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Making rapid strides - Agriculture in Madhya Pradesh: sources, drivers, and policy lessons

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Working Paper 339

Making Rapid Strides- Agriculture in Madhya Pradesh: Sources, Drivers, and Policy Lessons

**Ashok Gulati
Pallavi Rajkhowa
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April 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 the green revolution and was a front-runner in agriculture during the late 1960s, but slipped to low levels of agricultural growth in recent period. Gujarat and Madhya Pradesh have shown some extraordinary growth in the agriculture sectors (almost three times the all-India agricultural growth) in the last decade or so. The key idea of this study was to look for policy lessons from each of these states, and see how to increase the agricultural growth rate for faster alleviation of poverty.

We gratefully acknowledge the financial support provided by Bill and Melinda Gates Foundation for this important project. In particular, we would like to thank Mr Hari Menon, Mr Brantley Browning and Dr Purvi Mehta from the BMGF for their very productive and constructive interaction from the very conception of the project, and their suggestions as the project evolved.

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Abstract

Agriculture growth in Madhya Pradesh (MP) during the decade long period of 2005-06 to 2014-15 was around 9.7 per cent per annum, which is the highest growth rate registered in agriculture by any major state of India over a ten year period. The last five years have been even more spectacular: agricultural GDP grew at 14.2 per cent per annum. How did MP do it is a lesson worth learning for many states of India who are struggling to get their agriculture moving. In this paper, we study the composition, sources and drivers of agricultural growth in Madhya Pradesh to identify the factors that have contributed to robust agricultural growth in the state and discuss the lessons that can be drawn for many other states of India. The study finds that among the many measures taken by the state government to make rapid strides in agriculture, three interventions stand out – expanded irrigation, a strong procurement system put in place for wheat along with bonus over MSP for wheat, and all-weather roads to connect farmers to markets. In particular, irrigation coverage through tube-wells was expanded through the state government's strategy of initially focusing on providing good quality power supply to farmers during the wheat irrigation season. Canal irrigation, on the other hand, was expanded by utilising financial resources to complete a number of major and medium irrigation projects that had been under construction for several years. Once irrigation cover expanded for wheat cultivation, acreage and production under the crop increased significantly. Consequently, the government strategized to improve the supply chain of wheat by re-modelling the procurement system through digitization and initiated 'e-Uparajan' and by increasing storage capacity significantly. The third important factor that contributed to agriculture growth is the expansion of all-weather roads. In the light of these findings, the study makes three principal recommendations to stimulate agricultural growth in other states with somewhat similar characteristics, viz., improve the quality and quantity of rural power supply by strengthening transmission and distribution and by separation of feeders for irrigation and household use, increase the density of surfaced roads in rural areas, and improve procurement and marketing infrastructure to reduce market risk of farmers.

Keywords: *Agricultural Growth, Irrigation, Power, Surfaced Roads, Marketing Infrastructure, Procurement, Madhya Pradesh*

JEL Classification: Q10, Q15, Q25

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Executive Summary

Agriculture in Madhya Pradesh (MP) grew at 9.7 percent per annum during the decade long period of 2005-06 to 2014-15. The last five years have been even more spectacular when agricultural GDP grew at 14.2 per cent per annum. This is unprecedented in the annals of India's agriculture history since independence. Even Punjab did not grow at this rate during the green revolution period. Many people therefore see this growth rate even with scepticism. But agriculture growth is critical for easing poverty, as is indicated by earlier research by the World Bank (World Bank Report, 2008). MP has high poverty levels, and much of that is concentrated in rural areas. So, high growth in agriculture must result in substantial reduction in rural poverty. The poverty numbers do suggest that rural poverty has declined from 53.6 per cent in 2004-05 to 35.7 per cent in 2011-12. And when poverty numbers of later years comes about, one should expect even faster reduction in rural poverty in MP.

Keeping this background in mind, this paper studies the composition, sources and drivers of agricultural growth in Madhya Pradesh and discusses the lessons that can be drawn for other major states of India with somewhat similar characteristics.

Focusing on agriculture is not only good economics but also good politics. When the largest number gains from growth, it gives political legitimacy for further pushing the reform frontier. Madhya Pradesh is primarily an agricultural state, with almost 54.6 per cent of its workforce engaged in agriculture, much above the all-India average of 47 per cent (Labour Bureau, 2015-16)¹. Madhya Pradesh is mainly a food grain and oilseed growing state with around 62 per cent of its gross cropped area (GCA) devoted to food- grains and 32 per cent to oilseeds (TE 2014-15). Soybean and wheat are the two main crops grown in the state with around 25.4 per cent and 23.7 per cent of GCA devoted to the crops respectively. Wheat is the major crop grown during the rabi season and it is intercropped with gram, while in the kharif season, MP mostly grows soybean. No wonder, it is also known as the soya state of India.

The acreage and the production of these crops – wheat and soybean – has significantly increased over the past decade. Acreage under wheat increased from 3.5 million hectares in TE 2002-03 to 5.6 million hectares in TE 2014-15 while acreage under soybean increased from 4.4 million hectares to 6.0 million hectares in the same period. In tandem with the expansion of acreage under wheat cultivation, production of wheat increased from 5.3 million metric tonnes (MMT) in TE 2002-03 to 14.4 MMT in TE 2014-15. In fact between 2010-11 and 2011-12 wheat production jumped by 51 per cent from 7.6 MMT to 11.5 MMT and thereafter, maintained a high production growth rate. At present, MP is the third largest wheat producer in the country contributing around 16 per cent of total production. Production of soybean doubled from 3.3 MMT in TE 2002-03 to 6.6 MMT in TE 2014-15. MP is the largest producer of soybean, contributing around 53 per cent of total production in the country.

¹ The Census 2011 figure for employment share in agriculture stands at 70 percent for MP and at 55 percent for all-India.

Given the success of the state in increasing agricultural production, it has been conferred the “Krishi Karman Award” three times for food grain production. In 2011-12, 2012-13 and 2014-15, it received the award for food grain production, while in 2013-14, the award was conferred for wheat production.

Although MP is mainly a food grain producing state, there are indications of diversification into horticulture. From 2005-06 to 2014-15, the proportion of area under horticultural crops has jumped from 2 per cent to 6 per cent. Around 43 per cent of the total area under horticulture is devoted to vegetables. There has been a significant increase in vegetable production in MP from 3.6 MMT in TE 2010-11 to 14.2 MMT in TE 2013-14! This remarkable increase has improved MP’s position in vegetable production from thirteenth in TE 2010-11 amongst states to becoming the fourth largest vegetable producer in the country in TE 2013-14; MP’s contribution in total vegetable production has increased from 2.8 per cent to 7.4 per cent. In fact, production of horticultural crops as a whole has increased from 7.8 MMT in 2010-11 to 23.9 MMT in 2013-14, a stupendous increase of 206.4 per cent! Moreover, milk production has increased by 69 per cent from 6.4 MMT in 2006-07 to 10.8 MMT in 2014-15, and meat production tripled in the same period from 20 thousand tonnes to 60 thousand tonnes. The horticulture segment has become the sunrise sector for MP. Given the huge potential in the state for horticulture, the government of Madhya Pradesh announced the ‘Horticulture Hub (H2) Establishment Policy, 2012’. The purpose of this policy was to establish protected cultivation of horticultural crops in a commercial and organised manner.

The analysis on the sources of agricultural growth shows that primary sources of growth in MP were food-grains, followed by fruits and vegetables, oilseeds and livestock in that order. Of the 8.2 per cent average growth rate in the gross value of output of agriculture and allied activities (GVOA) for the period 2001-02 to 2013-14, 28 per cent was contributed by food grains, 17.9 per cent by fruits and vegetables, 15.4 per cent by oilseeds and 13.2 per cent by livestock.

Further, to understand the reasons for the transformation of agriculture in the state, we have used an ordinary least square model and Engel-Granger test of co-integration to estimate the drivers of agriculture growth in MP between 2000-01 and 2014-15. We find that among the many measures taken by the state government to make rapid strides in agriculture, three interventions stand out – expanded irrigation backed by reliable power supplies for groundwater irrigation, strong procurement system put in place for wheat along with bonus on its MSP, and expanded network of all-weather roads to connect farmers to markets and thereby reducing market risk.

In 2000-01, the irrigation ratio in MP was 24 per cent, which was around 17.2 percentage points lower than the all-India average. By 2014-15, the irrigation ratio in MP reached 42.8 per cent, less than 5 percentage points below all India average. The sharpest increase in irrigation coverage was via tube-wells, followed by government canals. One of the main reasons for the expansion of tube-well irrigation was the state government’s strategy to initially focus on expanding irrigation to the area under wheat by improving the quality of power supply to farmers during the wheat irrigation season. Canal irrigation was expanded by

utilising World Bank loans and internal resources for completing a number of major and medium irrigation projects which had been facing long delays in completion due to lack of resources. Moreover, the state gave priority to the completion of command area works, which resulted in an increase in the irrigated area in the state. Further, irrigation schedules were revised to remove the head-tail inequity endemic in canal irrigation.

Once assured water was made available for wheat cultivation through reliable power supplies during the wheat season, acreage and production under the crop increased significantly. Improved irrigation along with Madhya Pradesh government's bonus policy on wheat MSP over and above the centre's MSP between 2007-08 and 2014-15 played a significant role in increasing production and procurement of wheat. State bonus on MSP over and above the centre's MSP for wheat between 2007-08 and 2012-13 was Rs 100 per quintal, while in 2013-14 and 2014-15, it was Rs 150 per quintal. Consequently, government purchases by the state swelled from around 2 per cent of all India wheat procurement in TE 2002-03 to 24 per cent in TE 2013-14, making MP the second largest contributor to all India wheat procurement.

Further, the Government of MP re-modelled the procurement system through digitization and initiated 'e-Uparajan'. The 'e-Uparajan' initiative was conceptualised with the idea of regulating the number of farmers bringing their produce by maintaining records of farmers willing to sell at MSP and allocating a date to each farmer through SMS. This programme's primary objective was to enable a smooth, regulated and efficient process of procurement.

