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Pathways of agricultural transformation: a comparative analysis of Punjab and Bihar

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Abstract This paper discusses the process of structural transformation in Punjab and Bihar. These states lie at the extremes of the continuum of economic development in India – Punjab is at an advanced stage of structural transformation and it has the highest per capita income and lowest incidence of poverty, while the reverse holds true for Bihar – but agriculture is an important economic sector in both states and holds promise for future growth. In Bihar, agricultural growth is driven by technological change and diversification towards high-value crops; in Punjab technological change and price increases drive growth. The area expansion – through an increase in cropping intensity – has also contributed to growth in both states; however, the prospects of area-driven growth are limited, especially in Punjab, because the supply of land is fixed. Further, price-driven growth, as in Punjab, is unlikely to sustain in the long run. In Bihar, the recourse is to exploit the potential of existing and frontier technologies by investing in agricultural research and extension systems and strengthening institutions that link farmers to remunerative markets. In Punjab, the need is to diversify the crop portfolio from staple food crops to high-value food commodities that consume less water and to reorient the research agenda towards crops that can profitably substitute water-guzzling crops.

Keywords Agricultural transformation, technology, diversification, price

JEL classification O130, Q1, Q11, Q13, Q19

1 Introduction

One of the stylized facts of the process of economic development is that economic growth is associated with structural transformation, characterized by a decline in the share of agriculture in the gross domestic product (GDP) and workforce. India's economic development process is no exception. Relatively high growth in the industrial and services sectors led to a sharp decline in the share of agriculture in GDP from about 55% in 1971 to around 16% in 2017 (GoI, 2019), but it was not matched by a similar decline in its share in the workforce – the agricultural sector still engages about 50% of the workforce. The process of structural transformation in India has remained muted. However, the pace of structural transformation has varied at the subnational level (Rao et al. 1999; Dasgupta et al. 2000; Ahluwalia 2000; Sachs et al. 2002; Kumar & Subramanian 2012). Some states have witnessed significant transformation, while others have lagged behind owing to the differences in natural resource endowments, infrastructure, institutions and governance. Some of the laggards – for example, Bihar, Odisha and Madhya Pradesh – have started catching up with richer states like Punjab and Haryana. This invokes interest in understanding the causes of differential economic performance and experiences of structural transformation of states. In this paper, we examine the process of structural or agricultural transformation in two states – Punjab and Bihar[1] – that

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[1]This study considers the undivided state of Bihar.

Table 1. Level of per capita income and poverty

	Per capita income (Rupees at constant prices)			Incidence of poverty (%)		
	1	2	3	4	5	6
Years	Bihar	Punjab	Ratio (2/1)	Bihar	Punjab	Ratio (5/4)
1971	11,188	27,825	2.49	61.91	28.15	0.45
1981	12,516	37,176	2.97	62.22	16.18	0.26
1991	14,892	49,467	3.32	54.96	11.77	0.21
2001	15,036	54,918	3.65	42.60	6.16	0.14
2011	25,449	81,723	3.21	35.19	8.30	0.24
2015	29,386	96,040	3.26	—	—	—

Source: Estimated by authors using data on income from the EPW Research Foundation (http://www.epwrfits.in/) and poverty data from GoI (https://niti.gov.in/)

lie at the extremes of the continuum of economic and agricultural development; Punjab has always remained at the top of the income hierarchy and Bihar at the bottom.

The rest of this paper is organized as follows. In the following section, we discuss agricultural transformation. Section 3 discusses the sources of growth in agriculture. The drivers of agricultural growth are discussed in the fourth section. The concluding remarks and implications are made in the final section.

2 Agricultural transformation

We begin by comparing the economic status – measured in terms of per capita income – of Bihar and Punjab (table 1). In 1971, the per capita income of Punjab was 2.5 times that of Bihar, but the gap increased over time and peaked in 2001. Thereafter, it started narrowing, but slowly. The per capita income almost doubled in Punjab between 1971 and 2001, but it experienced little, if any, growth in Bihar until 2001, when it started gaining momentum. Bihar remains one of the poorest states of India, while Punjab has the lowest incidence of poverty. It has declined drastically in both states, but at a slower rate in Bihar; the head count poverty in Bihar fell from 62% in 1971 to 35% in 2011 but in Punjab from 28% to 8%. Bihar's current social and economic status is Punjab's status of four decades ago.

