

## Study on Agricultural Diagnostics for the State of Bihar in India

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Report    November  
20191101    2019



# Study on Agricultural Diagnostics for the State of Bihar in India

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**South Asia Research Hub, DFID**

**November, 2019**



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***Published by***

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*This report has been commissioned by South Asia Research Hub, Department for International Development, Government of UK. However, the views expressed do not necessarily reflect the UK Government's official policies.*

# Foreword

Bihar has undergone a remarkable turnaround in economic performance in the mid-2000s. Good policies, better infrastructure, governance, and social protection, and greater political stability have all contributed to this improvement. Yet Bihar remains India's poorest states: during 2008-16 its per capita income was a fifth of Haryana's and a just about a third of India's. Bihar lost the bulk of its mineral resources in 2000 when Jharkhand was created, but it retained its fertile agricultural land and water resources. Fully 70 percent of its rural work force is employed in agriculture, which contributes over a quarter of the state GDP. Hence, rapid agricultural development remains important for Bihar. Recognizing this, the State government started implementing what it called Agricultural Road Maps in 2008, and is currently on its third Road Map (2012-13 to 2016-17), all aimed at increasing productivity growth in the crop and livestock sectors and boosting farm incomes.

Agricultural growth responded well to these new initiatives in their first four years, reaching 3.1 percent per annum during the first Road Map, but declined to 1.3 percent in the second Road Map, averaged about 2.0 percent during 2001 to 2017, and has shown a decelerating trend since 2012-13. It has also remained quite volatile from year to year.

What explains these trends in Bihar's agriculture development? To answer these and related questions, NCAER has partnered with DFID, the UK Department for International Development in India, to do an agricultural sector diagnostic study for the state to understand the economic, natural, technological, and political constraints that Bihar agriculture faces, and what it should do to alleviate these constraints. The key goal of this work has been to identify the binding constraints to faster and more sustainable agricultural growth in Bihar. The search for such binding constraints has covered both the crop and livestock sectors, and has looked at land switching from low-value to higher value crops, crop diversification, crop yield improvements, and input intensification.

To identify the binding constraints and hence policy priorities for Bihar, the NCAER team has used the growth diagnostics framework pioneered by Hausmann et al (2008), developing a hybrid by combining it with the work of Minor et al. (2006). This framework explores a hierarchy of distortions from the largest to the smallest, and recommends starting by reducing the largest distortion or constraint, both on the output and the input sides, which is expected to have the largest direct effect on farmers' income or welfare. For instance, if the problem seems to be the low scale of farming, is that due to poor soil quality, inadequate irrigation, expensive labour, or government restrictions on specific cropping patterns? Is the low scale of farming due to insecure land tenure, fragmented landholdings, high rent, or restrictions on land leasing? Of course, while data analysis drives the answers to many of these questions, this is not an easy task and requires deep insights from knowledgeable experts who know Bihar agriculture well.

Using the framework, this Bihar agriculture diagnostic identifies growth-promoting factors and the binding constraints on them. Constraints on agricultural markets and the low level of crop diversification appear to be primarily responsible for holding down agricultural growth in Bihar. The study offers a range of policy and program recommendations to address these constraints, both on the output and marketing sides and on the input and institutional sides.

This study has benefitted greatly from the insights of many in government, in agriculture, and in industry. A diagnostic like this one cannot really expect to have impact or be credible without the ground-truthing that such help has made possible.

I am grateful to the DFID team in New Delhi for supporting this work. I particularly want to thank Dr Stuart Davies and Dr Sanjukta Roy, both of whom have been more than willing to help us with critical and constructive comments during the study.

This work was carried out by a NCAER team expertly led by Professor Sanjib Pohit and including Professors Elumalai Kannan (Jawaharlal Nehru University) and R. K. P. Singh as External Research Advisors, and Dr Saurabh Bandyopadhyay, Fellow. Ms Avisha Alawadhi, Research Associate, and Ms Lavanya Sayal, Research Intern, ably supported the study.

I hope that this NCAER study will have traction in Bihar policymaking and policy research circles and help Bihar accelerate its agricultural growth.

Dr Shekhar Shah  
Director General  
NCAER

New Delhi  
November 2019

# Abbreviations and Acronyms

Units used in the Report

1 lakh = 100 thousand

APEDA	Agricultural and Processed Food Products Export Development Authority
APMCs	Agricultural Produce Market Committees
ATMA	Agricultural Technology Management Agency
BAIF	Bharatiya Agro Industries Foundation
COMFED	Bihar State Milk Co-Operative Federation Ltd.
FGD	Focus Group Discussion
FPOs	Farmer Producer Organisations
GSDP	Gross State Domestic Product
ICAR	Indian Council of Agricultural Research
IFFCO	Indian Farmers Fertiliser Cooperative Limited
JEEVIKA	Bihar Rural Livelihood Project
KRIBHCO	Krishak Bharati Cooperative Ltd
KVK	Krishi Vigyan Kendra
LPC	Land Possession Certificate
MSP	Minimum Support Price
NABARD	National Bank for Agriculture and Rural Development
NCDC	National Cooperative Development Corporation
NGO	Non-Government Organisation
PACS	Primary Agriculture Cooperative Societies
PDS	Public Distribution System
RKVY	Rashtriya Krishi Vikas Yojana
RRBs	Regional Rural Banks
SHG	Self-help Groups
TFP	Total Factor Productivity

## STUDY TEAM

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# Executive Summary

## Background

The economy of Bihar has witnessed structural transformation in the last one and half decades. Agricultural sector occupies a prominent place in the structural changes of the economy with a significant contribution to the state's income and rural employment. For accelerating agricultural growth, the government of Bihar has introduced various policy initiatives at different points in time. These initiatives are being implemented under different phases of what is called agriculture roadmaps. While these policy initiatives seem to have helped in accelerating Bihar's agricultural growth from 2.0 per cent per annum during the period 2000–01 to 2007–08 to 3.1 per annum during the period 2008–09 to 2011–12, agricultural growth decelerated to 1.3 per cent during the subsequent period of five years (2012–13 to 2016–17). No doubt, the high volatility in growth is a dark spot for the economy.

## Objective

In this context, there is a need to conduct a diagnostic study of Bihar's agricultural sector to identify the drivers of growth within the sector and the binding constraints to farmers' incomes or economic activity in Bihar subject to its natural, political and institutional settings. It is our contention that a better understanding of these constraints would help to devise appropriate policy for sustained less-volatile growth in the sector.

## Methodology

Hausmann et al. (2008) proposed a growth diagnostic approach to identify the most binding constraints for introducing policy reforms to alleviate these constraints. In the present study, we adopt a modified growth diagnostic approach called Minot-Hausmann hybrid framework for agricultural growth diagnostics. The methodology of growth diagnostics is conceptualised as a decision tree, which follows a top-down approach in identifying the distortions that hinder the growth potential in Bihar's agriculture. The study uses both quantitative and qualitative data. The quantitative data on different variables compiled from various published sources, while qualitative data were collected through Focus Group Discussion of farmers and survey of various stakeholders from eight districts of Bihar.

## Key Findings

Our analysis indicates that agricultural growth rate accelerated to 3.1 per cent during the period of the first agriculture road map. However, the growth did not sustain in the second period. Within the crop sector, horticulture has registered relatively low average growth rate from 2000-01 to 2015-16. 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. We find that among the sources of output growth, yield improvements have largely contributed to crop output growth from 2001-02 to 2016-17. The effect of crop diversification on crop output growth is found to be positive. Further, a rise in total factor productivity (TFP) has led to increase in output. Our analysis suggests that output growth led by improvement in TFP is sustainable in the long run. At the same time, a certain level of input use is required to accelerate yield growth as most crop varieties are sensitive to external inputs. Low input intensification seems to have affected the level of crop yield. Further, livestock rearing has emerged as an important activity in Bihar, accounting for about 34 per cent of total output with average growth rate of over 6.0 per cent.

## **Binding Constrains for Low Growth**

We find that *poor functioning of agricultural markets* indicated by instability in the prices of agricultural produces and *low level of crop diversification* are the reasons for slow or lower rate of agricultural growth in Bihar. It is important to understand why the state of Bihar is constrained in agricultural markets and crop diversification. Relaxing the constraints on agricultural markets and the drive towards crop diversification would lead to higher growth in Bihar agriculture.

### **Agendas for Policy Actions**

- **Increasing Market Density**

Despite the abolition of the Agricultural Produce Market Committee (APMC) Act in 2006, private investment in the creation of new markets and strengthening of facilities in the existing ones did not take place in Bihar, leading to low market density. Further, the participation of government agencies in procurement and the scale of procurement of grains continue to be low. Thus, farmers are left to the mercy of traders who unscrupulously fix lower prices for agricultural produce that they buy from farmers. Inadequate market facilities and institutional arrangements are responsible for low price realisation and instability in prices.

- **Strengthening Public Procurement**

With respect to procurement of food grains in Bihar, Primary Agriculture Cooperative Societies (PACS) are entrusted with procurement of grains particularly paddy and wheat from the farmers at the government-announced minimum support price (MSP). The ground level evidence through discussion with farmers shows that procurement operation is limited to a certain amount and time. Farmers mentioned that non-availability of a fair price is the most important constraint in expanding agricultural output.

- **Improving Functioning of Farmers' Group**

Of late, the government of Bihar has launched an initiative to establish Farmer Producer Organisations (FPOs) in different parts of the state. FPOs enable farmers to innovate, diversify and adopt new agricultural practices to produce better quality products as demanded by the market. FPO is a potential medium to diversify crop production activities because marketing activities are collectively taken care of by the organisation. So what constrains the effective functioning of FPOs which could lead to profitable crop diversification?

Stakeholder interactions show that most farmers were aware of FPOs in the surveyed villages, but they have not come together to constitute an FPO. Even in the villages where FPOs were registered, they are found to be non-functional. Most farmers were optimistic that FPOs can play a potential role in reducing the current problems in marketing of agricultural produce. The lack of such an organisational set-up on the ground is a constraint for obtaining better price through collective bargaining. Since traditional crops such as rice, wheat and maize have, by and large, secured markets, area diversion for growing new crops comes with some risks for farmers. This is particularly true in the case of vegetables whose prices fluctuate often due to demand and supply gaps. So, lack of collective marketing through FPOs demotivates farmers to go for profitable crop diversification.

- **Creating Enabling Ecosystem for Contract Farming**

With regard to contract farming, farmers in some villages mentioned that they were aware of contract farming. But the practice of contract farming was not reported in any of the surveyed villages. Contract farming comes with a secured market for sale of products, pre-determined price, technical information and inputs supply. The absence of such arrangements is an important constraint for low diversification of crop area. Overall, it emerges that lack of proper institutional and marketing arrangements are responsible for low crop diversification in the state of Bihar.



# Contents

<b>Foreword</b> .....	<b>iii</b>
<b>Abbreviations and Acronyms</b> .....	<b>v</b>
<b>Study Team</b> .....	<b>v</b>
<b>Executive Summary</b> .....	<b>vii</b>
<b>List of Figures</b> .....	<b>xiii</b>
<b>List of Tables</b> .....	<b>xiv</b>
<b>1. Introduction</b> .....	<b>1</b>
<b>2. Methodological Framework and Data</b> .....	<b>3</b>
2.1 Introduction .....	3
2.2 Growth Diagnostics.....	3
2.2.1 Decomposition of Agricultural Output Growth .....	10
2.2.2 Resource Decomposition Method.....	10
2.3 The Data.....	11
2.4. Implementation of the Framework.....	14
<b>3. Review of the State of Agriculture in</b> .....	<b>17</b>
3.1 Introduction .....	17
3.2 Structural Changes and Relative Performance of the Bihar Economy in India .....	17
3.3 Changes in Land Use, Cropping Patterns and Irrigation .....	21
3.4. Government Expenditure on Agriculture and Allied Activities.....	26
3.5 Changes in Agricultural Production and Income .....	27
3.5.1 Growth in Crop Output and Variability.....	27
3.5.2 Changes in Cost and Crop Income.....	30
3.6 Livestock Production .....	32
3.7 Sources of Crop Output Growth.....	35
3.8 Drivers of Crop Output Growth .....	39
3.9 Summing Up .....	41
<b>4. Identifying Binding Constraints on Agriculture in Bihar</b> .....	<b>43</b>
4.1 Introduction .....	43
4.2 Factors Causing Lower Agricultural Growth in Bihar (Growth hypotheses) .....	43

4.3 Identifying Binding Constraints .....	49
4.3.1 Explaining Constraints on Agricultural Markets .....	49
4.3.2 Explaining the Low Level of Crop Diversification .....	50
4.4 Growth Diagnostics at the District Level .....	51
4.4.1 Bhagalpur District .....	52
4.4.2 Bhojpur District .....	54
4.4.3 West Champaran District .....	57
4.4.4 Jamui District .....	58
4.4.5 Khargaria District .....	60
4.4.6 Patna District .....	61
4.4.7 Purnia District.....	63
4.4.8 Samastipur District.....	64
4.5 Key Issues raised by Stakeholders in Various Sectors.....	65
<b>5. Summary and Policy Recommendations .....</b>	<b>70</b>
5.1 Summary of Findings .....	70
5.2 Key Policy Problems.....	70
5.3 Recommendations for Strengthening Market Linkages.....	71
5.4 Recommendations for Creating Ecosystem for Crop Diversifications .....	71
5.5 General Recommendations.....	72
<b>References.....</b>	<b>73</b>
<b>Annex 1: Questionnaires for Stakeholders' Interaction.....</b>	<b>75</b>
<b>Annex 2: Tables of Stakeholders Interactions .....</b>	<b>98</b>

## List of Figures

Figure 2.1: Decision Tree for Growth Diagnostics.....	4
Figure 2.2: Minot and Hausmann Hybrid Framework for Agricultural Growth Diagnostics....	7
Figure 3.1: Growth in Per Capita Income (%): 2000-01 to 2016-17.....	17
Figure 3.2: Ratio of Per Capita GSDP to India's GDP .....	18
Figure 3.3: Trend in Agricultural GSDP and Overall Economic Growth (3-year Moving Average Series) .....	20
Figure 3.4: Trend in Sources of Irrigation in Bihar .....	24
Figure 3.5: Trend in Gross Irrigated Area and Cropping Intensity (%) .....	25
Figure 3.6: Government Spending on Agriculture, Irrigation and Flood Control (2011-12 Prices) .....	26
Figure 3.7: Composition of Government Expenditure (revenue + capital) on Agriculture and Irrigation: TE 2015-16 .....	27
Figure 3.8: Trend in Overall Cost, Output and Crop Income.....	31
Figure 3.9: Trend in Output, Input and TFP Index.....	39
Figure 3.10: Contribution of Input Growth and TFP Growth by Different Periods .....	40
Figure 4.1: Ratio of Gross Value of Output to Total Input Costs.....	48
Figure 4.2: Grain to Fertiliser Price Ratio .....	49

## List of Tables

Table 2.1: List of Variables and Sources of Data.....	12
Table 2.2: Composition of Stakeholders.....	13
Table 2.3: Regional Composition of Stakeholders' Analysis .....	14
Table 2.4: Distribution of Sampling Units Canvassed (Location).....	14
Table 3.1: Average Annual Growth in Major Sectors of the Bihar Economy.....	19
Table 3.2: Changes in Composition of Agriculture and Allied Activities (%).....	21
Table 3.3: Changes in Land Use Pattern.....	21
Table 3.4: Distribution of Operational Holdings and Average Size of Operated Area.....	22
Table 3.5: Relative Share of Crop Area and Value of Output (%).....	23
Table 3.6: Productivity of Irrigation of Select Crops in Bihar .....	25
Table 3.7: Growth Trend in Area, Production and Yield of Field Crops: 2000-01-2016-17 (%) .....	28
Table 3.8: Area Under Horticultural Crops (000 ha).....	28
Table 3.9: Growth Trend in Area, Production and Yield of Horticulture Crops: .....	29
2000-01-2016-17 (%).....	29
Table 3.10: Instability in Area, Production and Yield of Major Crops (%).....	30
Table 3.11: Changes in Average Real Cost, Output and Income of Major Crops in Bihar (Rs/ha).....	31
Table 3.12: Annual Growth in Major Inputs Use: 2000-01 to 2015-16.....	32
Table 3.13: Livestock Population and Its Composition .....	33
Table 3.14: Production of Major Livestock Products.....	34
Table 3.15: Growth in Yield of Major Livestock Products .....	35
Table 3.16: Growth in Crop Output and Average Productivity.....	35
Table 3.17: Sources of Crop Output Growth .....	37
Table 3.18: Sources of Output Growth by Crops: 2001-02 to 2016-17.....	38
Table 3.19: Relative Contribution of Input Growth and TFP Growth to Output Growth: 2000-01 to 2015-16 .....	40
Table 4.1: Ratio of Agricultural Land and Non-agricultural Land in Total Reported Area....	44
Table 4.2: Yield of Major Crops in Bihar and India (ton/ha) .....	45
Table 4.3: Average Wholesale Price before and after Repeal of the APMC Act .....	46
Table 4.4: Comparative Advantage in Growing Horticultural Crops in Bihar .....	47
Table A1: Status of Cultivated Area and Irrigation.....	98
Table A2: Tenancy Status .....	98
Table A3: Access to Markets and Financial Institutions .....	98
Table A4: Changes in Land use Pattern.....	99
Table A5: Indicators of Technology Adoption .....	99
Table A6: Technological Slowdown and Motive to Adopt New Technology .....	100

Table A7: Sources of Information About Modern Agricultural Technology (%).....	100
Table A8: Marketing of Major Agricultural Produce.....	100
Table A9: Disposal Pattern of Agricultural Produce by Type of Agency (%).....	101
Table A10: Prices and Agricultural Output.....	101
Table A11: Importance of Contract Farming .....	101
Table A12: Importance of Farmer Producer Organisation (FPO) .....	102
Table A13: Use of Improved Seeds and Fertilisers .....	102
Table A14: Quality of Seeds and Fertilisers Supplied .....	102
Table A15: Access to Agricultural Credit.....	103



# Chapter 1 Introduction

India's agricultural sector has undergone considerable transformation over the past six decades. The elements of agricultural transformation can be seen in the form of reduction in the contribution of agriculture to national income, a decline in the share of labour and a reduction in rural poverty and malnutrition. These changes have occurred alongside the increase in the production of food grains, diversification from the cultivation of cereals to high-value products, the emergence of new marketing opportunities, and linkages with the non-farm sector and active land markets. However, these changes are not pervasive and there exist considerable variations across states. Some states such as Punjab and Haryana took advantage of their rich natural resource conditions to increase agricultural productivity and farm income through the adoption of yield-improving technology. Favourable technical, institutional and political environments have also enabled these states to achieve a higher growth trajectory in agriculture.

Despite the presence of rich natural resources, the state of Bihar has remained backward in agricultural development until recently. Although the economy of Bihar has started growing significantly since its bifurcation in 2000, primarily due to agriculture, it still remains one of the poorest states in India. Among the poorest states, Bihar scores very high on the under-development index (Government of India, 2013). Its combined poverty level was as high as 33.7 per cent compared to the national average of 21.9 per cent during 2011–12. The rural poverty level is even higher at 34.1 per cent. The state also has the dubious distinction of recording low health and educational outcomes (Government of Bihar, 2016).

There has been a structural shift in the economy of Bihar from the primary sector to the services sector in terms of income share in the last one and a half decades. However, agriculture still dominates the economy, contributing over a quarter of the state income and accounting for employment of about 70 per cent of the rural workforce. Hence, robust growth of the agriculture sector holds the key for the economic and social development of the state. Keeping this in view, the Government of Bihar has launched many initiatives for improving productivity growth in the crop and livestock sectors. 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 roadmaps as follows: the first agriculture roadmap (2008–09 to 2011–12); the second agriculture roadmap (2012–13 to 2016–17); and the third agriculture roadmap (2017–18 to 2022–23). These roadmaps focus on the holistic development of agriculture with an emphasis on increasing productivity growth and improving farmers' income.

These policy initiatives seem to have helped in accelerating Bihar's agricultural growth. In fact, the agriculture sector 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 overall state economic growth to 6.6 per cent. There has been high volatility in growth over the years. In this context, there is a need to conduct a diagnostic study of Bihar's agricultural sector to identify both the drivers of and barriers to its growth. The important aspect of the diagnostic study is to identify the most binding constraints on agricultural growth particularly the crop sector in Bihar. Removal of these binding constraints through policy

reforms would unleash the growth potential in the sector. The results of this analysis will be useful for devising appropriate policy recommendations aimed at achieving socially and regionally inclusive agricultural growth and for ensuring effective implementation of the current agriculture roadmap.

Of late, a lot has been said about the NDA government's strategy towards doubling farmers' income and the subsequent recommendations by a specially constituted committee on it. Unlike in the past, the core theme of this round of policy recommendations has been to consider farmers' income as the fulcrum of strategy. The report has laid out multiple recommendations for achieving the goal of doubling farmers' incomes by 2022. However, it must be noted that most of these recommendations are the outcome of a top-down approach at the Union level, even though many of these policy decisions need to be undertaken by State Governments. Moreover, only some of these recommendations pertain to particular States and these are to be identified after examination at the ground level, which was not undertaken in the committee's deliberations. Out of the seven-year period set for doubling of farmers' income, four full agricultural years have already gone. There is, therefore, a daunting task ahead. Finally, even though committee reports provide estimates of the investment required to double farmers' income by states, no attempt has been made to sequence investment needs. After all, given the fund constraints for investment and time limitation, the top priority should have been to identify the most binding constraints for increasing farmers' income state-wise and to allocate funds accordingly.

In this context, the objective of this study is to identify the binding constraints on farmers' income or economic activity in Bihar subject to its natural, political and institutional settings (see Box 1 for the salient objectives of the study). It is our contention that a better understanding of these constraints would help to devise appropriate policy for efficient allocation of scarce financial resources. The methodology of growth diagnostics is conceptualised as a decision tree, which follows a top-down approach. This methodology developed by Hausmann, Klinger and Wagner (2008) and Hausmann, Rodrik and Velasco (2008) considers the hierarchy of distortions, from the largest to the smallest. The strategy could be to start reducing the largest distortion to the level of the next largest and then proceed in a similar way in the subsequent round. This strategy is found to have welfare-improving effects. However, this requires a complete list of constraints, which is difficult to obtain and is unknown explicitly.

**Box 1. Scope of the Study on Agricultural Diagnostics for the State of Bihar**

- Review of the past and current state of agriculture
- Analysis of the drivers of agricultural growth
- Identifying the most binding constraints across the agricultural value chain with a view to prioritise the policy reforms for removing the bottlenecks in agricultural growth
- Understanding the future growth trajectories for the same

This report is organised in four chapters. Chapter 2 details the methodology of the present study. The sources of data and probable list of variables are also provided in this chapter. Chapter 3 traces the past and current state of agriculture in Bihar with a view to identify both the drivers of and barriers to its growth, as also other aspects such as social inclusivity, the regional dimensions of growth, and the future growth trajectory. The results of this analysis will be useful for devising appropriate policy recommendations aimed at achieving socially and regionally inclusive agricultural growth and for ensuring the effective implementation of the current agriculture roadmap. Chapter 4 attempts to identify the binding constraints to growth. Chapter 5 provides policy recommendations from our analysis.

# Chapter 2 Methodological Framework and Data

## 2.1 Introduction

This chapter outlines the principal methodologies that we have adopted for our analysis. We also discuss the sources of data and the implementation procedure in this chapter.

The plan of the rest of the chapter is as follows. Section 2 elaborates on the different methodologies adopted for our analysis. Section 3 discusses the data we have used for the analysis.

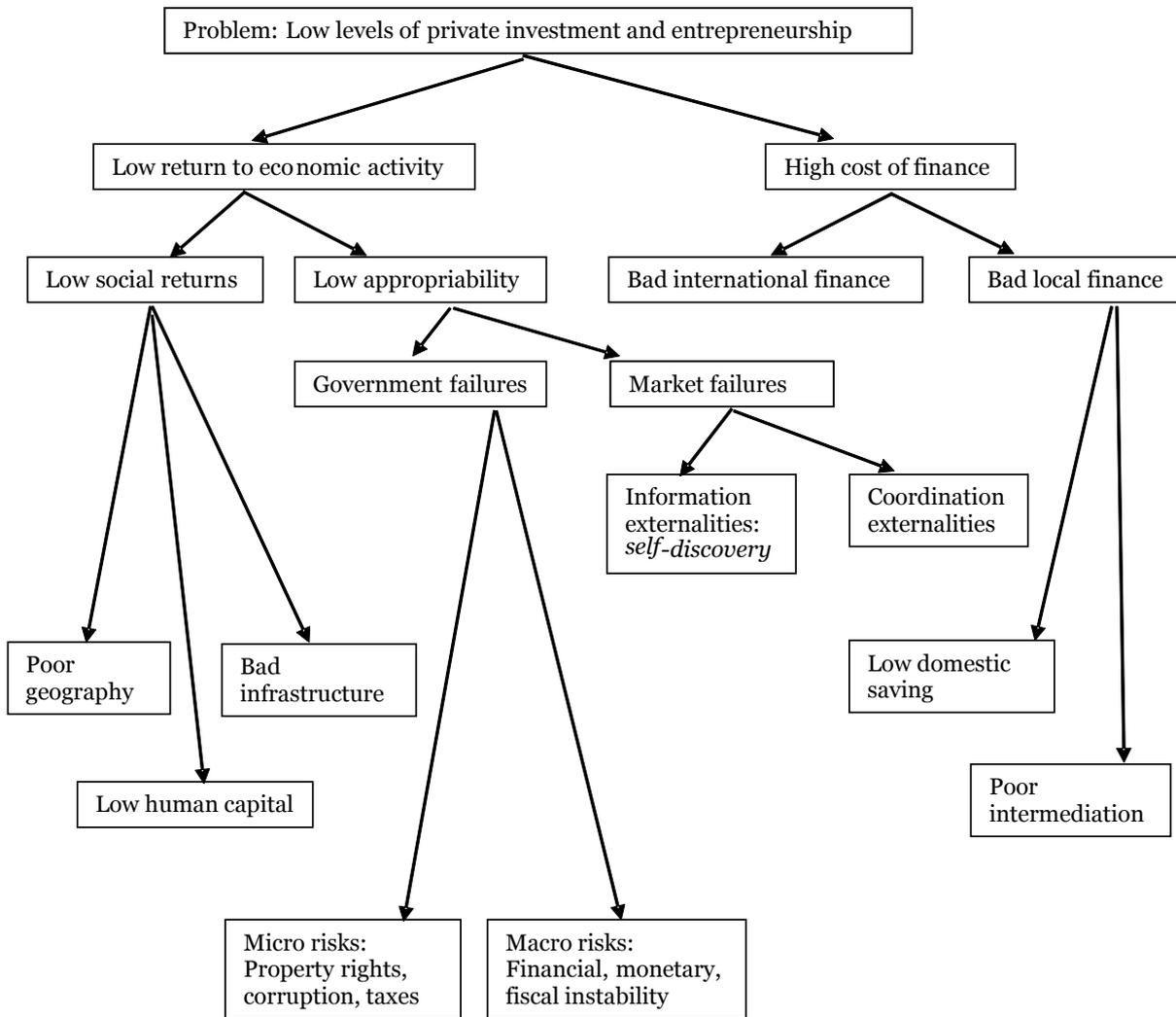
## 2.2 Growth Diagnostics

At the outset, increasing economic growth is the central focus of the growth diagnostics analysis. Poor performance of an economy can be attributed to distortions in the allocation of resources, which could be due to excessive interventions by the government or market imperfections. These distortions drive a wedge between private and social valuations of specific activities (Hausmann et al.).

Many factors affect the economic growth of a country. It is not necessary that all the constraints associated with these factors are binding on economic growth at the same time. Some constraints may have a minimal effect on growth. Therefore, wholesale reforms aimed at eliminating all the constraints may yield little result in promoting growth. The growth diagnostics framework proposed by Hausmann et al. (2008) aims at identifying most binding constraints on economic activity, so that policy priority can be targeted on these constraints. The release of these constraints would have the biggest direct impact on growth. Therefore, the focus should be on eliminating or reducing the biggest distortions.

Binding constraints on economic activity differ depending on the natural, political and institutional settings. A better understanding of the binding constraints helps to devise appropriate policy for efficient allocation of scarce financial resources. The methodology of growth diagnostics is conceptualised as a decision tree, which follows a top-down approach (Figure 1). This methodology considers the hierarchy of distortions from largest to smallest distortions. The strategy could be to start reducing the largest distortion to the level of the next largest and then proceed in a similar way in the subsequent round. This strategy is found to have welfare-improving effects. However, this requires a complete list of constraints, which is difficult to obtain and is unknown explicitly. Further, this method does not guarantee that the reforms that would have the biggest impact on welfare would be undertaken first.

**Figure 2.1: Decision Tree for Growth Diagnostics**



According to Hausmann, Rodrik and Velasco (2008), the best strategy, therefore, is to focus on reforms that would alleviate the most binding constraint. The relaxation of the most binding constraint is guessed to have the largest direct effects on welfare. Since it is impractical to identify the full list of constraints, it is useful to start focusing on proximate determinants of economic growth (e.g. infrastructure). After identification of proximate determinants, one should search for their associated economic distortions (e.g. tax, corruption), the removal of which would have the largest impact on economic growth. However, how to locate these distortions is a matter of empirical question.

