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Agricultural Growth Diagnostics for Bihar (India): Identifying the Binding Constraints and Policy Remedies

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AGRICULTURAL GROWTH DIAGNOSTICS FOR BIHAR (INDIA)

IDENTIFYING THE BINDING CONSTRAINTS AND POLICY REMEDIES

NCAER Working Paper

Elumalai Kannan* and Sanjib Pohit**

Abstract

Agriculture plays a significant role in the economic development of the underdeveloped regions. Bihar in eastern India remains the poorest State despite the introduction of various policy reforms in the agricultural sector since the mid-2000s. We develop a growth diagnostics framework for the agricultural sector in order to identify the most binding constraints on its growth. Our results show that poor functioning of agricultural markets and a low level of crop diversification are the reasons for lower agricultural growth in Bihar. A rise in the level of instability in the prices of agricultural produces indicates that price transmission across the markets is very weak even after repealing of the Market Committee Act. Weak market linkages and non-functional producer collectives are two important constraints responsible for the low level of crop diversification. Our policy suggestions include the state provision of basic market infrastructure to attract private investment in cold storage/warehousing facilities, strengthening of the functioning of ground-level institutions such as farmer producer organisations, and preparation of a comprehensive policy on crop diversification including contract farming.

Keywords: Agriculture, Growth Diagnostics, Binding Constraints, Bihar, India

JEL codes: Q10, Q11, Q12, Q13, Q15, Q16

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1 INTRODUCTION

Bihar is one of the poorest States in India despite being located in the fertile Gangetic plains, and it also scores very low on the Composite Development Index (Government of India, 2013).[1] The average per capita income of Bihar was twenty times less than that of the State of Haryana during 2008-16 (Pohit *et al.*, 2019).[2] However, since its bifurcation into the present States of Bihar and Jharkhand in the year 2000, the economy of Bihar has started growing significantly, exhibiting a definite structural shift from the primary sector to the services sector. Yet despite this shift in the structural composition of the economy, agriculture still contributes over a quarter of the State's income and employs about 70 per cent of the rural workforce. Robust growth in the agriculture sector thus holds the key for the economic and social development of the State (Thakur *et al.*, 2000; Government of India, 2008; Fujita, 2014). Keeping this in view, the Government of Bihar has, since 2008, launched multiple development initiatives under the so-called agriculture roadmaps.[3] The thrust is on the holistic development of agriculture with an emphasis on increasing productivity growth and improving farmers' income.

These initiatives seem to have helped in accelerating Bihar's agricultural growth (Minato, 2014). Our estimates show that the agriculture sector registered an annual growth of 2 per cent during the period 2000-01 to 2007-08. During the subsequent period from 2008-09 to 2011-12, agricultural growth increased considerably to 3.1 per cent, which led to a very high growth rate of 10.9 per cent in the Gross State Domestic Product (GSDP). However, during the subsequent period of five years, that is, 2012-13 to 2016-17,, agricultural growth decelerated to 1.3 per cent, which also pulled down the overall economic growth of the State to 6.6 per cent.

Given the scarcity of financial resources at the State level, it is extremely important to ensure the efficient use of resources for the holistic development of the agriculture sector. In this context, it is important to identify the most binding constraints on agricultural growth. It is our contention that the removal of these constraints through policy reforms would unleash the growth potential in the sector (Hausmann and Klinger, 2008). This paper, therefore, covers the growth diagnostics of Bihar's agriculture sector with the objective of identifying the most binding constraints on the factors responsible for accelerating the output growth. We specifically focus on the crop sector, as it accounts for over two-thirds of the agricultural output and its impact on the overall agricultural growth is relatively high as compared to that of the other sub-sectors.[4] This paper makes two important contributions by: (i) developing a growth diagnostics framework for the agricultural sector, and (ii) identifying the most

[1] For a recent analysis on the performance of Bihar in comparison with other Indian States, see World Bank (2005), Chanda (2011), Rasul and Sharma (2014), Ghatak and Roy (2015), and Hoda *et al.* (2017).

[2] A similar analysis of the income gap between agricultural households in Bihar and those in other Indian States can be found in Chakravorthy *et al.* (2019). For examining the income inequality between the regions in Bihar, please see Thakur *et al.* (2000) and World Bank (2005).

[3] The timelines of the agriculture roadmap are as follows: the first—2008/09 to 2011/12, the second—2012/13 to 2016/17, and the third—2017/18 to 2022/23. Each of these roadmaps lays down the production targets/milestones through popularisation of various technologies, such as quality seeds, machinery, animal breeds, and organic inputs through various programmes in a time-bound manner (Kannan and Pohit, 2019).

[4] Although the livestock sector accounts for over a quarter of the agricultural output, consistent and reliable data on different activities are not available (Pohit *et al.*, 2019).

binding constraints on agriculture in a particular region (Bihar), and suggesting policy remedies to deal with these constraints.

The rest of the paper is organised as follows. Section 2 provides the methodological framework, which is a modified growth diagnostics framework based on Hausmann *et al.* (2008a and 2008b). Section 3 traces the agricultural performance of Bihar with a view to identifying the most binding constraints in the crop sector. Section 4 discusses the dimensions of these constraints. The final section offers policy recommendations.

