agriculture sector. Along with this, some local agencies also work in the agriculture sector to provide training support to farmers in local settings, which help to enhance their incomes, especially for those having small landholdings.

As against the above background, this chapter analyses field data to evaluate the effect on incomes and expenditures of the farmers following the intervention by a local-level organisation to provide training on improved farming techniques and practices for onion cultivation in the villages of the Gaya district of Bihar.

The second section of the chapter describes the technological intervention undertaken in the survey areas. The motivation and objectives of the study are clarified in the third section. The fourth section describes the methodology and data. The results of the evaluation of the training programme are presented in the fifth section. The final section presents the conclusion and policy implication of the study.

## 15.2 TECHNOLOGICAL INTERVENTION IN SURVEY AREAS

Bringing technological innovation to agriculture may be possible in different ways. One of those is through extension services provided to farmers to meet challenges in agriculture and make them more resilient. The extension services in developing countries are mostly provided by the government. However, the role of civil society organisations in providing extension services has also been emphasised in the context of agricultural technology transfer. In India also, several such organisations take part in transferring new agricultural techniques, especially to small landholders (Farrington, 1997).

In this study, we focus on intervention by a local-level organisation in providing agricultural extension services. This intervention, carried out by the Microx Foundation, came in the form of providing support and training to the farmers for the application of advanced methods of cultivation of onions. This Foundation was created in 2014 in the Gaya district to provide agriculture extension support to farmers and improve their access to agricultural resources by organising Farmers' Field Schools (FFS). The FFS trained the farmers in local fields on the new technique of farming. The Foundation brought resource persons to demonstrate advanced farming techniques. This training used to be organised with some purposely selected (willing) farmers, who, in turn, were supposed to transfer the knowledge to other farmers in their vicinity. The main aim of this type of intervention was to promote the adoption of a new technique of onion cultivation by the farmers of Gaya. The farmers were provided 4–6 days of training and on-field demonstration. In those trainings, they were oriented about the new sowing technique, irrigation technique, caring for fungus and other diseases, harvesting, etc. The farmers taking part in the training were also supplied with seeds and other advisory support from the Foundation.

## 15.3 MOTIVATION AND OBJECTIVES OF THE STUDY

As pointed out above, the Foundation initiated the intervention in which willing farmers self-selected themselves to avail training regarding improved cultivation techniques and other advisory support. When we compared the incomes of the farmers (from the cultivation of onions) who obtained training with those who did not, we noticed a significant improvement in their income after the adoption of new techniques. However, the literature refers to this as a 'reflexive' method of impact assessment, on the basis of which one could not draw the conclusion with certainty that the improvement in income has happened due to programme intervention alone (Khandekar et al., 2010). As the impact of any programme (independent of other factors) can truly be assessed only by comparing actual and counterfactual, we have conducted a counterfactual impact assessment of the intervention by using the quasi-experimental technique. For this purpose, we have considered the participants of the training programme (treatment group) as well as another group of farmers as the control group (who did not take part in the training). The treatment group respondents are those who have taken training at least one to two years back from the date of the survey, and the control group respondents are those farmers who lived in the same village and have socio-economic–geographical attributes similar to the former group. The reference period for the survey is January–December 2018.

Having clarified the motivation of this study, our main objectives become: (i) to identify the factors that influence the farmers to self-select themselves for the training; and (ii) to assess the counterfactual impact of the training programme intervention regarding the improved technique of onion cultivation as may be reflected through their incomes and expenditure patterns.

## 15.4 METHODOLOGY AND DATA

To identify the main determinants of participation in the training and other orientation programmes, we have estimated a logit regression model where the dependent variable is a binary variable that is assigned a value of '1' for those who took part in the training programme and '0' for those who did not. The set of explanatory variables in such an exercise represents the sample farmers' economic condition (whether below poverty line (BPL)/above poverty line (APL)), educational level, possession of land and livestock, possession of assets, access to the market for crop sale, and so on.

However, one problem that arises while evaluating the impact of a programme emerges from the missing data on the counterfactual, as we do not know what would have happened to participants if they had not joined the programme. Likewise, it is also challenging to identify a suitable comparison group of non-participants whose outcome would provide an unbiased estimation of the outcome that programme participants would have had in the absence of the programme. Furthermore, given the self-selection of the farmers into the programme and also their non-random selection, a simple comparison between the agricultural incomes of participants and non-participants might be misleading and may yield biased estimates of the impact of the programme intervention (Khandekar et al., 2010). To address this problem, we have applied the propensity score matching (PSM) method to evaluate the impact of the intervention.

In the PSM method, propensity scores are estimated as the likelihood that a person would be assigned or self-select into a treatment condition. However, the goal of the propensity score is not to perfectly predict assignment conditions but to create a single comparison score to represent the whole set of covariates that can be used to account for group differences in all observed characteristics or confounding factors due to selection (Bai & Clark, 2019).

The necessary assumptions of the PSM are as follows: (i) stable unit treatment value, (ii) conditional independence, and (iii) the presence of common support (Bai & Clark, 2019; Khandekar et al., 2010). The assumption of a stable unit treatment value requires that the outcome does not depend on the assignment procedure (i.e., randomised or self-selection) and that the treatment is the same for all the participants in the treatment group. Here, while implementing the PSM method, it is assumed that within a matched pair, 'participant A' in the treatment group and 'participant B' in the control group have the same likelihood of being assigned to the treatment or control group and 'participant A' receives the same type and amount of treatment as the other participants in the treatment group who were selected through PSM. The assumption of conditional independence states that assignment to treatment conditions is independent of the treatment effect after accounting for a set of observed covariates. If $Y_i^T$ represents the outcomes for the participant and $Y_i^C$ represents the outcomes for the non-participant, conditional independence implies ($Y_i^T$ and $Y_i^C$) are independent of treatment given the covariates ($T_i/X_i$). Conditional independence further implies that the uptake of the programme is based entirely on observed characteristics. If unobserved characteristics determine programme participation, conditional independence will be violated. The assumption of common support implies that there is sufficient overlap in the distribution of the propensity score estimated for the treatment and control groups. The overlap condition is $0 < P(T_i = 1/X_i) < 1$. This condition ensures that treatment observations have comparison observations nearby in the propensity score distribution. It is argued that the effectiveness of PSM also depends on having a large and roughly equal number of participant and non-participant observations so that a substantial region of common support can be found. This requires treatment units to be similar to control units in terms of observed characteristics (Heckman et al., 1997).

### 15.4.1 Model for Estimating the Impact

If the conditional independence holds and if there is a sizeable overlap across participants and non-participants, the PSM estimator for the Average Treatment on Treated can be specified as the mean difference in outcome variable over the common support after weighting the comparison units by the propensity score distribution of participants (Khandekar et al., 2010). In this study, we assess the impact of the intervention by estimating the treatment effect. The treatment effect is estimated by comparing the changes in outcomes between participants and their matched counterparts.

The average impact of treatment on the treated ('causal effect' of programme participation) is estimated by computing mean differences across both groups. The following equation represents a typical cross-section estimator of the treatment effect:

$$\text{Treatment effect} = E_{P(X)/(T=1)} = E[Y^T/T=1, P(X)] - E[Y^C/T=0, P(X)]$$

where $Y^T$ refers to the value of the outcome variable of participants who have undergone the training and $Y^C$ represents the value of the outcome variable of the participants in the control group. A positive (negative) value of the treatment effect suggests that farmers who participated in the programme have a higher (lower) outcome than non-participant farmers.

We have considered four outcome variables to assess the impact of the intervention. These are (i) annual agricultural income, (ii) annual household expenditure on food, (iii) annual household expenditure on education, and (iv) annual household expenditure on healthcare. To explore the impact of an increase in income on the standard of living, we have considered data on annual expenditure on food, education and healthcare. The rationale for selecting these three variables is that household expenditure on education and health are indicators of social welfare and have a direct impact on human development. The theoretical underpinning in this case is that these components have been regarded as inputs in the human development improvement function (Ranis et al., 2000).

It needs to be mentioned that we followed the approaches of Godtland et al. (2004) and Tesso et al. (2015) for the selection of covariates (*X*). This involved the following two major considerations: (i) the theoretical framework for why and how particular variables are related to treatment conditions and outcomes; and (ii) how well the potential covariates are statistically related to treatment conditions and outcome variables (Bai & Clark, 2019). Godtland et al. (2004) studied the impact of FFS on potato cultivation in the Peruvian Andes. On the other hand, Tesso et al. (2015) examined the impact of training imparted through FFS on smallholder maize farmers in Ethiopia. Following these studies, the variables on which we collected data are listed in Table 15.1.

Table 15.1 Data Variables for the Study

| Variable | Definition |
|---|---|
| Treatment group | A binary variable that is assigned value '1' if the person received training about new method of cultivation and cultivated onion following that method; '0' otherwise. |
| **Outcome Variables:** | |
| Agricultural income | Annual income of the household from agriculture (₹) |
| Expenditure on food | Annual expenditure of the household on food (₹) |
| Expenditure on education | Annual expenditure of household on education (₹) |
| Expenditure on healthcare | Annual expenditure of household on healthcare (₹) |
| **Covariates:** | |
| Economic condition | A dummy variable that takes value '1' for BPL households and '0' for APL households. |
| Education | Average years of schooling by household members. |
| Asset | It is measured in an ordinal scale. Its value = 3 if the household possessed TV + Motorcycle + private tube well; = 2 if the household possessed any two of them; = 1 if the household possessed any one of them; = 0 if the household possessed none of them. |
| Livestock | Total number of livestock owned (Formula: Cow+ Buffalo+1/4 Goat) |
| Landholding | Amount of land possessed by the family (in acres) |
| Output sale | Proportion of produce sold in the market |

*Source:* Field Survey.

As already mentioned, this study is based on a primary survey. We collected data from 249 farmer households drawn from 23 villages of four blocks of the Gaya district in Bihar. Among them, 156 farmers (the treatment group) self-selected themselves for the training at least two years before the date of the survey and applied their newly acquired knowledge to cultivate onions. The remaining 93 farmers (control group) belonged to the same villages but did not

Table 15.2 Summary Statistics of Variables

| Variable | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|
| Agri-income | 105,134 | 116,106 | 5500 | 65,000 |
| Expenditure on food | 101,129 | 57,631 | 12,000 | 400,000 |
| Expenditure on education | 22,283 | 41,456 | 0 | 400,000 |
| Expenditure on healthcare | 19,189 | 34,321 | 500 | 42,000 |
| Poverty | 0.6 | 0.5 | 0 | 1.0 |
| Education (average years of schooling) | 11.3 | 4.1 | 0 | 19.0 |
| Assets | 1.5 | 0.9 | 0 | 3.0 |
| Livestock | 1.8 | 2.2 | 0 | 20.0 |
| Landholding (acres) | 2.3 | 3.4 | 0 | 37.5 |
| Proportion of output sold in the market (%) | 36.1 | 30.4 | 0 | 100.0 |

*Source:* Authors' computation.

take part in such training and hence continued with the traditional method of onion cultivation. The summary statistics relating to the abovementioned variables are presented in Table 15.2.

## 15.5 RESULTS AND DISCUSSION

### 15.5.1 Determinants of Participation in Training

The results of logit regression estimated to identify the determinants of the farmers' decision to participate in the training programme are presented in Table 15.3. It needs to be mentioned here that we followed the approach of stepwise regression to overcome the problem of multi-collinearity. Accordingly, there are five different models that have been estimated. It is found that the size of landholding turned out to be an important variable to motivate the farmers to take part in training programmes. The positive signs of estimated coefficients of land (Model I) and assets (Model III) and their statistical significance imply that the probability of participation in the training programme increases with an increase in the size of landholdings and/or assets of the farmers. It

Table 15.3 Logit Regression Results of Determinants of Participation in Training Programme by the Farmers

| ***Dependent Variable: Participation in Training*** | | | | | |
|---|---|---|---|---|---|
| ***Independent Variables*** | ***Estimated Coefficients*** | | | | |
| | ***Model I*** | ***Model II*** | ***Model III*** | ***Model IV*** | ***Model V*** |
| **Economic condition** | | | | –0.75** (0.30) | –0.75** (0.30) |
| **Education** | | | | 0.08** (.04) | 0.08** (0.04) |
| **Asset** | | | 0.30* (0.17) | 0.17 (0.18) | 0.11 (0.18) |
| **Livestock** | | –0.11* (0.06) | –0.11 (0.07) | –0.08 (0.07) | –0.09 (0.07) |
| **Landholding** | 0.13** (0.06) | 0.11* (0.07) | 0.07 (0.07) | | 0.05 (0.07) |
| **Sale of output** | | 0.01 (0.005) | 0.003 (0.005) | 0.003 (0.005) | 0.003 (0.005) |
| **Constant** | 0.23 (0.18) | 0.26 (0.30) | –0.02 (0.33) | –0.20 (0.50) | –0.17 (0.50) |
| **Pseudo $R^2$** | 0.019 | 0.029 | 0.039 | 0.076 | 0.080 |

*Notes:* (i) Figures in parentheses are standard errors; and (ii) '***', '**' and '*' imply level of significance at 1 per cent, 5 per cent and 10 per cent levels, respectively.

*Source:* Authors' computation.

is also observed that economically better-off farmers (those APL), as well as better-educated farmers, are more likely to join such a programme compared to their brethren from poorer (BPL) and less-educated families (Models IV and V). On the other hand, the farmers having more livestock are less likely to take part in such a programme (Model II).

Overall, it appears that economically better-off (in terms of ownership of land and assets and also belonging to APL families) and more-educated farmers have a higher probability of participation in the training programmes relating to improved cultivation practices in our study areas. This finding is similar to that of Suvedi et al. (2017) in the context of rural Nepal. In a similar study, Mittal and Kumar (2000) observed that education creates a conducive environment to enable farmers to make efficient decisions regarding the absorption and use of new cultivation practices.

Our finding underpins the system concept of the adoption and diffusion of agricultural technologies. As our survey areas are dominated by small and marginal farmers who are risk-averse by nature, only the better-off farmers seem to have come forward to learn and adopt the new technology.

### 15.5.2 Impact of Training on Farmers' Income

One important objective of our study is to evaluate the impact of the training programme on the income and expenditure of the farmers receiving the training. To understand the difference in the income of the treatment and control groups, we initially looked at the agricultural income of the participants before and after the adoption of the new cultivation technique. We found that the agricultural income of participants who had undertaken the training programme and applied the new cultivation method obtained statistically significant gains in their income compared to their income levels before the application of the new method. The result of the paired t-test presented in Table 15.4 confirms this. However, this result does not necessarily imply that the increase in agricultural income is due to training alone. Therefore, to explore the counterfactual impact of the training programme, we applied the PSM method to estimate the treatment effect.

### 15.5.3 Treatment Effects on Agricultural Income and Household Expenditures

Prior to using the propensity score to derive the treatment effect, it is necessary to assess the common support of the propensity score. One of the tools for examining common support is through graphs of the distribution of propensity scores between the treatment group (Group 1) and the control group (Group 0). Our examination of such graphs revealed that common support existed between these groups for different outcome variables[1].

To assess the counterfactual impact of the training programme with the farmers for a new set of techniques of onion

Table 15.4 Result of Paired t-test: Agriculture Income for the Treatment Group Before and After Application of New Technique of Cultivation

| ***Variable*** | ***No. of Observations*** | ***Mean*** | ***Std. Err*** | ***Std. Dev.*** | ***95 per cent Conf. Interval*** | |
|---|---|---|---|---|---|---|
| Agri-income now | 156 | 127,929.5 | 13,541.4 | 169,131.5 | 101,180.1 | 154,678.9 |
| Agri-income two years before | 156 | 113,673.1 | 12,948.2 | 161,722.4 | 88,095.5 | 139,250.7 |
| Difference | 156 | 14,256.4 | 1678.7 | 20,966.9 | 10,940.3 | 17,572.5 |
| **t** = **8.49*** | | | Degrees of freedom: 155 | | | |

*Source:* Authors' computation.

*Note:* * implies significance at 1% level.

farming, the treatment effect is calculated. The average treatment effect of the participation of farmers in the training programme is estimated by comparing the changes in individual outcomes between participants and their matched counterparts from the control group. The impact of treatment on the treated ('causal effect' of programme participation) is estimated by computing mean differences across both groups. Table 15.5 reports the estimates of the impact of the training programme based on the PSM method. As regards agricultural income, the average difference between the participants of the programme and their matched non-participants is estimated to be ₹27,746 only, which is statistically significant and might be treated as the impact of the training programme on farmers' agricultural income. Although no statistically significant difference between the treatment and control groups is observed with regard to expenditure on food, the treatment group is found to have spent a statistically significantly higher amount on education and healthcare compared to the control group. Thus, the training programme not only emerges as an instrument to enhance agriculture income through adoption of new farming techniques but also contribute towards improvement of the quality-of-life of the family members of the treatment group. Put differently, there are both direct and indirect effects of technological adoption in agriculture on the lives of people. All in all, it appears to be a virtuous cycle for better standard of living attained through adoption of improved agricultural technologies.

## 15.6 CONCLUSION

The ever-decreasing sizes of landholdings both in India and Bihar have disincentive effects on capital investment in agriculture and discourage the adoption of highly mechanised production techniques. In this situation, extension-type training to the farmers (e.g., the FFS training) can be a solution to this problem. The present study attempted to assess the impact of a training programme for the farmers on the new technique of onion cultivation on the agricultural income in the Gaya district of Bihar. For this purpose, we collected data from the farmers who self-selected themselves (treatment group) to obtain training on new techniques of onion cultivation at least two years prior to the date of the survey, as well as from the comparable group of farmers (control group) who had

Table 15.5 Results of Treatment Effects Estimation

| Estimator: PSM | | | | | | | |
|---|---|---|---|---|---|---|---|
| Treatment Model: Logit | | | | | | | |
| ***Outcome Indicator*** | ***Coefficient*** | ***Robust Std. ERROR*** | ***Z-value*** | ***p-value*** | ***95% Confidence Interval*** | | ***No. of Obs.*** |
| Agricultural income | 27,746.4 | 11,933.6 | 2.3 | 0.0 | 4357.0 | 51,135.9 | 239 |
| Food expenditure | –376.7 | 8795.4 | 0.0 | 1.0 | –17,615.4 | 16,861.9 | 237 |
| Expenditure on education | 12,466.2 | 7190.6 | 1.7 | 0.1 | –1627.2 | 26,559.6 | 238 |
| Healthcare expenditure | 10,596.6 | 3554.9 | 3.0 | 0.0 | 3629.2 | 17,563.9 | 235 |

*Source:* Authors' computation.

not obtained such training. Analysing the determinants of adoption of new techniques by farmers, we found that the probability of the adoption of new techniques is higher for more educated and economically better-off farmers and also for those having more land and assets. One implication of this finding is that the economically and educationally weaker farmers are of risk-averse type, which is why they are hesitant towards the application of an unknown (though improved) method of cultivation. As regards the effect of the adoption of a new technique of cultivation, our results (obtained through the application of the PSM method) revealed that new agricultural techniques produced statistically significantly higher agricultural income for those farmers who got training of the new technique and applied the same on their fields. It is also found that the adopters of new techniques spent more on education and healthcare compared to the non-adopters.