The strategy is to start with aggregate outcome such as economic growth (agricultural output growth in the case of the agricultural sector) and its proximate determinants. In the context of a particular country, Hausmann, Rodrik and Velasco (2008) begin the diagnostic of economic growth through three proximate determinants, viz., returns to accumulation, private appropriability and cost of financing accumulation. The first stage is to identify which of these three factors is the greatest obstacle to economic growth. In the next stage, distortions associated with the most binding constraints or the most severe of these constraints are to be identified. The most common distortions include inadequate infrastructure, poor property rights and corruption. In short, the growth diagnostic approach starts with determinants of economic growth and then the role of distortions that underlie the binding constraints.

The growth process of an economy could be described through a univariate approach or other correlates of growth. Of course, growth diagnostics should be pragmatic in identifying the binding constraints. These constraints may be identified through regression analysis, survey data, shadow price, focus group discussion or anecdotal information (Hausmann, Klinger and Wagner, 2008).

The growth diagnostics framework is highly useful for analysing the most binding constraints affecting overall economic growth of a country. But its application for uncovering the binding constraints of a particular economic activity or sector within the economy is a challenge. Though the binding constraints may vary across sectors due to specificities associated with their production, there could be some interactions of constraints affecting different sectors. The framework suggests that most binding constraints that have the largest direct effect on growth should be eliminated. But identification of the proximate factors that determine the growth and choosing the most binding constraints and their associated distortions largely relies on guesswork.

A proper diagnosis of economic growth involves identification of the correct maladies (binding constraints). As discussed earlier, the idea of growth diagnostics is that not all the constraints affect economic growth equally and that an appropriate strategy should consist of identifying the most serious constraints. Hence, the success of growth diagnostics depends on identification of drivers of growth and then the most binding constraints on growth drivers. Policy reforms can be prioritised for unleashing the most binding constraints on growth. Economic theory and evidence help in identification of growth drivers and binding constraints. The present study will employ a combination of different quantitative approaches (outlined below) to analyse agricultural output growth in Bihar and identify its drivers of growth as a first step in the growth diagnostics. Both parametric and non-parametric approaches to analyse the growth drivers will be used. These results will be useful to map onto agricultural output growth diagnostics to identify the most binding constraints (distortions) in the second step. Remedies (policy recommendations) to remove the binding constraints will be formulated in the third step.

We have slightly modified the above diagnostic framework for our analysis to capture the input side for the agricultural sector while keeping the key insights of the growth diagnostics framework. Since the profit-maximising objective function behind an agricultural producer is to equate marginal revenue to marginal cost, a producer would produce to the point where this condition holds. Of course, the producer as well as policymakers can make interventions to shift the producing point by removing constraints. We intend to understand the same in our methodology. In fact, the proposed framework may undergo some change in light of evidence gathered from various sources including stakeholder consultations.

The starting point of our modified growth diagnostics framework could be the Minot et al. (2006) strategy to analyse the drivers of output growth and then the Hausmann et al. framework to diagnose which of these forces pose the greatest obstacles to higher growth. The next step is to uncover the distortions associated with these growth constraints with the assumption that removal of these distortions would unleash growth. As the Minot et al. strategy focuses on only the revenue side of growth analysis, it can easily be extended to incorporate the cost incurred by farmers on material inputs, labour and other services in the production process. That is, total revenue can be written as

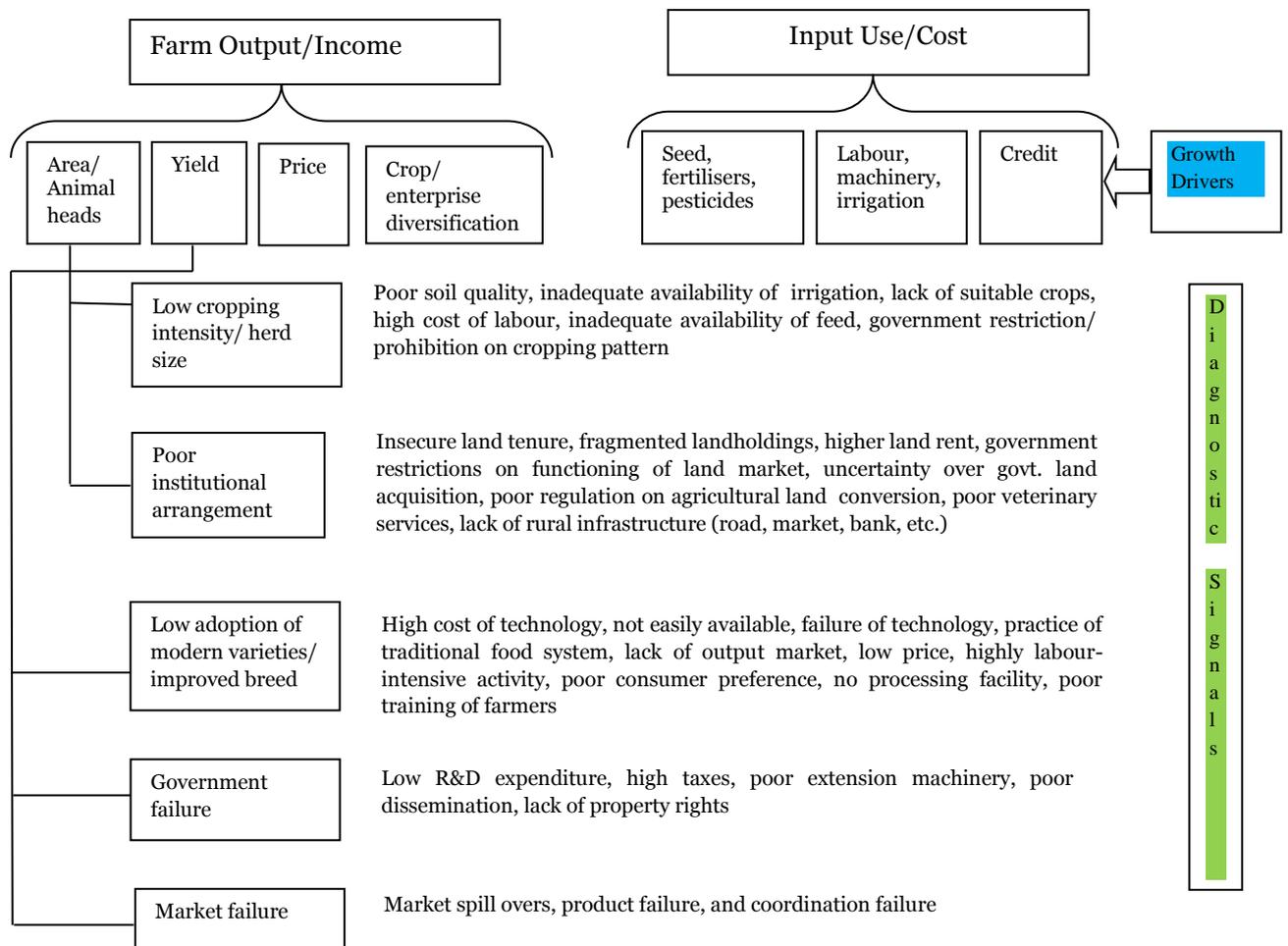
Total Revenue = Value of output – Cost of inputs

With the expectation of a higher market price, a profit-maximising farmer will grow better yield-giving crop varieties or animal breeds to increase production and adopt technology that would enable efficient use of inputs and thus help to save cost. In fact, modern agricultural technology tends to generate additional income streams at little cost. The objective of enterprising farmers is to maximise their profit from farming activities by adopting both output-enhancing and resource-saving technologies.

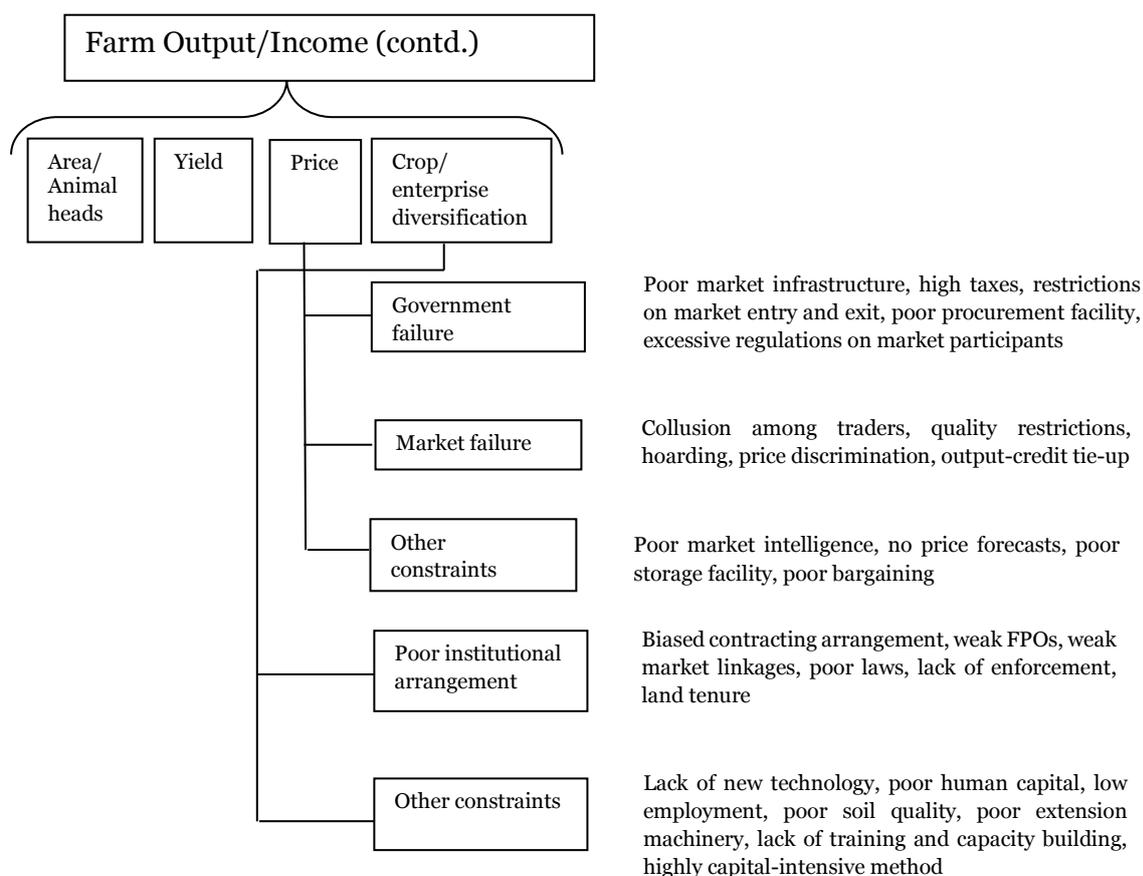
Farmers maximise profit at a point where Marginal Cost = Marginal Revenue.

However, there are many constraints that come in the way of achieving these goals of getting higher output/ income and adopting cost-saving technology by farmers. In the present study, a hybrid of the Minot and Hausmann frameworks will be followed to analyse the growth diagnostics of Bihar agriculture (Figure 2.2.). This figure attempts to address the possible channels which may cause slow agricultural growth in Bihar.

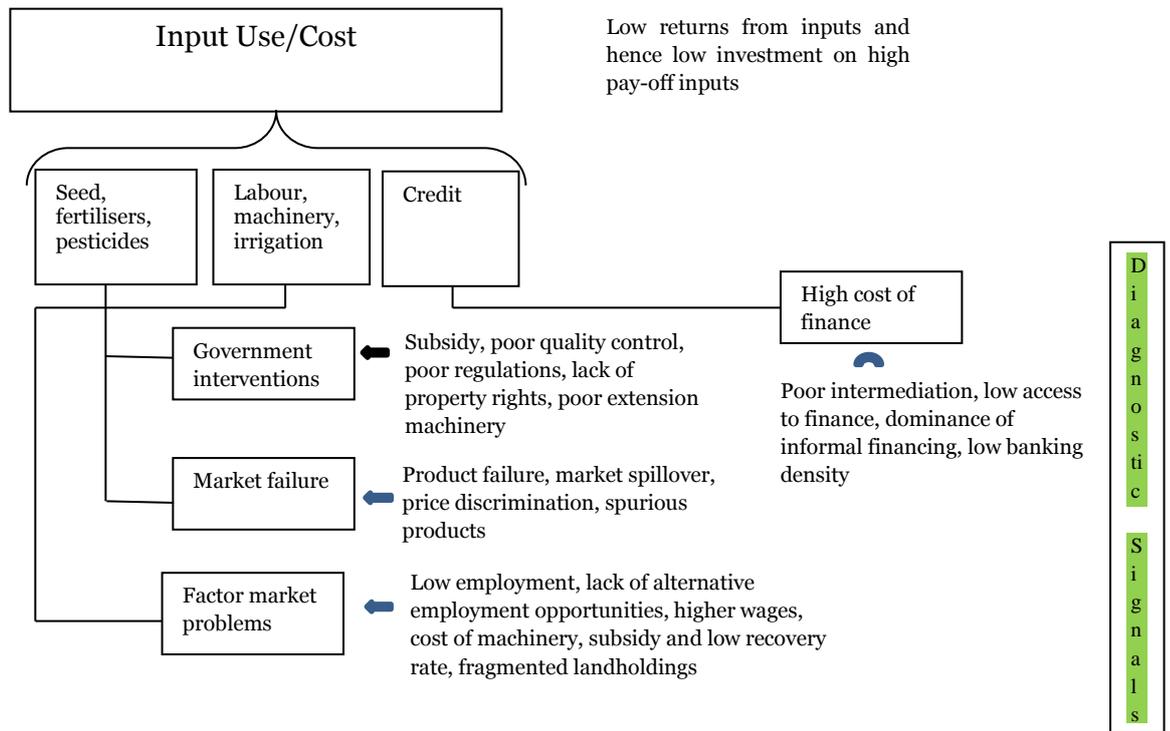
**Figure 2.2: Minot and Hausmann Hybrid Framework for Agricultural Growth Diagnostics**



**Figure 2.2: Minot and Hausmann Hybrid Framework for Agricultural Growth Diagnostics**



**Figure 2.2: Minot and Hausmann Hybrid Framework for Agricultural Growth Diagnostics**



A hybrid of the Minot and Hausmann approaches to growth diagnostics for the agricultural sector enables us to find the binding constraints on both the output and input sides. Agricultural output growth depends on farm size, yield (technology), price and crop/ enterprise diversification. Similarly, input use depends on availability of seed, fertiliser, pesticide, labour, machinery, irrigation and credit. Suppose that the overarching problem is why agricultural growth in Bihar state has slowed down in recent years. Application of growth diagnostics involves asking a series of questions about the binding constraints on growth determinants. For instance, if the problem seems to be the low scale of farming, is that due to poor soil quality, inadequate irrigation facility, expensive labour and government restriction on a particular cropping pattern? Is low scale of farming also due to insecure land tenure, fragmented landholdings, high rent or restrictions on land leasing? Yield is an important driver of output growth. If low crop yield appears to be a problem, is that due to lack of access to new technology, the high cost of technology, failure of technology, poor training of farmers on how to use the technology, low agricultural research and development expenditure, high taxes or poor definition of property rights? Similarly, binding constraints on other determinants of output growth can be identified, which can then be used to locate remedies to overcome these constraints.

On the input side, farmers could face a situation where they get lower returns from modern inputs and hence low motivation, resulting in underinvestment on high pay-off inputs. If the problem is with non-availability of quality inputs, is that due to corruption, poor quality control, poor delivery system or high cost? If the problem is over-use of inputs affecting the sustainability of production, is that due to subsidy, poor regulation or lack of awareness? Similarly, if the high cost of financing is a problem, is that due to poor intermediation, low banking density or the dominance of informal financing? In a similar way, binding constraints on specific inputs such as fertilisers, seed, labour,

irrigation and machinery can be identified and suitable remedies designed to remove the constraints.

Apart from the above hybrid framework, we have used the following tools to understand Bihar's agricultural growth pattern.

### 2.2.1 Decomposition of Agricultural Output Growth

A growth accounting approach is to be followed to analyse the contribution of different sources of agricultural growth (Birthal et al. 2014; Minot et al. 2006). According to this approach, the change in gross revenue is decomposed into: (i) area effect, (ii) yield effect, (iii) price effect, (iv) diversification effect, and (v) interaction effect.

If  $A_i$  is the area under crop  $i$ ,  $Y_i$  is its production per unit area, and  $P_i$  is the real price per unit of production, then the gross revenue  $R$  from  $n$  crops can be written as:

$$R = \sum_{i=1}^n A_i Y_i P_i$$

$A_i$  can be further expressed as the share of crop  $i$  in the total cropped area,  $a_i = \left(\frac{A_i}{\sum_i A_i}\right)$  and substituting this expression in the above equation, the following expression can be obtained:

$$R = \left(\sum_{i=1}^n a_i Y_i P_i\right) \sum_{i=1}^n A_i$$

Taking total derivatives of this equation and rearranging the terms gives the following expression:

$$dR \cong \left(\sum_{i=1}^n a_i Y_i P_i\right) d\left(\sum_{i=1}^n A_i\right) + \sum_{i=1}^n A_i \sum_{i=1}^n (a_i Y_i dP_i) + \sum_{i=1}^n A_i \sum_{i=1}^n (a_i P_i dY_i) + \sum_{i=1}^n A_i \sum_{i=1}^n (Y_i P_i da_i)$$

This equation decomposes the change in gross revenue due to changes in: (i) total cropped area, (ii) crop yields, (iii) real prices, and (iv) land re-allocation or diversification. The first term on the right-hand side of this equation represents the change in gross revenue due to a change in the total cropped area. The second term captures the change in gross revenue due to a change in the real prices of commodities. The third term measures the change in gross revenue due to changes in the crop yields or technology. The fourth term represents the change in gross revenue associated with changes in the crop composition, implying a re-allocation of land from low-value to high-value crops.

### 2.2.2 Resource Decomposition Method

This method involves, first, an estimation of total factor productivity TFP and then decomposition of the contribution of TFP and other inputs to output growth. Growth accounting has been widely used to measure TFP in India's agricultural sector (Chand et al. 2011; Evenson et al. 1999; Kannan 2011; Kumar, Kumar and Mittal 2004; Kumar, Mittal and Hossain 2008; Kumar and Mruthynjaya 1992; Mukherjee and Kuroda 2003). Under this method, TFP is estimated as the ratio of the aggregate output index to the aggregate input index. Therefore, TFP growth is the growth of the output minus growth of input. In the present study, the Tornqvist-Theil index will be used to estimate the TFP growth for the purpose of resource decomposition analysis. This index is widely used in the literature (Capalbo and Antle 1988; Coelli et al. 2005; Diewert 1976, 1978) and it can be expressed in logarithmic form as follows:

$$\ln\left(\frac{TFP_t}{TFP_{t-1}}\right) = \sum_j R_j \ln\left(\frac{Y_{jt}}{Y_{jt-1}}\right) - \sum_i S_i \ln\left(\frac{X_{it}}{X_{it-1}}\right)$$

where,  $R_j$  is revenue share of  $j^{\text{th}}$  output,  $S_i$  is cost share of  $i^{\text{th}}$  input,  $Y_{jt}$  is output and  $X_{it}$  is input measured, all in period  $t$ .

Here, the total output growth is estimated by summing the growth of each output weighted by its revenue share while the input growth is estimated by summing the growth of each input weighted by the cost share. The difference between the growth of total output and the growth of 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 land (area) and growth in yield of this particular resource.

This can be written as follows:

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

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:

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

The above equation provides a resource decomposition of output growth as it focuses on quantity changes in physical resource, that is, land. This equation can be extended to incorporate other natural resources such as irrigation. Expansion of irrigation leads to augmentation of the total crop area; the difference between the total crop area and irrigation provides the extent of the new area/land brought under cultivation. Hence, the contribution of irrigation to the total crop area and output growth can be easily estimated.

### 2.3 The Data

The present study is based on secondary data compiled from various published sources as well as primary information collated from stakeholders. The important lists of variables collated from secondary sources of data are provided in Table 2.1. The data analysis will pertain to the period 2000–01 to 2016–17. For analytical purposes, this period may be sub-divided into the pre-agriculture roadmap period (2000–01 to 2007–08) and the post-agriculture roadmap period (2008–09 to 2016–17). The post-agriculture roadmap period may further be analysed in terms of the different phases of implementation of the agriculture roadmap.

**Table 2.1: List of variables and sources of data**

<b>S. No.</b>	<b>Data</b>	<b>Level</b>	<b>Source</b>
1	Gross State Domestic Product (sector level) at 2011–12 prices	State	CSO, Government of India
2	Value of crop output	Crop level, State	CSO, Government of India
3	Value of livestock output	Product level, State	CSO, Government of India
4	Land use statistics (land use, irrigation)	State, district	DES, Ministry of Agriculture and Farmers' Welfare
5	Operational landholdings	State	NSSO (2002, 2012)
6	Operational landholdings	State, district	Ministry of Agriculture and Farmers' Welfare
7	Crop area, production and yield	State, district	DES, Ministry of Agriculture and Farmers' Welfare
8	Cost of cultivation	State	DES, Ministry of Agriculture and Farmers' Welfare
9	Livestock population	State	Department of Animal Husbandry and Dairying, Ministry of Agriculture and Farmers' Welfare
10	Livestock products	State	Department of Animal Husbandry and Dairying, Ministry of Agriculture and Farmers' Welfare
11	Agro-climatic zones and related information	State, district	Government of Bihar
12	Input use (seeds, fertilisers)	State, district	Government of Bihar
13	Agricultural labour	State, district	Population Census
14	High-yielding variety area	State	Government of Bihar
15	Prices of agricultural commodities		CSO, Government of India
16	Public expenditure in agriculture	State	Comptroller and Auditor General of India, Government of India
17	Area, production and yield of horticultural crops	State, district	National Horticulture Board and Government of Bihar
18	Information related to markets	State	Government of Bihar
19	Targets and achievements under the agriculture roadmap		Government of Bihar
20	Whole Price Index of agricultural commodities	India	Ministry of Industry, Government of India

**Source:** Prepared by NCAER's Project team

While data from secondary sources are useful for our exercise, inputs from stakeholder analysis are equally important for exploring various viewpoints and ground-level experiences in identifying binding constraints and possible ways of improving agricultural productivity. The inputs from these are drawn from discussions with farmers including focus group discussions (FGDs), state government officials, agricultural scientists, extension workers, Farmer Producer Organisations (FPOs) and development practitioners. The details of stakeholder interviews/ discussions we have undertaken are given in Table 2.2.

**Table 2.2: Composition of Stakeholders**

<b>Stakeholders</b>	<b>Institution/ Organisation</b>
Seed sector	National Seed Corporation, Academia in university, Agricultural Department, scientists/officials in Indian Council of Agricultural Research (ICAR), Krishi Vikas Yojana (KVK), seed producers, seed retailers, private seed and sapling producers
Fertiliser	Indian Farmers Fertiliser Cooperative Limited (IFFCO), Krishak Bharati Cooperative Ltd (KRIBHCO), Govt. of Bihar, wholesalers, retailers
Irrigation (crops)	Irrigation Department including Minor irrigation, In-charge of Distributaries, Traders dealing with pump sets, officials of the Rashtriya Krishi Vikas Yojana (RKVY) and block/ district-level officials engaged in providing subsidy for minor irrigation, Department of Agriculture
Marketing	Traders, members of PACS, officials in Cooperative Department
Processing sector	Processors of horticulture crops, rice millers, flour millers, Department of Industry, Govt. of Bihar, Industry Association, Agricultural and Processed Food Products Export Development Authority ( APEDA)
Horticulture sector	National Horticulture Mission (Govt. of Bihar), Sapling producers and retailers
Livestock sector	Bihar Animal Science University, Bihar State Milk Co-Operative Federation Ltd. (COMFED), semen producers (public & private), Bharatiya Agro Industries Foundation (BAIF), feed producers, poultry farm operators, Fisheries Department, hatcheries
Technology Generation	Agricultural University, ICAR Institute and Centres
Transfer of Technology	Officials/scientists in Govt. of Bihar (various departments), ICAR, agricultural universities, Bihar Animal Science University, Krishi Vigyan Kendra (KVK), Agricultural Technology Management Agency (ATMA), Non-Government Organisation (NGO), Bihar Rural Livelihood Project (JEEVIKA), extension services
Warehousing and storage	Officials in Bihar Civil Supply Corporation, Bihar State Warehouse Corporation, Regional Office of Central Warehouse Corporation, regional office of the Food Corporation of India, National Cooperative Development Corporation (NCDC), Department of Civil Supply, Govt. of Bihar, National Agricultural Cooperative Marketing Federation of India (Regional Office)
Agricultural credit	Officials in National Bank for Agriculture and Rural Development (NABARD), Regional/ Divisional office of major commercial banks, Regional Rural Bank (RRBs), cooperative department, Bihar State Cooperative Bank, Bihar Land Development Bank and JEEVIKA for credit through self-help groups (SHG)
Farmers (FGD)	Contacted for all aspects mentioned above

The regions where FGD, supply chain analysis were undertaken, apart from Patna where senior government officials were interviewed, are shown in Table 2.3. These districts were identified based on their agricultural performance in terms of output growth and operational convenience of undertaking focussed group discussions and stake-holders interactions.

**Table 2.3: Regional Composition of Stakeholders' Analysis**

<b>Zone</b>	<b>Best Performing District</b>	<b>Poor Performing District</b>
I	West Champaran	Samastipur*
II	Purnea	Khagaria
IIIA	Bhagalpur*	Jamui
IIIB	Bhojpur	Patna

Note: \*Agricultural universities located in these districts

Table 2.4 shows the distribution of the sampling units canvassed for our analysis. These are distributed equally among the districts.

**Table 2.4: Distribution of Sampling Units Canvassed (Location)**

<b>Stakeholders</b>	<b>Best Performing District</b>	<b>Poor Performing District</b>
Seed sector	12	12
Fertiliser	12	12
Irrigation	12	12
Marketing	12	12
Processing sector	12	12
Horticulture sector	12	12
Livestock sector	12	12
Technology generation	4	4
Transfer of technology	4	4
Warehousing and storage	8	8
Agricultural credit	8	8
Farmers (FGD)	12	12

## **2.4. Implementation of the Framework**

The proposed Minot-Hausmann hybrid growth diagnostics framework is highly useful for analysing the most binding constraints that affect the agricultural growth of Bihar state. This framework suggests that the binding constraints that have the largest direct effect on growth should be identified so that policy reforms can remove them in order to unleash the growth potential. But identification of the proximate factors that determine the growth and choosing the most binding constraints and their associated distortions are empirical challenges for researchers. In this regard, economic theory and evidence help in the identification of growth drivers and the binding constraints. Alongside, insights from different stakeholders associated with the sector will throw light on how serious the distortions are and how they affect the farmers' income and cost of

production. The profit-maximising farmer will tend to utilise the resources more efficiently by adopting cost-saving technology and improve profit through better price realisation.

There are various constraints operating within the farm and outside the farm. There is a need to identify and rank these constraints across the value chain in the order of their impact on growth, and then to prioritise the policy reforms in order to remove the most binding constraints on the activities in the value chain. For this purpose, it is important to discuss with various stakeholders in the value chain such as farmers, policymakers/implementation agencies, scientists, input dealers, market intermediaries, credit agencies and agro-processors. The proposed multi-stakeholder consultations will go a long way in identifying the drivers of agricultural growth and the constraints on these drivers. These stakeholder interactions will also help in confirming or disconfirming the pattern, trends and obstacles to growth for taking informed policy decisions. Further, the stakeholder interactions will capture the constraints across sub-sectors such as field crops, horticulture, livestock and other related activities.

The stakeholder consultations were conducted in different forms for different stakeholders. In the case of farmers, focus group discussions (FGDs) were used to solicit the information, while personal interviews were conducted for other stakeholders in the value chain. The FGDs were conducted in different agro-climatic regions of the state. A separate survey instrument (check list) was prepared for various stakeholders, which was a priori tested in the field. The survey instruments contained a series of interrelated questions about the obstacles/constraints faced by different actors along the value chain. The current situation, patterns, problems and likely solutions were captured. More importantly, implicit price/shadow price of different growth-constraining variables were captured. Since qualitative research methods have been adopted for stakeholder consultations, we preferred to ask open-ended questions with adept moderation to get informative responses.

The instrument prepared for conducting FGD of farmers, among other details, focused on the following issues:

- Land use constraints: land size, land use change, cropping intensity, tenancy, soil fertility, crop (field crops/horticulture), govt. policy, etc.
- Technology and related constraints: adoption of improved crop varieties (field crops/horticulture, yield, cultivation practices, other crop technologies, etc.
- Markets and institutional constraints: crop disposal pattern, price, market access, infrastructure, govt. policy, contract farming, FPO, training, etc.
- Input supply constraints: seed, fertiliser, irrigation, labour, machinery, credit, etc.;

- Constraints related to livestock and other allied activities including fishery (animal type, feed/fodder, veterinary services, herd size, govt. schemes, etc.
- Village-level prices for inputs/agricultural services

Separate instruments for conducting personal interviews with the following stakeholders have been prepared. Among other issues, they focus on examining the constraints on specific activity in the value chain:

- Seed producers/dealers: constraints on seed production, distribution, govt. policy-tax, subsidy, etc.
- Fertiliser dealers: constraints related to procurement, distribution, tax, subsidy, etc.
- Field crop /irrigation sector: govt. schemes/programmes, beneficiaries, achievement, impact on farmers, human resources, finance, implementation etc.
- Horticulture: govt. schemes/programmes, beneficiaries, achievement, impact on farmers, human resources, finance, implementation etc.
- Livestock: thrust areas, govt. schemes/programmes, beneficiaries, achievement, impact on farmers, human resources, finance, implementation etc.
- Agro-processing: raw materials, fixed assets, plant capacity, products manufactured, subsidy, tax, distribution networks
- Technology generation: Agricultural university/ICAR institute, release of crop varieties/hybrids, adoption problems, research and development, thrust areas, finance, etc.
- Technology transfer: extension machinery, human resource, finance, beneficiary, input distribution, etc.
- Warehousing/storage: capacity, facilities, commodities, charges, user type, etc.
- Agricultural market intermediaries/traders: price discovery, market infrastructure, credit tie-up, commodities, govt. policy, etc.
- Agricultural credit institutions: type of credit advanced, interest rate for agriculture and non-agriculture sector, users, accessibility, crop insurance, etc.