The economies of both states have undergone a structural transformation, especially after the green revolution. In the 1970s, the agricultural sector dominated the economies of both states, and more so in Bihar, but the share of the agricultural sector in GDP declined – from 63% in the 1970s to 23% during 2010-17 in Bihar and from 57% to 33% in Punjab. The industrial sector grew impressively in both states, and the services sector grew faster in Bihar (table 2). Until the beginning of the 21st century, the agricultural sector of Punjab grew at a faster rate, but afterwards Bihar's agricultural sector experienced impressive growth.

In terms of employment, the share of agriculture in the total workforce in Bihar declined from 82% in 1971 to 71% in 2011 but from 63% to 36% in Punjab (table 3). Thus, the structural transformation in Punjab is at an advanced stage and the state has succeeded in the transfer of labour from agriculture to non-agricultural sectors, while the agriculture sector in Bihar remains under excessive employment pressure despite a rapid decline in its share of GDP. In absolute terms, the size and trends of the agriculture workforce differ significantly between Bihar and Punjab (table 3). Since 1991, the size of the agricultural workforce has remained almost the same in Punjab but has increased considerably (63.2%) in Bihar. The composition of the agricultural workforce has changed in both states: the share of cultivators has declined and that of agricultural labourers increased (table 3). The share of cultivators in Bihar fell from 53% in 1971 to 33% in 2011 and from 68% to 54% in Punjab.

These differences in the change in the composition of the agricultural workforce can be due to several factors, including the rate of transfer of labour from the agricultural sector to the non-agricultural sector and changes in the agrarian structure. Table 4 shows the change in the average size of landholdings over time.

Table 2. Share and growth of subsectors in net state domestic product (NSDP)

Years	Share in NSDP (%)			Annual growth rate (%)			
	Primary	Secondary	Services	Primary	Secondary	Services	Overall
			Bihar				
1970s	62.56	7.32	30.12	0.77	4.88	6.12	3.24
1980s	52.96	9.98	37.07	2.75	7.25	5.61	4.97
1990s	43.23	10.68	46.08	-0.10	4.39	4.44	3.05
2000s	33.65	13.46	52.89	2.53	6.68	8.01	6.16
2010-17	23.23	18.92	57.84	2.09	2.65	7.57	5.11
1970-2017	43.96	11.79	44.26	2.00	4.70	6.00	4.27
			Punjab				
1970s	56.50	17.20	26.30	4.04	6.88	7.17	5.35
1980s	51.72	19.23	29.04	5.25	7.17	4.63	5.43
1990s	50.23	22.16	27.61	2.25	7.01	4.95	4.13
2000s	45.14	20.39	34.47	1.93	6.42	6.01	4.25
2010-17	33.03	23.50	43.48	0.95	4.09	8.01	4.8
1970-2017	47.08	20.50	32.41	3.05	5.20	5.83	4.46

Source: Estimated by authors by using data from the EPW Research Foundation (http://www.epwrfits.in/)

Table 3. Trends of agricultural workforce (in lakhs)

Years	Total workers	Cultivators (% of total agricultural workforce)	Agricultural labour (% of total agricultural workforce)	Cultivators + agricultural labour (% of total workforce)
		Bihar		
1971	175	76 (52.69)	68 (47.31)	144 (82.26)
1981	208	90 (55.10)	74 (44.90)	164 (79.07)
1991	256	112 (53.99)	95 (46.01)	207 (80.71)
2001	381	121 (42.62)	163 (57.38)	284 (74.45)
2011	478	110 (32.58)	228 (67.42)	338 (70.66)
		Punjab		
1971	39	17 (67.91)	8 (32.09)	25 (62.67)
1981	49	18 (61.80)	11 (38.20)	29 (58.03)
1991	61	19 (56.89)	15 (43.11)	34 (55.26)
2001	91	21 (58.09)	15 (41.91)	36 (38.95)
2011	99	19 (54.31)	16 (45.09)	35 (35.59)

Source: Estimated by authors by using data from GoI (various years, a)

Throughout the past four decades or so, the average landholding size in Bihar has been much smaller than in Punjab. In 2015-16, the average landholding size in Punjab was more than seven times larger than in Bihar. Since 1981, the average landholding size has remained almost the same in Punjab (4 hectares (ha)) but contracted in Bihar to half from about 1 ha to 0.5 ha. In Bihar, a larger proportion of the marginal and small landholders remain in agriculture but as suppliers of labour, compelled by the continual fragmentation of landholdings, marginalization of the agricultural workforce and limited opportunities for employment outside agriculture. The gap in labour productivity between agricultural and non-agricultural sectors has