An obvious policy recommendation of our study would be the organisation of training camps for all categories of farmers to train and educate them about modern cultivation practices so as to raise their incomes from farming. However, for the large-scale participation of the farmers in such programmes, especially the economically and educationally weaker ones, efforts should be made to raise their educational base as well as their level of awareness so that they can comprehend the usefulness of the application of new and more scientific methods of cultivation.

## NOTE

1. We have not presented the graphs due to scarcity of space.

## REFERENCES

Bai, H., & Clark, M. H. (2019). *Propensity score methods and application*. Sage Publications.

Farrington, J. (1997). The role of nongovernmental organizations in extension. In B. E. Swanson, R. P. Bentz, & A. J. Sofranko (Eds.), *Improving agricultural extension. A reference manual*. FAO.

Feder, G., Just, R. E., & Zilberman, D. (1985). Adoption of agricultural innovations in developing countries: A survey. *Economic Development and Cultural Change, 33*(2), 255–298.

Godtland, E. M., Sadoulet, E., Janvry, A. D., Murgai, R., & Ortiz, O. (2004). The impact of farmer field schools on knowledge and productivity: A study of Potato farmers in the Peruvian Andes. *Economic Development and Cultural Change, 53*(1), 63–92.

Government of Bihar. (2021). *Bihar economic survey 2020–21*. Finance Department, Government of Bihar.

Government of India. (2019). *Agriculture census 2015–16*. Ministry of Agriculture and Farmers' Welfare, New Delhi.

Heckman, J. J., Ichimura, H., & Todd, P. (1997). Matching ans an econometric evaluation estimator: Evidence from evaluating a job training programme. *Review of Economic Studies, 64*(4), 605–654.

Khandekar, S. R., Koolwal, G. B., & Samad, H. A. (2010). *Handbook on impact evaluation: Quantitative methods and practices*. The World Bank, Washington DC.

Mittal, S., & Kumar, P. (2000). Literacy, technology adoption, factor demand and productivity: An econometric analysis. *Indian Journal of Agricultural Economics, 55*(3), 490–499.

Pannell, D. J., Marshall, G. R., Barr, B. N., Curtis, A., Vanclay, F., & Wilkinson, R. (2006). Understanding and promoting adoption of conservation practices by rural landholders. *Australian Journal of Experimental Agriculture, 46*(11), 1407–1424.

Ranis, G., Stewart, F., & Ramirez, A. (2000). Economic growth and human development. *World Development, 28*(2), 197–219.

Suvedi, M., Ghimire, R., & Kaplowitz, M. (2017). Farmers' participation in extension programs and technology adoption in rural Nepal: A logistic regression analysis. *The Journal of Agricultural Education and Extension, 23*(4), 351–371.

Tesso, A., Negatu, W., & Asefa, S. (2015). Does farmer field school training improve technical efficiency? Evidence from smallholder maize farmers in Oromia, Ethiopia. *Journal of Economics and Sustainable Development, 6*(11), 49–65.

# PART VI

# INCOME DIVERSIFICATION OF RURAL HOUSEHOLDS

CHAPTER 16

# INCOME DIVERSIFICATION AMONG RURAL HOUSEHOLDS

## Patterns and Determinants

*Meghna Dutta and Niladri Sekhar Dhar*

### 16.1 INTRODUCTION

The lack of growth in agricultural production and productivity in India has resulted in a low surplus generation, forcing the large working population dependent on this sector to either supplement their income from crop production by engaging in non-farm work within the village production systems or resort to migration to distant locations in search of better remunerative occupations. In this situation, an understanding of the extent of income diversification remains important to comprehend the effectiveness of agriculture in reducing poverty more than any other sector, precisely because the incidence of poverty tends to be higher among the rural population engaged in agriculture than elsewhere (Ravallion & Chen, 2007; World Bank, 2008). Therefore, in this chapter, we attempt to study the determinants of income diversification in the low-productive agrarian economy of the eastern Indian state of Bihar. A large section of rural households in Bihar is either landless or operates on a small and marginal extent of land, with agricultural production and productivity lagging far behind the national average due to various exogenous and endogenous factors. We study the patterns and determinants of household income and their income diversification index across eight villages in the state, keeping in mind the complexity of the parameter 'income', which tends to make the task of income inquiry even more difficult for the farming community whose diversification strategy is contextually greatly varied.

Traditionally a subsistence activity for the majority of the people, agriculture has contributed to the food security of the country with an increased number of states becoming food surplus post the phase of the green revolution with the use of high-yielding variety seeds, extensive use of fertilizers, and irrigation schemes that have increased production faster than the average rate of population growth. However, the stagnation in agricultural productivity in recent years has had an adverse impact on farm income. This stagnation in income has a lot to do with the yield, price and idiosyncratic risks associated with farming (Barrett & McPeak, 2006). Farmers have traditionally managed such risks through *ex-ante* adaptation strategies, such as investing in wells, mixed farming, sharecropping, stocking grains and/or *ex-post* strategies adopted during risky situations, which include replanting, changing input use and thinning the standing crop, among others. Often, community support has been a major fall-back option to survive risks. Such risks potentially have long-term consequences on income paths and can have differential impacts on the lives and livelihoods of small and marginal farmers (Duong et al., 2019). In spite of the risks, augmenting income from additional sources has not been an obvious option for the farming community. Comparatively, deriving some additional income from non-farm jobs that give wage or salary income may appear easier in the short run than deriving income from farm or livestock activities (Satyasai & Mehrotra, 2016). This has resulted in a shift of focus towards income diversification for small and marginal farmers through livestock and poultry rearing, non-farm sector activities, etc., to increase farmers' incomes and improve resource use efficiency. Unsurprisingly, studies have found that the diversification index for poor farmers is very high, forcing them to engage in 'pluri-activity' to maintain subsistence livelihoods (Athreya et al., 1990; Dhar & Patra, 2017). Nonetheless, the impact of such methods in determining the income of the farmers has not been tested empirically, especially at the level of the households.

Given this backdrop, this chapter attempts to understand the current income level of the rural households and their income diversification pattern across two different agro-climatic zones of Bihar, controlling for farm size and social class[1]. We then seek to identify the determinants of income diversification by the households in our study areas.

The rest of the chapter is arranged to study the existing literature on the subject in the second section, introduce the study area and describe the method of selection of villages in the third section, discuss the composition of incomes of the households in the study areas in the fourth section, identify the determinants of incomes of the households in the fifth section, examine the degree of income diversification by the households and the factors determining income diversification by them in the sixth section, and present the conclusions in the final section.

## 16.2 LITERATURE ON SITUATION OF RURAL HOUSEHOLDS AND INCOME DIVERSIFICATION

In a typically backward agrarian economy, more so in Bihar, agricultural productivity and farmers' incomes are low, and the larger part of their incomes is accrued from farming activities. The strategies for agricultural development in India since independence have primarily focused on raising agricultural productivity and output through the implementation of improved technology, high-quality seeds, fertilisers, irrigation facilities, etc., and the whole process of increase in production and productivity has been primarily driven by state intervention. However, as Chand (2016) pointed out, the need to raise farmers' welfare has never been recognised by the earlier development strategies on the belief that growth in agricultural output has a built-in mechanism that increases income for farmers. Nonetheless, the incidence of severe poverty among rural households provides evidence that the income of most of them has remained low even with the expanding agricultural output, which remains their major occupation. Due to a lack of data on farm income from large-scale surveys in India, most researchers rely on policies or indicators that have a direct or indirect effect on agriculture. Some studies show a strong bias in policies against the farm sector (Lipton, 1970), whereas others argue that markets remain biased against the farm sector as the prices of primary goods increase at a much slower rate than those of the manufacturing sector (Harvey et al., 2010; Sarkar, 1994; Singer, 1950). The performance of the agriculture sector in India has been examined using data on terms of trade (ToT) between agriculture and other sectors. Some studies find ToT to be in favour of the farm sector (Gulati & Rao, 1994; Kahlon & Tyagi, 1983), whereas others (Dholakia & Sapre, 2013; Misra & Hazell, 1996) show the same to be against agriculture. Chand et al. (2015) emphasised the massive agrarian affliction associated with the rising disparity in rural India. Chand (2016) pointed out that the losses from farming and the high degree of uncertainty associated with agriculture in terms of scanty rainfall, infertile soils, and poor infrastructure (Walker & Ryan, 1990) have been the important factors behind the rapid increase in the annual average rate of farmers' suicide that India witnessed during the period 1995–2004; the rate is very high in states like Maharashtra, Karnataka and Andhra Pradesh (Sainath, 2010). In their study, Mohanty and Shroff (2004) showed that agriculture in states like Maharashtra and Andhra Pradesh (Gruère & Sengupta, 2011), which used to focus on low-cost rain-fed food crops, has gradually shifted towards the production of cash crops (groundnut and oilseeds), leading to a major decline in the area under food crops (Mishra, 2006; Sridhar, 2006). Mitra and Shroff (2007) provided evidence that the increase in the cost of cultivation, particularly in Maharashtra, is not compensated for by the prices of crops, resulting in negative net revenues for the farmers. Although a sizable population in India relies on agriculture for their living, a large portion of farmers remain below the poverty line, especially in bigger states like Uttar Pradesh, Bihar, and Jharkhand.

Sainath (2010) observed that even with the announcement of agricultural debt waivers and debt relief schemes by the Government of India in 2008 to address the financial indebtedness of the farmers and prioritizing the agricultural sector to achieve inclusive growth in the Eleventh Plan (Planning Commission, 2010), farm suicides in the country continued to occur with a fast exodus from agriculture. The main causes of farm distress are identified as a massive decline in investment, withdrawal of bank credit at the time of a rapid increase in input cost, and the lower price of agricultural produce (Narayanamoorthy, 2006). In addition, there is an apparent shift from food crops to cash crops in some areas, corporate hijack of the agricultural output market, illiteracy, high degree of indebtedness, lack of access to basic facilities related to education and health (Deshpande & Arora, 2010), lack of social integration (Mohanty, 2005) and lack of alternative rural employment opportunities (Kumari, 2009) for the farmers. Narayanamoorthy (2013) claimed that in order to reduce the problem of indebtedness that mainly occurs due to poor returns from crops, the issue of profitability in some of the major crops needs to be examined in detail. The cost of cultivation survey data published by the Commission for Agricultural Costs and Prices that provides information on the cost and output of various crops on a temporal basis (Sen & Bhatia, 2004; Swaminathan, 2008) shows that profits earned from most of the crops were less than 30 per cent of the cost of farming during the 1990s. The continued sufferings due to low-profit margins from cultivation make the farmers reluctant to engage in agriculture.

Given that the income generation from agriculture is low and volatile, rural households, particularly farmer households, do diversify their income and derive a substantial portion of the income from non-farm activities. The level and contribution of income derived from non-farm activities depend on the development of the non-farm sector. Ellis (2000) argued that household-level diversification of income is a social process to adopt a diverse portfolio of activities over time in order to secure survival and improve the standard of living. The diversification strategies adopted by the rich and poor households differ because of their physical, financial and human resource endowments (Barrett et al., 2005). Furthermore, Demurger et al. (2010) differentiated between pull and push factors to understand differences in income diversification strategies among different strata of rural households and listed market development, improvement of infrastructure and diversification of asset accumulation as the major pull factors. On the other hand, risk management and coping strategies, high transaction cost, and failures of credit and insurance markets were identified as the push factors (*ibid.*).

The risk in crop production systems with inadequately developed forces of production plays an important role in determining the degree of diversification. Households majorly dependent on agriculture adopt both on-farm and off-farm diversification mechanisms to reduce income volatility (Ellis, 2000). The eagerness to take risks in production processes among the farm households, especially the poorer ones, is low (Murdoch, 1990). Lanjouw and Shariff (2002) showed that non-farm earnings form a considerable proportion of household income in rural India, with significant variation across quintiles as well as across major states of India. On the basis of the data collected from three villages of Tamil Nadu, Sujithkumar (2008) examined the effect of rural income diversification on income inequality. He observed that both the agricultural and transfer incomes are the main sources of increasing inequality whereas non-farm earning sources result in a reduction in inequality. However, the lack of access of poor households to education and wealth acts as a barrier to their entry into the non-farm occupation. As a consequence, the non-farm sector fails to contribute to poverty alleviation in rural India. Farrington et al. (2006) observed that poor landless households continue to remain economically and socially excluded and they are unable to access economic opportunities because of their scarce and poor social capital, resulting in little prospect for economic advancement.

The empirical evidence gathered over the years from different parts of rural India suggests that the incomes from non-farm avenues have contributed significantly to the total household incomes. Haggblade et al. (2010) observed that about 35 per cent of rural household incomes in India come from non-farm sources. Furthermore, in rural India, government jobs account for nearly 20 per cent of rural non-farm employment, which is considered to be the most secure and stable source of income (Fisher et al., 1997). Walker and Ryan (1990) found that the self-employment sub-sector within the non-farm sector contributes significantly to the household income and ensures stability in the total household income in the semi-arid areas of India.

## 16.3 STUDY AREAS AND SELECTION OF VILLAGES

This study is conducted in the eastern state of India, called Bihar. The state is the world's fourth-most populous sub-national entity and the twelfth largest by territory, with an area of 94,163 km$^2$ (Census, 2011). Within the state, we study eight villages spread across four districts: West Champaran, Sheohar, Muzaffarpur and Rohtas. In West Champaran, we study Sirji Barhampur and

Bishunpur Raghunath. In Sheohar, we study the villages Ajrakbe Pota and Bisanpur Bindi. In Muzafarpur, we study Adalpur and Harpur villages. In Rohtas, we study the villages Bisi Khurd and Nanhu. The villages were chosen from two agro-climatic zones of Bihar: the North-West Alluvial Plain Zone (selected districts were West Champaran, Sheohar, and Muzafarpur) and the South Bihar Alluvial Zone (selected district was Rohtas). The choice of three districts from North-West Alluvial Plain Zone was guided by the diversity in cropping patterns and differences in the development of productive forces in the region.

### 16.3.1 Methodology of Village Selection

As pointed out above, we chose the districts from two agro-climatic zones of Bihar, with very distinct and diversified cropping patterns to understand the issues related to farmers' income. The caste composition and extent of irrigated land have been considered for obtaining the sample frame. A stratified sampling technique was used to identify the households for the survey. The survey frame is detailed in Table 16.1.

## 16.4 INCOME COMPOSITION OF RURAL HOUSEHOLDS

The income from crop production was estimated as the value of both food crops and other crops produced by the household over the last agricultural year. The income from animal husbandry was estimated as the income from the sale of live animals or livestock products. The income earned as labourers (outside their own farms) in agriculture was classified as agricultural labouring out, and wages received from work in non-farm opportunities are classified as non-agricultural wage income. The rental income, income from petty businesses, salaried income and income from traditional caste work are put in the income category 'Other'. Transfer income received from members who have out-migrated was classified as remittances.

To understand the distribution of the major source of income for rural households, i.e., income from crop production, we plot the densities of computed log residuals of crop income for the study

Table 16.1 Sampling Frame for Selection of Villages

| ***District*** | ***Village*** | ***No. of Household*** | ***Total Population*** | ***Caste Composition*** | ***Total Irrigated Land (ha)*** | ***No. of Households Surveyed*** |
|---|---|---|---|---|---|---|
| Muzaffarpur | Adalpur *aka* Abdulpur | 319 | 1527 | SC: 19%, Others: 81% | 58.2 | 54 |
| Muzaffarpur | Ajitpur *aka* Harpur | 329 | 1366 | SC: 25 %, Others: 75% | 44.0 | 54 |
| West Champaran | Sirji Barhampur | 263 | 1745 | SC: 10%, ST: 11%, Others: 79% | 235.4 | 54 |
| West Champaran | Bishunpur Raghunath | 274 | 1646 | SC: 18%, ST: 0.1%, Others: 81.9% | 101.2 | 54 |
| Rohtas | Bisi Khurd | 153 | 1189 | SC: 17%, Others: 83% | 265.0 | 51 |
| Rohtas | Nanhu | 157 | 945 | SC: 19%, Others: 81% | 148.0 | 51 |
| Sheohar | Bisanpur Bindi | 88 | 412 | SC: 22%, Others: 78% | 50.6 | 32 |
| Sheohar | Ajrakbe Pota | 113 | 616 | SC: 21%, Others: 79% | 22.6 | 32 |

*Sources:* Census 2011 and Field Survey 2020–21.

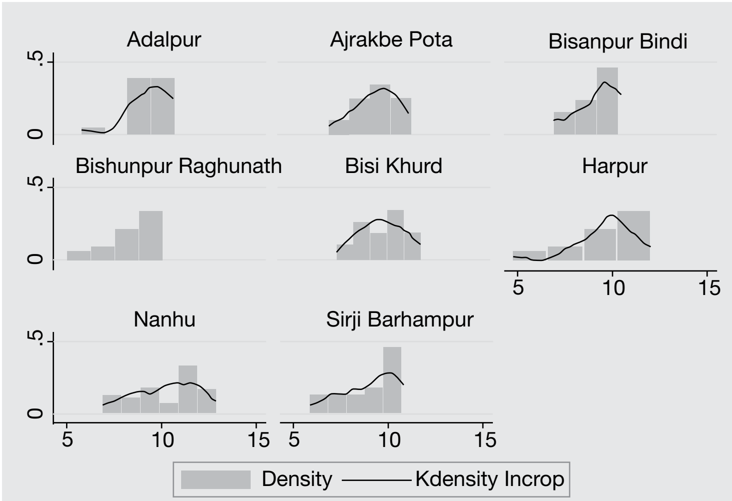



Figure 16.1 Kernel Density Plot of Crop Income in the Study Villages

*Source:* Constructed by authors using field survey data.

villages, which is presented in Figure 16.1. It is observed that in villages, such as Adalpur, Sirji Barhampur and Bisanpur Bindi, the distribution of crop income is spread over a few households and remains highly unequal, with higher income obtained by only a few households. However, in the villages Harpur, Nanhu, Bisi Khurd, the crop income is more evenly distributed across all households.

When we look at the distribution of income from the various sources, we find that except for Rohtas, which mostly produces non-food crops, all the other districts have very low net income from crop production, with Sheohar and West Champaran actually having losses from crop production. Across all the districts, income from animal husbandry seems to be compensating for losses from agricultural income or supplementing it. Non-agricultural income is mostly concentrated in the two districts of Rohtas and Sheohar. Other income accounts for a major source of income in all the districts but is concentrated in a few households. The village-level information presented in Table 16.2 confirms that in villages where income from crop production has been low or losses have been reported, households have resorted to migration and relied on remittance earnings to stabilise household income.

