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Unleashing Bihar's agriculture potentia: Sources and drivers of agriculture growth

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Working Paper 336

Unleashing Bihar's Agriculture Potential: Sources and Drivers of Agriculture Growth

**Anwarul Hoda
Pallavi Rajkhowa
Ashok Gulati**

March 2017



INDIAN COUNCIL FOR RESEARCH ON INTERNATIONAL ECONOMIC RELATIONS

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Acknowledgement

This paper forms a part of the study on Agricultural growth and its linkages to poverty alleviation in six selected states of India, namely Bihar, Uttar Pradesh (UP), Odisha, Punjab, Gujarat and Madhya Pradesh (MP). Bihar, UP and Odisha have experienced low to moderate growth in agriculture over the period 2000-01 to 2014-15. Punjab has been the seat of green revolution and was a front-runner in agriculture during late 1960s, but slipped to low levels of agri-growth in recent period. Gujarat and Madhya Pradesh have shown some extra-ordinary growth in their agriculture sectors (almost three times the all India agriculture growth) in the last decade or so. The key idea of this study was to look for policy lessons from each other within Indian context, and see how to propel growth in agriculture for faster alleviation of poverty.

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Abstract

Bihar's agricultural development in the latest 10 years between 2005-06 and 2014-15, presents a mixed picture. Agriculture growth was around 4.7 per cent, which was above the national average of 3.6 per cent and in the latest five years, its performance was even more commendable, with an average annual growth rate of 7.1 per cent. However, agriculture productivity of two of its major crops, rice and wheat, is lower than the national average, despite the relatively high private investment in yield augmenting inputs such as fertilisers, certified seeds, tube wells and farm machines. Bihar's agriculture has diversified impressively through dairy development although productivity in milk production is lagging behind other major milk producing states, but poultry development has not taken off. In this paper, we study the composition, sources and drivers of agricultural growth in Bihar with a view to identifying the factors that explain the paradox of low agricultural productivity and high use of productivity augmenting inputs. The study finds that poor public investment in power, all-weather roads and marketing infrastructure, have constrained agriculture in Bihar. In particular, deficiencies in the power infrastructure have resulted in high dependency on diesel for pumping out groundwater for irrigation; this, along with soaring petroleum prices, has depressed returns from cultivation of crops. Further, the proportion of surfaced roads in the state is one of the lowest in the country and needs attention in order to link farmers to markets. Another major difficulty that farmers in Bihar face is the lack of marketing infrastructure, resulting in their inability to reap the price incentives given by the Government of India in the form of minimum support price. Livestock development has not achieved its potential because of strategic deficiencies. In dairy, productivity has remained low because germ plasm from superior breeds has not been used. In poultry, the culture of contract farming involving large integrator companies has not yet been adopted. In the light of these findings, the study makes five principal recommendations to stimulate agricultural growth and productivity in the state, viz., improve the quality and quantity of rural power supply by strengthening transmission and distribution and obtaining separation of feeders for irrigation, increase in the intensity of surfaced roads in rural areas, improve procurement and marketing infrastructure, improve health and reproduction management of dairy animals and obtain a quantum increase in poultry by employing the integrator model as has been done in states like Andhra Pradesh and Odisha.

Keywords: *Agricultural Growth, Irrigation, Power, Surfaced Roads, Marketing Infrastructure, Bihar*

JEL Classification: *Q10, Q15, Q25*

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Executive Summary

Bihar is endowed with abundant natural resources, especially fertile soil and ground water. Yet, it is one of the poorest states in the country. Bihar's per capita income (Rs 15,506 in FY14) was around 39 per cent of all India average (Rs 39,904 in FY14). It is even lower than Chhattisgarh (Rs 28,373) and Jharkhand (Rs 28,882) – the poorest states of the country. Moreover, it remains way below states like Sikkim (Rs 83,527), Maharashtra (Rs 69,097), Haryana (Rs 67,260) and Gujarat (Rs 63,168). In terms of poverty, 34 per cent of Bihar's population is poor, compared to the all India figure of 22 per cent.

A study by the World Bank (World Bank Report, 2008) shows that agriculture growth has the potential to reduce poverty faster than growth generated from other sectors. This is particularly so as 89 per cent of poverty in Bihar is rural and 74 per cent of its workforce is dependent on agriculture. Bihar's agricultural development in the last 10 years between 2005-06 and 2014-15 presents a mixed picture. Agricultural growth was around 4.7 per cent, which was above the national average of 3.6 per cent and in the latest five years, its performance was even more commendable, with an average annual growth rate of 7.1 per cent. However, agricultural productivity of two of its major crops, rice and wheat, is lower than the national average, despite the relatively high private investment in yield augmenting inputs such as fertilisers, certified seeds, tube wells and farm machines. Bihar's agriculture has diversified impressively through dairy development, but poultry development has not taken off and its productivity in milk production is also lagging behind other major milk producing states in the country. In this paper, we study the composition, sources and drivers of agricultural growth in Bihar with a view to identifying the factors that explain the paradox of low agricultural productivity and high use of productivity augmenting inputs.

The study finds that in recent years, there has been an encouraging development towards diversification and the livestock sector, particularly dairy farming, has gained importance. The share of dairy products in the total value of output from agriculture and allied activities (GVOA) increased from 14 per cent in TE 2003-04 to 23 per cent in TE 2013-14, while at the all-India level, the share of dairy farming in GVOA remained at 17 per cent in the same period. Between 2001-02 and 2013-14, milk production in Bihar increased from 2.7 million tonnes to 7.2 million tonnes, a CAGR of 7.9 per cent. Despite this impressive growth in production, milk productivity in Bihar is lower than in some of the other states; for example, while Bihar's productivity in milk production stood at 0.7 mt per lactating animal, Punjab's productivity was 2.4 mt per lactating animal, Gujarat 1.1 mt per lactating animal, UP 1.0 mt per lactating animal and MP 0.8 mt per lactating animal. The study finds that productivity of milk has remained low because germ plasm from superior breeds has not been used in Bihar. For example, the exotic/crossbred female cattle population in Punjab is 91.5 per cent of the total female cattle population, while that of Bihar was only 32.9 per cent in 2012. The potential yield from cross-bred cows is much higher than that from indigenous breeds. On average, a cross-bred cow yields 7.2 litres a day nationally, but in Punjab, a typical cross-bred cow yields about 11.2 litres a day, while in Bihar it is only 6.5 litres a day. This means, cross-bred yield in Bihar is almost half of the yield in Punjab. The production trait of milk

producing cattle in Punjab is better than in Bihar because of the use of germ plasm from superior breeds in cross breeding in the former.

Although the dairying sector is growing in importance in Bihar, food grain cultivation continues to be significant. The cropping pattern in Bihar has not undergone much change over the years in as much as cereals remain dominant, accounting for about 79 per cent of the acreage. Although the production of the two main crops grown in the state – rice and wheat – has increased over the years, productivity of these two crops has remained below the national average. In fact, Bihar's productivity in rice (2.0 mt/ha in TE 2014-15) is lower than the national average of 2.4 mt/ha and much lower than state like Punjab (4 mt/ha), Haryana (3.2 mt/ha), Tamil Nadu and Andhra Pradesh (3.0 mt/ha). Similarly, wheat yields in Bihar (2.2 mt/ha) are lower than the national average (3 mt/ha) and much lower than states like Punjab (4.7 mt/ha), Haryana (4.3 mt/ha) and Rajasthan, Gujarat, Uttar Pradesh (3mt/ha)

This trend of rice and wheat yield lagging behind the national average is striking when seen against the trends in the use of yield enhancing assets and inputs. For example, irrigation coverage in Bihar is around 68.5 per cent of the gross cropped area as compared to the national average of 47.6 per cent (2012-13). Consumption of fertiliser has also been increasing over the past decade. According to the data made available by the Fertiliser Association of India (FAI), the apparent consumption of fertilisers in the state is around 199.7 kg per hectare against the all-India figure of around 130.8 kg/ha (2012-13). Mechanisation has also been making progress in Bihar with a robust expansion in the use of zero tillage machines from just 126 machines in 2008-09 to 9,760 units in 2013-14, a CAGR of 106.5 per cent. Similarly, combine harvesters have increased from 55 units in 2008-09 to 261 units in 2013-14, a CAGR of 29.6 per cent. Another significant development has been a rapid increase in the seed replacement rates of the three major crops. In the early 2000s, Bihar's seed replacement rates for paddy, wheat and maize were as low as 6.3 per cent, 8.4 per cent and 21.2 per cent respectively, but these have increased to 38 per cent, 34.8 per cent and 100 per cent respectively by 2011-12.

Irrigation, fertilisers, quality seeds and mechanisation are the main inputs required to improve the productivity of crops. Currently, Bihar is on par with or above the national average in the utilisation of all these inputs, and yet there is a yield gap. The paradox here is that despite investment by farmers in technology and inputs, their returns are low. Like Kishore, Sharma and Joshi (2014), we too find that poor public- infrastructure and poor incentive structure has negated the benefits of private investments in irrigation, fertilizer use, mechanization and certified seed use and has kept productivity of crops low. For example, Bihar has an ultimate irrigation potential (UIP) of 11.7 million hectares, out of which major and medium projects can irrigate 5.3 million hectares which require public investment. As on 2013-14, Bihar has achieved around 53.7 per cent of UIP from major and medium projects and 59.4 per cent of its ultimate ground water irrigation potential, Bihar still has 46.3 per cent of its ultimate irrigation potential through major and medium projects and 40.6 per cent of its ground water irrigation potential that remain to be exploited. What is more, public investment deficit in the power sector has resulted in a poor power supply situation and consequently, on high

dependence on diesel pump-sets. It is particularly worrying that only a small proportion of the total sale of power goes to agriculture, with the proportion of sales to the agricultural sector to total sales having fallen from 13.1 per cent in 2009-10 to 6.1 per cent in 2013-14. In comparison, states like Madhya Pradesh and Gujarat, which have recorded robust agriculture growth, provide 33.7 per cent and 24.7 per cent of total sales to agriculture respectively. Reliance on diesel pump sets for groundwater irrigation along with the rising price of diesel has increased the cost of irrigation substantially for farmers. The high cost of irrigation nullifies the natural advantage that Bihar could have enjoyed due to an abundance of ground water resources. In recent years, groundwater levels in south Bihar have fallen, adding to the cost of pumping water through diesel sets. Even in certain pockets of North Bihar, there has been a fall in groundwater levels due to repeated spells of deficient rains, making irrigation through tube wells costlier.

Another disadvantage that farmers in Bihar face is inadequate price incentives. The benefit of the minimum support price (MSP) scheme of the Government of India has not been filtering down to the farmers because of inadequate procurement operations in the state. Currently, procurement of food grains from Bihar is low compared to states like Punjab and Haryana. In TE 2013-14, the FCI procured around 19.4 per cent of Bihar's total production of rice, while the share of procurement to production in Punjab was 73.0 per cent, and 34.6 per cent in Madhya Pradesh. Even in Odisha, it was 44.9 per cent. The low scale of procurement operations in Bihar translates into a large gap between the farm harvest price and the MSP. In 2013-14, the average farm harvest price was Rs 1,115.5 per quintal, substantially below the MSP of Rs 1,397.5 per quintal for that year. In a state like Bihar that is subject to frequent natural calamities, despite private investment in the form of increased consumption of fertiliser and certified seeds and private tube well irrigation, inadequate public investment in irrigation, power, marketing facilities and surfaced roads have kept productivity low for most crops. Through our econometric model, we have shown that increasing irrigation, and surfaced road density, maintaining an effective price policy and supporting the milk segment can contribute significantly to putting agriculture growth on a higher growth trajectory in Bihar. We have also identified several other policy changes that the state could introduce to improve agricultural performance further. Some of these are based on the policies and practices prevalent in states that have been more successful in agricultural development.

Unleashing Bihar's Agriculture Potential: Sources and Drivers of Agriculture Growth

Anwarul Hoda, Pallavi Rajkhowa and Ashok Gulati

1. Introduction

In the past 60 years, Indian agriculture has made remarkable improvement in food grain production. During this period, India has turned from a food deficit to a food surplus country, despite the increase in population from 361 million to 1.2 billion. The country has also made strides in the diversification of agriculture from cereals to high value commodities. It is not only the world's second largest producer of wheat, rice, fruits and vegetables and cotton but also the largest producer of milk and pulses. However, the performance in agricultural development has been uneven across states. Some states like Punjab in the earlier days, Gujarat and more recently Madhya Pradesh have seized growth opportunities and forged ahead. Others like Odisha and Uttar Pradesh have lagged behind in several development indicators. Bihar, on the other hand, has recorded a high agriculture growth rate in recent years as compared to other states. Between 2005-06 and 2014-15, the agricultural sector in Bihar grew at 5.6 per cent as compared to the national average of 3.6 per cent. However, this growth rate has been extremely volatile due to recurring natural disasters and is highly sensitive to the choice of the initial and final years. Moreover, productivity in agricultural crops remains low vis-à-vis the national average despite the use of significant productivity augmenting inputs such as fertilisers, quality certified seeds, farm machines, etc., in the state. There has also been impressive diversification of agriculture particularly through dairy development, but again, the productivity in milk production lags behind the milk productivity of major milk producing states in India. In this paper, we explore the reasons behind this paradox of low agricultural productivity and high use of inputs in crops, and robust expansion but low productivity in dairy, while analysing the sources and drivers of agriculture growth in Bihar.

In Section 2, we first discuss data sources and methodology used in the study. In Section 3, we give a description of the geographical and demographic features as well as the land and water resources of the state, briefly reviewing natural calamities that have afflicted agriculture. Section 4 examines the composition and sources of agricultural growth in the state. In Section 5, we discuss the status of physical infrastructure in Bihar and the drivers of agricultural growth using econometric analysis. Section 6 concludes with recommendations for policy interventions that would stimulate and sustain agricultural growth in the state.

2. Data and Methodology

The study has used secondary data compiled from various published sources, covering the period 2000-01 to 2014-15. We analyse and compare the performance of Bihar vis-à-vis the performance of other states. For the purpose of comparison, we have chosen two sub-groups of three comparator states each: the first comprising Gujarat, Madhya Pradesh and Punjab,

and the second Bihar, Odisha and Uttar Pradesh. The basis for selecting these sets of states is that, Gujarat and Madhya Pradesh have experienced rapid agricultural growth in the past decade while Punjab had achieved high growth earlier during the green revolution. Bihar, Odisha and Uttar Pradesh are considered moderately performing states due to their poor agriculture growth and high poverty rates.

To examine the composition of agriculture, we have calculated the share of value of output from different segments as a percentage of the total value of output from agriculture and allied activities. To study the sources of growth, we have deflated the current series of each segment by the WPI at 2004-05 prices and then decomposed the year-on-year growth in gross value of output from agriculture and allied activities (GVOA) by taking the absolute year-on-year difference in GVO from each segment as a proportion of the previous year's GVO from agriculture and allied activities.

The drivers of growth were analysed by using a three-step procedure to estimate the association between agriculture growth and selected control variables. First, we test if the natural logarithm of the selected variables is integrated of the same order using the Augmented Dickey Fuller (ADF) test. Based on the outcome of the test, in the second stage, we determine if the series are co-integrated (i.e., testing for a long-term relationship between the variables) using Engle and Granger's (1986) two-stage residual based method. This method was adopted because we are interested in the elasticity of the explanatory variables. Accordingly, we first run an ordinary least square model to analyse the determinants of agricultural growth in Bihar and then perform a unit root test on the residuals of the model to examine if it is stationary. The null hypothesis in the Engle-Granger procedure is no co-integration and the alternative is co-integration.

3. Agriculture in Bihar

3.1 Geography, Demography and Structural Composition

Bihar is a land-locked state situated in the eastern part of the country, with West Bengal in the east, Uttar Pradesh to its west, Nepal to its north and Jharkhand to its south. Its total geographical area is 9.4 million hectares and it is divided into three agro-climatic zones namely, northwest alluvial, northeast alluvial and south Bihar alluvial plains.

Bihar has around at 115.2 million (2016) people in the state, accounting for about 8.8 per cent of India's population. It is the third most populous state after Uttar Pradesh and Maharashtra. The state has a very high population density of 1,218 per sq km as compared to the national average of 396 per sq km, increasing the pressure on land and compounding the problem of rural poverty. Around 88.5 per cent of the population lives in rural areas as compared to the national average of 68.8 per cent, thereby making Bihar largely a rural economy. Like the rest of the country, Bihar has also undergone a structural change, moving away from agriculture towards industry and services. The agricultural sector's share in total GSDP has fallen from

32.8 per cent in Triennium Ending (TE)¹ 2003-04 to 22.0 per cent in TE 2013-14, with a corresponding increase in the share of industry and services. Despite this decline in share, around 74 per cent of the workforce is reliant on the agriculture sector for a livelihood as compared to the national average of 55 per cent (Census 2011). Further, around 72 per cent of the total agricultural workforce consists of agricultural labourers, while only 28 per cent are cultivators (Census 2011) as compared to the national average of 55 per cent and 45 per cent respectively. The rural population in Bihar is not completely dependent on agriculture but earns a part of their income as wage labourers, migrant labourers and small entrepreneurs. The composition of agricultural income in the state is such that 48.2 per cent is contributed by cultivation, 37.2 per cent by wages, 7.8 per cent by farming of animals and 6.7 per cent by farm business (NSS 70th Round).

Figure 1: Bihar in the Context of India

3.2 Water Resources and Climatic Risk

¹ For a trend analysis, we use a moving average of three years (Triennium Ending average) to even out the annual fluctuations in data

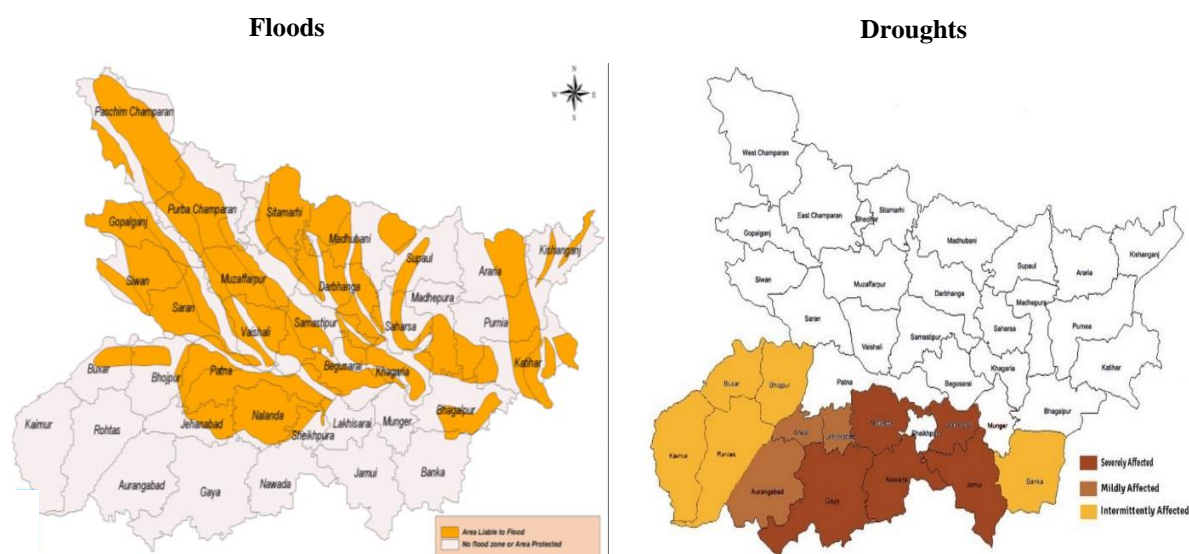
rainfall across agro-climatic zones, for example the northwest zone receives a mean rainfall of 1,234.7 mm, the northeast zone 1,382.2 mm and the south zone 1,102.1 mm.

The topography of Bihar is described as fertile alluvial plain lying wholly in the Gangetic Valley. The state is richly endowed with water resources, both ground and surface water. Besides rainfall, rivers that flow within the state are an important source of water. The main defining feature of the state is that the River Ganges flows through it and divides it broadly into water abundant north and south Bihar. The whole of North Bihar benefits from the Himalayan Rivers while South Bihar has rivers flowing from central India. Most of the rivers in North Bihar, Saryu (Ghaghra), Gandak, Burhi Gandak, Bagmati, Kamla-Balan, Koshi and Mahananda (Adhwara group of rivers) are of Himalayan origin and have a considerable portion of their catchment in the glacial region falling in Nepal and Tibet. They are positioned to receive copious amount of rainfall during the monsoons. The southern part of Bihar, on the other hand, is drained by rivers that are largely rain fed having their origin either in the Vindhya Hills or in the hills of Chhotanagpur and Rajmahal. These rivers are either dry or have scanty discharge in non-monsoon months. Karmanasa, Sone, Punpun, Kiul, Badua, Chandan are important rivers of this region.

The huge endowment of water resources in Bihar also makes the state India's most flood-prone state (Water Resource Department, Bihar). North Bihar, where around 76 per cent of the population resides is subject to recurring incidence of floods. The rivers of North Bihar, with 65 per cent of their large catchment areas lying in the Himalayas in Nepal/Tibet cause floods in around 74 per cent (Prasad and Routray, 2014) of its geographical area. These rivers carry large amounts of water and a very high sediment load, which is deposited in the plains of Bihar (Water Resource Department, Bihar). Between 2000 and 2015, Bihar experienced severe floods in 2001, 2002, 2003, 2004, 2007, 2008 and 2013. According to the data given by the Flood Management Information System of Bihar, between 2004 and 2013, 4 million hectares of cropped area, 71.1 million people and 14.8 million animals were affected by floods in Bihar.

Although South Bihar also experiences floods in some years, these are less serious as compared to those in North Bihar. This part of the state is more prone to severe droughts. Although the average annual rainfall is around 1,198 mm, there is considerable variation within the state. The extreme eastern and northern parts receive around 2000 mm while the western and southern parts receive less than 1000 mm. About 33 per cent of the state in the southern part receives less than 750 mm rainfall, making it vulnerable to drought. Even the 35 per cent of North-Eastern part of Bihar that receives average rainfall of around 1,120 mm suffers from drought once in four to five years (Prasad and Routray, 2014). Between 2000 and 2015, Bihar recorded more than 20 per cent deficient annual rainfall in 2005, 2007, 2009, 2010 and 2012.