Table 4. Distribution of operational holdings (%)

Years	Marginal (<1 ha)	Small (1-2 ha)	Semi-medium (2-4 ha)	Medium (4-10 ha) size (ha)	Large (>4 ha)	Average landholding
			Bihar			
1970-71	64.32	14.63	12.07	7.17	1.81	1.64
1980-81	75.87	10.84	8.47	4.2	0.62	0.98
1990-91	78.61	11.09	7.29	2.71	0.36	0.83
2000-01	84.14	9.23	5.12	1.41	0.07	0.59
2010-11	87.79	7.29	3.69	1.11	0.12	0.51
2015-16*	88.00	7.16	3.63	1.09	0.12	0.50
			Punjab			
1970-71	37.63	18.91	20.44	18.01	5.01	2.89
1980-81	19.41	19.5	28.18	25.61	7.25	3.81
1990-91	26.47	18.25	25.86	23.41	6.01	3.61
2000-01	12.34	17.35	32.90	30.19	7.22	4.04
2010-11	15.62	18.57	30.83	28.35	6.62	3.77
2015-16	14.13	18.98	33.67	27.93	5.28	3.62

Source: GoI (various years, b)

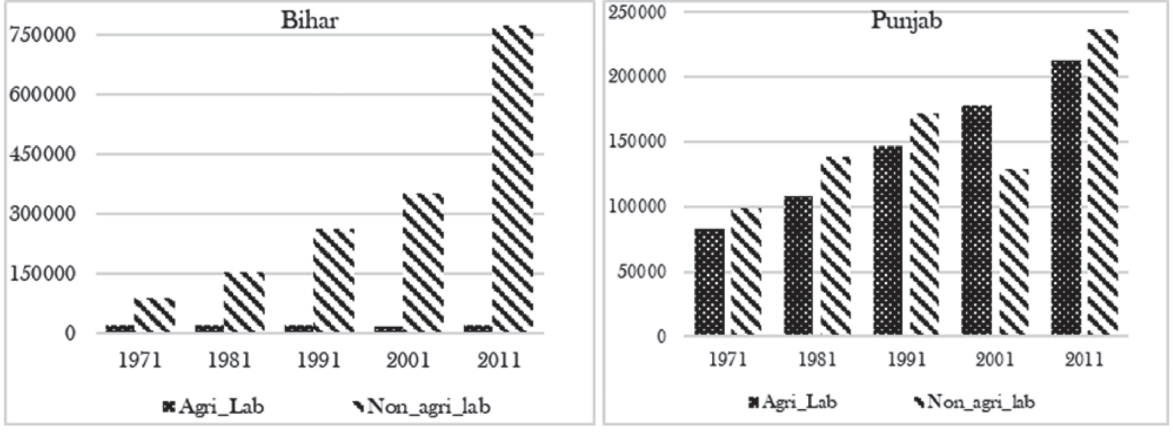

Figure 1. Labour productivity in agriculture versus non-agriculture in Bihar and Punjab (rupees/worker at constant prices)
Source: Estimated by authors

widened due to the structural transformation (figure 1). The growth in labour productivity in agriculture shows little, if any, change over time, but labour productivity in the non-agricultural sector has grown substantially. The productivity gap between agriculture and non-agriculture, however, is not large in Punjab – the labour productivity of non-agriculture is mostly above 0.75 times that in agriculture.

3 Sources of growth in agriculture

3.1 Economic structure of agriculture

The agricultural sector is composed of crops, livestock, fisheries and forestry. The crop subsector remains dominant in both the states, accounting for 58.5% of the total value of agricultural sector output in Bihar and 60.9% in Punjab in 2012-15 (table 5)[2]. Since 1991,

[2] For our analysis, the current series of value of output of each segment is deflated by the WPI of all commodities at 2004-05.

Table 5. Composition of agricultural sector, and growth in subsectors

	% share in total value of output				% annual growth	
	Bihar		Punjab			
	TE 2001-03	TE 2013-15	TE 2001-03	TE 2013-15	Bihar	Punjab
Crops	65.99	58.52	68.05	60.92	4.55	2.95
Livestock	24.37	30.54	30.67	29.73	6.76	4.32
Fisheries	4.10	5.11	0.66	0.88	7.25	5.50
Forestry	5.55	5.82	0.61	8.47	9.80	28.40

Source: Authors' estimates using data from GoI (various years, c)

the value of the output of crops has grown at 2.8% per annum in Bihar and 2.9% per annum in Punjab. The livestock subsector contributes 30.5% in Bihar and 29.7% in Punjab and it has been growing faster than the crop subsector in both the states. Although the contribution of fisheries is small, it has been increasing in both states. The subsequent discussion in this paper revolves around the crop subsector.