Table 16.2 Average Income from Various Sources in Study Villages (in ₹)

| Village | Crop Production | Agrl. Wage Earning | Non-Agrl. Wage | Animal Husbandry | Other | Remittance |
|---|---|---|---|---|---|---|
| Adalpur | –5682.89<br>(21,390.86) | 23,245.23<br>(13,287.57) | 101,075.8<br>(80,577.11) | 9295.5<br>(10,438.88) | 35,698.11<br>(123,627) | 108,857.1<br>(68,030.37) |
| Harpur | 7666.623<br>(44,985.66) | 16,863.13<br>(12,826.87) | 141,308.3<br>(111,634.3) | 14,735.53<br>(19,552.44) | 36,339.62<br>(91,996.64) | 155,571.4<br>(43,003.32) |
| Bishunpur Raghunath | –8245.46<br>(25,206.64) | 8866.25<br>(8524.69) | 79,020.83<br>(94,827.12) | 14,644.61<br>(11,434.15) | 24,133.33<br>(139,038.6) | 60,000* |
| Sirji Barhampur | 6000.83<br>(21,392.94) | 17,781.43<br>(15,517.8) | 67,993.48<br>(60,186.03) | 7333.71<br>(12,976.25) | 9226.415<br>(45,344.26) | 63,333.33<br>(29,949.45) |
| Ajrakbe Pota | 5847.41<br>(25169.84) | 24,330<br>(16242.66) | 105,325<br>(101718.4) | 12,598.17<br>(12289.65) | 38,832.19<br>(65447.05) | 91,285.71<br>(48896.88) |
| Bisanpur Bindi | –12,019.09<br>(29,780.04) | 17,211.92<br>(11,164.63) | 78,489.47<br>(46,298.08) | 12,742.79<br>(14,799) | 19,843.75<br>(45259.19) | 56,400<br>(15,019.99) |
| Bisi Khurd | –15,453.42<br>(90,497.44) | 14,392.22<br>(14,145.52) | 193,422.1<br>(469,205.7) | 10,379.56<br>(21,070.78) | 40,940<br>(111,616) | 116,800<br>(53,923.4) |
| Nanhu | 62,300.81<br>(107,968) | 9220.78<br>(6227.72) | 131,503.8<br>(187,500) | 19,051.28<br>(27,535.4) | 42,039.22<br>(94,333.65) | 116,571.4<br>(39,626.83) |

*Source:* Field Survey, 2020–21.

*Notes:* (i) Standard deviation is presented in parenthesis; and (ii) *only one household reported remittance earning.

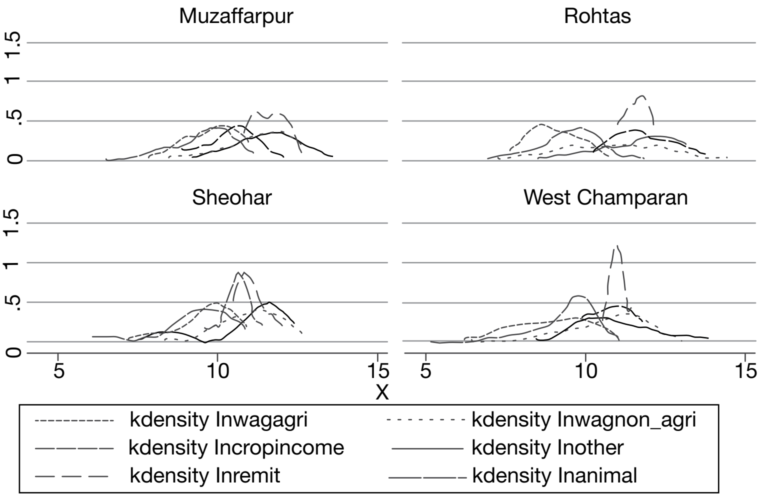



Figure 16.2 Kernel Density of Various Types of Income by Districts

*Source:* Constructed by authors using field survey data.

To have an idea about how the different income sources are distributed across the households within the districts, we obtain the kernel density plot of income received from various sources (Figure 16.2). Crop income remains highly skewed in all the districts. In West Champaran, animal husbandry and non-agricultural wage work turn out to be the major sources of income among some households. It is likely that this group of households does not have access to 'Other incomes' and agricultural income, if any, is not a positive income-generating source, causing them to rely on animal husbandry and non-agricultural wage work. In Rohtas and Muzaffarpur, remittance inflow remains skewed.

Disaggregating the analysis of income from different sources to the village level (Figure 16.3) we find, the 'Other' income category is the major income-generating source for households who have access to it but is concentrated among only a few households in all the districts. Return from crop cultivation remains at a precarious state, with four out of eight study villages having negative income (losses) from therein. Interestingly, these are also the villages where households have substantially resorted to income from 'Other' sources and migration, probably indicating that

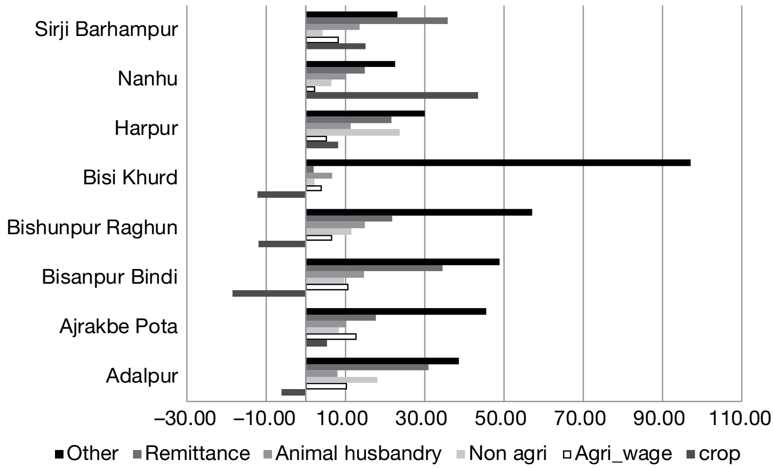



Figure 16.3 Shares of Different Income Sources in Total Income of Households in Study Villages

*Source:* Constructed by authors using field survey data.

agriculture has always been a weak income-generating source. Non-agricultural wage work also remains a far cry from being a substantial income-generating opportunity across all the villages, highlighting the absence of non-agricultural wage opportunities. In villages where agricultural income is high, as in Nanhu, households rely less on animal husbandry, remittance or non-agricultural wage work as additional sources of income.

## 16.5 IDENTIFICATION OF FACTORS DETERMINING HOUSEHOLD INCOME

In this section, we attempt to identify the factors that determine the income of the rural households in the villages that we studied. For this purpose, we estimate an econometric model wherein the dependent variable is household income that is defined as the income generated from crop production, animal resources, agricultural labouring out, non-agricultural wage work, remittances and 'Other' income. The explanatory variables considered and their definitions are presented in Table 16.3.

Table 16.3 Explanatory Variables Used in Regression

| ***Independent Variables*** | ***Definition*** |
|---|---|
| **Caste** | Information on the social category of each household was collected. Such information was grouped into the categories of Scheduled Caste (SC), Scheduled Tribe (ST), Backward Class-1/ Economically Backward Class (EBC), Backward Class-2 (BC-2) and Others. To capture the impact of the caste position of the household in our analysis, we generated dummy variables with the reference category being BC-1. |
| **Operational holding** (operational) | This is the total agricultural land that the household actually cultivates. It may or may not be equal to the household's ownership holding. The household may choose to keep a portion of land fallow in some seasons or lease out land or may choose to lease in more land. |
| **Workers** (Worker) | The number of members in a household between 15- and 64-year age group, who have reported any primary occupation during the survey. |
| **Part-time workers** (part-time) | Household members in the 15–64 year age group who have reported education or household chores as their primary occupation but have reported some wage earning or work on the family farm as their secondary occupation. |
| **Education level of the head of the household** (educ) | It represents the level of education attained by the head of the household and is measured in the number of years of schooling done. |
| **Technology** (tech) | Technology is calculated by the ratio of capital to labour. Since it is extremely difficult to collect data on the number of labourers hired and the exact quantity of capital employed, we take wage cost and rental payment as a proxy for labour and capital used in production. The wage–rental ratio is, therefore, a measure of how labour-intensive or capital-intensive agricultural production is at the household level. |
| **Amount borrowed** (debt) | This is the amount of money borrowed by the households. In case the amount was borrowed for a period of more than one year, data were annualised. We have taken a natural log of the amount borrowed. |
| **Input costs** | We have considered information regarding the various inputs used in agricultural production. Log of the cost of irrigation (irrigation), cost of seeds used (seedcost), and value of fertilisers used (fertiliser) were individually included to study their impact on crop income. |
| **Wages of hired labour** | The current wage rates of hired labour for both males (Wage_M) and females (Wage_F) are taken as independent variables. It is important to note that the wages vary across crops and crop operations. However, in this study, we have considered the average wage across crops and crop operations for both males and females. |

*Source:* Field Survey, 2019–20.

The reduced-form model that we estimate is the following:

$$\begin{aligned}\ln(\text{income}) = {} & \alpha_i + \beta_1\text{operational} + \beta_2\text{seedcost} + \beta_3\text{Worker} \\ & + \beta_4\text{Parttime} + \beta_5\text{Tech} + \beta_6\text{Educ} + \beta_7\text{fertilizer} \\ & + \beta_8\text{irrigation} + \beta_9\text{Dist} + \beta_{10}\text{wage\_M} + \beta_{11}\text{wage\_F} \\ & + \beta_{12}\text{Debt} + \beta_{13}\text{BC2} + \beta_{14}\text{Other} + \beta_{15}\text{ST} + u_i\end{aligned} \tag{16.1}$$

where $\beta$ is the vector of parameters to be estimated, and $u_i$ is the idiosyncratic error term.

We use three different methods of estimation, which are pooled ordinary least squares (OLS), Fixed Effects (FE) and Feasible Generalised Least Square (FGLS). To account for the fact that each household studied has its own individual characteristics that may impact or bias the outcome variable (household income), we undertake the FE estimation, i.e., we assume that there is a correlation between the error term and predictor variables and we need to control for this. Furthermore, the time-invariant characteristics of the households are unique to themselves and should not be correlated with other households, and, therefore, the household's error term and the constant (which captures individual characteristics) should not be correlated with the others, rendering the FE model an appropriate method of estimation. There can also be cross-sectional correlation and heteroskedasticity across panels, prompting us to undertake FGLS estimation.

The results (Table 16.4) show that with increasing distance from the nearest town, household income tends to decrease. An increase in the size of operational holding increases household income significantly. The more the number of workers and part-time workers in the households, the higher the level of household income. However, it is worth noting that the contribution of workers (full-time) to household income is more than that of part-time workers. This is obvious given the fact that the primary occupation of the part-time workers is not wage work. The costs of agricultural inputs, like seeds and fertilisers, reduce income levels, whereas irrigation raises it. This is probably because of the positive impact of good irrigation on crop productivity. Debt reduces household income significantly. The education level of the head of household tends to

Table 16.4 Regression Results for Determination of Total Household Income

| *Explanatory Variables* | *Estimated Coefficients Under* OLS | FE | FGLS |
|---|---|---|---|
| Dist | 0.41 | | –0.06*** |
| Worker | 0.32* | 0.31* | 0.32*** |
| Part-time | 0.08 | 0.12* | 0.18** |
| Debt | –0.26** | –0.06** | –0.22*** |
| Seed cost | 0.48 | –0.03*** | –1.36** |
| Fertiliser | 0.04 | 0.17 | –0.03** |
| Irrigation | 1.13*** | –0.47 | 1.34* |
| Wage_M | 0.27 | 0.40** | 1.84*** |
| Wage_F | 0.15 | 0.04 | 1.46** |
| Educ | 0.21 | 0.23** | 1.12*** |
| Tech | –0.79 | –0.66 | 0.01 |
| Operational | 1.00** | 1.14** | 1.07*** |
| BC-2 | 0.32 | 0.46 | 0.03 |
| Other | 1.52* | 1.47** | 1.38** |
| SC | 0.29 | 0.18 | 0.07 |
| Constant | 13.23*** | –23687.77** | 13.22*** |
| District fixed effects | | Included | |
| No. of observations | 302 | 284 | 269 |
| $R^2$ | 96.63 | 96.29 | |
| Wald Chi 2 (12) (Prob > Chi 2) | | | 2394.73*** (0.0000) |

*Source:* Authors' computation.

*Note:* *, ** and ***imply significance at 10, 5 and 1 per cent levels, respectively.

raise income levels. Belonging to the social group 'Other' compared to the reference category BC-1 raises income significantly.

## 16.6 INCOME DIVERSIFICATION BY RURAL HOUSEHOLDS

In most developing countries, sufficient survival means of rural households are not provided by farming alone (Bhaumik, 2002). They had to engage in 'pluri-activity' to maintain their subsistence living. The capacity to diversify income by the households depends on their ownership of land and non-land assets. Theory predicts that as the wealth of the households increases (in land and non-land assets), the less risk-averse they will be, and hence the more willing they will be to undertake investments with uncertain returns (Newbery & Stiglitz, 1981). In the presence of a binding liquidity constraint or underdeveloped credit markets, wealthier households could rely on their own liquid resources (either directly for investment, or as collateral) to enter into non-farm activities. On the other hand, drawing on portfolio theory, it is argued that households with less land or non-land assets (e.g., livestock, food stocks, savings) tend to be more risk-averse and hence more sensitive to the need to diversify to lower the overall instability of returns. In static terms, a household-level land constraint would translate into limited food output and the need to undertake off-farm activities to substitute for or supplement crop income.

The existing literature identifies various factors as determinants of household-level income diversification. Earnings from casual labour and remittances are found to raise household income significantly (Rangathan et al., 2016). Other important factors that impact income diversification by households are the availability of proper infrastructure for livestock, adequate production technology, access to information, access to market, and climatic risks (Khan et al., 2020). The literature on 'cash income target'[2] considers cash cropping as a substitute for non-farm activities and an avenue for income diversification. Farm households are confronted by different incentives and constraints due to the differences in transaction costs and market prices they face. This culminates in heterogeneity in the income diversification strategies farm households pursue (Barrett et al., 2005). Therefore, assessing the determinants of income diversification is likely to appropriately facilitate the provision of public goods (infrastructure, extension service delivery, etc.) and household empowerment programmes by the state and non-governmental organisations, respectively, to the rural households in the region.

### 16.6.1 Degree of Income Diversification

In our analysis of income diversification by the households in our survey areas, we use Simpson's Index of Diversity (SID) to understand the degree of income diversification among them. The SID takes into consideration both the number of income sources and how evenly the distributions of the income between the different sources are (Joshi et al., 2003). The SID ranges between 0 and 1, with 0 implying specialisation and 1 implying the extremity of diversification. The closer the SID value is to 1, the more diversified the household is. The formula of the SID is given as follows:

$$\text{SID} = 1 - \sum_{i=1}^{n} P_i^2 \tag{16.2}$$

where $n$ is the number of income sources and $P_i$ is the proportion of income obtained from the source $i$.

The SID values across the study villages are presented in Table 16.5. It is found that the income diversification among households is within 50 per cent. The villages such as Adalpur, Bishunpur Raghunath and Bisi Khurd, which have losses from crop production, have comparatively higher income diversification index, confirming that when the major income source fails, households tend to rely more on diversified sources for maintaining subsistence.

We further disaggregate the sample into two sub-samples: small farms and big farms. For this, we take the average operational holding of 2 acres as the threshold and categorise the households with less or equal to 2 acres of operational holding as small farms and those with greater than 2 acres as big farms. Except for the two villages in Rohtas, in all other villages, the big farms have a higher income diversification index (Table 16.6), indicating the prevalence of the motive of 'diversification as accumulation' in the actual behaviour of rural households[3]. The benefits of strategic

Table 16.5 Degree of Income Diversification of Households in Study Villages

| District | Village | Mean SID |
|---|---|---|
| Muzaffarpur | Adalpur | 0.44 |
| | Harpur | 0.37 |
| Sheohar | Ajrakbe Pota | 0.5 |
| | Bisanpur Bindi | 0.44 |
| West Champaran | Sirji Barhampur | 0.39 |
| | Bishunpur Raghunath | 0.39 |
| Rohtas | Bisi Khurd | 0.42 |
| | Nanhu | 0.41 |

*Source:* Authors' computation.

Table 16.6 Degree of Income Diversification by Size of Landholding in Study Villages

| District | Village | Small Farms | Big Farms |
|---|---|---|---|
| Muzaffarpur | Adalpur | 0.44 | 0.59 |
| | Harpur | 0.36 | 0.42 |
| Sheohar | Ajrakbe Pota | 0.5 | 0.52 |
| | Bisanpur Bindi | 0.38 | 0.51 |
| West Champaran | Sirji Barhampur | 0.37 | 0.48 |
| | Bishunpur Raghunath | 0.38 | 0.44 |
| Rohtas | Bisi Khurd | 0.51 | 0.34 |
| | Nanhu | 0.45 | 0.37 |

*Source:* Authors' computation.

complementarities that exist between activities, such as crop-livestock integration, or local engines of growth, such as commercial agriculture or proximity to an urban area that creates opportunities for income diversification, can often be realised by households that are better off compared to households that need to diversify as a matter of necessity and survival. The latter group tends to lose out due to the higher initial costs that need to be borne to opt for these various diversification strategies.

### 16.6.2 Determinants of Income Diversification

To identify the factors that determine households' engagement in income diversification, we estimate the censored Tobit regression model (Greene, 2003). The application of this method is justified by the presence of zeros (i.e., households having no diversification) in the dependent variable, which is SID. In general, this model is specified as follows:

$$\begin{aligned} y_i^* &= x_i'\beta + \varepsilon_i \\ y_i &= 0 \text{ if } y_i^* \leq 0 \\ y_i &= y_i^* \text{ if } y_i^* > 0 \end{aligned} \tag{16.2}$$

where $y_i^*$ is a censored variable (SID in our case), $\beta$ is the vector of parameters to be estimated, $x$ is the vector of explanatory variables and $\varepsilon$ is the error term.

Our reduced-form model is given as follows:

$$\begin{aligned} SID = \alpha_i &+ \beta_1\text{operational} + \beta_2\text{workers} + \beta_3 part-time \\ &+ \beta_4 dist\_town + \beta_5 irrig + \beta_6 debt + \beta_7 educ \\ &+ \beta_8 BC2 + \beta_9 Other + \beta_{10} SC + \beta_{11}\text{ST} + u_i \end{aligned} \tag{16.3}$$

The results of the estimated Tobit regression are presented in Table 16.7. It is found that the education level of the head of the household significantly reduces the income diversification index, indicating that the income obtained due to a higher level of education is adequate, thereby causing the households to engage less in pluri-activity. Households having loans are required to work in more jobs to service the loans, and hence the diversification index rises statistically significantly with household debt. The availability of workers (full-time) and part-time workers significantly raises the diversification index, implying that the more the number of workers, the more the number of income sources exploited by the household. An increase in the size of operational holding raises the opportunity for income diversification significantly, whereas

Table 16.7 Results of Tobit Regression for Determination of Degree of Diversification by Households

| *Variables* | *Estimated Coefficients* |
|---|---|
| Educ | –0.18*** |
| Debt | 8.45*** |
| Worker | 1.01*** |
| Part-time | 0.09** |
| Operational | 1.05*** |
| Dist | –0.03** |
| Irrig | 0.14*** |
| BC-2 | 0.13* |
| Other | 0.17* |
| SC | 0.06 |
| ST | –0.52*** |
| Constant | 0.30** |
| No. of Observations | 282 |

*Note:* *, ** and *** imply significance at 10, 5 and 1 per cent levels respectively.

*Source:* Authors' computation.

the increasing distance of residence from the nearest town reduces the availability of different types of work. The availability of irrigation tends to increase income diversification, a corroboration of the literature that considers cash cropping as a substitute for non-farm activities and, therefore, a means to diversify household income. Compared to the reference caste category of BC-1, those belonging to BC-2 and Other enjoy a greater degree of income diversification, whereas those belonging to ST significantly reduce it.