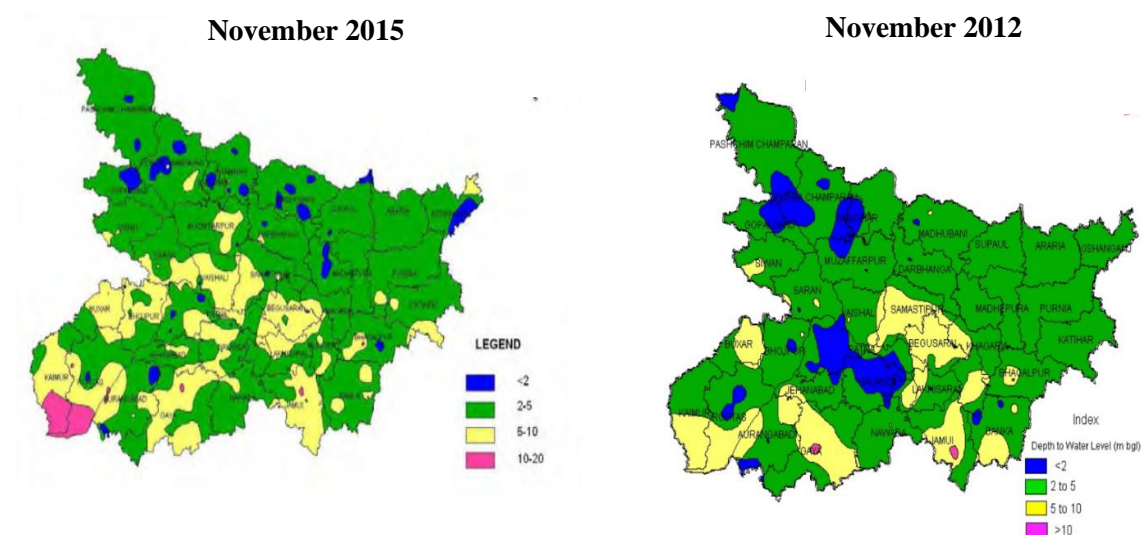
Figure 2: Floods and Droughts in Bihar



Source: UNDP and NIDM

The recurrent spells of deficient rains in recent years have caused a decline in groundwater levels in certain parts of the state. Figure 3 shows the comparative picture of the level of ground water district-wise in 2012 and 2015 after the monsoon. It is seen that the ground water level has been declining in south Bihar and in certain pockets in north Bihar as well.

Figure 3: Status of Groundwater water level in Bihar

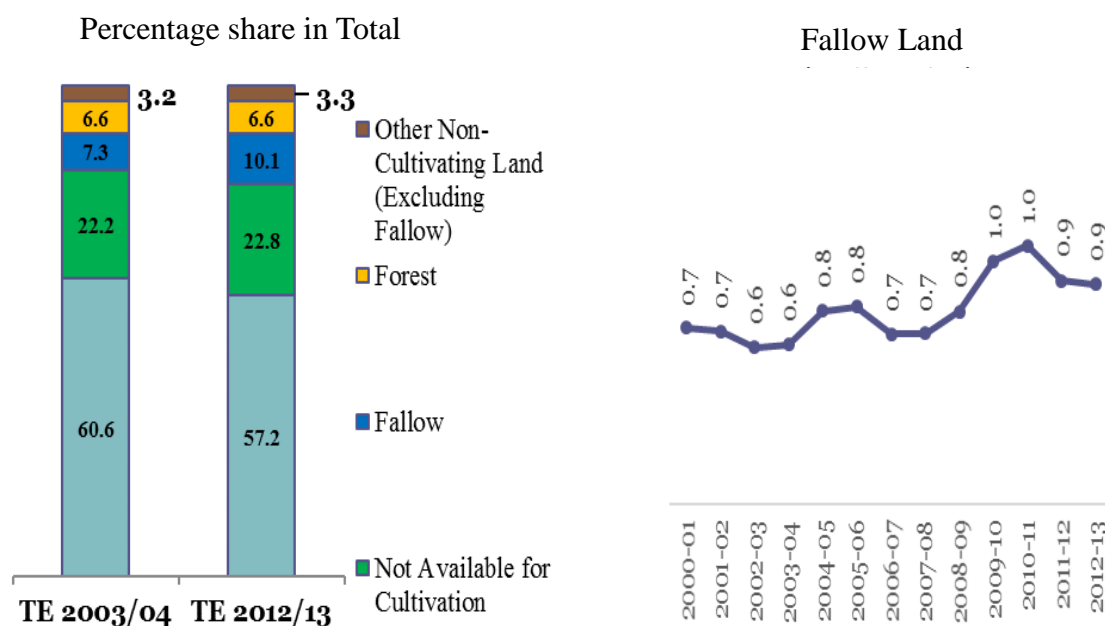


Source: Central Groundwater Board

3.3 Land Utilisation

Prior to the bifurcation of Bihar in 2000-01, the total geographical area of the state was 17.4 million hectares. Out of this, an area of 8.0 million hectares was earmarked for Jharkhand, leaving Bihar with a geographical area of 9.4 million hectares. From Figure 4, it can be seen that the land use pattern in Bihar has undergone only a small change since the early 2000s. The area under forests, other non-cultivating land which includes permanent pastures, miscellaneous tree crops and groves, grazing land, culturable waste land have remained almost the same. However, the net sown area has declined from 60.6 per cent to 57.2 per cent between TE 2003-04 and TE 2012-13, while fallow land has registered a corresponding increase from 7.3 per cent to 10.1 per cent in the same period. Water logging is mainly responsible for the decrease in the net sown area and increase in fallow land. It is also significant that the gross cropped area in Bihar has declined by 0.4 million hectares or almost 5 per cent between TE 2003-04 and TE 2012-13.

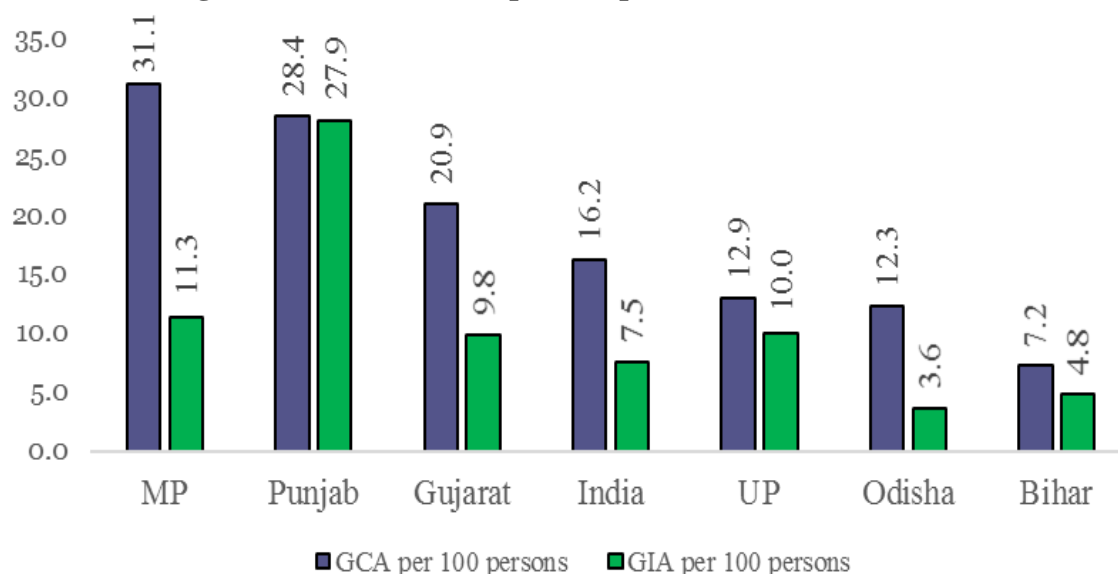
Figure 4: Structure of Land Use (Percentage share in Total Geographical Area)



Source: Directorate of Economics & Statistics

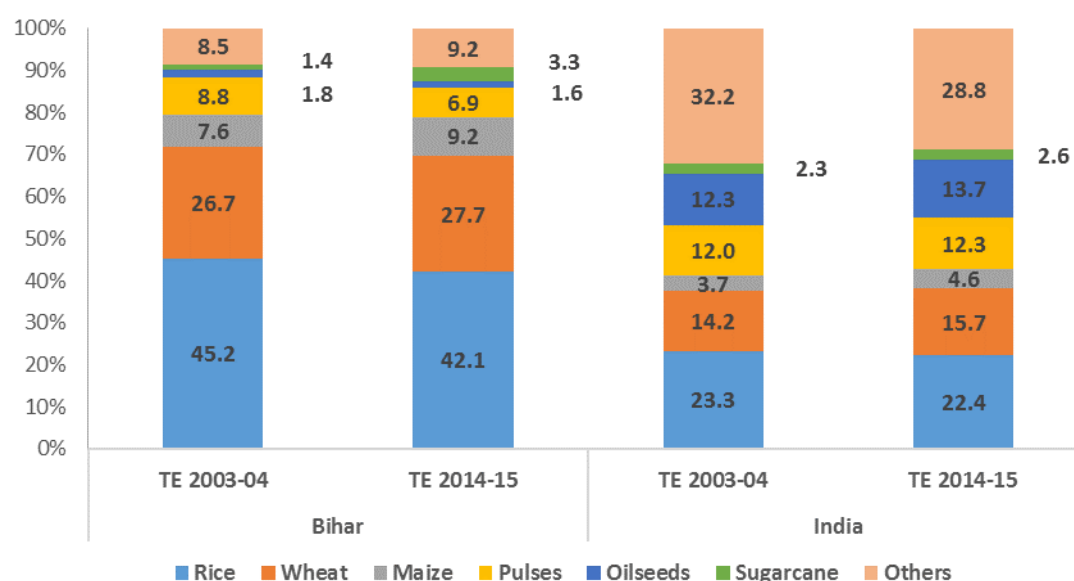
Increased fallow land and high density of rural population have both contributed to relatively scarce land availability for agricultural purpose in Bihar. Figure 5 shows that while the gross cropped area per 100 persons in Madhya Pradesh, Punjab and Gujarat are 31.1, 28.4 and 20.9 hectares, that of Bihar is only 7.2 hectares. This highlights that more individuals are reliant on a small amount of land for farming in Bihar.

Figure 5: GCA and GIA per 100 persons (in ha) TE 2012-13



Source: Directorate of Economics & Statistics

Figure 6: Area under major Crops in Bihar (Percentage of Gross Cropped Area)



Source: Directorate of Economics & Statistics

3.4 Cropping Pattern

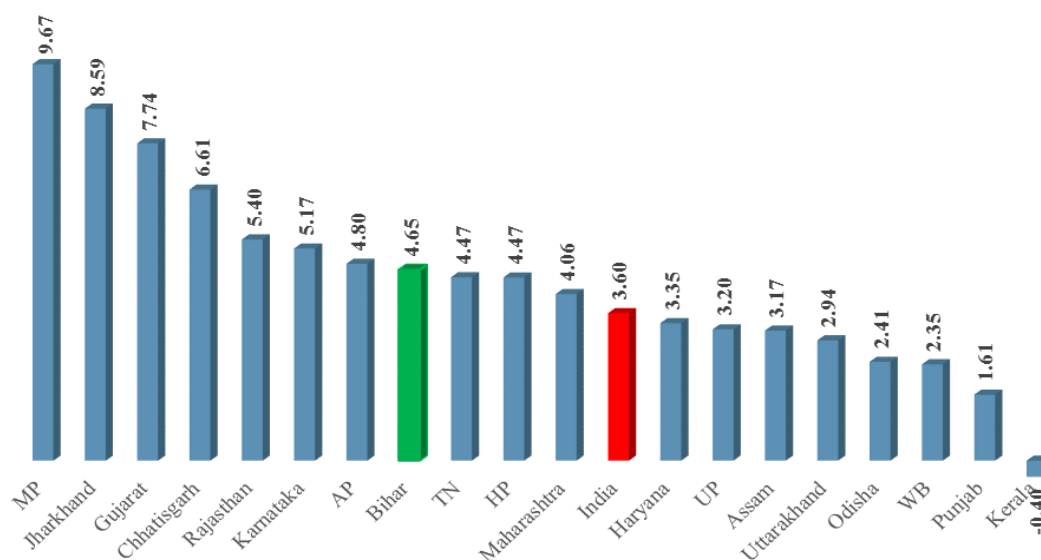
Bihar predominantly cultivates cereals. It devotes around 79 per cent of its gross cropped area (TE 2014-15) for cereal production as compared to the national average of 51 per cent. In Bihar, rice and wheat dominate the agricultural sector, contributing around 70 per cent of GCA. Rice is the dominant kharif crop and wheat the most important rabi crop. From Figure 6, it can be seen that while the share of rice in GCA has declined, that of wheat and maize

has increased in Bihar. Both the decline in the acreage of rice and the increase in acreage under wheat and maize are more pronounced in the state than at the national level. Food grains (cereals and pulses) account for around 86 per cent of GCA in the state – the highest percentage among all states – and their share in GCA has declined only marginally over the years.

3.5 Agriculture Growth Trends

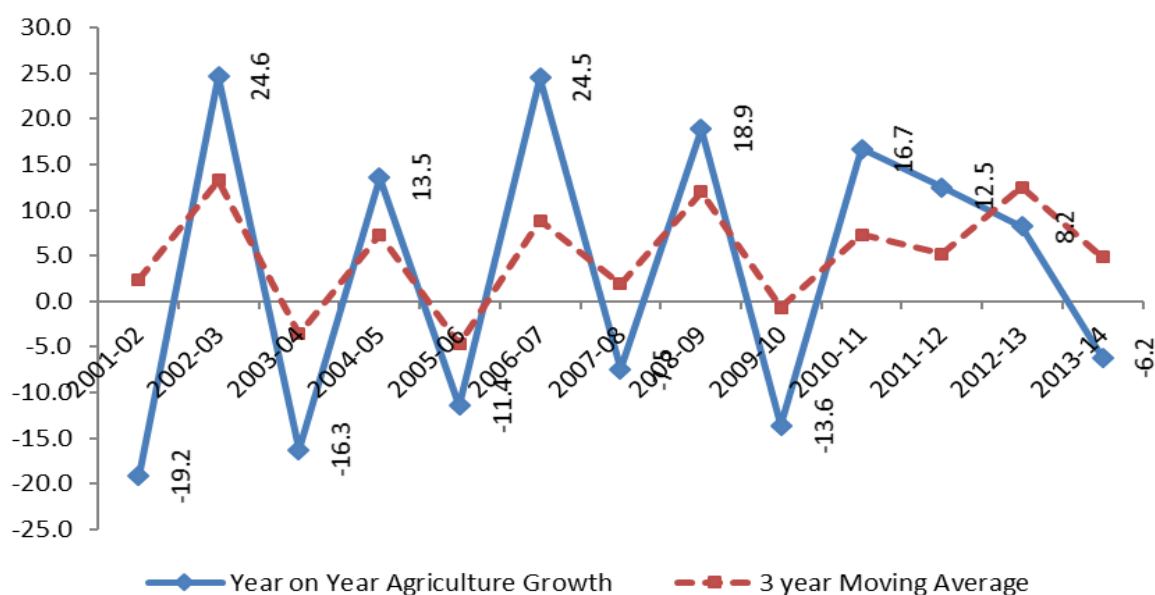
In recent years, Bihar has experienced high agriculture growth. Between 2005-06 and 2014-15, the agricultural sector recorded a growth rate of 4.7 per cent, which was above the national average of 3.6 per cent (Figure 7). In the latest five years, Bihar's performance was even more commendable, with an average annual growth rate of 7.1 per cent, although it has been volatile. It is observed that agricultural GDP in the state has not had two consecutive years of growth between 2000-01 and 2009-10. Figure 8 further shows that the year-on-year agricultural growth increased to 16.7 per cent in 2010-11, declined to minus 6.2 per cent in 2013-14 and recorded a 4.4 per cent increase in 2014-15. Due to this volatility, the growth rate we arrive at is highly sensitive to the choice of the initial and final years. Therefore, to get a better picture, we also look at the three-year moving average. The three-year moving average line in Figure 8 shows that volatility persisted between 2002-03 and 2011-12. In the following section, we examine in greater detail the sources of this growth and look at each sub-sector in terms of value added, production and productivity.

Figure 7: Agriculture Growth Rate State-wise (2005-06 to 2014-15)



Source: Government of India, Central Statistical Organization. GSDP at Factor cost in 2004-05 prices

Figure 8: Agricultural Growth in Bihar 2001-02 to 2014-15



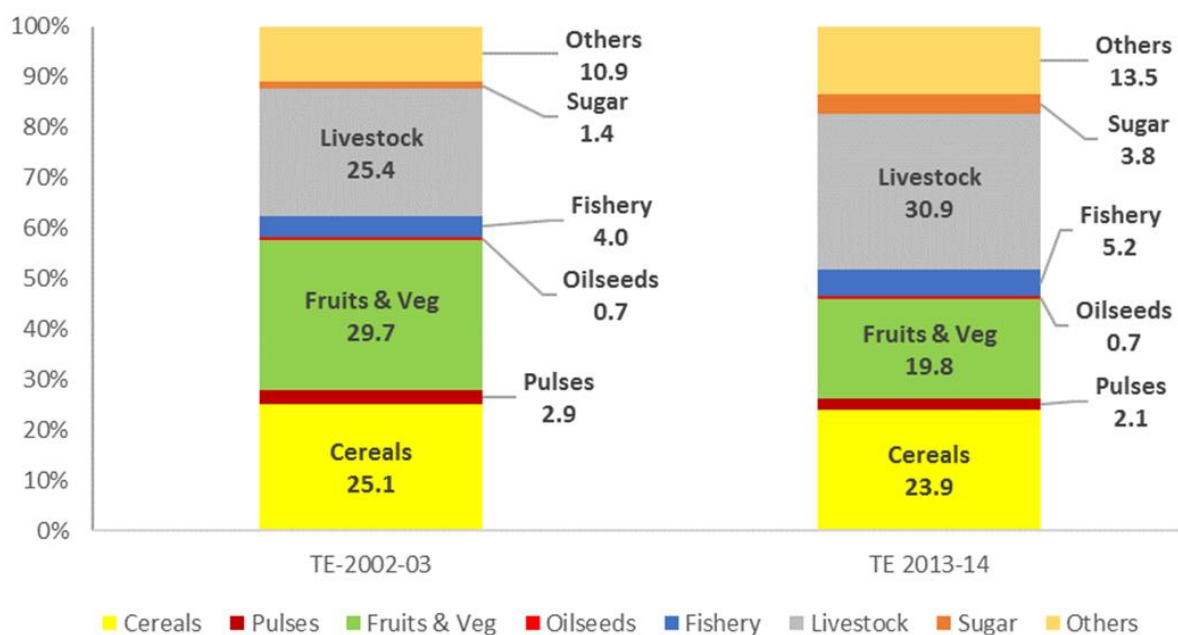
Source: Government of India, Central Statistical Organization. GSDP at Factor cost in 2004-05 prices

4. Composition of Agriculture Sector and Sources of Growth

In order to study the composition of the agriculture sector in Bihar, we have calculated the share of the value of output from different segments as a percentage of the total value of output from agriculture and allied activities (GVOA) (at current prices). Further, to analyse the sources of agricultural growth, we have decomposed the year-on-year growth in GVOA by taking the absolute year-on-year difference in GVOA from each segment as a proportion of the previous year's GVOA. Additionally, we look at production trends and growth rates reflecting sectoral performance. Given the high volatility in agriculture growth in Bihar, this exercise is important to throw light on the sub-sectors that are driving agriculture growth.

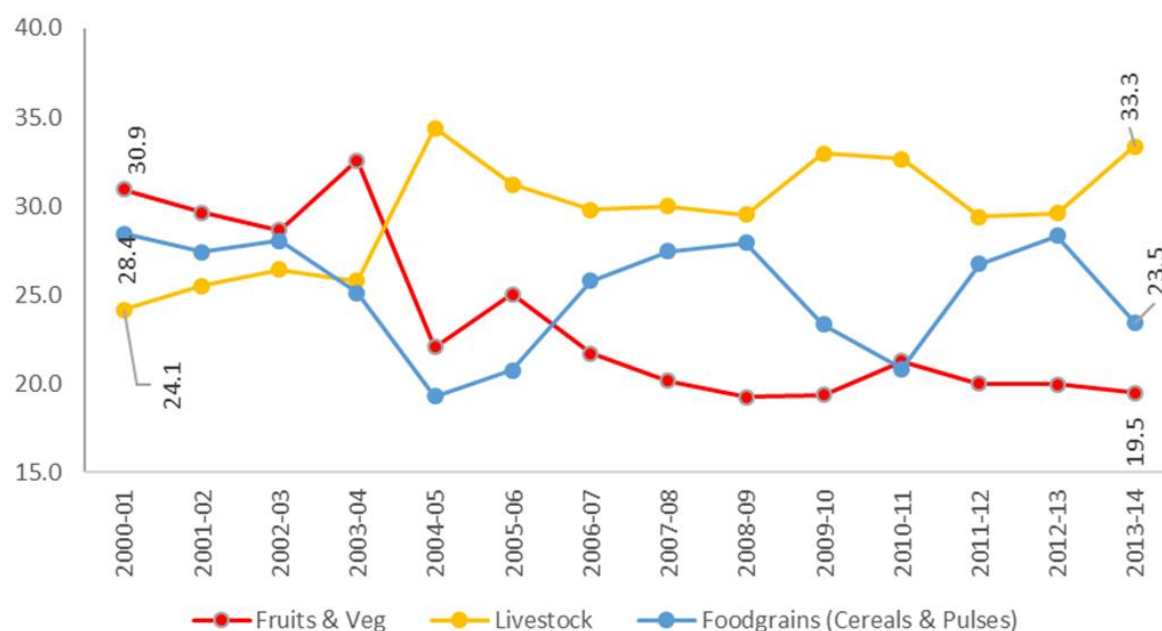
Figure 9 highlights the changing composition of Bihar's agrarian economy. In the early 2000s, the value of output from agriculture (food grains, non-food crops and horticulture) constituted the largest share of GVOA in Bihar. In recent years, although agriculture (crops) continues to be the dominant sector, the importance of the livestock sector has grown. Between 2000-01 and 2013-14, the share of livestock in the GVOA increased from around 24 per cent to 33 per cent. On the other hand, agriculture (crops) declined from 68 per cent to 54 per cent during the period. This decline has been due to a decline in both the food grains and fruits and vegetables segment. The share of fruits and vegetables in GVOA fell from 30.9 per cent in 2000-01 to 19.5 per cent in 2013-14, while food grains declined from 28 per cent to 26 per cent in the same period. The main source of agricultural growth in Bihar for 2001-02 and 2013-14 was milk, followed by food grains. In this period, GVOA on average grew at 4.3 per cent, out of which 40.1 per cent was contributed by milk and 19.1 per cent by food grains (Table 7).