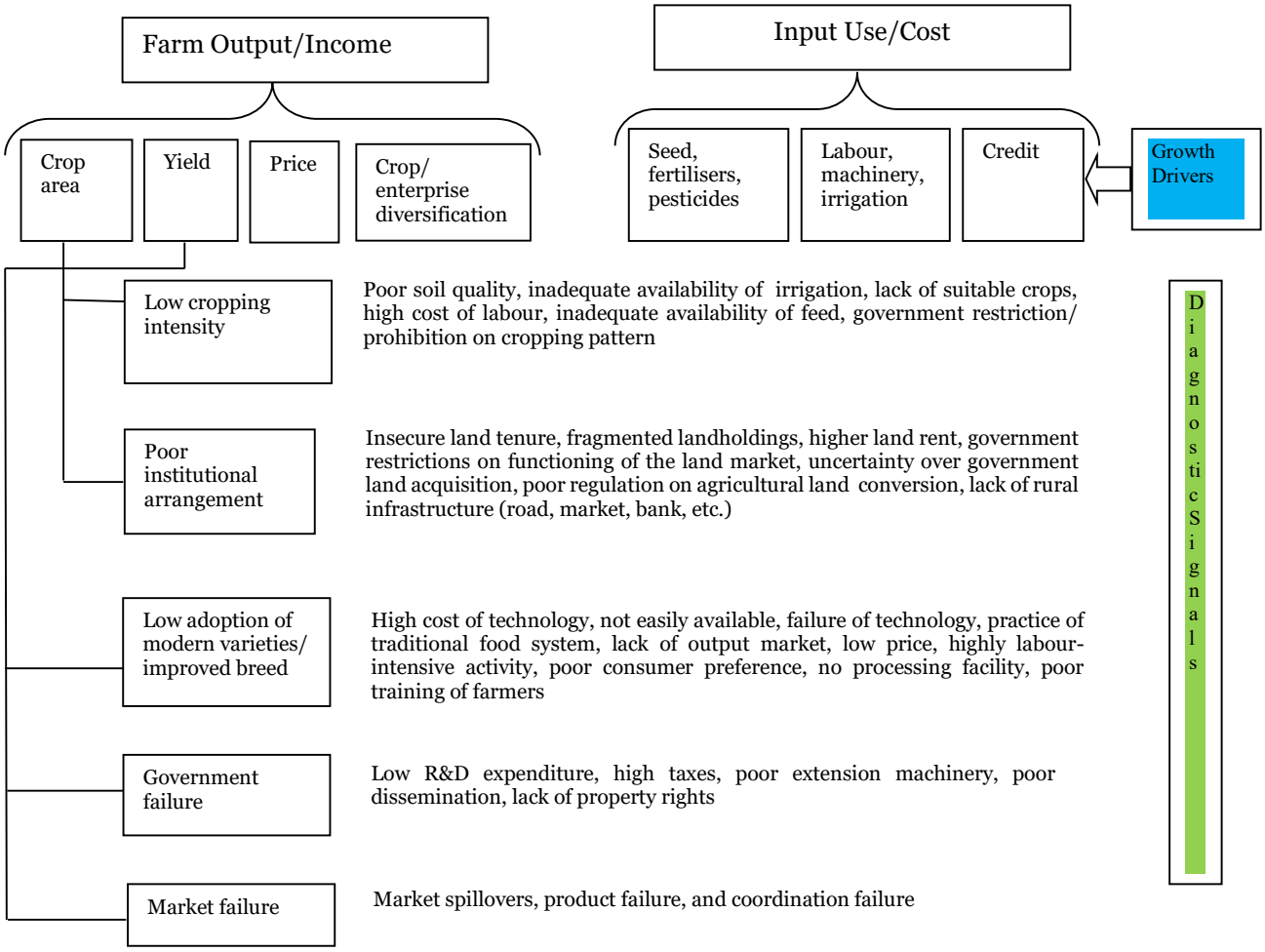
2 METHODOLOGICAL FRAMEWORK AND DATA

The growth diagnostic framework is conceptualised as a decision tree, which follows a top-down approach. This framework starts with the determinants of economic growth and then identifies the distortions that underlie the binding constraints (Hausmann *et al.*, 2008a; 2008b). Economic theory and existing empirical evidence help in the identification of growth drivers and binding constraints. Although this framework is widely used for analysing the binding constraints affecting the overall economic growth of a country (World Bank, 2006; Hausmann and Klinger 2008; Obuchi *et al.*, 2016; Hausmann *et al.*, 2017), its application for unravelling the constraints of a particular economic activity or sector at a regional level within a country is much limited. Hence, we develop a growth diagnostics approach for agriculture that can easily be adopted in the context of any country. Our framework retains the insights of the Hausmann *et al.* (2008a) growth diagnostics while capturing the key elements of agriculture.

The starting point of our modified growth diagnostics framework is the Minot *et al.* (2006) approach. This approach helps to analyse the drivers of output growth and then to diagnose which of these forces poses the greatest obstacles to higher growth. The next step is to uncover the distortions associated with these growth constraints with the assumption that the removal of these distortions would unleash growth. As the Minot *et al.* strategy focuses only on the gross revenue side of the growth analysis, it can easily be extended to incorporate the cost side as well. With the expectation of a higher market price, a profit-maximising farmer will grow better yield-giving crop varieties to increase production and adopt technology that would facilitate the efficient use of inputs and thereby help to save costs.[5] The objective of enterprising farmers is to maximise their profit from farming activities through the adoption of both output-enhancing and resource-saving technologies. Therefore, it is useful to combine the elements of the growth decomposition approach of Minot *et al.* with those of Hausmann *et al.* for analysing the agricultural growth diagnostics.

[5] In fact, modern agricultural technology tends to generate additional income streams at a little co

Figure 1: The Minot and Hausmann Hybrid Framework for Agricultural Growth Diagnostics