The results spell important implications for income diversification. It is to be noted that the choice between specialisation and diversification and the decision as to how far to pursue the latter are constrained by two aspects. First, there are constraints of specialisation in cropping in the short run[4] combined with an aversion to the riskiness of cropping, implying that households will desire to diversify income sources. Second, the desire and capacity to diversify are constrained by factors specific to households, villages, and agro-ecological zones[5].

## 16.7 CONCLUSION

Statistics on the income of agricultural households in India are hard to calculate and, therefore, harder to obtain. This makes policy formulation and hence addressing the major issues of income generation for farmer households extremely difficult. Consequently, to understand the issues and determinants of income generation, we have undertaken a primary survey across eight villages in Bihar. Different infrastructural, financial and input structures in agriculture interact with various sociological processes to determine household income. Therefore, factors such as the extent of operational holding, debts of the households, family size, irrigation level, wage of hired workers, extent of machines used and belonging to the social groups as Others play important roles in determining household income.

Our study of the income diversification index across the study villages shows that, on the whole, there is about 50 per cent income diversification by the households and the diversification behaviour of households in rural Bihar is driven by accumulation motives since households with larger operational holdings tend to diversify more. This also points to the lack of opportunity available to poorer households to supplement their already low income from crop cultivation. While identifying the determinants of income diversification, we find that the size of operational holding, debts taken, number of full-time and part-time workers and availability of irrigation opportunities increase the income diversification index at the household level. On the other hand, the education level of the head of household, distance from the nearest town and belonging to the social group of ST reduce income diversification.

To conclude, we would say that in view of the falling income from crop production with ever-rising costs of cultivation, diversification of income toward the non-agricultural sector is an important alternative to supplement household income. The increasing importance of non-farm activities and micro- and small-scale industries can enlarge the mass domestic market in consumption and exchange spheres. State policies should be tailored to support the infrastructural needs, ensure access to relevant technology and just distribute the outcome of such a growth process. The generation of more non-farm income opportunities, especially during the lean season and for weaker social groups, would help to reduce poverty. Finally, since our study confirms the intricate intertwining of social factors with economic ones in reducing diversification opportunities, land reforms are of utmost importance in increasing the agricultural income of rural households, along with an increase in investment in rural development projects.


## ACKNOWLEDGEMENT

The authors acknowledge financial support from ICSSR in completing this study. Thanks are due to Rishu Kumar for his able research assistance.


## NOTES

1. The importance of social class in India and more so in Bihar emanates from its continued permeation in the society, causing differential access to factors of production, resources and heterogeneity in extension access across caste groups.
2. See Khatkhate (1962).
3. See Ellis (2000) for similar arguments.
4. The constraint arises due to (i) short and single cropping season per year; (ii) fixed household size, combined with what appears to be a supply- and demand-constrained market for hired agricultural labour; (iii) low labour productivity from crop production; (iv) lack of adequate irrigation; and (v) low rainfall and poor soils that put strict technical limits to cropping options.
5. These factors may include but are not limited to the degree of infrastructural development, wages, prices, possession of assets, education level, etc.

## REFERENCES


Athreya, V. B., Djurfeldt, G., & Lindberg, S. (1990). *Barriers broken.* Sage Publications.

Barrett, C., Bezuneh, M., Clay, D. C., & Reardon, T. (2005). Heterogeneous constraints, incentives and income diversification strategies in rural Africa. *Quarterly Journal of International Agriculture, 44*(1), 37–60.

Barrett, C., & McPeak, J. (2006). Poverty traps and safety nets. In A. Janvry & R. Kanbur (Eds.), *Poverty, inequality and development: Essays in honor of Erik Thorbecke*. Springer.

Bhaumik, S. K. (2002). Employment diversification in rural India: A state level analysis. *The Indian Journal of Labour Economics, 45*(4), 718–744.

Census (2011). *Primary Census Abstracts*, Registrar General of India, Ministry of Home Affairs, Government of India.

Chand, R., Saxena, R., & Rana, S. (2015). Estimates and analysis of farm income in India: 1983−84 to 2011−12. *Economic and Political Weekly, 40*(22), 139–145.

Chand, R. (2016). *Doubling farmers' income: Strategy and prospects* (Presidential Address at the 76 Annual Conference). Indian Society of Agricultural Economics, Assam Agricultural University, Jorhat, Assam.

Démurger, S., Fournier, M., & Weiyong, Y. (2010). Rural households' decisions towards income diversification: Evidence from a township in northern China. *China Economic Review*, *21*(S1), S32–S44.

Deshpande, R. S., & Arora, S. (Eds). (2010). *Agrarian crisis and farmer suicides*. Sage Publications.

Dhar, N., & Patra, S. (2017). Labour in small farms: Evidence from village studies. In M. Swaminathan & S. Bakshi (Eds.), *How do Small farmers fare? Evidence from village studies*. Tulika Books.

Dholakia, R. H., & Sapre, A. (2013). *Intersectoral terms of trade and aggregate supply response in Gujarat and Indian agriculture* (WP No 2013-07-02). IIMA Working Paper, IIM, Ahmedabad.

Duong, T. T., Brewer, T., Luck, J., & Zander, K. (2019). A global review of farmers' perceptions of agricultural risks and risk management strategies. *Agriculture, 9*(1), 1–16.

Ellis, F. (2000). *Rural livelihoods and diversity in developing countries*. Oxford University Press.

Farrington, J., Deshingkar, P., Johnson, C., & Start, D. (Eds.). (2006). *Policy windows and livelihood futures*. Oxford University Press.

Fisher, T., Mahajan, V., & Singha, A. (1997), *The forgotten sector: Non-farm employment and enterprises in rural India*. Intermediate Technology Publications.

Greene, W. (2003). *Econometrics analysis*. Prentice Hall.

Gruère, G., & Sengupta, D. (2011). Bt cotton and farmer suicides in India: An evidence-based Assessment. *The Journal of Development Studies, 47*(2), 316–337.

Gulati, A., & Rao, C. H. (1994). Indian agriculture: Emerging perspectives and policy issues. *Economic & Political Weekly, 29*(53), A158–A169.

Haggblade, S., Hazell, P., & Reardon, T. (2010). The rural non-farm economy: Prospects for growth and poverty reduction. *World Development, 38*(10), 1429–1441.

Harvey, D. I., Kellard, N. M., Madsen, J. B., & Wohar, M. E. (2010). The prebisch-singer hypothesis: Four centuries of evidence. *Review of Economics and Statistics, 92*(2), 367–377.

Joshi, P.K., Gulati, A.A., Birthal, P. S., & Tiwari, L. (2003). *Agriculture diversification in South Asia: Pattern, determinants and policy implications*. (Discussion Paper No. 57). IFPRI, Washington, D.C.

Kahlon, A. S., & Tyagi, D. S. (1983). *Agricultural price policy in India*. Allied.

Khan, W., Jamshed, M., Fatima, S. & Dhamija, A. (2020), Determinants of income diversification of farm households in Uttar Pradesh, India, *Forum for Social Economics*, *49*(4), 465–483.

Khatkhate, D. R., (1962, May). Some notes on the real effect of foreign surplus disposal in underdeveloped economies. *Quarterly Journal of Economics, 76*, 186–196.

Kumari, B. R. (2009). *Farmers' suicides in India: Impact on women*. Serials Publications.

Lanjouw, P., & Shariff, A. (2002). *Rural non-farm employment in India: Access, income and poverty impact*. (Working Paper No. 81). NCAER.

Lipton, M. (1970). *Why poor people stay poor*. Harvard University Press.

Mishra, S. (2006). Farmer suicides in Maharashtra. *Economic and Political Weekly, 41*(16), 1538–1545.

Misra, V. N., & Hazell, P. (1996). Terms of trade, rural poverty, technology and investment: The indian experience, 1952–53 to 1990–91. *Economic & Political Weekly, 31*(13), A2–A13.

Mitra, S., & Shroff, S. (2007). Farmers' suicides in Maharashtra. *Economic and Political Weekly, 42*(49), 73–77.

Mohanty, B. B. (2005), We are like the living dead: Farmer suicides in Maharashtra, Western India. *Journal of Peasant Studies, 32*(2), 243–76.

Mohanty, B. B., & Shroff, S. (2004). Farmers' suicides in Maharashtra. *Economic and Political Weekly, 39*(52), 5599–5606.

Murdoch, J. (1990). *Risk, production and saving: theory and evidence from Indian households*, Harvard University.

Narayanamoorthy, A. (2006). State of India's farmers. *Economic & Political Weekly, 41*(6), 471–473.

Narayanamoorthy, A. (2013). Profitability in crops cultivation in India: Some evidence from cost of cultivation survey data. *Indian Journal of Agricultural Economics, 68*(1), 104–121.

Newbery, D., & Stiglitz, J. (1981). *The theory of commodity price stabilization: A study in the economics of risk*. Clarendon Press.

Planning Commission. (2010). *Mid-term appraisal of the eleventh plan* (Chapter 4). Agriculture, Government of India, New Delhi.

Ranganathan,T, Tripathi, A. & Rajoriya, B. (2016). Changing sources of income and income inequality among Indian rural households, Paper presented at the *National Seminar on Dynamics of Rural Labour Relations* held at National Institute of Rural Development and Panchayati Raj (NIRD & PR), Hyderabad, March 10–12.

Ravallion, M., & S. Chen (2007). China's (Uneven) progress against poverty. *Journal of Development Economics, 82*(1), 1–42.

Sainath, P. (2010, January 25). Farm suicides: A 12-year saga. *The Hindu*.

Sarkar, P. (1994). Long term behaviour of terms of trade of primary products vis-à-vis manufactures: A critical review of recent debate. *Economic & Political Weekly, 29*(26), 1612–1614.

Satyasai, K. J. S., & Mehrotra, N. (2016). *Enhancing farmers' income*. NABARD.

Sen, A., & Bhatia, M. (2004). *Cost of cultivation and farm income, State of the Indian farmer: A millennium study* (Vol. 14). Academic Foundation.

Singer, H. W. (1950). The distribution of gains between investing and borrowing countries. *The American Economic Review, 40*(2), 473–485.

Sridhar, V. (2006). Why do farmers commit suicide? The case of Andhra Pradesh. *Economic and Political Weekly, 41*(16), 1559–1565.

Sujithkumar, P. (2008). Rural income diversification and inequality: A decomposition analysis by source income. *Social Change, 38*(2), 263–273.

Swaminathan, M. S. (2008, March 3). Ending the debt trap and attaining food security. *The Hindu*.

Walker, T., & Ryan, J. (1990). *Village and household economies in India's semi-arid tropics*. The Johns Hopkins University Press.

World Bank. (2008). *World development report: Agriculture for development*. The World Bank.

# CHAPTER 17

# CAN LIVESTOCK PROMOTE INCLUSIVE AGRICULTURAL GROWTH?

*Anjani Kumar, Seema Bathla and Vinay K Sonkar*

## 17.1 INTRODUCTION

The rising importance of the livestock sector in the agricultural economy has been one of the most important features of India's agricultural transformation. This is even more apparent in Bihar, where livestock has emerged as the most important driver of agricultural growth. Its contribution to the agricultural value of output has been increasing steadily. The contribution of livestock in agricultural households' income has also increased from 13 per cent in 2002–03 to about 23 per cent in 2018–19. Agriculture and livestock have a symbiotic relationship: Crops provide fodder and feed to livestock, which in turn supply dung and draught power to agriculture. Furthermore, the distribution of livestock resources favours households at the lower end of land distribution, where poverty is acute. Some studies indicated that growth in the livestock sector may have a larger impact on poverty reduction than similar growth in the land-intensive crop sector (Hann et al., 1997; Patel, 1993; Sere, & Steinfeld, 1996; Singh et al., 2005).

The livestock population in Bihar has increased from 30.3 million to 36.4 million during 2007–2019, i.e., an addition of about 6.1 million. The buffalo and goat populations have also increased. The production of milk, meat, eggs, and other livestock products has grown at more than 5 per cent per annum, contributing significantly to household income as well as nutrition levels. This may be in response to an increasing consumption demand for animal-based products, growing industrial livestock and poultry production (Birthal et al., 2008).

A rapid increase in the demand for animal food products offers significant opportunities to enhance agricultural growth and lessen rural poverty in Bihar. However, the productivity of livestock tends to be low and is constrained by several factors, viz. lower adoption of improved technologies, scarcity of feed and fodder, and poor animal health (Singh, 2019). Institutional and policy support for this sector in terms of public investment, institutional credit, insurance, extension, and markets is also not consistent with its contribution to the gross value added. Importantly, the extent to which the pro-poor growth opportunities offered by the livestock sector can be harnessed will depend on how these constraints are addressed.

In this backdrop, the main objective of this chapter is to discuss the potential of the livestock sector in enabling higher income and promoting inclusive growth in Bihar, its challenges, and the way forward. The second section describes the data sources. The third section discusses the place of the livestock sector in the agricultural and household economies of India in general and Bihar in particular. The distribution of land and livestock holdings in Bihar is discussed in the fourth section. This section also discusses the determinants of household income in Bihar and India. The challenges and strategies for pro-poor livestock sector growth are discussed in the fifth section. The final section concludes this chapter.

## 17.2 DATA SOURCES

The data used in our study are drawn from various published and unpublished sources. The data on Net State Domestic Product, Agricultural GDP (AgGDP), and the value of outputs from livestock and crops are collected from various issues of the *National Accounts Statistics* of the Central Statistical Office, Ministry of Statistics and Program Implementation, Government of India (GoI). The data on livestock population are compiled from different livestock censuses. The data on the production of different livestock products are taken from various issues of *Basic Animal Husbandry Statistics*, published by the Department of Animal Husbandry and Dairying, Ministry of Agriculture, GoI. We also used unit-level data from the 59th, 70th and 77th rounds of the Agricultural Situation Assessment Survey conducted by the National Sample Survey Office for the years 2003, 2013 and 2019, respectively (GoI, 2005, 2014, 2021d). These surveys collected detailed information on indicators of landholdings, land use patterns, types of crop production and animal farming activities, seasonal variations in household farm activities, and livestock ownership in rural and urban locations. These surveys also collected information on social, economic, institutional, and organisational aspects of farming, production, farming expenses, and marketing patterns of crops, livestock, and fisheries.

## 17.3 LIVESTOCK, AGRICULTURE AND THE HOUSEHOLD ECONOMY

At the national level, the share of livestock in the agricultural Value of Product (VOP) increased from 24.4 per cent in TE 2001–02 to 30.8 per cent in TE 2018–19. The increase in the share of livestock in agricultural VOP during this period in Bihar was much higher, from 25.5 per cent to 34.9 per cent. This underscored a greater prominence of livestock in the agricultural economy of Bihar.

In terms of growth, the livestock sector grew at an annual rate of 5.0 per cent at the national level and 6.1 per cent in Bihar between 2001–02 and 2018–19. As shown in Table 17.1, the rate of growth was high during the 2000s and 2011s. The livestock sector also contributed significantly to agricultural growth. At the national level, its contribution was 33 per cent during the 2000s, which increased to 49 per cent during the 2010s. Bihar's figure is equally impressive at 54 per cent during this period.

Notably, agricultural growth in Bihar is by and large driven by the livestock sector, even though its contribution to agricultural growth had gone down from 85 per cent during the 2000s to 57 per cent during the 2010s. The growth of the livestock sector has outpaced the growth of the crop sector, and its importance in generating sustainable agricultural growth is unprecedented.

Table 17.1 Contribution of Livestock in Agricultural Growth (2011–12 Prices)

| Years | Per cent Annual Growth in VOP of Livestock Sector | | Per cent Annual Growth in VOP of Agriculture Sector | | Per cent Contribution of Livestock Sector in Agricultural Growth | |
|---|---|---|---|---|---|---|
| | Bihar | India | Bihar | India | Bihar | India |
| 2001–02 | 8.7 | 4.5 | 2.8 | 3.3 | 85.2 | 33.1 |
| 2011–12 | 5.6 | 5.8 | 3.1 | 3.3 | 57.3 | 49.0 |
| 2018–19 | 6.1 | 5.0 | 3.4 | 3.5 | 54.0 | 37.3 |

*Source:* State-wise estimates of the value of output from agriculture and allied activities (base year 1999–2000, base year 2004–05, and base year 2011–12), Ministry of Statistics & Programme Implementation, GoI.

Table 17.2 shows that the VOP of livestock in Bihar increased from ₹10,561 crores in 2001–02 to ₹22,098 crores in 2011–12 and then to ₹32,138 crores in 2018–19. It has grown at an annual rate of 6.1 per cent during this period, in real terms. The annual rate of growth in VOP of livestock was much higher (8.7 per cent) during the 2000s than that during the 2010s (5.6 per cent).

Table 17.2 also exhibits the VOP of foodgrains, specifically of paddy, wheat, and maize. It shows an increase from ₹16,321 crores in 2001–02 to ₹21,540 crores in 2018–19, growing at a modest rate of 3.1 per cent per annum. Paddy, wheat, and maize have grown at an annual rate of 3.7 per cent, 2.6 per cent and 3.9 per cent, respectively, during the same period. The growth rate in VOP of foodgrains in Bihar was significantly higher during the 2010s than that in the 2000s, mainly due to the adoption of high-yielding modern cultivars of paddy, wheat, and maize by farmers (Kumar et al., 2021a,b). Higher adoption of modern cultivars has contributed to reducing the large gaps in the growth rates of VOP of livestock and foodgrains over time. The VOP of livestock has grown at a much higher rate as compared to the VOP of foodgrains. Among various livestock products, milk holds the key.

Despite a higher rate of growth in livestock, Bihar's share of VOP of livestock in India barely increased from 3.3 per cent in 2001 to 4.5 per cent during 2018–19. Similarly, Bihar's share of VOP of

Table 17.2 Annual Value of Output of Livestock vis-à-vis Foodgrains in Bihar and All-India (₹ Crores), 2011–12 Prices

| *Year* | *Live-stock* | *Milk* | *Food-grains* | *Paddy* | *Wheat* | *Maize* |
|---|---|---|---|---|---|---|
| **Bihar** | | | | | | |
| 2001–02 | 10,561 | 6665 | 16,321 | 7548 | 5832 | 1456 |
| 2011–12 | 22,098 | 16,322 | 20,121 | 10,720 | 6133 | 1576 |
| 2018–19 | 32,138 | 24,054 | 21,540 | 9155 | 8409 | 2429 |
| CAGR (per cent) 2001–02 to 2010–11 | 8.7 | 10.7 | –0.4 | –2.5 | 1.7 | 1.3 |
| CAGR (per cent) 2011–12 to 2018–19 | 5.6 | 5.9 | 1.9 | 0.6 | 4.0 | 4.4 |
| CAGR (per cent) 2001–02 to 2018–19 | 6.1 | 6.9 | 3.1 | 3.7 | 2.6 | 3.9 |
| **All-India** | | | | | | |
| 2001–02 | 316,173 | 222,129 | 325,517 | 152,117 | 91,671 | 14,810 |
| 2011–12 | 487,751 | 327,767 | 388,510 | 170,595 | 118,068 | 23,539 |
| 2018–19 | 715,977 | 478,585 | 431,305 | 187,293 | 128,979 | 29,577 |
| CAGR (per cent) 2001–02 to 2010–11 | 4.5 | 4.0 | 2.1 | 1.6 | 2.5 | 5.6 |
| CAGR (per cent) 2011–12 to 2018–19 | 5.8 | 5.7 | 1.7 | 1.2 | 1.4 | 3.6 |
| CAGR (per cent) 2001–02 to 2018–19 | 5.0 | 4.6 | 2.2 | 1.8 | 2.4 | 4.8 |

*Source:* State-wise estimates of value of output from agriculture and allied activities (base year 1999–2000, base year 2004–05, and base year 2011–12), Ministry of Statistics & Programme Implementation, GoI.