The questionnaires used for interaction with the various stakeholders are given in Annex 1 for interested readers.

# Chapter 3 Review of the State of Agriculture in Bihar

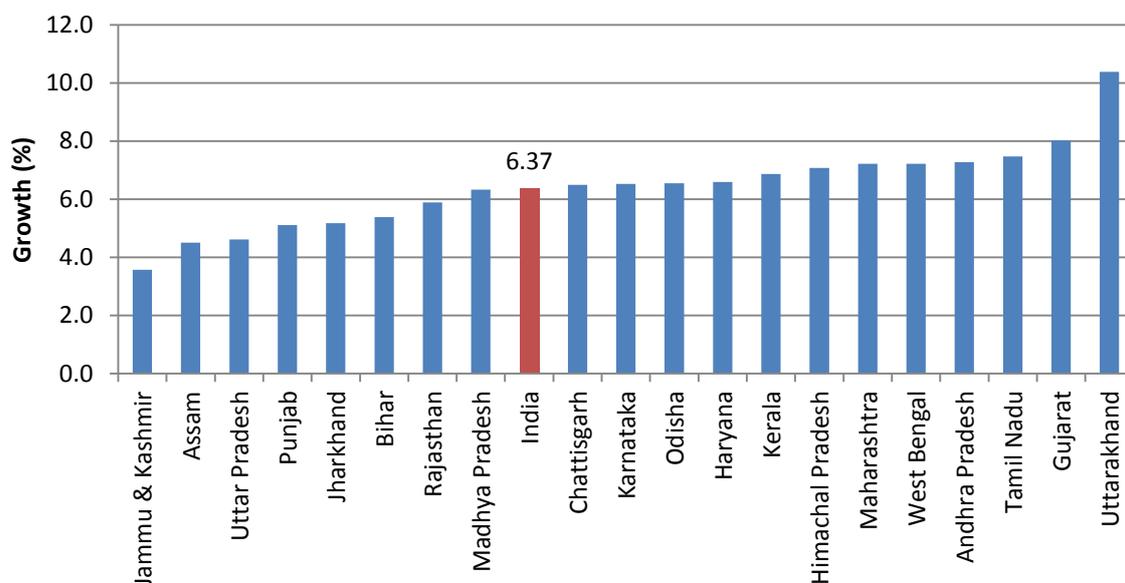
## 3.1 Introduction

This chapter provides an overview of the performance of the agricultural sector in Bihar post bifurcation of the state in 2001. The following issues are addressed in this chapter: (a) Structural change and relative performance of the Bihar economy in India; (b) Changes in land use, cropping pattern and irrigation; (c) Changes in agricultural production and income; (d) Sources of output growth; and (e) Drivers of crop output growth.

## 3.2 Structural Changes and Relative Performance of the Bihar Economy in India

The turnaround in the performance of Bihar's economy since the mid-2000s has been much discussed in the literature in recent years (Chanda 2011; Ghatak and Roy 2015). Favourable policy initiatives to improve the investment climate, infrastructure, governance and social protection seem to have broken the long history of poor economic growth, lawlessness, low human capital, labour out-migration, and agricultural and industrial stagnation. There is a perceptible change in the image of Bihar from a poorly governed and weak infrastructure state to one of the fastest growing economies in India. Besides sound social and economic policies, political stability has had a transformative effect in placing Bihar on a high income growth path.

**Figure 3.1: Growth in Per Capita Income (%): 2000-01 to 2016-17**

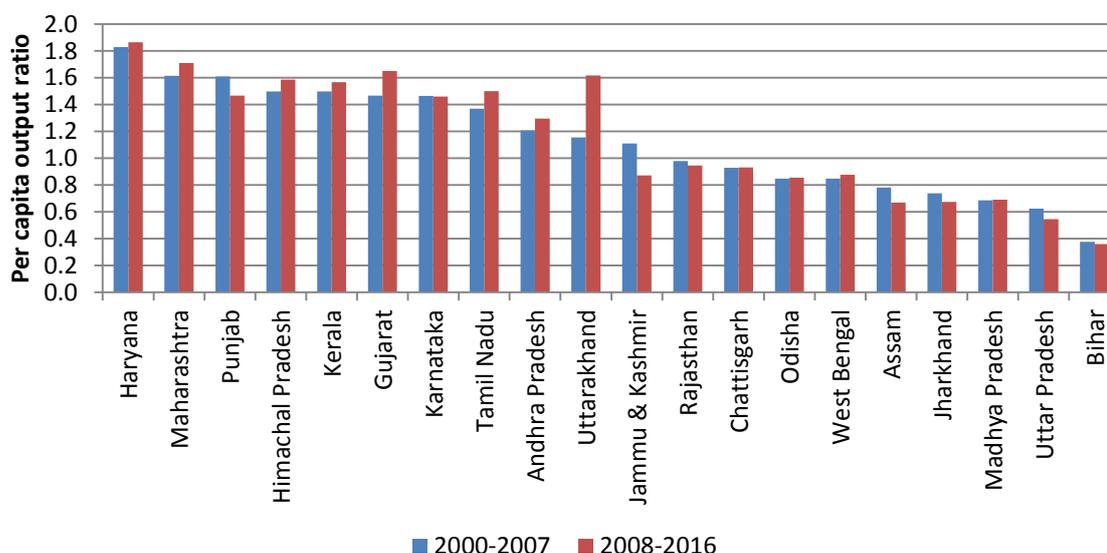


Source: National Accounts Statistics (various issues)

The average per capita income growth of 20 major states from 2000-01 to 2016-17 at 2011-12 prices is given in Figure 3.1. Although the average income growth of Bihar was below India's average, it was considerably higher than earlier at 5.38 per cent. Other poor states such as Rajasthan and Madhya Pradesh have also registered decent growth during the study period. With a higher growth rate, Bihar tends to catch up with these emerging fast-growing economies as well as the national average. With the pursuance of sound economic policies to promote growth, there is likely to be convergence among states over time.

However, evidence on the convergence of growth across states in India is slightly mixed. The ratio of states' GSDP to India's GDP shows wide divergence in per capita income in relative terms (Figure 3.2). Two time periods have been formed to analyse the relative changes in income. The period 2000-2007 corresponds to the early phase of agricultural reforms introduced in Bihar, while the period 2008-2016 can be considered as the implementation phase of reforms. The latter phase comprises notable initiatives such as agricultural road maps and skill development programmes. Further, there was a continuity of the government mainly ruled by a single political party and was headed by the same Chief Minister. With strong political will and big push for key reforms, there was considerable improvement in the sectoral performance during the study period. But despite that the relative position of Bihar among the states remained at the bottom.

**Figure 3.2: Ratio of Per Capita GSDP to India's GDP**



Source: National Accounts Statistics (various issues)

The ratio of Bihar's per capita GSDP to India's GDP was 0.37 during 2000-07 and marginally declined during 2008-16. Besides Bihar, a relative fall in per capita GSDP during the recent period can be observed in a few other states, while it improved in some states. This implies that there is a considerable divergence in per capita GSDP, a proxy for per capita income, among the states. The poor states at the bottom will certainly try to catch up with the national average. However, paradoxically there still exist huge differences in per capita GSDP between the best performing state of Haryana at one end and the poor state of Bihar at the other end. The average per capita

GSDP of Haryana was almost five times higher than the same of Bihar. So, it will take time for Bihar to move up the ladder despite high growth.

As observed at the national level, the Bihar economy has also undergone changes in its structural composition. The bifurcation of Bihar in 2000 resulted in the formation of Jharkhand, which took away the mineral resources-rich part of the state and it left the fertile agricultural land and water resources to the present state of Bihar. Agriculture holds the key to the overall development of the Bihar economy. For accelerating agricultural growth, the government of Bihar has introduced various policy initiatives at different points in time. These initiatives are being implemented under different phases of what is called agriculture roadmaps: the first agriculture roadmap (2008–09 to 2011–12); the second agriculture roadmap (2012–13 to 2016–17); and the third agriculture roadmap (2017–18 to 2022–23). After long years of neglect, these roadmaps intend to create the holistic development of agriculture with an emphasis on increasing productivity growth and improving farmers’ income. It is important to recognise that the path to higher economic growth was to be achieved through raising agricultural productivity growth.

**Table 3.1: Average Annual Growth in Major Sectors of the Bihar Economy**

<b>Particulars</b>	<b>2001-02 to 2007-08</b>	<b>2008-09 to 2011-12</b>	<b>2012-13 to 2016-17</b>	<b>2001-02 to 2016-17</b>
<i>Agriculture &amp; Allied</i>	1.98	3.11	1.28	2.04
Industry	8.78	14.18	6.09	9.29
Services	6.38	14.56	7.65	8.82
<i>Non-agriculture</i>	6.93	14.44	7.02	8.83
<i>Overall</i>	4.68	10.86	6.56	6.81

Source: National Accounts Statistics (various issues)

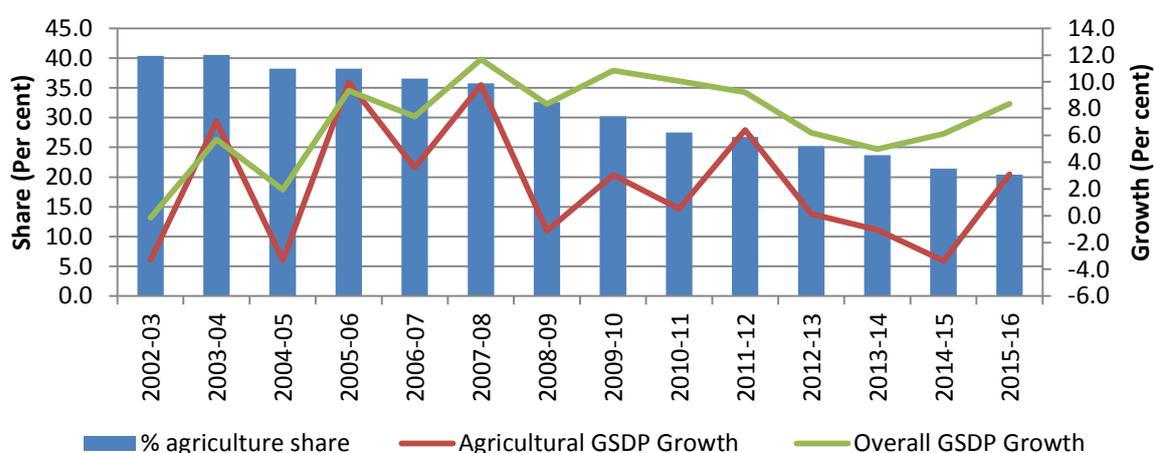
Considering the fact that agriculture road maps had been prepared to revive the sector in a time-bound manner, most analyses have been carried out in line with the time-frame of these road maps. As expected, the agriculture sector has seen a turnaround in its performance, registering a positive growth rate during different periods. The average annual growth in agriculture and allied activities during the pre-agriculture road map (2001-02 to 2007-08) was only about 2.0 per cent (Table 3.1). During the period of the first agriculture road map, the growth rate accelerated to 3.1 per cent, which was almost equal to the national average agricultural growth. However, this higher growth in agriculture did not sustain in the long run. In fact, the average annual growth rate declined to 1.28 per cent during the period of the second agriculture road map. During the overall period 2001-02 to 2016-17, average growth was only 2.0 per cent, which was much below the national average agricultural growth of 3.1 per cent.

However, industry and the services sector have registered excellent growth in all the periods. Average growth was exceptionally high at 14.2 per cent in industry and 14.6 per cent in services from 2008-09 to 2011-12. This led to overall economic growth of about 11.0 per cent in this period. From 2012-13 to 2016-17, the average growth in industry and services decelerated, leading to a fall in overall economic growth to 6.6 per cent. During the entire period, Bihar’s economic growth was 6.8 per cent, which was largely led by the non-agricultural sector comprising industry and services. Even at this overall average growth rate, Bihar still remains one of the fast growing states in India.

Despite having great potential to sustain a higher growth rate, agriculture showed weak performance during recent years. Further, its year-over-year growth has shown wide fluctuations

that are mostly induced by variation in weather factors (Figure 3.3). Although average agricultural growth is much lower than that of non-agricultural growth, agriculture still continues to play an important role in influencing the overall economic growth. In fact, overall economic growth more or less came down during the years where agricultural growth actually slumped. The share of agriculture and allied activities in the state income is almost halved to reach 20 per cent between triennium 2002-03 and 2015-16. However, decline in the contribution of agriculture to state economy does not mean that agriculture need not register a higher growth rate. In fact, it is not paradoxical to have higher agricultural growth in light of its low contribution to the economy (de Janvry 2010; Timmer 1998).

**Figure 3.3: Trend in Agricultural GSDP and Overall Economic Growth (3-year Moving Average Series)**



Source: Authors' compilation from National Accounts Statistics (various issues).

The higher economic growth, changes in consumption patterns, entry of multinational corporations and rising urbanisation at the national level are acting as catalysts of transformation within agriculture. The changes in composition of agricultural output reveal the pattern of structural changes over time (Table 3.2). The contribution of agriculture to overall output has declined, from 66.3 per cent in 2002-03 to 53.6 per cent in 2015-16. Within agriculture, horticulture accounted for a little less than a quarter of output, while field crops constituted roughly one-third of agricultural output. The output from field crops and horticulture registered splendid growth during the period of agriculture road maps as compared to the pre-agriculture road map period. However, there is a need to look into the reasons for low horticulture growth in Bihar.

**Table 3.2: Changes in Composition of Agriculture and Allied Activities (%)**

Particulars	% share			Trend Growth Rate (%)		
	TE* 2002-03	TE 2007-08	TE 2015-16	2000-01 to 2007-08	2008-09 to 2015-16	2000-01 to 2015-16
Agriculture	66.3	56.4	53.6	-0.69	3.63	3.03
<i>Field crops</i>	34.7	32.4	31.0	1.53	4.29	4.00
<i>Horticulture</i>	31.6	24.0	22.7	-3.51	2.85	1.85
Livestock	25.4	30.3	33.8	6.39	6.22	6.26
Forestry	4.4	9.5	6.1	18.99	1.75	5.84
Fishery	4.0	3.8	6.5	2.43	9.62	8.15
Overall	100.0	100.0	100.0	2.57	4.66	4.29

Source: Authors' compilation.

\* TE: triennium ending.

Interestingly, decline in agricultural 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 per cent of total output during 2015-16. 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.

### 3.3 Changes in Land Use, Cropping Patterns and Irrigation

Land is an important factor of production and it is increasingly being put to use for multiple purposes. Given the limit on availability of land, there is high competition for its use in agriculture as well as for non-agricultural activities. Bihar has highly fertile land that falls in the Gangetic plain. But unfortunately, a significant part of the area is prone to floods and at the same time part of Bihar is subject to drought. Bihar has 9.4 million ha of reported geographical area. Of this, over 55 per cent of land is utilised for cultivation (Table 3.3). However, during recent years the net area sown has declined, implying that agricultural land has been diverted for non-agricultural uses. If the trend in agricultural land diversion continues without a significant rise in productivity, it is likely to affect agricultural development in the state. The decline in net sown area has also brought down the total cropped area.

**Table 3.3: Changes in Land Use Pattern**

Type of Land Use	Area (000 ha)		% share in reported area	
	TE 2002-03	TE 2014-15	TE 2003-04	TE 2014-15
<i>Forest</i>	619.9	621.6	6.62	6.64
<i>Not available for cultivation</i>	2077.8	2142.6	22.20	22.89
a) Area under non-agri. uses	1641.0	1710.9	17.53	18.28
b) Barren & uncultivable land	436.5	431.7	4.66	4.61
<i>Uncultivated land excluding fallow land</i>	298.2	307.5	3.19	3.29
a) Permanent pastures & other grazing land	17.9	15.5	0.19	0.17
b) Misc. tree crops, groves	234.3	247.2	2.50	2.64
c) Culturable waste land	46.0	44.9	0.49	0.48
<i>Fallow Land</i>	680.1	976.8	7.27	10.44
a) Current fallow	546.1	856.3	5.83	9.15
b) Other fallow land	134.4	120.6	1.44	1.29
<i>Net Area Sown</i>	5684.2	5311.0	60.73	56.74
Area sown more than once	2265.0	2365.9	24.20	25.28
Total Cropped Area	7948.8	7676.9	84.92	82.02

Source: Land Use Statistics, DES, Ministry of Agriculture and Farmers' Welfare

It can be observed that the fall in net sown area is largely due to an increase in fallow land and area under non-agricultural uses. The current fallow land is land that is not used for cultivation during the current year. The increase in current fallow is generally due to lack of adequate irrigation water, labour shortage and water logging due to flood. However, the rising proportion of fallow land is a concern because there is a tendency to convert the fallow land to plantation crops or to non-agricultural uses. A part of this process is already evident from the increasing trend in area under non-agricultural uses.

Among others, land market dynamics, changes in land use policy and demographic pressure affect the land use pattern. Compared to other states, Bihar has highly fragmented landholdings and has experienced increasing subdivision of land over time. The partial implementation of land reforms and demographic pressure are responsible for this uneven distribution of landholdings. At the national level, marginal holdings constituted about 68.5 per cent in 2015-16, whereas in Bihar it was 91.2 per cent, implying that there is high incidence of marginalisation of landholdings in the state (Table 3.4). Landholdings with less than 2 hectares (ha) accounted for 97.0 per cent of total landholdings and this has shown an upward trend over time. Consequently, the average size of operated area has come down considerably from 0.43 ha in 2005-06 to 0.39 ha in 2015-16. The average size of operated area of Bihar is 60 per cent less than the operated area of India as a whole.

**Table 3.4: Distribution of Operational Holdings and Average Size of Operated Area**

State	2005-06		2015-16	
	Bihar	All India	Bihar	All India
<b>Operational Holdings (%)</b>				
Marginal (<1.0 ha)	89.64	64.77	91.21	68.52
Small (1.0-2.0 ha)	6.67	18.52	5.75	17.69
Semi-medium (2.0-4.0 ha)	2.99	10.93	2.52	9.45
Medium (4.0-10.0 ha)	0.67	4.93	0.49	3.76
Large (> 10.0 ha)	0.03	0.85	0.02	0.57
All sizes	100	100	100	100
<b>Average size of operated area (ha)</b>				
Marginal (<1.0 ha)	0.25	0.38	0.25	0.38
Small (1.0-2.0 ha)	1.25	1.38	1.25	1.41
Semi-medium (2.0-4.0 ha)	2.59	2.68	2.60	2.70
Medium (4.0-10.0 ha)	5.16	5.74	5.29	5.72
Large (> 10.0 ha)	20.56	17.08	14.48	17.10
All sizes	0.43	1.23	0.39	1.08

Source: Agricultural Census, Ministry of Agriculture and Farmers' Welfare

The increase in number of landholdings with a size of less than 1 ha and the reduction in average size of operated area are important challenges facing Bihar agriculture. The shrinking size of landholdings affects economic viability of farming and its capacity to support the livelihoods of farmers. The size of landholdings also influences the type of crops grown, technology adoption, price realisation and effective bargaining in the output and input markets. Farmers in Bihar have mostly used cultivable land to grow cereals, which constituted about 80 per cent of total cropped area (Table 3.5). With a more or less constant area share, there is an area substitution among the

cereals, particularly between paddy, wheat and maize. These three crops account for about 70 per cent of total cropped area and 40 per cent of total value of crop output.

**Table 3.5: Relative Share of Crop Area and Value of Output (%)**

Particulars	% share of crop area			% share of value of output		
	TE 2002-03	TE 2007-08	TE 2016-17	TE 2002-03	TE 2007-08	TE 2016-17
Paddy	45.3	44.5	43.0	20.4	19.7	20.8
Wheat	26.5	27.2	27.8	13.7	16.1	13.0
Maize	7.6	8.4	9.3	3.6	4.5	5.9
Total Cereals	80.1	80.7	80.4	37.9	40.3	39.9
Moong	2.4	2.3	2.2	1.1	0.8	1.1
Lentil	2.2	2.1	2.0	1.2	1.1	1.5
Khesari	1.9	1.3	0.8	0.4	0.3	0.3
Total Pulses	8.8	7.9	6.8	4.3	3.6	3.9
Total Food grains	88.9	88.6	87.3	42.2	43.9	43.8
Jute	1.8	1.7	1.2	0.8	1.1	1.2
Total Fibres	2.2	2.0	1.5	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	1.5	1.0	1.2	1.0
Sugarcane & Gur	1.3	1.5	3.2	2.1	1.6	3.4
Potato	1.8	1.9	4.2	2.1	2.7	2.4
Fruits & Vegetables	5.1	5.4	6.0	47.5	42.3	42.0
Horticulture	5.2	5.6	6.2	47.7	42.5	42.3
Others	0.3	0.3	0.2	7.0	10.8	9.5
Overall	100.0	100.0	100.0	100.0	100.0	100.0

Source: DES, Ministry of Agriculture and Farmers' Welfare

The importance of paddy among the farmers has come down marginally. This is evident from a decline in its area from 45.3 per cent in the triennium 2002-03 to 43.0 per cent in 2016-17. 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. The decline in area under rabi coarse cereals has been compensated by a rise in wheat area.

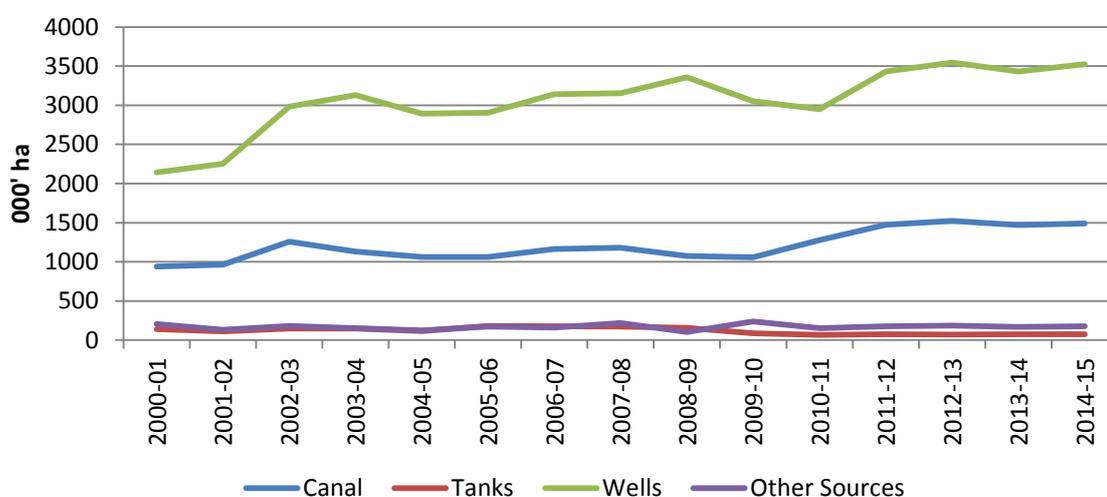
The area under pulses has declined by over 20 per cent between 2002-03 and 2016-17. Green gram (moong), lentil, lathyrus (khesari) and gram are the important pulses grown in Bihar. Despite a significant rise in minimum support prices of pulses in the past few years, the decline in their area and value 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 0.91 lakh hectares between 2002-03 and 2016-17. Lack of a proper policy and institutional support, and weak markets are responsible for the decline in jute cultivation.

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 3.2 per cent between 2002-03 and 2016-17. 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 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 over 40 per cent 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 act as deterrents for increased diversification towards cultivation of fruits and vegetables.

Irrigation plays an important role in rising crop productivity. The state of Bihar has rich groundwater as well as surface water resources. The irrigation water sector faces twin challenges of periodic floods in the northern region and poor groundwater development in the southern region. Despite these challenges, the total area irrigated has increased considerably over time due to concerted efforts by both the state and central government to implement irrigation and flood control programmes. In absolute terms, total irrigated area increased from 34.3 lakh ha in 2000-01 to 52.7 lakh ha in 2014-15 with an average growth rate of 2.4 per cent.

**Figure 3.4: Trend in Sources of Irrigation in Bihar**

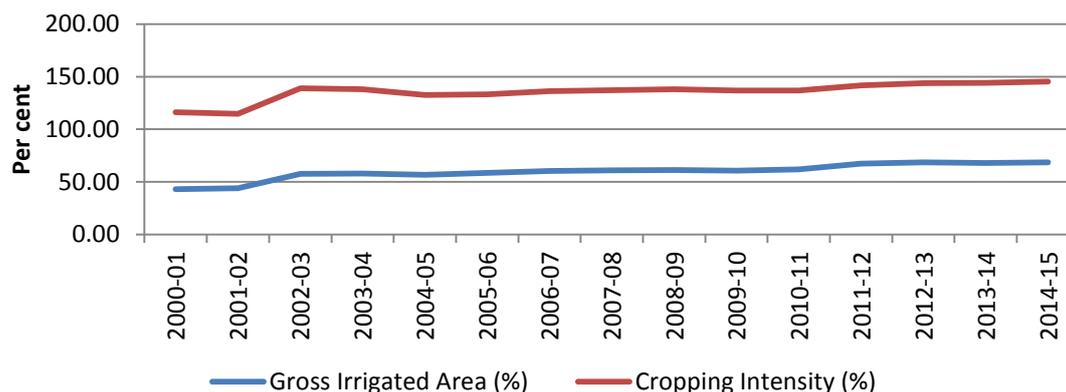


Source: DES, Ministry of Agriculture and Farmers' Welfare

Among the sources of irrigation, the area irrigated through well irrigation has steadily increased over time (Figure 3.4). Tube wells, which constitute most of well irrigation, are powered by diesel engines, but these are more expensive to repair and maintain than electricity-run tube wells. Yet lack of adequate supply of power remains a constraint in expanding the area under groundwater irrigation. Interestingly, the area irrigated through canal water has shown an upward trend, which is highly encouraging. This shows improved efficiency in the utilisation of irrigation potential created by different public irrigation schemes. However, there still exists scope to utilise the potential created by about 15 per cent (Government of Bihar, 2019).

The availability of irrigation facility augments the area under various crops through an increase in cropping intensity. The proportion of gross irrigated area to total cropped area increased remarkably by 26 percentage points between 2000-01 and 2014-15. Gross irrigated area stood at 68.7 per cent during 2014-15. In correspondence with the increase in irrigated area, cropping intensity rose from 116 per cent to 145 per cent. This trend in parallel movement of gross irrigated area and cropping intensity can be seen in Figure 3.5. The correlation between gross irrigated area and cropping intensity stands at 0.97.

**Figure 3.5: Trend in Gross Irrigated Area and Cropping Intensity (%)**



Source: DES, Ministry of Agriculture and Farmers' Welfare

Irrigation acts a catalyst for the adoption of new technologies such as improved crop varieties, fertilisers, crop protection measures and other management techniques. Adoption of these new technologies helps to increase crop output and the income of farmers. The contribution of irrigation to crop output growth depends upon many factors including crop variety, time and method of application, soil characteristics and rainfall. Productivity of irrigation water can be defined as the difference between the growth in crop output and growth in area irrigated. Although it is a partial measure of productivity of irrigation, it throws important insights into the growth pattern in irrigation and response of output growth of different crops.

**Table 3.6: Productivity of Irrigation of Select Crops in Bihar**

Crops	Growth in Gross Irrigated Area	Growth in Crop Output	Irrigation Productivity
<b>Rice</b>			
2000-01 to 2007-08	-0.41	-4.18	-3.77
2008-09 to 2014-15	2.82	7.87	5.06
2000-01 to 2014-15	0.35	1.92	1.58
<b>Wheat</b>			
2000-01 to 2007-08	0.15	-1.59	-1.73
2008-09 to 2014-15	1.11	0.13	-0.97
2000-01 to 2014-15	0.74	1.29	0.55
<b>Maize</b>			
2000-01 to 2007-08	2.10	0.63	-1.47
2008-09 to 2014-15	3.01	8.13	5.12
2000-01 to 2014-15	2.41	3.17	0.76

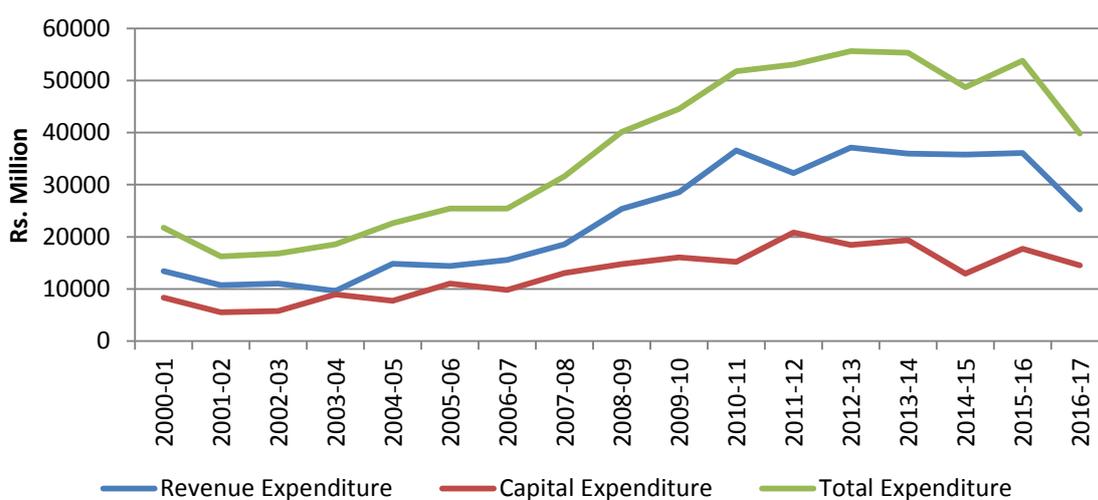
Source: Authors' estimation

It can be seen from Table 3.6 that productivity of irrigation water was negative for rice, wheat and maize during the pre-agriculture road map period. There has been a turnaround in irrigation productivity for rice and maize in the latter period, but it remained negative for wheat. For the overall period of analysis (2000-01 to 2014-15), growth in output was slightly higher than growth in irrigation, which has resulted in positive growth in productivity of irrigation water. Lower values of productivity of irrigation water indicate that there is still a scope for better management of irrigation water.