The third important factor that has contributed to agricultural growth, as per our econometric analysis, is the rapid expansion of all-weather roads. Road density in MP has increased from 526.8 per thousand sq km in 2000-01 to around 742.3 per thousand sq km in 2012-13. Further, surfaced roads as a percentage of total roads have increased from 49 per cent to 68 per cent in the same period. This has enabled farmers to access markets over a larger area, and thereby reducing their market risk.

But there are many other factors as well that have driven agricultural growth in MP, which cannot be captured easily in an econometric analysis. Nevertheless they are important. One such factor is the political leadership of the state and its focus on agriculture. The leadership not only gave priority but also persevered in erecting a system of wheat procurement, connecting villages to markets through a network of roads and ensuring ample power supply to rural areas to run tube wells for irrigation. MP's achievements serve as lessons for states like Odisha, Bihar, and Uttar Pradesh where there is ample scope for expansion of ground-water irrigation by providing reliable power supplies to rural areas, development of roads and improvement in procurement systems for their main crops. In 2016, the Chief Minister's Task Force on Agriculture in MP recommended shifting gears from wheat and soybean led growth to more high-value based agriculture, especially dairy and horticulture. The ground work for that is being laid and the coming years will hopefully see not only high growth in Madhya Pradesh agriculture but also more diversified and stable incomes for farmers.

Making Rapid Strides- Agriculture in Madhya Pradesh: Sources, Drivers and Policy Lessons

Ashok Gulati, Pallavi Rajkhowa and Pravesh Sharma

1. Introduction

In 2015, Madhya Pradesh contributed over 8 million metric tonnes (MMT) of wheat to the central procurement pool. This was the second highest procurement of wheat by any state that year and even higher than that of Haryana, traditionally the second highest contributor after Punjab. The event capped a remarkable period of eight years, which saw Madhya Pradesh emerge as the state with the highest growth rate in agriculture. Long clubbed with the so-called BIMARU group of poor northern, central and eastern states, MP successfully broke ranks to set a scorching pace of growth, which has been unparalleled in the past quarter century. Understanding the factors that helped to drive this growth and drawing lessons for other states at similar levels of development is the main objective of this paper.

Madhya Pradesh spans over 30.8 million hectares of land and comprises around 6.0 per cent of India's population. The state is primarily an agricultural state, with almost 70 per cent of its workforce engaged in agriculture, much above the all-India average of 55 per cent. Unlike other states where the share of agriculture in GDP has been falling, MP has undergone a reverse structural change after 2010-11. Between 2003-04 and 2010-11, the share of agriculture in GDP declined from 29.8 per cent to 22.5 percent (2004-05 prices), which reflected the national trend. However, after 2010-11, the share of agriculture in GDP has increased from 22.5 to 30.0 per cent (2004-05 prices) in 2014-15.

Not only has the importance of the sector in the overall economy of MP increased but the sector has also performed significantly better than other states in the country. The agricultural GDP of Madhya Pradesh increased at 9.7 per cent per annum during 2005-06 to 2014-15, surpassing even record holder Gujarat's 7.7 per cent. The last five years have been even more spectacular: agricultural GDP increased at 14.2 per cent per annum. Keeping this background in mind, this paper has used secondary data published by the government to study the composition, sources and drivers of agriculture growth in Madhya Pradesh and the lessons that can be drawn for developing states. Earlier research by the World Bank (World Bank Report, 2008) shows that higher agriculture growth holds the key to faster alleviation of poverty. This is particularly so, as 82 per cent of poverty in Madhya Pradesh is rural. Although MP has recorded a significant decline in poverty rates from 53.6 per cent in 2004-05 to 35.7 per cent in 2011-12, there is still much to be done to improve the livelihood of the rural population. Moreover, MP's per capita income is low, standing at Rs 51,798 (FY14 at current prices) as compared to the national average of Rs 74380. Although it is much better than that of Bihar (Rs 31,199) and Uttar Pradesh (Rs 36,250), it remains way below top performing states like Sikkim (Rs 1, 76,491), Maharashtra (Rs 1,14,392), Haryana (Rs 1,33,427) and Gujarat (Rs 1,06,831). Therefore, the study also makes policy suggestion to bolster agriculture growth in MP.

Accordingly, in section 2, we first discuss the data sources and methodology used in the study. In section 3, we give a description of the geographical and demographic characteristics of Madhya Pradesh (MP) and MP's agricultural landscape. In section 4 we examine the composition of the agriculture sector in the state and the main sources of agriculture growth. In section 5, we discuss the potential drivers of agriculture growth using econometric analysis. Section 6 concludes with recommendations on policy interventions that would sustain agricultural growth in the state and the lessons MP's achievements provide for moderate performing states.

2. Data and Methodology

The study has used time-series secondary data compiled from various published sources by the Government of India and the Madhya Pradesh Government. The study covers the period 2000-01 to 2014-15. We analyse and compare the performance of Madhya Pradesh vis-à-vis the performance of other states. To analyse the composition of agriculture, we have computed the share of value of output from different segments as a percentage of total value of output from agriculture and allied activities (at current prices). To determine the sources of growth we have deflated the current series of each segment by the WPI (2004-05 prices) and then decomposed the year-on-year growth in the gross value of output from agriculture and allied activities (GVOA), by taking the absolute year on year difference in gross value of output from each segment as a proportion of the previous year's GVOA.

To determine the drivers of growth, we use a three-step procedure to estimate the relationship between agricultural growth and the selected explanatory variables. In the first step, we test if the natural logarithm of the selected variables is integrated of the same order using the Augmented Dickey Fuller (ADF) test. Depending upon the outcome of the tests, the second stage involves determining if the series are co-integrated (i.e., testing for long-term relationship between the variables) using Engle and Granger's (1986) two-step residual based procedure. We use this method because we are interested in the elasticity of the explanatory variables. Accordingly, we first run a simple ordinary least square model to analyse the determinants of agricultural growth in Madhya Pradesh and then perform a unit root test on the residuals of the model to determine 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 Madhya Pradesh

3.1 Geography, Demography and Structural Composition

Madhya Pradesh (MP), located at the centre of India, is often called as the "Heart of India". It is a land locked state, surrounded by Uttar Pradesh, Chhattisgarh, Maharashtra, Rajasthan and Gujarat. Until 2000, it was the largest state of the country in terms of geographical area; however, in November 2000, Chhattisgarh was carved out of the south-eastern part of erstwhile Madhya Pradesh. Currently, MP is the second largest state in India after Rajasthan and it spreads over a geographical area of about 308 lakh hectares, which is about 9 per cent of the total area of the country.

MP is the sixth most populous state in the country, with a population of 72.6 million in 2011, which has been projected to increase to 79.0 million in 2016, accounting for about 6.0 per cent of India's population. Around 71.3 per cent of the population lives in rural areas as compared to the national average of 68.8 per cent, making MP a largely rural economy. Unlike other states where the share of agriculture in GDP has been falling, MP has undergone a reverse structural change after 2010-11. Between 2003-04 and 2010-11, the share of agriculture in GDP declined from 29.8 per cent to 22.5 per cent, reflecting the national trend. However, after 2010-11, the share of agriculture in GDP has increased from 22.5 to 30.3 per cent in 2014-15 (Figure 1). This trend clearly shows the growing importance of the agriculture sector in the state. Moreover, the sector provides employment to around 54.6 per cent of its workforce, much above the all-India average of 47 per cent (Labour Bureau, 2015-16)².

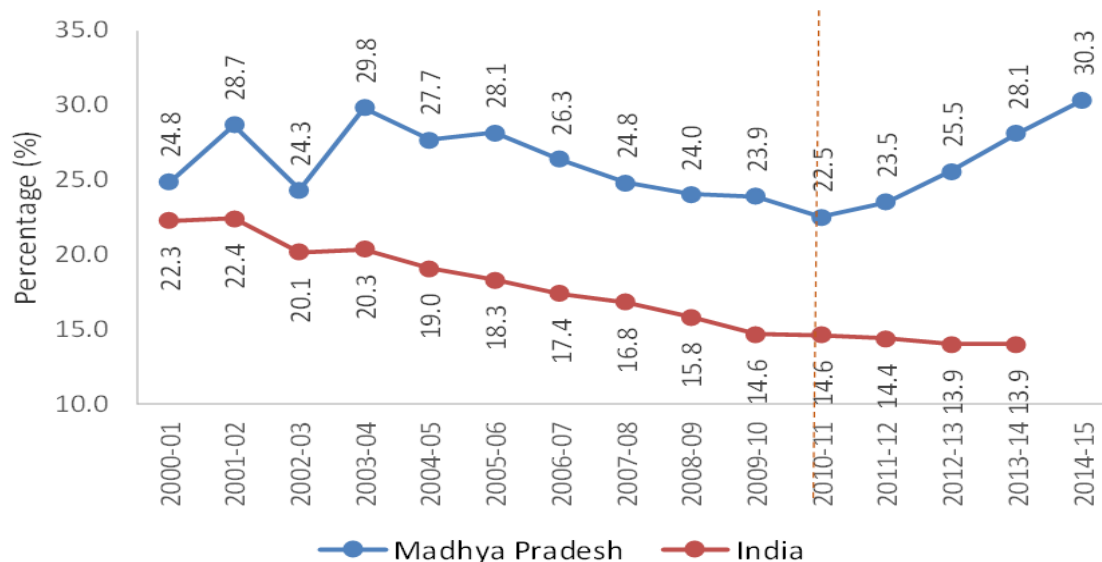


Figure 2: Madhya Pradesh in the Context of India

² The Census 2011 figure for employment share in agriculture stands at 70 percent for MP and at 55 percent for all-India.