3.2 Growth sources in the crop subsector

Growth in the crop subsector can occur through area expansion, price increases (in real terms), yield improvements or technological change and area reallocation or diversification.[3] Following the growth accounting approach (Minot et al. 2006; Birthal et al. 2013), we quantify the contribution of these sources to the overall growth in the crop subsector (figure 2).

Interestingly, the sources of agriculture growth are different in Bihar from those in Punjab. In Bihar, yield improvement and diversification had been the dominate sources of growth, while in Punjab, the growth was driven by yield improvement and price increases. The expansion of gross cropped area also contributed to the growth in both the states. Interestingly, the price effect on growth was negative in Bihar to the tune of 26%, while the contribution of diversification in Punjab hardly exceeds 10%.

For a deeper insight into the dynamics of growth sources, we examine the behaviour of annual changes

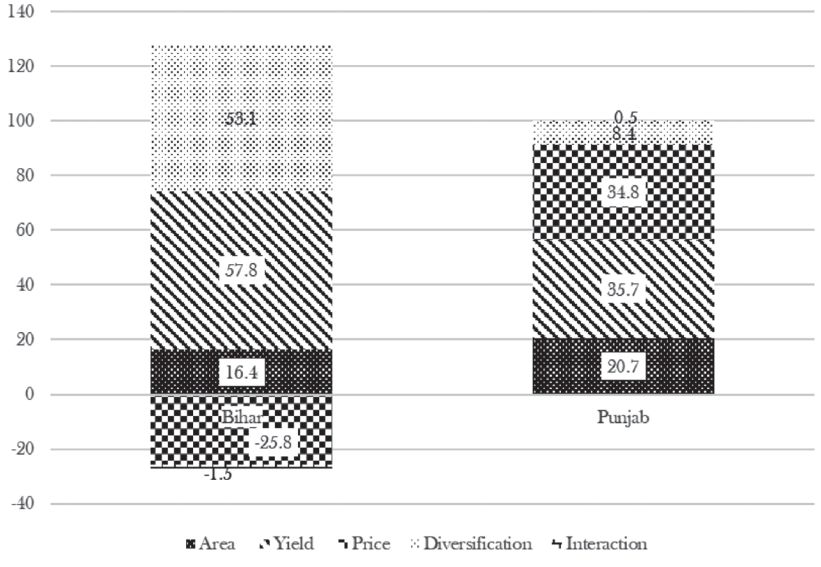

Figure 2. Share of different sources to the growth of crop subsector during 1991-2015 (%)
Source: Authors' estimates using data from GoI (various years, c)

[3] In this paper, we define diversification as area reallocation from lower to higher value crops such as vegetables, fruits, spices, condiments, beverages, etc.