Figure 9: Segment-wise shares in GVOA in Bihar (at Current prices)



Source: Government of India, State-wise Estimates of Value of Output from Agriculture and Allied Activities

Figure 10: Composition of the agriculture & allied sector over the years (percentage of GVOA)



Source: Government of India, State-wise Estimates of Value of Output from Agriculture and Allied Activities

4.1 Food grain and Non-Food Crops Segment

Food grains in Bihar constitute around 26 per cent of GVOA; cereals have a larger share (24 per cent) than pulses (2 per cent). As at the national level, the share of food grains has declined from 28 per cent to 26 per cent between TE 2002-03 and TE 2013-14. At the disaggregated level, it is observed that the share of cereals declined from 25.1 per cent in TE 2002-03 to 24 per cent in TE 2013-14, while the share of pulse fell from 2.9 per cent to 2.1 per cent in the given period.

As mentioned earlier, within cereals, rice and wheat are the most important cereals. However, the composition of this segment is undergoing some minor changes. Rice continues to be the most dominant crop contributing around 54 per cent of the total value from cereals; however, the share of wheat has fallen marginally from 36 per cent to 34 per cent between TE 2002-03 and TE 2013-14, while that of maize has increased from 10 to 12 per cent. The growing importance of maize as a cash crop in Bihar is due to the advantage the state has in winter maize cultivation (planting in October-December and harvesting in April-June) as it is one of the few states that supply maize to processing units at a time when most other states are not producing. Demand for maize comes largely from three sectors – poultry feed, livestock feed and human consumption. As per the World Bank (2007), 35 per cent of the maize demand in Bihar comes from the cattle and poultry feed market (Kishore, Sharma and Joshi, 2014). Currently, Bihar is in the third position in maize production in India (10 per cent of total production), after Karnataka (17 per cent) and Telangana (11 per cent). Besides, maize yields in Bihar (3.3 MT/ha) is higher than the national average (2.6 MT/ha). Apart from domestic demand, states such as Andhra Pradesh, Tamil Nadu and the neighbouring state of West Bengal have huge maize demand. Therefore, increasing the acreage under maize and establishing feed plants within the state can deliver significant benefits to the state.

Rice cultivation on the other hand is subject to the frequent problem of floods and water logging, especially in North Bihar. Despite this, between TE 2003-04 and TE 2014-15, rice production increased from 5.2 million tonnes to 6.5 million tonnes, an average annual growth rate of 9 per cent between 2001-02 and 2014-15. In 2011-12 and 2012-13, Bihar recorded a bumper crop and produced around 7 million tonnes of rice. The state stands sixth amongst rice producing states in the country. Around 6 per cent of total rice production is contributed by Bihar, standing only after West Bengal (14.2 per cent), Uttar Pradesh (13 per cent), Punjab (10.6 per cent), Odisha (7.3 per cent), Andhra Pradesh (6.6 per cent) and Chhattisgarh (6.2 per cent). However, rice productivity in Bihar has only marginally improved from 1.4 MT/ha in TE 2003-04 to 2.0 MT/ha in TE 2014-15. In fact, Bihar's productivity in rice is still lower than the national average of 2.4 MT/ha and much lower than that of states like Punjab (4 MT/ha), Haryana (3.2 MT/ha), Tamil Nadu and Andhra Pradesh (3.0 MT/ha).

Further, rabi cropping in the state is dominated by wheat, followed by pulses. The state devotes around 28 per cent of GCA to wheat and 8 per cent of GCA to pulses. However, wheat production between TE 2003-04 and TE 2014-15, has only marginally increased from 4.0 million tonnes to 4.7 million tonnes. As in the case of rice production, Bihar is the sixth largest wheat producer in India, contributing around 5.1 per cent of the country's total

production, after Uttar Pradesh (30 per cent), Punjab (18 per cent), Madhya Pradesh (16 per cent), Haryana (12 per cent) and Rajasthan (10 per cent). Wheat yields in Bihar (2.2 MT/ha) are lower than the national average (3 MT/ha) and much lower than in states like Punjab (4.7 MT/ha), Haryana (4.3 MT/ha) and Rajasthan, Gujarat, Uttar Pradesh (3 MT/ha). One of the factors that have kept wheat productivity low is inappropriate sowing time. The recommended sowing time for wheat in Bihar is November 19-25, when kharif paddy is still in the field in much of the state (due to delayed sowing in July and August). A one-month delay in sowing of wheat reduces its productivity by more than 50 per cent (Singh et al, 2001).

A study by Fujita (2012) emphasises that low productivity of rice and wheat cultivation in Bihar is mainly because of limited availability of improved varieties of cereals (especially rice). Based on a field survey in Madhepura District, it was observed that rice farmers mainly used local rice varieties, although several hybrid rice varieties developed by private companies were also being used on a smaller scale. The study argues that high yielding varieties (HYVs) of rice such as Sorna, MTU1001 (released by the state government in 1997) and Rajendra Mansuri (released in 2004), were not disseminated in the study area because of the high water requirement of these varieties and high cost of irrigation, which made these varieties unprofitable for farmers. On the other hand, hybrid rice varieties required less water than HYVs, and this was the major reason for the diffusion of hybrid rice in certain regions of Bihar. However, despite the potential of hybrid rice to give a yield 2 to 3 times higher than traditional local varieties, the adoption was not as fast as one would expect. The reason for this is the higher price of hybrid seed, which has to be purchased every year as compared to traditional varieties and because they require more intensive use of inputs such as chemical fertilisers and insecticides. Additionally, the market price of hybrid rice was around 30 to 40 per cent lower than local varieties, mainly because of the inferior taste. Moreover, frequent droughts and floods have made farmers reluctant to adopt new technologies. Although there has been rapid expansion of tube wells in the state in the recent past (details discussed later), tube wells continue to run on diesel oil due to poor access to electricity for agriculture purposes. This makes the water rate in Bihar very expensive (Fujita, 2012). The high water rate along with low crop yields, arising from the non-availability of improved seeds, has discouraged farmers from using more water for intensive cultivation. Both these reasons of low adoption of improved varieties of cereals as well as backwardness in tube well irrigation technology have kept yields of cereals low.

Pulses, on the other hand, contribute only around 7 per cent of GCA and 2 per cent of GVOA. Further, pulses contribution in GCA and GVOA has been falling. Interestingly, in recent years, Bihar has seen an increase in the acreage under and production of sugarcane. Acreage under sugarcane increased from 1.4 per cent of gross cropped area in TE 2003-04 to 3.3 per cent in TE 2014-15. The production of sugarcane increased from 4.7 to 14 million tonnes in the period 2001-02 to 2014-15. This is a positive trend as Bihar has potential in sugarcane production, especially in north Bihar, which is climatically conducive for the crop. Bihar has a long history of producing sugar, going back to 1840, when the Dutch set up the first white sugar-manufacturing unit in north Bihar. Earlier, Uttar Pradesh and Bihar were the

leading states in sugar production, but over the last 50 or 60 years, they ceded leadership to states like Maharashtra, and Tamil Nadu. A large number of sugar mills shut down due to declining sugarcane production and competition with khandsari units. Currently, there are 28 sugar mills in the state, out of which 19 are closed and only nine are working, all in the private sector. In 2011, two sugar mills, which were earlier under the Bihar Sugar Corporation, were handed over to Hindustan Petroleum Corporation Ltd (HPCL). In order to give a thrust to the sugar industry in the state, the Government of Bihar has introduced several concessions and rebates, which include reduction in VAT on ethanol and denatured spirit from 12.5 per cent to 4.0 per cent and abolition of literage fees on ethanol and liquor (Economic Survey 2014-15). The government supports sugarcane farmers by giving them a subsidy of Rs.135 per quintal on the purchase of certified sugarcane seeds of improved variety, based on a declaration by sugar mills.² Incentives are also given for inter-cropping with sugarcane and for the use of diesel for irrigating the crop. Despite these efforts and good soil quality, Bihar's sugarcane yield is much lower (50.8 Mt/ha) than the national average (70.1 MT/ha) (Table 8). This is because only 25-30 per cent of the area under sugarcane has irrigation facility, and even irrigated areas receive only one or two waterings on average and water is not available in canals during the months of April-June. Moreover, Bihar faces a shortage of planting material of high-yielding varieties of sugarcane (Economic Survey of Bihar 2014-15).

4.2 Fruits and Vegetables Segment

Figure 9 shows that the share of fruits and vegetables in GVOA has declined from 30 per cent in TE 2002-03 to 20 per cent in TE 2013-14. However, in absolute terms, the value of output from fruits and vegetables has increased from Rs.81.6 billion to Rs.172.4 billion in the same period.

Within the fruits and vegetables segment, vegetables constitute the larger share. In terms of acreage, the state devotes around 11 per cent of its gross cropped area to vegetable production, which is way above the national average of 5.0 per cent. In TE 2013-14, Bihar was the third largest vegetable producer (8.9 per cent), after West Bengal (14.9 per cent) and Uttar Pradesh (11.8 per cent). Potato is the most important vegetable grown in the state with around 38 per cent of vegetable area dedicated to the crop. Apart from potato, the other main vegetables grown in Bihar are cauliflower, okra, brinjal, onion, tomato and cabbage.

Bihar is the third largest producer of potatoes in the country after Uttar Pradesh³ and West Bengal.⁴ In TE 2013-14, potato yield in Bihar was around 20.2 MT per hectare as compared to the all-India average of 21.9 MT per hectare. In comparison, Uttar Pradesh's productivity was 24.4 MT per hectares, West Bengal's 25.9 MT per hectare and Gujarat's 28.2 MT per hectares, the highest productivity in potato cultivation in the country.

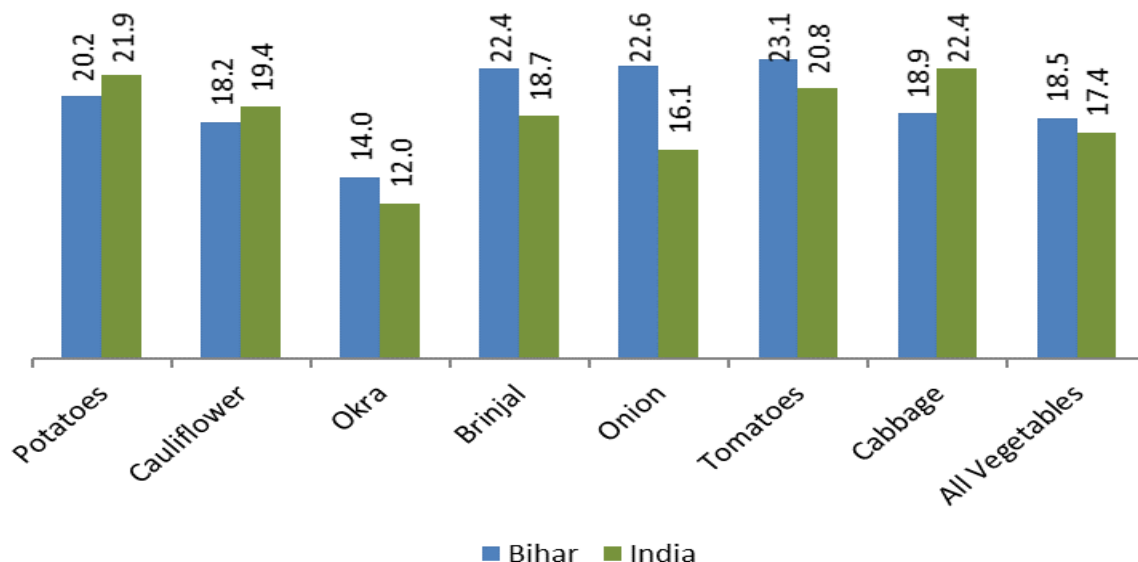
² A farmer gets the benefit of this scheme for a maximum of 5 acres and once the farmer has availed of the subsidy, he is not entitled to avail of the subsidy for the next 3 years

³ 33 per cent of total potato production in the country

⁴ 23.6 per cent of total potato production in the country

As Figure 11 shows, Bihar's productivity in okra, brinjal, onion and tomato as well as in vegetables as a group is higher than the national average. However, it is lower in cauliflower and cabbage, apart from potatoes to which we have already referred. Even in these three vegetables, Bihar seems to be closing the gap with the national average. Clearly, vegetable cultivation is an area of promise in Bihar.

Figure 11: Productivity of Vegetables (MT/ha) TE 2013-14



Source: National horticulture Database

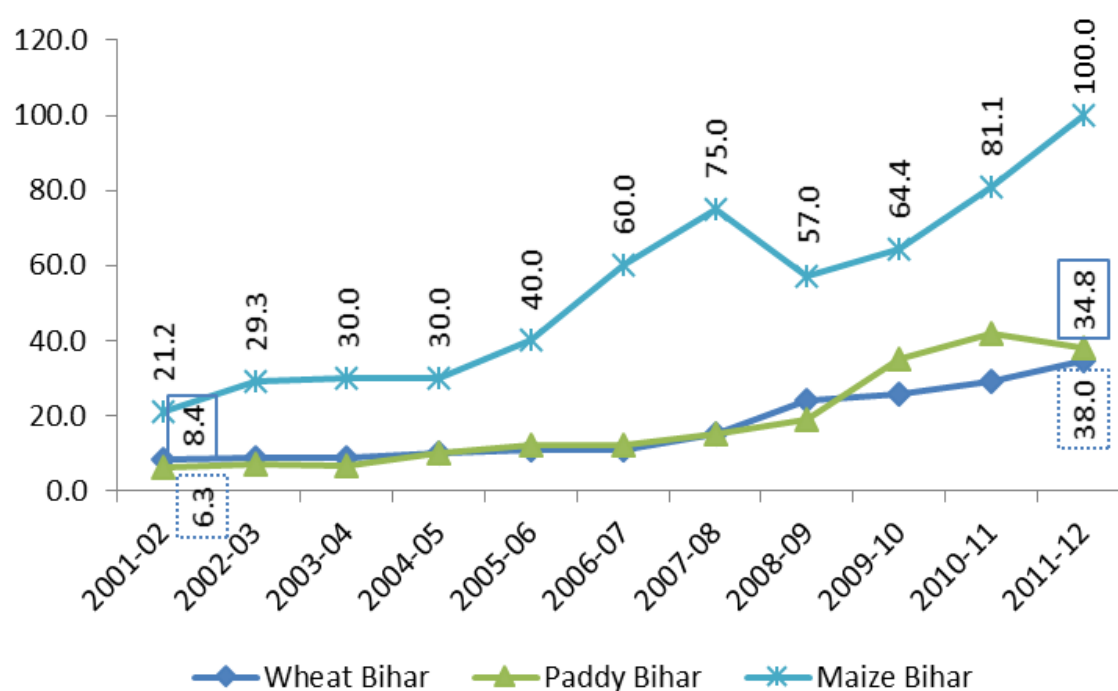
Around 4 per cent of its GCA is dedicated to fruit cultivation as compared to the national average of 3.4 per cent. Mango, banana, litchi and guava are the main fruits grown in Bihar. In TE 2013-14, around 49 per cent of the area under fruit cultivation was devoted to mango orchards, 11 per cent to banana, 10.4 per cent to litchi and 9.9 per cent to guava. Bihar's productivity in fruit cultivation is around 13.5 MT per hectare, which is higher than the national average of 11.8 MT per hectare. Out of all the fruits grown in the state, there has been robust growth in the production of banana and guava in recent years (Table 12). Bihar is the top litchi producing state in the country and the state contributes around 42.7 per cent of total production. In terms of mango production, Bihar ranks fifth contributing around 8 per cent of the total production. Mango and litchi together account for around 59.4 per cent of the area under fruits.

4.3 Paradox of Stagnant Productivity and Increased Input Use in Crop Production

From the above discussion, it is clear that although rice and wheat are the dominant crops grown in the state, the productivity of these crops is rising very slowly in Bihar and, in fact, is lower than the national average. Similarly, in the case of sugarcane and potatoes, productivity is lower than the national average. The pertinent question that arises is – are farmers in Bihar slow in adopting yield-enhancing inputs? The trends in use of inputs such as quality seeds, irrigation, fertilizers, machines, etc., that we discuss next show a contrary picture.

In the early 2000s, Bihar's seed replacement rates (SRR) for crops like paddy and wheat were as low as 6.3 per cent and 8.4 per cent respectively (Figure 12). Consequently, the Agriculture Road Map of Bihar-I (2008) stressed the need to produce and apply quality seeds to improve productivity of crops. Twenty-three crops were identified and promotion programmes initiated by the state government. Programmes such as Chief Minister's Crash Seed Programme (2008), Seed Village Programme (Beej Gram Yojana), provision of subsidy for the production and purchase of certified seeds, revival of the previously dormant Bihar Rajya Beej Nigam (BRBN), strengthening the Bihar Seeds Certification Agency, and multiplication of foundation and breeder seeds by state farms have resulted in Bihar achieving the targets set by the Agriculture Road Map (ARM)-I. Indeed, the performance of Bihar in increasing the SRR of major food grains over a short period of four years. There was an impressive increase in the SRR of major crops between 2001-02 and 2011-12 is commendable' it increased from 6.3 per cent to 38 per cent in paddy, from 8.4 per cent to 34.8 per cent in wheat and 21.2 per cent to 100 per cent in maize. As a result, as Figure 12 shows, in 2011-12, Bihar's SRR for maize is now far higher than the all India average of 56.6 per cent. It was higher in that year at 34.8 per cent against the national average of 32.6 per cent. In paddy too, the earlier gap in the SRR vis-à-vis the all-India average has narrowed down substantially, but it is still on the lower side.

Figure 12: Seed Replacement Rate Wheat, paddy and Maize in Bihar (%)

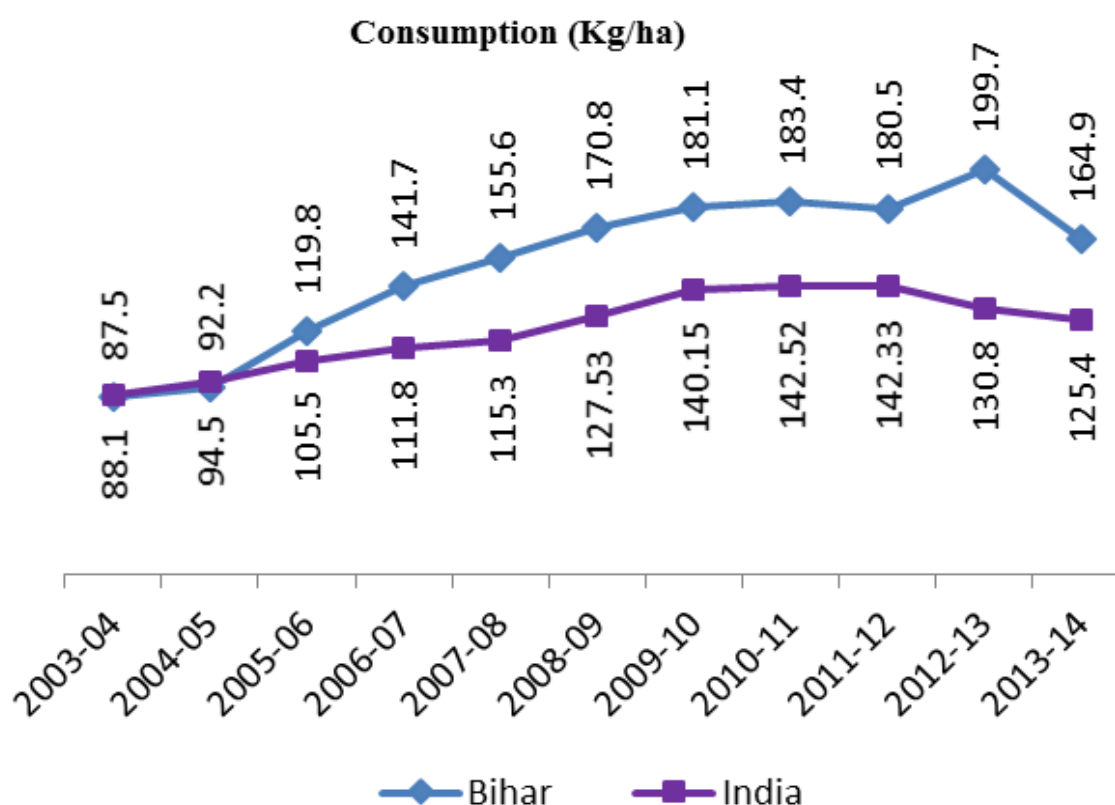


Source: Seednet India Portal

Further, along with the use of better quality seeds, irrigation and use of chemical fertilisers also play a key role in increasing agricultural productivity. Irrigation coverage in Bihar has increased from 57 per cent of GCA in 2001-02 to around 68.5 per cent in 2012-13 as compared to the national average of 47.6 per cent (we discuss irrigation in details in the

section on drivers of agricultural growth). Further, fertiliser (NPK) consumption has increased from 87.5 kg/hectare in 2003-04 to 199.7 kg/hectare in 2012-13, which is much higher than the national average of around 130.8 kg per hectare (Figure 13). The corresponding figures for comparator states are 249.5 kg/ha for Punjab, 102.5 kg/ha for Gujarat and 83 kg/ha for Madhya Pradesh. However, the data provided by Directorate of Economics and Statistics shows that wheat cultivation in Bihar required 125 kg/ha while paddy consumed 97 kg/ha (2012-13). This divergence in fertiliser consumption data raises the question of whether subsidised fertilizer from Bihar is being diverted to neighbouring countries⁵ (Gulati, 2016). One adverse aspect of fertiliser use in the country is that there is an imbalanced and excessive use of nitrogenous fertilisers, and Bihar is no exception, although it must be acknowledged that the possible diversion of fertilisers, particularly urea, to other countries may have accentuated the imbalance. Against the NPK norm of 4:2:1, the ratio was 62:19:1 in Punjab, 25:3:8 in Uttar Pradesh and 10:2:1 in Bihar in 2013-14.