3.2 Water Resources and Climatic Risk

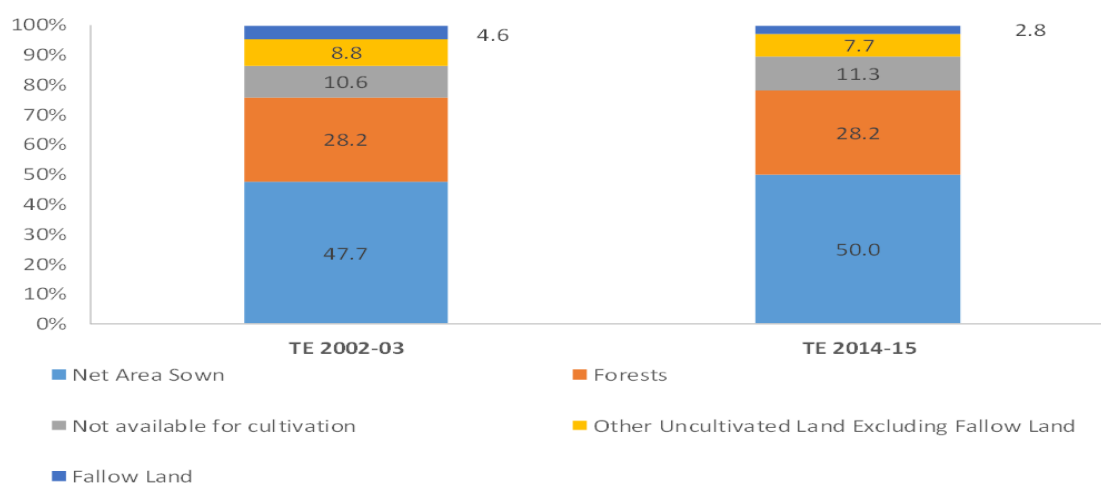
The average rainfall received by MP is around 95.2 cm during the monsoon season. This accounts for around 91 per cent of the total rainfall in the state. In MP, the eastern parts receive relatively higher amount of monsoon rainfall (105.1 cm) as compared to the western parts (87.6 cm).

Natural calamities like drought, floods and hails storms are common features in Madhya Pradesh. Almost every alternate year, one part or the other of the state is hit by natural calamities of varying intensity. In the last 26 years, 32 districts have been affected by floods and seven districts were prone to drought.

3.3 Land Utilisation

Prior to the bifurcation of MP in 2000-01, the total geographical area of the state was 44.3 million hectares. Out of this, an area of 13.5 million hectares was earmarked for Chhattisgarh, leaving MP with an area of 30.8 million hectares. From Figure 3, it can be observed that half of the state's geographical area is under cultivation, representing net sown area. Further, analysing land use over a period of time shows that the pattern of land use in MP has undergone only a small change since the early 2000s. The area under forests has remained virtually the same, while the net sown area has increased marginally from 47.7 per cent (14.7 million hectares) of the geographical area in TE 2002-03 to 50.0 per cent in TE 2014-15 (15.4 million hectares) and area unavailable for cultivation increased from 10.6 per cent of geographical area to 11.3 per cent of geographical area. Further, fallow land registered a decline from 4.6 per cent (1.5 million hectares) to 2.8 per cent (0.9 million hectares) in the same period, while other non- cultivable land such as permanent pastures, grazing land, miscellaneous tree crops and groves, and culturable waste land declined marginally from 8.8 per cent to 7.7 per cent. The fallow land and cultivable lands together form the agricultural potential of the state and can be brought under cultivation by the use of technology and irrigation.

Figure 3: Land-use Statistics (Percentage Share in Total Geographical Area)

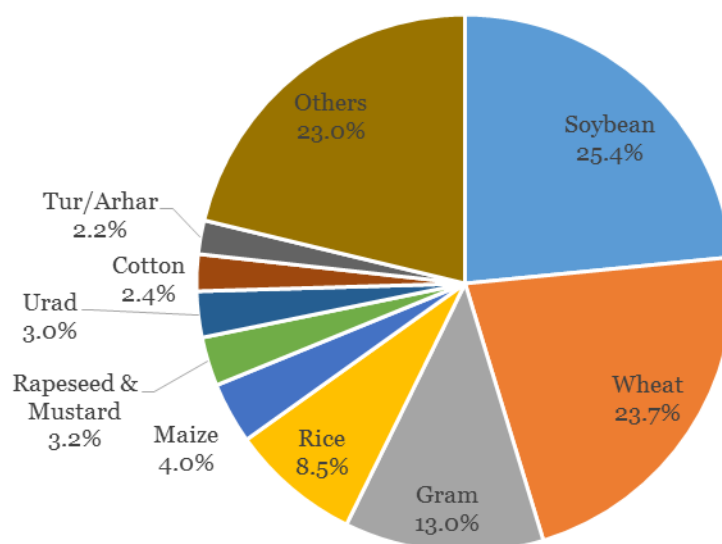


Source: Directorate of Economics & Statistics

3.4 Cropping Pattern

Madhya Pradesh is primarily a food grain growing state with around 62 per cent of its gross cropped area (GCA) devoted to food grains and 32 per cent to oilseeds in TE 2014-15. Within food grains, a larger area is devoted to cereals (39.4 per cent of GCA) as compared to pulses (23 per cent). Wheat is the most important cereal grown in the state, with around 24 percent of GCA devoted to the crop. Within pulses, gram is the chief pulse crop grown with around 13 per cent of GCA dedicated to the crop (63 per cent of pulse area), followed by arhar (2 per cent of GCA and 10 per cent of pulse area) (Figure 4). Wheat is the major crop grown during the rabi season and it is intercropped with gram while in the Kharif season, MP mostly grows oilseeds, specifically soybean. Around 25.4 per cent of GCA is devoted to soybean.

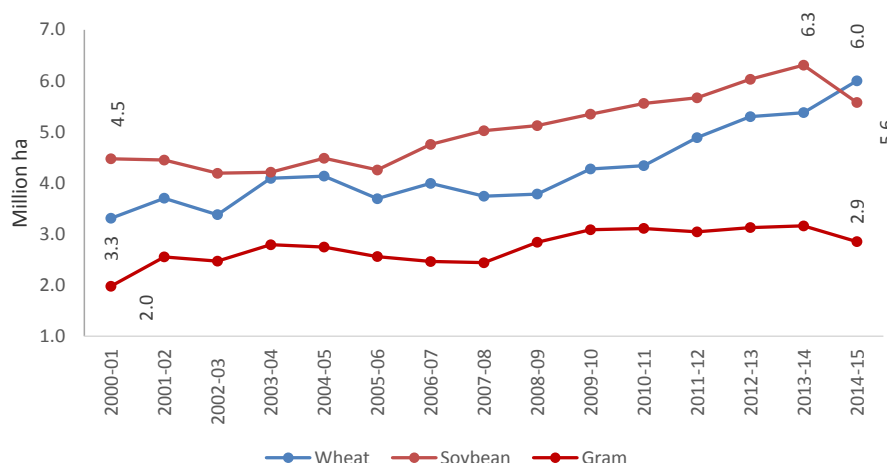
Figure 4: Cropping Pattern-Percentage of GCA (TE 2014-15)



Source: Directorate of Economics & Statistics

Moreover, acreage of the two main crops of MP – wheat and soybean – has increased significantly over the years. Figure 5 shows that acreage under wheat increased from 3.5 million hectares in TE 2002-03 to 5.6 million hectares in TE 2014-15. Similarly, acreage under soybean increased from 4.4 million hectares to 6.0 million hectares in the same period. Further, the relative importance of wheat has also increased over the given period. In TE 2002-03, wheat contributed around 19 per cent of GCA; this has increased to 24 per cent in TE 2014-15. Similarly, the share of area under soybean as a percentage of GCA has increased (from 23 per cent to 25 per cent) but the increase has been less than in the case of wheat. Acreage under gram on the other hand has increased only marginally from 2.3 million hectares in TE 2002-03 to 3.0 million hectares in TE 2014-15. Consequently, its share in GCA has only increased from 12.3 per cent to 13 per cent in the same period.

Figure 5: Increase in Acreage under Wheat, Soybean and Gram



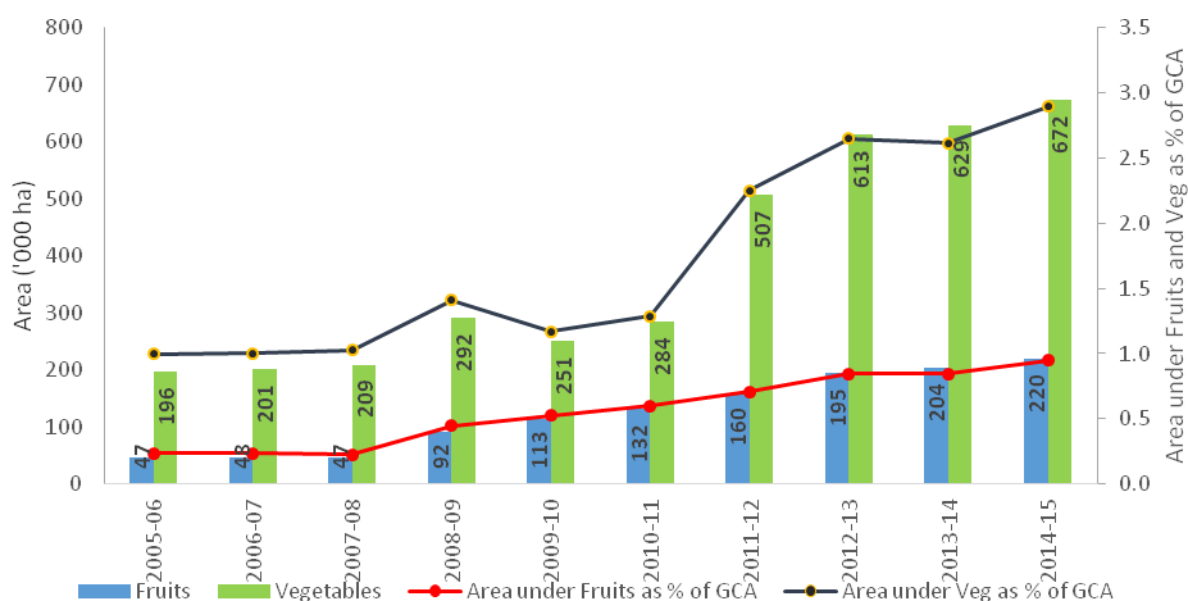
Source: Directorate of Economics & Statistics

Although MP is one of the major food grain producing regions of India, there has been an increasing trend towards the cultivation of horticultural crops as a cash crop. Over the period from 2005-06 to 2014-15, the proportion of area under horticulture crops has jumped from 2 per cent to 6 per cent. Around 43 per cent of the total horticulture area is devoted to vegetables, 37 per cent to spices,³ 15 per cent to fruits and 5.3 per cent to medicinal and aromatic plants and flowers.