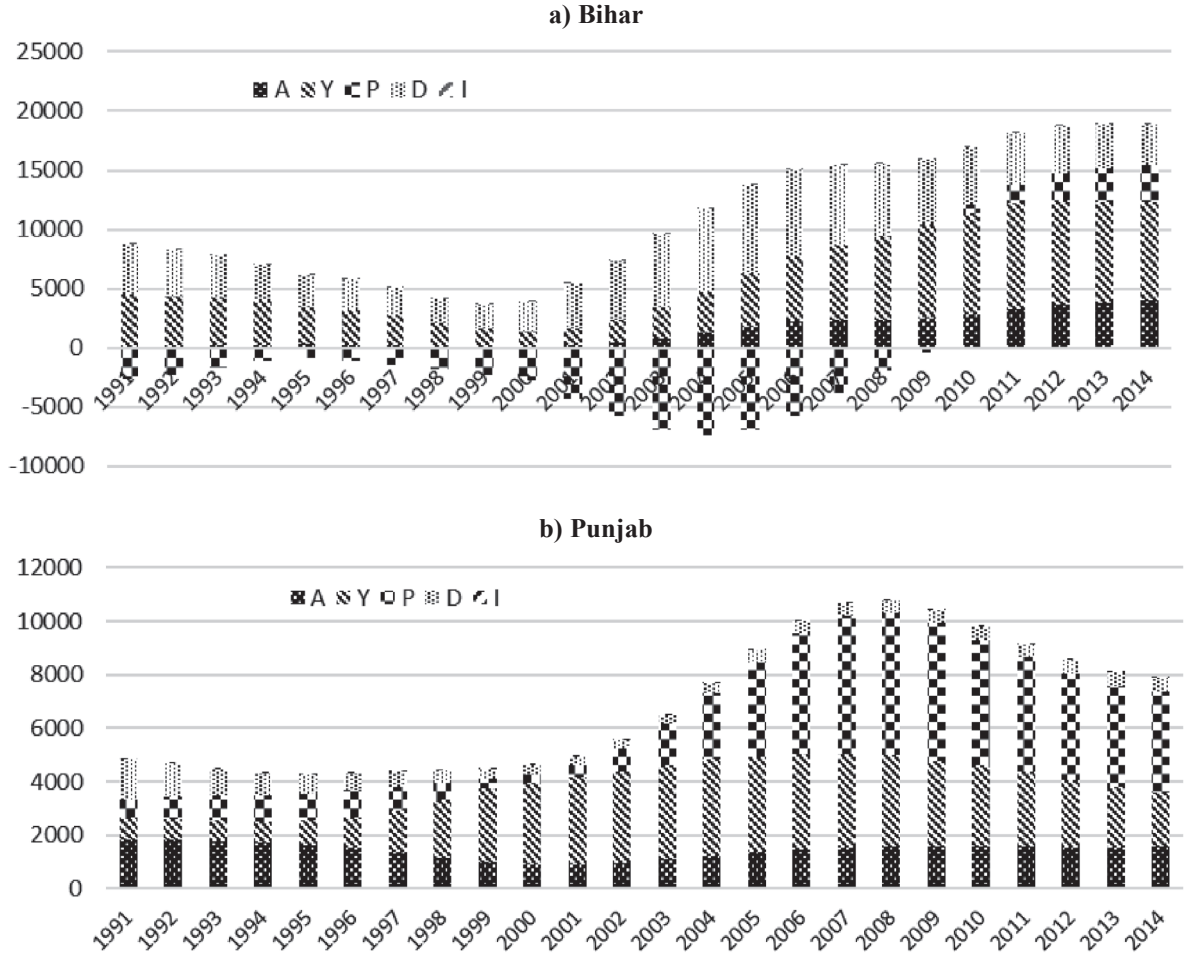

Figure 3. Year-on-year changes in sources of growth (in Rs. lakh)
Source: Authors' estimates using data from GoI (various years, c)

in their contribution to the overall change in the crop subsector (figures 3a and 3b).

Let us first see how the growth story of Bihar has unfolded. Agricultural growth decelerated until 1999 but started improving afterwards. Technological change was not an important source of growth until 2001, but its effect became stronger afterwards. Area expansion (in terms of cropping intensity) started gaining importance after 2002. The price effect remained negative until 2008, but turned out positive afterwards. On the other hand, diversification has remained a sustainable source of growth throughout. In Punjab, agricultural growth in Punjab shows a cyclical pattern, decelerating until 1999, then accelerating until 2007 and decelerating afterwards. Technological change remained the dominant source of growth in agriculture until 2005; afterwards, the price effect became stronger. Area expansion also remained a sustainable source of growth. The contribution of diversification, though not large, has been declining.

3.3 Contribution of crops to overall growth

In both the states, agriculture grew at an annual rate of close to 3%, and rice and wheat are the dominant crops, but growth was stronger in Punjab than in Bihar. Oilseeds and pulses experienced strong growth in Bihar but negative growth in Punjab (table 6). Horticultural crops experienced steady, fast growth in both states. The growth of sugarcane in Bihar has been impressive.