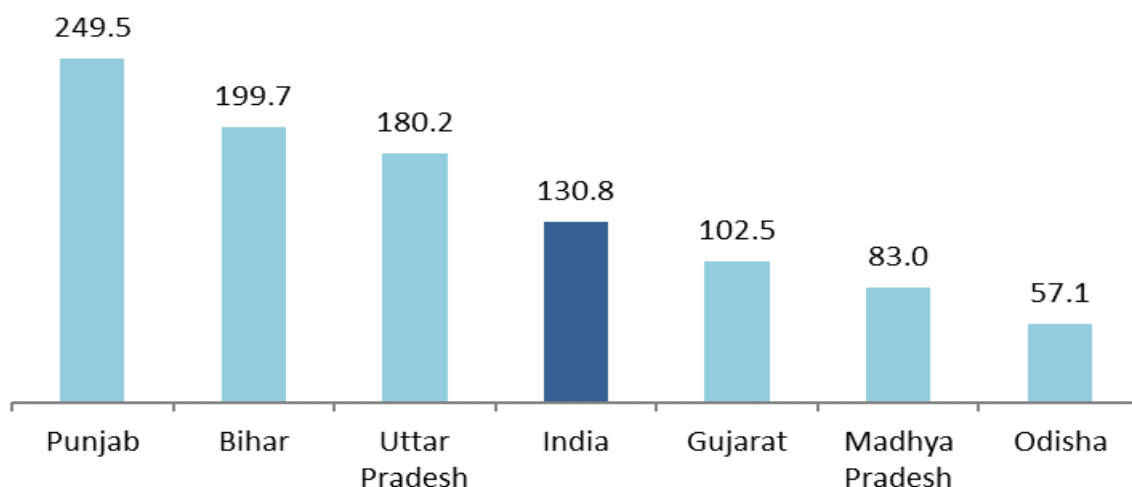
Figure 13: Consumption of Fertiliser in Bihar (kg/ha)



Source: Department of Agriculture Bihar, *Several Issues of Economic survey of Bihar and agriculture Statistics at a Glance*, 2014

⁵ <http://indianexpress.com/article/opinion/columns/india-economic-reforms-indian-farmers-fertiliser-subsidy-union-budget-modi-govt-organic-farming-2892089/>

Figure 14: Fertiliser Consumption (kg/ha) 2012-13, in Selected States



Source: Agriculture Statistics at a Glance 2014-15 and Fertiliser statistics 2012-13

Further, to reduce the cost of cultivation and increase productivity, farm mechanisation was an integral strategy of the state government. In addition to centrally sponsored schemes to augment farm mechanisation, the state government has provided additional support to farmers for mechanisation from state resources. The government has focused more on the zero tillage machine, which is considered more suitable for small and marginal farmers. From Table 33, it can be observed that these efforts have borne fruit and there has been robust expansion of zero tillage machines in Bihar from just 126 machines in 2008-09 to 9,760 units in 2013-14, a CAGR of 106.5 per cent. Similarly, combine harvesters have increased from 55 units in 2008-09 to 261 units in 2013-14, showing a CAGR of 29.6 per cent. The use of power tillers has, however declined marginally.

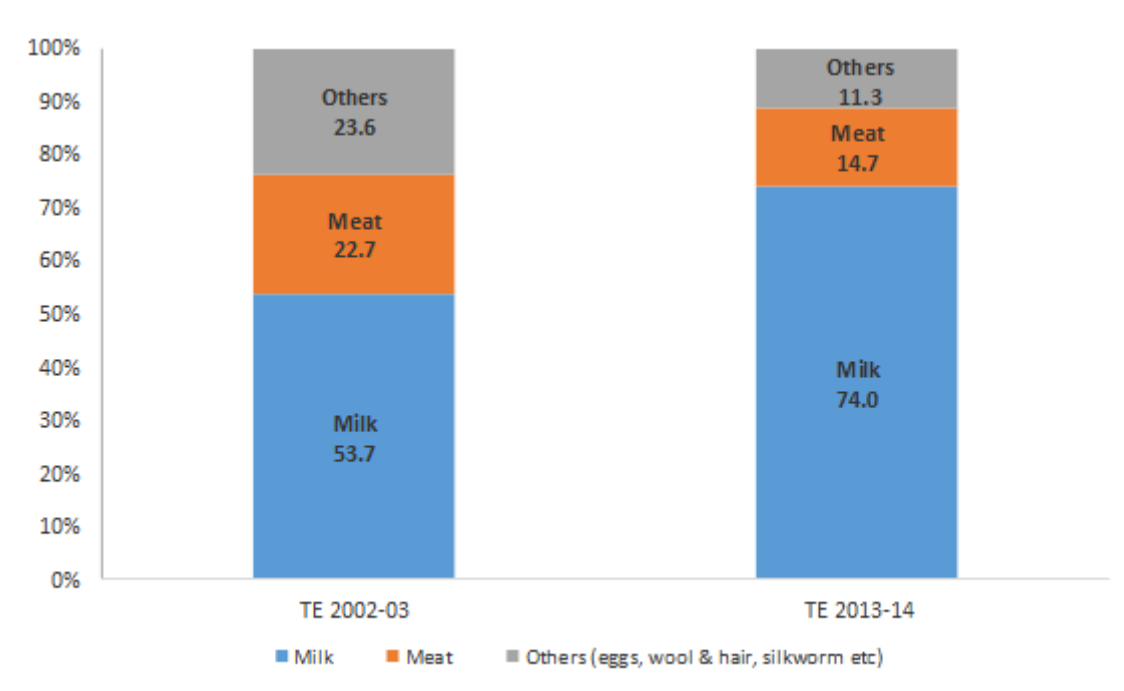
The above discussion highlights that low productivity in Bihar is not due to low utilisation of productivity augmenting inputs. In fact, farmers in Bihar have caught up with the rest of India in input use by investing heavily in assets such as quality seeds, fertilisers and farm machines. An interesting aspect is that the increasing investment in inputs has taken place even though Bihar is behind national average and advanced agriculture states in disbursement of agricultural credit from institutional sources. Our calculations show that in 2014-15 the per hectare crop plus term loan in rupees⁶ amounted to 30,163 for Bihar as compared to the national average of Rs 42,085 per hectare and Rs 92,974 per hectare in Punjab and Rs 62,489 per hectare in Haryana, for instance. What is impeding the advancement of loans from commercial institutions is the fact that the land records are not updated, and land ownership is a pre requisite as a collateral for availing financing from formal institutions. The state is ceased of the problem and is taking action for updating the records. As soon as progress is made on this front it would be possible for farmers to access more agriculture credit for such purposes as mechanisation and expansion of crop and livestock production.

⁶ Latest data for gross cropped area available for 2013-14

4.4 Livestock Sector

Animal husbandry and dairy is an important income generating activity for the rural poor in Bihar in addition to crop cultivation. There has been robust of the livestock sector in Bihar in the 2000s and, as mentioned earlier, its share in GVOA has increased from 25.4 per cent in TE 2002-03 to 31 per cent in TE 2013-14. In comparison, the all-India share of livestock in GVOA stood at 26 per cent in TE 2013-14. From Figure 15, we also observe that the composition of the livestock sector has itself undergone a change in the state. The share of meat in the total value of output from livestock sector has declined while that of milk has increased.

Figure 15: Composition of Livestock Segment (Percentage of Total value of Output from Livestock Sector)



Source: Government of India, *State-wise Estimates of Value of Output from Agriculture and Allied Activities*

4.4.1 Milk Segment

The main contributor to the expansion in the livestock sector has primarily been the milk sector. In Figure 9, it can be seen that between TE 2003-04 and TE 2013-14, the share of milk in GVOA has increased from 14 per cent to 23 per cent, while at the all-India level, the share of milk in GVOA remained at 17 per cent during the same period. Around 55 per cent of the total milk produced in the state is cow milk and 42.0 per cent buffalo milk.

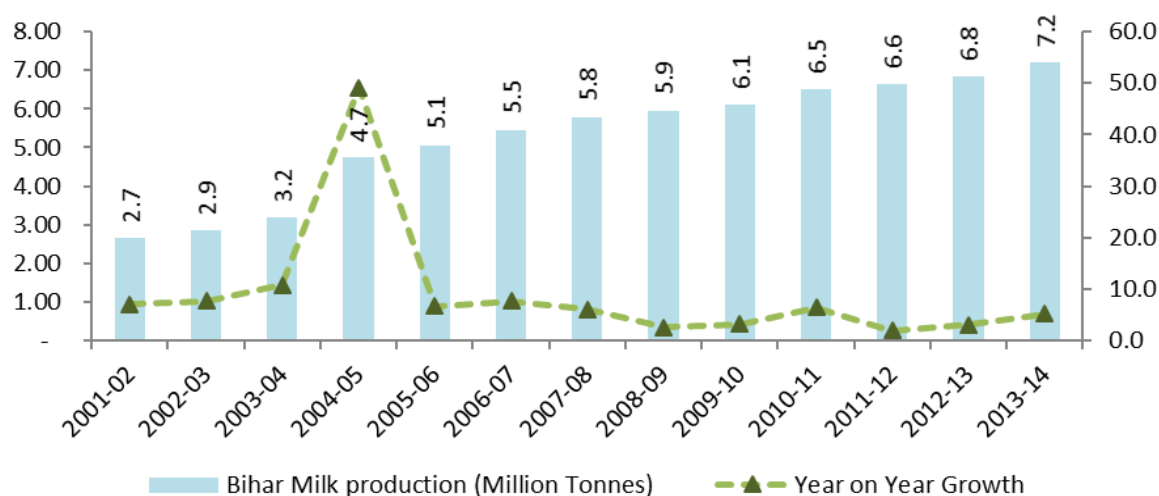
It needs to be mentioned here that available CSO data on the value of output shows a sudden jump in the value of milk output from Rs.48.3 billion in 2003-04 to Rs.71.0 billion in 2004-05, an increase of 47 per cent in just one year, which strains credibility. Kishore, Sharma and

Joshi (2014), suggest that the apparent discrepancy in the value of milk output was because Bihar did not conduct a livestock census in 1987, 1992 and 1997, and earlier estimates of milk output were based on the 1977 and 1982 census of livestock. In 2003, when Bihar conducted its livestock census after two decades, the number of livestock was found to be much higher than what earlier projections suggested. This led to a sharp upward revision in the value of dairy and other livestock output in the year 2004-05, implying that the value of output from livestock was under estimated prior to 2003-04.

Production of milk in the state increased from 2.7 million tonnes in 2001-02 to 7.2 million tonnes in 2013-14, a CAGR of 7.9 per cent as compared to the national average of 3.8 per cent. The latest data available is for 2014-15 by when the production had increased to 7.8 million tonnes. Milk processing capacity has registered an impressive increase in recent years, rising from 2.3 million tonnes in 2013-14 to 5.2 million tonnes in 2015-16. Like the value of milk output data, milk production data also shows a jump from 3.2 million tonnes in 2003-04 to 4.7 million tonnes in 2004-05, an increase of 47 per cent in just one year. If we just look at the data from 2004-05, milk production in Bihar increased to 7.2 million tonnes in 2013-14 from 4.7 million tonnes, a 53 per cent increase in 10 years or a CAGR of 4.3 per cent. Therefore, if we compare current milk production data to the data of 2000-01, we will be overestimating production growth. However, if we look at data from 2004-05 to 2013-14, it appears that Bihar is the sixth fastest growing milk producing state after Andhra Pradesh (CAGR 6.0 per cent), Rajasthan (5.8 per cent), Madhya Pradesh (5.7 per cent), Gujarat (5.0 per cent) and Karnataka (4.4 per cent). In terms of volume, currently Bihar is the tenth largest milk producing state in India.⁷ Despite this impressive growth in production, productivity of milk in Bihar is less than in Punjab, Gujarat, UP and MP. For example, while milk productivity in Bihar stood at 0.7 MT per lactating animal, Punjab's productivity was 2.4 MT per lactating animal, Gujarat's 1.1 MT per lactating animal, UP's 1.0 MT per lactating animal and MP's 0.8 MT per lactating animal.

⁷ After Uttar Pradesh (17.6 per cent), Rajasthan (10.6 per cent), Andhra Pradesh (9.5 per cent), Gujarat (7.8 per cent), Punjab (7.4 per cent), Madhya Pradesh (6.7 per cent), Maharashtra (6.6 per cent), Haryana (5.3 per cent), and Tamil Nadu (5.3 per cent)

Figure 16: Production of milk in Bihar (Million Tonnes)



Source: National Dairy Development Board

An important reason for low milk productivity is the lower proportion of genetically superior cattle (crossbred). From Table 14, it can be seen that the exotic/crossbred female cattle population in Punjab was 91.5 per cent of total female cattle population, while that of Bihar was only 32.9 per cent in 2012. Although this proportion was still low, there had been an increase in the proportion from 21.0 per cent in the five years since 2007.

Exotic/cross-bred cows have superior genetic potential to yield proportionately higher productivity compared to native breeds. On average, a cross-bred cow yields 7.2 litres a day nationally, but in Punjab, a typical cross bred cow yields about 11.2 litres a day while in Bihar, it is only 6.5 litres a day. This means that cross-bred yield in Bihar is almost half the yield in Punjab. The production trait of milk producing cattle in Punjab is better than in Bihar because of the use of germ plasm from superior breeds in cross breeding in the former.

The Bihar State Milk Co-operative Federation (COMFED) has played a pivotal role in developing the dairy sector in the state. It was established in 1983 as the implementing agency of the Operation Flood Programme in the state. COMFED's co-operative model is similar to the pattern of Anand in Gujarat. It is a three-tier structure under which there is the milk producer's co-operative society at the village level, milk union at the district level and milk federation at the state level. COMFED markets its milk product under the brand name of 'Sudha' Milk. Procurement by COMFED increased from 114.3 thousand kg per day in 1994-95 to around 1,074.9 thousand kg per day in 2011-12, recording a CAGR of 13.3 per cent. Despite this robust growth in milk procurement, only about 10 percent of the milk produced is procured and processed by COMFED at present with another 2 to 3 per cent being procured by the private sector.⁸ Therefore, there is huge untapped market for milk processing in Bihar.

⁸ <http://www.udyogmitrabihar.com/sectors/food-processing/#dairy>

4.4.2 Meat Segment

The meat sector constitutes around 5 per cent of GVOA in Bihar and its share has marginally declined from 6 per cent in TE 2002-03. Meat production in the state recorded an increase of 4.7 per cent (CAGR) in the period 2001-02 to 2013-14, much lower than the national average of 9.5 per cent growth (CAGR). As a result, Bihar's share in all-India meat production has fallen from 8.3 per cent in TE 2003-04 to 4.2 per cent in TE 2013-14 (Table 16). Currently, Bihar is the eighth largest meat producing state after Uttar Pradesh, Andhra Pradesh, West Bengal, Maharashtra, Tamil Nadu, Haryana and Kerala.

At a disaggregated level, mutton (22.5 per cent) constitutes the largest share in the total meat production, followed by pork (20.5 per cent) and buffalo meat (15.2 per cent). Poultry's share in the total meat production is only 12.2 per cent (2012-13). However, between 2008-09 and 2012-13, poultry has grown at the fastest rate as compared to other animal meats in Bihar, due to the robust expansion of poultry farms and hatcheries as compared to backyard poultry. As per the 19th Livestock Census (2012), Bihar's backyard poultry shrank at the rate of 1.7 per cent CAGR in the period 2007 and 2012. This is analogous to the national trend, which shows a fall in backyard poultry, and an increase in farms and hatcheries. In Bihar, the number of poultry birds in broiler farms increased from 3.1 million to 5.1 million in this period, a CAGR of 7.8 per cent, as compared to the national average of 6.3 per cent. Bihar has also recorded a robust expansion in duck population in duck farms (Table 17).

As mentioned above, in Bihar goat meat, pork and buffalo meat are the main types of meat produced. In 2012-13, Bihar contributed 7.0 per cent of total mutton production in the country, making it the fifth largest producer, while the top producers were West Bengal (25.7 per cent), Uttar Pradesh (19.5 per cent), Andhra Pradesh (9.3 per cent) and Maharashtra (7.5 per cent). In the same year, Bihar was the second largest producer of pork, contributing around 13.2 per cent of total pig meat production in the country, after Uttar Pradesh (38.0 per cent). In terms of buffalo meat production, Bihar ranks sixth (4.0 per cent) in the country after Uttar Pradesh (46.8 per cent), Punjab (11.1 per cent), Andhra Pradesh (10.7 per cent), Kerala (9.1 per cent) and Maharashtra (4.7 per cent).

An ambitious programme was envisaged in ARM-II to increase meat production through a goat distribution programme, establishment of feed factories, establishment of modern slaughter houses and distribution of chicks to poor families in the villages. However, none of these schemes, except the distribution of chicks through the Jeevika programme, took off because of shortage of funds.

4.5 Fishery

Bihar has rich aquatic resources, which includes about 3,200 km of rivers, 100,000 hectares of *chaurs* and floodplains and wetlands, 9,000 hectares of oxbow lakes and mauns, 7,200 hectares of reservoirs and 6,900 hectares of ponds and tanks.⁹ However, the fishery segment contributes only around 5.2 per cent of the total value of output from agriculture and allied

⁹ <http://ahd.bih.nic.in/Docs/ICAR-Report-Fisheries-Dev-Bihar.pdf>

activities (TE 2013-14) and the supply of fish falls short of demand in the state. Currently, Bihar is the ninth largest fish producing state. In evaluating Bihar's rank among fish producing states, we have to take into account the fact that Bihar is a non-maritime state and fishery is dependent on inland resources. In TE 2013-14, Bihar produced around 0.43 million tonnes of fish, contributing only around 4.3 per cent of total fish production in the country (Table 19). In 2014-15, the production had increased to 0.48 million tonnes, showing a year-on-year increase of around 11 per cent.

An ICAR report¹⁰ (2008) has confirmed the substantial potential for expansion of inland fishery in the state, particularly in two water resources, ponds and oxbow lakes (mauns). It assessed that fish production could be doubled in 4 to 5 years from the level of 2.6 lakh MT existing at that time. The main interventions identified for realising the potential were clearance of weed infestation, renovation and desilting of ponds, establishment of brood banks and hatcheries to enhance seed production, leasing of seed rearing space with buy back arrangements, long-term leasing of water bodies to enable their development, stocking of ponds with adequate fingerlings and development of post-harvest fish handling and marketing facilities (ICAR, 2008).

Some of the suggestions made in ICAR Report were picked up in ARM-2, which envisaged fingerling rearing by farmers in pens and rearing ponds constructed near ox-bow lakes, construction of large rearing ponds and reservoirs, and long-term leasing of ponds so that the lessees invested their own funds. ARM -2 also included provisions for the establishment of feed mills and wholesale and retail outlets and purchase of refrigerated vans for transport of fish to the market. There was a plan for the establishment of cold storage-cum-ice plants at the district level as well. Training for farmers and extension workers has also been envisaged.

5. Drivers of Agriculture Growth

We noted the major paradox of high investment in productivity augmenting inputs and low agricultural productivity in Bihar's agriculture situation. Deficiencies in public infrastructure are mainly responsible for this paradox. In this section, we examine these deficiencies by first discussing the status of public infrastructure and later, examining the potential drivers of agriculture growth using an OLS regression model. We also undertake the Engle-Granger Test for co-integration to test the for long-term relationship between the selected variables.

5.1 Status of Physical Infrastructure in Bihar

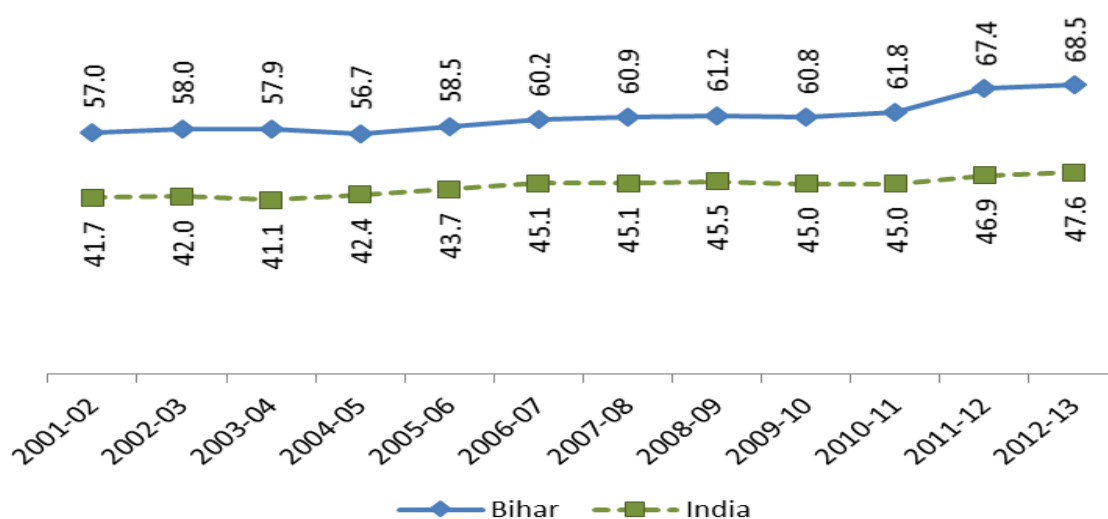
Irrigation, power and roadways play a vital role in augmenting agriculture investment and growth (FAO, 1996). Several earlier studies (Antle, 1984; Binswanger et al, 1993; Fan, Gulati and Thorat, 2007; Fan and Zhang 2004) have highlighted that investment in rural infrastructure has the ability to increase farmer's access to markets, encourage development of the rural non-farm economy, invigorate rural towns, and bolster rural consumer demand. In this section, we discuss the development of infrastructure in Bihar to understand the reasons for low productivity in the agricultural sector.