There has been a significant expansion of area under vegetables in MP after 2010-11. Vegetable acreage increased from 284 thousand hectares in 2010-11 to 507 thousand hectares in 2011-12, a growth rate of around 78 per cent (Figure 6). This has almost doubled the share of area under vegetables in GCA from 1.3 per cent in 2010-11 to 2.3 per cent in 2011-12. While the expansion of area under vegetables was sudden and took place after 2010-11, in the case of fruits, the expansion began as early as 2008-09. The area under fruit cultivation increased from 47 thousand hectares in 2007-08 to 92 thousand hectares in 2008-09.

³ Coriander (34%), Chillies (27% of spice area), garlic (18%) and ginger (5%) are the main spices grown in MP.

Figure 6: Increase in Area under Fruits and Vegetables

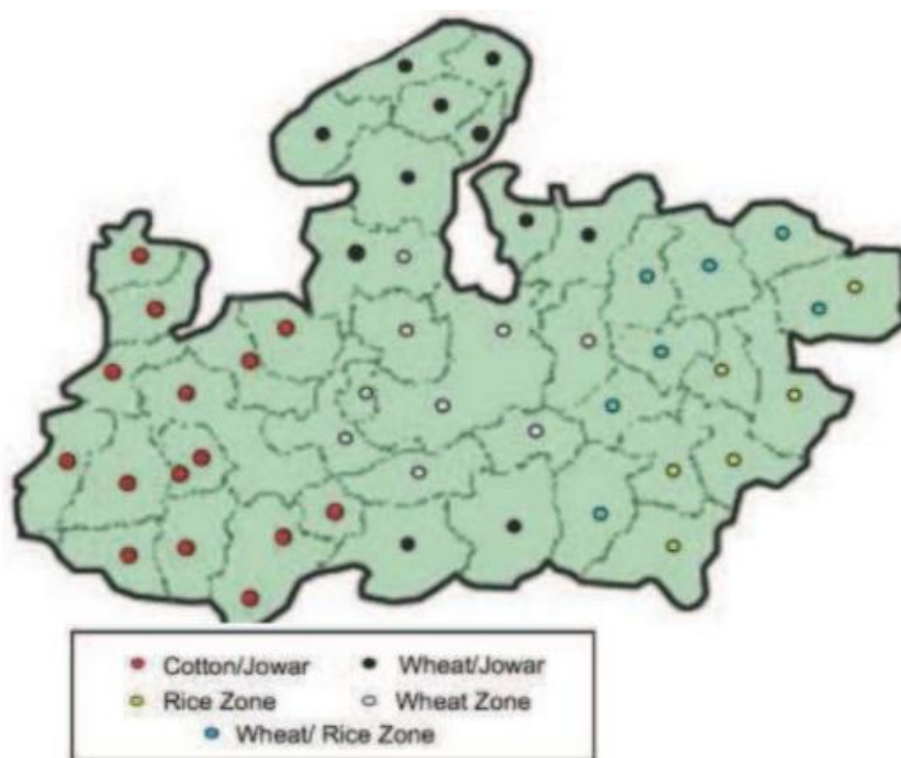


Source: National Horticulture Database and Directorate of Economics & Statistics

An important characteristic of Madhya Pradesh is that different crops can be grown in different parts of the state during different seasons, allowing for uninterrupted agricultural activities throughout the year. Broadly, the state can be divided into following five distinctive crop zones:

- (i) Cotton/Jowar – Cotton/jowar crops can be grown in the western, north-western and south western parts of MP, where medium and deep soils are prevalent
- (ii) Wheat/Jowar – Wheat/jowar crop zones are predominant in the northern strip of the state. Some southern areas of the state also have the potential to grow these crops.
- (iii) Rice Zone – This zone is confined to the eastern part of the state where black soil type is present.
- (iv) Wheat Zone – This crop zone is the central part of the state.
- (v) Wheat/Rice Zone – This crop zone is present in the eastern part of MP where the soil type is black (Figure 7).

Figure 7: Different Crop Zones of Madhya Pradesh

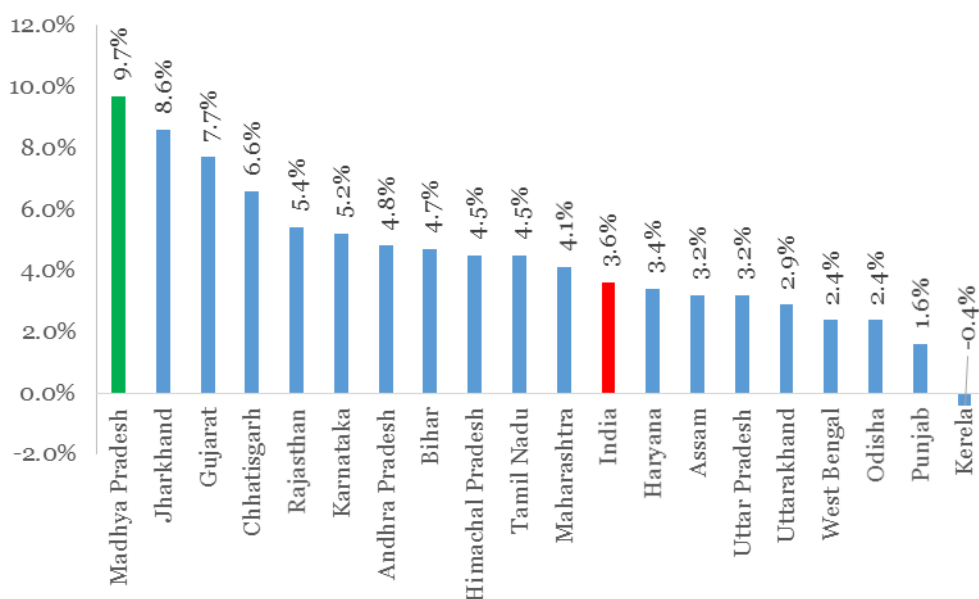


Source: GoMP, 2016

3.5 Trends in Agriculture Growth

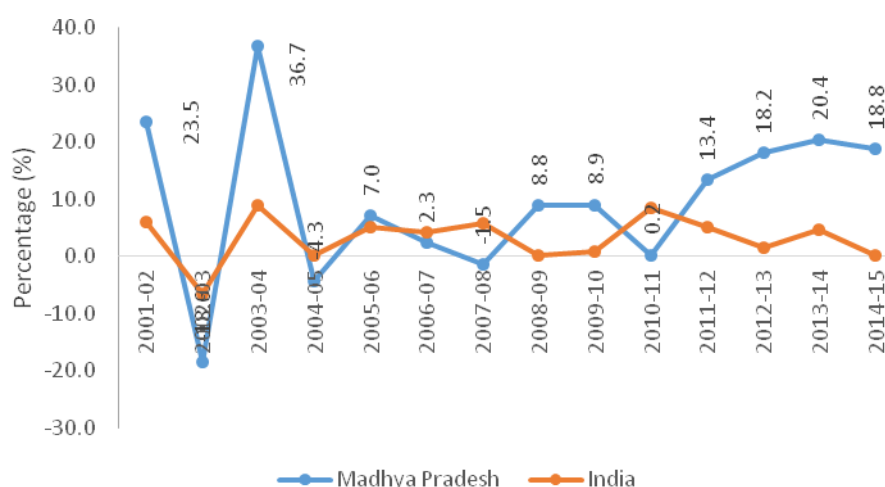
In the recent past, MP has been lauded for its excellent performance of agriculture – MP’s agricultural GDP grew at 9.7 per cent per annum during 2005-06 to 2014-15, surpassing even record-holder Gujarat’s 7.7 per cent (Figure 8). The last five years have been even more spectacular: Agricultural GDP grew at 14.2 per cent per annum as compared to the national average of 4.0 per cent. As evident from Figure 9, the agriculture growth rate since 2010-11 has been on an increasing trajectory and reached a peak of 20.4 per cent in 2013-14, which was a good agricultural year for the state with normal rainfall yielding better agriculture output. In 2014-15, the agriculture growth moderated marginally due to a bad monsoon that resulted in a drought. What is interesting is that agricultural growth in the two drought years 2008-09 and 2009-10 was around 9 per cent in Madhya Pradesh while the all-India growth rate plummeted to less than 1 per cent. Further, with very good monsoons in 2011-12 in all the four months of monsoon season, agricultural growth was around 13.4 per cent.

Figure 8: State-wise Agriculture Growth Rate (2005-06 to 2014-15)



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

Figure 9: Trend in Agriculture Growth in Madhya Pradesh



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

4. Composition of Agriculture Sector and Sources of Agriculture Growth

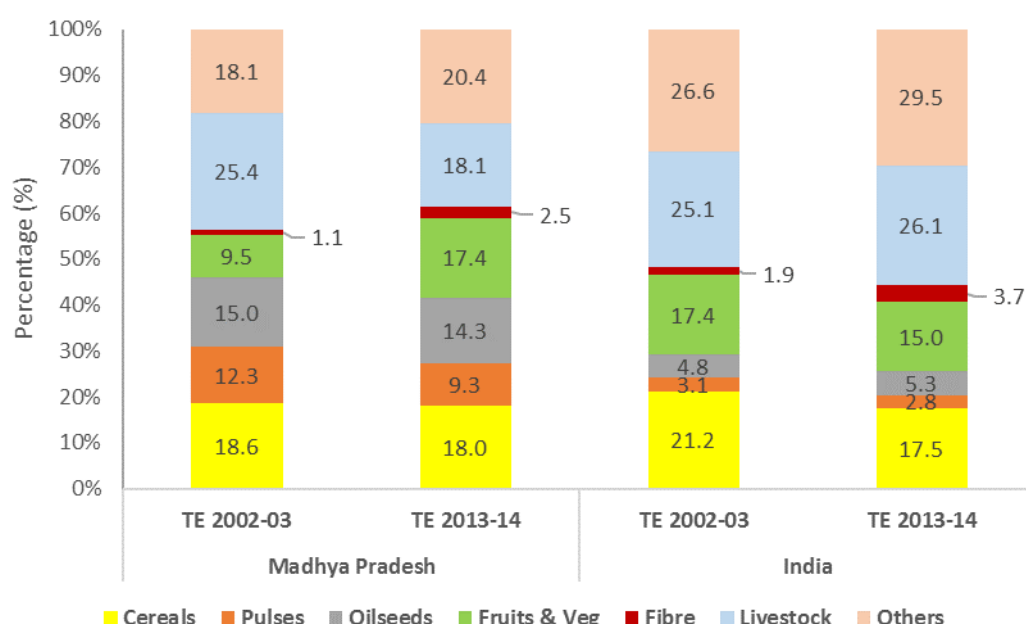
To analyse the composition of agriculture in MP, we have computed the share of value of output from different segments as a percentage of the gross value of output from agriculture and allied activities (at current prices), and to determine the sources of growth, we have deflated the current series of each segment by the WPI at 2004-05 prices and then decomposed 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.