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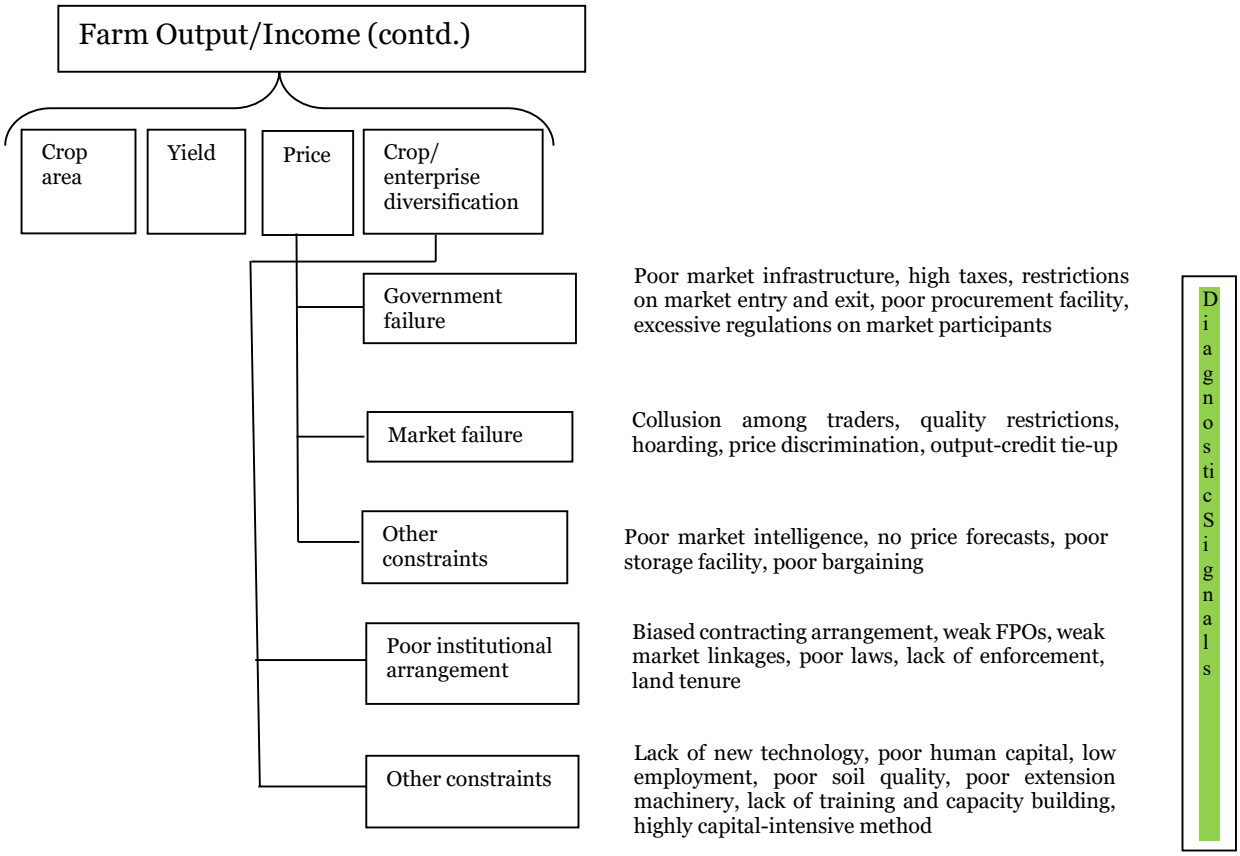

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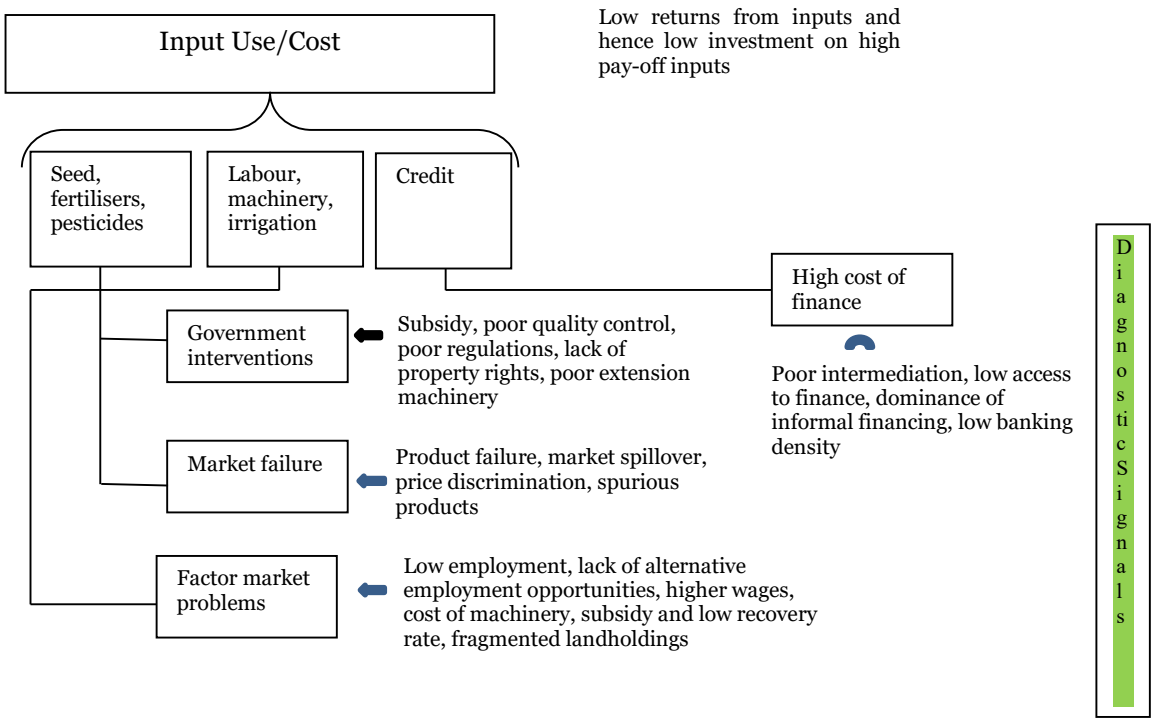


Figure 1 depicts a hybrid of the Minot and Hausmann framework developed to analyse agricultural growth. Agricultural output growth depends on farm size, yield (technology), price and crop/enterprise diversification. Similarly, input use depends on the availability of seeds, fertilisers, pesticides, labour, machinery, irrigation, and credit. Let us suppose that the overarching problem in Bihar is identification of the reason as to why agricultural growth has slowed down in the State in recent years. The application of growth diagnostics entails 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 (land constraint), it is important to assess if that is due to poor soil quality, inadequate irrigation facility, expensive labour, or government restrictions on a particular cropping pattern. Is the low scale of farming also due to an insecure land tenure, fragmented landholdings, high rent or restrictions on land leasing? The 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, high cost of technology, failure of technology, poor training of farmers on how to use the technology, low expenditure on agricultural research and development, high taxes, or poor definition of property rights? Similarly, binding constraints on other determinants of output growth can be identified. The information thus obtained can be used to locate remedies for overcoming the obstacles to growth.

On the input side, farmers could face a situation wherein they get lower returns from the use of inputs, leading to a low level of motivation, in turn, resulting in under-investment on high pay-off inputs. If the problem is the non-availability of quality inputs, is that due to poor quality control, corruption, a poor delivery system, or high costs? If the problem is the 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, seeds, labour, irrigation, and machinery can be identified and suitable remedies designed to remove these constraints.

The broad framework discussed above is complemented by the following analytical tools.

A growth accounting approach proposed by Minot *et al*. (2006) is followed to analyse the sources of crop output growth. According to this approach, the change in gross crop income is decomposed into the: (i) area effect, (ii) yield effect, (iii) price effect, (iv) diversification effect, and (v) interaction effect. The elements of these components have already been depicted in Figure 1.