Table 6 shows the contribution of each crop or crop group to the overall growth of agriculture. In Punjab agriculture, rice and wheat dominate and account for 85% of the overall growth, but they contribute only 25% of the output growth in Bihar. Horticulture has

Table 6. Contribution of main crops to overall growth of agriculture (%)

	Bihar			Punjab		
Crops	VoP share 2013-15	VoP growth 1991-2015	Share in growth 1991-2015	VoP share 2013-15	VoP growth 1991-2015	Share in growth 1991-2015
Paddy	24.4	1.5	19.6	37.6	3.6	45.8
Wheat	11.8	1.1	5.8	39.4	2.5	38.3
Maize	5.0	3.3	5.8	1.0	1.5	0.6
Others coarse cereals	0.0	-4.2	0.0	0.0	-5.0	-0.3
Total cereals	41.2	1.7	31.2	78.0	2.6	84.4
Total pulses	6.3	2.7	5.8	0.1	-5.2	-0.6
Total oilseeds	1.9	4.0	2.2	0.4	-6.2	-2.3
Sugarcane	6.3	6.5	8.5	2.9	0.8	2.4
Fibres	1.0	1.9	0.6	6.9	0.1	-1.9
Drugs and narcotics	1.0	8.1	2.6		-	-
Fruits and vegetables	41.6	3.2	49.1	11.3	5.1	17.6
Overall	100.0	2.8	100.0	100.0	2.9	100.0

Source: Authors' estimates using data from GoI (various years, c)

been the main contributor to agricultural growth in Bihar; horticultural crops account for approximately 50% of the growth in the crop sector in the state.

A number of policy and non-policy factors are responsible for the observed patterns of growth of different crops and their contributions to overall growth. Demand-side factors played an important role. The observed changes in the production mix are consistent with the changes in the consumption basket. Between 1990 and 2015, India's food basket underwent a significant transformation away from cereals and towards high-value commodities, and the export demand for fruits and vegetables acted as catalysts in the growth of high-value agriculture. The demand-driven growth in the horticultural sector was facilitated by the improvements in roads, transportation, communication and electricity (Joshi et al. 2004) and development of retail chains (Joshi et al. 2005; Roy and Thorat 2008).

4 Factors influencing sources of growth

Several policy and non-policy factors explain these changes in growth sources.

The increase in cropping intensity led to the recent improvement in the contribution of area expansion to agricultural growth. Punjab state had made remarkable progress in agriculture through taking a big leap forward in terms of irrigation facilities, use of chemical fertilizer, pesticide, high yielding varieties, mechanization etc. Backed with effective agricultural policies, the farmers of state tended their crops according to the advice of experts through well-established agricultural extension network and achieved the record productivity levels. However, the net sown area declined in Bihar and remained almost stagnant in Punjab, but the area cultivated more than once increased in both the states and led to a rise in cropping intensity (table 7), facilitated by the increased availability of irrigation water. Since 1990-93, the gross irrigated area increased by 17% in Bihar and 5% in Punjab.

Yield improvements emerged as one of the most important sources of growth. Since paddy and wheat are the main crops in both the states (figure 4), we show the trends in their yields and, as expected, both the crops in both states experienced continual growth in crop yields but with greater volatility in Bihar. But differences in input use and cropping practices have led yields in Bihar and Punjab to differ significantly. In Bihar, mechanization is low, and farmers practise largely traditional methods of cultivation and use less of high-yield variety (HYV) seeds and fertilizers (Pandey 2016).

Table 7. Net sown area and cropping intensity

	1971-73	1981-83	1991-93	2001-03	2012-14
			Net sown area (000 ha)		
Bihar	8,261.3	7,901.7	7,526.3	7,293.1	6,696.6
Punjab	4,071.5	4,201.2	4,190.2	4,235.1	4,143.1
			Cropping intensity		
Bihar	129.47	132.45	132.76	135.02	138.82
Punjab	141.9	163.5	179.59	186.17	189.9

Source: Estimated by authors by using data from the EPW Research Foundation (http://www.epwrfits.in/)