Figure 10 shows that in MP, food grains (cereals and pulses) is the largest segment constituting around 27.3 per cent of GVOA followed by livestock (18 per cent), fruits and vegetables (17.4 per cent) and oilseeds (14.3 per cent). However, the primary source of agricultural growth in MP for the period 2001-02 to 2013-14 was food-grains, followed by fruits and vegetables, oilseeds and then livestock. Of the 8.2 per cent average growth in GVOA for the period 2001-02 to 2013-14, 28 per cent was contributed by food grains, 17.9 per cent by fruits and vegetables, 15.4 per cent by oilseeds and 13.2 per cent by livestock (Table 3).

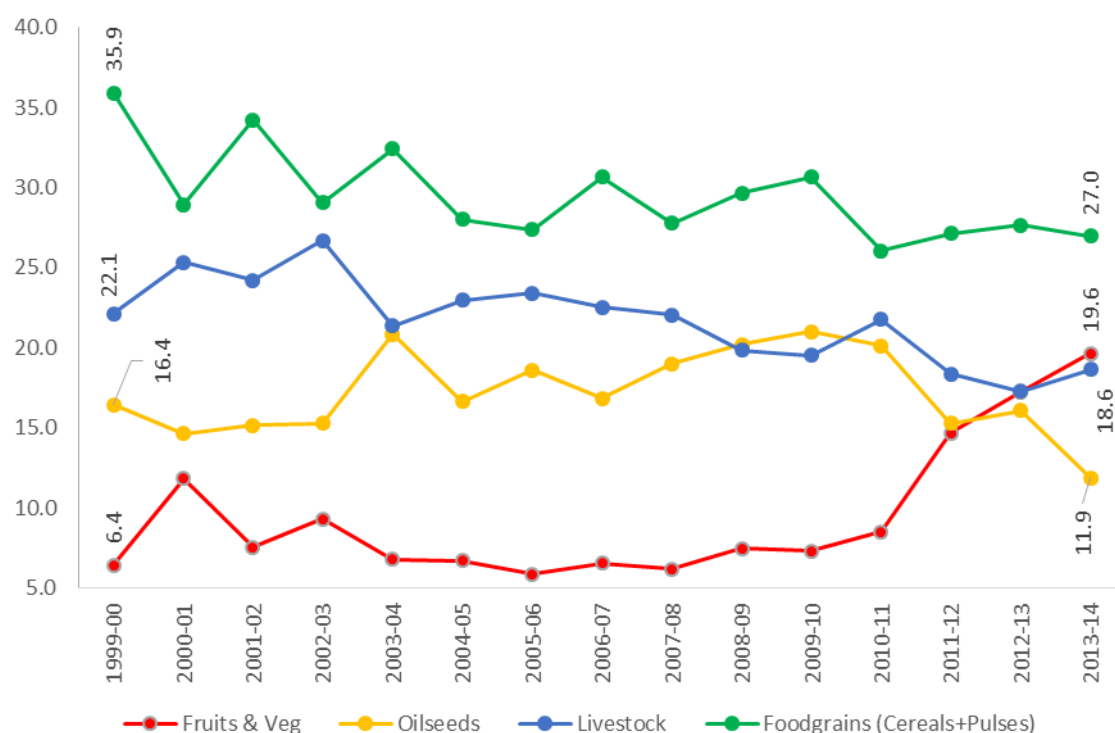
Figure 11 highlights the changing composition of agriculture in MP. The share of food grains in total value of output from agriculture and allied activities fell from 30.9 per cent in TE 2002-03 to 27.3 per cent in TE 2013-14, while that of livestock fell from 25.4 per cent to 18.1 per cent and oilseeds marginally declined from 15 per cent to 14.3 per cent in the same period. In comparison, there was a significant expansion in the share of the fruits and vegetables segment from 9.5 per cent in TE 2002-03 to 17.4 per cent in TE 2013-14. This shows that although food grains continue to be a dominant segment, MP is also diversifying towards high-value crops such as fruits and vegetables. In the following section, we look in greater detail at the disaggregated changes within each segment.

Figure 10: Sector-wise Share in Total value of Output from Agriculture and Allied Activities (at Current prices)



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

Figure 11: Changing Composition of the Agriculture & Allied Sector in MP (Percentage of Value of Output from Agriculture & Allied Activities)



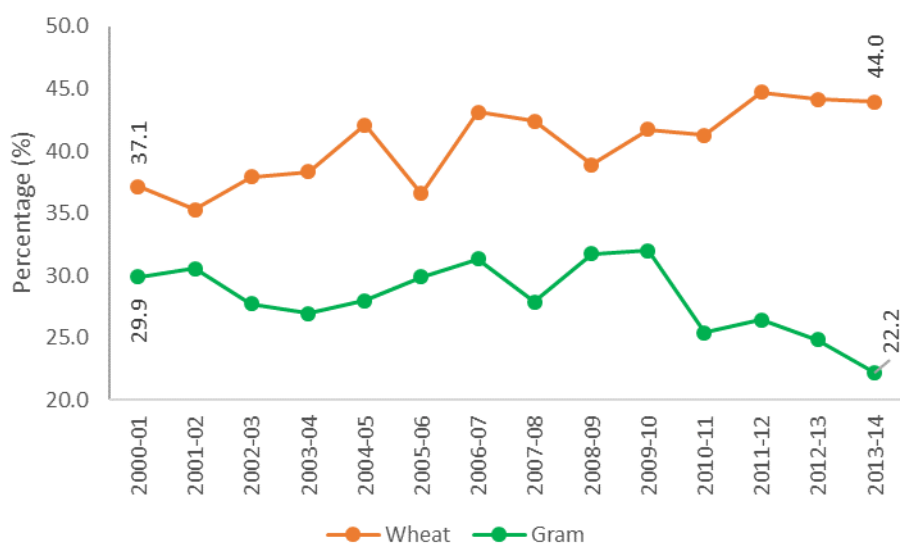
Source: Government of India, State-wise Estimates of Value of Output from Agriculture and Allied Activities

4.1 Food grain Segment

In MP, the largest segment in terms of acreage and value is food grains. This segment contributed around 27.3 per cent of total value of output from agriculture and allied activities. The sectoral decomposition of this segment shows that cereals constitutes around 66 per cent of total value of output from food grains, while pulses contribute around 34 per cent in the state. Further disaggregation shows that within cereals, wheat constitutes around 67 per cent of total value of output from cereals while paddy constitutes around 21 per cent. Similarly, of the total value of output from pulses, 72 per cent was contributed by gram and 9 per cent by arhar/tur.

As mentioned earlier, the share of food grains in GVOA declined from 30.9 per cent in TE 2002-03 to 27.3 per cent in TE 2013-14 in MP (Figure 10). This is similar to the national trend - the share of food grains in national GVOA has fallen from 24.3 per cent to 20 per cent in the same period. In MP, the decline in the share of food grains has been contributed by the decline in the share of jowar, barley, maize and small millets within the cereals segment. These crops together contribute only around 7 per cent of the total value of output from food grains and can be considered as minor cereals grown in MP. Wheat, the main cereal grown in MP, has shown a gradual increase in its importance in the production basket (Figure 12).

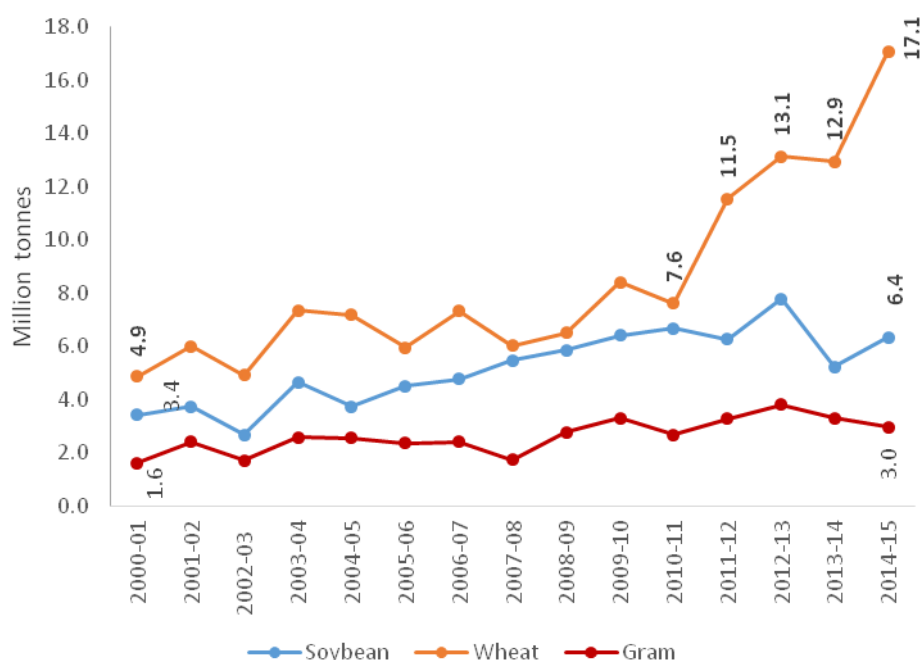
Figure 12: Value of Output from Wheat and Gram as a Percentage of Total Value of Output from Food-grains in MP



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

In tandem with the expansion of acreage under wheat cultivation, production of wheat also increased significantly in MP from 5.3 million metric tonnes in TE 2002-03 to 14.4 million metric tonnes in TE 2014-15. Between 2010-11 and 2011-12, wheat production jumped by 51 per cent from 7.6 million metric tonnes to 11.5 million metric tonnes and thereafter kept a high production trajectory (Figure 13). Currently, MP is the third largest wheat producer in the country contributing around 16 per cent of total production, only after Uttar Pradesh (30 per cent) and Punjab (18 per cent). However, this was not the case in the early 2000s. In TE 2002-03, MP contributed only 8 per cent of total production of wheat and it was the fourth largest producer after Uttar Pradesh (36 per cent), Punjab (22 per cent) and Haryana (14 per cent). Productivity of wheat cultivation in the state also increased from 1.5 MT per hectare in TE 2002-03 to 2.6 MT per hectare in TE 2014-15. However, MP has much to achieve in terms of productivity as its productivity is still lower than that of Punjab (4.7 MT/ha), Haryana (4.4 MT/ha) and Rajasthan (3.0 MT/ha). In the following section, we discuss the reasons for this robust expansion in wheat cultivation in MP in greater detail.