¹⁰ <http://ahd.bih.nic.in/Docs/ICAR-Report-Fisheries-Dev-Bihar.pdf>

5.1.1 Irrigation

We have alluded earlier to the fact that while normal rainfall received by Bihar is sufficient to sustain agriculture, there are spatial and temporal uncertainties surrounding it. As a result, farming in Bihar remains substantially dependent on irrigation. The irrigation ratio (the gross irrigated area as a proportion of the gross cropped area) in Bihar is more favourable (68.5 per cent) as compared to the country as a whole (47.6 per cent), and, in fact, the comparative position of the state has improved during the period 2001-02 to 2012-13 (Figure 17). Currently, Bihar has the fourth highest irrigation ratio in the country after Punjab (98.2 per cent), Haryana (87.2 per cent) and Uttar Pradesh (77.2 per cent). In these three states, GCA and GIA have been increasing, except in Punjab where GCA has remained constant (Table 3).

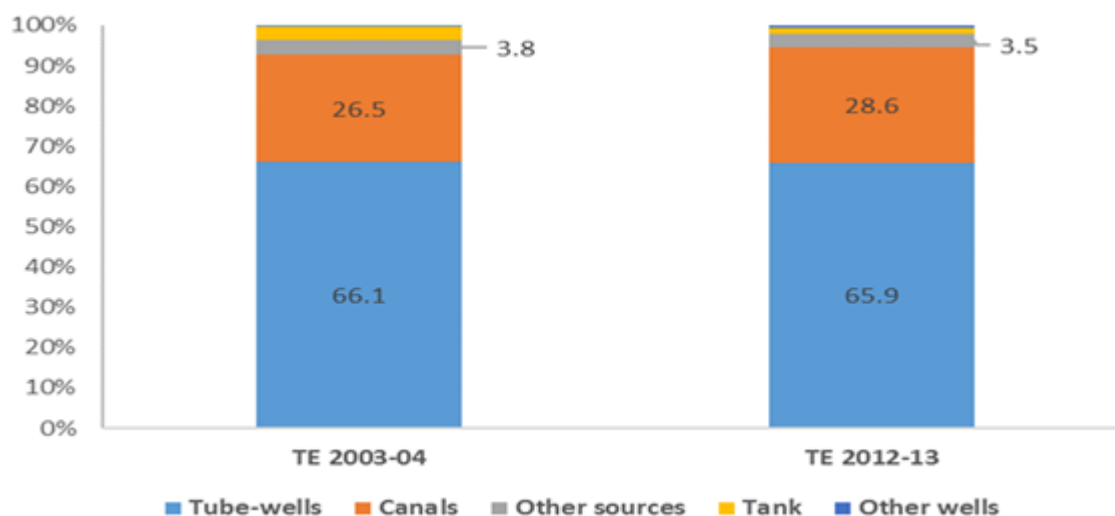
Figure 17: Gross irrigated Area as a percentage of Gross Cropped Area



Source: Directorate of Economics & Statistics

The source wise picture of the evolution of irrigation during the period under consideration in comparator states is given in Figure 18. Tube wells and canals are the main sources of irrigation in Bihar, contributing around 65.9 per cent and 28.6 per cent of the GIA respectively and there was modest expansion in the number of tube wells and canals during the period between TE 2003-04 and TE 2012-13. However, irrigation from tanks has been shrinking in Bihar, and there is substantial under-exploitation of dug wells as compared to Madhya Pradesh and Gujarat.

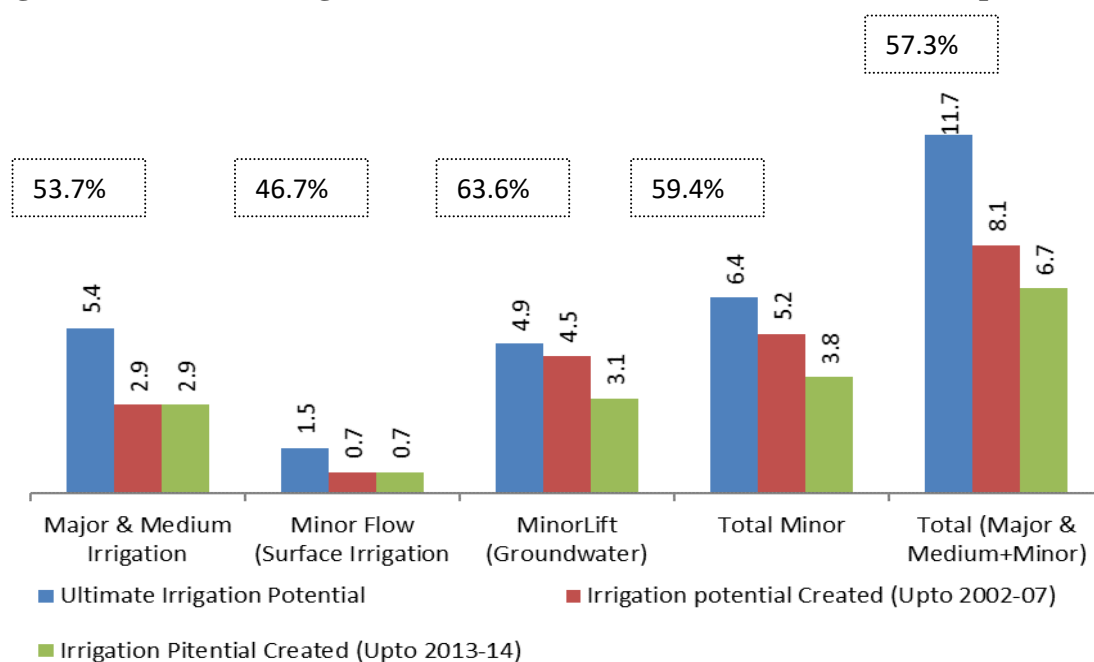
Figure 18: Source-wise irrigation (per cent of Gross Irrigated Area)



Source: Directorate of Economics & Statistics

Bihar's ultimate irrigation potential (UIP) stands at 11.7 million hectares, out of which 5.3 million hectares can be irrigated through major and medium projects and 1.5 million hectares through minor flow and 4.9 million hectares through minor lift irrigation (Figure 19). If this potential is exploited fully, Bihar can more than cover the total cultivable area (TE 2012-13: 6.2 Million Hectares). As per Central Water Commission estimates (CWC), by 2006-07, Bihar had achieved 53.7 per cent of its total irrigation potential from major and medium irrigation projects and 59.4 per cent of minor irrigation potential (Table 24). If we compare these figures to the latest figures given by the Economic Survey of Bihar 2014-15 (Figure 19), it appears that the irrigation potential created through major and medium projects and minor flow projects has remained stagnant since 2006-07 at 3.6 million hectares, while the irrigation potential created through lift irrigation projects has actually declined from 4.5 million hectares in 2006-07 to 3.1 million hectares in 2013-14. State government officials attribute the decline to the fall in the water table in recent years due to deficient rains in large parts of the state. There is thus substantial scope for expanding surface water irrigation in the state through major, medium as well as minor flow projects. Moreover, there is scope for restoring the irrigation potential of 0.8 million out of 2.9 million hectares, which has been lost due to heavy sedimentation and breach in irrigation canals (Economic Survey of Bihar 2014-15). Similarly, the irrigation potential in lift irrigation of 1.4 million hectares lost due to the fall in water table because of prolonged spells of deficient rains will need to be restored by rejuvenating the aquifers through watershed projects.

Figure 19: Potential Irrigation Created and Utilized (Million Hectares) up to 2013-14



Note” Figures in box gives ratio of percentage of irrigation potential created to ultimate irrigation potential in TE 2013-14

Source: Water Related Statistics, 2015 and Economic Survey of Bihar 2014-15

5.1.2 Floods and Flood Protection

We have seen earlier (Figure 9) that over the last decade or so that growth in agriculture in Bihar has been intermittent, with years of good growth in some years followed by contraction in others. The years in which contraction have occurred are the years in which the state experienced either severe floods (2001, 2002, 2003, 2004, 2007, 2008 and 2013) or drought (2005, 2007, 2009, 2010 and 2012)

This demonstrates how critically agriculture has been affected by variation in water availability. Construction of embankments is the main strategy adopted by the state government to contain the damage from floods. Up to 2012-13, a cumulative length of 3,732 km of embankments had been constructed, protecting an area of 3.6 million ha from floods, which constitutes 52.8 per cent of the flood affected area. For the period 2013-2017, the state government had set a target of constructing an additional 1,555.7 km of embankments, which would provide protection to 81.2 per cent of the flood affected areas. There are indications, however, that the state government is moving away from the emphasis laid on building embankments and there has been no addition during the period 2012-16 to the area protected from floods. The new strategy in flood management adopted by the state government is to rehabilitate pre-existing natural drainage systems and give enough room to the rivers to flow.

The limitations of building embankments are well-known. The areas outside the embankments are denied the benefit of the rich alluvial sediments that the river flows bring. Besides, the silt brought by the rivers raises the riverbeds. Rainwater gets stuck outside the

embankments and river water seeps through the embankments into the countryside. Additionally, waters from the tributaries are restricted from entering the main river because of the embankments. Although sluice gates facilitate the process of directing water from tributaries to the main river during the off season, during the peak flood season, the sluice gates cannot be opened because of the risk of the main river flowing back into the tributaries. Further, there is also the risk of breach of embankments, which can create havoc for populations residing close to embankments (Mishra, 1999). For these reasons, experts and planners have been looking beyond embankments for a permanent solution. In the past, the thinking has been that there is substantial potential for upstream reservoir storage in the Himalayan headwaters, which could be harnessed through large multipurpose dams to provide three benefits, viz., regulate river flows to contain floods, deliver irrigation water and produce hydropower. Recent evaluation made by the Ganges Strategic Basin Assessment (SBA) undertaken by the World Bank (Sadoff et. al 2013) in cooperation with several leading research institutions has come to some sobering conclusions. The potential to control floods by providing for upstream storage is limited. There could be benefits from irrigation in the dry season but in Bihar where the water table is high even in the dry season, such irrigation could cause harm by increasing water logging. The SBA confirms the existence of a considerable hydropower potential: as much as 40,000 megawatts of economically feasible hydropower potential is believed to exist. But the development of power would be capital intensive and would take several years to implement.

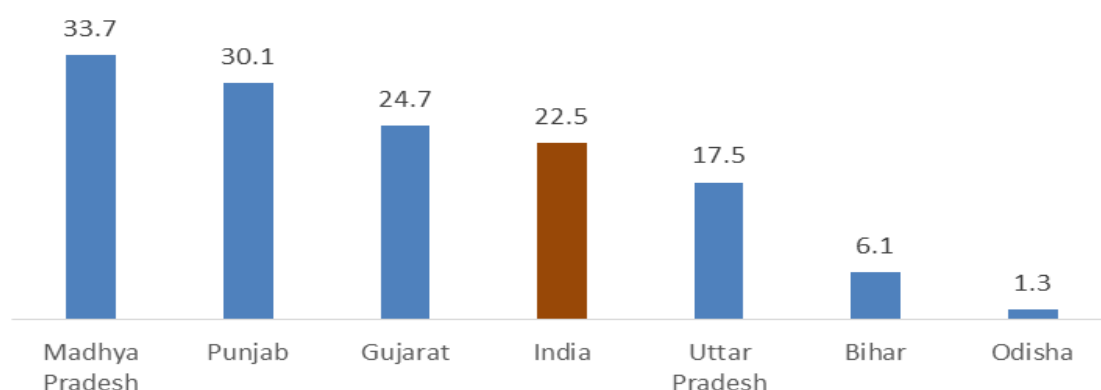
The SBA report does not touch upon the environmental aspects, which, according to some authors, make the proposal for construction of multipurpose dams in the Himalayas a non-starter for the reason that “in the Himalayas, we confront one of the most fragile ecosystems in the world” (Shah, 2016).

5.1.3 *Energy for Agriculture*

An important determinant of development is the availability of adequate, reliable and quality power at a competitive rate but the state is chronically deficient in this regard. In 2013-14, the state generated only 94 MW from its own sources and imported around 2,241 MW from other sources. Per capita power consumption in the state is only 144 kwh, much lower than the all-India average of 927 kwh. Bihar is almost entirely dependent on central sector allocations to meet its energy demand. The availability of ample power supplies from the central grid in recent months has reduced the pressure for increasing domestic generation and enabled the government to focus on improving transmission and distribution. However, Bihar has recently made good progress in the renovation of existing units and the construction of new ones and it is expected that, in about a year or two, it will be able to meet from its own generation close to 50 per cent of the power needs of about 3500 MW.

The three biggest sectors to which power is sold are domestic (39.8 per cent), industry (28.2 per cent) and commercial (8.8 per cent). In comparison to these sectors, agriculture accounts for a dwindling proportion of the sale of power, having fallen from 13.1 per cent in 2009-10 to 6.1 per cent in 2012-13. In comparison, in states like Madhya Pradesh and Gujarat, 33.7 per cent and 24.7 per cent respectively of total sales goes to agriculture (Figure 20).

Figure 20: Share of agriculture in total power sales (2012-13)

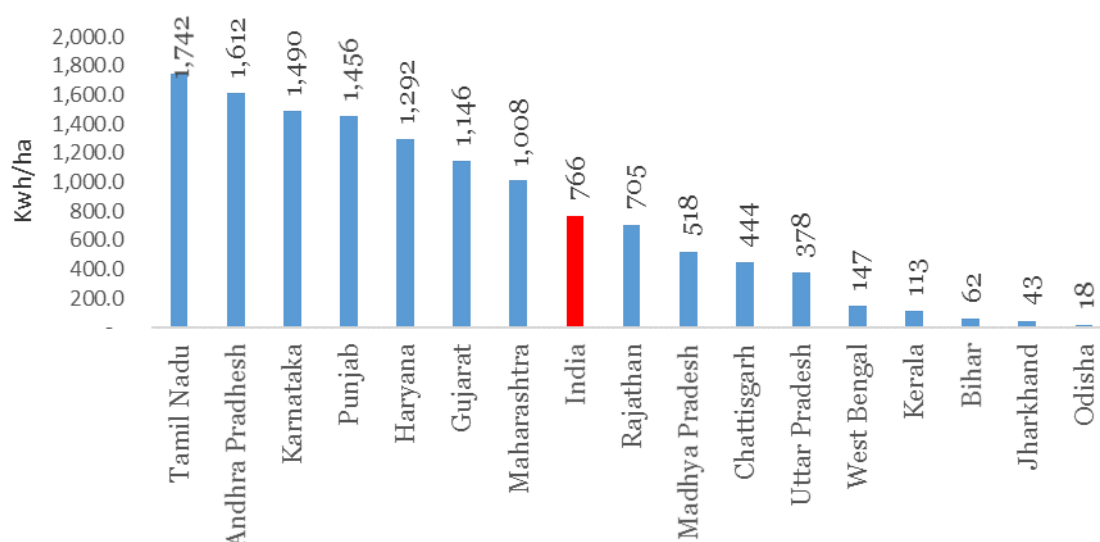


Note: Odisha data for power available until 2011-12

Source: Annual report (2013-14) on the Working of State Power Utilities & Electricity Departments, Planning and Energy Division of Planning Commission

State-wise data on power intensity, i.e., the ratio of electricity used per hectare, underscores the extremely low use of electricity by the agriculture sector in Bihar. Tamil Nadu, Andhra Pradesh, Karnataka, Punjab, Haryana, Gujarat and Maharashtra use over 1,000 Kwh/ha, while Bihar shows an abysmally low usage of 62 Kwh/ha (Figure 21).

Figure 21: Power Intensity (Power Sales/GCA (KWh/ha) TE 2012-13



Source: Calculated from Planning Commission, Planning and Energy Division and DES

The relative position of various states in the rural electrification infrastructure and rural power supply is also mirrored in the progress made over the last decade or so in the energisation of pump sets, whether for tube wells or wells. The number of energised pump sets was already high in the agriculturally advanced states of Gujarat and Punjab in relation to the gross cropped area (energised pump sets per 1000 Ha) in 2000-01 at 66.5 and 98 respectively, and they have risen to 77 and 146 respectively by 2011-12. On the other hand,

in Bihar, the number of energised pump sets was 34.8 per 1000 Ha of gross cropped area in 2000-01 and has only marginally increased to 36.1 per 1000 hectares in 2011-12, as can be seen in Table 30.

The progressive decline in the quantity and quality of power supplied by power utilities has increased the dependency of farmers in Bihar on diesel tube wells. Further, the increase in diesel prices have increased the cost of irrigation and reduced the profitability of farming in Bihar. The poor state of power supplies for irrigation is one of the main reasons for the plentiful supplies of ground water in the state's aquifers not being fully exploited. Against the ultimate lift irrigation potential of 4.9 million hectares, an irrigation potential of only 3.1 million hectares has been created. In order to expand coverage and bring down the cost of cultivation, the government has to provide an assured supply of power for agriculture by increasing expenditure on transmission and distribution to rural areas.

The low and dwindling use of power by agriculture can be attributed to the weak distribution and transmission infrastructure, which results in interruptions as well poor quality of supply. However, with the recent initiatives of the central and state government, the situation is expected to change dramatically in the next two years. Under the Deen Dayal Upadhaya Gram Jyoti Yojana the Government of India has sanctioned 38 projects valued at Rs.5856.35 crore. Seventy per cent of the allocation or Rs.4439.69 crore has been earmarked for feeder segregation for power supplies for irrigation and the remaining for system strengthening. The entire work on feeder segregation has been bid out and implementation has already begun. In addition, the state government has taken a loan of Rs.800 crore from the ADB for undertaking the work of strengthening the transmission system.

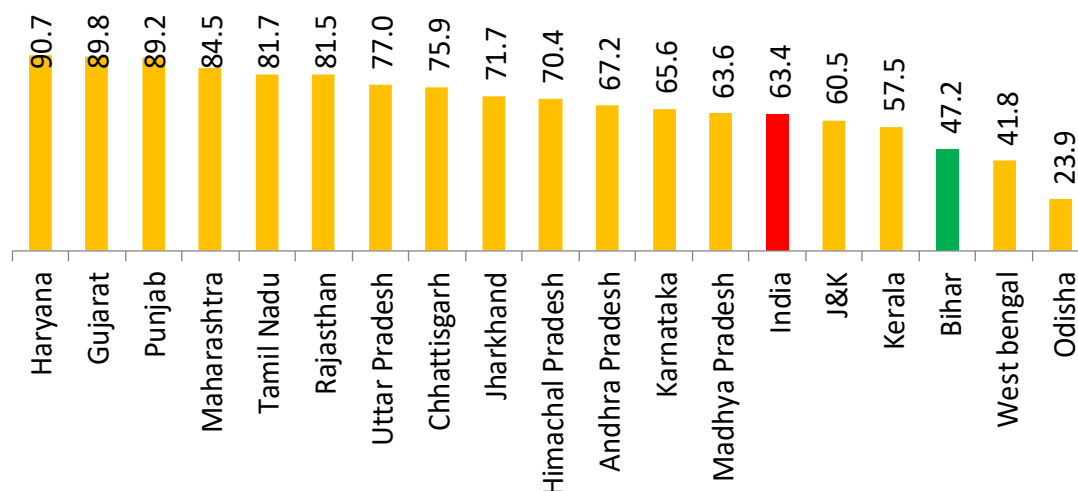
After the launch of the solar pumping programme for irrigation and drinking water by the Ministry of New and Renewable Energy (MNRE) the state has made a good start in solar pumping. Bihar supplemented the Government of India subsidy of 30 per cent with 45 per cent of its own. As a result, 1000 solar pumps were installed in 2015-16 and 3300 more are planned to be taken up in 2016-17, against which about 2000 applications have been received already and are being processed. It, however, has not been possible to make arrangement to enable farmers to sell back surplus power to the grid.

5.1.4 Roads

All weather roads are vital for the development of rural areas, as they lower transportation cost, intensify competition, reduce marketing margins, connect input and output markets, provide access to information and build social networks, and hence, improve farm incomes. Rural roads are one of the most effective public spending items in promoting agricultural growth and poverty reduction (Fan, Gulati, and Thorat, 2008). Road density in Bihar is slightly higher than the all-India average, but surfaced road density is much lower than the national average and the levels in comparator states. In 2012, only 47.2 per cent of total road length was surfaced against the higher figures of 89 per cent in both Gujarat and Punjab, 77 per cent in Uttar Pradesh, and 61.5 per cent in Madhya Pradesh (Figure 22). Only Odisha

among comparator states had a lower proportion of surfaced roads at 23.9 per cent. It is not sufficient just to increase rural road density: what is needed is to increase surfaced roads.

Figure 22: Surfaced Roads – 2012 (% of Total road length)



Source: Ministry of Roads, Transports & Highway, *Several issues of Basic Road Statistics of India*

5.1.5 Procurement System

Besides the bottlenecks mentioned above, another major difficulty that farmers producing food grain in Bihar face is the lack of marketing infrastructure, resulting in their inability to reap the price incentives given by the Government of India. It is well known that the Food Corporation of India is the main buyer of food grains in the country and it procures food grains to ensure that farmers receive minimum support prices (MSP) and to ensure food security by making available food grains at affordable prices to the weaker sections of society through the public distribution system. Although MSPs are announced for 23 crops, the actual procurement is restricted to a few crops like paddy and wheat.