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:

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

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:

$$R = \left(\sum_{i=1}^{n} a_i Y_i P_i\right) \sum_{i=1}^{n} A_i \quad (2)$$

Taking the total derivatives of this equation and re-arranging the terms gives the following expression:

$$dR \cong \left(\sum_{i=1}^{n} a_i Y_i P_i\right) d\left(\sum_{i=1}^{n} A_i\right) + \sum_{i=1}^{n} A_i \sum_{i=1}^{n} (a_i Y_i dP_i) + \sum_{i=1}^{n} A_i \sum_{i=1}^{n} (a_i P_i dY_i) + \sum_{i=1}^{n} A_i \sum_{i=1}^{n} (Y_i P_i da_i) \quad (3)$$

Equation (3) decomposes the change in gross revenue to various factors. 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 while the second term factors in the effect 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. Finally, 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. In order to compute the sources of output growth, we consider 31 crops which account for about 98 per cent of the total cropped area in the State.

Further, we have estimated the growth in Total Factor Productivity (TFP) for major crops by using the Tornqvist-Theil Index to analyse the contribution of technological change in output growth. The logarithmic form of the Index is given 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 the revenue share of the jth output, S_i is the cost share of the ith input, Y_{jt} is the output and $X_{it}$is the input measured, all in period t.

Here, the total output growth is estimated by adding the growth of each output weighted by its revenue share while the input growth is estimated by adding the growth of each input weighted by the cost share. The difference between the growth of

the total output and the growth of the total input is called 'TFP growth'. The cost of cultivation survey provides detailed information about the inputs and output for six major crops, viz., paddy, wheat, maize, gram, lentil, and potato, and the same has been utilised here for computation of TFP.

The present study relies on both secondary and primary data. Secondary data on crop production, operational landholdings, and farm harvest prices were sourced from the Directorate of Economics and Statistics, Ministry of Agriculture and Farmers' Welfare, and the value of the crop output was derived using data from the Central Statistics Office, Government of India. With respect to primary information, field work[6] comprising in-depth discussions with various stakeholders was conducted during the period February-July 20These stakeholder discussions included 24 Focus Group Discussions (FGDs) with farmers and 24 personal interviews with experts in the areas of seeds, fertilisers, irrigation, marketing, processing, horticulture, agricultural technology, and credit. The field work was conducted primarily for exploring various viewpoints and ground-level experiences in identifying the binding constraints and possible options for removing these constraints. The results from the analysis of qualitative information were useful to explain the findings from the quantitative analysis.[7] In order to ensure consistency in our analysis, we use the latest available data for the post-bifurcation period from 2000-01 to 2016-17.

3 THE RELATIVE PERFORMANCE OF AGRICULTURE

Agriculture holds the key to the overall development of Bihar's economy. The average annual growth in agriculture and allied activities during the pre-agriculture roadmap was only about 2 per cent (Table 1). During the period of the first agriculture roadmap, 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 was not sustained in the long run. The average annual growth rate declined to 1.28 per cent during the period of the second agriculture roadmap. During the overall period of 2001-02 to 2016-17, the average growth was only 2 per cent, which was much below the national average agricultural growth of 3.1 per cent. The moot question is: What explains the fall in agricultural growth despite the prevalence of a stable political environment, improvements in investment on rural infrastructure, and the advent of reforms in agricultural marketing (Intodia, 2012; Fujita, 2014).

[6] Field work was carried out in eight districts spread across all the four agro-climatic zones (ACZs). They include West Champaran and Samastipur (ACZ-I), Purnea and Khagaria (ACZ-II), Bhagalpur and Jamui (ACZ-IIIA), and Bhojpur and Patna (ACZ-IIIB). Three villages were selected from each district.

[7] For details of the qualitative analysis, see Pohit *et al.* (2019).

TABLE 1: Average Annual Growth in Major Sectors of Bihar's Economy

Sectors	Agricultural Roadmap Period			Overall
	Pre (2001/02 – 2007/08)	***First (2008/09 – 2011/12)***	***Second (2012/13 – 2016/17)***	***2001/02 – 2016/17***
Agriculture and allied	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
Non-agriculture	6.93	14.44	7.02	8.83
Overall	4.68	10.86	6.56	6.81

Source: National Accounts Statistics (various years), Government of India.

3.1. Changes in Landholding and Crop Area

In Bihar, landholdings are highly fragmented and increased sub-division of land has taken place over time. The partial implementation of land reforms and excessive demographic pressure, among others, are responsible for the uneven distribution of landholdings (Chakravarthi, 2001; Kishore, 2004; Sharma, 2005; ADRI 2008; Minato, 2014). At the national level, marginal holdings constituted about 68.5 per cent in 2015-16, whereas the corresponding figure in Bihar was 91.2 per cent (Table 2). Landholdings with less than 2 hectares (ha) accounted for 97.0 per cent of the total landholdings, and this has shown an upward trend over time. As a result, the average size of the operated area came down considerably from 0.43 ha in 2005-06 to 0.39 ha in 2015-16.

Table 2: Distribution of Operational Holdings and Average Size of the Operated Area

State	2005-06		2015-16	
	Bihar	***All-India***	***Bihar***	***All-India***
Operational Holdings (%)				
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
Average size of operated area (ha)				
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, Government of India.

The shrinking size of landholdings affects the economic viability of farming and its capacity to support the livelihoods of farmers (Otsuka *et al.*, 2016). The size of

landholdings influences the type of crops grown, technology adoption, price realisation, credit-worthiness, and effective bargaining in the output and input markets (Singh *et al.*, 2009; Dev, 2012). Some of these features seem to have influenced the decision of Bihar's farmers in allocating the cultivable area to different crops (Table 3). Three crops, viz., paddy, wheat, and maize account for about 70 per cent of the total cropped area and 40 per cent of the total value of crop output. However, the importance of paddy among the farmers has come down marginally. The area under paddy is being shifted to the cultivation of maize. Farmers increasingly prefer to grow maize due to its growing demand in the food processing industry and as poultry feed (Hellin and Erenstein, 2009; Sinha, 2018). Similarly, the area under wheat has increased and it constituted over a quarter of the total cropped area. The decline in area under the Rabi (winter) coarse cereals has been compensated by a rise in the area under wheat.