### 3.4. Government Expenditure on Agriculture and Allied Activities

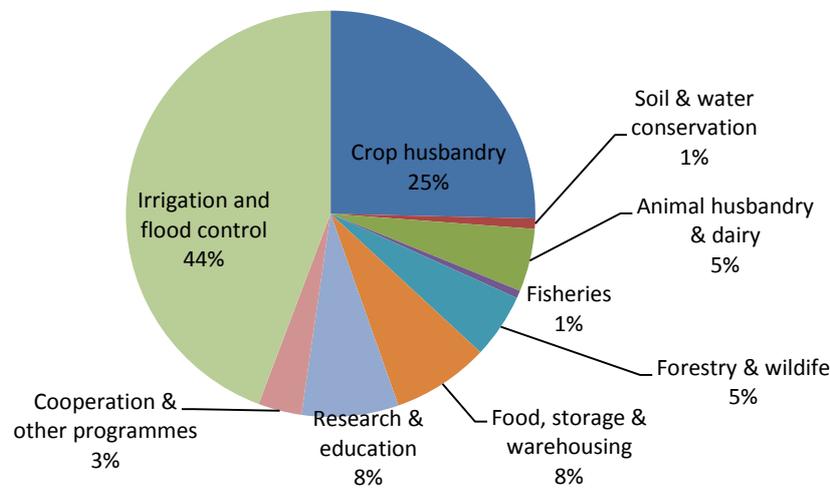
The improved performance of agriculture holds the key to social and economic development of rural people in Bihar. A strong budgetary support is required to revive and sustain the growth momentum in the long run. Although the amount of government spending on agriculture and irrigation has increased in 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.

**Figure 3.6: Government Spending on Agriculture, Irrigation and Flood Control (2011-12 Prices)**



In Bihar, revenue expenditure and capital expenditure in agriculture and irrigation have shown upward trend since 2000-01 (Figure 3.6). But, 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 2016-17. 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 total expenditure will hinder future growth potential.

**Figure 3.7: Composition of Government Expenditure (revenue + capital) on Agriculture and Irrigation: TE 2015-16**



The analysis of composition of government spending in agriculture and irrigation reveals that irrigation and flood control, and crop husbandry accounted for 69 per cent of total expenditure. Within crop husbandry, there is significant rise in capital expenditure on construction of buildings for agricultural office under different plan schemes since 2012-13 (Figure 3.7). The rise in capital expenditure under this heading appears to have reduced considerably the spending on irrigation and flood control. Agricultural research and education, and food, storage and warehousing each accounted for 8.0 per cent of the total expenditure. Animal husbandry and fisheries have received lesser attention with low share of government spending on these sectors.

### 3.5 Changes in Agricultural Production and Income

#### 3.5.1 Growth in Crop Output and Variability

Among food grains, growth in the production of maize was the highest at 4.37 per cent followed by rice (3.78 per cent) and wheat (1.90 per cent) during 2001-02 to 2016-17 (Table 3.7). The higher growth in production of these crops was largely contributed by growth in yield. The average growth in yield of rice was appreciable at 4.40 per cent and for maize it was 3.05 per cent. Despite positive growth in the yields of barley and ragi, negative growth in area led to a fall in their output growth. Among pulses, growth in output was positive for gram and lentil only due to a higher growth in yield over area growth. This was not the case for other pulses. In the case of oilseeds, output growth of rapeseed and mustard was positive at 2.77 per cent, which was mainly contributed by its yield growth. The average growth in production of sugarcane was spectacular at 10.00 per cent and it was largely due to a remarkable growth in its area at 7.85 per cent.

**Table 3.7: Growth Trend in Area, Production and Yield of Field Crops: 2000-01-2016-17 (%)**

<b>Crops</b>	<b>Area</b>	<b>Production</b>	<b>Yield</b>
Rice	-0.59	3.78	4.40
Wheat	0.13	1.90	1.77
Maize	1.28	4.37	3.05
Barley	-5.01	-3.52	1.57
Ragi	-8.50	-5.13	3.69
Total coarse cereals	0.92	4.20	3.26
Total cereals	-0.17	3.14	3.31
Tur	-4.91	-2.05	3.01
Gram	-1.46	0.11	1.59
Urad	-5.55	-3.86	1.79
Horse gram	-4.75	-3.34	1.47
Moong	-1.06	-0.14	0.94
Lentil	-0.91	1.31	2.24
Khesari (Lathyrus)	-6.36	-4.40	2.10
Total pulses	-2.29	-0.64	1.70
Total food grain	-0.36	2.98	3.35
Jute	-3.01	2.32	5.50
Mesta	-0.20	6.55	6.76
Linseed	-5.65	-4.95	0.74
Rapeseed & Mustard	-0.12	2.77	2.90
Sunflower	-1.91	-1.42	0.50
Total oil seeds	-1.42	0.81	2.27
Sugarcane	7.85	10.00	1.99

Source: Authors' compilation from DES, Ministry of Agriculture and Farmers' Welfare.

Area expansion seems to have been limited to a few crops. Except for wheat, maize and sugarcane, growth in area under other crops was negative during 2001-02 to 2016-17. Among crops, the largest reduction in area was observed in ragi, khesari, linseed and urad. The area under coarse cereals and pulses has been replaced by maize to a large extent and wheat to some extent. Sugarcane seems to have replaced the area under oilseeds and other commercial crops in the northern region of Bihar. Overall, it appears that farmers have reallocated cultivable area mostly in favour of commercial crops such as maize and sugarcane.

**Table 3.8: Area under Horticultural Crops (000 ha)**

<b>Crops</b>	<b>TE 2002-03</b>	<b>TE 2007-08</b>	<b>TE 2016-17</b>
Vegetables	288.6	311.5	359.6
Fruits	116.2	104.1	101.7
Fruits & Vegetables	404.8	415.6	461.2
Horticulture	416.6	427.6	474.2

Source: DES, Ministry of Agriculture and Farmers' Welfare

However, area under horticultural crops has expanded rather at a slow pace despite the state having rich natural resources particularly irrigation water and a change in consumption demand

towards to fruits and vegetables. Total area under horticulture has increased only marginally from 0.42 million ha to 0.47 million ha between 2002-03 and 2016-17. Most of this increase in area under horticulture was contributed by vegetables whose area has expanded by about 25 per cent between these periods. Area under fruits has declined overtime.

The growth in area, production and yield of major horticultural crops is given in Table 3.9. For the study period, consistent data on different variables are available only for some important horticultural crops. Except for sweet potato, peas and tobacco, average growth in output of other crops was highly appreciable from 2001-02 to 2016-17. The average growth in production of onions was the highest followed by bananas and potatoes. Both area and yield growth have contributed to the output growth of these crops. Ginger, coriander and garlic are the other important horticultural crops grown in Bihar. Despite negative growth in yield, considerable area growth had led to respectable growth in the output of garlic. Given the suitable agro-climatic conditions, there exists very high potential to promote horticultural crops and help to increase farmers' income.

**Table 3.9: Growth Trend in Area, Production and Yield of Horticulture Crops: 2000-01-2016-17 (%)**

Crops	Area	Production	Yield
Chillies	-1.30	0.52	1.85
Ginger	1.72	2.37	0.64
Turmeric	0.03	0.45	0.42
Coriander	0.39	1.63	1.24
Garlic	5.75	1.30	-4.21
Potatoes	7.34	15.31	7.42
Sweet Potatoes	-12.17	-16.31	-4.72
Bananas	7.40	17.74	9.63
Onions	13.20	23.71	9.28
Peas	-2.40	-1.70	0.71
Tobacco	-2.50	-2.53	-0.02

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

So far the analysis has shown that net sown area has been shrinking over time and farmers reallocate the existing area for growing commercial crops. Therefore, area expansion is unlikely to be the source of output growth. This will be further analysed through decomposition analysis by taking other factors into account. Yield improvements can be an important factor in achieving higher crop production. But higher growth in production is sustainable only when the yield growth shows less instability. Among others, variability in weather, poor crop technology and incidence of pest and diseases cause instability in yield.

The instability index for major field crops is given in Table 3.10. Unfortunately, a higher growth in output has been accompanied by an increase in instability in the production of major crops such as wheat, maize, moong, lentil and sugarcane. Exceptional crops are paddy, khesari, jute, rapeseed and mustard. The yield instability index of these crops has come down between 2001-02 to 2007-08 and 2008-09 to 2016-17. The highest fall in yield instability could be observed for rapeseed and mustard. This could be due to adoption of improved varieties and better management technology in the cultivation practices. Overall, the reduction in yield instability augurs well for sustainable crop production and for ensuring stable income to the farmers.

**Table 3.10: Instability in Area, Production and Yield of Major Crops (%)**

Crop	2001-02 to 2007-08			2008-09 to 2016-17		
	Area	Production	Yield	Area	Production	Yield
Rice	6.08	35.59	30.74	7.77	34.81	28.11
Wheat	2.74	10.87	8.93	4.39	11.91	11.99
Maize	2.81	12.13	13.04	2.88	16.68	17.42
Moong	3.99	13.39	13.24	5.10	15.67	13.67
Masur	4.73	13.15	14.03	16.25	18.95	13.40
Khesari (Lathyrus)	10.41	16.89	16.06	15.55	14.77	13.89
Jute	6.37	11.61	12.02	5.87	10.82	11.71
Rapeseed & mustard seed	3.81	13.23	12.51	4.09	6.14	7.16
Sugarcane	13.69	23.57	11.29	24.71	30.07	9.15

Note: Instability is estimated as the standard deviation of logarithm of  $Y_t/Y_{t-1}$ , where Y is area/production/yield; t is current year and t-1 is previous year.

### 3.5.2 Changes in Cost and Crop Income

The farmers' choice of crops is determined by, among others, profitability, intensity of inputs use, access to markets and availability of finance. 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 cost of production 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 C2) 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, own assets and 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, seed, fertiliser, insecticides, irrigation, interest on working capital, rent paid for leased-in land and owned 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 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 total cropped area as the weight.

Details of average real cost, output and income of major crops are given in Table 3.11. Except for paddy, net income obtained for other crops was positive. There are considerable variations in average value of output and cost among the crops, which affect the level of average income. Within field crops, average net income was relatively high for gram with Rs. 18,730 per hectare and for maize with Rs. 18,286 per hectare. In the case of paddy, the rate of increase in total cost was much

higher than a 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. This could be due to various factors including low market price, poor technology and over-use of inputs.

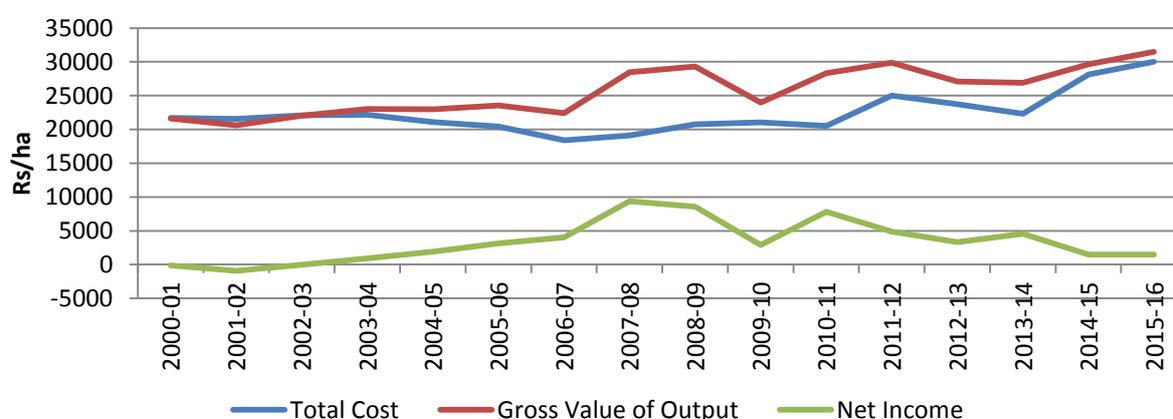
**Table 3.11: Changes in Average Real Cost, Output and Income of Major Crops in Bihar (Rs/ha)**

Particulars	Gross Value of Output		Total Cost		Net Income	
	2000-01 to 2007-08	2008-09 to 2015-16	2000-01 to 2007-08	2008-09 to 2015-16	2000-01 to 2007-08	2008-09 to 2015-16
Maize	36816	45809	24820	27523	11996	18286
Paddy	22863	25661	22994	26432	-131	-771
Gram	31695	39980	17847	21250	13848	18730
Lentil	25754	25857	17221	18245	8533	7612
Wheat	28283	34429	25296	27147	2988	7282
Potato	65939	70840	55696	50262	10242	20579
Overall (weighted)	23091	28315	20807	23935	2284	4381
Coefficient of Variation (%)	10.24	8.21	6.75	14.85	145.88	60.68

Source: CACP, Ministry of Agriculture and Farmers' Welfare

There is considerable improvement in the value of output over total cost cultivation of wheat. This has led to an increase in average net income by 2.5 times between the pre-agriculture road map and the agriculture road map periods. In the case of lentil, average net income has marginally declined. This was because total cost increased more than a proportionate rise in the gross value of output. In contrast, net income from potato cultivation doubled during the study periods with a substantial increase in gross value of output and a marginal decline in total cost. Overall, weighted average income from all the six crops has increased from Rs. 2,284 to Rs. 4,381 per hectare. Importantly, the coefficient variation of net income has declined during the recent period even though it is still high at 60.68 per cent.

**Figure 3.8: Trend in Overall Cost, Output and Crop Income**



Source: CACP, Ministry of Agriculture and Farmers' Welfare

Figure 3.8 shows 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 then declined marginally. 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 total cost over the value output led to negative net income during the initial period. Later, the net income recovered from its negative trend and remained positive. But unfortunately it has been on the downward trend since 2010 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.

**Table 3.12: Annual Growth in Major Inputs Use: 2000-01 to 2015-16**

Particulars	Human Labour	Animal Labour	Machine Labour	Seed	Fertiliser & Manure
Maize	1.97	-53.57	2.28	8.30	3.71
Paddy	2.68	-12.82	2.40	-1.17	5.33
Gram	4.92	-15.45	1.57	0.38	9.41
Lentil	3.73	-1.63	-0.40	-0.29	7.35
Wheat	2.91	-19.15	-0.97	1.88	3.08
Potato	-1.15	-62.41	6.07	-0.06	-2.91

Source: CACP, Ministry of Agriculture and Farmers' Welfare

In this context, it is pertinent to look at the expenses on major inputs use in crop cultivation. There is considerable variation in the use of inputs across crops in Bihar (Table 3.12). Except for potato, average growth in the use of human labour was above 2.0 per cent in crops. This implies that human labour still constitutes an important component of the cost of cultivation despite the policy push towards mechanisation of agricultural operations. In fact, mechanisation is picking up slowly and the use of machines for planting, and harvesting is evident in crops such as potato, maize and paddy. The use of chemical fertilisers and manure has increased considerably in the state. Similarly, the use of insecticides for select crops seems to be picking up for controlling the damage caused by pests and diseases.

### 3.6 Livestock Production

Livestock plays a significant role in improving the livelihoods of the farming community particularly in the dry land areas. Evidence shows that regular income from sale of livestock products such as milk, egg and meat supplements the household income considerably. Increased consumption of livestock products improves household nutrition and labour productivity. Though livestock rearing is considered to be a supplementary activity to crop production, large-scale industrial livestock and poultry production is emerging quite faster in recent decades in response to changes in consumption demand for animal-based products.

There exists a complementary relationship between crop and animal agriculture through the flow of resources between these sectors. Crop agriculture provides fodder and feed to livestock, while animal agriculture supplies dung and draught power to the crop sector. This complementary relationship helps to enhance overall productivity of the farm. Further, the crop-livestock system helps to enhance soil fertility, farmers' income, household nutrition, employment and poverty reduction.

**Table 3.13: Livestock Population and Its Composition**

Particulars	Population (in million)		% share	
	2007	2012	2007	2012
Cattle	12.6	12.2	41.4	37.1
<i>Indigenous</i>	10.6	8.8	84.3	71.6
<i>Crossbred</i>	2.0	3.5	15.7	28.4
Buffaloes	6.7	7.6	22.1	23.0
Sheep	0.2	0.2	0.7	0.7
Goats	10.2	12.2	33.5	36.9
Pigs	0.6	0.6	2.1	2.0
Horses & Ponies	0.1	0.0	0.2	0.1
Other	0.0	0.1	0.1	0.2
Total Livestock	30.3	32.9	100.0	100.0
Total Poultry	11.4	12.7	-	-

*Source:* Computed from Basic Animal Husbandry and Fisheries Statistics, Ministry of Agriculture and Farmers' Welfare, Government of India

Bihar has considerable area under grazing and pasture land to support a vibrant livestock sector. Changes in cropping pattern towards maize and wheat provides adequate fodder and feed concentrates required for growth of the livestock and poultry sectors. Table 3.13 provides trends in livestock population and its compositional changes in Bihar. Total livestock population increased from 30.3 million in 2007 to 32.9 million in 2012 with an addition of about 2.6 million. Annual growth in livestock population was at 1.7 per cent between these periods.

Though the share of cattle population in total livestock has marginally declined, it still dominates the overall livestock population at 37.1 per cent. Within cattle population, indigenous cattle has accounted for over 70 per cent. Interestingly, the number of crossbred cattle increased from 2.0 million to 3.5 million with an annual growth rate of 12.0 per cent between 2007 and 2012. Crossbred cattle are high milk-yielders and the rise in their numbers indicates their increased adoption by farmers.

Similarly, buffaloes are gaining importance for dairying activities among farmers. This is evident from the increase in their population from 6.7 million to 7.6 million with an annual growth of 2.5 per cent. Cattle and buffaloes together constitute about 65 per cent of the total livestock population.

Goats are the second largest constituent of livestock population in Bihar. The goat population increased by 2.0 million between 2007 and 2012 and it accounts for about 36.9 per cent of the total livestock population. The development of poultry farming has been quite appreciable in recent years. The number of poultry birds increased from 11.4 million to 12.7 million between 2007 and 2012. There is huge scope for development of the poultry industry, both layer chickens and broilers, in the state. Increased availability of raw materials such as maize for manufacturing poultry feed can boost the growth of this industry in an organised way.

**Table 3.14: Production of Major Livestock Products**

Year	Milk (million tonnes)	Eggs (in million)	Meat (000 tonnes)	Wool (000 kg)
2009-10	6.12	1100	218.4	260.0
2010-11	6.52	745	222.6	260.1
2011-12	6.64	755	227.8	266.1
2012-13	6.84	837	228.3	267.5
2013-14	7.20	931	292.3	270.6
2014-15	7.77	984	294.3	278.4
2015-16	8.29	1002	301.7	240.2
2016-17	8.71	1112	326.3	280.9
2017-18	9.24	1219	343.0	298.1
Average Annual Growth Rate (%)	5.29	2.41	6.13	2.03

Source: Computed from Basic Animal Husbandry and Fisheries Statistics, Ministry of Agriculture and Farmers' Welfare, Government of India

Production of major livestock products such as milk, egg, meat and wool is given in Table 3.14. Growth in the production of milk and meat was impressive at 5.3 per cent and 6.1 per cent, respectively, from 2009-10 to 2017-18. In absolute terms, milk production increased from 6.12 million tonnes in 2009-10 to 7.20 million tonnes in 2013-14 and then to 9.24 million tonnes in 2017-18. Of the total milk produced, cow milk constitutes about 59 per cent, buffalo milk 39 per cent and the remaining is goat milk.

Egg production has increased consistently since 2010-11. The average annual growth in egg production was 2.41 per cent. Besides the prospects for growing layer chickens, broilers for meat production are likely to gain more importance among farmers and poultry specialists due to increasing consumption demand. In fact, with an impressive growth performance, total meat production increased from 218.4 million tonnes in 2009-10 to 343.0 million tonnes in 2017-18. Poultry meat, goat meat and pig meat constitute about 70 per cent of the total meat produced in the state. Prospects for the growth of the meat sector are also very high. In the case of the performance of the wool sector, wool production has increased consistently over time with average annual growth of 2.0 per cent.

Livestock output is determined by growth in animal population and growth in yield of livestock products. As discussed in the previous section, growth in the population of major livestock species has been positive. Positive growth in the yield of livestock products results in impressive growth in their output. Table 3.15 provides trends in the yield of major livestock products in Bihar. In the case of milk, the average milk yield of crossbred cows was more or less stagnant until 2013-14 and it has slightly increased. A similar trend can be observed in the milk yield of indigenous cattle and buffaloes.

**Table 3.15: Growth in Yield of Major Livestock Products**

Year	Milk Yield (kg/day)			Annual Egg Yield (number/layer)	Annual Meat Yield (kg/animal)				
	Indigenous	Crossbred	Buffaloes	Fowls	Buffalo	Sheep	Goat	Pig	Poultry
2009-10	2.91	6.19	3.92	167.90	62.14	8.28	7.94	26.04	0.66
2010-11	2.85	6.16	3.92	167.70	62.14	8.28	7.75	26.00	0.74
2011-12	2.86	6.10	3.94	168.00	62.00	8.00	8.00	26.00	1.00
2012-13	2.87	6.05	3.95	168.07	62.15	8.38	7.96	25.37	1.30
2013-14	2.94	6.11	3.95	168.13	76.43	8.54	8.72	27.49	0.75
2014-15	3.10	6.49	4.24	169.63	71.08	7.62	9.36	23.31	0.72
2015-16	3.25	6.40	4.27	170.50	73.79	8.13	9.93	24.18	0.77
Annual growth (%)	1.89	0.59	1.47	0.26	3.30	-0.15	3.88	-0.95	6.30

Source: Computed from Basic Animal Husbandry and Fisheries Statistics, Ministry of Agriculture and Farmers' Welfare, Government of India

Average annual growth in egg yield was meagre at 0.26 per cent from 2009-01 to 2015-16. In the case of meat, growth in average annual meat yield was the highest for poultry followed by goat and buffalo. In fact, growth in poultry meat yield was impressive at 6.30 per cent. Trends in the yield of pig meat fluctuated between 23.3 kg/animal and 27.49 kg/animal. Overall, the analysis shows that impressive growth in animal stock as well as yield has resulted in impressive output growth. Economic conditions in terms of raising per capita income, urbanisation and transport network are highly favourable for the growth of the livestock sector in Bihar. The analysis of stakeholder discussions, which will be presented in subsequent chapters, shows that lack of veterinary hospitals and related services are constraints on the growth of this sector. This does not seem to affect the growth of livestock output as of now, but they may pose serious concerns in the long run if these issues are not addressed properly.

### 3.7 Sources of Crop Output Growth

Crop output growth is influenced by many factors including rainfall, soil fertility, modern inputs, improved varieties and crop management practices. Knowledge about the sources of output growth and their contribution is important for formulating appropriate policy interventions to achieve higher growth. Further, the resources at the disposal of different stakeholders are finite and hence proper allocation of resources in various growth-promoting activities needs to be encouraged for achieving higher agricultural productivity.

**Table 3.16: Growth in Crop Output and Average Productivity**

Crop	Growth Rate (%)		Average Productivity (Rs/ha)		
	2000-01 to 2007-08	2008-09 to 2015-16	TE 2002-03	TE 2007-08	TE 2015-16
Paddy	-1.14	5.09	18917	18738	28845
Wheat	3.03	0.54	21712	25042	27780
Jowar	14.40	-9.78	5154	6623	11190
Bajra	30.31	3.68	5285	4590	16892
Barley	-2.80	1.63	10467	11438	17269
Maize	3.15	9.67	20040	22543	37925

**Table 3.16: Growth in Crop Output and Average Productivity**

Crop	Growth Rate (%)		Average Productivity (Rs/ha)		
	2000-01 to 2007-08	2008-09 to 2015-16	TE 2002-03	TE 2007-08	TE 2015-16
Ragi	-9.49	6.15	5989	5648	26251
Gram	-3.77	-1.49	30850	28380	29012
Arhar	-2.33	-1.64	35692	37839	61350
Urad	-2.34	2.49	18673	19573	51120
Moong	-5.18	8.56	19240	14679	28422
Lentil	-3.36	2.17	23637	20916	45629
Khesari	-3.61	-3.57	8571	10723	21953
Linseed	-2.98	-4.85	20975	22160	29553
Rapeseed & Mustard	1.64	6.59	23030	28244	42240
Sugarcane	-5.98	12.12	67171	46052	62226
Jute	5.19	6.32	18647	27144	56707
Mesta	1.69	17.60	16913	23637	56279
Dry Chillies	-5.84	2.98	64516	62692	113205
Dry Ginger	15.03	8.63	35581	53755	76755
Turmeric	8.26	-0.38	40362	58049	71579
Coriander	5.92	3.85	17385	24047	37837
Garlic	2.21	13.06	34030	32096	59532
Potato	4.67	4.93	49578	59720	34586
Sweet Potato	4.97	-18.90	104505	142807	95412
Banana	-6.11	3.35	209949	149166	83153
Onion	11.53	11.68	54167	88663	51379
Overall	-0.69	3.63	51387	57405	86268

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

Growth in output and average land productivity by major crops are provided in Table 3.16. Land productivity is measured as the gross value of output per hectare 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. Garlic and onion registered higher growth in output. Land productivity was the highest for dry chillies followed by sweet potato, banana and dry ginger. For most horticultural crops, 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. 62,226/ha during the triennium 2015-16 with a robust average output growth of 12.12 per cent during the period of agriculture road map. The performance of pulses particularly red gram (arhar), black gram (urad) and lentil has been very impressive. A similar encouraging trend in land productivity is evident among cereals as well. Overall, the aggregate land productivity has improved by one and a half times between 2002-03 and 2015-16 to reach Rs. 51,387/ha. The average growth in output was appreciable at 3.63 per cent. In this context, it is important to analyse the drivers of crop output growth. This will help to identify growth-promoting as well as growth-

inhibiting factors and removal of the latter would put the agricultural sector on a higher growth trajectory.

The sources of crop output growth have been analysed by using the decomposition approach discussed in Chapter 2. The analysis covers 31 crops, which account for about 98 per cent of total cropped area in the state. Data on area, production and yield were compiled from the Directorate of Economics and Statistics, Ministry of Agriculture and Farmers' Welfare. The value of output (2011-12 prices) of different crops was collected from the Central Statistics Office, Government of India. The real farm harvest price has been used for the analysis.

Between 2001-02 and 2007-08, the contribution of price was significantly higher along with diversification (Table 3.17). These effects could not help much in boosting output growth in this period. However, output growth of about 3.6 per cent in 2008-09 to 2016-17 has been bolstered with the impressive contribution of yield effect. The contribution of diversification effect has also improved and has positively influenced output growth. Improvement in diversification effect shows the reallocation of area by farmers from low-productive crops to high-productive crops such as horticultural crops. The contribution of real price and area expansion in the overall output growth was negative in the recent period implying they cease to be a positive factor for growth.

**Table 3.17: Sources of Crop Output Growth**

Particulars	2001-02 to 2007-08	2008-09 to 2016-17	2001-02 to 2016-17
Area effect	-6.9	-7.8	-7.5
Diversification effect	8.1	36.8	26.9
Yield effect	-54.4	210.8	119.3
Price effect	176.1	-77.2	10.2
Interaction effect	-23.0	-62.6	-48.9
Total	100.0	100.0	100.0

Source: Authors' compilation.

In the overall study period, yield effect was dominant, along with positive diversification and price effects. The contribution of price effect to output growth is lower at 10.2 per cent than that of yield effect. Improvement in yield is the sustainable source of output growth in the long term. The negative interaction effect is largely due to a fall in the contribution of area effect to output growth. Diversion of productive agricultural land for non-agricultural uses and increase in fallow land contribute to a fall in cultivated land.

There is considerable variation in sources of output growth for individual crops (Table 3.18). The area effect was negative and it was relatively large for rice and khesari. This implies that the actual area under cultivation of these crops has been kept fallow or it has been diverted for growing other crops. This is, in fact, evident from the value of the diversification effect, which shows reallocation of area between crops. The positive value of diversification effect shows gain in area under a particular crop, while the negative value indicates loss of its area to other crops. It can be seen that there is a large shift in area from urad, khesari, jute, mesta, chillies and banana towards barley, ragi, tur, horse gram, linseed, sugarcane, potato, sweet potato and onion. This implies that coarse cereals, pulses and commercial crops are gaining importance among farmers due to an increase in demand from food processing industries. Besides these crops, the contribution of diversification effect was positive for wheat, maize and gram.