Figure 13: Production of Wheat, Soybean and Gram in MP



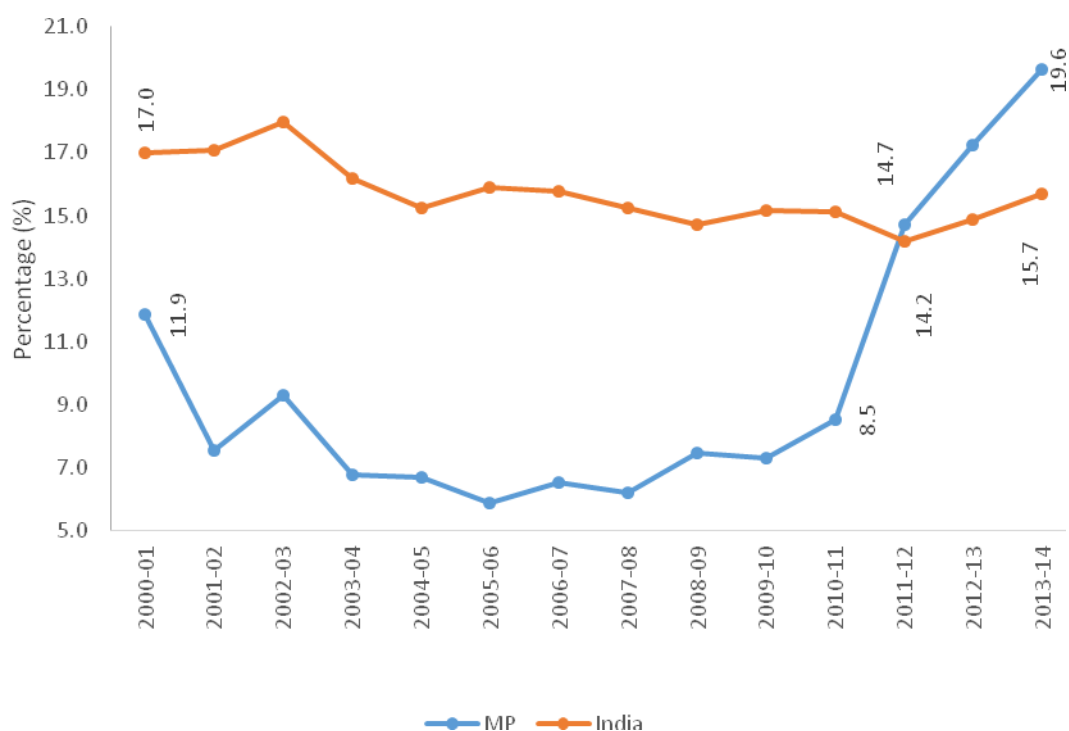
Source: Directorate of Economics & Statistics

In comparison, the share of the pulses segment in GVOA declined in both the major pulse crops – gram and arhar. However, in terms of production, gram production increased from 1.9 million metric tonnes in TE 2002-03 to 3.4 million metric tonnes in TE 2014-15, while arhar production increased from 0.2 million metric tonnes to 0.5 million metric tonnes in the same period. Currently, MP is the largest gram producer in the country (39 per cent of the total production) and third largest arhar/tur producing state (13 per cent of total production)

4.2 Fruits and Vegetables

The largest increase in the state's production of agricultural products has been in the fruits and vegetable segment. Figure 11 shows the increase took place after 2010-11, with the value of output from fruits and vegetables as a percentage of GVOA increasing from 8.5 per cent in 2010-11 to 19.6 per cent in 2013-14. Private sector investment in irrigation augmented the productive capacity and the involvement of public investment in roads connected the hinterland to markets, bolstering the production of perishables like fruits and vegetables (we discuss irrigation and roadway expansion in the section on drivers of growth).

Figure 14: Value of Output from Fruits & Vegetables as a Percentage of GVOA

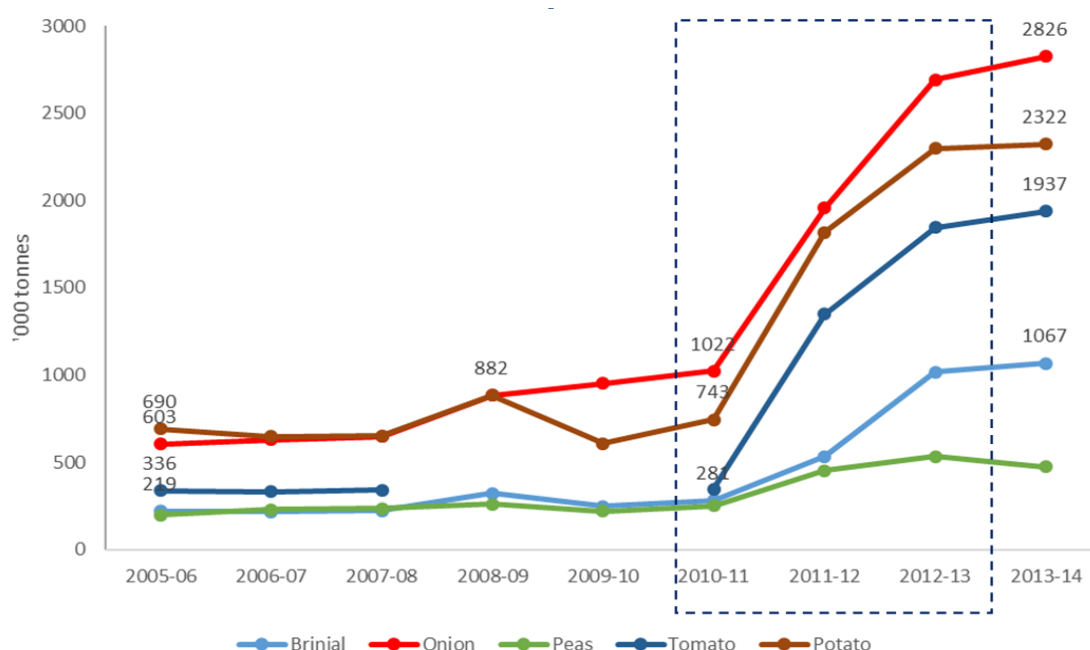


Source: Government of India, State-wise Estimates of Value of Output from Agriculture and Allied Activities

In tandem with the increase in acreage, vegetable production increased from 3.6 million metric tonnes in TE 2010-11 to 14.2 million metric tonnes in TE 2013-14! This remarkable increase has improved MP's position in vegetable production from 13th in TE 2010-11 amongst other states to becoming the fourth largest vegetable producer in the country in TE 2013-14; this helped increase MP's contribution to total production from 2.8 per cent to 7.4 per cent, only after West Bengal (14.9 per cent), Uttar Pradesh (11.8 per cent) and Bihar (9.8 per cent). The productivity of vegetables stood at 20.4 MT/ha in TE 2013-14, which was higher than the national average (17.4 MT/ha) and higher than productivity in West Bengal (17.7 MT/ha) and Bihar (18.5 MT/ha), two of the three top vegetable producing states.

In terms of acreage, the top three vegetables cultivated in MP are potatoes, onions and tomatoes. Potatoes and onions account for round 18 per cent of the area under vegetable cultivation in the state while tomatoes account for 11 per cent. Figure 15 indicates that all major vegetables grown in MP have shown a sharp increase in production after 2010-11.

Figure 15: Production of Various Vegetables ('000 tonnes)



***Note Tomato production data for 2008-09 and 2009-10 is not available in NHB

Source: National Horticulture Database

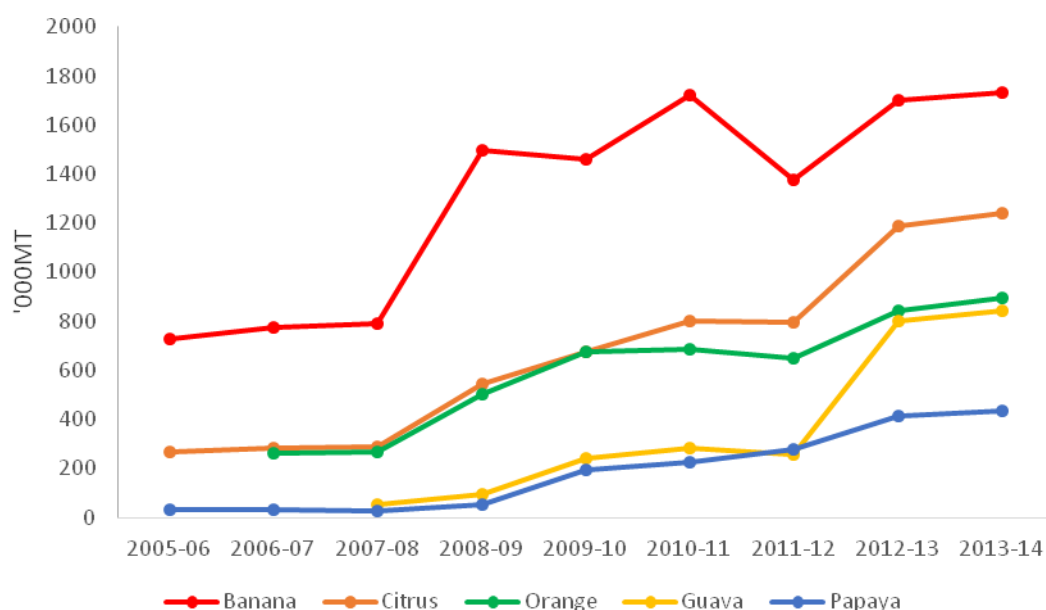
Currently, MP is the second largest producer (14 per cent of total production) of onions after Maharashtra (30 per cent of total production). Its productivity is around 23.6 MT/ha, which is much higher than Maharashtra (14.6 MT/ha) and the national average of 16.1 MT/ha. Gujarat (25.3 MT/ha) is the only state that has recorded a productivity higher than MP.