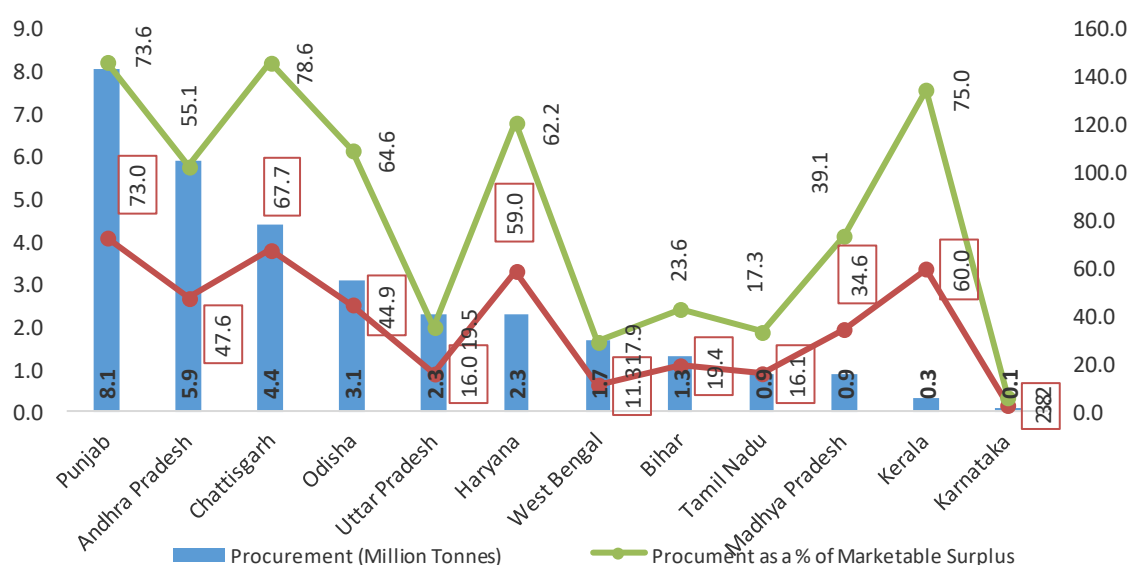
The proportion of production that is procured in the state can be regarded as an indicator of the extent to which the guaranteed support price is provided to producers. Currently, procurement of food grains from Bihar is low compared to states like Punjab and Haryana. In TE 2013-14, the FCI procured around 19.4 per cent of Bihar's total production of rice, while the share of procurement to production in Punjab was 73.0 per cent, in Chhattisgarh 67.7 per cent, in Andhra Pradesh 47.6 per cent and in Haryana 59.0 per cent. Although the ratio was lower in Uttar Pradesh at 16.0 per cent, it was much higher in Madhya Pradesh at 34.6 per cent and even higher in Odisha at 44.9 per cent (Figure 23). Similarly, for wheat, only 9.0 per cent of total wheat production was procured¹¹ in Bihar as compared to 67.4 per cent in Punjab and 52.7 per cent in Madhya Pradesh.

The low procurement ratio has affected the farm harvest prices of rice and wheat, which has remained lower in the state than the minimum support prices (MSP). It is seen in Figure 24

¹¹ Agriculture Statistics at a Glance 2014 and DES

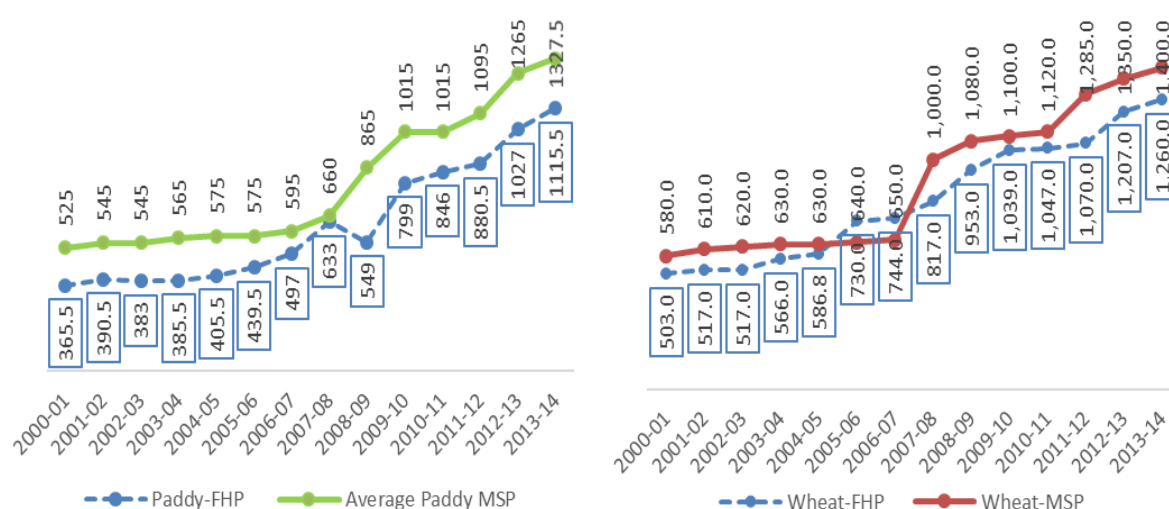
that the farm harvest price (FHP) of rice and wheat has been significantly lower than the MSP consistently over a long period for both wheat and paddy. It is a matter of concern that the deviation between the FHP and MSP for both paddy and wheat has increased in recent years. The average price difference between the MSP and FHP for the period 2008-09 to 2013-14 for paddy was 22.6 per cent and for wheat, 10.2 per cent (Figure 24). The low procurement ratio in the state is primarily due to the absence of infrastructure for marketing and, in particular, the lack of storage facilities, which the state is now endeavouring to build.

Figure 23: Rice Procurement as a percentage of Production and Marketed Surplus-TE 2013-14



Source: CACP, Price Policy for Kharif Crops 2015-16

Figure 24: Farm Harvest Price (FHP) of Paddy and Wheat Compared to MSP in Bihar



Paddy MSP is taken as the average MSP for Paddy Common and Paddy A Grade

Source: Directorate of Economics and Statistics and CACP

5.1.6 *Agriculture Marketing and Storage*

Bihar took the unique step of repealing the APMC Act in 2006 and, at present, there is no legislation regulating agricultural marketing. It was learnt informally from government sources that a new legislation to replace the repealed APMC Act is not under consideration by the state government. Instead, the government is setting up administrative structures to ensure the smooth functioning of markets. There will be an administrator with the rank of district magistrate assisted by a team of officials to oversee the functioning of markets, which have arrangements for food grains, fruits and vegetables, fish, etc. Kishore, Sharma and Joshi (2014) highlights that the post-APMC era in Bihar seems to have been a mixed experience for different stakeholders. For farmers, the liberalised regime seems to have been similar to the APMC days. They continue to sell their produce to village aggregators, who take the collected produce to the nearby mandis, keeping farmers isolated from the institutional changes being effected in markets, at least in the short run.

On the other hand, the liberal market environment favours processing industries as they now have increased sourcing options without paying mandi taxes. However, the food processing industry is at a very nascent stage in Bihar and therefore these benefits are limited. As at national level, only 2 to 3 per cent of total fruits and vegetables go through any kind of processing activity. However, for Bihar, food processing is much more important as the high value segment dominates the agricultural output. Bihar produces around 10 per cent of total vegetables in the country and around 5 per cent of fruits, yet only 4 per cent of total cold storages in India is in Bihar. Of the total 304 cold storages in Bihar, more than 75 per cent were exclusively used for potatoes. Worse, a substantial number of cold storages have shut down in the recent past because they have become unviable. The assessment is that cold storages can become viable only if they have multi-product capability. The shortcomings in the quality and quantity of power supply in the state have also contributed to the closure of cold storages. In order to bolster cold storage construction, the Bihar Government has initiated a cold storage scheme under which cold storages with a capacity of 5 to 10 thousand tonnes can avail of a subsidy of 30 per cent on capital expenditure. For a capacity of more than 10 thousand tonnes, subsidy can be availed of to the extent 35 per cent. The maximum amount of subsidy is limited to Rs.5 crore. Cultivation of fruits and vegetables is a risky activity due to high post-harvest losses because of their short shelf life. In order to minimise post-harvest losses, cold storages play an important role. According to a study, post-harvest losses in fruits and vegetables vary from 15-50 per cent¹² in Bihar (IL&FS, 2007).

Further, Bihar has ambitious plans to expand storage of food-grains, the lack of capacity in which has been identified as one of the main impediments in increasing procurement. The estimated capacity needed is 12.61 lakh metric tonnes against which 6.98 lakh metric tonnes was in existence at the beginning of the year 2016-17. The plan is to make good the shortfall of 5.63 lakh metric tonnes during 2016-17 and to add a further capacity of 60,000 metric tonnes every year up to 2020-21.

¹² Post-harvest loss: mango: 25-30%; banana: 15-25%; papaya: 30-50%; litchi:20-36%; potato: 15-29%; cabbage:17-27%; cauliflower:41-47%

Figure 25: Number of Cold Storages (2015)



Source: Lok Sabha and Rajya Sabha Questions

5.2 Econometric Analysis

Several supply-side factors influence agricultural growth such as technology (seed replacement rate, irrigation, fertiliser use, farm mechanisation, extension, etc.), incentives (terms of trade), rural infrastructure (electricity, roads) and climatic conditions. However, it is difficult to analyse the effects of all the variables in a single framework, both due to lack of availability of data and the fact that many of these variables can be associated. Therefore, we use a simple model to determine the potential drivers of growth. Table 35 gives the correlation matrix of the variables. It is observed that GDPA shows a significant and positive correlation with irrigation, certified seed use and fertiliser consumption, diversification towards milk, terms of trade and road density.

5.2.1 Estimating the Equation

The logarithmic value of GDPA is the dependent variable and the variables mentioned above are our explanatory variable. In the analysis, we have used data from 2000-01 to 2012-13 and have run varying specifications of the model by using different variables and have finally presented only those variables that have a significant effect on agriculture GDP. Based on this exercise, the following static models were estimated in model 1 and model 2 (Table 36).

$$Y_t = \beta_0 + \beta_1 X_{t1} + \beta_2 X_{t2} + \beta_3 X_{t3} + \beta_4 X_{t4} + u_t \quad (1)$$

where, X_{t1} is the irrigation ratio; X_{t2} is terms of trade; and X_{t3} is the share of milk in GVOA and X_{t4} is road density. We have added the share of milk in GVOA as a proxy for the milk segment and terms of trade as a proxy for price incentives in favour of agriculture. We present the results in Table 36.

Model 1:

$$Y_t = 7.7^{***} + 1.5^{**} X_{t1} + 0.9^{***} X_{t2} + 0.3^{**} X_{t3} + u_t$$

Model 2:

$$Y_t = 11.7^{***} + 1.2^{***} X_{t2} + 0.4^{**} X_{t4} + u_t$$

From Table 36, it can be seen that in Model 1, irrigation, terms of trade and the milks sector have a significant and positive effect on agriculture's share in GDP. The three independent variables together explain around 86 per cent of variation in agricultural GDP for the studied period. Since we have estimated a double log model, the results in Model 1 indicate that, *ceteris paribus*, a one per cent growth in the irrigation ratio increases agriculture growth by 1.5 per cent. Bihar has substantial potential to increase surface water irrigation. Currently, Bihar has achieved only 53.7 per cent of total ultimate potential through major and medium projects and 46.7 per cent of minor surface flow irrigation. Similarly, Table 36 shows that, all else being equal, a one per cent improvement in the terms of trade in favour of agriculture increases agricultural GDP by 0.9 per cent. Price policy plays a very important role in driving the agriculture sector. Remunerative prices in the open market help farmers take informed decision on cropping and also encourages farmers to undertake higher investments. Currently, procurement of food grains from Bihar is low compared to states like Punjab due to poor marketing infrastructure; this has affected the market price of food grains, which is lower than the minimum support prices (MSP). Bihar contributed around 6.1 per cent of total rice production in TE 2013-14 but only 3.7 per cent of total production was procured by the government (CACP). In comparison, Punjab and Haryana produce around 11 per cent and 3.9 per cent of total rice production in India respectively while the government procures around 24.2 per cent from Punjab and 7 per cent from Haryana. Therefore, it is important that Bihar strengthens its marketing infrastructure and procurement system to levels prevailing in Haryana and Punjab to correct the perpetual bias in procurement and to ensure that farmers in the state can avail of the benefits of the pricing policy (MSP) and increase their ability to incur higher investment and adopt new technologies. Finally, Model 1 shows that, all else being equal, a one per cent increase in the share of milk in the total value of output from agriculture and allied activities will increase agriculture growth by 0.3 per cent.

In Model 2, we show that roads and terms of trade in favour of agriculture have a significant and positive effect on agricultural GDP. The two independent variables together explain around 78 per cent of variation in agricultural GDP. As in the case of Model 1, the second model can be interpreted as follows. *Ceteris paribus*, a one per cent growth in road density increases agriculture growth by 1.2 per cent and a one per cent growth in terms of trade (in favour of agriculture) increases agriculture growth by 0.4 per cent. Roads play a very important role in overall agricultural development. It is the only means through which farmers are connected to both output and input markets. However, it is not enough to just increase road density. The government needs to increase surfaced road density, which is only 47.2 per cent of total roads in Bihar.

5.2.2 Stationarity and Co-integration

It is important to note that time series data have a common tendency of growing over time. If we ignore this tendency of two or more sequences trending in the same or opposite direction, we can erroneously conclude that changes in one variable are actually caused by changes in another variable. In many cases, two time series processes appear to be correlated only because they are both trending over time for reasons related to other unobserved factors (Wooldridge, 2009). In other words, we need to account for unobserved, trending factors that affect the dependent variable can also be correlated with the explanatory variables. If we ignore this possibility, we may find a spurious relationship between our dependent and explanatory variables. According to Granger and Newbold, $R^2 > d$, where d is the Durbin-Watson statistics, is a good rule of thumb to suspect that the estimated regression is spurious. From Table 36, we find that $R^2 < d$; therefore, based on this rule of thumb and the theory of agricultural production, we can conclude that the estimated regression is not spurious.

We also check for the stationarity of our time series variables by using the Augmented Dickey Fuller test and Kwiatkowski-Phillips-Schmidt-Shin test (KPSS). In Table 37, we have presented the results of the Augmented Dickey Fuller test (ADF). We find that GDPA, irrigation ratio, terms of trade, share of milk in GVOA and road density¹³ are integrated of order 1 at 1 and 5 per cent level of significance, i.e., they are stationary in the first difference form, $I(1)$ at 1 per cent and 5 per cent level of significance. However, we reject the null hypothesis of unit root for the variable ‘terms of trade’ at the 10 per cent level of significance. However, the KPSS test (Table 38) with its natural null of stationarity contradicts the results of ADF at 10 per cent level of significance for the variable terms of trade. Based on the results of the unit root tests, the four series are taken to be integrated of order 1 but their differenced values are $I(0)$. It is possible that these series contain a common stochastic trend and need not be spurious. In this case, despite the trend, they will move together over time such that they will be co-integrated. Economically speaking, the four series will be co-integrated if they have a long term, or equilibrium relationship between them.

5.2.3 Engle-Granger Test for Co-integration

To test for co-integration between the 4 non-stationary time series, we simply run the OLS regression in equation (1), and then run the ADF test on the residual to determine if it is stationary. The time series are said to be co-integrated if the residual is itself stationary. In effect the non-stationary $I(1)$ series have cancelled each other out to produce a stationary $I(0)$ residual. Table 39 presents the Augmented Dickey Fuller Test for the residuals. We reject the null hypothesis of non-stationarity at 1 per cent level of significance for both Model 1 and Model 2. Given that we have established that there is co-integration between GDPA, irrigation ratio, road density, share of milk in GVOA and terms of trade in the respective models, the OLS results presented in Table 36 are perfectly meaningful and not spurious, even though we are using levels of non-stationary data. Further, there is a long-run relationship between GDPA, irrigation ratio, share of milk in GVOA and terms of trade in

¹³ All variables in Log form

Bihar in Model 1 and a long run relationship between GDPA, road density and terms of trade in Model 2.

6. Conclusion and Policy Recommendations

With around 88.5 per cent of the population living in rural area with an average land holding size of around 0.4 ha and 34 per cent of rural population living below the poverty line, an increase in the agricultural growth rate and incomes can play an important role in the development of the state, which is one of the poorest in the country. However, agricultural growth in Bihar has been extremely volatile due to frequent natural disasters like floods in North Bihar and droughts in South Bihar. Bihar is predominantly a food grain growing state with around 80 per cent of its GCA under rice, wheat and maize. However, the productivity of two of its main crops, rice and wheat, is lower than the national average. The productivity remains low relative to the national average despite the steady increase over the past 10 years or so in the use of productivity augmenting inputs such as irrigation, fertilisers, certified seeds and farm mechanisation. We find that, in recent years, the livestock sector, particularly the milk segment, has gained importance in Bihar, with its share in the total value of output from agriculture and allied activities at 35 per cent in TE 2013-14, well ahead of the national average of 17 per cent. However, milk productivity in Bihar is low compared to states like Punjab and Gujarat.

Further, it is seen that, the state is deficient in public infrastructure and infrastructure services, including irrigation, power and all weather roads, and improvements in these can contribute significantly to agriculture growth in Bihar. In particular, improvement in rural electrification for providing good quality and required quantity of power for groundwater irrigation can help increase agricultural prosperity in the state. The absence of marketing infrastructure for facilitating procurement operations also deprives farmers of the price incentive under the MSP programme. It is on account of these factors that the state is lagging behind the national average in productivity. Natural disasters have compounded the problem. Attention to infrastructure is imperative for Bihar to climb up to the next level of agricultural development, and increase production and enhance productivity. In terms of the way forward the following points are worth considering.

1. Roughly seventy-three per cent of North Bihar is affected by floods and 33 per cent of South Bihar receives less than 750 mm of rainfall, making the southern part of the state drought prone. There is need to increase investment in flood management in North Bihar and watershed management and rain water harvesting in south Bihar. In flood management, the state has already moved away from the construction of embankments and is placing emphasis on the rehabilitation of natural drainage systems. Implementation of the new strategy will need perseverance as it can succeed only through a process of social mobilisation, which involves working in partnership with civil society organisations. Since parts of North Bihar have also experienced falling water tables due to frequent spells of drought, watershed management and rain water harvesting will have to be undertaken in selected pockets of North Bihar as well.

2. Bihar has so far actualised 53.7 per cent of the ultimate irrigation potential of major and medium irrigation projects, 46.7 per cent of minor flow and 63.9 per cent of ground water irrigation potential. The government needs to increase investment in both surface water and ground water irrigation. The current irrigation ratio of 65.9 per cent (TE 2012-13) is relatively high compared to most other states but we have to remember that there is huge population pressure and a high level of rural poverty in the state. The state needs to expand agricultural production substantially in order to provide livelihood to the rural population. In order to achieve higher agricultural production, the state needs more irrigation. A higher irrigation ratio will facilitate higher crop intensity and will increase production.
3. To facilitate ground water irrigation, the government needs to effectively and expeditiously implement plans to increase investment to bolster the infrastructure for transmission and distribution of power. Since, at present, there is adequate supply of power in the national grid, investment in generation may be sequenced to come next. In fact, it may be much better to plan on the basis of purchase of power from efficient central undertakings such as NTPC. In order to ensure an assured supply of electricity for agriculture, high priority needs to be given to feeder separation to supply power to agricultural consumers and to non-agricultural consumers separately through dedicated feeders. Through the Deen Dayal Upadhaya Gram Jyoti Yojana, the Government of India has already made additional funds available for the separation of agriculture and non-agriculture feeders as well as to strengthen and augment sub-transmission and distribution (ST&D) infrastructure in rural areas. The state has separately undertaken work to strengthen transmission for which it has taken an ADB loan of Rs.800 crore. The implementation of these programmes will play a critical role in the agricultural development of Bihar.
4. The use of solar pumping sets also needs to be popularised as an alternative to dependence on power supply from the grid, especially in North Bihar, which has higher water tables and the bulk of shallow private tube wells. The Agriculture Road Map-II already had a plan for the installation of 285000 solar pumps, with subsidies of 30 per cent each from the central and state governments. Since then, the Government of India has come out with the solar pumping programme for irrigation and drinking water, with a provision for financial assistance from the Ministry of New and Renewable Energy (MNRE) of 30 per cent of project cost. The initial sanction is for the installation of 100000 solar photovoltaic water pumping systems. Commercial banks will also lend a hand through loans. The state government has made a good start with the installation of 1000 solar pumps in 20015-16 and setting a target of installing 3,300 solar pumps in 2006-17. However, the allocation is too small to satisfy the enormous demand.
5. Roads play an important role in agricultural development by connecting farmers to markets. Bihar has recorded high road density but the density of surfaced roads is much lower. The government needs to increase the length of all-weather surfaced roads in Bihar so that there is efficient movement of inputs and products to and from rural areas.