**Table 3.18: Sources of Output Growth by Crops: 2001-02 to 2016-17**

Crop	Area Effect	Diversification Effect	Yield Effect	Price Effect	Interaction Effect
Rice	-17.7	-22.5	165.4	-10.2	-14.9
Wheat	0.7	16.4	70.9	9.0	3.0
Jowar	-0.1	-33.9	37.5	205.4	-108.9
Maize	1.9	27.8	82.6	17.1	-29.4
Bajra	0.0	75.0	4.3	186.8	-166.1
Barley	1.2	242.0	-162.9	-515.8	535.5
Ragi	3.1	1933.0	280.4	-4237.6	2121.1
Tur	2.2	488.8	-211.1	-301.9	122.0
Gram	1.0	54.7	-27.4	-12.2	83.9
Urad	-0.9	-283.9	101.0	350.4	-66.5
Horse Gram	0.6	289.7	-92.8	-177.6	80.1
Moong	-0.3	-6.2	62.3	65.2	-21.0
Masoor	-1.2	2.8	49.7	164.1	-115.4
Khesari (Lathyrus)	-45.8	-3111.4	1188.6	3761.7	-1693.1
Jute	-0.7	-54.3	88.7	77.2	-10.8
Mesta	-0.4	-96.0	70.3	135.0	-8.8
Sanhemp	0.4	43.3	148.5	-1074.3	982.2
Linseed	1.0	244.7	-63.9	-125.5	43.7
Rapeseed & Mustard	-0.4	-35.3	81.1	66.9	-12.3
Sesamum	0.0	-57.2	36.7	109.0	11.4
Sunflower	-0.1	46.0	3.6	267.4	-216.9
Sugarcane	1.9	144.6	29.6	-0.5	-75.5
Chillies	-0.5	-804.6	-15.7	1503.1	-582.3
Dry Ginger	0.0	-29.8	126.1	108.3	-104.5
Turmeric	0.0	51.9	35.1	100.3	-87.2
Coriander	0.0	-5.2	40.5	67.7	-3.0
Garlic	0.0	41.8	-25.4	92.0	-8.4
Potatoes	4.4	191.5	169.7	-136.7	-128.9
Sweet Potato	0.1	101.5	13.0	-35.6	21.1
Banana	-1.9	-869.6	-1972.9	-323.8	3268.2
Onion	0.4	173.3	88.7	12.1	-174.4

Source: Authors' compilation.

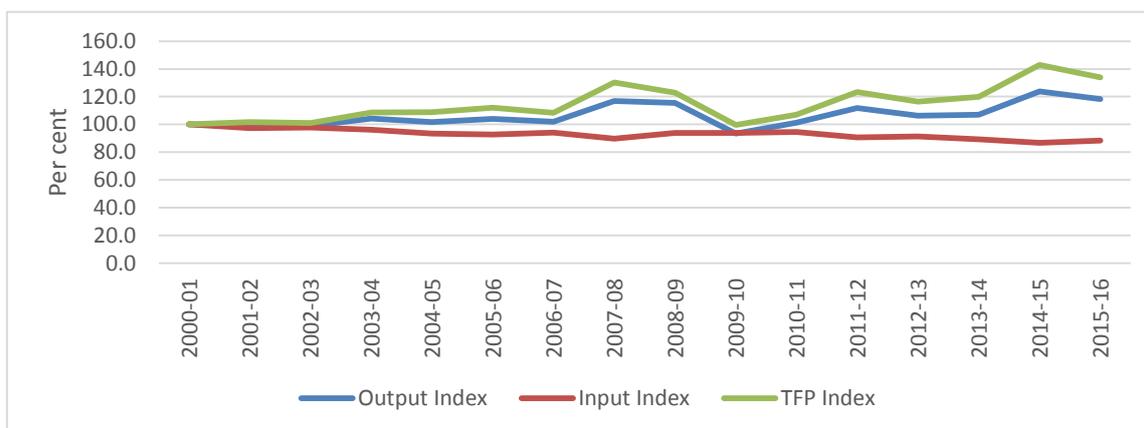
The contribution of yield effect to output growth was relatively high among rice, wheat, maize, ragi, khesari, rapeseed and mustard, potato, ginger and onion. In other crops, there is huge scope for increasing yield, which could be a sustainable source of growth. However, better yield growth alone is not sufficient, and adequate price realisation with proper market linkages is important for encouraging farmers in cultivation. For most crops under consideration, price effect was positive and contributed significantly to output growth. However, negative price effect for a few crops has a depressing effect on output growth. It also affects significantly total income received by the farmers. Overall, yield improvements have largely contributed to crop output growth between 2001-02 and 2016-17. The effect of crop diversification from low-value cereals to high-value commercial crops has been also gaining momentum in recent years.

### 3.8 Drivers of Crop Output Growth

The analysis of sources of output growth revealed that most of the growth in crop output was contributed by yield improvements. Improvements in crop yield can be brought out by the introduction of new technology in the form of improved seeds, increased use of inputs and adoption of better crop management technology. Given the fact that the crop output growth has registered an appreciable growth rate, it is useful to analyse whether input intensification or technological innovation is driving this growth. It is also important to analyse the sustainability of this higher growth in the long run. This section provides further insights into the factors influencing crop output growth.

The resource decomposition method proposed by Fuglie (2012, 2015) enables one 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 total factor productivity (TFP) growth and input growth. Details of this method have already been discussed in Chapter 2. To accomplish the resource decomposition analysis, detailed information about inputs and output are required. The cost of cultivation survey provide this information for six major crops, viz., paddy, wheat, maize, gram, lentil and potato, and the same has been utilised here.

**Figure 3.9: Trend in Output, Input and TFP Index**



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. The aggregate output index has shown a gradual rising trend from 2000-01 to 2006-06 (Figure 3.9). It suddenly increased in subsequent years and then declined in 2009-10. There seems to be 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.

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 overall rise in TFP has led to an increase in the output index.

The relative contribution of various material inputs, labour, TFP and natural resources such as land and irrigation water is given in Table 3.19. Taking all six crops into consideration, the aggregate TFP growth was only 1.71 per cent between 2000-01 and 2015-16. Output growth was about 1.0 per cent, which was mainly contributed by TFP growth. Input growth was negative. 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 38 per cent of output growth, followed by mechanisation with 23 per cent.

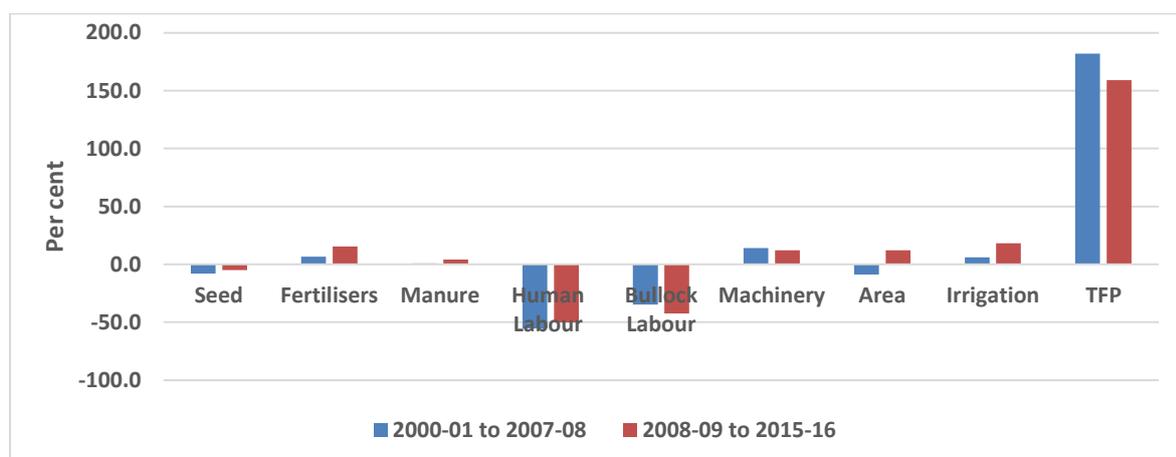
**Table 3.19: Relative Contribution of Input Growth and TFP Growth to Output Growth: 2000-01 to 2015-16**

Crop	Output	Input	TFP	Seed	Fertilisers	Manure	Human Labour	Bullock Labour	Machinery	Area	Irrigation
Maize	0.72	-0.35	1.07	0.00	0.13	0.04	-0.98	-0.64	0.19	0.31	0.34
Paddy	0.76	-1.08	1.85	-0.16	0.15	0.04	-0.78	-0.74	0.19	-	0.30
Gram	1.89	0.75	1.15	0.03	0.27	0.04	0.33	-0.25	0.27	0.74	0.28
Lentil	0.21	-0.18	0.39	-	0.14	0.00	-0.11	-0.22	0.25	0.29	0.00
Wheat	1.35	-0.37	1.72	0.02	0.08	0.01	-0.38	-0.93	0.34	0.05	0.03
Potato	1.60	-1.09	2.69	0.44	-0.27	-0.31	-1.52	-0.63	0.06	1.25	0.08
All Crops	0.99	-0.72	1.71	0.10	0.12	0.05	-0.68	-0.61	0.23	0.08	0.38

Source: Authors' compilation.

Looking at the relative contribution of inputs and TFP to output growth in different periods, the contribution of TFP stands out clearly (Figure 3.10). 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. But their effect 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.

**Figure 3.10: Contribution of Input Growth and TFP Growth by Different Periods**



The contribution of various inputs and technological change to output growth is varied across crops. Output growth was relatively high for gram and potato with 1.89 per cent and 1.60 per cent, respectively (Table 3.19). Both TFP growth and input growth are responsible for output growth in gram, while TFP growth alone has contributed significantly to output growth in potato. The TFP growth was appreciable at 1.85 per cent in paddy and 1.72 per cent in wheat during the study period. Input growth for these crops was negative.

As evident from the previous 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 seed 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 slightly impressive, low input intensification is a concern and affects yield growth.

### 3.9 Summing Up

Despite registering higher economic growth, Bihar still remains at the bottom of economic growth among the states. Agriculture holds the key to the overall development of the Bihar economy. Agriculture roadmaps implemented in different phases since 2008-09 intend to create holistic development of agriculture with an emphasis on increasing productivity growth and improving farmers' income. As anticipated, the agriculture sector has seen a turnaround in its performance, registering a positive growth rate during recent years.

During the period of the first agriculture road map, the growth rate accelerated to 3.1 per cent, which did not sustain in the second period. Within the crop sector, horticulture has registered a relatively low average growth rate between 2000-01 and 2015-16. Livestock rearing has emerged as an important activity, accounting for about 34 per cent of total output with average growth rate

of over 6.0 per cent. Within the crop sector, there is reallocation in area from low-value cereals and oilseeds to high-value commercial crops such as maize, sugarcane and vegetables.

Among the sources of output growth, yield improvements have largely contributed to crop output growth between 2001-02 and 2016-17. The contribution of crop diversification on crop output growth is positive. Simultaneously, there has been a rise in TFP growth. The output growth led by improvement in TFP is sustainable in the long run since output growth is largely caused by the technical progress. However, accelerating further yield growth is concomitant with an increase in certain level of input use as most crop varieties are sensitive to external inputs. In sum, low input intensification seems to have affected the level of crop yield.

# Chapter 4 Identifying Binding Constraints on Agriculture in Bihar

## 4.1 Introduction

Analysis has shown that Bihar's agricultural growth was lower at 2.04 per cent than the all India average growth of 3.12 per cent during the period 2001-02 to 2016-17. This has happened despite a stable political environment, improvement in investment on rural infrastructure, policy initiatives under agriculture road maps and reforms in agricultural marketing. Crop output growth is determined by four factors viz., area effect, yield effect, price effect and diversification effect. Among these growth drivers, contribution of yield improvement to output growth was dominant, along with positive diversification and price effects. The contribution of price effect to output growth is lower at 10.2 per cent than that of yield effect. In order to examine the low growth syndrome and examine the distortions associated with these growth drivers, we have undertaken a growth diagnostics analysis on the revenue and the cost side to identify the factors that could influence both farm income and input costs associated with pattern of inputs use.

This chapter seeks to identify the binding constraints following the methodology outlined in Chapter 2. The plan of the chapter is as follows. Section 1 first attempts to identify the factors responsible for lower agricultural growth in Bihar. The subsequent section attempts to identify the binding constraints following the methodology adopted by us. Our analysis suggests that there are two principal binding constraints. In Section 3, we have continued our analysis of growth diagnostics at the district level to draw policy lessons.

## 4.2 Factors Causing Lower Agricultural Growth in Bihar (Growth Hypotheses)

The analysis in the earlier chapter has shown that Bihar's agricultural growth was lower at 2.04 per cent than the all-India average growth of 3.12 per cent between 2001-02 and 2016-17. The government of Bihar has taken several initiatives to accelerate agricultural growth as envisaged in agriculture road maps by enhancing investment in rural infrastructure and agricultural research, modernisation of value chains, improvement in access to credit and markets, natural resources management, flood and drought protection and access to modern technologies. Besides, the central government has been providing financial assistance to implement various agricultural development programmes in the state. Some of the centrally sponsored programmes include Rashtriya Krishi Vikas Yojana, National Mission on Oilseeds, National Horticulture Mission and Pradhanmantri Krishi Sinchayee Yojna. Despite all these initiatives, Bihar's agricultural growth has remained low and year-over-year growth is found to be highly volatile. Further, annual agricultural growth has shown a decelerating trend since 2012-13. All this has happened in spite of a stable political environment, improvement in investment on rural infrastructure and reforms in agricultural marketing.

What explains this lower agricultural growth in Bihar? Growth diagnostic analysis begins with identification of the determinants of agricultural growth and examines how these determinants characterise the agriculture sector in the state of Bihar. It is surmised that an average farmer would attempt to maximise revenue from the cultivation of crops in a given piece of land. This is

important because the market orientation of farmers has increased with a rise in the amount of crop outputs sold and inputs purchased. Under this situation, farmers would tend to maximize the value of crop output (farm income) and minimise the input costs by adopting various output-enhancing and cost-saving technologies. The framework of growth diagnostics strives to identify the factors that influence both farm income and input costs associated with the pattern of input use.

To recapitulate, the present study employs the Minot-Hausmann hybrid framework to analyse the proximate determinants of value of farm output and input costs. First, to deal with farm output, according to Minot and others, growth in farm output is determined by four factors viz., area effect, yield effect, price effect and diversification effect. Now the question is: Can the poor performance of agriculture in Bihar be explained by decline in agricultural land, low crop yield, low output price and low level of crop diversification? It is useful to examine the how each of these factors can be responsible for low growth in agriculture.

With respect to agricultural land, Bihar has highly fertile alluvial soil and most of the cultivated land falls in the Gangetic plain. There is increased competition for land between agricultural and non-agricultural uses. The rising population density and urbanisation seem to put pressure on the existing stock of agricultural land. These factors tend to divert the agricultural land for non-agricultural uses such as residential plots and industrial buildings. However, proportion of non-agricultural land to total land area remained constant in Bihar (Table 4.1). But the area under agricultural land has marginally declined in recent years. The land use patterns in Bihar are not dissimilar to the trend observed at the national level.

**Table 4.1: Ratio of Agricultural Land and Non-agricultural Land in Total Reported Area**

Year	Bihar		India	
	AL/Total Area	NAL/Total Area	AL/Total Area	NAL/Total Area
TE 2002-03	0.68	0.18	0.55	0.08
TE 2007-08	0.68	0.18	0.54	0.08
TE 2014-15	0.67	0.18	0.54	0.09

*Note:* AL-Agricultural land; NAL-Non-agricultural land; Agricultural land includes net sown area and fallow land

*Source:* Computed from DES, Government of India

Further, analysis of sources of output growth showed that overall area effect was negative and there was significant variation across the crops. For a few cereals such as wheat, maize and barley, and pulses, sugarcane and vegetables, area expansion contributed only marginally to output growth. With near stagnation or fall in net sown area, the area gain for these crops has happened through reallocation of existing amount of land by the farmers. There is no scope for further expansion of cultivated land. However, one important problem that Bihar agriculture faces is fragmented landholdings. But this cannot be the source of low agricultural growth. Therefore, it is clear that agricultural land is unlikely to be a causal factor for the poor performance of agriculture in Bihar.

Can low yield of major crops be the reason for lower agricultural growth? Given the fact that there is little scope for further expansion of the area under cultivation, productivity of crops determines the level of production. Many factors affect yield growth. If low yield is a problem, one would expect low level of technological breakthrough or innovation and limited use of material inputs that are

essential for achieving a certain level of yield. Technological change in agriculture is generally analysed through changes in total factor productivity (TFP). TFP measures growth in output which is not accounted for in growth in inputs. Residual growth, net of input growth from output growth, is considered to be the measure of technological progress. A lower TFP growth, keeping the effects of material inputs constant, would indicate lower yield growth and consequently results in lower output growth.

The analysis of TFP growth presented in an earlier chapter has clearly shown that technological progress has taken place in the crop sector of Bihar. The average annual growth in TFP was 1.71 per cent between 2000-01 and 2015-16. This is very much comparable with TFP growth of agriculture at the national level. This implies that Bihar agriculture tends to catch up with technological progress at the national level. In fact, the average TFP growth in India's agriculture was estimated at only 1.6 per cent during the same period (Fuglie, 2018). Therefore, it is clear that slow or lack of technological progress is not the basic reason for the poor performance of Bihar agriculture.

**Table 4.2: Yield of Major Crops in Bihar and India (ton/ha)**

Particulars	Bihar			India		
	TE 2002-03	TE 2007-08	TE 2016-17	TE 2002-03	TE 2007-08	TE 2016-17
Rice	1.46	1.27	2.17	1.91	2.15	2.40
Wheat	2.04	1.86	2.17	2.69	2.71	2.92
Maize	2.38	2.35	3.54	1.83	2.06	2.61
Green gram	0.59	0.59	0.62	0.33	0.35	0.46
Lentil	0.88	0.73	0.95	0.64	0.62	0.74
Rapeseed & Mustard	0.80	0.97	1.11	0.93	1.07	1.14

Source: DES, Government of India

A comparison of actual yield of major crops in Bihar with crop yield at the national level also reveals a similar picture (Table 4.2). 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 trend growth of about 4.40 per cent in rice and 1.77 per cent in wheat between 2000-01 and 2016-17, the yield of these crops will certainly surpass the national average in the short run. The yield of other crops such as maize, green gram, lentil, and rapeseed and mustard in Bihar was well above the average yield obtained at the national level. This evidence further establishes that there has been an improvement in crop yield over time and hence low yield cannot be the reason for poor agricultural growth.

The market prices of different agricultural commodities provide signals to farmers to make decisions on area allocation, type of crops to be grown, investment in technology and so on. Agricultural markets have long been regulated and controlled by the government-run agricultural produce market committees (APMCs). Agricultural markets come under the purview of state governments and they formulate policies to govern these markets to ensure fair market forces, transparency in transactions and provision of the necessary infrastructure. However, effective functioning of APMCs in ensuring an efficient price discovery of markets has always been questioned for various reasons. Some well-documented problems affecting the working of APMCs included collusion of traders, malpractices in transactions, high market fees, poor infrastructure,

diversion of market fees for development works other than markets and lack of competition (Acharya, 2004).

Many reforms were introduced to strengthen competition in agricultural markets and ensure better price for farmers through legislative measures. For instance, the Model Act on the State Agricultural Produce Marketing (Development & Regulation Act 2003) contained far-reaching reforms, among others, to provide a level playing field for farmers, rationalise the structure of market fees and encourage private investment to create the necessary infrastructure. Most state governments amended their Acts to incorporate these suggested provisions of the Model Act. However, the government of Bihar took a decision to repeal the APMC Act itself in 2006. Now, traders are allowed to purchase agricultural commodities directly from farmers and the market fee is not levied on purchases.

Did these reforms improve price efficiency in the agricultural markets of Bihar? Is low price realisation of agricultural products a reason for the poor performance of agriculture in Bihar? The analysis of sources of crop output growth presented in the previous chapter has shown that contribution of prices to output growth was as low as 10.2 per cent from 2001-02 to 2016-17. But analysis by sub-periods has revealed that the price effect was negative in the recent period. It could be due to instability in prices, which could potentially affect the overall output growth through low investment in improved inputs and low adoption of better technology.

With the abolition of the APMC Act, one would expect that grain markets in Bihar are integrated within the state of Bihar and also with national markets. Farmers are free to sell to traders in any part of Bihar and elsewhere in the country. This would imply that there is effective price transmission between the grain markets within the state and hence better price received by farmers. Further, this will also imply that volatility in grain prices will be low with better flow of information about the supply and demand conditions across markets.

**Table 4.3: Average Wholesale Price before and after Repeal of the APMC Act**

Commodity	Before Repeal (2002-06)		After Repeal (2007-16)	
	Average Price (Rs/ton)	Coefficient of Variation (%)	Average Price (Rs/ton)	Coefficient of Variation (%)
Paddy	511	11.0	1154	27.7
Wheat	771	12.2	1279	14.1
Maize	600	11.2	1084	24.9

Source: Computed from agmarknet.gov.in, Government of India

The average price of major crops such as paddy, wheat and maize has increased in the post-market reforms period compared to the pre-reform period (Table 4.3). The average price of paddy has increased by 126 per cent, wheat by 66 per cent and maize by 81 per cent. However, volatility in grain prices has increased, which is evident from the increase in the value of coefficient of variation. Although average price received by the farmers has increased over time, increase in volatility of prices affects the stability of farmers' income. Instability in prices of agricultural produce also affects the farmers' decision to allocate area under different crops and adopt improved cultivation practices. Therefore, instability in the prices of agricultural commodities could be a reason for the lower agricultural growth in Bihar.

In the Minot-Hausmann hybrid framework, crop diversification is another important element contributing to output growth. Given the fixed amount of land, farmers diversify cropping patterns for various reasons including market demand for certain commodities, to augment farm income, as a mechanism to mitigate price risk and to enrich soil fertility. Among them, changes in consumption demand of the Indian population and the response of the agricultural production system to meet this rising consumption demand seem to be plausible reasons for changes in cropping patterns during recent decades. The evidence shows that per capita consumption of cereals has declined, while the consumption of fruits, vegetables, and animal-based products has increased over time. However, farmers' decision to diversify from cereals to horticultural crops is largely determined by the relative profitability of different crops and the availability of secured marketing arrangements.

Can a low level of crop diversification be the reason for low output growth in Bihar? Analysis of the sources of output growth has shown that crop diversification has contributed over a quarter of output growth in the past one and half decades. Importantly, the effect of crop diversification on output growth has improved considerably during recent years. However, looking at the relative share of crop area gives an impression that the level of crop diversification is very low. In fact, just three crops, viz., paddy, wheat and maize, dominate the cropping pattern, occupying about 80 per cent of total cropped area during 2016-17. The share of area under fruits and vegetables was only about 6.0 per cent, but their contribution to agricultural output was 42 per cent.

Is there scope for the state of Bihar to go for greater diversification towards high-value horticultural crops? Among others, two important factors--level of productivity and market linkages--determine the degree of crop diversification. Interestingly, land productivity is much higher for horticultural crops than for field crops. For instance, land productivity was as high as Rs. 113,205/ha for dry chillies, while among cereals, it was the maximum at Rs. 37,925/ha for maize.

**Table 4.4: Comparative Advantage in Growing Horticultural Crops in Bihar**

<b>Particulars</b>	<b>2013-14</b>	<b>2014-15</b>	<b>2015-16</b>
Fruits	0.88	0.98	1.01
Vegetables	1.82	1.76	1.72
Flowers	0.07	0.11	0.08
Aromatic & medicinal plants	0.20	0.12	0.01
Spices	0.09	0.08	0.10

*Source:* Computed from DES, Government of India

To assess the comparative advantage in growing horticultural crops in the state of Bihar, an index of relative importance has been developed. This comparative advantage index is defined as the ratio of share of area a crop in Bihar to share of area of that particular crop in the country as a whole. The total horticultural area was used as the base value for working out the share. An index value of greater than one for a particular crop/group indicates comparative advantage in growing that crop in Bihar.

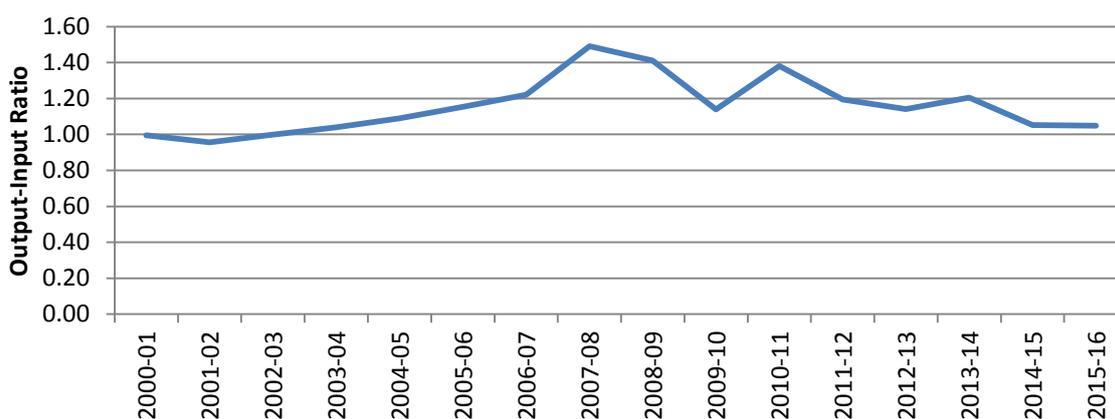
It can be seen from Table 4.4 that Bihar has a very high relative advantage in growing vegetables. But, the value of the comparative advantage index for vegetables has declined from 1.82 in 2013-14 to 1.72 in 2015-16. There is some improvement in relative advantage in the cultivation of fruits during the recent year. Even though Bihar has rich alluvial soil, groundwater and favourable

climatic conditions, the relative importance of horticultural crops is found to be low. Therefore, a low level of crop diversification can be another reason for poor agricultural growth in Bihar.

An important feature of the Minot-Hausmann hybrid framework is that it takes into account the input side of total revenue. This is important because farmers maximise their income by either enhancing the value of output or reducing the cost of inputs. Expenses on inputs can be reduced through the use of the required quantity of inputs, timely application, proper method of application and effective bargaining in the input markets. The agriculture road maps implemented since 2008 have focused on the distribution of material inputs such as seed, fertilisers, machinery and credit to farmers. Mechanisation of agricultural operations has been progressing faster in response to rising wages and shortage of agricultural labourers.

Can rising input costs be the reason for the lower output growth in Bihar? Increase in cost of inputs leads to reduction in profitability of crop cultivation. Low profitability affects the decision of the farmers to invest in productivity-enhancing inputs such as irrigation, improved seeds and fertilisers. Low farm investment as a consequence of low profitability further leads to reduction in both the quantity as well as quality of products produced. This also in a way affects the farmers' motive to diversify the cropping pattern and adopt new technological practices.

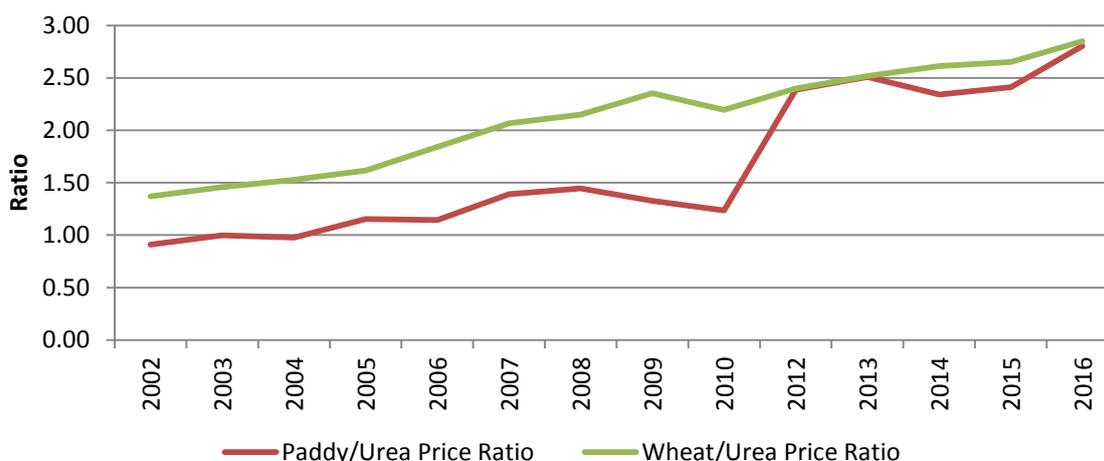
**Figure 4.1: Ratio of Gross Value of Output to Total Input Costs**



Source: Computed based on CACP data

However, aggregate output to inputs ratio reveals that the value of output was much higher than total input costs (Figure 4.1). The ratio of value of output over inputs showed an increasing trend until 2007-08 and thereafter it started fluctuating with a declining trend. The ratio has remained above 1, indicating that proportionate increase in output is higher than total inputs, though it has weakened during recent years. This also implies that profitability in crop cultivation has declined.

**Figure 4.2: Grain to Fertiliser Price Ratio**



The use of purchased inputs in the cultivation of crops has increased over time. With adequate availability of irrigation, farmers apply external inputs such as fertilisers and pesticides to attain higher yield. The ruling crop varieties are, in fact, responsive to application of these inputs for producing their potential yield. However, use of these purchased inputs entail access to finance and availability of quality inputs on time. Since it is difficult to analyse the price of all the individual inputs, ratio of fertiliser price (urea) to grain price is analysed here to know if input costs affect the growth performance. It can be seen from Figure 4.2 that the ratio of wholesale price of wheat to urea price was more than 1 throughout the study period. A similar trend could also be observed in the relation of paddy price to urea price. This indicates that grain price was higher than the fertiliser price. This corroborates the earlier finding that output value has proportionately risen more than the input costs. Further, the analysis of drivers of output growth presented in the earlier section has clearly shown that input intensification in Bihar agriculture is low. These findings show that rising input costs cannot be the reason for lower agricultural growth in Bihar.