Table 3: Relative Share of the Crop Area and Value of the 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 Foodgrains	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 and *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 and 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: Computed based on data from the Directorate of Economics and Statistics (DES), Ministry of Agriculture and Farmers' Welfare, and National Accounts Statistics (various years), Government of India.
Note: TE-Triennium Ending.

Between 2002-03 and 2016-17, the area under pulses declined by over 20 per cent despite a significant rise in their minimum support prices during the past few years (Government of India, 2016). Similarly, the area under jute, cultivated in north Bihar, has declined considerably. Lack of a proper policy and institutional support, and weak

markets are responsible for the decline in jute cultivation (Sarkar, 1986; Jha and Viswanathan, 1999).

However, the area under sugarcane has increased considerably during recent years. The share of sugarcane in the total cropped area rose from 1.3 per cent to 3.2 per cent between 2002-03 and 2016-17. The availability of groundwater and an increase in the number of sugar mills are partly responsible for the increase in the area under sugarcane (Solomon, 2016). Because of its 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 only about 6 per cent of the total cropped area, they contributed over 40 per cent of the total value of output. However, evidence from the field shows that the lack of proper marketing arrangements, poor infrastructure, and inadequate institutional support act as deterrents to increased diversification towards the cultivation of fruits and vegetables.

3.2. Sources of Output Growth

The sources of crop output growth are delineated in Table 4. Between 2001-02 and 2007-08, the contribution of price to the crop output growth was significantly higher along with diversification. These effects could not help much in boosting output growth due to the large negative effect of yield during this period. However, output growth of about 3.6 per cent during the period 2008-09 to 2016-17 has been bolstered with the impressive contribution of the yield effect. The contribution of the diversification effect has also improved and has positively influenced output growth. Improvement in the diversification effect shows the extent of area re-allocation by farmers from low-productive crops to high-productive crops such as horticultural crops. The contribution of real price and area expansion to the overall output growth was negative during the recent period implying that they have ceased to be positive factors for growth.

On the whole, the yield effect was dominant, along with positive diversification and price effects. The contribution of the price effect to output growth is lower, at 10.2 per cent, than that of the yield effect. The negative interaction effect is largely due to a fall in the contribution of the area effect to output growth. The diversion of productive agricultural land for non-agricultural uses and the increase in fallow land are responsible for a fall in the cultivated land (Pohit *et al.*, 2019; van Duijne, 2019).

Table 4: 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' estimates.

Having examined the factors responsible for the slow-down of agricultural growth, we now focus on distortions associated with the growth drivers by identifying their proximate determinants as depicted in the diagnostics framework. In the case of farm output, the proximate determinants are area expansion, yield improvement, price, and the diversification effect. The question is whether any or more than one of these factors explain the slow-down in agricultural growth in Bihar.

To begin with, can the poor performance of agriculture be explained by the decline in agricultural land? Similar to other Indian States, there is increased competition for land between agricultural and non-agricultural uses in Bihar as well (Hoda *et al.*, 2017; van Duijne, 2019). However, the proportion of non-agricultural land to the total land area remained constant in Bihar (Table 5). The land use patterns in Bihar are not dissimilar to the trend observed at the national level.

Table 5: Ratio of Agricultural Land and Non-Agricultural Land in the 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

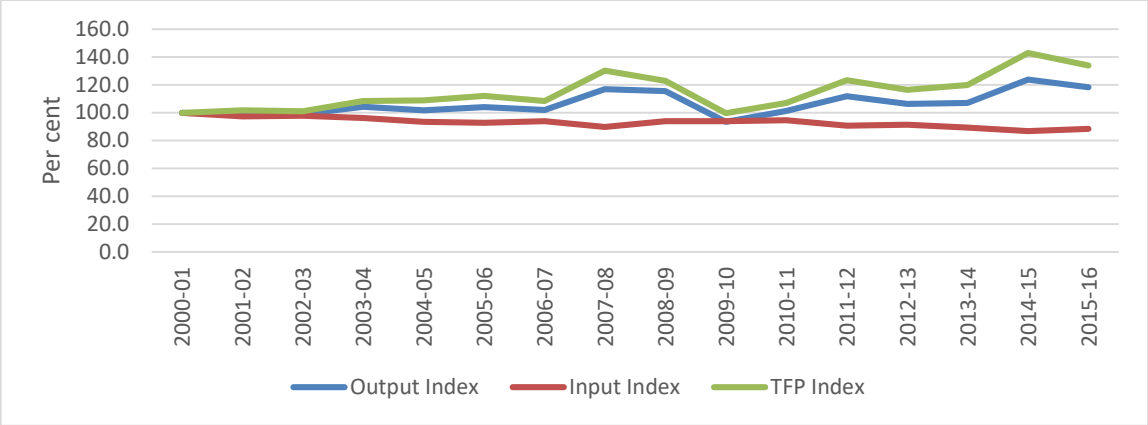
***Source*:** Computed based on data from the Directorate of Economics and Statistics (DES), Ministry of Agriculture and Farmers' Welfare, Government of India.
***Note*:** AL-Agricultural land; NAL-Non-agricultural land; Agricultural land includes net sown area and fallow land.

Further, an analysis of the sources of output growth showed that the overall effect of the crop area was negative. There was a significant variation in the relative shift of area across the crops. With near stagnation or fall in the net sown area, the gain in area for wheat, maize, sugarcane, and vegetables has happened through the re-allocation of the existing land by the farmers. There is no scope for further expansion of cultivated land. However, one important problem that Bihar's agriculture sector faces is that of fragmented landholdings. This can be a potential problem, leading to low economies of scale, but this cannot be a source of low agricultural growth as small-sized farms are

found to be more productive (Chand *et al.*, 2011; Dev, 2012).[8] Therefore, it is clear that agricultural land is unlikely to be a causal factor for the slow-down of agricultural growth in Bihar.

Can the low yield of major crops be the reason for lower agricultural growth? If low yield is a problem, one would expect a low level of technological 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 the TFP. A lower TFP growth, keeping the effects of material inputs constant, would indicate lower yield growth and consequently results in lower output growth (Fuglie, 2019).

Figure 2: Trend in Output, Input, and TFP Index



Source: Computed by the authors.