6. Poor marketing facilities have led to FCI procuring only a small proportion of food grains from Bihar. The average percentage difference in the last 5 years in the farm harvest price and MSP was 22.2 per cent for paddy and 10.2 per cent for wheat. There is need to expedite the construction of marketing infrastructure at designated locations to ensure that farmers benefit from the government's price policies. Markets also need to be connected with surfaced roads. Besides, farmers in Bihar need to integrate with the National Agriculture Markets ENAM – an initiative launched by GOI under which agricultural producers can fully participate in agricultural markets nationwide for better price discovery without intermediaries.
7. Milk contributes around 35.7 per cent of the value of output from agriculture and allied activities and production is increasing at a CAGR of 4.3 per cent. However, only 10 per cent of milk produced is being processed by COMFED and another 2 to 3 per cent by other private players. There is considerable scope for expansion of dairy co-operative societies to increase collection, processing and marketing of the milk produced in the state.
8. Milk productivity in the state is lower than in states like Punjab and Gujarat. Health and reproduction management is crucial for increasing productivity. Bihar needs to increase the proportion of cross-bred bovines and to use germ plasm from superior breeds in cross-breeding. Furthermore, the state needs to make use of recent developments in technology and reduce the number of births of male calves to increase the number of milch animals in the herd. Additionally, the government should focus on utilising degraded and wasteland for quality fodder production, encourage short duration fodder crops in the periods between main crops and encourage efficient utilisation of available resources such as crop residue.
9. Poultry development in Bihar is in a poor shape because of the lack of contract farming, which has taken root in Andhra Pradesh. The beginning made in the state this year for distributing one-day old chicks among poor household looks like a welfare measure and is welcome but it is unlikely to lead to the growth of the poultry industry. For that to happen, there should be a tie-up for marketing of adult birds. The growth of the industry in Andhra Pradesh received stimulus from the activities of large integrator companies such as Venkateshwara Hatcheries and Saguna Foods through contract farming. In Andhra Pradesh, the integrators enter into a contract with farmers, providing contract growers with intermediate inputs such day-old chicks, feed and medicine, who in turn provide land labour and other variable inputs. Once the birds reach a certain age, the integrator takes back the birds and pays a guaranteed wage to the contract grower. Bihar seems to have a large scope for such contract farming in poultry. Given the advantage that Bihar enjoys in the winter maize market, integrators should find it attractive to move into the state. In fact, if the activities of integrators expand, there will also be scope for the establishment of maize processing units, which is currently insignificant to reap the benefit of vertical integration in the maize value chain, and give a fillip to the poultry industry in Bihar.

10. Although there has been a relative improvement in the crop yield gap closure, especially in the case of maize, a lot of the potential still remains untapped as far as wheat, rice, sugarcane, oilseeds and pulses are concerned. The agro climatic zones, with rich alluvium soil in Bihar are ideally suited for such crops. The gaps can be sustainably closed with the adoption of appropriate technology, research and incentives to farmers. Agricultural research in Bihar needs to be greatly strengthened, both financially and institutionally. In fact, a comprehensive view will need to be taken of the entire agricultural research system existing in the state to ensure that the system functions effectively. Accountability and responsibility of the state agricultural universities and the krishi vigyan kendras (KVKs) need to be clearly established and the relevance of their research reviewed. The KVKs now exist in all the districts of Bihar and can be invaluable assets in enhancing the untapped production potential of the state. This is also true for the important allied segments of horticulture, dairy, fisheries and poultry. Further, there is need for co-operative research activities with the private sector and institutionalisation of public-private partnerships. Several areas in which opportunities exist to partner include extension of production practices, delivery of inputs, seed production, skill enhancement, etc.
11. The availability of a large number of fresh water bodies in the state provides a good basis for the development of fishery and the state government has taken a number of promotional measures to accelerate it. But the water bodies (sairats) are auctioned every year to private players including fishermen's co-operatives. Yearly leases do not allow the lessees to invest in the water body and work for the long-term development of fisheries. If the water bodies are leased out for longer periods, say three to five years, this shortcoming can be overcome.
12. To facilitate the advancement of agricultural credit by commercial banks to farmers, it is critical that land surveys are completed quickly to revise and update land records to reflect current ownership.

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Annexure: Detailed Tables

Table 1: Geography, Demographics and Sectoral Composition

	Odisha	Bihar	Uttar Pradesh	Madhya Pradesh	Punjab	Gujarat	India
Geographical Area (Million Hectares)	15.6	9.4	24.3	30.8	5.0	19.6	328.0
% of Total Geographical Area	4.7%	3.0%	7.4%	9.4%	1.5%	6.0%	100.0%
% of Gross Cropped Area	2.6%	3.8%	13.2%	11.5%	4.0%	6.5%	100.0%
Total Population (Million) : 2011	41.9	104.1	199.8	72.6	27.7%	60.4	1,200.0
% of India's Population	3.0%	9.0%	16.7%	6.1%	2.3%	4.9%	100%
Projected Population (Million): 2016	44.7	115.2	217.3	79.0	29.5%	65.5	1,305.6
Rural Population (%)	83.0%	88.5%	77.7%	72.3%	62.5%	57.4%	68.8
% of Persons Below Poverty Line: Rural***	[60.8%] (35.7%)	[55.7%] (34.1%)	[42.7%] (30.4%)	[53.6%] (35.7%)	[22.1%] (7.7%)	[39.2%] (21.5%)	[41.8%] (25.7%)
Normal rainfall in Monsoon (in mm)	1,150	1,028	657	952	491	657	886.9
% of Rainfall by the South-West monsoon (June-Sept)	79.5%	85.8%	88.5% ¹⁴	91.2%	79.5%	95.4%	76.8%
Agriculture Share in Total GSDP (% of Total GSDP)							
• TE 1992-93	36.0%	41.4%	40.4%	37.3%	45.0%	27.5%	30.0%
• TE 2013-14	17.3%	22.0%	28.8%	28.1%	28.0%	19.3%	14.1%
Agriculture Workforce (% of Total Workforce)							
• 2001	64.8%	77.3%	65.8%	71.5%	39.0%	51.5%	58.2
• 2011	61.8%	74.0%	59.2%	69.8%	35.6%	49.0%	55.0

*** Note: Figures given in [] gives data for 2004-05 and () for 2011-12

Source: Directorate of Economics & Statistics, Census of India and Agriculture Statistics of India, 2014

Table 2: Agro-climatic zones of Bihar

	Mean Annual Rainfall (in mm)	Soil Group
Zone 1: North-West Alluvial	1,234.7	Medium acidic, heavy textured, sandy loam to clay loam, flood prone.
Zone 2: North-East Alluvial Plain	1,382.2	Light to medium textured, slightly acidic, sandy to silty loam
Zone 3: South Bihar Alluvial plains	1,102.1	Alluvial to sandy loam

Source: National Institute of Disaster Management (NIDM)

¹⁴ East UP 89% and West UP 88%

Table 3: Land-use Pattern

	Gross Cropped Area (Million Ha)		Gross Irrigated Area (Million Ha)	
	TE 2003/04	TE 2012/13	TE 2003/04	TE 2012/13
Bihar	7.9 (4.3)	7.5 (3.8)	4.6 (6.0)	5.0 (5.5)
Odisha	8.4 (4.6)	8.9 (4.6)	2.4 (3.1)	3.2 (3.5)
Uttar Pradesh	25.1 (13.6)	25.8 (13.2)	18.2 (23.8)	19.9 (21.9)
Gujarat	10.9 (5.9)	12.6 (6.5)	3.8 (5.0)	5.9 (6.5)
Punjab	7.9 (4.3)	7.9 (4.0)	7.6 (9.9)	7.7 (8.5)
Madhya Pradesh	19.2 (10.4)	22.6 (11.5)	5.1 (6.7)	8.2 (9.0)
India	183.9 (100.0)	195.9 (100.0)	76.5 (100.0)	91.1 (100.0)

**Figure in parentheses are percentage of All India Cropped Area, All India Irrigated area and All India Fallow land respectively

Source: Directorate of Economics & Statistics

Table 4: Area under major Crops in Bihar (Million Hectares)

	Bihar		India	
	TE 2003-04	TE 2012-13	TE 2003-04	TE 2012-13
Rice	3.6	3.2	42.9	43.2
Wheat	2.1	2.2	26.0	29.6
Maize	0.6	0.7	6.9	8.7
Coarse Cereals	0.7	0.7	29.1	26.1
Total Cereals	6.3	6.0	98.0	99.4
Pulses	0.7	0.6	22.0	24.7
Food grains	7.0	6.6	120.0	124.1
Oilseeds	0.1	0.1	22.6	26.7
Sugarcane	0.1	0.2	4.3	5.0

Source: Directorate of Economics & Statistics

Table 5: Average Annual Growth Rates of Gross (State) Domestic Product from Agriculture and Allied Activities (2000-01 to 2013/14)

	Bihar	All India
	Average Annual Growth Rate	Average Annual Growth Rate
2000-01 to 2004-05	6.2 (3.5)	1.7 (3.5)
2005-06 to 2009-10	2.2 (8.3)	3.2 (0.8)
2010-11 to 2013-14	7.8 (1.3)	4.9 (0.6)
2000-01 to 2013-14	5.3 (3.2)	3.2 (1.3)

****Note:** Figures in parentheses gives the coefficient of variation

Source: Government of India, Central Statistical Organization. GSDP at Factor cost in 2004-05 prices

Table 6: Segment-wise shares in Total value of Output from Agriculture and Allied Activities (at current prices)

	Bihar		India	
	TE-2002-03	TE 2013-14	TE-2002-03	TE 2013-14
Cereals	25.1	23.9	21.2	17.5
Pulses	2.9	2.1	3.1	2.8
Fruits & Veg	29.7	19.8	17.4	15.0
Oilseeds	0.7	0.7	4.8	5.3
Fishery	4.0	5.2	5.1	4.8
Livestock	25.4	30.9	25.1	26.1
Sugar	1.4	3.8	4.5	3.9
Others	10.9	13.5	18.9	24.6

Source: Government of India, State-wise Estimates of Value of Output from Agriculture and Allied Activities

Table 7: Sectoral composition of growth in GVOA (2001-02 to 2013-14)

	Food grains	Fruits & Veg	Milk	Meat	Livestock	Sugar	Fibre	GVOA
2001-02	-1.6	-1.9	0.6	0.4	0.8	0.4	-0.2	-2.1
2002-03	1.3	-0.3	0.6	0.3	1.6	-0.5	0.0	2.4
2003-04	-1.1	6.2	0.7	-0.2	1.1	0.4	0.0	7.0
2004-05	-8.6	-13.7	6.8	-0.6	3.6	-0.5	0.1	-14.5
2005-06	3.4	5.3	-1.0	0.4	-0.3	0.4	0.0	9.2
2006-07	6.5	-2.1	0.2	-0.1	0.2	0.4	0.0	5.7
2007-08	3.2	-0.5	1.0	0.2	1.8	-0.5	0.0	5.3
2008-09	5.1	2.3	4.0	0.8	4.5	3.6	-0.1	16.8
2009-10	-4.7	0.1	2.6	0.5	3.3	0.9	0.1	-0.4
2010-11	-1.8	2.6	1.0	-0.3	0.7	0.8	0.1	3.3
2011-12	9.1	1.2	0.8	-0.3	0.3	-1.2	0.2	12.1
2012-13	5.2	2.5	3.2	0.5	3.9	0.4	0.0	12.7
2013-14	-5.2	-0.7	2.2	0.9	3.4	0.0	0.0	-1.2
Average growth (2001-02 to 2013-14)	0.8	0.1	1.7	0.2	1.9	0.3	0.0	4.3
Share of each segment in total growth in GVO	19.1	1.5	40.1	4.4	44.6	8.0	0.6	100.0

Note: To determine the sources of growth, we have deflated the current series of each segment by the WPI and then decomposed the year-on-year growth in GVO from agriculture and allied activities, by taking the absolute year-on-year difference in GVO from each segment as a proportion of the previous year's GVO from agriculture and allied activities.

Source: Calculated by authors

Table 8: Production and Productivity of Major Crops

	Production (Million Tonnes)						Productivity(MT/hectares)			
	Bihar			India			Bihar		India	
	TE 2003-04	TE 2013-14	CAGR	TE 2003-04	TE 2013-14	CAGR	TE 2003-04	TE 2013-14	TE 2003-04	TE 2013-14
Rice	5.2 (6.2)	6.7 (6.4)	0.4%	84.6 (100.0)	105.7 (100.0)	1.0%	1.5	2.1	2.0	2.4
Wheat	4.0 (5.8)	4.9 (5.2)	0.6%	70.2 (100.0)	94.8 (100.0)	2.1%	1.9	2.3	2.7	3.1
Maize	1.4 (11.0)	2.1 (9.1)	2.7%	13.1 (100.0)	22.8 (100.0)	4.8%	2.4	3.0	1.8	2.6
Coarse Cereals	1.5 (4.6)	2.1 (5.0)	2.6%	32.3 (100.0)	41.8 (100.0)	2.0%	2.3	2.9	1.1	1.6
Total Cereals	10.8 (5.8)	13.8 (5.7)	0.8%	187.1 (100.0)	242.3 (100.0)	1.6%	1.7	2.3	1.9	2.4
Pulses	0.6 (4.2)	0.5 (2.9)	-0.4%	13.1 (100.0)	18.3 (100.0)	2.8%	0.8	1.0	0.6	0.8
Food grains	11.3 (5.7)	14.3 (5.5)	0.8%	200.3 (100.0)	260.5 (100.0)	1.7%	1.6	2.2	1.7	2.1
Oilseeds	0.1 (0.6)	0.1 (0.5)	1.5%	20.2 (100.0)	31.2 (100.0)	3.6%	0.8	1.1	0.9	1.2
Sugarcane	4.7 (1.6)	12.3 (3.5)	7.2%	293.5 (100.0)	351.5 (100.0)	1.3%	43.2	50.8	66.5	70.1

##Figures in Parenthesis give percentage of all India production

Source: Directorate of Economics and Statistics

Table 9: State-wise Productivity of Selected Crops (MT/ha)

	Rice		Wheat		Maize		Sugarcane	
	TE 2003-04	TE 2013-14	TE 2003-04	TE 2013-14	TE 2003-04	TE 2013-14	TE 2003-04	TE 2013-14
Bihar	1.5	2.1	1.9	2.3	2.4	3.0	43.2	50.8
Gujarat	1.5	2.1	2.4	3.0	1.8	1.6	70.7	69.1
Madhya Pradesh	0.9	1.4	1.6	2.4	1.9	1.7	40.7	42.2
Odisha	1.3	1.7	1.4	1.7	1.1	2.4	56.8	64.2
Punjab	3.6	3.9	4.3	4.9	2.6	3.9	59.8	72.3
Uttar Pradesh	2.0	2.4	2.7	3.1	1.4	1.7	56.6	60.0
India	2.0	2.4	2.7	3.1	1.9	2.6	63.4	70.1

Source: Directorate of Economics and Statistics

Table 10: State-wise Production and Productivity of Fruits and Vegetables TE 2013-14

	Fruits		Vegetables		Total Fruits & Vegetables	
	Production (Million Tonnes)	Productivity (Metric Tonnes/Hectare)	Production (Million tonnes)	Productivity (Metric Tonnes/Hectare)	Production (Million tonnes)	Productivity (Metric Tonnes/Hectare)
Maharashtra	11.3 (13.7)	7.2	9.0 (5.6)	15.3	20.2 (8.3)	16.9
Andhra Pradesh	11.4 (13.9)	15.3	10.8 (6.7)	18.1	22.2 (9.1)	22.4
Gujarat	8.0 (9.7)	21.7	10.7 (6.7)	19.6	18.7 (7.7)	24.6
Tamil Nadu	7.5 (9.2)	23.2	8.5 (5.3)	29.3	16.1 (6.6)	30.1
Uttar Pradesh	6.0 (7.2)	17.1	18.9 (11.8)	21.6	24.8 (10.2)	22.3
Karnataka	6.6 (8.0)	17.1	7.7 (4.8)	17.6	14.2 (5.9)	20.6
Madhya Pradesh	4.8 (5.9)	25.7	11.9 (7.4)	20.4	16.7 (6.9)	25.5
Bihar	4.1 (4.9)	13.5	15.7 (9.8)	18.5	19.7 (8.1)	18.1
West Bengal	3.0 (3.7)	13.8	24.0 (14.9)	17.7	27.0 (11.1)	17.3
Kerala	2.6 (3.2)	8.0	3.5 (2.2)	24.0	6.2 (2.5)	17.4
Odisha	2.2 (2.6)	6.6	9.5 (5.9)	13.8	11.6 (4.8)	11.3
Punjab	1.5 (1.8)	20.0	3.8 (2.4)	20.6	5.3 (2.2)	21.0
India	82.2 (100.0)	11.8	160.5 (100.0)	17.4	242.7 (100.0)	55.7

**Figures in parenthesis are percentage of respective total fruit vegetable production in the country

Source: National Horticulture Database, 2014

Table 11: Production and Productivity of Vegetables in Bihar

	Production (Million tonnes)						Productivity (Metric Tonnes/hectare)			
	Bihar			India			Bihar		India	
	TE 2007-08	TE 2013-14	CAGR (%)	TE 2007-08	TE 2013-14	CAGR (%)	TE 2007-08	TE 2013-14	TE 2007-08	TE 2013-14
Potatoes	5.8 (19.0)	6.4 (15.0)	2.3%	30.7 (100.0)	42.9 (100.0)	6.1%	18.5	20.2	18.1	21.9
Cauliflower	1.0 (17.7)	1.2 (14.8)	3.4%	5.6 (100.0)	7.9 (100.0)	8.3%	16.5	18.2	18.6	19.4
Okra	0.7 (17.4)	0.8 (13.0)	1.6%	4.1 (100.0)	6.3 (100.0)	8.1%	12.6	14.0	10.8	12.0
Brinjal	1.1 (11.6)	1.3 (9.6)	3.1%	9.5 (100.0)	13.2 (100.0)	6.4%	20.4	22.4	17.3	18.7
Onion	1.0 (9.2)	1.2 (6.8)	4.3%	19.8 (100.0)	22.6 (100.0)	12.8%	19.8	22.6	14.2	16.1
Tomatoes	0.9 (8.6)	1.1 (5.9)	6.5%	10.0 (100.0)	18.5 (100.0)	11.4%	18.5	23.1	19.2	20.8
Cabbage	0.6 (3.1)	0.7 (8.6)	4.1%	20.0 (100.0)	8.7 (100.0)	8.2%	16.5	18.9	21.9	22.4
Total Vegetables	13.7 (11.7)	15.7 (9.7)	2.1%	117.4 (100.0)	161.1 (100.0)	6.5%	16.7	18.5	16.7	17.4

**Figures in parenthesis are percentage of total production of the vegetable in the country

Source: National Horticulture Database, several issues

Table 12: Production and Productivity of Fruits in Bihar

	Production (Million Tons)						Productivity (MT/ha)			
	Bihar			India			Bihar		India	
	TE 2007-08	TE 2013-14	CAGR (%)	TE 2007-08	TE 2013-14	CAGR (%)	TE 2007-08	TE 2013-14	TE 2007-08	TE 2013-14
Banana	1.1 (5.4)	1.6 (5.6)	7.0%	21.0 (100.0)	28.2 (100.0)	7.8%	38.9	47.5	34.6	47.5
Guava	0.2 (12.8)	0.3 (9.4)	11.1%	1.8 (100.0)	3.1 (100.0)	13.8%	8.3	9.8	10.6	12.9
Litchi	0.2 (52.4)	0.2 (42.7)	2.7%	0.4 (100.0)	0.6 (100.0)	6.9%	7.3	7.7	7.3	6.9
Mango	1.1 (52.4)	1.3 (7.5)	1.9%	13.4 (100.0)	17.5 (100.0)	6.5%	8.0	8.9	8.0	7.1
Fruits	3.3 (5.5)	4.1 (4.9)	8.2%	59.5 (100.0)	82.2 (100.0)	8.2%	11.4	13.5	11.6	11.8

**Figures in parenthesis are percentage of total production of the fruit in the country

Source: National Horticulture Database, several issues

Table 13: State-wise Milk Production (Million Tonnes)

	TE 2003-04	TE 2010-11	TE 2013-14	CAGR 2004-05 to 2013-14 (%)	Adult Female Bovine Population [Cows and Buffaloes '000 Number]	Production (MT) per female animal
Uttar Pradesh	15.3 (17.7)	20.3 (17.3)	23.4 (17.6)	3.9%	24,501	0.95
Gujarat	6.1 (7.1)	8.9 (7.6)	10.4 (7.8)	5.1%	9,787	1.06
Punjab	8.2 (9.5)	9.4 (8.0)	9.8 (7.4)	1.6%	4,101	2.37
Madhya Pradesh	5.3 (6.2)	7.2 (6.1)	8.9 (6.7)	5.7%	11,204	0.79
Bihar	2.9 (3.4)	6.2 (5.3)	7.0 (5.2)	4.3%	9,999	0.69
Odisha	1.0 (1.1)	1.6 (1.4)	1.8 (1.3)	3.8%	3,709	0.48
Andhra Pradesh	6.5 (7.5)	10.4 (8.9)	12.6 (9.5)	6.0%	9,241	1.37
India	86.2 (100.0)	116.8 (100.0)	132.7 (100.0)	4.1%	1,33,271	1.00

**Figures in parenthesis are share in total production of Milk and total milk animals

Source: National Dairy Development Board, 19th Livestock Census

Table 14: Livestock Population in Bihar and selected states (in percentage)

		2007				2012			
		Bihar	Gujarat	Punjab	Andhra Pradesh	Bihar	Gujarat	Punjab	Andhra Pradesh
Cattle	Female as a percentage of total Cattle	61.8	55.8	75.9	50.2	74.4	67.8	82.1	58.4
	In-Milk as a percentage of total Female Cattle	34.6	38.9	46.5	38.5	31.1	39.1	46.1	39.2
	Exotic Crossbred as a % of Female Cattle	21.0	20.9	79.8	26.4	32.9	25.6	91.5	35.6
	Indigenous as a % of Female Cattle	79.0	79.1	20.2	73.6	67.1	74.4	8.5	64.4
Buffaloes	Females as a % of total Buffaloes	80.7	88.4	89.8	84.1	87.1	92.0	89.7	87.3
	In-Milk as a % of Female Buffalo Population	35.6	39.2	45.0	41.9	31.1	37.0	42.4	40.5
Total Bovines	Female as a percentage of total Bovines	68.4	72.9	86.2	68.6	79.2	80.1	87.2	73.6
	In-Milk as a percentage of total Female Bovines	35.0	39.1	45.4	40.7	31.1	37.9	43.5	40.0