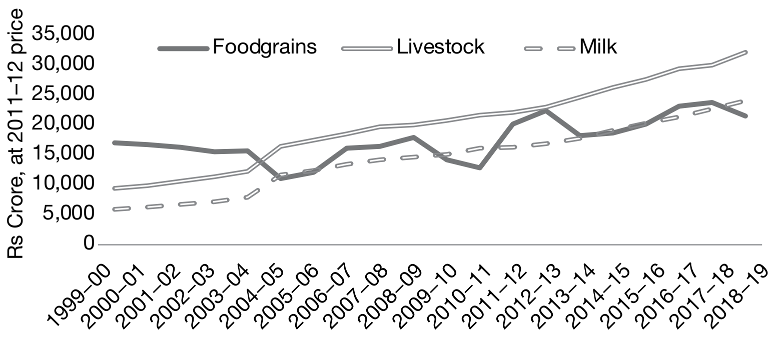



Figure 17.1 Annual VOP of Foodgrains and Livestock in Bihar (2011–12 Prices)

*Source:* State wise estimates of value of output from agriculture and allied activities (base year 1999–2000, base year 2004–05, and base year 2011–12), Ministry of Statistics & Programme Implementation, GoI.

foodgrains in India continues to be low at 5.01 per cent. Among the various reasons cited above behind an increasing diversification of livestock, year-to-year stability in the livestock VOP is an important factor. It is evident from Figure 17.1 that the annual real VOP of foodgrains has a growth pattern with marked fluctuations, whereas the VOP of livestock exhibits a smooth pattern.

The fluctuations in the VOP of foodgrains may imply high production and price risks associated with their cultivation and of the VOP of livestock with a reduction in income risks for farmers. The large differences in the annual changes in the real VOP of foodgrains in contrast to livestock shown in Figure 17.2 also endorse the abovementioned finding. However, at the national level, the VOP of livestock exhibits a smooth pattern of growth, whereas the VOP of foodgrains shows fluctuations but is lower than that in Bihar, perhaps due to procurement of paddy and wheat at pre-announced prices (Figure 17.3). Figure 17.4. shows a smooth trend in the annual change in VOP of foodgrains and livestock at the national level, from 2000–01 to 2018–19, at 2011–12 prices.

## 17.4 DISTRIBUTION OF LIVESTOCK AND DETERMINANTS OF HOUSEHOLD'S INCOME

In the face of the growing importance of livestock, this section examines the distribution of livestock among the rural agricultural

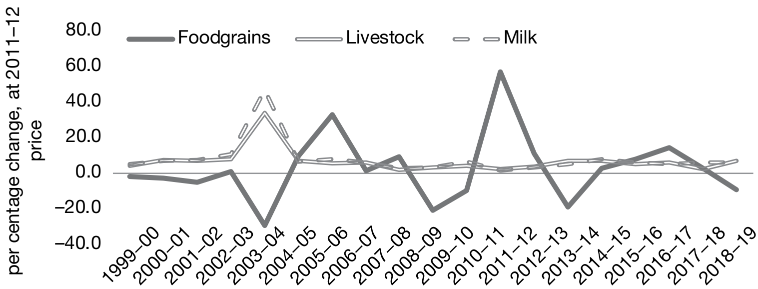



Figure 17.2 Annual Change in VOP of Foodgrains and Livestock in Bihar

*Source:* State-wise estimates of value of output from agriculture and allied activities (base year 1999–2000, base year 2004–05, and base year 2011–12), Ministry of Statistics & Programme Implementation, GoI.

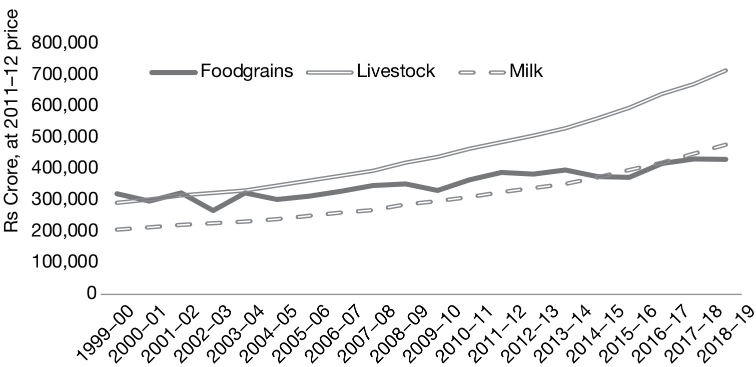



Figure 17.3 Annual VOP of Foodgrains and Livestock in India (2011–12 Prices)

*Source:* State-wise estimates of value of output from agriculture and allied activities (base year 1999–2000, base year 2004–05, and base year 2011–12), Ministry of Statistics & Programme Implementation, GoI.

households according to their size of landholdings. Table 17.3 presents the distribution of land and livestock among farm households in Bihar during 2002–03, 2012–13 and 2018–19. These years correspond to the NSS Situation Assessment of Farmers. The average area of owned land in Bihar has decreased from 0.64 ha in 2003 to 0.60 ha in 2013 and further to 0.55 ha in 2019. However, there is not much change in the distribution of farmers over this period. In 2003, approximately 84 per cent agricultural households were

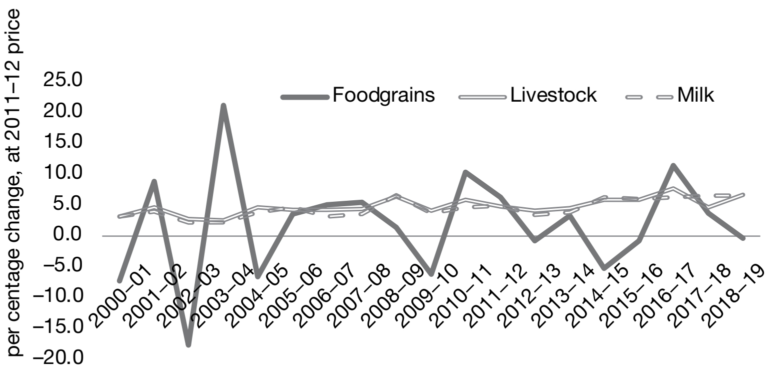



Figure 17.4 Annual Change in VOP of Foodgrains and Livestock in India Not Required

*Source:* State-wise estimates of value of output from agriculture and allied activities (base year 1999–2000, base year 2004–05, and base year 2011–12), Ministry of Statistics & Programme Implementation, GoI.

marginal farmers, which increased slightly to 85.9 per cent in 2013 and then to 86.6 per cent in 2019. The share of large farmers in Bihar was 0.87 per cent in 2003 and fell to 0.7 per cent in 2013 and further to 0.27 per cent in 2019.

Table 17.3 also exhibits the distribution of livestock based on the total number of livestock and owned livestock among these farm categories. In 2003, approximately 90 per cent of livestock was with small and marginal farmers, which increased to about 95 per cent in 2019. The large farmers had a greater share (31 per cent) in the number of poultry/ducks in 2018–19.

Table 17.4 shows the share of net livestock income in total net household income in Bihar and India among various farm categories. The share of livestock income in the total household income has increased for all categories of farmers. However, the increase is relatively higher for the marginal and small farmers in comparison to other categories, especially in Bihar. The study by Satyasai and Bharti (2016) also reported the same. As shown in the table, the income share of livestock by small farmers was negative (–23.5 per cent) during 2012–13, and it increased significantly to 24.1 per cent in 2018–19. At the national level, the percentage increase in the share of livestock income in total income is relatively more for medium and large categories of farmers.

Table 17.3 Distribution of Land and Livestock Holdings in Bihar

| | Marginal (<1 ha) | Small (1–2 ha) | Medium (2–4 ha) | Large (> 4 ha) | Total |
|---|---|---|---|---|---|
| **Year: 2003–04** | | | | | |
| Agricultural households (%) | 84.21 | 11.24 | 3.68 | 0.87 | 100 |
| Area owned per holding (ha) | 0.37 | 1.43 | 2.84 | 6.89 | 0.64 |
| **Distribution Based on Numbers** | | | | | |
| Cattle/buffalo | 71.59 | 18.98 | 6.63 | 2.8 | 100 |
| Sheep, goat, pigs, and rabbits | 82.44 | 15.36 | 1.9 | 0.31 | 100 |
| Poultry/ducks | 85.33 | 12.57 | 1.31 | 0.78 | 100 |
| **Distribution Based on HHs Owned** | | | | | |
| Cattle/buffalo | 79.85 | 14.27 | 4.52 | 1.36 | 100 |
| Sheep, goat, pigs, and rabbits | 86.11 | 11.65 | 2.11 | 0.14 | 100 |
| Poultry/ducks | 87.88 | 10.66 | 0.97 | 0.49 | 100 |
| **Year: 2012–13** | | | | | |
| Agricultural households (%) | 85.9 | 10.18 | 3.22 | 0.7 | 100 |
| Area owned per holding (ha) | 0.4 | 1.35 | 2.49 | 5.39 | 0.60 |
| **Distribution Based on HHs Owned** | | | | | |
| Cattle/buffalo | 83.92 | 12.01 | 3.19 | 0.88 | 100 |
| Sheep, goat, pigs, and rabbits | 73.08 | 19.91 | 5.47 | 1.53 | 100 |
| Poultry/ducks | 58.71 | 27.65 | 10.41 | 3.22 | 100 |
| **Year: 2018–19** | | | | | |
| Agricultural households (%) | 86.64 | 10.34 | 2.75 | 0.27 | 100 |
| Area owned per holding (ha) | 0.39 | 1.29 | 2.42 | 8.57 | 0.55 |

| | Marginal (<1 ha) | Small (1–2 ha) | Medium (2–4 ha) | Large (> 4 ha) | Total |
|---|---|---|---|---|---|
| **Distribution Based on Numbers** | | | | | |
| Cattle/buffalo | 81.2 | 13.59 | 4.71 | 0.51 | 100 |
| Sheep, goat, pigs, and rabbits | 88.04 | 9.72 | 2.15 | 0.09 | 100 |
| Poultry/ducks | 19.64 | 48.77 | 0.43 | 31.16 | 100 |
| **Distribution based on HHs owned** | | | | | |
| Cattle/buffalo | 84.18 | 11.88 | 3.61 | 0.33 | 100 |
| Sheep, goat, pigs, and rabbits | 88.93 | 9.05 | 1.97 | 0.05 | 100 |
| Poultry/ducks | 83.53 | 14.65 | 1.46 | 0.36 | 100 |

*Source:* Situation Assessment Surveys (2003, 2013 and 2019).

*Note:* The data for distribution based on numbers for the year 2012–13 are not available.

Table 17.4 Share of Net Livestock Income in Net Household Income of Agricultural Households in Bihar and India

| | Bihar | | India | |
|---|---|---|---|---|
| | 2012–13 | 2018–19 | 2012–13 | 2018–19 |
| Marginal | 13.6 | 25.3 | 13.7 | 15.8 |
| Small | –23.5 | 24.1 | 11.0 | 16.3 |
| Medium | 7.3 | 20.7 | 10.8 | 16.0 |
| Large | –1.6 | 8.9 | 7.4 | 13.7 |
| All | 7.8 | 23.3 | 11.9 | 15.7 |

*Source:* Situation Assessment Surveys (2013 and 2019).

To what extent does income from livestock activities impact households' total income? We have investigated this question empirically using the unit-level NSS data (the Situation Assessment Survey, 2019) in Bihar and at the all-India level. Table 17.5 presents the results of the OLS regression. The dependent variable is

Table 17.5 Impact of Livestock on Household Income in Bihar and India, OLS Model

| ***Outcome Variable: Annual Total HH Income (log)*** | ***Bihar*** | | ***All India*** | |
|---|---|---|---|---|
| ***Explanatory Variables*** | ***Coeff*** | ***SE*** | ***Coeff*** | ***SE*** |
| Livestock rearing HHs^ | 0.322*** | (0.039) | 0.220*** | (0.024) |
| Household head age (years) | 0.002 | (0.002) | –0.001 | (0.001) |
| Male-headed household^ | 0.382*** | (0.122) | 0.225*** | (0.030) |
| Household size (nos.) | 0.083*** | (0.010) | 0.116*** | (0.004) |
| Household head illiterate^ | –0.138*** | (0.046) | –0.163*** | (0.018) |
| Caste: Base - SC and ST^ | | | | |
| OBC | 0.062 | (0.059) | –0.044 | (0.027) |
| General | 0.131 | (0.080) | –0.013 | (0.032) |
| Land Category^: Base – Marginal | | | | |
| Small (1–2 ha) | 0.596*** | (0.043) | 0.318*** | (0.025) |
| Medium (2–4 ha) | 1.007*** | (0.053) | 0.570*** | (0.035) |
| Large (>4 ha) | 1.720*** | (0.184) | 0.911*** | (0.072) |
| Have bank account^ | –0.065 | (0.118) | 0.152** | (0.067) |
| Have any outstanding loan^ | –0.010 | (0.034) | 0.018 | (0.018) |
| Have KCC^ | 0.029 | (0.046) | 0.102*** | (0.024) |
| Access to progressive farmers^ | –0.020 | (0.050) | 0.050* | (0.030) |
| Access to veterinary department^ | 0.386*** | (0.072) | 0.127*** | (0.041) |
| Access to cooperative/dairy cooperatives^ | 0.423*** | (0.077) | 0.201*** | (0.050) |
| Access to print media^ | 0.046 | (0.129) | 0.033 | (0.042) |
| Access to electronic media^ | –0.076 | (0.076) | 0.084*** | (0.030) |
| Access to smartphone^ | 0.459** | (0.179) | 0.156** | (0.071) |
| District fixed effect | Yes | | Yes | |
| Constant | 7.248*** | (0.182) | 7.723*** | (0.080) |
| Observations | 3872 | | 44,142 | |
| *R*-squared | 0.313 | | 0.223 | |

*Source:* Authors' calculation using unit-level data from Situation Assessment Survey, 2019.

*Note:* Robust standard errors in parentheses; ***p<0.01, **p<0.05, *p<0.1; clustering at district level; ^dummy variable(s).

the net annual household income earned by a household from all sources. The main variable of interest is the owned livestock, which is a dummy variable that takes the value of '1' if the household owns livestock and '0' otherwise. We have also controlled other variables and employed district fixed effects to control the unobserved variables at the district level.

As expected, possession of livestock by the households increases annual households' income, and this relationship is significant at 1 per cent level. It is found that the annual income for households owning livestock in Bihar is approximately 32 per cent higher compared to those who do not own livestock. The same at the all-India level is about 22 per cent. This may be explained by a threefold increase in the share of livestock income in total household income in Bihar between 2013 and 2019. The study by Saxena et al. (2017) validates this finding. Our results further show that the household heads who are literate and aware of diversified activities to minimize risks tend to have higher annual household income in comparison to illiterate households. The small, medium, and large farmers owning livestock have higher annual household income compared to the marginal farmers. There is also a direct relationship between land size and household income.

Access to public extension services (from veterinary departments), dairy cooperatives and smartphones are also positively and statistically significantly correlated with annual household income. The empirical findings are almost the same at the national level, except for a few explanatory variables, viz. bank account, access to progressive farmers, electronic media and KCC that have a significant bearing on household income.

## 17.4 CHALLENGES AND STRATEGIES FOR PRO-POOR LIVESTOCK GROWTH

Our above results reveal that the poor households (marginal and small farmers) are relatively more dependent on livestock activities for sustenance. In that situation, what should be the strategy to promote pro-poor livestock growth in Bihar? This section discusses some of the challenges faced by the farm households to draw feasible strategies.

## 17.4.1 Milk Production and Yield

Table 17.6 provides information on milk production in Bihar and at the national level during 2000–02 to 2019–20 for different species. It is observed that the average milk production of indigenous cows in Bihar increased from 4.5 lakh tons in 2001–02 to 27.9 lakh tons in 2019–20, growing at an annual rate of 7.5 per cent (GoI, 2021a), whereas at the national level, milk production grew at an annual rate of 4.3 per cent. In Bihar, the average milk production of crossbred cows has grown at a much higher rate of 19.7 per cent per annum, increasing from a meagre 0.5 lakh tons in 2001–02 to 33.0 lakh tons in 2019–20, whereas at the national level, this has grown at a nominal rate of 7.9 per cent. The annual growth rate of milk production for indigenous and crossbred cows and buffalo was much higher during the 2000s than in the 2010s for Bihar and at the national level. Bihar's share of milk production of crossbred cows in India increased from 0.3 per cent in 2001–02 to 5.8 per cent in 2019–20. Similarly, for the indigenous cow, it increased from 2.3 per cent to 7.0 per cent during the same period. However, the share of milk production of buffalo has not increased much.

The average milk yield of crossbred cows in Bihar was 6.7 kg per day per animal during 2019–20, almost double that of indigenous cows (Table 17.7). The milk yield for buffalo was 4.5 kg per day per animal. Interestingly, the milk yield of indigenous cows increased at an annual rate of 4.1 per cent during 2001–02 and 2019–20, much higher than that for crossbred cows (1.2 per cent) and buffalo (1.5 per cent) in the same period.

## 17.4.2 Public Spending

Bihar's state budget expenditure on livestock and overall agriculture and allied sectors increased at a brisk rate during the 2000s but slowed during the 2010s (Table 17.8). Expenditure on animal husbandry and dairy development increased from ₹100.8 crore in 2001–02 and 234.3 crore in 2011–12 to ₹446.5 crore in 2019–20, growing at an annual rate of 9.2 per cent during 2001–02 to 2019–20, at constant price. The annual growth rate in the 2000s (15.1 per cent) was higher than that in the 2010s (6.1 per cent). The share of animal husbandry in agricultural and allied activities was

Table 17.6 Growth in Milk Production of Different Species in Bihar and India

| | Milk Production (in Lakh Tones) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Bihar | | | India | | | % Share of Bihar in India | | |
| **Year** | **Indigenous** | **Crossbred** | **Buffalo** | **Indigenous** | **Crossbred** | **Buffalo** | **Indigenous** | **Crossbred** | **Buffalo** |
| 2001–02 | 4.5 | 0.5 | 13.3 | 193.0 | 152.2 | 454.0 | 2.3 | 0.3 | 2.9 |
| 2011–12 | 22.5 | 14.2 | 28.1 | 267.0 | 310.8 | 653.5 | 8.4 | 4.6 | 4.3 |
| 2018–19 | 26.5 | 31.0 | 38.5 | 385.7 | 512.6 | 918.2 | 6.9 | 6.0 | 4.2 |
| 2019–20 | 27.9 | 33.0 | 41.5 | 397.7 | 568.8 | 959.4 | 7.0 | 5.8 | 4.3 |
| CAGR (%) 2001–02 to 2010–11 | 17.3 | 39.6 | 8.0 | 3.2 | 8.8 | 3.7 | | | |
| CAGR (%) 2011–12 to 2019–20 | 2.0 | 13.3 | 4.8 | j.6 | 8.0 | 5.0 | | | |
| CAGR (%) 2001–02 to 2019–20 | 7.5 | 19.7 | 4.8 | 4.3 | 7.9 | 4.2 | | | |

*Source:* Basic Animal Husbandry Statistics, Department of Animal Husbandry and Dairying, GoI.