It is clear from the above discussion that poor functioning of agricultural markets indicated by instability in the prices of agricultural products and the low level of crop diversification are the reasons for slow or lower agricultural growth in Bihar. Now it is important to explain why the state of Bihar is constrained in agricultural markets and crop diversification. Relaxing the constraints on agricultural markets and the drive towards crop diversification would lead to higher growth in Bihar agriculture.

### **4.3 Identifying Binding Constraints**

#### **4.3.1 Explaining Constraints on Agricultural Markets**

After the APMC Act was abolished in 2006, it was expected that private investment would take place in creating new markets and strengthening facilities in the existing markets. On the contrary, the situation at the ground level has not improved. Market density remained low; in other words, a particular market serving a number of villages was very high. Further, the participation of government agencies in procurement and the scale of procurement of grains seems to be low. Under these situations, farmers are left to the mercy of traders who unscrupulously fix a lower

price for agricultural produce that they buy from farmers. Inadequate market facilities and institutional arrangements are responsible for low price realisation and instability in prices.

Results from the focus group discussion (FGD) with farmers and traders throw useful insights into the marketing problems in Bihar. Farmers in all the surveyed villages reported that the grain and vegetable/fruit markets are located far from the villages. Reportedly, there were no storage facilities available in the villages. A private warehouse facility is available about 30 km from the select villages. This warehouse serves many nearby villages, but its capacity is very low. It has also been reported that the storage cost in private warehouses is very high and it is difficult for most farmers, particularly marginal and small farmers, to afford such a high cost. However, large landholders-cum-traders could avail of the warehouse facility.

Over 90 per cent of the output of crops including paddy, wheat, maize, lentil, gram, mustard and banana is sold within the village to traders and commission agents. Farmers reported that they do not get a fair price for their agricultural produce. Most farmers reported that their poor economic conditions and the need for immediate cash after harvest compel them to sell at a lower price to traders. Further, government market facilities are not available near the village. Even if farmers take their produce to a distant market yard, they face the problem of paying extra (bribe) to commission agents. Farmers also cannot store produce at their household due to lack of space and the necessary storage conditions to avoid spoilage of grains. Therefore, they are forced to sell at whatever the price the traders are willing to offer.

With respect to procurement of food grains in Bihar, Primary Agriculture Cooperative Societies (PACS) are entrusted with procurement of grains particularly paddy and wheat from the farmers at the government-announced minimum support price (MSP). Ground-level evidence through discussion with farmers shows that the procurement operation is limited to a certain amount and time, and these restrictions are considered to be highly arbitrary. Further, PACS do not procure wheat at a time, which otherwise it should, when there is a glut in the market and consequently farmers get lower price. Unfortunately, even at PACS, farmers reportedly received a price much lower than the MSP and payments are not made in time after selling their produce at PACS. Farmers mentioned that non-availability of a fair price is the most important constraint in expanding agricultural output.

#### **4.3.2 Explaining the Low Level of Crop Diversification**

Although crop diversification acts as a cushion against unforeseen climatic events, it also entails investment in new technology and institutional and marketing arrangements. Evidence shows that crop diversification has the potential to increase farm income and reduce poverty. So the question is what constraints keep crop diversification at a low level in Bihar at present. One of the nodes shown in the growth framework under crop diversification pertains to poor institutional arrangements particularly in weak market linkages and ineffective producer organisations. Constraints related to crop diversification can be better understood from the perspectives of different stakeholders as discussed below.

The government of Bihar with support from the central government has launched an initiative to establish Farmer Producer Organisations (FPOs) in different parts of the state. Under FPOs, farmers are organised to market their products successfully to reap the benefit of economies of scale. FPOs enable farmers to innovate, diversify and adopt new agricultural practices to produce

better quality products as demanded by the market. FPO is a potential medium to diversify crop production activities since the marketing activities are collectively taken care of by the organisation. So what constrains the effective functioning of FPOs such that it would lead to profitable crop diversification?

Survey results showed that farmers were aware of FPOs in some villages, but they have not come together to constitute an FPO. In a few villages, FPOs were registered, but found to be non-functional. Most farmers were optimistic that FPOs can play a role in reducing the current problems in marketing of agricultural produce. The lack of such organisational set-up on the ground is a constraint on obtaining a better price through collective bargaining. Since traditional crops such as rice, wheat and maize have, by and large, secured markets, area diversion for growing of new crops comes with some risks for farmers. This is particularly true in the case of vegetables whose prices fluctuate often due to demand and supply gaps. So, lack of collective marketing through FPOs demotivates farmers from going in for a profitable crop diversification.

Similarly, farmers in some villages mentioned that they were aware of contract farming. But the practice of contract farming was not reported in any of the surveyed villages. The lack of a proper policy and suitable legislative measures to promote contracting arrangements in the state could be responsible for agro-business firms not showing an interest in contract farming in Bihar. Most farmers in the surveyed villages said that contract farming could be an important avenue to overcome marketing problems. In fact, contract farming comes with a secured market for the sale of products, a pre-determined price, technical information and inputs supply. The absence of such arrangements is an important constraint for the diversification of crop area. Overall, it emerges that lack of proper institutional and marketing arrangements are responsible for low crop diversification in the state of Bihar.

#### **4.4 Growth Diagnostics at the District Level**

This section summarises the diagnostics on unravelling the growth constraints in agriculture. Removing these constraints through targeted policy reforms would unleash the growth potential in the sector. Relevant information pertaining to different aspects of growth drives and diagnostics signals were compiled through focus group discussions (FGDs) with farmers in 24 villages (three villages in eight districts) in Bihar. These districts represent different agro-climatic conditions and geographical regions of the state. Summary statistics on important variables representing different growth drivers are presented in Annex Tables (A1-A15).

Broadly speaking, the perception that one gets from the farmers from the FGD is that agriculture is no more their primary source of income. Of course small size of land holdings and decrease in profitability from cultivation are identified as two most important factors.

There is unanimous view that there is a rise in input cost relative to the sale price of crops. On the input side, the electrification of farm land has not taken off resulting in farmer using diesel farm set for irrigation purpose, which increase their production cost. The twin factors -lack of irrigation facility and shortage of labour – have resulted in increase of fallow land in the villages where we have undertaken FGDs. To some extent, there has been attempt to complement shortage of labour by use of agricultural implements. But, farmers in Bihar have not able to do same on a large scale due to poor economic conditions. There has been attempt on the part of the government to provide subsidy to purchase farm implements. The outcome has not been too rosy. The absence of land

possession certificate, corruption in the process to avail same denies the farmers to avail benefit from this scheme.

There have increase in use of certified seeds and fertiliser for higher yield. But, farmers have opined that the qualities of seed or fertiliser are not up to the mark, and there is large scale sale of duplicate products under the certified brands. There is general anguish against government's inaction on this front. Most of the farmers rely on informal money markets for credit in cultivation as they are denied loan from formal markets due to absence of land possession certificate. They have opined that corruption is a major constraint for availing loan from the institutional sources as bank officials typically demands a certain percentage of loans as commission from the farmers to sanction the loan. On top of it, lingering loan process, lengthy documentation are major bottlenecks for less educated farmers.

The low price realisation by farmers is a real issue in Bihar. Most of the farmers sell their produce within their village to the trader/commission agent at low price. The lack of storage facility in the sample villages or in nearby block level imply they have no option but to dispose their produce at low price. There exist some private storage facilities at nearby urban area. But these are commercially operated and give priority to traders and not farmers. Thus, the farmers have to dispose their produce at low price.

The summary of district-wise constraints identified is presented here.

#### **4.4.1 Bhagalpur District**

##### **General Profile**

In Bhagalpur district, three villages viz., Amba, Bhuriya and Kumadpur were selected for the survey. In Amba, the number of tenants was relatively high and the area under tenancy was also higher than in other villages. The dominant mode of tenancy in all three villages was share cropping and fixed rent. The per cent area irrigated ranged from 45 per cent to 100 per cent and groundwater is the major source of irrigation. The use of tractors in the sample villages was found to be low.

There was no banking facility available in these villages. The maximum distance people of Amba village have to travel for a banking facility is 4 km, for people for Kumadpur it is 3 km and it is only 1 km for Bhuriya villagers. In the case of markets, the nearest grain and vegetable/fruit market is 40km for both Amba and Bhuriya village, while for Kumadpur it is located at a distance of 10 km. There is no cold storage/ warehousing facility available in the villages. There is a private storage/ warehouse facility available outside the village called Bhagalpur and Kahalgaon. The Bhagalpur storage facility is the nearest for Amba and Kumadpur at 40 km and 35 km, respectively, but the storage facility is not enough. The nearest storage facility for Bhuriya village is located at a distance of 25 km at Kahalgaon, and it has reportedly enough storage facility. All the villages are connected with pucca roads and there is also adequate transport facility for goods.

##### **Land Use Constraints**

Major crops grown in in the sample villages were paddy, red gram and maize in kharif season and wheat, gram, maize, mustard, lentil and khesari in rabi season. Sugarcane and banana have also been grown in these villages. Farmers reported that they do not effectively use all agricultural land for cultivation for various reasons, such as shortage of agricultural labour, lack of irrigation facility, low and irregular rainfall, non-availability of seeds in time and non-availability of tractor for

ploughing. Notwithstanding these problems, there was an overall increase in cropping intensity in the past five years.

The small size of landholdings/scale of farming is a constraint on improving income from cultivation. Due to small and scattered landholdings, farmers incur high input cost, face problem in operating agricultural equipment, in availing of loan and irrigation facilities and transporting crops from the field to the market. Farmers reported that land consolidation based on quality and cost of land may be good solution to overcome the scale problem. But it is not easy because farmers have different opinions and there is no consensus. However, they prefer to adopt cooperative farming as a system of cultivation.

Farmers have some teething issues with respect to legal issues on land and that seems to affect investment in agriculture. Land Possession Certificate (LPC) is not issued due to lack of a land title, which means that farmers cannot get an agricultural loan. Mutation is a major problem due to non-cooperation and demands for bribes by the revenue department, and online mutation is unavailable.

### **Technology-Related Constraints**

Adoption of improved crop varieties was common in the selected villages. Almost all the farmers in these villages use modern varieties. The average yield of maize was 18.6 quintal/acre and in paddy it was 16 quintal/acre. Some farmers reported a decline in the yield of major crops in the past 10 years, which they attribute to low irrigation facility and non-availability of organic manure.

In this context, farmers showed interest in experimenting with new technology to improve the yield level. But some farmers still would like to continue with the current technology because of constraints related to the new technology. These constraints include lack of guidance about new technological aspects, non-availability of cold storage, lack of agro-processing centres and the high cost of modern technologies.

### **Constraints Related to the Market and Institutions**

Output of crops such as paddy, wheat, maize, lentil, gram, mustard and banana are sold within the village to traders and commission agents in almost all villages. Farmers reported that a fair price for their agricultural produce is not available. This is stated to be the most important obstacle in expanding agricultural output. The constraints are non-availability of government markets in nearby villages and the problem of bribes and commissions persisting in the market. Due to their poor economic condition and their need for cash, they sell their produce at a very low price to traders. There is a storage problem as well.

Farmers in Bhuriya village are not aware of contract farming. In Amba and Kumadpur village, farmers knew about contract farming, but they did not practice it in the village. Similarly, farmers are aware of Farmer Producer Organisations (FPOs) except in Bhuriya village, but they have not formed an FPO. Farmers in Kumadpur think that FPO is an important option to overcome the marketing problem.

### **Constraints Related to Inputs Supply**

Over 100 per cent of farmers in Amba and Kumadpur villages and 95 per cent in Bhuriya village used purchased/certified paddy seeds. They are generally bought from a private dealer and the price varies from village to village. Depending on the variety, the price ranges from Rs. 40/kg to 80/kg. In the case of wheat, 100 per cent of farmers in Amba, 50 per cent in Bhuriya and 90 per cent in Kumadpur use purchased/ certified seeds from private input dealers. The price of seed ranged from Rs. 45/kg to Rs. 70/kg. A similar pattern with respect to the use of certified seeds and price variations could be observed in other important crops such as maize, green gram, red gram, gram and mustard. In the case of lentil and khesari, farmers mostly used their farm-saved seeds.

Generally, farmers were not fully satisfied with the quality of seeds supplied by the private input dealers. They reported germination problems in the seeds. The price of seeds is also stated to be considerably higher.

For fertilisers, farmers in Bhuriya and Kumadpur village largely relied on private input dealers, but in Amba village, fertilisers were supplied by government agencies. Farmers were not happy with the quality of fertilisers supplied by private agents due to reported absence of sufficient nutritional elements in the fertilisers and the supply of spurious fertilisers.

Most farmers in the surveyed villages largely depended on non-institutional sources to borrow money for agriculture-related expenses. Although non-institutional money lenders charge high interest rates, farmers continue to borrow from them because there are constraints on accessing institutional sources of finance. The constraints are the following: (a) banks demand the land possession certificate; (b) harassment and corruption in sanctioning the loan; (c) non-cooperative bank staff; and (d) increased level of documentation.

Farmers reported non-availability of labour to carry out agricultural operations on time. It is because there is increased migration of local labour to cities because jobs in the local area are seasonal. Further, there is reluctance to work in agriculture because food grain is available through the public distribution system at a lower price of Rs. 2.0 per kg. A natural response to non-availability of labour is mechanisation. But farmers reported that due to poor economic conditions, they could not purchase agricultural equipment. To avail of a subsidy from the government to purchase equipment, one needs to pay a bribe and approach middlemen to get the subsidy sanctioned.

#### **4.4.2 Bhojpur District**

##### **General Profile**

In Bhojpur district, three villages viz., Galjarpur, Hatpokhar and Gunj Shirpalpur were selected for the survey. Among these villages, Galjarpur had the highest area under cultivation and also the highest number of tenants. However, in terms of area under tenancy, it was the highest in Hatpokhar with both share cropping and fixed rent as the terms of tenancy. The area under irrigation in all the villages was found to be 100 per cent.

There is no banking facility in the villages and farmers have to travel about 6 km to access a banking facility. Similarly, farmers have to travel a long distance to access the grain market and its facilities. There is no cold storage in the villages of Bhojpur but cold storage facility/ warehousing facility is available about 55 km away. These are owned by private individuals and capacity of warehouse is

stated to be inadequate. All the villages have been connected with pucca road and transport facilities are also found to be adequate.

### **Land Use Constraints**

The major crops grown in the villages during the kharif season are paddy, maize and bajra and in the rabi season, crops such as wheat, gram, lentil and mustard are grown. The area under sugarcane cultivation has increased in recent years. Farmers reported that the available cultivable land in the villages has been effectively utilised and hence there is no perceptible increase in fallow land in the past five years. Cropping intensity seems to have increased.

Farmers in the sample villages have access to improved variety of seeds and technology. However, the small size of landholdings is a constraint for efficient utilisation of farm implements. Since landholdings are small and scattered, machines cannot be used for ploughing and a high cost is incurred on collecting the harvested produce from different parcels of land. Most farmers suggested land consolidation and the adoption of cooperative farming as potential solutions to overcome the constraints related to scale of farming.

Farmers also reported that legal issues such as lack of land title, inheritance, mutation and recognition of tenancy affect their investment. In most cases, the land title remains unchanged after the death of the previous land owner for which the present land holder faces problems. Due to the lack of a land title, farmers are not issued a land possession certificate and are thus unable to apply for bank loans. The online system of mutation does not seem to function properly and mutation is a serious problem. It has been reported that farmers have been asked to pay huge bribes to complete the mutation process.

### **Constraints Related to the Market and Institutions**

Farmers in the sample villages mostly sold their crop output within the village to traders and commission agents. No farmer reported selling the produce outside the village. The main concern of the farmers is not getting a fair price for their agricultural produce. There are no grain markets (*mandis*) near the village and farmers are compelled to sell their products to private agents at a lower price. Lack of a storage facility is also a problem reported by farmers.

There is general awareness about contract farming among farmers in Hatpokhar and Gunj Shirpalpur, but no one practised contract farming in these villages. Farmers were not aware of FPOs. The lack of strong institutional and marketing arrangements is a constraint on the adoption of new technology and profitable crop diversification.

### **Constraint Related to Inputs Supply**

Farmers in the sample villages used purchased/certified seeds of paddy. These seeds are generally bought from private input dealers. The price of paddy seeds varied between Rs. 75/kg and 100/kg. In the case of wheat, over 90 per cent of farmers used certified seeds through private input dealers. A similar pattern can be observed in the case of gram, pea and mustard.

Farmers are not satisfied with the seeds purchased from private input dealers. For instance, they reported that paddy seeds contained 10 per cent admixture and had germination problems. In this context, one may draw lesson from the startup like Shiv Ganga Seeds, where a few framers have shifted from crop cultivation to seed production (see Box 4.1).

Private traders are also the main source of supply of fertilisers as well, but farmers were not happy with the quality of fertilisers supplied.

Over 60 per cent of farmers in the sample villages rely on non-institutional sources to borrow money for agricultural expenses. The interest rate on loans was very high. Institutional sources are better, but there are problems in accessing the loans. Farmers reported that bank loans are not available without middlemen and bribes. Further, it involves a lot of documentation work and the bank staff do not provide the relevant information.

#### **Box 4.1: Crop Cultivation to Seed Production**

Farmers in the surveyed villages of Bhojpur were traditionally cultivating Maize and paddy. This is a risky proposition as many a times they suffer loss during kharif season due to floods.

During 2010-11, under *Technology Demonstration for Harnessing Pulses Production* programme, KVK, SCADA, Bhojpur has taken initiation for Lentil Demonstration with a very promising variety *HUL-57*. To their surprise, the lentil yield was 12-16 qt./ha. Subsequently, a large number of farmers have moved to pulses cultivation leading to significant increase in demand for seed of same.

Seeing the opportunity in seed cultivation, a few farmers led by Mr Praveen Kumar Singh formed an association of seed producer. The training was provided by KVK, and the group was attached with Bihar Rajya Beej Nigam (BRBN) for marketing of their seeds.

It is an economical success story with more than 150 farmers as members of this association. It is now producing quality seed of lentil, chickpea, wheat, oat, and coriander. Reputed seed company are now buying their seeds.

Now, Praveen Kumar Singh has formed his own Composite Seed Processing Plant with a capacity of 3.5 Ton/hour and registered seed company (M/s Shiv Ganga Seeds). The present turnover of the M/s Shiv Ganga Seed Company is more than Rs 40 million.

While the seed production technology has now spread to more than 11 Village, there is urgent need to scale up this kind of initiatives.

The availability of labour for timely agricultural operations is a problem. Farmers reported that welfare programmes such as the public distribution system (PDS) have discouraged labourers from doing hard work on a farm. The government supplies rice at Rs. 2.0/ kg and wheat at Rs. 3.0/kg through PDS, and the wages earned from a few days of work is sufficient to buy these supplies. Further, local labourers have migrated due to the low wages.

Availability and use of machinery for agricultural operations are important to overcome labour issues. But farmers mentioned that it is expensive to own agricultural equipment. Small landholders prefer to rent rather than buy a machine. Farmers reported that subsidised agricultural equipment from the government is more expensive than direct purchase from the private market because the former involves paying a commission and a bribe.

### **4.4.3 West Champaran District**

#### **General Profile**

From West Champaran district three villages viz., Semuhepur, Samhota and Bhawal from Chanpatia, Natkhatia Ganj and Ramnagar Blocks, respectively, were selected for the survey. Natkhatia Ganj and Ramnagar Blocks have a relatively large number of tenants and a higher incidence of tenancy. In Chanpatia, the terms of tenancy was share cropping and in Natkhatia Ganj and Ramnagar, it was share cropping and fixed rent. Over 50 per cent of the cropped area was irrigated, mostly through groundwater.

Farmers reported non-availability of a banking facility in their village, and they have to travel a long distance to access it. There is a similar problem with access to grain markets. Cold storage facilities are absent in the select villages. Cold storage facility/ warehousing facility is available outside the village at a distance of 20 km, 27 km and 7 km from Semuhepur, Samhota and Bhawal, respectively. These are owned by private individuals and their storage capacity is inadequate. All the villages have been connected with pucca road with adequate transport facilities.

#### **Land Use Constraints**

In kharif season, paddy occupied over 30 per cent of the cropped area, while wheat constituted 20 per cent in the selected villages. Other major crops grown are lentil, rabi maize, green gram and mustard. Sugarcane also occupies a significant proportion of the area. It is found that all available agricultural land is under cultivation in these villages. Farmers reported an increase in cropping intensity in the past five years.

The small size of landholdings is reported to be a constraint on improving income from cultivation. It is reported that small holdings entail high input costs, lower output and small marketed surplus. The use of farm implements is difficult. Small landholders also reportedly lack credit-worthiness. The suggested solutions to these problems are similar to those reported by farmers in Bhagalpur and Bhojpur districts. The reported legal issues on land title transfer, mutation, payment of bribes and involvement of middlemen are also very similar.

#### **Constraints Related to Markets and Institutions**

Most farmers in the sample villages sold the output of crops such as paddy, wheat, maize, lentil and mustard within the village to traders and commission agents. Farmers reported non-availability of a fair price for their agricultural produce. It has been pointed out that profitability from crop cultivation is declining for various reasons. Among others, they include increase in input costs compared to the MSP, lack of proper market facilities, late procurement of grains by the government, delayed payment and lack of warehousing facilities.

There is general awareness about contract farming among the farmers of Samhota village, but no one practised contract farming. Similarly, farmers in Samuhepur village were aware of FPOs, but not in Samhota and Bawal villages. None of the surveyed villages have formed FPOs.

#### **Constraints Related to Inputs supply**

The use of certified seeds is varied across the surveyed villages. In Samuhepur village, about 20 per cent of farmers used farm-saved seeds and 80 per cent used certified seeds. Farmers rely on private input dealers to get the seeds. In Bawal village, 99 per cent of farmers used certified seeds.

A similar proportion is observed in the use of certified seeds by source of supply for wheat and maize. In the case of lentil, most farmers used farm-saved seeds.

It was found that farmers are not satisfied with the seeds purchased from private traders. For instance, in the case of paddy seeds, farmers noticed infected seeds, physical impurities, varietal admixture and consequently poor germination. Similarly, wheat seeds suffer from physical impurities, germination failure and insect damage. Mustard and lentil seeds are insect-damaged. Maize seeds were found to have a problem of grain setting.

In supply of fertilisers, farmers in Bawal village procure fertiliser from the government/cooperative society and are satisfied with the quality of fertiliser. Farmers in Samuhepur and Samhota village procure fertiliser from private individuals and some are reportedly not satisfied with the quality of fertiliser.

With respect to access to credit, most farmers borrowed money from non-institutional sources. The reported reasons for not availing of institutional loans include poor banking service, complicated process and documentation and demand for 10 per cent commission by middlemen to get a bank loan.

Due to non-availability of agricultural labourers when required, farmers tend to use agricultural machines. Unfortunately, there are constraints related to access and use of machines. Since agricultural machines are expensive, only farmers with large landholdings can afford to own and use them. Small and medium landholders rely on government subsidies to purchase the agricultural machines and equipment. However, farmers reported that there is excessive delay by the government in processing the subsidy and farmers have to make initially full farmers. Moreover, there is complicated process and documentation. All these constraints affect the profitable cultivation of different crops and farmers' interest in continuing to farm in the state.

#### **4.4.4 Jamui District**

##### **General Profile**

In Jamui district, three villages covered for the study are Chakai, Abgila Chourah and Jeet Jhingoi. The land leased-in was the highest in Abgila Chourah. Both share cropping and fixed rent were terms of tenancy practised in Abgila Chourah, while share cropping was the predominant mode in Chakai and Jeet Jhingoi.

Although banking facilities were not available within these villages, they were located near the villages and were easily accessible. But grain markets were located far away. The nearest grain market from Jeet Jhingoi is located at 44 km, and from Abgila Chourah it located is at 36 km. Chakai has easy access to markets within a distance of 1 km. The absence of cold storage facilities forces farmers to sell their produce immediately after harvest at lower price to traders. Villages were connected with pucca roads.

##### **Land Use Constraints**

The major crops grown in the sample villages were paddy, green gram, gram, lentil, maize, red gram, wheat, khesari, onion and potato. The share of area under paddy was the highest at 75 per cent. Farmers reported that cultivable agricultural land is not fully utilised and there has been an increase in fallow land. This is mainly due to erratic rainfall, un-assured irrigation facility and non-

availability of quality seeds. Therefore, a rise in area under fallow land is temporary only. Farmers reported an increase in cropping intensity in the past five years. However, the small size of landholdings/low scale of farming is reported to be a constraint on increasing income from cultivation. The problems related to small landholdings and suggested solutions are similar to those reported for other districts. The legal issues pertaining to land possession certificate, mutation, bureaucratic hurdles and transaction costs have been pointed out by the farmers as constraints.

### **Technology-Related Constraints**

Over 98 per cent of farmers use modern varieties of paddy, wheat and soybean. The proportion of area under traditional varieties for maize, mustard and green gram was higher than the area under modern varieties. Farmers reported a decline in crop yield in the past 10 years. Among others, the reasons for decline in yield include use of old seeds, traditional varieties, decline in soil fertility and low irrigation.

Farmers in the sample villages are keen to experiment with modern agricultural technology to get a higher yield and income. But the constraints are poor quality seeds and lack of marketing and storage facilities for growing profitable crops.

### **Constraints Related to Markets and Institutions**

Farmers reported that they do not get fair and remunerative price for their agriculture produce. The main reasons include the absence of a grain market (*mandi*) near the villages, limited procurement of grains by the government and lack of storage facilities. Farmers in the surveyed villages were not aware of contract farming. Similarly, farmers in Chakai and Abgila Chourah did not know about FPOs. Although farmers in Jeet Jhingo formed an FPO, it is stated to be non-functional. Farmers are of the view that lack of such marketing and institutional arrangements are responsible for low output price and a hindrance to crop diversification.

### **Constraints Related to Inputs Supply**

About 90 per cent of farmers used certified paddy seeds purchased from private input dealers. There is considerable variation in the price of paddy seeds. It ranged from Rs. 44/kg to Rs. 80/kg. In the case of wheat, maize, mustard and green gram, almost all the farmers used purchased seeds. Farmers were concerned about the quality of seeds supplied by private input traders. In the case of supply of fertilisers, farmers procure from private traders in nearby villages. Farmers reported supply of poor quality fertilisers, which may be harmful to soil health in the long run. The problem with these adulterated fertilisers is that they do not dissolve easily and get absorbed in the soil.

With respect to access to finance, about 60 per cent of farmers reportedly borrowed money for agricultural operations. They usually borrow from non-institutional sources because they face constraints in accessing institutional sources. Some of these constraints include lengthy bank loan process and documentation procedures, and demand of 10 per cent commission for sanctioning the loan. These constraints ultimately demotivate the farmers from investing in yield-improving technologies and diversifying crop cultivation.

#### **4.4.5 Khargaria District**

##### **General Profile**

In Khargaria district of Bihar three villages are selected viz., Aadawari, Asurari Mujauna and Mehsauri. Mehsauri has the highest number of tenants, which is why the area under tenancy is higher than in the other villages of Khargaia. The mode of tenancy in all three villages are share cropping and fixed rent. There are no banking facilities within the village. The distance villagers have to travel for their banking needs varies, with the maximum distance being 10 km. Grain markets are located far from the villages.

In all three villages, there is no storage /warehousing facility. These are located outside the village at a distance about 17.5 km. The warehousing facilities are provided by private individuals and the capacity of these warehouses is not adequate. Villages are connected with pucca roads.

##### **Land Use Constraints**

The major crops grown in the selected villages include paddy in kharif season, and wheat, maize, soybean, potato and mustard in rabi season. Paddy occupied nearly three-fourth of the total cropped area. The agricultural land in each village seems to have been fully utilised for cultivation. There has been a reported increase in cropping intensity in the past five years. Increase in cropping intensity is largely due to the availability of new agricultural technology, technical knowledge and encouragement from Krishi Vigyan Kendra (KVK), availability of irrigation facility and availability of modern seeds.

However, the small size of fragmented landholding is reported to be a constraint on increasing agricultural output. Problems associated with small landholdings include high input cost for ploughing, irrigation, collection of produce after harvesting from different parcels, inability to use agricultural equipment in a small field and problems in availing of bank loans. Legal issues pertaining to land are similar to those reported by farmers in other districts.

##### **Technology-Related Constraints**

Almost all the farmers in the sample villages grow modern varieties of major crops such as paddy, wheat, maize, gram, green gram, lentil and mustard. Farmers reported a decline in yield of crops in the past 10 years. Among others, the reasons for decline in yield can be attributed to lower use of organic manure, climate change and decrease in soil fertility.

Farmers expressed an interest in experimenting with new technology, but they reported some constraints. These include high input cost, low output price, lack of availability of agricultural labour and lack of market facility.

##### **Constraints Related to Markets and Institutions**

Farmers mostly sold the output of crops such as paddy, wheat, maize, mustard, soybean, potato and green gram within the village to traders and commission agents. Non-availability of remunerative prices for agriculture produce is a major concern. Constraints on the market include the absence of a physical grain market near the villages, lack of storage facility and limited/no procurement of grains by the government.