The trend in weighted indices of output, input, and TFP is presented in Figure 2. The aggregate output index showed a gradual rising trend from 2000-01 to 2005-06. The output index increased in the subsequent years and then declined in 2009-10. There seems to have been a structural break in the output series during 2009-10, which was caused by widespread drought in the different regions of Bihar (GoB, 2016). 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 roadmap. However, the aggregate input index declined steadily during the entire period. This indicates that input use in the cultivation of the crops is low and 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 average annual growth in TFP was 1.71 per cent between 2000-01 and 2015-16. Bihar's agricultural TFP growth is quite comparable with the TFP growth of 1.60 per cent at the national level (Fuglie, 2019). This implies that Bihar's agriculture sector tended to catch up with technological progress at the national level. Therefore, it is clear that slow or non-existent technological progress is not the basic reason for the slow-down in agricultural growth.

[8] For recent international evidence on this relationship, see Sheng et al. (2019).

Table 6: Yield of Major Crops in Bihar and India (Ton/Ha)

Particulars	Bihar			India		
	TE 2002-2003	***TE 2007-2008***	***TE 2016-2017***	***TE 2002-2003***	***TE 2007-2008***	***TE 2016-2017***
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 and Mustard	0.80	0.97	1.11	0.93	1.07	1.14

Source: Computed based on data from the Directorate of Economics and Statistics (DES), Ministry of Agriculture and Farmers' Welfare, Government of India.
Note: TE-Triennium ending.

A comparison of the actual yield of major crops in Bihar with the crop yield at the national level also reveals a similar picture (Table 6). The yield of crops under consideration has shown an increasing trend over time. The yields of rice and wheat in Bihar was slightly lower than the corresponding yields at the national level. However, with a trend growth of about 4.40 per cent in rice and 1.77 per cent in wheat between 2000-01 and 2016-17, the yields of these crops will certainly surpass the national average yields in the short run. The yields 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 the fact that there has been an improvement in the crop yield over time and hence, low yield cannot be the reason for low agricultural growth.

India's agricultural markets have long been regulated by the government-run Agricultural Produce Market Committees (APMCs). These markets fall under the purview of State governments, which formulate policies to ensure fair trading, transparency in transactions, and provision of the necessary infrastructure facilities, leading to better price discovery. However, a multitude of problems has affected the effective functioning of the APMCs. Some of the well-documented problems of the APMCs have included the collusion of traders with each other, malpractices in transactions, high market fees, poor infrastructure, diversion of market fees for development works other than for markets, and lack of competition (Banerji and Meenakshi, 2002; Chand, 2003; Acharya, 2004).

Many reforms were introduced to promote competition in agricultural markets and ensure better prices for farmers through legislative measures. For instance, the Model Act on the State Agricultural Produce Marketing (Development and Regulation Act 2003) mandated far-reaching reforms, among others, to provide a level playing field for farmers, rationalise the structure of market fees, and encourage private investment for creating the necessary infrastructure. While most State governments amended their Acts to incorporate these suggested measures Bihar was the only State that repealed the APMC Act itself in 2006. This allows the traders to purchase agricultural commodities directly from the farmers.

Did these reforms improve price efficiency in the agricultural markets of Bihar? With the abolition of the APMC Act, one would expect the grain markets in Bihar to be integrated not only within the State but also with markets in the other States. Farmers are free to sell to traders in any part of Bihar and elsewhere in the country. This would imply that there is an effective price transmission between the grain markets within the State, allowing farmers to receive better prices. Further, with the integration of markets, volatility in grain prices will be low because of a better flow of information about the supply and demand conditions across the markets.

Table 7: Average Wholesale Price before and after the Repeal of the APMC Act

Commodity	Before the Repeal (2002-06)		After the 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 prices[9] of major crops, such as paddy, wheat, and maize, have increased during the post-market reforms period as compared to the pre-reform period (Table 8). However, the volatility in grain prices has also increased, which is evident from the increase in the value of the coefficient of variation. Instability in the prices of agricultural produce also affects the farmers' decision to allocate areas under different crops and adopt improved cultivation practices (Acharya, 2004; Acharya *et al.*, 2012; Kishore, 2004). 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 the market demand for certain products, augmenting farm income, as a mechanism to mitigate price risk, and for enriching soil fertility (Kumar *et al.*, 2010; Kannan, 2012). The evidence shows that the per capita consumption of cereals has declined, while the consumption of fruits, vegetables, and animal-based products has increased over time (Kumar *et al.*, 2007; Ganesh Kumar *et al.*, 2012). However, the 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 (Joshi *et al.*, 2005; Birthal *et al.*, 2015).

Can a low level of crop diversification be the reason for low crop output growth in Bihar? An analysis of the sources of output growth has shown that crop diversification has contributed over a quarter of the output growth during the past one and half

[9] Consistent data on the wholesale prices of different agricultural commodities have not been available since the abolition of the APMCs. We could compile market-wise data for paddy, wheat, and maize from the government portal, agmarknet.gov.in. For other crops, a continuous series of price data are not available.

decades. Importantly, the effect of crop diversification on output growth has improved considerably during recent years. However, looking at the relative share of the crop area gives the impression that the level of crop diversification is very low. In fact, just three crops, viz., paddy, wheat, and maize, dominate the cropping pattern, accounting for about 80 per cent of the total cropped area during 2016-17. The share of the area under fruits and vegetables was only about 6 per cent.

Is there a scope for the State of Bihar to go in for greater diversification towards high-value horticultural crops? An index of the relative importance of crops has been developed to assess the comparative advantage in growing horticultural crops in the State of Bihar. The Comparative Advantage Index (CAI)[10] is defined as the ratio of the area share of a crop in Bihar to the area share 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 a comparative advantage in growing that crop.

Table 8: Comparative Advantage in Growing Horticultural Crops in Bihar

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

Source: Computed based on data from the Directorate of Economics and Statistics (DES), Ministry of Agriculture and Farmers' Welfare, Government of India.