Table 17.7 Average Milk Yield of Different Species in Bihar and India

| Year | Average Milk Yield per Animal (kg per day) | | | | | |
|---|---|---|---|---|---|---|
| | Bihar | | | India | | |
| | Indigenous | Crossbred | Buffalo | Indigenous | Crossbred | Buffalo |
| 2001–02 | 1.7 | 5 | 3.5 | 1.9 | 6.4 | 4.1 |
| 2011–12 | 2.9 | 6.1 | 3.9 | 2.3 | 7 | 4.7 |
| 2018–19 | 3.4 | 6.6 | 4.4 | 3 | 8 | 5.6 |
| 2019–20 | 3.4 | 6.7 | 4.5 | 3.1 | 8.2 | 5.8 |
| CAGR (%) 2001–02 to 2010–11 | 7.9 | 2.1 | 1.6 | 2 | 0.4 | 0.7 |
| CAGR (%) 2011–12 to 2019–20 | 2.4 | 1.2 | 1.8 | 4 | 2.2 | 2.5 |
| CAGR (%) 2001–02 to 2019–20 | 4.1 | 1.2 | 1.5 | 2.9 | 1.3 | 1.9 |

*Source*: As in Table 17.6.

19.6 per cent in 2001–02, sharply declined to 9.1 per cent in 2011–12 and slightly increased to 11.2 per cent in 2019–20 (Table 17.8).

Expenditure specifically on dairy development increased sharply from ₹8.4 crores in 2001–02 to 48.4 crores in 2011–12, growing at an annual rate of 34.8 per cent but expenditure on dairy development increased at a lower rate of 2.7 per cent per annum during 2011–12 to 2019–20. This may be a possible reason for the higher growth in average milk-yield for indigenous and crossbred cows in Bihar during the 2000s than in the 2010s.

Low public spending on livestock also reflects inadequate infrastructure. The number of veterinary institutions has increased modestly from 1670 in 2004–05 to 2417 in 2011–12 and 2732 in 2019–20 (Table 17.9). However, the cattle equivalent units per veterinary institution have steadily declined from 8281 in 2004–05 to 6077 in 2019–20. Similarly, there is a decline in cattle equivalent units per veterinarian from 4814 in 2011–12 to 4619 in 2019–20.

Table 17.8 Public Spending in Livestock Sector in Bihar (at 2011–12 prices) (₹ Crore)

| Year | Public Spending in Livestock Sector (at 2011–12 Prices) (₹ Crore) | | | | % Share in Agricultural and Allied Activities | | |
|---|---|---|---|---|---|---|---|
| | Animal Husbandry | Dairy Development | Animal Husbandry and Dairy Development | Agriculture and Allied Activities | Animal Husbandry | Dairy Development | Animal Husbandry and Dairy Development |
| 2001–2002 | 92.4 | 8.4 | 100.8 | 472.4 | 19.6 | 1.8 | 21.3 |
| 2011–2012 | 185.8 | 48.4 | 234.3 | 2031.8 | 9.10 | 2.4 | 11.5 |
| 2019–2020 | 372.9 | 73.6 | 446.5 | 3337.9 | 11.2 | 2.2 | 13.4 |
| CAGR (per cent) 2001–02 to 2010–11 | 11.6 | 34.8 | 15.1 | 21.2 | | | |
| CAGR (per cent) 2011–12 to 2019–20 | 7.8 | 2.7 | 6.1 | 2.9 | | | |
| CAGR (per cent) 2001–02 to 2019–20 | 8.1 | 16.2 | 9.2 | 13.7 | | | |

*Source:* Bihar State Plans, Finance Department, Government of Bihar.

Table 17.9 Veterinary Infrastructure in Bihar

| Year | No. of Veterinary Institutions | No. of Veterinarians | Cattle Equivalent Units per Veterinary Institution | Cattle Equivalent Units per Veterinarian |
|---|---|---|---|---|
| 2004–05 | 1670 | 3104 | 8281 | 4455 |
| 2011–12 | 2417 | 3322 | 6617 | 4814 |
| 2019–20 | 2732 | 3594 | 6077 | 4619 |

*Source:* Basic Animal Husbandry Statistics, Department of Animal Husbandry and Dairying, GoI.

*Notes:* (i) Veterinary institutions include veterinary hospitals/polyclinics/dispensaries/aid-centres; (ii). Number of veterinarians for 2004–05 relate to 2010, that for 2011–12 relate to 2013, and for 2019–20 relate to 2018. No. of veterinarians' data available at three time points 2010, 2013 and 2018.

The decline in veterinary infrastructure may be another possible reason behind the lower growth in milk production in Bihar during the 2010s. An increase in public spending on the creation of veterinary infrastructure is necessary to achieve the full growth-potential of the livestock sub-sector. Bihar also needs private veterinary institutes. In 2015, there were only 4.4 per cent private veterinary institutes, which were very low compared to other countries, such as the USA having 87 per cent and European countries having 60 per cent (Miftahul, 2017). As per the Veterinary Council of India, there should be one veterinarian for every 5000 livestock population. As estimated, 1.1–1.2 lakh veterinarians are required, but at the national level, only just half of what is recommended exists (Damodaran 2015).

### 17.4.3 Insurance and Credit Supply

Table 17.10 reveals the status of livestock insurance in Bihar. In 2007, approximately, 1.05 million livestock were insured out of a total of 30.3 million in Bihar. This was 3.5 per cent of total livestock, whereas this figure at the all-India level was 10.1 per cent (GoI, 2021b). This shows that the livestock insurance has not taken off yet in Bihar. In 2012, the number of insured livestock was way

Table 17.10 Status of Livestock Insurance in Bihar and India

| | Bihar | | | India | | |
|---|---|---|---|---|---|---|
| Year | No. of Livestock Insured | Total No. of Livestock | % Share | No. of Livestock Insured | Total No. of Livestock | % Share |
| 2007 | 1,048,400 | 30,342,000 | 3.5 | 53,422,600 | 529,700,000 | 10.1 |
| 2012 | 351,900 | 32,938,000 | 1.1 | 81,396,400 | 512,060,000 | 15.9 |
| 2019 | 0 | 36,540,820 | – | 54,696,000 | 536,760,000 | 10.2 |

*Source:* Ministry of Agriculture, GoI.

below that in 2007. Approximately 3.5 lakh livestock were insured against 32.9 million livestock in Bihar, which was just 1.1 per cent of total livestock. In the same year, this figure at the national level went up, and about 16 per cent of livestock were insured. Despite implementing a risk management and insurance scheme in May 2014 for all animals, including non-milch ones, the number of insured livestock has dipped to 10.2 per cent at the all-India level. In 2019, not a single livestock was insured in Bihar, which is to be seen to cover farmers' risk.

We may also look at the distribution of borrowed credit among livestock and non-livestock holders in Bihar. Overall, about 36.5 per cent of livestock holder households borrowed credit from institutional sources, such as public and private banks, commercial banks, and regional rural banks, whereas 63.5 per cent of livestock holder households borrowed credit from non-institutional sources, such as money lenders, friends and relatives, and agricultural traders or commission agents (Table 17.11). Among the farm categories, landless farmers owning livestock, about 83 per cent borrowed credit from non-institutional sources, whereas only 6.4 per cent of the large farmers owning livestock borrowed credit from institutional sources. One may find that the small and marginal farmers mainly borrowed credit from informal sources. Among farmers who did not own any livestock, approximately 41 per cent borrowed credit from institutional sources, whereas 59 per cent borrowed credit from non-institutional sources. The non-livestock households who were landless (about 39 per cent) borrowed credit from

Table 17.11 Land Category-wise Percentage Share of Institutional and Non-institutional Sources Among Livestock and Non-livestock HHs Who Borrowed Credit (Bihar)

| Farmer Types | Livestock Holder | | Non-livestock Holder | | All HHs | |
|---|---|---|---|---|---|---|
| | Institutional | Non-institutional | Institutional | Non-institutional | Institutional | Non-institutional |
| Landless | 17.1 | 82.9 | 39 | 61.1 | 32.2 | 67.8 |
| Marginal | 35.1 | 65 | 41 | 59 | 37.9 | 62.1 |
| Small | 56.1 | 43.9 | 33 | 67 | 50.8 | 49.2 |
| Medium | 45.6 | 54.4 | 73.9 | 26.1 | 51.6 | 48.4 |
| Large | 93.6 | 6.4 | 17.5 | 82.5 | 85.3 | 14.8 |
| All | 36.5 | 63.5 | 40.8 | 59.2 | 38.5 | 61.5 |

*Source:* Unit-level data and Report on NSS 77th Round, January 2019–December 2019 (Debt and Investment).

institutional sources, whereas this figure for livestock owners and landless was just 17 per cent (GoI, 2021e).

### 17.4.4 Extension Services

Table 17.12 presents information on the access to extension services across farming categories for the households who owned livestock. In recent years, the GoI spent less than 1 per cent of AgGDP on extension services, which is very less compared to its benefits (Chander & Prakashkumar, 2013). In 2012–13, farmers who owned livestock in Bihar accessed extension services mainly from the progressive farmers and digital and print media, such as radio, television, internet, and newspapers, whereas at the national level, in addition to these extension services, they also got extension services from the veterinary department and private commercial agents. In 2018–19, although the sources of access to extension services remained the same both in Bihar and India, the percentage share went down. For instance, in 2012–13, approximately 37 per cent farmers who owned livestock had access to extension services

Table 17.12 Access to Extension Services Across Land Class for the Livestock HHs (per cent)

| | 2012–13 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | India | | | | | Bihar | | | | |
| Source | M | S | Me | L | T | M | S | Me | L | T |
| Extension agent | 4.8 | 10.7 | 14.3 | 13.9 | 7.3 | 5.1 | 7.3 | 12.1 | 14.4 | 5.7 |
| KVK | 2.9 | 3.7 | 5.7 | 7.7 | 3.6 | 1.8 | 4.8 | 4.9 | 4.0 | 2.2 |
| Agricultural university/college | 0.8 | 2.4 | 3.0 | 5.0 | 1.5 | 0.0 | 0.2 | 1.1 | 0.1 | 0.1 |
| Private commercial agents | 10.6 | 11.4 | 14.6 | 15.3 | 11.4 | 4.1 | 4.0 | 6.5 | 0.8 | 4.1 |
| Progressive farmer | 26.3 | 32.4 | 34.8 | 32.6 | 28.6 | 34.3 | 37.5 | 34.5 | 43.9 | 34.8 |
| Radio/tv/newspaper/internet | 21.4 | 30.5 | 34.7 | 39.5 | 25.4 | 21.3 | 33.6 | 45.0 | 56.8 | 23.8 |
| Veterinary department | 8.9 | 11.9 | 14.9 | 14.8 | 10.4 | 2.5 | 5.4 | 8.4 | 12.5 | 3.1 |
| NGO | 1.6 | 0.9 | 2.0 | 1.3 | 1.4 | 3.3 | 0.8 | 3.7 | 0.0 | 3.0 |

*(Continued)*

Table 17.12 (Continued)

| | 2018–19 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | India | | | | | Bihar | | | | |
| | M | S | Me | L | T | M | S | Me | L | T |
| Extension agent | 3.3 | 4.9 | 5.0 | 6.8 | 3.9 | 1.0 | 4.4 | 13.9 | 0.0 | 1.8 |
| KVK | 1.3 | 2.2 | 2.5 | 4.3 | 1.7 | 0.3 | 1.2 | 8.1 | 0.0 | 0.6 |
| Agricultural university/college | 0.3 | 0.6 | 0.7 | 2.8 | 0.5 | 0.0 | 0.0 | 0.9 | 6.6 | 0.1 |
| Private commercial agents | 1.2 | 2.0 | 2.6 | 4.6 | 1.6 | 0.1 | 0.9 | 1.2 | 0.0 | 0.2 |
| Progressive farmer | 19.9 | 25.6 | 28.8 | 36.1 | 22.4 | 18.3 | 14.6 | 17.9 | 60.3 | 18.0 |
| Radio/tv/newspaper/internet | 13.1 | 18.0 | 22.9 | 27.9 | 15.5 | 4.0 | 8.7 | 13.9 | 6.0 | 4.8 |
| Veterinary department | 12.4 | 13.7 | 16.7 | 21.7 | 13.4 | 3.8 | 5.0 | 4.9 | 0.0 | 4.0 |
| NGO | 0.8 | 0.7 | 0.6 | 2.2 | 0.8 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 |

*Source:* Situation Assessment Surveys, 2012–13 and 2018–19.

*Note:* M, S, Me, L and T stand for Marginal, Small, Medium, Large and Total, respectively.

from progressive farmers, but in 2018–19, this figure declined to about 18 per cent. Similarly, in Bihar, in 2012–13, access to extension services from digital and print media was approximately 20.5 per cent and came down to 5.4 per cent in 2018–19, which is approximately one-fourth of what they had access to extension services in 2012–13. In relative terms, large farmers who owned livestock had greater access to extension services in comparison to other farmer categories.

To improve digital information among livestock farmers, the GoI launched National Digital Livestock Mission in 2021. Through this mission, livestock farmers will receive accurate information about the market price and technical support at the right time so that they can realise better income. Under the Digital India mission, the government needs to build infrastructure, such as an optical fibre network, in the poorest and undeveloped regions of Bihar so that livestock farmers can access information related to livestock activities through digital media. Also, GoI needs to focus on the education of livestock farmers to understand and adapt to extension services (Rao, 2013).

## 17.6 CONCLUSION

Our study validates the extant literature that shows livestock activities have immense potential and can help achieve inclusive growth in Bihar. Its contribution to the value of agricultural output has increased over time, which is also visible through an increase in farmers' income from this sector in total income from 13 per cent in 2002–03 to 23 per cent in 2018–19. The production of milk, meat, eggs, and other products has grown by more than 5 per cent, contributing not only to households' income but also to their nutritional levels. The livestock population in Bihar has increased from 30.3 million in 2007 to 36.4 million in 2019 with an addition of about 6.1 million livestock population. The distribution of livestock resources has favoured the households at the lower end of land distribution, where poverty is acute. However, small and marginal farmers have lower yields both from crop and livestock activities and meagre capital to make investment. Livestock activities can reduce their risk from farming.

Nevertheless, farmers face several constraints, such as lower adoption of improved technologies, scarcity of feed and fodder for animals and their poor health, besides inadequate institutional and policy support in terms of investment, finance, insurance, and extension services. It is, therefore, important for the State Government to increase public expenditure on agriculture and livestock and provide insurance, extension services and veterinary facilities for higher growth in this sector. Although livestock serves as a promising economic activity for poor households, quite often the market is not consistent with its economic contribution. The Government can facilitate the Development of Livestock and Other Allied Activities by strengthening the existing organised dairy cooperative societies, working societies and registered societies. It can also facilitate the linkage of farmers (upstream actors) with downstream actors (processors/poultry firms), preferably through FPOs/ cooperative societies and self-help groups. Since the majority of farmers own smartphones, app-based digital farm services for livestock can be provided. The existing app-based services across the districts can be penetrated for monitoring livestock, poultry, etc., and also to disseminate knowledge about food safety and quality norms.

## REFERENCES


Birthal, P. S. (2008), Linking smallholder livestock producers to markets: Issues and approaches, *Indian Journal of Agricultural Economics*, *63*(1), 19–37.

Chander, M., & Prakashkumar, R. (2013). Investment in livestock extension activities by State Departments of Animal Husbandry (SDAH) in India: An appraisal. *Indian Journal of Animal Sciences, 83*(2), 185–189.

Damodaran, H. (2015). 30 crore cattle and rising, but where are the country's vets? *The Indian Express*. https://indianexpress.com/article/india/india-others/30-crore-cattle-and-risingbut-where-are-the-countrys-vets/

GoI (Government of India). (2005). *Unit level data & report on NSS 59[h] round (Situation Assessment Survey of Farmers)*. Ministry of Statistics and Programme Implementation, New Delhi.

GoI. (2014). *Unit level data & report on NSS 70th round (Situation Assessment Survey of Agricultural Households)*. Ministry of Statistics and Programme Implementation, New Delhi.

GoI. (2021a). *Basic animal husbandry statistics 2020* (various issues). Ministry of Fisheries, Animal Husbandry & Dairying, New Delhi.

GoI. (2021b). *Number of animal insured under livestock insurance scheme in India* (outsourced from indiastat.com). Ministry of Agriculture and Farmers' Welfare, New Delhi.

GoI. (2021d). *Unit Level data & Report on NSS 77th Round for Schedule - 33.1 (Land and Livestock Holding of Households and Situation Assessment of Agricultural Households)*. Ministry of Statistics and Programme Implementation, New Delhi.

GoI. (2021e). *Unit level data & report on NSS 77th round for schedule - 18.2 (Debt and Investment)*. Ministry of Statistics and Programme Implementation, New Delhi.

Hann, D., Steinfeld, C., & Blackburn, H. (1997). *Livestock and the environment: Finding a Balance*. AO/USAID/World Bank.

Kumar, A., Tripathi, G., & Joshi, P. K. (2021a). Adoption and impact of modern varieties of paddy in India: Evidence from a nationally representative field survey. *Journal of Agribusiness in Developing and Emerging Economies, 11*(3), 255–279

Kumar, A., Hazrana, J., Negi, D. S., Bithal, P. S., & Tripathi, G. (2021b). Understanding the geographic pattern of diffusion of modern crop varieties in India: A multilevel modeling approach. *Food Security, 13*(3), 637–651.

Miftahul, I. B. (2017, April 4). *Scope for private veterinarians in India*. https://www.vethelplineindia.co.in/scope-for-private-veterinarians-in-india/

Patel, R. K. (1993). Present status and promise of dairying in India. *Indian Journal of Agricultural Economics, 48*(1), 1–33.

Satyasai, K. J. S., & Bharti, S. (2016). Doubling farmers' income: Way forward. *Rural Pulse, 14*, 1–4.

Saxena, R., Singh, N. P., Choudhary, B. B., Balaji, S. J., Paul, R. K., Ahuja, U., Kumar, R., Khan, M. A., & Joshi, D. (2017). Can livestock Sector be the game changer in enhancing the farmers' income? Reinvesting thrust with special focus on dairy sector. *Agricultural Economics Research Review, 30*, 59–76.

Sere, C., & Steinfeld, H. (1996). *World livestock production systems: Current status, issues and trends* (Paper 127). FAO Animal Production and Health Rome.

Singh, B. (2019). Proposal for vaccine and vaccination policy for control of animal diseases in India. *NCR-Veteran, 31*, 3–4.