Farmers in the sample villages are not aware of contract farming. Sadly, farmers are also not aware of the FPO in the sample villages. The lack of such ground-level organisations to bring farmers together and handle marketing arrangements are responsible for reduced price realisation and lower income.

### **Constraints Related to Inputs Supply**

Most farmers in the sample in villages used certified seeds of paddy bought from private input dealers. There is considerable price variation across the villages. A similar pattern can be observed in the case of wheat and maize. For mustard, soybean and green gram cultivation, farmers mostly use farm-saved seeds. Fertilisers are generally procured from private input dealers.

Farmers mostly relied on non-institutional sources for borrowing money to meet their cultivation needs. The constraints related to accessing institutional sources of finance are similar to those reported by farmers in other districts. Similarly, with respect to access to farm implements, problems in accessing subsidised implements distributed by the government are more or less the same. In fact, these constraints affect the profitable cultivation of crops and farm-level innovation with new methods of cultivation and new crops.

## **4.4.6 Patna District**

### **General Profile**

In Patna district, three villages viz., Parsa, Faridpura and Mahnakuli were selected for conducting the focus group discussions with farmers. Among these villages, the maximum amount of land is under cultivation in Faridpura. The number of tenants and the area under tenancy were also the highest in Faridpura. The mode of tenancy are both sharecropping and fixed rent. All the villages are highly irrigated.

There are no banking facilities in any of these three villages, but they are located only at a distance of 3.0 km. But the distance that farmers have to travel for selling their grains in the market is about 20 km from Chipura and Faridpura, and 8 km from Parsa. Villages do not have cold storage facilities and farmers have to travel outside the village to access the cold storage facilities at a distance of 9 km from Parsa and 25 km from Faridpura. As reported in other districts, these cold storage facilities are owned by private individuals and their storage capacity is reported to be inadequate. All the villages are connected with pucca roads and have adequate transport facilities.

### **Land Use Constraints**

The major crops grown in the sample villages include paddy, maize, wheat, red gram, gram, lentil, mustard, pea, green gram, khesari and onion. Among these crops, paddy accounted for a relatively high proportion of the total area. Farmers reported that not all the available agricultural land is put under cultivation, because of constraints such as low irrigation facility, erratic rainfall, non-availability of seeds on time, conversion of agricultural land for non-agricultural purposes and shortage of labour. There are some area-specific problems as well: agricultural lands near the river banks get swallowed by river water and consequently some of the lands remain unused.

Notwithstanding these problems, farmers reported an increase in cropping intensity in the past five years. The rise in cropping intensity can be attributed to the use of improved seeds, increase in population density, urbanisation of the villages and use of agricultural implements for quicker completion of agricultural operations. The small size of landholdings is reported to be a constraint

for increasing income from cultivation. The constraints on small landholdings and proposed solutions by the farmers are the same as those reported in other districts, as are the legal issues pertaining to land that potentially affect private investment on agricultural operations.

### **Technology-Related Constraints**

Over 90 per cent of farmers in the sample villages have grown modern varieties of different crops. Among the various crops, the average yield of paddy was found to be high. However, farmers have reported a decline in the crop yield in the past 10 years. Though farmers are keen to experiment with modern agricultural technology, they face various constraints that include lack of quality seeds, lack of organic manure, high cost of technology, low availability of modern agricultural implements, lack of market facility and storage facility and lack of technical know-how. In this respect, one may consider the success stories arising from integrated farming system, which seems to be a win-win situation for small farmers (see Box 4.2).

#### **Box 4.2: Crop Diversification- Cereal Crop to Integrated Farming System**

Traditionally, I used to cultivate cereals (paddy/wheat) in my 2.5 acre of land. However, my profit declined sharply with rising production cost and near stagnating sale price of my crops.

So, I have switched to cultivate new crops like **potato/maize** under the direction of Indian Council of Agricultural Research (ICAR) research institute at Patna, which have increased my income by about Rs. 20,000 per annum.

Simultaneously, I have commenced poultry farming which provides me additional income. In a year, I complete 5 cycles of about 500 chickens which provide me with net income of Rs 50,000 - 60,000 per year. Since the chicken are feed only broken wheat grains, paddy husk, and banana thumb, the production costs are minimal.

Additionally, I have made some vermicomposting pits in which I make earthworm manure using the residues from my field. The use of natural fertilizer has increased my soil nutrients and further I apply now less chemical fertilizer causing in effect in reduction in my production cost of crops.

*Location: Village Simra, NaubatPur Block (Patna district)*

### **Constraints Related to Markets and Institutions**

Most farmers sell their crop produce within the village to traders and commission agents, but they do not get a fair/remunerative price for their produce. The reasons for not getting a fair price include the absence of a physical grain market (*mandi*) near the village, lack of storage facility, middlemen expropriations and lack of an agro-processing facility.

Farmers in the sample villages were reportedly unaware of contract farming. Farmers had some information about FPOs, but it has not been constituted in any of the villages. Farmers felt that contract farming and FPOs can help to overcome some of the existing marketing problems.

### **Constraints Related to Inputs Supply**

Most farmers used certified seeds of paddy, wheat and maize. Most farmers borrow from non-institutional sources because they face constraints in accessing institutional sources. These constraints are the same as those discussed in the other districts. It is the same with problems in access to farm implements.

#### **4.4.7 Purnia District**

##### **General Profile**

From Purnia district, three villages viz., Ghushar Tikapatti, Rajghat Garel and Chandi were selected for the study. The number of tenants and area under tenancy was the highest at Ghushar Tikapatti. The terms of tenancy was both share cropping and fixed rent. The sample villages have 100 per cent irrigated area.

Ghushar Tikapatti has banking facilities. Farmers from Rajghat Garel and Chandi have to travel about 10 km to access these facilities. The distance that farmers have to travel to the nearest grain market varied. The grain market is located just 8 km from Ghushar Tikapatti, while farmers from the other villages had to travel about 60 km to reach the nearest grain market.

Besides the problem of remote accessibility, these markets did not have cold storage/ warehousing facilities. Farmers had to travel about 40 km from Ghushar Tikapatti and Rajghat Garel to avail of these facilities. These storage/warehousing facilities are provided by private individuals and their capacity is stated to be inadequate. All the villages are connected with pucca roads.

##### **Land Use Constraints**

The major crops grown in the villages are paddy, maize, wheat, jute, green gram, lentil, mustard and potato. Among these crops, the area under maize was relatively high. Farmers reported that all the available agricultural land is not put into cultivation. The constraints on agricultural land use include the inability to use tractors because the landholdings are small and scattered and the low availability of agricultural labour. Farmers reported an increase in fallow land in the past five years.

The small size of landholdings is considered to be a constraint on improving crop output. The problems associated with small landholdings include the inability to use tractors and other agricultural equipment in a small field, a higher requirement for labour and high input cost for ploughing and irrigation. These tend to restrict the capacity of farmers to invest more on land and increase output. The legal issues on lack of land title, problem of inheritance, mutation and tenancy are similar to those reported in other districts.

##### **Technology-Related Constraints**

Most farmers in the sample villages have grown modern varieties of all the major crops. Reportedly, the average yield of major crops has declined in the past 10 years. Although farmers have an interest in adopting modern agricultural technology, they face certain constraints on technology adoption. These include small landholdings, lack of food processing facility and shortage of agricultural labour.

Most farmers purchased improved seeds and fertiliser from private input dealers. Constraints on inputs supply are very similar to those reported by farmers in other districts.

##### **Constraints Related to Markets and Institutions**

As observed in other districts, almost all the farmers sold their crop output to traders or commission agents. Consequently, farmers do not get a fair/remunerative price for their agricultural produce. Constraints on getting a fair price for agricultural produce include non-

availability of a physical market, lack of storage facilities, no proper market facility, low rate of MSP, delayed payments, distant market and faulty weighing system. Farmers were not aware of contract farming or FPOs. The absence of these ground-level marketing organisations impairs growth prospects through low crop diversification and low price realisation.

#### **4.4.8 Samastipur District**

##### **General Profile**

In Samastipur district, three villages viz., Ladaura, Kothiya and Mohandinagar were selected from three blocks of Kalyanpur, Tajpur and Rosra, respectively. The cultivated land is relatively high at Rosra Block and it has a large number of tenants and a higher incidence of tenancy. Share cropping and fixed rent are the common terms of tenancy in the villages. The sample villages have 100 per cent irrigated area.

Banking facility is not available within the villages and farmers have to travel on average of 8 km to access the formal banking institution. The distance to the nearest grain market is the highest for Ladaura. Villages do not have cold storage/warehouse facility. Private warehouses are located at a distance of 10 km from Ladaura and Kothiya, and only 3 km from Mohandinagar. The capacity of these warehouses is stated to be inadequate.

##### **Technology-Related Constraints**

The major crops grown in the selected villages include paddy, soybean, maize, red gram, wheat, lentil, green gram, banana and sugarcane. Reportedly, the area under sugarcane seems to be expanding. Farmers mentioned that all available agricultural land has been put under cultivation and there is no perceptible increase in the fallow land in the past five years. Interestingly, cropping intensity has improved due to an increase in irrigation facility, availability of technical guidance and cultivation of new crops.

Issues related to the small size of landholdings and their effect on crop output are very similar to those reported by farmers in other districts. The observations are similar on legal issues about the lack of land title, mutation and tenancy. Bribing officials to change the land title and to obtain a land possession certificate are the common constraints faced by farmers in the sample village of Samastipur.

##### **Constraints Related to Markets and Institutions**

Almost all the farmers sold their crop output within the village to traders and commission agents. No farmer reported having sold agricultural produce outside the village. Not getting a fair or remunerative price for agriculture produce is the major concern. The reported constraints on agricultural markets are similar to those found in other districts.

Some farmers reported that they are aware of contract farming, but there is no evidence of contract farming being practised in the villages. Similarly, farmers were aware of FPOs and its importance in augmenting farmers' income through collective marketing of agricultural produce. In Kothiya and Mohadinagar, farmers have formed an FPO and it has also been registered. But, unfortunately, it is not functional. Farmers felt that contract farming and FPOs are important options to overcome some of the marketing problems.

### **Constraints Related to Inputs Supply**

Most farmers have used certified seeds of paddy, maize and wheat purchased from private input dealers. There is considerable variation in the price of seeds across the villages. Farmers reported that they are not satisfied with the quality of seeds supplied by private input dealers. Constraints on seeds that farmers face are infected seeds, poor germination and varietal admixture.

Farmers in Ladaura village procure fertilisers from the government/cooperative society and they expressed satisfaction with the quality of fertiliser supplied to them. But farmers in Kothiya and Mohadinagar generally procure fertiliser from private input dealers. These farmers mentioned that they are not happy with the quality of fertiliser supplied to them.

Most farmers depend on non-institutional sources for borrowing money. Constraints on accessing institutional sources of lending are similar to the findings reported from other districts. Also similar are the constraints on using agricultural implements and problems in obtaining them through government subsidy programmes.

### **4.5 Key Issues Raised by Stakeholders in Various Sectors**

During the study, we conducted in-depth interviews with public and private players engaged with the distribution of seed, fertilisers, irrigation, credit, and agro-processing activity and markets. The constraints raised by them related to these activities are summarised here.

- **Seed Sector**

Most seed distributors/retailers mentioned the rampant sale of spurious and duplicate brand seeds in the market. The spurious seeds have problems of poor germination, poor standing crop and lower yield. Unfortunately, there is weak enforcement of quality checks by government departments. To some extent, the absence of scientific storage facilities for storing seed at the level of wholesalers and distributors results in damage to seeds.

Stakeholders mentioned that it is important for all seed production agencies in Bihar to be registered with a seed certification agency. There should be a mechanism for regular monitoring of the firms by a seed certification agency at different stages of seed production to ensure the quality of seeds produced. This could help develop an ecosystem for the sale of only quality seeds to farmers. This would also help remove the supply constraints on seed, reduce price fluctuations and encourage farmers to use the right amount of seeds.

- **Fertiliser Sector**

Different fertiliser distributors mentioned that there is seasonal mismatch between demand and supply of fertilisers. This leads to fluctuation in fertiliser prices. This is particularly the case of urea supply in Bihar. The availability of good quality of fertiliser is an issue. There is no proper monitoring to check the quality of products sold. Stakeholders mentioned that lack of finance to purchase fertilisers is not a problem for farmers since they mostly sell fertilisers on credit.

The government of Bihar has recently introduced the direct benefit transfer (DBT) system to streamline the provision of subsidy on fertilisers. Its implementation on the ground seems to face some bottlenecks. Most fertiliser distributors mentioned that farmers are not aware of such the

new system and they are hesitant to give information about their identity such as their Aadhar number.

Lack of proper and adequate facilities for storing fertilisers is a constraint, which results in spoilage and loss of quality during the rains. There is considerable delay in the receipt of the fertiliser by dealers, which results in shortage of supply in the sowing season and also a problem in managing the working capital. Most of the stakeholders deal in chemical fertiliser and only a limited number of players deal in bio-fertilisers and micro-nutrients.

- **Crop Irrigation**

While the state government has introduced many schemes related to development of irrigation, their implementation is tardy reportedly due to a shortage of technical staff. There is considerable delay in the receipt of funds by farmers in these schemes due to delays in the release of funds by government departments.

Quite often, farmers are denied the benefits of various agricultural development schemes such as subsidy on irrigation pump sets and promotion of lift irrigation due to the absence of a land possession certificate and/or Aadhar card. Most of the marginal farmers are in a disadvantaged position as their land size is typically lower than the prescribed size laid down to become eligible for availing of benefits under these schemes.

The farmers can avail of benefits from these schemes only once. Under these schemes maintenance guarantee for any of the supplied capital items (pump-set/tube-well) is not provided. Stakeholders mentioned that there should be a provision for built-in repair of items distributed under these schemes. Further, it would be useful to encourage distribution of electric pump-sets instead of diesel ones to reduce the operating cost for farmers. It is essential that land ownership document is digitised and made available online to the public for using it for availing benefits under various schemes.

- **Horticulture Sector**

Under various horticulture development schemes, beneficiaries are advised first to purchase the required items such as horticultural implements using their own capital and then get reimbursed through DBT. But due to reported inefficiencies in the working of the DBT system, farmers are reluctant to invest under these schemes, particularly since those schemes are based on a reimbursement mode.

Stakeholders mentioned that land is a constraint in the development of nurseries and there is a need for a specific policy to promote the growth of nurseries.

The procedures for availing of a loan for the development of nursery activities should be made simple and easy to follow. Quite often, farmers are denied the benefits of various schemes including credit due to the absence of land possession certificate and/or Aadhar card.

- **Livestock Sector**

Stakeholders recognise the importance of livestock in the farmers' household economy. As Box 4.3 suggests, success stories of livelihood improvement by transition from crop to livestock farming exists. There is need to scale-up this model in overall Bihar for small farmers.

It should be noted that there is little awareness among farmers regarding the diseases that may affect their livestock and the need for immunisation of livestock. Unfortunately, access to veterinary hospitals is limited and non-availability of trained manpower to treat livestock diseases is a concern. Technical knowledge about profitable rearing of animals is not available. Stakeholders mentioned that formal financial institutions (banks) are not keen to provide loans for animal rearing because of the perceived risks. Non-availability of livestock insurance is also a constraint on expansion of the livestock sector in Bihar.

**Box 4.3: Farming to Livestock (Fish, Ducks, Buffalo)**

I am a poor farmer owning only ½ acre land in which I used to cultivate. I also have one desi cow from which I get milk to fulfil the needs of the children in the family.

Since 2006, I have been mentored by ICAR (Patna) to augment by income. There was a pit land behind my house in which dirty water and thorns were present. A group of scientist inspected my land and suggested the idea of digging a 300-square-meter pond in the pit land, and also helped me financially too. I was able to acquire fish seeds and 7 ducks due to NAIP scheme of ICAR.

In the initial years, my earning from fish fetched me about 7000-8000 per year and additionally I earned income of about Rs. 4000-5000 selling duck eggs.

Subsequently, I brought a buffalo which helped me to earn Rs. 25,000-30000 per annum by selling its milk. Along with this I started using cow dung manure and vermicomposting as suggested by the ICAR scientists. This helps me to increase yield and income from crop cultivation.

From my savings from additional income, I have bought a vehicle which I give on rent.

My financial condition has improved considerably and I am able to send my grandchildren to school.

**Message:** Integrated farming system may be a boon to marginal farmers.

*Location: Village Chak Ramdas (Vaishali district)*

- **Agro-Processing Industry**

Agro-processing industries play a significant role in value addition, employment generation and enhancing farmers' income through effective utilisation of locally available raw materials. In the sample districts, rice mills, wheat flour mills and milk processing units were the major types of agro-processing industries.

Most firms reported that they are not in a position to operate the plants throughout the year due to the shortage of raw materials. Sourcing of raw material from neighbouring states is an option to increase the productivity of the firms. But, inadequate information about the prevailing prices of raw materials in the neighbouring states is a constraint.

Market linkages are found to be weak not only for sourcing of raw materials, but also for the sale of output produced. The market is located far from the producing centre. Irregular electricity supply is a major constraint reported by entrepreneurs. Though most of these units are located in an industrial estate, the absence of basic facilities like sanitation, drainage system and good quality

roads are major constraints. Further, firms lack adequate capital for technological upgrading in order to achieve full capacity.

Most of these units do not have the funds for technological upgrading to increase efficiency. A scheme may be introduced to encourage firms to upgrade their equipment by providing incentives.

- **Warehouse**

In the study area, there were both government-owned and private-owned warehouses. The government-owned warehouses were used by government agencies to store food grain while private warehouses were mostly used by farmers and traders to store potatoes and onions. The warehouses issue receipts against the total value of the commodity stored by farmers. Farmers can use this receipt as a pledge to take a bank loan to the extent of 50-70 per cent of the value of the product stored. But this does not seem to be working well on the ground. Among the factors responsible for this, farmers take money in advance from traders against their harvests and therefore they are forced to sell their produce as early as possible to settle the money borrowed.

It was reported that markets are not available near the cold storage and hence farmers have to incur huge transportation costs to transport the commodity to the market. Further, to avail of a private storage facility, farmers have to pay rental charges, which most farmers, particularly the small landholders, cannot afford. Erratic power supply is a major constraint in running warehouses. To overcome the problem of abrupt cuts in power supply, diesel generators are used, which are very expensive. To meet this additional cost, warehouse operators fix higher rental charges.

- **Technology Transfer**

Different agencies are involved in the transfer of agricultural technology to farmers. Lack of trained manpower is considered to be an important bottleneck for the transfer of technology at the ground level.

It has been reported that farmers are averse to adopting new technologies because they are not sure that they would continue to receive advice on a regular basis during the process of moving from traditional ways to modern ways of crop production. The small size of landholdings is a constraint in the adoption of new technologies. The formation of FPOs may be a medium for consolidation of landholdings to achieve the benefits of economies of scale. Stakeholders mentioned that facilities for custom hiring of farm machineries need to be provided with adequate technical know-how. The regular monitoring and inspection by a team of experts during the cropping season would go a long way to allay the farmers' worries. Of course, the adoption rate would be higher if the government introduced a compensation mechanism in the case of crop failure due to adoption of new technologies.

- **Agricultural Marketing**

Primary Agriculture Cooperative Societies (PACS) are responsible for the procurement of paddy and wheat from farmers at a minimum support price. PACS undertake procurement operations at the behest of the Bihar State Food and Civil Supplies Corporations (BSFC). Field evidence shows that farmers are not interested in selling their produce to PACS. Among the various reasons, payment to farmers in many cases is reportedly delayed due to late receipt of payment from BSFC by PACS. Further, most PACS do not have weighing facilities, which forces farmers to weigh their products privately on a payment basis before offering their produce. Even though many of the

PACS deal in vegetables, cold storage facilities are typically not built at PACS, resulting in wastage. Policymakers may have some ideas on the matter.

Efficient marketing of agricultural produce seems to have been affected due to a shortage in quality storage facilities. Direct purchases from farmers that bypass multi-level intermediaries would help farmers to realise better prices and minimise the marketing cost.

- **Credit Institutions**

Under Bihar Rural Livelihoods Promotion Society (BRLPS), community institutions in the form of women self-help groups have been formed. BRLPS, locally known as JEEVIKA, attempt to bring social and economic change in rural areas through these local community institutions. Self-help groups are formed to mobilise savings and promote internal lending activities within the group. In the study area, JEEVIKA and Gramin Banks were the prominent institutions for providing loan facilities to farmers in the villages.

Various stakeholders mentioned that the low limit on lending is a constraint. Further, intermediaries/ loan brokers play a dominant role in getting a loan sanctioned to farmers from formal institutions on a commission basis. It was pointed out that the involvement of middlemen is not a good practice and farmers should have direct access to banking facilities without much hassle. Lack of proper land title deeds is reported to be a major constraint in availing of institutional finance.

# Chapter 5 Summary and Policy Recommendations

## 5.1 Summary of Findings

In Bihar, agriculture contributes one-fifth of the state income and employs nearly three-fourth of rural workforce. Agriculture roadmaps implemented in different phases since 2008-09 intend to create the holistic development of the sector with a focus on increasing productivity growth and improving farmers' income. After a few decades of neglect, agricultural sector has seen a turnaround in its performance registering appreciable growth rate during the recent years. In 2015-16, contribution of crop sector to overall agricultural output stood at 53.6 per cent. Horticulture accounted for a little less than quarter of output, while field crops constituted roughly one-third of agricultural output. In terms of growth in value of output, field crops and horticulture registered splendid growth rates during the periods of agriculture road maps (2008-09 to 2015-16) as compared to pre-agriculture road map period (2000-01 to 2007-08).

The cropping pattern in Bihar is not so diversified. Three crops viz., paddy, wheat and maize have constituted over 70 per cent of the total cropped area in the state. There is some degree of area substitution taking place among cereals favouring maize and wheat. Area under pulses has declined by over 20 per cent between 2002-03 and 2016-17. But there is a significant increase in area under sugarcane from 1.3 per cent to 3.2 per cent of total cropped area between 2002-03 and 2016-17. Area under fruits and vegetables constituted about 6.0 per cent of total cropped area. With changes in crop composition, the aggregate net income from crop cultivation has increased overtime, but it had remained low on per hectare basis.

Among the sources of output growth, yield improvement has largely contributed to crop output growth during 2001-02 to 2016-17. The effect of crop diversification on crop output growth is positive. The contribution of real price to output growth is lower than that of yield effect and crop diversification. Aggregate TFP growth was 1.71 per cent during 2000-01 to 2015-16. Analysis shows that the output growth was largely led by improvement in TFP, which is actually desirable in the long run to sustain the output growth. At the same time, low input intensification is a concern and it seems to have affected the level of crop yield.

## 5.2 Key Policy Problems

Growth diagnostics through Minot-Hausmann Hybrid framework has revealed that **poor functioning of agricultural markets** indicated by instability in the prices of agricultural produces and **low level of crop diversification** are the reasons for slow or lower agricultural growth in Bihar. The abolition of APMC Act in 2006 did not usher in private investment for creating new markets or strengthening facilities in the existing ones leading to low market density. The participation of government agencies in procurement and scale of procurement of grains continues to be low. Thus, farmers are left to the mercy of traders who unscrupulously fix lower price for agricultural produce that they buy from farmers. Inadequate market facilities and institutional arrangements are responsible for low price realisation and instability in prices. Two factors constraining the crop diversification are weak market linkages and poor institutional arrangements such as producer collectives at the village level.

### **5.3 Recommendations for Strengthening Market Linkages**

- With the introduction of the Bihar Agriculture Produce Market (Repealing) Act, 2006, government intervention in setting up agricultural markets and managing them was done away with. It was expected that this would enable private players to set up and run the markets. Unfortunately, this did not happen. Therefore, the government may design incentive mechanisms such as tax concessions to attract private investment in the development of agricultural markets including cold storage/warehousing facilities.
- Since the participation of private players at present is low, the government should step in to provide the necessary market infrastructure. Periodic rural markets play an important role not only as a point of contact for farmers at the local level, but they also assume significance in the socio-cultural life of local people. There is a need to strengthen these markets with the necessary infrastructure and upgrade them to connect with other national-level markets.
- It is important to provide an enabling environment for direct marketing of agricultural produce by farmers. Group marketing reduces the length of marketing channels and marketing costs. The government should promote and strengthen farmer producer organisations (FPOs). There is a need to move from the stage of “notional FPOs” to “functional FPOs”. Further, FPOs should be provided with adequate initial financial support for their successful operation. Members of FPOs should be given periodic training and work as contact persons for disseminating new technology and the benefits of development programmes.
- Sharing information about market conditions, particularly prevailing prices on a real-time basis, will help farmers make the right decisions about timing and quantity of products to be sold. Availability of market information will also strengthen the bargaining power of farmers. Besides price details in the domestic market, providing information about international market conditions will also be useful for informed decision-making not only for selling of produce but also for reorganising production. There is a need to strengthen data collection and dissemination machinery at the state level.
- Agricultural output and credit markets are highly interlinked. Weak credit markets result in the inefficient performance of agricultural markets. There is a need to expand the coverage of institutional credit through strengthening of primary agriculture credit societies (PACS). A strong network of PACS with adequate capital base will also improve their procurement operations of rice, wheat and other food grains.
- Farmers encounter the problem of a sudden crash in prices of agricultural commodities when there is over-production and farmers find difficulty in disposing of the produce. Under these conditions, the government should intervene in the markets to undertake procurement operations to stabilise market conditions. It would be useful to set up a ‘price stabilisation fund’ to undertake such operations by the government.

### **5.4 Recommendations for Creating Ecosystem for Crop Diversifications**

- The government should prepare a comprehensive policy on crop diversification. The policy should provide enough incentives for farmers to diversify from a low-value cereal-based system to a high-value fruits and vegetable system. The policy should concomitantly encourage private investment in establishing adequate storage and primary processing infrastructure for grading, sorting, etc. of fruits and vegetables.
- Contract farming provides a secured market with assured prices for agricultural products. This is important particularly for the growing of perishable products such as vegetables. A

suitable legislative measure on contract farming may be introduced along the lines of the Model Contract Farming Act brought out by the Centre. The Act should provide a level playing field for both the producers and agro-commercial firms.

- Investment in the education of farmers is crucial to motivate them to grow new crops, adopt new methods of cultivation and improve marketing practices. Public extension activities on different aspects of agricultural production and marketing services need to be strengthened. There is a need to strengthen the agricultural extension system with adequate manpower and build their capacity on integrated value chain approach (from farm to fork) for better price realisation and increasing income of the farmers.
- Agricultural commodities pass through different stages, right from the farmer to the consumer. There is a need to strengthen the supply chain with appropriate value additions. This is especially important if farmers diversify from cereals to fruits and vegetables. Development of the agro and food processing industry at a cluster level where adequate raw materials are available will enhance value addition, generate employment and increase the income of farmers.

## **5.5 General Recommendations**

- Stakeholders in the seed and fertiliser sector have stressed the absence of quality checks of the product they sell to farmers. Most of them do not have facilities to check the quality of the product they procure from large distributors. There is an urgent need for the government to ensure the distribution of quality products.

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# Annex 1: Questionnaires for Stakeholders' Interaction

## *Seed Producers/Dealers (Questionnaire)*

1. Name of the respondent:
2. Name of the organisation:
3. No. of years of operation:
4. Mention the name of crops and varieties you deal with.  

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5. Provide the type of activities you are engaged in the seed sector (Tick).  
(a) Production only (b) Distribution only (c) Both production and distribution
6. If engaged in seed production, please provide the following details.  
(a) Type of basic seed material (e.g. stage of seed): \_\_\_\_\_  
(b) Supplier of basic seed material: \_\_\_\_\_  
(c) Distance from your company to supplier: \_\_\_\_\_
7. Do you have your own farm for seed production? Yes/No.
8. If yes, how much land? \_\_\_\_\_
9. Do you have contract with farmers for seed production? Yes/No.
10. If yes, please provide the details.  

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11. Explain the seed distribution network of your company.  

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12. How is the quality of seed produced and sold monitored?  

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13. Explain the constraints faced in seed production activities (e.g. credit, etc.).  

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14. Explain the constraints faced in seed distribution activities (e.g. credit, etc.).  

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15. What possible solutions that you think can work for addressing above mentioned constraint?

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***Fertiliser Producers/ Dealers (Questionnaire)***

1. Name of the respondent:
2. Name of the organisation:
3. No. of years of operation:
4. Mention the type of fertilisers you deal with.

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5. Where do you procure your materials from? Please mention the supply chain.

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6. Explain the seed distribution network of your company.

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7. How are the quality of fertiliser produced and sold monitored?

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8. Explain the constraints faced in production/procurement of fertilisers.

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9. Explain the constraints faced in fertiliser distribution activities.

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10. What possible solutions that you think can work for addressing above mentioned constraint?

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### ***Crop/Irrigation Sector (Questionnaire)***

1. Name of the respondent/Official:
2. Name of the Department:
3. No. of years of experience in the department:
4. Mention the major activities of your department.

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5. Please list the major schemes implemented by your department.

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6. Are sufficient human resources and financial resources available for successful implementation of these schemes? Yes/No. If No. please explain.

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7. How do you select the farmer beneficiaries?

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8. Please mention about the financial and physical achievements of these schemes.

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9. Have these schemes made any impact on improving the livelihoods of farmers? Yes/No. How do you assess?

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10. Explain the constraints faced in the implementation of agricultural development schemes.

---

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11. What possible solutions that you think can work for addressing above mentioned constraint?

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### ***Horticulture Sector (Questionnaire)***

1. Name of the respondent/Official:
2. Name of the Department:
3. No. of years of experience in the department:
4. Mention the major activities of your department.