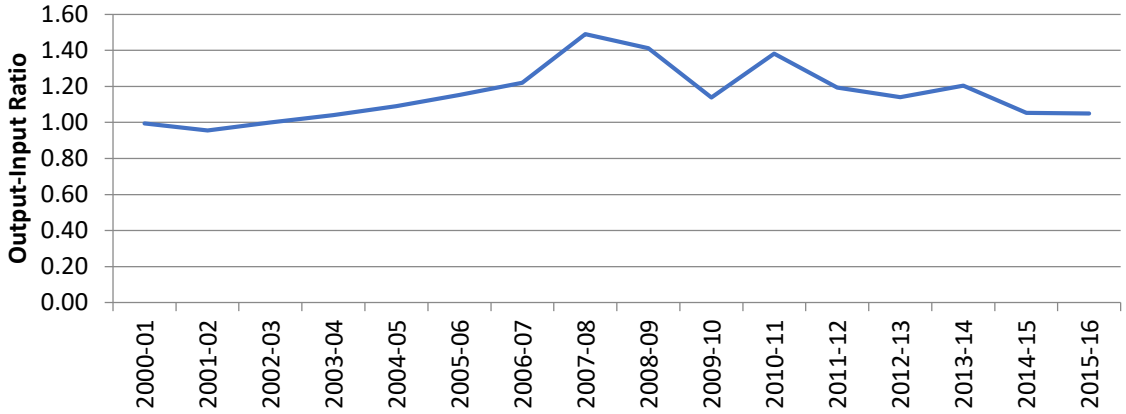
Table 8 shows that Bihar has a very high relative advantage in growing vegetables but the value of the CAI for vegetables declined from 1.82 in 2013-14 to 1.72 in 2015-16. There has been some improvement in the relative advantage in the cultivation of fruits during the recent year. Even though Bihar 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 the low agricultural growth in Bihar.

An important feature of the Minot and Hausmann hybrid framework is that it considers the input side of total revenue. This is important because farmers maximise their incomes by either enhancing the value of output or reducing the cost of inputs. Expenses on inputs can be reduced through the use of inputs in the correct amounts, application of timely inputs, and the proper method of its placement. The agriculture roadmaps implemented have focused on, among others, the distribution of material inputs such as seeds, fertilisers, pesticides, machinery, and the provision of credit to farmers. Evidence shows that the use of these inputs and mechanisation of agricultural operations in response to rising wages has increased over time (Biggs *et al.*, 2011; Reddy *et al.*, 2014). These developments entail a rise in the cost of cultivation of crops.

[10] $CAI_{ij} = (X_{ij}/X_j) / (X_{iw}/X_w)$, where, X_{ij} is area under crop j in the state i, X_i is total crop area of state i, X_{iw} area of crop j in the country and X_w is total crop area in the country.

Can rising input costs be the reason for the lower output growth in Bihar? An increase in the cost of inputs leads to reduction in the 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 3: Ratio of Gross Value of Output to the Total Input Costs



Source: Computed based on CACP data, Ministry of Agriculture and Farmers' Welfare, Government of India.

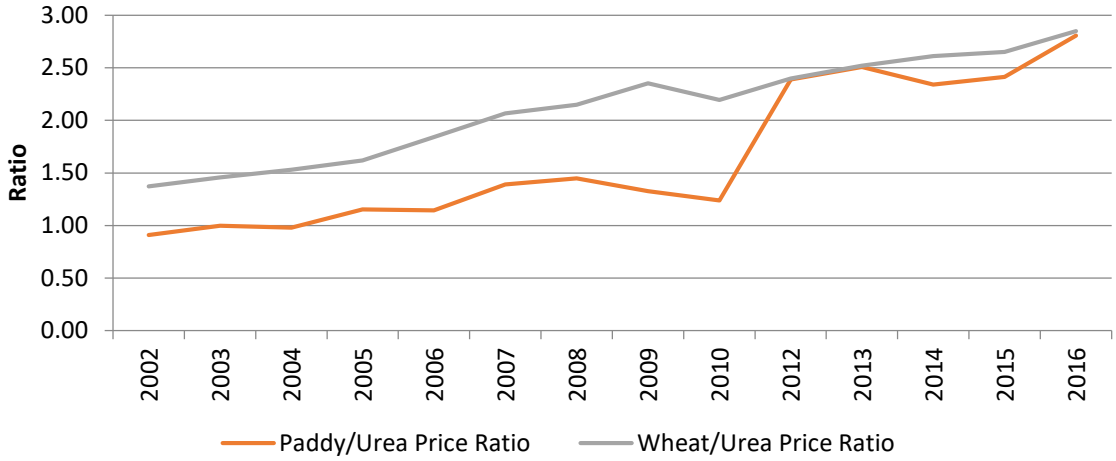
In order to analyse the extent of increase in the input costs, we take the ratio of the value of the aggregate crop output to the aggregate input costs. This shows that the value of the crop output was much higher than the total input costs (Figure 3). The ratio of output over inputs showed an increasing trend until 2007-08, and thereafter it started fluctuating with a declining trend. It has, however, remained above 1, indicating that a proportionate increase in the output value is higher than the total inputs, though it has weakened during recent years. This also implies that profitability in crop cultivation has declined.

The use of purchased inputs in the cultivation of crops has increased over time (Sen and Bhatia, 2004; Kannan, 2015; Government of India, 2017). With the adequate availability of irrigation, farmers apply external inputs such as fertilisers and pesticides to attain higher yields. The existing crop varieties are, in fact, responsive to the application of these inputs for producing higher yields. However, the use of these purchased inputs entails access to finance and the availability of quality inputs on time. Since it is difficult to analyse the price of all the individual inputs, the ratio of the fertiliser price[11] (urea) to the grain price has been analysed here to assess if the input costs affect the growth performance. Figure 4 shows that the ratio of the wholesale price of wheat to the urea price was more than 1 throughout the study period. A similar trend could also be observed in the relation of the paddy price to the urea price. This indicates that the grain price was higher than the fertiliser price. This corroborates the

[11] Among various types of fertilisers, the application of urea is relatively high among the farmers (Sharma and Thaker, 2010; Chand and Pavithra, 2015).

earlier finding that the output value has proportionately risen more than the input costs. Further, the analysis of the 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.

Figure 4: Grain to Fertiliser Price Ratio



Source: Computed based on CACP data, Ministry of Agriculture and Farmers' Welfare, Government of India.

It is clear from the analysis that the 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's agriculture sector.

4 EXPLAINING THE BINDING CONSTRAINTS

This section analyses the factors/distortions associated with the most binding constraints on agricultural growth in Bihar.