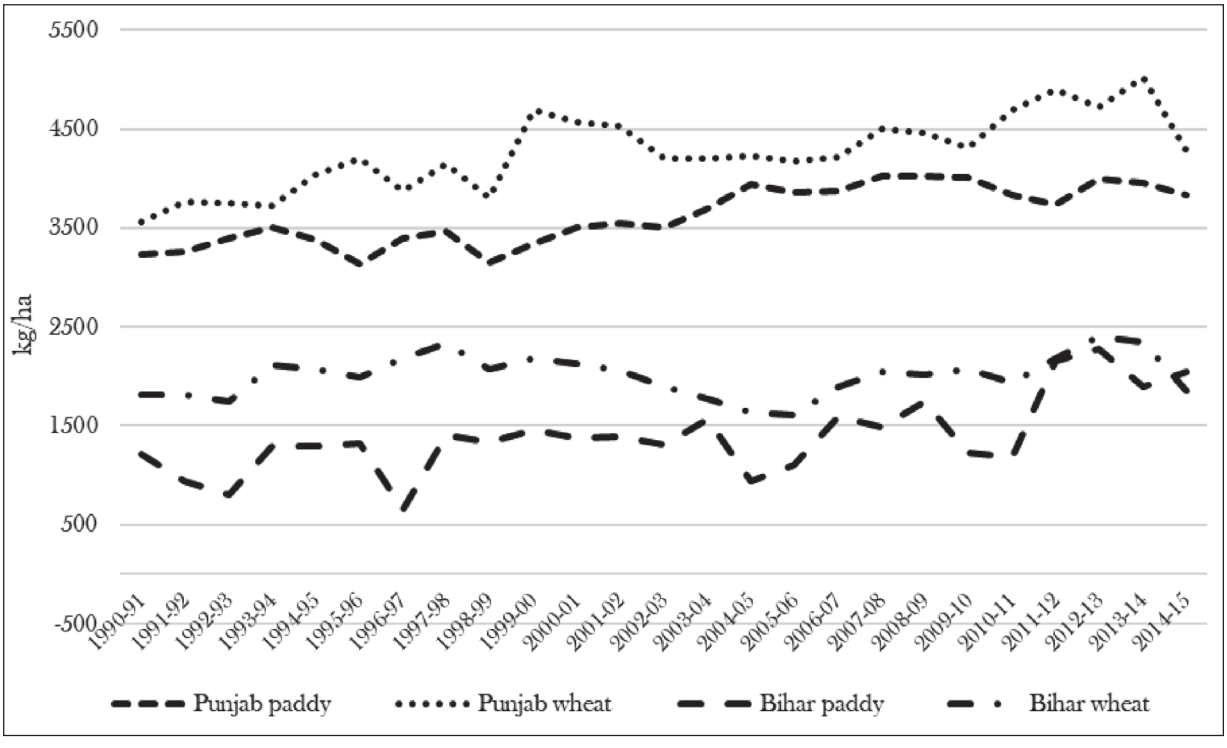

Figure 4. Trend in yield paddy and wheat
Source: Estimated by authors by using data from the EPW Research Foundation (http://www.epwrfits.in/)

The input use in agriculture is much less in Bihar than in Punjab (table 8). Almost the entire area in Punjab is irrigated, but only 60% of the cropped area in Bihar receives irrigation, because the state lacks the electricity needed to pump groundwater, and the quality of irrigation is poor. Fertilizer consumption has increased substantially in Bihar, but it is yet to achieve the level in Punjab. Diversification is a sustainable and important source of growth in Bihar, but not in Punjab (table 9).

The area share of food grains has been increasing in Punjab and the share of cash crops (including cotton, sugarcane and horticultural crops) that generate comparatively higher returns has decreased. Horticultural crops account for a meagre 5.8% of the total cropped area in 2014-15, slightly higher than in 1990-93. It can be concluded that despite all the efforts to diversify agriculture in the state, the imbalance in favour of the two main cereals – rice and wheat – in the cropping pattern has sharpened further, because these crops are more profitable than others and their production and marketing risk is minimal. In Bihar the situation is opposite. The share of food grains in the total cropped area has declined and cash crops have gained in their area share. In 2014-15, horticultural

Table 8. Inputs use

	1971-73	1981-83	1991-93	2001-03	2012-14
			Fertilizer consumption (kg/ha)		
Bihar	9.16	19.63	60.08	88.25	166.23
Punjab	37.51	137.45	162.33	176.05	229.16
			% of total cropped area irrigated		
Bihar	25.58	33.67	41.37	48.22	58.87
Punjab	75.96	86.83	94.4	96.7	98.54

Source: Estimated by authors by using data from the EPW Research Foundation (http://www.epwrfits.in/)

Table 9. Share of various crops in total gross cropped area (%)

	Punjab			Bihar		
	1991-93	2001-2003	2013-15	1991-93	2001-2003	2013-15
Cereals	76.2	79.8	84.5	78.6	78.6	69.8
Pulses	1.5	0.6	0.6	10.8	8.2	9.9
Oilseeds	2.2	1.1	0.6	2.3	1.8	3.4
Sugarcane	1.4	1.7	1.1	1.4	1.1	2.3
Fibrous crops	9.0	6.3	5.1	1.6	1.7	1.0
Horticulture	2.9	3.2	5.8	5.0	5.4	12.5
Others	6.8	7.3	2.3	0.3	3.2	1.1

Source: Estimated by authors by using data from the EPW Research Foundation (http://www.epwrfits.in/)

crops occupied over 12.5% of the gross cropped area, more than double of that in 1990-93.