Further, MP is the fourth largest producer of potatoes (5 per cent) after Uttar Pradesh (33 per cent), West Bengal (24 per cent) and Bihar (15 per cent). The state's productivity in potato production for TE 2013-14 was 21 MT/ha, marginally lower than the national average of 22 MT/ha. States like Gujarat (30.4 MT/ha), West Bengal (25.8 MT/ha), Punjab (25 MT/ha), UP (24.4 MT/ha) and Haryana (22.8 MT/ha) have recorded productivity which is higher than MP.

MP is the third largest producer of tomatoes contributing around 15 per cent of total production, after Andhra Pradesh (43 per cent) and Karnataka (17.6 per cent). Its productivity is around 28 MT/ha, which is much higher than Andhra Pradesh (20 MT/ha) and the national average of 18.8 MT/ha. Karnataka (34 MT/ha) and Himachal Pradesh (29.2 MT/ha) are the only two states that have recorded a higher productivity than MP.

As mentioned earlier, only 0.9 per cent of GCA is under fruit production in the state. In terms of acreage, the top three fruits produced in MP are citrus, orange, and banana. Around 35 per cent of the area under fruits is under citrus fruit cultivation, 26 per cent under orange cultivation and 14 per cent under banana. Figure 16 shows that production of all these fruits has increased since 2007-08.

Figure 16: Production of Various Fruits ('000MT)



Source: National Horticulture Database

The horticulture segment has become the sunrise sector for MP. Given the huge potential in the state for horticulture, the Government of Madhya Pradesh announced the 'Horticulture Hub (H2) Establishment Policy, 2012'. The purpose of this policy was to establish protected cultivation of horticultural crops in a commercial and organised manner. One or more centralised facilities will be made available for production of high quality plantation material, grading, sorting, packaging, etc., for products to be grown in horticultural clusters. It is expected that generally more than one cluster (village groups) will be linked with a hub. In 2012-13, Rs 250 million was made available to establish horticultural hubs in the state. Under this policy, facilities are expected to be established by engaging private investors through the MP Agro Industries Development Corporation. As per the policy, land is allotted to information technology companies investing in Madhya Pradesh on a 99-year lease. Prior to the H2, land was allotted to such companies on a 33-year lease under the Information Technology Policy, 2006. Hubs are expected to be established after preparing detailed project reports and getting the reports endorsed by an empowered committee headed by the Chief Secretary. The hub will run under the PPP mode.

Further, to promote agricultural processing, the state initiated the agro and food processing policy in 2012. Under this policy, land allotment to MSME is done at a concessional rate of 25 per cent and exemption of stamp duty and registration charges of Rs 1 per 1,000. Moreover, fruits, vegetables, floriculture and other notified agricultural produce purchased in any market area of the state for processing/production are exempted from payment of mandi fee. Additionally, power has been subsidised at Rs 1.5 per unit, subject to a ceiling of 25 per cent of the electric units consumed in cold storage, cold chambers, ripening chambers and individual quick freezing enterprises for five years. In 2009-10, there were 812 agro-based food product industries in MP, accounting for nearly one fourth of the total industries. This

sector contributes an average 30 per cent to the total industrial output value in Madhya Pradesh. The sector is one of the highest growing sectors in terms of gross capital formation as well as gross value addition with an annual compound growth rate of 37 and 25 per cent respectively (GoMP, 2016)

4.3 Non-Food Crops

In TE 2013-14, the non-food segment consisting of oilseeds, fibre and sugar comprised around 17 per cent of the total value of output from agriculture and allied activities as compared to the national average of 13 per cent. In MP, oilseeds alone constitute around 15 per cent of GVOA vis-à-vis the national average of 5.3 per cent. At a disaggregated level, soybean comprises of around 79 per cent of the total value of output from oilseeds while rapeseed and mustard comprises of around 13 per cent and groundnut 5 per cent.

Between TE 2002-03 and TE 2013-14, the share of oilseeds in GVOA marginally declined from 15.0 per cent to 14.3 per cent. This decline was mainly due to the decline in the share of minor oilseeds such as groundnut, linseed, sesamum and niger seeds. These together constitute only around 9 per cent of total value of output from oilseeds.

Production of soybeans has doubled from 3.3 million tonnes in TE 2002-03 to 6.6 million tonnes in TE 2014-15 (Figure 13). MP is the largest producer of soybeans contributing around 53 per cent of the total production in the country, followed by Maharashtra (32 per cent)

4.4 Livestock

Livestock is the second largest segment after food grains in MP, contributing around 18.1 per cent of the GVOA. The milk segment contributes around 83 per cent of total value of output from livestock and the meat segment contributes around 5 per cent. The livestock sector's share in GVOA has declined from 25.4 per cent in TE 2002-03 to 18.1 per cent in TE 2013-14. This is primarily because other segments such as fruits and vegetables have expanded more than livestock. In absolute terms, the value of milk output has increased from Rs 62.7 billion in TE 2002-03 to Rs 214.1 billion in TE 2013-14.

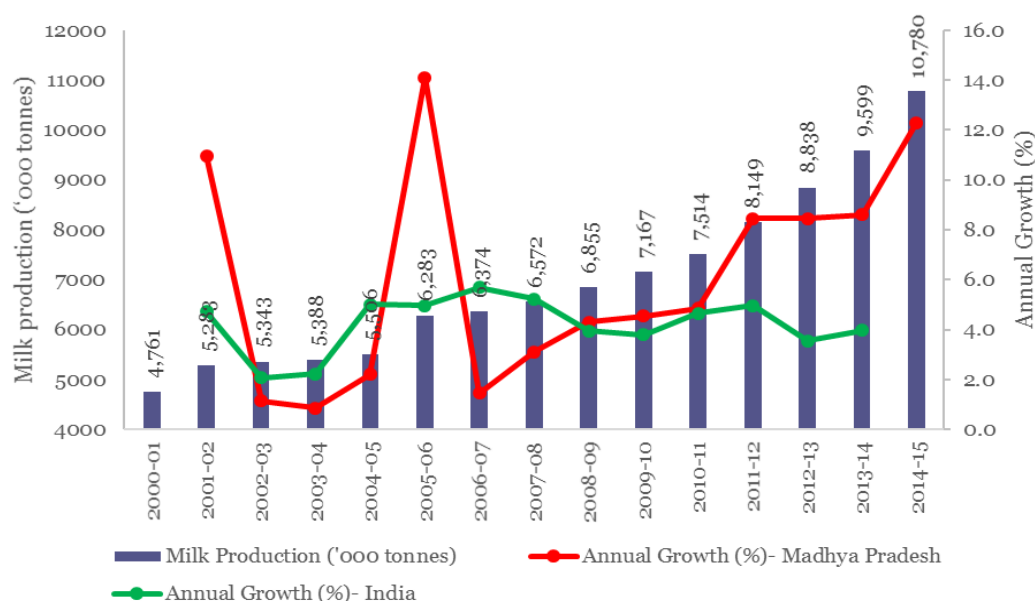
4.4.1 Milk Segment

In MP, the share of milk in the GVOA has declined from 21 per cent in TE 2002-03 to 15 per cent in TE 2013-14. However, this segment continues to be an important segment for improving farmers' livelihood in MP.

Milk production in MP has grown from 4.8 million metric tonnes in 2000-01 to 10.8 million metric tonnes in 2014-15 (Figure 17), a CAGR of 5.6 per cent as compared to the national average of 4.1 per cent. Around 45 per cent of milk production is cow milk and 49 percent is buffalo milk.

In terms of volume, MP is the sixth largest milk producing state contributing around 7 per cent of total milk production in the country. Although milk production in the state has been increasing, milk productivity in MP is lower than in some other states; for example while MP's productivity in milk production stood at 0.8 MT per female animal, Punjab's productivity was 2.4 MT per female animal, Gujarat 1.1 MT per female animal, UP 1.0 MT per female animal.