Singh, N. P., Kumar, R., & Singh, R. P. (2005). Dynamics of bovine economy in Indo-Gangetic Plains of India: Issues in growth, equity, and sustainability. *Agricultural Economics Research Review, 18*(1), 51–70.

# CHAPTER 18

# DEVELOPMENT, MIGRATION AND PRODUCTIVITY IN AGRICULTURE

***Brajesh Jha***

## 18.1 INTRODUCTION

The incomplete transition of the Indian economy,[1] an earlier problem of development, was further aggravated in the recent decades with the increased concentration of economic growth,[2] a city-centric growth of the economy,[3] a low rate of urbanization[4] and an increased gap between rural and urban regions of the country. These have resulted in increased migration of the 'rural to urban' type (Appendix Table 18.1A). The rural-urban migration has also increased with the deterioration of the rural situation, as has been reflected by the decrease in the size of farm holdings, and many others.[5] An unviable size of holdings owing to an adverse land-labour ratio requires a vibrant non-farm sector that can absorb the excess rural labour (Green et al., 2006). However, the rural non-farm sector has not grown enough to absorb the surplus labour in the recent decades.[6] In the dearth of sufficient opportunities in the non-farm sector, many agricultural labourers are migrating for work at distant places. The migrant workers, in many cases, are landholders, and their absence during key agronomic operations from the hinterland affects agriculture production.

Table 18.1 Categories of States Based on the Income of an Average Farmer Household in 2019

| *Categories of States with a Range* | *States with Monthly Farm Income in Thousand Rupees in Parentheses* |
|---|---|
| Low farm income (less than 8 thousand rupees) | Jharkhand (4.9), Odisha (5.1), West Bengal (6.8), **Bihar (7.5)** |
| Middle farm income (between 8 to 12 thousand rupees) | Uttar Pradesh (8.0), Madhya Pradesh (8.3), Telangana (9.4), Chhattisgarh (9.6), Andhra Pradesh (10.4), Assam (10.6), Gujarat (12.6), Maharashtra (11.5), Tamil Nadu (11.9), **All-India (10.2)** |
| High income (more than 12 thousand rupees) | Himachal Pradesh (12.1), Rajasthan (12.5), Karnataka (13.4), Uttarakhand (13.5), Kerala (17.9), Jammu & Kashmir (18.9), Haryana (22.8), Punjab (26.7) |

*Source:* Situation Assessment of Agricultural Households, NSS 77th Round, 2019

Against this backdrop, this chapter looks into the kind of agriculture and rural development that has increased migration, especially the rural-urban kind, and discusses the effect of migration on agricultural productivity. We also suggest some policies that might reduce migration and hence its adverse effect on agriculture productivity.

## 18.2 PARTIAL TRANSITION OF RURAL ECONOMY, MIGRATION AND PRODUCTIVITY

With the small size of farm holdings, the multiplicity of livelihood activities has become a common affair for landholders. This has several consequences, of which the effect on agricultural productivity is one. In this section, we first discuss the elements of development that have caused the increase in rural-urban migration, followed by a discussion on the possible impact of migration on the productivity of crops.

### 18.2.1 Farm Income, Off-Farm Opportunities, and Migration

The agricultural holdings at the national level are around 140 million, of which more than two-thirds are of marginal size (less than one hectare). In a state like Bihar, the marginal size of holdings exceeds 90 per cent of total operational holdings. Many studies suggest that holdings of this size are not sufficient for the livelihood of a family dependent on it. Table 18.2 shows that the size of holdings is largely associated with the income of landholders.

The NSS Situation Assessment of Farmers for 2019 (NSSO, 2021) finds income (monthly) of an average Indian farmer (landholder) at around ₹10,000 in the year 2018–19. This income is less than ₹8000 in many states (Bihar, Jharkhand, Odisha, Uttar Pradesh and West Bengal); and in a few states like Jharkhand and Odisha, farm income has been as low as ₹5000 (Table 18.1). These states are an important contributor to the list of districts with high out-migrantion.[7] Some other states which contribute to the above list are Chhattisgarh and Madhya Pradesh, and they have a monthly farm income of less than ₹10,000. The high farm income states like Punjab, Haryana, Kerala and Karnataka have hardly any districts with high out-migration. This evidence suggests that the low income of farmers is associated with distress migration of rural-urban kind in many states of the country.

The meagre incomes of the farmers are earned from multiple activities, which are also determined by the sizes of their land holdings. Table 18.2 shows that agriculture (cultivation of crops and livestock) ceases to be the principal source of income of an agricultural household with less than one hectare of land (marginal farmer).[8] Another interesting point is that in this category of landholders (marginal and sub-marginal), off-farm earnings exceed their earnings from farm sources. For them, the wages and salary earned from other's premises account for more than 43 per cent of the household income. This group of landholders possibly migrate the most in lack of enough earning opportunities around their villages. The same is evident with the high share of remittances in this category of landholders at the country level (Table 18.2).

The landholders' dependence on the wage and salary component of farm income decreases as the size of (land) holding increases. The wage presented here is the income earned in casual or regular work from others' farm and non-farm businesses. The landholders' income earned from their premises is from the cultivation of crops, livestock and non-farm business (NFB), as

Table 18.2 Monthly Income Per Agricultural Household and Distribution of Household Income to Different Sources in India in 2018–19

| Size class of Land Possessed (ha) | Income per Household (Rs.) | | % Share in Total Household Income (including Pension and Remittances) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | *Excluding Pension and Remittances* | *Including Pension and Remittances* | *Crop Cultivation** | *Livestock & Similar Activity** | *Non-farm Business* | *Wage/ Salaried Employ-ment* | *Others* | *Pension and Remit-tances* |
| < 0.01 | 11,204 | 11,775 | 14.1 | 17.7 | 6.6 | 54.6 | 2.1 | 4.9 |
| 0.01–0.40 | 7,522 | 8,131 | 12.0 | 14.3 | 8.6 | 55.2 | 2.3 | 7.5 |
| 0.41–1.00 | 8,571 | 9,094 | 29.5 | 14.7 | 6.3 | 43.0 | 0.8 | 5.7 |
| 1.01–2.00 | 11,449 | 12,182 | 43.3 | 15.1 | 5.0 | 29.9 | 0.6 | 6.0 |
| 2.01–4.00 | 16,435 | 17,109 | 55.1 | 14.9 | 4.4 | 20.7 | 0.9 | 3.9 |
| 4.01–10.00 | 28,292 | 28,830 | 68.1 | 12.0 | 1.6 | 14.8 | 1.6 | 1.9 |
| 10.00 + | 60,758 | 62,095 | 70.2 | 18.5 | 1.9 | 6.3 | 0.9 | 2.2 |
| All sizes | 10,218 | 10,841 | 35.0 | 14.6 | 5.9 | 37.5 | 1.2 | 5.7 |

*Note:* * only out-of-pocket expenses were considered for working out net receipts.

*Source:* Situation Assessment of Agricultural Households, NSS 77th Round, 2019 presented separately in columns in Table 18.2. It is observed that agriculture (cultivation of crops and livestock) accounts for more than 58 per cent of income (principal source) of all landholders possessing more than one hectare of land. The livelihood is less multitasking for this group of landholders, especially for those belonging to the medium and large size classes. They are possibly farmers who are open to the adoption of improved agricultural practices. Interestingly, livestock has been contributing significantly to the income of all sizes of landholders.

With the incommensurate transition of the economy where many people still depend on agriculture, and landholders have to depend on multiple activities for livelihood. In this context, the development literature suggests an important role of NFB in farmers' income. The importance is reflected with a high and increasing share of NFB in the incomes of farmers from lower size classes. However, the share of NFB in average farmer's income is as low as 5.9 per cent in 2018–19 at the country level. Different NSS rounds on Situation Assessment of Farmers suggest that the share has decreased consistently, from 11 to 8 to about 6 per cent in 2002–03, 2012–13 and 2018–19, respectively. Figure 18.1 presents the

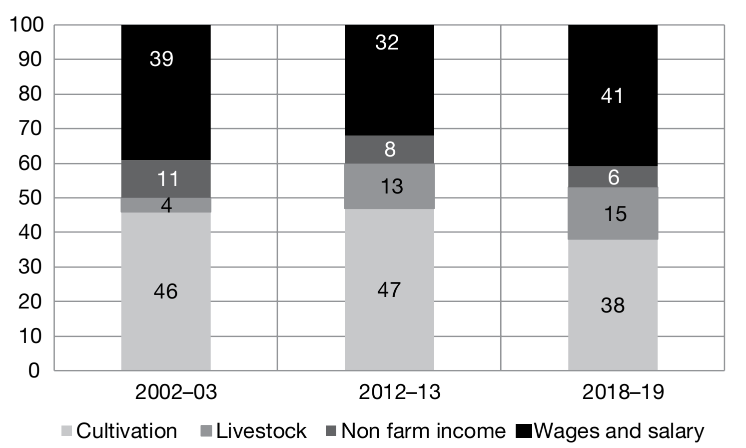



Figure 18.1 Change in Sources of Income of an Average Farmer (in per cent) Between 2002–03, 2012–13 and 2018–19

*Source:* Different rounds of NSSO surveys on Farmers' Income (2004, 2014 and 2021).

Table 18.3 Contribution of Non-farm (NF) Business Income in Total Income of an Average Farming Household in Major States of India, 2018–19

| *Contribution of Non-farm Income in Farmers' Income* | *States with per cent in Parentheses* |
|---|---|
| Less than 5 per cent | Karnataka (1.96), Madhya Pradesh (2.31), Gujarat (2.92), Jharkhand (3.23), Chhattisgarh (3.32), Punjab (3.8) |
| Between 5 – 8 per cent | Haryana (5.47), Tamil Nadu (6.2), Andhra Pradesh (6.32), Assam (6.33), **Bihar (6.35)**, Uttar Pradesh (4.80), Maharashtra (7.37), Uttarakhand (7.85), Telangana (7.95), Rajasthan (7.99) |
| Above 8 per cent | Odisha (8.78), Himachal Pradesh (10.91), Jammu & Kashmir (11.63), West Bengal (13.83), Kerala (16.05) |

*Source:* Computed from NSSO, 2021.

change in constituents of household income of an average farmer in 2002–03, 2012–13 and 2018–19.

Although the share of NFB in average farmer's income is low at the country level, it varies across states. Table 18.3 presents the share of the NFB income of an average farmer (in parentheses) for major states in 2018–19.[9] Comparing the information from Table 18.3 with Table 18.1, we may infer that the high share of the NFB income in farmer's income (FI) generally leads to higher farm income in a state; though there have been some exceptions as that of Punjab and West Bengal. In Punjab, despite the low share of NFB in farmers' income, the income of an average farmer is the highest in the country. It is almost a foregone conclusion that the state has been an early adopter of biochemical technology. The productivity-induced growth in agriculture in the state, following the forward linkage, has also had a positive effect on the non-farm sector (Jha, 2011; Mellor, 1978). The non-farm sector is not necessarily located in rural regions of the state. Therefore, unlike many states, less than 40 per cent of rural workers depend on agriculture in Punjab; the state is an example of the better transition of the rural economy. It appears that the agriculture and non-agriculture sectors are separated to the extent that an average landholder (farmer) is less dependent on the non-agriculture (farm) sector in the state. Contrary to Punjab, farm income is low in West Bengal despite a high share of NFB in the household income of an average farmer. Table 18.4 shows that income from on-farm sources (cultivation and livestock) has been very low in West Bengal; this reflects the poor state of agriculture in the state as a high share of NFB does not necessarily imply a good state of the rural non-farm sector in the state. As observed in the literature, the farmers quite often diversify their income sources to escape poverty (Rantso, 2016).

Haryana, Kerala and Tamil Nadu belong to that category of states where the farmers' monthly income (from all sources) has been high, but the dependence of rural workers on agriculture is low (Appendix Table 18.2A).[10] The distribution of rural workers in different sectors (industries) of the economy across states shows that contribution of some of the non-farm sectors (manufacturing, trade and transport, business services) is significantly high in these states, which has also increased during the reference period from 1999 to 2019. Interestingly there is hardly any news of distress-induced migration from these states.

In the process of transition of the rural economy, the state-specific situation varies. For example, farmers' income in Madhya Pradesh is low despite the good contribution of on-farm sources (crops and livestock), as apparent from Table 18.4. Again, the contribution of the on-farm source of income in Bihar is good, but the size of holdings is so small for an average landholder that his income is low. In such a situation, landholders depend on off-farm income, and in a dearth of the same many landholders are migrating for work (Datta, 2016; Jha, 2020). This is reflected in the increase in remittances.[11]

The above discussion presents different kinds of rural transitions in states. Farmer's income has been good in a state if the dependence of rural workers on agriculture is low, and performance of one or more of the non-agricultural sectors (manufacturing, construction, transport and business services) has been good. Extremely low size of holding dominates, especially in some states, and the majority of landholders in such states are dependent on off-farm income derived from other's premises (farm and non-farm). However, such opportunities have decreased in recent years in

Table 18.4 Monthly Income and Its Distribution Across the Sources of Income of an Average Farmer (agriculture household) in the States, 2018–19

| State | Monthly income of an average agricultural household (Rs.) | % share of | | | |
|---|---|---|---|---|---|
| | | Off-farm Income | | On-farm Income | |
| | | Wages | NFB-I | Livestock | Crop |
| Andhra Pradesh | 10,480 | 46.3 | 6.3 | 19.5 | 27.9 |
| Assam | 10,675 | 52.3 | 6.3 | 10.5 | 30.9 |
| Bihar | 7,542 | 33.2 | 6.4 | 23.1 | 37.3 |
| Chhattisgarh | 9,677 | 45.9 | 3.3 | 5.4 | 45.4 |
| Gujarat | 12,631 | 34.9 | 2.9 | 27.5 | 34.7 |
| Haryana | 22,841 | 34.4 | 5.5 | 17.6 | 42.5 |
| Himachal Pradesh | 12,153 | 52.6 | 10.9 | 14.9 | 21.6 |
| Jammu & Kashmir | 18,918 | 64.3 | 11.6 | 12.0 | 12.1 |
| Jharkhand | 4,895 | 56.9 | 3.2 | 16.9 | 23.0 |
| Karnataka | 13,441 | 34.1 | 2.0 | 12.4 | 51.5 |
| Kerala | 17,915 | 56.9 | 16.1 | 5.9 | 21.1 |
| Madhya Pradesh | 8,339 | 29.9 | 2.3 | 15.5 | 52.3 |
| Maharashtra | 11,492 | 37.6 | 7.4 | 13.4 | 41.6 |
| Odisha | 5,112 | 51.8 | 8.8 | 8.2 | 31.2 |
| Punjab | 26,701 | 22.4 | 3.8 | 16.7 | 57.1 |
| Rajasthan | 12,520 | 42.8 | 8.0 | 18.8 | 30.4 |
| Tamil Nadu | 11,924 | 54.5 | 6.0 | 16.8 | 22.7 |
| Telangana | 9,403 | 31.5 | 8.0 | 7.3 | 53.2 |
| Uttarakhand | 13,552 | 27.5 | 7.9 | 24.3 | 40.3 |
| Uttar Pradesh | 8,061 | 36.0 | 4.8 | 16.9 | 42.3 |
| West Bengal | 6,762 | 55.0 | 13.8 | 6.9 | 23.3 |
| All India | 10,218 | 39.8 | 6.2 | 15.5 | 38.5 |

*Notes:* (i) Income comprises net receipt from different (on- and off-farm) sources like the cultivation of crops, animals, non-farm business, wages, and salary; and (ii) Income from cultivation also includes income from leasing out of the land.

*Source:* NSSO, 2021.

many regions of the country, and landholders are migrating for work. Some of such migration in the earlier years was happening in nearby places, but with the stagnation of smaller towns, the landholders often migrate to distant places. This is also evident with the National Sample Survey (NSS) survey rounds on migration as rural-urban migration of interstate kind has increased. This has possibly affected agricultural production in certain regions of the country; the next subsection discusses this point.

## 18.3 MIGRATION AND PRODUCTIVITY IN AGRICULTURE: AN ILLUSTRATION

The migration of landholders to distant places restricts their regular presence in the village (hinterland), and their absence during key agronomic operations affects agricultural production, especially when the land tenancy for agriculture is prohibited in a state (Government of India, 2016). The observation of the present author on the litchi production in Bihar is presented below as an illustration of this point.

In litchi, Bihar accounts for the largest share of the total area under litchi in the country. While the area under litchi in the state continues to increase, the productivity of litchi started declining after the 1990s. Interestingly during the same period, the productivity of litchi has increased in other litchi-growing states (Assam, Jharkhand, Odisha, West Bengal and Punjab), as shown in Table 18.5 (also see Jha, 2018). An investigation into the increase of area in litchi despite a significant decline of productivity (yield) in Bihar has found an overwhelming presence of 'absent landowners' in litchi orchards, who view land as an asset rather than a means of production.

In Bihar, around 93 per cent of farm-holdings are of less than one hectare. The size of many of these holdings is not sufficient to provide a livelihood to a family dependent on them. Therefore, many of these landholders migrate for work. Some other landholders also move away from their villages for better livelihood and facilities, and they are not distressed migrants. This process is often referred to as 'rural stagnation'. Both types of landholders leave their land under a certain arrangement that varies as per the use of land for annual (orchard) or seasonal crops. In the orchard,

Table 18.5 Periodic Growth of Yield and Area in Litchi in Some States

| Period | ® State / Indicators | Bihar | Assam | Punjab | Bihar | Assam | Punjab |
|---|---|---|---|---|---|---|---|
| | | Yield of Litchi (tons/ha) | | | Area under Litchi ('000 ha) | | |
| Phase 1 (1991–92 to 1997–98) | Mean | 11.53 | 3.47 | 6.00 | 22.41 | 4.03 | 1.91 |
| | CAGR | 3.09 | 6.99 | 0.00 | 7.52 | 0.44 | 6.05 |
| Phase II (1998–99 to 2004–05) | Mean | 10.69 | 4.54 | 9.37 | 27.29 | 4.16 | 1.36 |
| | CAGR | –8.16 | 2.95 | 9.82 | 1.61 | 1.98 | –9.07 |
| Phase III (2005–06 to 2016–17) | Mean | 7.17 | 7.78 | 13.85 | 30.65 | 5.12 | 1.69 |
| | CAGR | –1.26 | 5.62 | 4.95 | 1.23 | 1.62 | 4.39 |
| Entire period (1991–92 to 2016–17) | Mean | 9.38 | 5.66 | 10.40 | 27.40 | 4.54 | 1.66 |
| | CAGR | –1.99 | 4.68 | 4.23 | 2.18 | 1.38 | 1.45 |

*Source:* Adapted from tables of IEG working paper no. 375, Jha (2018)

agronomic operations are less frequent than seasonal crops. Therefore, many absent landowners, keeping in view the prohibition of the lease for agricultural land, cultivate litchi in orchards.

In the orchard, the absent landowner undertakes a verbal agreement with a person (caretaker) for the security of fruit; often, this agreement is for a short period and does not attract undue attention.[12] Further, in orchards, litchi is preferred over other annual crops (mango) as its harvest duration is shorter than others. The verbal agreement with the caretaker does not necessarily include any effort to maintain the orchard. In a field study, we observed that for most of the absent landowners the security of land is more important than the productivity of litchi.[13] Therefore, the area under litchi is on the rise, irrespective of the decline in its productivity in Bihar.