4.1. Constraints on Agricultural Markets

The repeal of the APMC Act in 2006 did not usher in private investment to create new markets and/or to strengthen the facilities in the existing markets. Further, FGDs with farmers and traders revealed that agricultural markets are located far away from the villages and that a particular market serves a large number of villages. Reportedly, there were no storage facilities available in the villages. Even though limited private warehouse facilities were available within a radius of about 25-30 km from the

surveyed villages, the storage cost[12] in private warehouses was too high for most farmers. Only, large landholders and 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 were not getting a fair price for their agricultural produce. Most farmers reported that their poor economic conditions and the need for immediate cash after the harvest compelled them to sell at a lower price to traders or commission agents. Further, government market facilities are not available near the village. Even if farmers take their produce to a distant market yard, they need to bribe the commission agents for facilitating the transactions. Farmers also cannot store produce in their households due to lack of space and the necessary storage conditions to avoid the spoilage of grains. Therefore, they are forced to sell at whatever the price the traders are willing to offer.

Further, the participation of government agencies in the procurement of grains and the scale of procurement are reportedly very low. In Bihar, Primary Agriculture Cooperative Societies (PACS) are entrusted with the procurement operation, particularly of paddy and wheat, from the farmers at the government announced Minimum Support Price (MSP). Ground-level evidence through discussions with farmers show that the procurement operation is limited to a certain amount and time, and these restrictions are considered to be highly arbitrary. The PACS do not procure wheat at a time, which otherwise it should, when there is a glut in the market and consequently farmers get a lower price for it. Unfortunately, even at the PACS, farmers reportedly receive a price that is much lower than the MSP, and even these payments are not made in time. Further, an important function of the PACS is to provide crop loans to farmers. In case farmers have taken loans, the final settlement of the sale proceeds is made after deduction of the loan amount. These issues potentially deter the farmers from selling their crop harvests to PACS.

Under these situations, farmers are left to the mercy of traders who unscrupulously fix a lower price for the agricultural produce that they buy from farmers. Farmers mentioned that the non-availability of a fair price is the most important constraint in expanding agricultural output. Inadequate market facilities and poor institutional arrangements for procurement are responsible for low price realisation and instability in prices.

4.2. Constraints on Crop Diversification

Although crop diversification acts as a cushion against unforeseen climatic events, it also entails investment in new technology and marketing arrangements (Shiyani and Pandya, 1998; Rahman, 2009). Evidence shows that crop diversification has the potential to increase farm income and reduce poverty (Behera *et al.*, 2007; Birthal *et al.*, 2013; Birthal *et al.*, 2015). So, the question is what constrains the farmers from presently keeping crop diversification at a low level. One of the nodes shown in the growth diagnostics framework under crop diversification pertains to poor institutional arrangements, particularly weak market linkages and ineffective producer organisations. The Government of Bihar, with support from the Central Government, has launched an initiative to establish Farmer Producer Organisations (FPOs) in

[12] The monthly storage cost for potato ranged from Rs. 160/quintal to Rs. 280/quintal in the different survey districts.

different parts of the State since 2011-12. Under the FPOs, farmers are organised to market their products successfully to reap the benefit of the economies of scale. FPOs enable farmers to innovate, diversify, and adopt new agricultural practices to produce better quality products as demanded by the market (Prasad and Prateek, 2019; Govil *et al.*, 2020). FPO is a potential medium to diversify crop production activities since the marketing activities are collectively taken care of by the organisation. So, what are the constraints in the efficient functioning of FPOs?

Field evidence shows that farmers were aware of the FPOs in some villages, but they have not come together to constitute an FPO. Out of 24 villages, FPOs were registered in only 6 villages, none of which was found to be functional. Most farmers were optimistic that FPOs can play a role in reducing the current problems in the marketing of agricultural produce. However, the lack of such an organisational set-up on the ground is a constraint in obtaining a better price through collective bargaining. Since traditional crops such as rice, wheat, and maize have, by and large, secured markets, the area diversion for the growing of new crops comes with some risks for farmers. This is particularly true in the case of vegetables, the prices of which fluctuate often due to demand and supply gaps. So, the lack of collective marketing through FPOs demotivates farmers from going in for a profitable crop diversification.

Similarly, farmers in 10 villages mentioned that they were aware of contract farming, but the practice of contract farming was not reported in any of the surveyed villages. No proper policy and suitable legislative measures have been put in place to promote contracting arrangements in the State. These could be the probable reasons for the 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 the supply of inputs. The absence of such arrangements is an important constraint in the diversification of crop areas. Overall, it emerges that the lack of proper institutional and marketing arrangements is responsible for low crop diversification in the State of Bihar.

5 CONCLUSIONS AND POLICY RECOMMENDATIONS

Our analysis shows that despite a thrust on boosting agricultural productivity and a stable political regime, agricultural growth in Bihar has plummeted since 2012-13. We apply a modified growth diagnostics framework to identify the most binding constraints to agricultural growth and suggest appropriate policy interventions for the removal of these constraints. The Minot-Hausmann hybrid framework has revealed that the poor functioning of agricultural markets and low level of crop diversification are the reasons for slow or lower agricultural growth in Bihar. We suggest the following policy measures for relaxing these binding constraints.

There is a need to design incentive mechanisms to attract private investment in the development of agricultural markets, including cold storage and warehousing facilities. The Government may step in to provide the basic market infrastructure, such as roads and market yards to attract investment. Sharing information about market conditions, particularly prevailing prices on a real-time basis, will help farmers to make the right decisions about the timing and quantity of the products to be sold. While FPOs have the potential to create an enabling environment for the direct

marketing of agricultural produce by farmers, they require adequate initial financial support and periodic training for their successful operation.

A comprehensive policy on crop diversification is required to provide incentives for farmers to diversify from a low-value cereal-based system to a high-value fruits and vegetable system. The policy may concomitantly encourage private investment in establishing processing infrastructure for grading, sorting, and value addition of fruits and vegetables. The development of the agro and food processing industry at a cluster level, where adequate raw materials are available, will generate employment and increase the incomes of farmers, among others. Contract farming provides a secured market with assured prices for agricultural products. This is particularly important for growing perishable products such as vegetables. A suitable legislative measure on contract farming is needed along the lines of the Model Contract Farming Act brought out by the Centre. The Act should provide a level playing field for both producers and agro-commercial firms. 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 have to diversify from cereals to fruits and vegetables.

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