The contrasting effect of prices on agricultural growth in Bihar and Punjab is due to the government policy of procurement of rice and wheat at government-determined minimum support prices (MSP). The procurement infrastructure is strong in Punjab but almost non-existent in Bihar. In Bihar, the government hardly procures these grains but in Punjab, the government procured 72.4% of the total production in the state of rice and 71.8% of wheat. The marketing infrastructure is also poor in Bihar; farm harvest prices of paddy and wheat have rarely exceeded MSPs (figure 5).

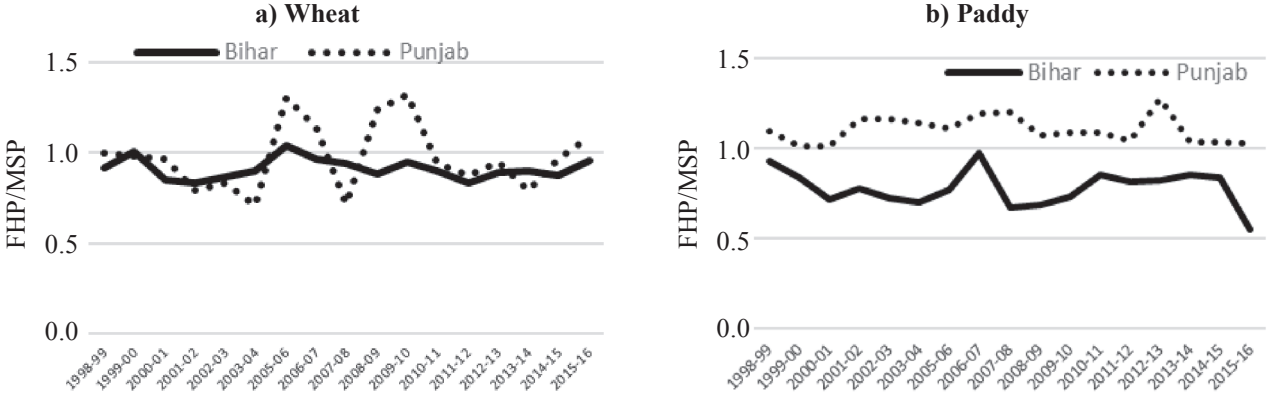

Figure 5. Ratio of farm harvest price to minimum support price
Source: Authors' estimates using data from GoI (Various years, d) https://eands.dacnet.nic.in/FHP(District).htm

5 Conclusions and implications

In the past five decades, the Indian economy has undergone a structural transformation – agriculture's share in the GDP has declined faster than that of the workforce – but the experiences at the subnational level vary. This paper compared the pace and process of structural transformation in Punjab and Bihar and decomposed the growth in the crop subsector – due to area expansion, yield improvements, diversification and price increases – to identify prospects for future growth.

In Bihar, agricultural growth has been dominated by technological change and diversification towards horticultural crops. The area expansion also contributed to overall agricultural growth. However, area-driven growth will be limited because the population pressure on land is increasing and the landholding size is declining. The price effect on growth was negative until 2009 but turned positive afterwards. Yield improvements have driven growth only after 2003, but the potential to fill the yield gap is still huge, indicating much scope for agricultural growth. Horticulture has driven the growth in agriculture. Harnessing this requires investment in agricultural research, development of infrastructure (electricity) and institutions (credit, insurance and extension) and creating profitable markets.

In Punjab, agricultural growth came primarily from technological change and price increases; diversification yielded little growth. Price increases over time overshadowed the contribution of technologies to agricultural growth. This has implications for the growth of agriculture. The prospects for area-driven growth in the state are limited as the cropping intensity is about 200%. Improvements in the yield of rice and wheat, the main crops, and the benefit of assured offtake by the government at predetermined prices (MSP), have driven the growth in agriculture. But the rice-wheat dominated production system is not desirable from the ecological perspective, as rice is a water-guzzling crop, and its extensive and intensive cultivation has resulted in over-extraction of groundwater. And price-led growth is unsustainable in the long run. The need is to create a level playing field for a market-led cropping pattern and enable the growth of efficient, sustainable agriculture by diversifying the crop portfolio in favour of high-value crops that consume less water. And the research agenda needs to be oriented towards evolving technologies for crops that can profitably substitute water-guzzling crops.

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