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---

5. Please list the major schemes implemented by your department.

---

---

6. Are sufficient human resources and financial resources available for successful implementation of these schemes? Yes/No. If No. please explain.

---

---

7. How do you select the farmer beneficiaries?

---

---

8. Please mention about the financial and physical achievements of these schemes.

---

---

9. Have these schemes made any impact on improving the livelihoods of farmers? Yes/No. How do you assess?

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---

10. Explain the constraints faced in the implementation of agricultural development schemes.

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11. What possible solutions that you think can work for addressing above mentioned constraint?

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***Livestock Sector (Questionnaire)***

1. Name of the respondent/Official:
2. Name of the Department/Company:
3. No. of years of experience:
4. Mention the major activities.

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5. Please list the major schemes implemented by your department.

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6. Are sufficient human resources and financial resources available for successful implementation of these schemes? Yes/No. If No, please explain.

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---

7. How do you select the farmer beneficiaries?

---

---

8. Please mention about the financial and physical achievements of these schemes.

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9. Have these schemes made any impact on improving the livelihoods of farmers? Yes/No. How do you assess?

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10. Explain the constraints faced in the implementation of agricultural development schemes.

---

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11. What possible solutions that you think can work for addressing above mentioned constraint?

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***Agro-Processing Sector (Questionnaire)***

1. Name of the respondent/Official:

2. Name of the Organisation:

3. No. of years of Operation:

4. Mention the type of commodities you produce.

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5. What raw materials do you use? From where and how do you procure?

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6. Mention about your plant capacity, fixed assets, employment structure, no. of days of operation in a year, etc.

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7. How do you meet your capital requirements? Mention the source of credit, interest rate, loan outstanding, etc.

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8. Please mention about distribution/sale networks.

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9. Explain the constraints faced in your product manufacturing activities.

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10. Explain the constraints faced in the distribution/sale of final products.

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11. What possible solutions that you think can work for addressing above mentioned constraint?

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### **Technology Generation (Questionnaire)**

1. Name of the respondent/Official:  
\_\_\_\_\_
2. Name of the Department and University:  
\_\_\_\_\_
3. No. of years of experience in the department:  
\_\_\_\_\_
4. Mention the major activities of your department.  
\_\_\_\_\_  
\_\_\_\_\_
5. Provide type of crops and varieties/hybrids released by your University/Institutions in the past two decades?  
\_\_\_\_\_  
\_\_\_\_\_
6. How many of these varieties/hybrids have been adopted by farmers?  
\_\_\_\_\_
7. Provide the reasons for no/slow adoption of these varieties.  
\_\_\_\_\_  
\_\_\_\_\_
8. Please mention other crop improvement technologies developed by your University/Institutions in the past two decades?  
\_\_\_\_\_  
\_\_\_\_\_
9. Are these technologies being successfully adopted by the farmers? Yes/No.  
\_\_\_\_\_
10. If No, please provide the reasons.  
\_\_\_\_\_  
\_\_\_\_\_
11. Provide new technologies developed for improvement of livestock and other allied activities and their extent of adoption by farmers.  
\_\_\_\_\_  
\_\_\_\_\_
12. Mention the constraints encountered in agricultural research and technology generation by the Scientists in your University/ Institution.  
\_\_\_\_\_  
\_\_\_\_\_
13. What possible solutions that you think can work for addressing above mentioned constraint?  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

### ***Technology Transfer (Questionnaire)***

1. Name of the respondent/Official:  
\_\_\_\_\_
2. Name of the Department/ Agency:  
\_\_\_\_\_
3. No. of years of experience:  
\_\_\_\_\_
4. Mention the major activities.  
\_\_\_\_\_  
\_\_\_\_\_
5. Provide details of technologies demonstrated to farmers in the past five years?  
\_\_\_\_\_  
\_\_\_\_\_
6. How many farmers are adopting these technologies?  
\_\_\_\_\_  
\_\_\_\_\_
7. Provide the reasons for dis-adoption or no adoption of these technologies.  
\_\_\_\_\_  
\_\_\_\_\_
8. Do you distribute agricultural inputs to farmers? Yes/No.
9. If yes, please provide details (type of inputs, supplied free/ subsidised price, etc.).  
\_\_\_\_\_  
\_\_\_\_\_
10. How do you select the beneficiary farmers? Please explain.  
\_\_\_\_\_  
\_\_\_\_\_
11. Mention the constraints faced in dissemination of agricultural technology to farmers.  
\_\_\_\_\_  
\_\_\_\_\_
12. What possible solutions that you think can work for addressing above mentioned constraint?  
\_\_\_\_\_  
\_\_\_\_\_

### ***Warehousing and Storage (Questionnaire)***

1. Name of the respondent/Official:  
\_\_\_\_\_
2. Name of the Organisation:  
\_\_\_\_\_
3. No. of years of Operation:  
\_\_\_\_\_
4. Mention the major activities of your facility.  
\_\_\_\_\_  
\_\_\_\_\_
5. Provide the salient features/facilities of your warehouse (capacity etc.).  
\_\_\_\_\_  
\_\_\_\_\_
6. Mention type of commodities you store, who stores, and amount charged.  
\_\_\_\_\_  
\_\_\_\_\_
7. Provide the extent of use of this facility by farmers. Outline the problems faced by them.  
\_\_\_\_\_  
\_\_\_\_\_
8. Do you issue the kind of warehouse receipt that can be used for taking loan by farmers? Yes/No. Please provide details.  
\_\_\_\_\_  
\_\_\_\_\_
9. Explain the constraints faced in the running of warehouse/storage facility.  
\_\_\_\_\_  
\_\_\_\_\_
10. What possible solutions that you think can work for addressing above mentioned constraint?  
\_\_\_\_\_  
\_\_\_\_\_

***Agricultural Market Intermediaries/Traders (Questionnaire)***

1. Name of the respondent:
2. Name of the Market:
3. Type of trader (Tick): Wholesale trader/Commission Agent/Wholesale Trader cum Commission Agent
4. No. of years of Operation:
5. Mention your major activities.

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6. Provide type of agricultural commodities do you deal with?

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7. Mention how do you fix the price of these commodities for purchasing from farmers? Please provide average purchase price for the previous year.

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8. Do you provide credit facilities to farmers? Yes/No. If yes, mention whether it is for agricultural purpose or household expenditure?

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9. Do you have storage or warehouse facility? Yes/No. If yes, provide the details.

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10. If No, where do you store your purchased commodities? \_\_\_\_\_

11. Where, to whom and when do you sell your commodities? Provide average sale price for previous year.

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12. Explain the marketing constraints faced by you.

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13. What possible solutions that you think can work for addressing above mentioned constraint?

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### ***Agricultural Credit Institution (Questionnaire)***

1. Name of the respondent/Official:  
\_\_\_\_\_
2. Name of the Organisation:  
\_\_\_\_\_
3. No. of years of Operation:  
\_\_\_\_\_
4. Mention the major activities of your facility.  
\_\_\_\_\_  
\_\_\_\_\_
5. Provide the salient features/facilities of your institution.  
\_\_\_\_\_  
\_\_\_\_\_
6. Mention type of loans issued, interest rate and other terms of conditions for availing loans by farmers.  
\_\_\_\_\_  
\_\_\_\_\_
7. Provide the extent of use of this facility by farmers. Outline the problems faced by them.  
\_\_\_\_\_  
\_\_\_\_\_
8. Do you provide agricultural inputs along with credit facilities? Yes/No. Please provide details.  
\_\_\_\_\_  
\_\_\_\_\_
9. Do you provide crop insurance facility to farmers? Yes/No.
10. If yes, please mention how works, whether successful during the bad harvest?  
\_\_\_\_\_  
\_\_\_\_\_
11. Explain the constraints faced in providing credit to farmers.  
\_\_\_\_\_  
\_\_\_\_\_
12. What possible solutions that you think can work for addressing above mentioned constraint?  
\_\_\_\_\_  
\_\_\_\_\_

## **Questionnaire for Farmers (Focus group discussion)**

### **Instruction**

Set the stage by introducing the purpose of the survey and create common understanding among the participants. State the purpose of present survey as to understand the current agricultural practices, cropping pattern, production, marketing, finance and availability of labour and material inputs and utilisation. Bring out the constraints faced with respect to land, irrigation water, fertilizers, seed, labour, machinery, prices, subsidy and infrastructure. Ask to state the **most important/biggest problem** that farmers face in the survey area and find out the causes of problem.

It is not necessary to reach consensus, in that case indicate range of answers. When estimating percentage, ask out of 10 how many ..... Any additional information should be noted down in a separate sheet.

### **I. Village Particulars**

Name of village	
Name of village panchayat	
Block/Tehsil	
District	
Cultivated area (acre)	
Tenancy status (land leased-in)	No. of tenants : _____ Area under tenancy (acre) : _____ Mode of tenancy :Share cropping-1; Fixed rent-2; Both-3; Others (specify____)-4 <input type="checkbox"/>
% area irrigated _____ and sources (%)	Open/bore well: _____ Canal : _____ Tanks : _____ Others : _____
No. of farmers using electric pump sets	
No. of farmers using diesel pump sets	
No. of tractors in the village	
Banking facilities & Distance from your village (Km)	Yes/ No _____

Nearest grain market	Place name : _____ Distance (Km) : _____
Nearest vegetable and fruits market	Place name : _____ Distance (Km) : _____
Presence of cold storage/warehousing facility: Yes-1; No-2 <input type="checkbox"/>	(a) If yes, where is located? <input type="checkbox"/> within village-1; outside village-2 (b) If outside village, where? _____ (c) Distance (Km) : _____ (d) Who owns it? Government-1; Private-2; Others (specify _____)-3 <input type="checkbox"/> (e) Is capacity of cold storage adequate? Yes-1; No-2 <input type="checkbox"/>
Approach road to village <input type="checkbox"/>	Pucca Road-1; Kuccha Road-2; Both-3
Status of transport facility available in the village for goods <input type="checkbox"/>	Adequate-1; Inadequate-2; No facility-3

## II. Land Use Constraints

2.1. Provide details of major crops grown in your village.

S.No.	Season	Crop Name	% Share of Area under Each Crop
I	Kharif		
II	Rabi		
III	Summer		
IV	Annual/Perennial		
		All crops	100%

2.2. Are all available agricultural land put under cultivation in your village?

Yes-1; No-2

2.3. Under what circumstances, cultivable agricultural land is not fully utilized in your village?  
(e.g. Inadequate rainfall, Inadequate groundwater, labour shortage, soil problem (specify),

*scattered parcels of land, non-availability of crop varieties (provide details), tenancy problem (insecurity, higher rent), etc.)*

**Note:** First ask the group's response and then go to the above list; rank them in the order of importance in a scale of 1-10 with 1 being the most important and 10 being the least important)

S. No	Constraints	Rank (1-10)

2.4. Did you observe increase in fallow land in your village in the past five years?      Yes-1; No-2     

2.5. Whether the number of times land cultivated has changed in the past five year?      Yes-1; No-2

2.6. If yes, indicate if it has      Increased-1; Decreased-2; No Change-3     

2.7. What reasons do you attribute for such a change (increase/decrease/no change) in the intensity of land use? (*e.g. high cost of inputs, low output price, low yield, pest and diseases, higher land rent, labour shortage etc.*). Read the Note in 2.3.

S. No	Reasons for Change (Tick: Increase/Decrease/No Change)	Rank (1-10)

2.8. Do you think small size of land holdings/scale of farming is a constraint for improving income from cultivation?      Yes-1; No-2     

2.9. If yes, mention the constraints. (*e.g. lack of credit worthiness, small marketed surplus, lumpy inputs, input costs, etc.*). Read the Note in 2.3.

S. No	Constraints	Rank (1-10)

2.10. What possible solutions you think that can work to increase scale of farming given the present social and economic relation among people in your village? (*e.g. functional land lease market, land pooling, cooperative farming, etc.*). Read the Note in 2.3.

S. No	Items	Rank (1-10)

2.11. Can anybody in your village lease-in land from any landowner in the village for cultivation purpose? Yes-1; No-2

2.12. If No, mention the problems in leasing the land (*e.g. government restrictions, leased-out to same caste persons, higher rent, insecure tenure etc.*). Read the Note in 2.3.

S. No	Constraints	Rank (1-10)

2.13. Do you feel that the capacity of land (soil fertility) to produce agricultural output has come down over time in your village? Yes-1; No-2

2.14. If Yes, what are the reasons for decline in soil fertility? (*e.g. intensive cultivation, excessive use of chemical fertilisers, waterlogging, unsuitable crops extracting more nutrients etc.*). Read the Note in 2.3.

S. No	Reasons	Rank (1-10)

2.15. Mention any legal issues (*e.g. lack of land title, inheritance, mutation, tenancy, etc.*) that affect investment on land by farmers in your village. Read the Note in 2.3.

S. No	Constraints	Rank (1-10)

### III. Technology and Related Constraints

3.1. Please provide the following details with respect to adoption of crop varieties in your village.

S. No.	Crop Name	Mention Names of Traditional Varieties	% of Farmers Using Traditional Varieties	Mention Names of Modern Varieties	% of Farmers Using Modern Varieties

3.2. Mention the average yield of major crops grown in your village.

S. No.	Crop Name	Yield (Quintal/acre)

3.3. Did you observe decline in crop yield in the past 10 years? Yes-1; No-2

3.4. If Yes, provide the reasons for decline in the crop yield (*e.g. use of old seeds, traditional varieties, decline in soil fertility, lack of irrigation, etc.*). Read the Note in 2.3.

S. No	Reasons	Rank (1-10)

3.5. If Yes, specify what kind of technological innovations are required?

S. No	Crop name	Items	Rank (1-10)

3.6. Did farmers in your village ever show interest to experiment some modern agricultural technology? Yes-1; No-2

3.7. Were they successful in adoption and continuing to follow such technology? Yes-1; No-2

3.8. If No, mention the problems faced in technology adoption (*e.g. high cost of technology, no technical advice, poor yield, poor quality of produce, no processing facility, etc.*). Read the Note in 2.3.

S. No	Constraints	Rank (1-10)

3.9. Which agency has provided modern agricultural technology to you? Government-1; Private-2; Krishi Vigyan Kendra-3; Agricultural University-3; Others (specify \_\_\_\_\_) -4

#### IV. Markets and Institutional Constraints

4.1. Provide the disposal pattern of agricultural produce by farmers in your village

S. No	Crop	Sold Within Village			Sold Outside the Village (e.g. Mandi)			
		% farmers sold	% quantity sold	To whom sold? (Code)*	% farmers sold	% quantity sold	To whom sold? (Code)*	Distance from village if sold outside (Km)

\*Code: Trader/Commission Agent-1; Govt. Procurement Agency (specify \_\_\_\_\_) -2; Agro-processing firms/contract farming agent-3; Others (specify \_\_\_\_\_) -4

4.2. Does market where you sell your agricultural produce has adequate infrastructure facilities (*e.g. weighing machine, warehouse, drinking water, rest room etc.*)? Yes-1; No-2

4.3. Do you get fair/remunerative price for your agricultural produce? Yes-1; No-2

4.4. If No, provide the reasons for not getting a fair price. *Read the Note in 2.3.*

S. No	Constraints	Rank (1-10)

4.5. Do you think that non-availability of fair price is the most important obstacle in expanding agricultural output? Yes-1; No-2

4.6. Are you aware of contract farming? Yes-1; No-2

4.7. Do farmers in your village practice contract farming? Yes/No.

4.8. Do you think that contract farming is an important option to overcome marketing problem?  Yes/No.

4.9. Mention the problems related to contract farming that farmers face in your village (*e.g. no dispute resolution system, high rejection rate, unfavourable price, violation of contract, etc.*). *Read the Note in 2.3.*

S. No	Constraints	Rank (1-10)

4.10. Are you aware of Farmer Producer Organisation (FPO)? Yes/No.

4.11. Have you formed any FPO in your village? Yes/No.   
If yes, how many \_\_\_\_\_

4.12. Do you think that FPO is an important option to overcome marketing problem? Yes-1; No-2

4.13. Briefly explain how FPO is functioning in your village? (*e.g. details of crop, logistics, marketing strategy, processing if any etc.*)

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What problems do you face in running the FPO successfully?

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4.14. Any new crops introduced in your village by farmers in the past 10 years? Yes-1; No-2

4.15. If yes, mention the name of the crops: \_\_\_\_\_

4.16. What proportion of farmers in your village has grown these new crops? \_\_\_\_\_

4.17. What constraints do farmers face in scaling up the area under these crops? *Read the Note in 2.3.*

S. No	Constraints	Rank (1-10)

4.18. Did farmers in your village ever attend agricultural training programmes or demonstrations? Yes-1; No-2

4.19. If Yes, when was the most recent training programme or demonstration conducted? \_\_\_\_\_

4.20. Who has conducted the above mentioned programme? \_\_\_\_\_

4.21. In what ways do you think that the training programmes are useful for improving agricultural production? (*e.g. knowledge about new technology and adoption, skill upgradation, etc.*). *Read the Note in 2.3.*

S. No	Items	Rank (1-10)

## V. Constraints Related to Inputs Supply

5.1. Provide details on use of seeds

Crop	% Farmers Using Farm-saved Seeds	% Farmers Using Purchased/Certified Seeds	If Purchased, Source (code)*	Cost of Seeds (Rs.)	% Area Covered Under Certified Seeds in Your Village

\***Source Codes:** Department of Agriculture-1, Agricultural University-2, Cooperatives/ Growers' Association-3, Private dealers/retailers-4, Krishi Vigyan Kendra-5; Fellow Farmers-6, Others (specify)-7

5.2. Are you satisfied with the quality of seeds supplied to you? Yes-1; No-2

5.3. If No, mention the problems (*e.g. varietal admixture, germination failure, physical impurity, insect damage, etc.*).

S.No	Crop Name	Constraints	Rank (1-10)

5.4. From which agency do you procure fertilisers from? Government/Cooperative Society-1; Private-2; Others (specify \_\_\_\_\_)-3

5.5. Are you satisfied with the quality of fertilisers supplied to you? Yes-1; No-2

5.6. If No, mention the problems. *Read the Note in 2.3.*

S. No	Constraints	Rank (1-10)

5.7. What percentage of farmers in your village does borrow money for carrying out various agricultural operations? \_\_\_\_\_

5.8. Mention the source of borrowing/loan for farmers in the village.

Institutions sources (e.g. banks, cooperatives) : \_\_\_\_\_ % of farmers

Non-institutional sources (e.g. traders, money lender, friends): \_\_\_\_\_ % of farmers

5.9. Mention the problems that farmers face in getting the credit.

S. No.	Institutional Sources	Rank (1-10)	Non-institutional Sources	Rank (1-10)

5.10. List the problems related to availability of labour for agricultural operations.

S. No	Constraints	Rank (1-10)

5.11. List the problems related to availability and use of machinery for agricultural operations.

S. No	Constraints	Rank (1-10)

## VI. Constraints Related to Livestock and Other Allied Activities

6.1. Mention the composition of livestock in your village.

S. No.	Particulars	No. of animals	No. of households rearing
1	No. of indigenous cows		
2	No. of crossbred cows		
3	No. of adult male cattle		
4	Buffalo		
5	Goats		
6	Sheep		
7	Pig		
8	Poultry		
9	Others (specify)		
10			

6.2. Did you observe changes (increase/decrease/no change) in livestock population in your village during the past 10 years? Yes-1; No-2

6.3. If yes, provide the following details.

S. No	Which Animals?	Population: Increase-1; Decrease-2 No Change-3	Provide Reasons

6.4. Has the farmers' preference for rearing certain type of animals changed over time in your village? Yes-1; No-2

6.5. If yes, mention which type of animals? Why?

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6.6. What is the predominant mode of feeding of animals in your village?

Stall feeding-1; Grazing-2; Both-3

6.7. Provide average yield of milk of dairy animals in your village.

S. No.	Particulars	Milk Yield (litres/day)
1	Indigenous cow	
2	Crossbred cow	
3	Buffalo	
4	Goat	

6.8. Did you observe changes (increase/decrease/no change) in milk yield in the past 10 years? Yes-1; No-2

6.9. If Yes, indicate whether it has: Increased-1; Decreased-2; No change-3

6.10. Do you have veterinary hospital at your village? Yes-1; No-1

6.11. If No, where is it located? \_\_\_\_\_ Distance from your village (Km) \_\_\_\_\_

6.12. Do farmers in your village in engaged in fishery activities? Yes-1; No-2

6.13. If Yes, how many farmers are involved? \_\_\_\_\_ how much acre \_\_\_\_\_ (or) how many ponds \_\_\_\_\_

6.14. What constraints do they face in expanding the fishery activities?

S. No.	Constraints	Rank (1-10)

**VII. Provide the prevailing rate for the items/activities in your village**

S. No	Particulars	Unit Rate (Rs)
1	Casual Agricultural Wage Rate	
	<i>Male worker</i>	
	<i>Female worker</i>	
2	Casual Non-agricultural Wage Rate	
	<i>Male worker</i>	
	<i>Female worker</i>	
3	Land Rent	
	<i>Irrigated</i>	
	<i>Rainfed</i>	
4	Tractor Rent	
5	Bullocks Rent	
6	Canal Water Rate	
7	Electricity	
8	Diesel	
9	Green Fodder (bhusa)	
10	Dry Fodder	
11	Farm yard manure	
12	Transport (tempo etc.)	
13	Others (specify)	

**I. Mention any other important problem affecting farming conditions in your village.**

S. No	Constraints	Rank (1-10)

## Annex 2: Tables of Stakeholders Interactions

**Table A1: Status of Cultivated Area and Irrigation**

District	% Area Irrigated	No. of Electric Pump-sets / Cultivated Land (1000 acre)	No. of Diesel Pump-sets/ Cultivated Land (1000 acre)	Average Number of Tractors	No. of Tractors / Cultivated Land (1000 acre)
Samastipur	92	21.32	4.02	18.67	3.52
Khagaria	100	0.87	0.38	17.00	7.39
Jamui	17	36.99	23.59	6.67	4.25
Patna	97	211.76	124.57	14.00	8.24
West Champaran	74	11.76	5.54	33.67	15.84
Purnia	99	0.67	0.22	23.67	7.89
Bhagalpur	73	12.03	4.14	10.00	3.44
Bhojpur	83	7.74	1.87	22.33	5.40

**Table A2: Tenancy Status**

District	% Area Under Tenancy	% Villages Reported		
		Share Cropping	Fixed Rent	Share Cropping & Fixed Rent
Samastipur	25.47	0.0	0.0	100.0
Khagaria	40.87	0.0	0.0	100.0
Jamui	34.57	66.7	0.0	33.3
Patna	30.59	0.0	0.0	100.0
West Champaran	3.76	33.3	0.0	66.7
Purnia	20.67	0.0	0.0	100.0
Bhagalpur	14.78	0.0	0.0	100.0
Bhojpur	12.09	33.3	33.3	33.3

**Table A3: Access to Markets and Financial Institutions**

District	Average distance to any banking facility (km)	Average distance to grain market (km)	Average distance to vegetable and fruit market (km)	% villages with pucca road
Samastipur	5.0	10.0	10.0	100.0
Khagaria	5.0	14.0	21.7	100.0
Jamui	3.3	27.0	17.0	100.0
Patna	2.3	16.0	21.7	100.0
West Champaran	4.7	11.0	11.0	100.0
Purnia	3.7	36.0	34.0	100.0
Bhagalpur	2.7	30.0	30.0	100.0
Bhojpur	4.7	24.0	24.0	100.0

**Table A4: Changes in Land use Pattern**

<b>District</b>	<b>% villages reported increase in fallow land in 5 years</b>	<b>% villages reported increase in cropping intensity in 5 years</b>	<b>% reported small landholding is a constraint</b>	<b>% reported fall in soil fertility over time</b>
Samastipur	0.0	66.7	100.0	100.0
Khagaria	0.0	100.0	100.0	100.0
Jamui	66.7	100.0	100.0	100.0
Patna	66.7	66.7	100.0	100.0
West Champaran	0.0	33.3	100.0	100.0
Purnia	33.3	100.0	100.0	100.0
Bhagalpur	66.7	66.7	100.0	100.0
Bhojpur	33.3	100.0	100.0	100.0

**Table A5: Indicators of Technology Adoption**

<b>District</b>	<b>% Farmers using modern varieties</b>	<b>Average yield of paddy (ton/ha)</b>	<b>Average yield of wheat (ton/ha)</b>	<b>Average yield of maize (ton/ha)</b>
Samastipur	80.83	2.27	2.03	3.47
Khagaria	75.38	1.73	1.47	3.00
Jamui	37.33	2.07	1.33	1.50
Patna	72.86	1.60	1.20	1.00
West Champaran	78.11	1.87	1.00	2.50
Purnia	83.83	1.60	1.20	3.83
Bhagalpur	83.02	1.60	1.18	2.80
Bhojpur	91.94	2.00	2.53	0.60

**Table A6: Technological Slowdown and Motive to Adopt New Technology**

District	% villages reported decline in crop yield in 10 years	% shown interest in experimenting with modern technology	% successful in adoption and continuity of technology
Samastipur	0.0	100.0	33.3
Khagaria	100.0	100.0	66.7
Jamui	0.0	100.0	100.0
Patna	33.3	100.0	66.7
West Champaran	33.3	100.0	100.0
Purnia	0.0	100.0	100.0
Bhagalpur	66.7	100.0	66.7
Bhojpur	0.0	100.0	66.7

**Table A7: Sources of Information About Modern Agricultural Technology (%)**

District	Government Agency	Private Agency	Krishi Vigyan Kendra	Agricultural University
Samastipur	100.0	100.0	0.0	66.7
Khagaria	0.0	75.0	25.0	0.0
Jamui	75.0	75.0	0.0	0.0
Patna	66.7	66.7	0.0	33.3
West Champaran	100.0	0.0	0.0	0.0
Purnia	100.0	66.7	0.0	0.0
Bhagalpur	100.0	0.0	33.3	33.3
Bhojpur	66.7	33.3	33.3	33.3

**Table A8: Marketing of Major Agricultural Produce**

Particulars	Paddy	Wheat	Maize	Moong	Lentil	Potato
<b>Sold within village</b>						
% farmers sold	74.58	57.42	91.14	7.17	24.17	82
% quantity sold	72.92	51.67	86.79	25.83	25	72

**Table A9: Disposal Pattern of Agricultural Produce by Type of Agency (%)**

<b>Particulars</b>	<b>Paddy</b>	<b>Wheat</b>	<b>Maize</b>	<b>Potato</b>
Trader/Commission agent	91.7	95.8	100.0	100.0
Govt. procurement agency	12.5	0.0	0.0	0.0
Agro-processing firms	0.0	0.0	0.0	0.0
Others	0.0	0.0	0.0	0.0

**Table A10: Prices and Agricultural Output**

<b>District</b>	<b>% reported not getting fair price</b>	<b>% reported lack of remunerative prices affecting agricultural output</b>
Samastipur	100	100
Khagaria	100	100
Jamui	100	100
Patna	100	100
West Champaran	100	100
Purnia	100	100
Bhagalpur	100	100
Bhojpur	100	100

**Table A11: Importance of Contract Farming**

<b>District</b>	<b>% farmers aware of contract farming</b>	<b>% farmers practicing contract farming</b>	<b>% farmers reported contract farming is an option to overcome marketing problem</b>
Samastipur	66.7	0.0	100.0
Khagaria	0.0	0.0	
Jamui	0.0	0.0	
Patna	66.7	0.0	100.0
West Champaran	33.3	0.0	
Purnia	33.3	0.0	100.0
Bhagalpur	66.7	0.0	100.0
Bhojpur	66.7	0.0	0.0

**Table A12: Importance of Farmer Producer Organisation (FPO)**

<b>District</b>	<b>% villages having FPO</b>	<b>% farmers reported FPO is an option to overcome marketing problem</b>	<b>% farmers reported ever attended agricultural training programmes</b>
Samastipur	66.7	100.0	100.0
Khagaria	0.0	0.0	66.7
Jamui	66.7	66.7	100.0
Patna	66.7	66.7	100.0
West Champaran	0.0	0.0	100.0
Purnia	0.0	0.0	33.3
Bhagalpur	0.0	33.3	66.7
Bhojpur	0.0	0.0	100.0

**Table A13: Use of Improved Seeds and Fertilisers**

<b>Particulars</b>	<b>% farmers using certified seeds</b>	<b>% area covered under certified seeds</b>
Paddy	97.8	64.7
Wheat	88.5	30.9
Maize	87.5	32.1
Moong	39.8	5.0
Lentil	18.6	3.5

**Table A14: Quality of Seeds and Fertilisers Supplied**

<b>District</b>	<b>% farmers satisfied with quality of seeds</b>	<b>% farmers satisfied with quality of fertilisers</b>
Samastipur	0.0	66.7
Khagaria	100.0	100.0
Jamui	66.7	33.3
Patna	0.0	0.0
West Champaran	0.0	33.3
Purnia	33.3	66.7
Bhagalpur	33.3	66.7
Bhojpur	0.0	33.3

**Table A15: Access to Agricultural Credit**

<b>District</b>	<b>% farmers indebted</b>	<b>% farmers borrowed from institutional sources</b>	<b>% farmers borrowed from non-institutional sources</b>
Samastipur	56.67	2.29	97.71
Khagaria	66.67	3.06	96.94
Jamui	36.67	26.67	73.33
Patna	70.00	17.16	82.84
West Champaran	83.33	26.30	73.70
Purnia	93.33	11.11	88.89
Bhagalpur	86.67	11.67	88.33
Bhojpur	76.67	8.56	91.44



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