Some migrant landholders also cultivate seasonal crops, but they often have to depend on someone else, and therefore, it is not surprising that the extent of informal leasing of agricultural land in Bihar is on the higher side (see Appendix Table 18.3A). The informal lease of land also causes a decrease in productivity of a crop,[14] but discerning the same requires crop-specific analysis that separates the effect of the absent-landowner from others. The case of litchi is easy to generalise as it is frequently cultivated by absent landowners. Considering the number of absent landowners, the aggregate decline in productivity of a crop because of such arrangements is easily perceptible from secondary data.

The above example of litchi shows that landholders are going for orchards to skirt the strict law against the tenancy cultivation of agricultural land. The Government of India (2016) report on land lease considers Bihar's law against tenancy as one of the strictest. In spite of this, Appendix Table 18.3A shows that the lease of agricultural land in Bihar is higher than in many other states. Another important point is that all farm groups (small and large) are participating in the lease of land. The landholders with family labour available for cultivation hire-in land (for cultivation) to increase the viability of their holdings.

The pattern of the land lease as apparent from the NSS survey shows that the earlier concerns regarding strict tenancy like the security of tenure to tenants, land for self-cultivation and fixity of fair rent have become dormant as all size groups of landholders take part in land leasing. The objectives behind the strict land laws (against tenancy) are defeated with landowners' ingenious way of skirting the rigid land laws. The economic forces seem to have dominated over the legislative restrictions.

The informal lease of land for agricultural purposes has much adverse fallout. The decrease in productivity is one example. The small holders' efforts to lease-in land to increase their operational holdings (for viability) are also defeated by the informality of tenancy and its consequent restriction for availing institutional credit and similar other facilities. The present study, therefore, supports legalising tenancy for agricultural land.

However, a land-lease market that assures land rights for lessors and lessees is important. Adoption of such legislation would lead to a vibrant land-lease market that may allow the lessor to migrate without any fear of losing their land. The lessee will also gain, as his/her status of being a tenant will then be recorded, and it will help them to access institutional credit, insurance and other support services while leasing land. The legalisation of tenancy would promote agricultural productivity and increase farmers' (landowners) income as certainty in tenure will encourage productive investments in leased-in land as well. This may encourage the transition of the rural economy.

## 15.4 CONCLUSION AND SUGGESTION

The increase in rural-urban migration in recent decades has been a consequence of the deterioration of the rural situation in large parts of the country. The same is reflected in the decrease in the size of landholdings, rural stagnation and inadequate growth of rural enterprises. The deterioration of the rural situation is particularly bad in a state like Bihar, where marginal landholders are around 93 per cent, and the non-agriculture sector is not in a good state.

Considering the small size of agricultural holdings, an average landholder depends heavily on off-farm income. The off-farm earnings exceed the farm earnings (income) in sub-marginal and marginal sizes of holdings, while they account for more than two-thirds of total landholdings in India. The information from different NSS rounds on the farmers' situation suggests that the contribution of off-farm earnings to farmers' income decreases with the increase in the size of the holdings. Yet the share (off-farm earnings in the farmer's income) remains important (double-digit) for most of the farmers barring the large. The large landholdings are less than a per cent at the country level.

In a situation when more than 99 per cent of landholders (farmers) are dependent on off-farm income opportunities, the role of rural enterprises (non-farm sector) becomes important. However, the share of NFB in farmers' income has decreased in recent decades. We, therefore, argue for developing the non-agricultural sector in the rural vicinity. The rural vicinity is the place (cities, towns, small towns and villages) where farmers can commute on a daily basis for their livelihood.

The development experiences suggest that the growth of the non-farm sector requires productivity-induced growth in agriculture. There are many studies that discuss ways to increase productivity in agriculture; one of the most comprehensive studies in the recent period is on Doubling Farmers' Income (GoI, 2018). The present study, however, opines that the enhancement of productivity (in agriculture) is difficult to infuse in the system when smallholders dominate, farmers are engaged in multiple activities and farms are being managed by the proxy of absent landowners and informal lessees of land. The productivity suffers in any of these situations, and if such holdings account for almost half of agricultural land, the productivity of the region is affected adversely. We, therefore, suggest legalisation of tenancy that would protect the interest of lessors and lessees. This will increase the productivity of agriculture and may encourage the transition of the rural economy.

Besides the productivity-induced growth in agriculture, a robust non-farm sector also requires proximity to growth centres. The growth centre can be a manufacturing hub or town with good infrastructure where small landholders work on a daily basis to complement their meagre on-farm income. Such a centre would trigger growth in other non-agriculture sectors (construction, trade, business, and services) in the region. Therefore, decentralisation of development has been an important instrument for non-farm growth. However, following trade liberalisation, the rationale for decentralised development appears to have weakened.[15]

In addition to the above, infrastructure has been a key to many problems in the rural sector. The strong infrastructure, besides giving impetus to rural enterprises, will arrest the problem of rural stagnation in large part of the country. The rural stagnation, besides the multiplicity of activities of landholders, has also been inhibiting the adoption of superior technology, techniques and good agricultural practices. The rural stagnation might have been discouraging persons with good entrepreneurial skills and non-cognitive traits essential for the creation of rural enterprises.

## NOTES

1. This refers to an incommensurate share of agriculture and non-agriculture sectors in the income and employment of country.
2. The concentration is reflected as the increased divergence in the economy, including the agricultural economy of states. The

statistics show that farmer's income in the prosperous state (Punjab) is more than five times of the poorer states (Jha, 2020).

3. Some studies, including that of Mitra and Mehta (2011), found that million-plus cities have emerged as the engine of growth in recent years.
4. Though the rate of urbanization for the country is 31 per cent as per 2011 data, it is extremely low for Bihar (11.3 per cent).
5. The size of farm holdings has reduced due to fixed land area, growing population, equal inheritance law in large part of the country and other factors. Rural stagnation (Jodhka, 2014) is another important phenomenon fuelling deterioration in the rural situation in large part of the country.
6. The rural non-farm sector might not have done well, or the unsatisfactory growth of rural enterprises might have resulted because of the growing disparity in infrastructure between rural and urban regions and changed incentive structure.
7. The Expert Committee report on Migration (Government of India, 2017) found that 25 per cent of total male out-migrants belonged to 53 districts of the country of which Uttar Pradesh and Bihar account for 24 and 20 districts, respectively. Apart from this, there have been two districts in each Uttarakhand and West Bengal, and one in each of the states of Jharkhand, Karnataka, Maharashtra, Odisha and Rajasthan.
8. Please note that for an activity to become principal source, 60 per cent or more of total household income should come from the activity.
9. The contribution of non-farm business (NFB) is an underestimation, as the wages earned by farmers in "others" farm and non-farm businesses is a separate source of farm income. A part of wages earned by farmers is from "others" NFBs. Therefore, the meagre share of NFB (in Table 18.3) influences an average landholder's wages and salary earned from "others" premise.
10. Kerala is a state where the dependence of rural workers on agriculture has been the lowest (28 per cent) in the country, whereas in Haryana, and Tamil Nadu less than 40 and 42 per cent of rural workers, respectively, are in agriculture.
11. At country level, the remittance of the average farmer is nearly 6 per cent of their household income in 2018–19, which is marginally higher than 5 per cent in the year 2012–13 (as per the previous NSS round). In some states like Haryana, the remittance is as high as 10 per cent, with vibrant urban and non-agricultural sectors and better quality of agricultural workers. The remittance per cent is not very high in Bihar (4 per cent).
12. The present law in Bihar bars ordinary people from leasing agricultural land. The expert committees, as that of Bandyopadhyay (2009), upheld the stringent rule against tenancy of agricultural

land (*Source*: Report of the Expert Committee on Land Leasing, NITI Aayog; GoI, 2016, March).

13. Considering the volatility in price of asset (gold), the land is considered an important instrument of long-term security. The absent landholders frequently avoid cultivation of seasonal crops as this requires some kind of tenure arrangement for land, and informal tenancy at times leads to litigation and dangers of losing land.
14. There are many studies that have found a decrease in productivity of a crop because of the informal lease. The reasons vary as per the micro-settings of the place, yet some of the reasons often cited are lack of investment on land due to uncertainty of tenure, inaccessibility of informal tenants to institutional credit and similar other facilities.
15. Following trade liberalization, the unit cost of production and economies of scale (mega clusters) become more important, and rural manufacturing in particular stagnates in the country. The stagnation in rural manufacturing is evident with marginal change (7.4 per cent to 7.7 per cent) in the share of manufacturing in the rural workforce in 18 years between 1999–2000 to 2017–18 (Jha, 2020).

## REFERENCES


Bandyopadhay D. (2009). Lost opportunity in Bihar. *Economic and Political Weekly*, *44*(47), 12–14.

Datta, A. (2016). Migration, remittances and changing source of income in rural Bihar (1999–2011). *Economic Political Weekly, 51*(31), 85–93

Government of India. (2016). *Report of expert committee on land leasing*. Niti Aayog, New Delhi.

Government of India. (2017). *Report of the working group on migration.* Ministry of Housing and Urban Poverty Alleviation, New Delhi.

Government of India (GOI). (2018). *Report of the committee on doubling farmers income* (headed by Ashok Dalwai). Niti Aayog, New Delhi.

Green, C. J., Kirkpatrick, C. H., & Murinde, V. (2006). Finance for small enterprise growth and poverty reduction in developing countries. *Journal of International Development, 18*(7), 1017–1030.

Jha, B. (2018). *Litchi production and marketing in Bihar*, *India* (IEG Working Paper 375). Institute of Economic Growth, Delhi.

Jha, B. (2020). *Farmers' distress, income, and role of non-farm business* (IEG Working Paper 408). Institute of Economic Growth, Delhi.

Jodhka, S. S. (2014). *What is happening to villages, revisiting rural life and agrarian change in Haryana. Centre for the study of social system* (Working Paper). JNU, New Delhi.

Mellor, J. W. (1978). *The new economics of growth: A strategy for India and developing world*. Cornell University Press.

Ministry of Agriculture and Farmers Welfare. (2018). *Agricultural statistics at a glance 2018*. GoI, New Delhi.

Ministry of Agriculture and Farmers Welfare. (2019). *Report of the Committee on Doubling Farmers Income*. GoI, New Delhi.

Mitra, A., & Mehta, B. (2011). Cities as the engine of growth: Evidence from India. *Journal of Urban Planning and Development, 137*(2), 171–183.

National Sample Survey Organisation (NSSO). (2010). *Report on migration in India* (Report no. 533). GoI, New Delhi.

National Sample Survey Organisation. (2014). *Key Indicators of Situation of Agricultural Households in India* (NSS 70th round). GoI, New Delhi.

National Sample Survey Organisation. (2019). *Periodic labour force survey 2017–18*. GoI, New Delhi.

National Sample Survey Organisation (NSSO). (2021). *Situation assessment of agricultural households, land and holdings of households in rural India, 2018–19* (NSS 77th round, Report No. 587[77]/33.1/1). GoI, New Delhi.

Rantso T. A. (2016). The role of non-farm sector in rural development in Lesotho. *The Journal of Modern African Studies, 54*(2), 217–338.

Appendix Table 18.1A Distribution of Internal Migrants by Last Usual Place of Residence for Each Component of Migration Streams

| Streams of Migration | 1999–00 (55th round) | | 2007–08 (64th round) | |
|---|---|---|---|---|
| | Intra-state | Inter-state | Intra-state | Inter-state |
| Rural to rural | 95.4 | 4.6 | 95.6 | 4.4 |
| Rural to urban | 80.3 | 19.6 | 74.8 | 25.2 |
| Urban to rural | 80 | 20 | 82.6 | 17.5 |
| Urban to urban | 80.1 | 19.9 | 77.1 | 22.9 |

*Note:* Intra-state in each of the reference years is an aggregation of inter and intra district in a state. The intra- and inter-become 100 in each of the reference years.

*Source:* NSSO (2010) Report No. 533.

Appendix Table 18.2A Percentage Distribution of Usual Working Persons in Rural Areas in Some Important Industries in Major States in 2017–18

| *State* | *Agriculture* | *Manufacturing* | *Construction* | *Trade & Transport* | *Services & Others* |
|---|---|---|---|---|---|
| Andhra Pradesh | 66.9 | 6.0 | 9.3 | 10.7 | 7.1 |
| Assam | 50.2 | 6.1 | 10.2 | 18.0 | 15.6 |
| Bihar | 48.8 | 8.6 | 16.6 | 15.5 | 10.5 |
| Gujarat | 66.6 | 9.1 | 6.3 | 11.1 | 7.0 |
| Haryana | 40.8 | 11.5 | 15.1 | 17.7 | 15.0 |
| Himachal Pradesh | 59.9 | 4.5 | 14.8 | 9.4 | 11.5 |
| Karnataka | 67.2 | 7.6 | 5.6 | 11.9 | 7.8 |
| Kerala | 26.7 | 10.2 | 19.7 | 24.0 | 19.5 |
| Madhya Pradesh | 74.3 | 3.0 | 11.3 | 5.3 | 6.1 |
| Maharashtra | 74.5 | 5.4 | 4.5 | 8.2 | 7.4 |
| Odisha | 56.0 | 6.0 | 18.0 | 11.5 | 8.6 |
| Punjab | 40.7 | 11.6 | 17.0 | 15.0 | 15.8 |
| Rajasthan | 60.9 | 5.7 | 14.5 | 8.5 | 10.4 |
| Tamilnadu | 42.5 | 14.3 | 17.9 | 14.9 | 10.4 |
| Uttar Pradesh | 59.7 | 8.3 | 14.7 | 11.4 | 5.9 |
| West Bengal | 50.7 | 13.6 | 12.1 | 14.8 | 8.9 |
| All India | 59.4 | 7.8 | 12.3 | 11.7 | 8.9 |

*Notes:* (i) Trade & Transport include employment in Trade, Hotel and Restaurant and also Transport & Storage; (ii) Services & Others include private finance, real estate and business services and public community, social and personal services; and (iii) Others include rural employment in Mining & Utilities.

*Source:* NSSO (2019).

Appendix Table 18.3A Percentage of Households Leasing-in and Percentage of Operated Area Leased-in in Some Selected States in 2012–13

| | Percentage of Households Leasing-in | | | | | Percentage of Operated Area Leased in | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| ***State*** | ***Marginal*** | ***Small*** | ***Small + Medium*** | ***Large*** | ***All Sizes*** | ***Marginal*** | ***Small*** | ***Small + Medium*** | ***Large*** | ***All Sizes*** |
| Haryana | 15.4 | 7.0 | 19.5 | 3.5 | 15.1 | 13.8 | 8.7 | 17.9 | 1.1 | 15.1 |
| Bihar | 21.6 | 24.7 | 10.3 | 24.8 | 21.5 | 19.2 | 14.5 | 9.8 | 20.2 | 15.8 |
| Gujarat | 5.3 | 4.6 | 10.0 | 35.0 | 6.1 | 7.7 | 1.6 | 5.7 | 34.1 | 5.7 |
| Tamil Nadu | 10.8 | 11.2 | 31.8 | 51.5 | 13.0 | 12.1 | 8.0 | 21.0 | 14.5 | 15.1 |
| All-India | 13.2 | 13.6 | 17.1 | 21.7 | 13.7 | 11.4 | 9.9 | 9.8 | 12.6 | 10.4 |

*Source:* NSSO (2014).

# ABOUT THE EDITOR AND CONTRIBUTORS

## EDITOR

**Sankar Kumar Bhaumik** is the Director of Patliputra School of Economics. He has vast experience of teaching and research spanning over four decades. Prior to joining the Patliputra School of Economics, he served the Departments of Economics of Calcutta University (22 years), Vidyasagar University (9 years) and Central University of South Bihar (3.5 years). He became Professor and Head of Economics Department of Calcutta University, and Professor and Head of Economics Department and Dean of Social Sciences at the Central University of South Bihar. He also served as Director of the Institute of Development Studies in Jaipur. His fields of specialization are econometrics, economics of agriculture, Indian economic development and research methodology. Besides teaching these papers to the postgraduate and PhD students, he has done extensive research in the areas of agrarian relations, agricultural development, rural credit, and globalization and employment. His book publications include *Principles of Econometrics: A Modern Approach Using EViews*, *Reforming Indian Agriculture: Towards Employment Generation and Poverty Reduction, and Tenancy Relations and Agrarian Development: A Study of West Bengal*. He has to his credit 35 papers published in refereed journals/edited books. He has so far completed 5 research projects, and supervised 14 PhD theses (all awarded) and 11 MPhil dissertations (all awarded).

## CONTRIBUTORS

**Seema Bathla,** Professor of Economics, Centre for the Study of Regional Development, Jawaharlal Nehru University, New Delhi

**Deepak Kumar Behera,** Assistant Professor, Department of Humanities and Social Sciences, National Institute of Technology, Patna

**Ramesh Chand,** Member, NITI Aayog, New Delhi

**Anirban Dasgupta,** Associate Professor of Economics, South Asian University, New Delhi

**Niladri Sekhar Dhar,** Associate Professor of Economics, Centre for Economic Policy and Public Finance, Asian Development Research Institute, Patna

**Meghna Dutta,** Assistant Professor of Economics, Department of Humanities and Social Sciences, Indian Institute of Technology, Patna

**Binoy Goswami,** Assistant Professor of Economics, South Asian University, New Delhi

**Brajesh Jha, Professor,** Institute of Economic Growth, Delhi

**Elumalai Kannan,** Associate Professor of Economics, Centre for the Study of Regional Development, Jawaharlal Nehru University, New Delhi

**Anjani Kumar,** Senior Research Fellow, International Food Policy Research Institute, New Delhi

**Manish Kumar,** Assistant Professor of Economics, Delhi School of Economics, Delhi

**N. Saravana Kumar,** Secretary, Department of Agriculture, Government of Bihar

**Sunil Kumar,** Chief General Manager, National Bank for Agriculture and Rural Development, Patna

**Sunny Kumar,** Research Scholar, Department of Environmental Science, Central University of South Bihar, Gaya

**Tulika Kumari,** Assistant Professor, Dr Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar

**Subhankar Mukherjee,** Assistant Professor, Department of Industrial and Management Engineering, Indian Institute of Technology, Kanpur

**Bibhudatta Nayak,** Deputy General Manager, National Bank for Agriculture & Rural Development, Patna

**Sanjib Pohit,** Professor, National Council of Applied Economic Research, New Delhi

**Sk. Abdul Rashid,** Associate Professor of Economics, Ananda Mohan College, Kolkata

**Maryam Sabreen,** Research Scholar, Department of Humanities and Social Sciences, National Institute of Technology, Patna

**Debabrata Samanta,** Assistant Professor of Economics, Chandragupta Institute of Management, Patna

**P. Parth Sarthi,** Professor and Dean, School of Environmental Sciences, Central University of South Bihar, Gaya

**Sibananda Senapati,** Assistant Professor of Economics, Chandragupta Institute of Management, Patna

**K. M. Singh,** Professor and Dean, Dr Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar

**Vinay K Sonkar,** Senior Research Assistant, International Food Policy Research Institute, New Delhi

**Santosh Verma,** Assistant Professor of Economics, Tata Institute of Social Sciences, Hyderabad

# INDEX