Source: 18th and 19th Livestock Census

Table 15: Species wise yield of in-milk animals (Kg/Day) in select states

State	2004-05			2014-15			CAGR (%)		
	Cross bred	Local cow	Buffalo	Cross bred	Local cow	Buffalo	Cross bred	Local cow	Buffalo
Andhra Pradesh	7.365	1.857	3.920	7.430	2.300	6.070	0.1	2.2	4.5
Bihar	5.517	1.687	3.411	6.490	3.100	4.240	1.6	6.3	2.2
Gujarat	8.183	3.308	4.193	9.080	4.190	4.960	1.0	2.4	1.7
Punjab	8.738	3.106	6.798	11.210	6.820	8.720	2.5	8.2	2.5
All India	6.395	1.945	4.287	7.150	2.540	5.150	1.1	2.7	1.9

Source: Basic Animal Husbandry Statistics, DAD&F, GoI

Table 16: Meat Production (Million Tonnes)

	Bihar	India
TE 2003-04	0.2 (8.3)	2.0 (100.0)
TE 2009-10	0.2 (5.0)	4.2 (100.0)
TE 2013-14	0.3 (4.2)	5.9 (100.0)
CAGR 2001-02 to 2013-14 (%)	4.7%	9.5%

Source: Economic Survey of Bihar 2014-15, Department of Animal husbandry

Table 17: Poultry Population in Bihar (in million)

	Bihar			India		
	2007	2012	CAGR	2007	2012	CAGR
Backyard Poultry						
(i) Fowls	7.5	7.1	-0.9%	265.5	196.2	-4.9%
➤ Hens	2.3	2.6	2.1%	96.6	72.2	-4.7%
➤ Cocks	2.1	1.9	-1.7%	55.1	39.1	-5.6%
(ii) Chicken below 5 Months	3.1	2.6	-2.9%	113.8	84.9	-4.8%
(iii) Ducks	0.5	0.3	-8.2%	26.1	18.6	-5.5%
(iv) Other Poultry Birds	0.12	0.11	-1.4%	1.7	2.7	8.0%
Total Backyard Poultry [i+ii+iii+iv]	11.2	10.1	-1.7%	407.1	302.4	-4.8%
Poultry Farms/Hatcheries						
(i) Layer	0.1	0.4	26.0%	154	214.2	5.7%
(ii) Broiler	3.1	4.6	6.8%	198.3	282.2	6.1%
(iii) Ducks	0.01	0.06	34.8%	1.5	4.9	21.8%
(iv) Others	0.02	0.01	-10.9%	1.7	10.4	35.2%
Total Poultry Farms/Hatcheries	3.2	5.1	7.8%	355.5	511.7	6.3%
Total Poultry (Backyard+ Farms/Hatcheries)	14.5	56.8	25.6%	762.6	814.1	1.1%

Source: 18th Livestock census (2007) and 19th Livestock Census (2012)

Table 18: Total Meat Production ('000 MT)

	Buffalo Meat	Sheep Meat	Goat Meat	Pig Meat	Poultry	Total Meat
2008-09	39.2 (18.8)	1.2 (0.6)	61.9 (29.6)	58.8 (28.1)	25.7 (12.3)	209.2 (100.0)
2009-10	42.2 (19.3)	1.4 (0.7)	60.7 (27.8)	61.2 (28.0)	31.3 (14.3)	218.4 (100.0)
2010-11	42.1 (18.9)	1.3 (0.6)	59.7 (26.8)	61.5 (27.6)	36.8 (16.5)	222.6 (100.0)
2011-12	43.0 (18.9)	1.0 (0.4)	63.0 (27.7)	62.0 (27.2)	37.0 (16.2)	227.8 (100.0)
2012-13	44.3 (15.2)	1.3 (0.5)	65.6 (22.5)	60.0 (20.5)	35.7 (12.2)	292.0 (100.0)
CAGR 2008-09 to 2012-13	2.4	2.1	1.1	0.4	6.8	6.9

Figures in parenthesis gives share in total meat produced in Bihar

Source: Basic Animal Husbandry & Fisheries Statistics, 2014

Table 19: State-wise Fish Production ('000 Tonnes)

	TE 2002-03	TE 2006-07	TE 2013-14
Andhra Pradesh	697.9 (11.8)	867.0 (13.2)	1,809.9 (19.9)
West Bengal	1,093.4 (18.4)	1,274.7 (19.4)	1,514.2 (16.7)
Gujarat	713.4 (12.0)	705.5 (10.7)	790.2 (8.7)
Kerala	667.3 (11.8)	664.3 (10.1)	693.9 (7.6)
Tamil Nadu	468.0 (7.9)	488.2 (7.4)	618.7 (6.8)
Maharashtra	525.8 (8.9)	574.8 (8.7)	589.3 (6.5)
Uttar Pradesh	227.8 (3.8)	291.1 (4.4)	448.0 (4.9)
Odisha	276.4 (4.7)	327.7 (5.0)	401.9 (4.4)
Bihar	241.2 (4.1)	271.4 (4.1)	392.3 (4.3)
Punjab	58.7 (1.0)	83.3 (1.3)	100.3 (1.1)
Madhya Pradesh	46.2 (0.8)	62.7 (1.0)	85.6 (0.9)
India	5,937.0 (100.0)	6,581.8 (100.0)	9,094.5 (100.0)

Figures in parenthesis give the shares in total production of fish in the country

Source: *Indiastat*

Table 20: Certified Seeds Produced and Distributed

	Seed Production (Thousand Quintal)	Seed Distribution (Thousand Quintal)
2006-07	70.7	6.2
2007-08	142.6	59.5
2008-09	173.6	356.9
2009-10	207.6	483.0
2010-11	511.1	543.6

Source: Agriculture Road Map of Bihar, 2012-17

Table 21: Productivity Targets and Achievement of ARM-I (MT per hectare)

	Target for 2011-12	Achievement 2011-12	Shortfall from Target
Rice	3.0	2.2	0.8
Wheat	3.1	2.2	0.9
Maize	3.5	2.4	1.1
Pulses	1.0	1.0	0.0
Oilseeds	1.2	1.1	0.1
Sugarcane	60.0	51.7	8.3
Fruits	14.6	13.2	1.4
Vegetables	20.1	18.1	2.0

Source: Agriculture Road Map 2008-12 and DES

Table 22: Gross Irrigated Area by Source (Million Hectares)

	Bihar		Madhya Pradesh		Gujarat		Punjab		Uttar Pradesh	
	TE 2003-04	TE 2012-13	TE 2003-04	TE 2012-13	TE 2003-04	TE 2007-08**	TE 2003-04	TE 2012-13	TE 2003-04	TE 2012-13
Canals	1.21 (26.5)	1.42 (28.6)	0.91 (17.8)	1.39 (16.9)	0.51 (13.5)	0.90 (18.8)	2.02 (26.4)	1.77 (22.9)	3.97 (21.8)	3.84 (19.3)
Tanks	0.15 (3.2)	0.07 (1.4)	0.11 (2.1)	0.22 (2.6)	0.02 (0.5)	0.04 (0.9)	Neg (0.0)	Neg (0.0)	0.13 (0.7)	0.13 (0.6)
Tube wells	3.01 (66.1)	3.28 (65.9)	1.23 (24.2)	2.53 (30.8)	1.24 (32.8)	1.35 (28.4)	5.61 (73.4)	5.97 (77.1)	12.99 (71.5)	14.10 (70.8)
Other Wells	0.02 (0.4)	0.03 (0.6)	2.11 (41.3)	2.95 (36.0)	1.99 (52.7)	2.41 (50.5)	Neg (0.0)	Neg (0.0)	0.99 (5.4)	1.79 (9.0)
Other Sources	0.17 (3.8)	0.17 (3.5)	0.74 (14.5)	1.12 (13.7)	0.02 (0.5)	0.06 (1.4)	Neg (0.2)	Neg (0.0)	0.09 (0.5)	0.05 (0.3)
Gross Irrigated area	4.6 (100.0)	5.0 (100.0)	5.1 (100.0)	8.2 (100.0)	3.8 (100.0)	4.8 (100.0)	7.6 (100.0)	7.7 (100.0)	18.2 (100.0)	19.9 (100.0)

Figures in parenthesis gives percentage of gross irrigated for the particular state. Neg is Negligible. **Latest comparable data from DES available up to 2007-08

Source: Directorate of Economics & Statistics

Table 23: State-wise Irrigation Coverage (Million Hectares) and Irrigation Ratio

	TE 2003-04	TE 2012-13	Absolute Change in GCA TE 20112-13 over TE 2003-04	CAGR in Gross Irrigated Area TE 2003-04 and TE2012-13	Ultimate Irrigation Potential (Million hectares)
Punjab	7.6 (97.1)	7.7 (98.2)	0.1	0.1%	6.0
Uttar Pradesh	18.2 (72.5)	19.9 (77.2)	1.7	0.8%	29.6
Bihar	4.6 (57.6)	5.0 (65.9)	0.6	0.7%	11.7
Gujarat	3.8 (34.5)	5.9 (47.0)	2.1	3.9%	6.1
Madhya Pradesh	5.1 (26.8)	8.2 (36.3)	3.1	4.0%	16.2
Odisha	2.3 (26.6)	3.2 (35.6)	0.9	2.9%	8.8
India	76.5 (42.1)	91.1 (46.5)	14.6	1.5%	139.9

Figures in parenthesis gives irrigation ratio* i.e., gross irrigated area/gross cropped area

Source: Directorate of Economics & Statistics

Table 24: Potential Irrigation Created and Utilised (Million Hectares) up to 2013-14

Source of Irrigation	Ultimate Irrigation Potential (UIP)	Irrigation Potential Created (IPC)	% IPC to UIP	Irrigation Potential Created (IPC)	Irrigation Potential Utilized (IPU)	% IPC to UIP
		Up to 10 th Plan (2002-07)		Up to 2013-14		
Major & Medium Irrigation	5.4	2.9	53.7%	2.9	2.1	53.7%
Minor Irrigation						
(i) Flow (Surface Irrigation)	1.5	0.7	46.7%	0.7	0.7	46.7%
(ii) Lift (Ground-water)	4.9	4.5	91.8%	3.1	3.1	63.6%
(iii) Total Minor	6.4	5.2	81.3%	3.8	3.8	59.4%
Total	11.7	8.1	69.2%	6.7	5.9	57.3%

Source: Water Related Statistics, 2015 and Economic Survey of Bihar 2014-15

Table 25: Status of Minor Irrigation in Bihar (Million Hectares)

Irrigation Sources	Ultimate Potential	Created Potential (2007-14)
1. Surface Irrigation	1.54	0.70
(i) Arhar/Pynes/Irrigation Tanks		0.25
(ii) Lift Irrigation		0.24
(iii) Surface Minor Irrigation Bear/Sluice gates		0.22
2. Ground Water Irrigation	4.86	3.10
(i) State Tube wells		0.74
(ii) Private Tube wells		2.40
Total	6.40	3.80

Source: *Economic Survey of Bihar 2014-15*

Table 26: Power Generation and Purchase vis-à-vis Peak Demand (MW)

		Met by					
	Peak Demand	Own Generation	Import (Purchased)	Total	Peak Deficit	Peak Deficit as % of Peak Demand	Own Generation as % of Peak Demand
2005-06	1,175	42.7	1,052.3	1,095	80	6.8	3.6
2006-07	1,275	37.5	1,175.5	1,213	62	4.9	2.9
2007-08	1,800	64.2	1,179.8	1,244	556	30.9	3.6
2008-09	1,900	72.2	1,275.9	1,348	552	29.1	3.8
2009-10	2,200	56.4	1,451.7	1,508	692	31.5	2.6
2010-11	2,250	152.0	1,512.0	1,664	586	26.0	6.8
2011-12	2,500	66.0	1,646.0	1,712	788	31.5	2.6
2012-13	2,650	NA	1,802.0	1,802	848	32.0	-
2013-14	3,000	94.0	2,241.0	2,335	665	22.2	3.1
CAGR 2005-06 to 2013-14	11.0%	9.2%	8.8%	8.8%	26.5%		

Source: *Economic Survey of Bihar 2014-15*

Table 27: Share of Agriculture in Total Sales of Power in Selected States

	2009-10	2010-11	2011-12	2012-13	2013-14
Bihar	13.1	6.3	5.4	6.1	6.1
Gujarat	28.0	26.5	25.4	25.1	24.7
Madhya Pradesh	30.0	30.6	31.4	35.3	33.7
Odisha	1.2	1.4	1.3		NA
Punjab	32.5	30.3	29.3	30.3	30.1
Uttar Pradesh	17.4	17.3	17.3	17.2	16.3
India	23.2	21.6	22.7	23.3	22.5

Source: Annual report (2013-14) on the Working of State Power Utilities & Electricity Departments, Planning and Energy Division of Planning Commission

Table 28: Consumer category – Sale of Power (MkWh)

	Domestic	Commercial	Irrigation	Industry	Railway Transaction	Outside the State/UT	Others	Total Sales
2009-10	1,964.7 (32.4)	470.2 (7.8)	794 (13.1)	1,667.5 (27.5)	444.8 (7.3)	555.5 (9.2)	170.5 (2.8)	6,067 (100.0)
2010-11	2,133.2 (34.7)	490.4 (8.0)	388.6 (6.3)	1,727.1 (28.1)	458 (7.5)	848.4 (13.8)	93.6 (1.5)	6,139 (100.0)
2011-12	2,368.2 (35.4)	520.7 (7.8)	363 (5.4)	1,673.3 (25.0)	537.4 (8.0)	1,164.4 (17.4)	67.9 (1.0)	6,695 (100.0)
2012-13	3,127.3 (39.6)	687.6 (8.7)	479.3 (6.1)	2,209.7 (28.0)	709.6 (9.0)	600 (7.6)	89.7 (1.1)	7,903 (100.0)
2013-14	4,009.1 (39.8)	881.4 (8.8)	614.5 (6.1)	2,832.8 (28.2)	909.8 (9.0)	700 (7.0)	115 (1.1)	10,063 (100.0)
CAGR	15.3%	13.4%	-5.0%	11.2%	15.4%	4.7%	-7.6%	10.6%

****Figures in parenthesis gives percentage of Total Sales**

Source: Economic Survey of Bihar 2014-15

Table 29: Aggregate Technical and Commercial (AT&C) Losses (%)

	2011-12	2012-13	2013-14
Bihar	59.2	54.6	46.3
Odisha	44.7	42.9	NA
Uttar Pradesh	41.9	42.9	NA
Gujarat	19.3	19.9	15.9
Madhya Pradesh	38.3	31.2	NA
Punjab	19	17.6	NA
India	26.6	25.4	22.7 [#]

Figure taken from Central Electricity Authority

Source: Lok Sabha Starred Question No 222, answered on 12.03.2015, Audit of Power Companies and Central Electricity Authority

Table 30: Number of Pump-sets Energised

	Gross Cropped Area Million Ha		Number of Pump sets Energized ('000)		Number of Pump sets Energized per '000 Ha	
	2000-01	2011-12	2000-01	2011-12	2000-01	2011-12
Bihar	7.9	7.6	274.9	276.0	34.8	36.1
Odisha	7.9	8.8	74.6	76.6	9.5	8.7
Uttar Pradesh	25.3	25.9	808.2	898.2	31.9	34.6
Gujarat	10.4	13.1	694.2	1,002.0	66.5	76.6
Punjab	7.9	7.9	777.9	1,153.5	98.0	145.9
Madhya Pradesh	19.0	22.5	1,236.7	1,374.9	64.9	61.1
India	188.0	195.7	12,823.5	18,178.1	68.2	92.9

Source: India Stat

Table 31: Status of Road Development – Total Road Density and Surfaced Road Density

	Total Road density (per 1000 sq km)		Surfaced Road density (per 1000 sq km)		Surfaced Roads (% of total Roads)	
	2004	2012	2004	2012	2004	2012
Bihar	783.8	1,488.5	302.5	1,241	38.6	47.2
Punjab	908.1	1,862.5	628.2	1661.1	69.2	89.2
Uttar Pradesh	1,014.7	1,673.3	755.7	1288.5	74.5	77.0
Orissa	1,373.3	1,635.9	209.8	390.8	15.3	23.9
Gujarat	733.0	747.8	663.2	747.8	90.5	89.8
Madhya Pradesh	536.5	653.0	261.7	401.9	48.8	61.5
India	812.2	1,206.3	464.2	765.2	57.2	63.4

Source: Ministry of Roads, Transports & Highway, Several issues of Basic Road Statistics of India

Table 32: Seed Replacement Rate of Wheat, Paddy and Maize

	Wheat		Paddy		Maize	
	Bihar	India	Bihar	India	Bihar	India
2001-02	8.4	13.0	6.3	19.2	21.2	21.0
2002-03	8.7	13.0	6.9	19.3	29.3	21.4
2003-04	8.7	13.0	6.8	19.2	30.0	24.4
2004-05	10.0	16.5	10.0	16.3	30.0	31.5
2005-06	11.0	17.6	12.0	21.3	40.0	35.4
2006-07	11.0	21.8	12.0	22.4	60.0	43.8
2007-08	15.0	25.2	15.0	25.9	75.0	44.2
2008-09	24.0	26.8	19.0	30.1	57.0	48.5
2009-10	25.6	31.9	35.2	33.6	64.4	46.9
2010-11	29.2	32.6	41.7	37.5	81.1	54.1
2011-12	34.8	32.6	38.0	40.4	100.0	56.6

Source: Seednet India Portal

Table 33: Farm Mechanization (in Numbers)

	Tractor	Combine Harvesters	Zero Tillage	Pump sets	Power Tillers	Manually Operated Tools/Implements	Threshers
2008-09	3,543	55	126	11,288	4,678	71,063	8,323
2009-10	3,672	42	860	37,293	4,635	245,969	5,723
2010-11	3,644	65	301	30,340	5,330	179,790	4,316
2011-12	3,848	109	3,787	28,615	7,567	146,849	4,857
2012-13	8,158	322	7,701	25,520	6,445	485,209	4,984
2013-14	5,053	261	9,760	18,019	4,293	43,078	3,652
CAGR	6.1%	29.6%	106.5%	8.1%	-1.4%	-8.0%	-12.8%

Source: Economic Survey of Bihar 2014-15

Table 34: Number of Extension Personnel and Net cropped area per Extension Personnel in 2012

	Number of Extension Personnel	Number of Operational Holdings/Extension personnel	Net Cropped Area (Million Hectares)	Net Cropped Area/Extension personnel (in hectare)
Bihar	10,231	1,583	5.7	557.1
Gujarat	3,501	1,353	10.3	2,942.5
Madhya Pradesh	10,775	823	15.4	1,424.8
Odisha	3,794	1,230	4.4	1,156.0
Punjab	1,398	753	4.2	2,968.5
Uttar Pradesh	12,976	1,767	16.6	1276.5
India	1,19,048	1,156	140.0	1,175.4

Source: Sajesh and Suresh (2016)

Table 35: Correlation Matrix

	GDPA	Irrigation Ratio	Fertiliser Consumption (Kg/Ha)	SRR-Rice (%)	SRR-Wheat (%)	SRR-Maize (%)	Diversification towards Milk**	Surfaced Road Density	SW Rain	Terms of Trade #
GDPA	1.00									
Irrigation Ratio	0.84***	1.00								
Fertilizer Consumption (Kg/Ha)	0.75***	0.65**	1.00							
SRR-Rice (%)	0.84***	0.84***	0.93***	1.00						
SRR-Wheat(%)	0.89***	0.89***	0.90***	0.98***	1.00					
SRR-Maize (%)	0.85***	0.79***	0.90***	0.92***	0.90***	1.00				
Diversification towards Milk**	0.75***	0.70***	0.89***	0.87***	0.84***	0.94***	1.00			
Road Density	0.60**	0.46	0.90***	0.83***	0.76***	0.78***	0.73***	1.00		
SW Rain	-0.23	-0.11	-0.16	-0.23	-0.15	-0.36	-0.25	-0.30		
Terms of Trade[#]	0.58**	0.43	0.11	0.34	0.36	0.29	0.06	0.23	1.000	

**Diversification: Share of Milk in Total Value of Output from Agriculture & Allied Activities; # Agriculture Deflator/Industry Deflator

*** Significant at 1% **significant at 5% * significant at 10 percent ## Variables are in log form

Source: Calculated by Authors

Table 36: OLS Results: Determinants of Agriculture Growth in Bihar

Period: 2000-01 to 2012-13	Model 1 GDPA	Model 2 GDPA
Irrigation Ratio	1.5** (0.49)	
Terms of Trade (Agriculture Deflator/Industry Deflator)	0.9*** (0.27)	1.2*** (0.32)
Share of Milk in GVOA	0.30** (0.09)	
Road Density		0.4*** (0.09)
Constant	7.7*** (1.9)	11.7*** (0.66)
Adjusted R squared	0.86	0.78
Durbin-Watson D Statistics	2.6	2.3

*** significant at 1 percent, ** significant at 5 percent and * significant at 10 percent. Figures in parenthesis are robust standard error

Source: Estimated by Authors

Table 37: Augmented Dickey Fuller test (ADF)

Variable	Augmented Dickey Fuller Test	
	Level (t-stat)	First-Difference (t-stat)
Log(GDPA)	-1.6	-9.1***
Log (Irrigation Ratio)	0.7	-2.96**
Log (Road Density)	-0.3	-3.4***
Log(Terms of Trade)	-2.7*	-1.4***
Log(Share of Milk in GVOA)	-1.9	-4.0***

** p < 0.01. * p < 0.05. * p < 0.1. The null hypothesis is that the series is non-stationary.

Source: Estimated by Authors

Table 38: Kwiatkowski–Phillips–Schmidt–Shin test (KPSS)

	Lag	Test Statistics	Critical Value at 10% level of significance
Level	1	0.13*	0.11
First Difference	1	0.117*	0.119

Source: Estimated by Authors

Table 39: Engle-Granger Test for Co-integration – ADF on Residuals

	Augmented Dickey Fuller Test			
	Model 1		Model 2	
Variable	Level (Coefficient)	Level (t-stat)	Level (Coefficient)	Level (t-stat)
Residuals	-1.45***	-4.67***	-1.27***	-3.75***

Source: Estimated by Authors

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