Figure 17: Milk Production in MP

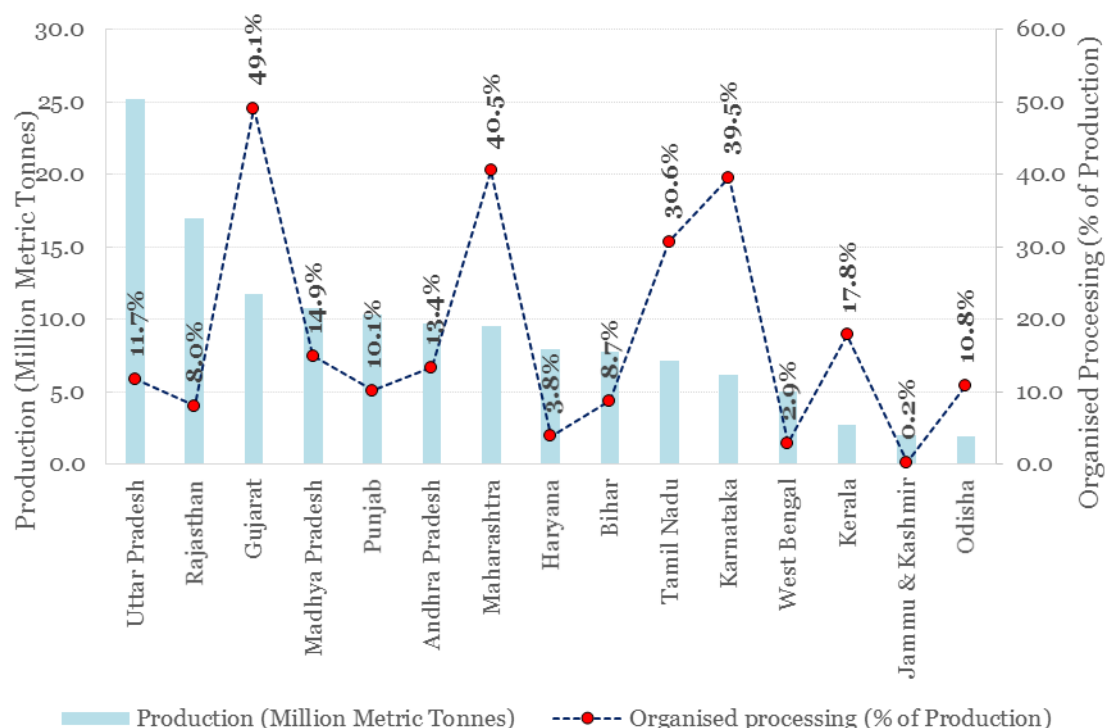


Source: National Dairy Development Board (NDDB)

One of the factors for this low milk productivity could be the lower proportion of genetically superior cattle (crossbred). From Table 5, it can be observed that exotic/ crossbred female cattle population in Punjab is 91.5 per cent of total female cattle population, while that in MP is only 6.0 per cent in 2012. Although this proportion is still low, the state has shown a rise in the proportion from 3.2 per cent in the five years since 2007. However, the state requires significant scaling up of the population of crossbred/exotic female cattle population in order to improve milk productivity. The yield from cross-bred cows is much higher as compared to indigenous breeds. On average, a cross-bred cow yields 7.2 kg/day nationally while an indigenous cow yields 2.5 kg/day. In MP, the average yield of exotic/crossbred cow is around 6.5 kg/day while indigenous cows yield around 2.1 kg/day.

Milk in MP is mainly marketed by dairy co-operatives. The Madhya Pradesh State Cooperative Federation is the apex body and it has five regional milk unions located in Bhopal, Gwalior, Indore, Jabalpur and Ujjain for procurement. On average, these unions procure around 9.3 lakh kgs of milk per day from 2.4 lakh members. These members are associated with 6,219 dairy co-operatives (2015-16). Only about 15 percent of total milk produced in MP is processed by the organised sector compared to 49 percent in Gujarat (Figure 18).

Figure 18: Milk Production and Organized Processing in Major Producing States: 2014-15



Source: Verma, Gulati, and Hussain, 2017

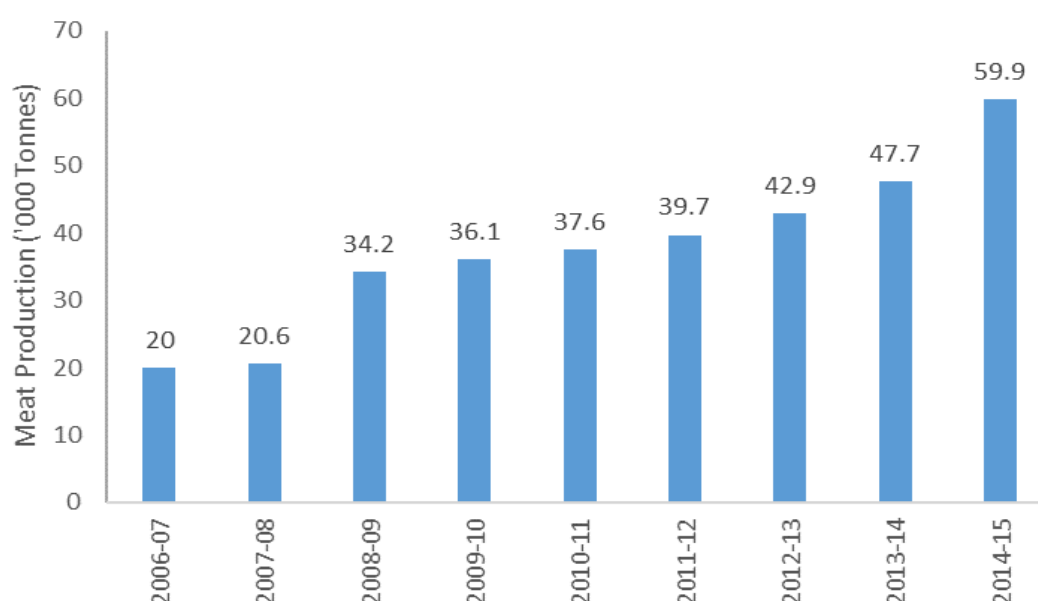
4.4.2 Meat and Egg Segment

Meat accounts for only 5 per cent of the total value of output from the livestock segment. Its share in GVOA has marginally increased from 0.6 per cent in TE 2002-03 to 0.9 per cent in TE 2013-14. Between 2006-07 and 2014-15, meat production increased from 20 thousand tonnes to 60 thousand tonnes (Figure 19), an increase of 200 per cent! Of the total meat produced in the state, around 76 per cent is poultry meat, 36 per cent is buffalo meat and 28 per cent is goat meat. The poultry segment in MP got a stimulus with the establishment of the Madhya Pradesh Women Poultry Producer Company Pvt. Ltd. (MPWPCL). It has ten producer organisations operating under it, each holding a stake in the producer company. Each of these producer organisations is an independent entity involved in providing services such as raw materials, working capital assistance, risk mitigation from input and output price movements, production support as well as marketing broiler poultry to its members and providing training and building capacity among women. The co-operative membership extends to 4,214 women poultry producers belonging to poor tribal and Dalit families. Currently, MPWPCL is one of the biggest producers of broiler chicken in the state. This was achieved by first establishing four feed processing units, which supplied feed to the co-operatives, and then taking on the contract for manufacturing medicines. Marketing is done under the brand name 'Sukhtawa Chicken'. In 2011, a parent farm and hatchery was commissioned. The end-to-end integration and scale of operations under MPWPCL has given

the producers bargaining power to influence market decisions and protect farmers from market volatility and depletion in their profit margin (Garg and Kumar, 2011).

Egg production in MP has also increased significantly from 951.8 million in 2006-07 to 1,177.6 million in 2014-15. Such a phenomenal rise in the production of meat and eggs requires enlargement of storage capacity so as to minimise wastage and damage. Although, at present, there are around 122 cold storages in the state with a total capacity of approximately 712.3 million MT (2012-13), there is a pressing need to develop storage and marketing infrastructure to further bolster the segment.

Figure 19: Meat Production in MP



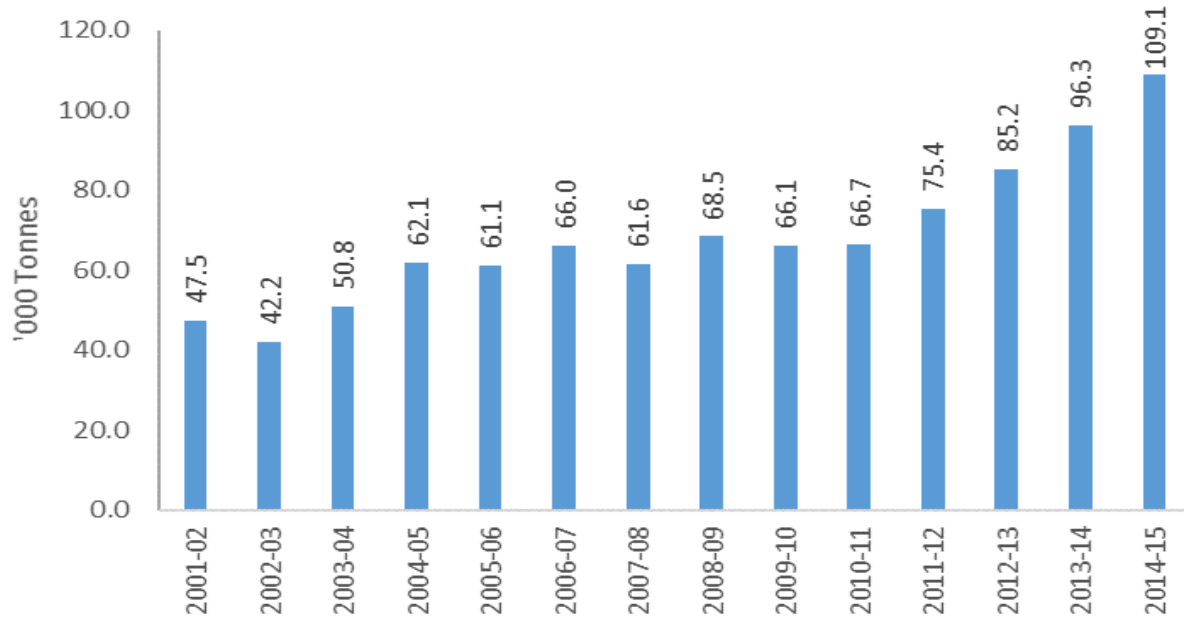
Source: GoMP, 2016

4.5 Fisheries

Since Madhya Pradesh is land locked, inland fishery is favoured in the state. Although only 0.2 per cent of the state GDP is contributed by fishery, this sector has huge potential. MP has around 4.03 lakh hectares of reservoirs and tanks, which can be utilised for fishing.

Fish production has increased from 47.5 thousand tonnes in 2001-02 to 109.1 thousand tonnes in 2014-15, (Figure 20) a CAGR of 5.7 per cent. MP contributes only about 1.6 per cent of the total inland fish production, while major inland fish producing states in India such as Andhra Pradesh and West Bengal contribute around 26 per cent and 23 per cent respectively (GoMP, 2016).

Figure 20: Fish production in MP



Source: GoMP, 2016

5. Drivers of Agriculture Growth

5.1 Econometric Analysis

Agricultural growth is influenced by a number of supply-side factors. *A priori*, we would expect (i) technology (seed replacement rate, irrigation, fertiliser use, farm mechanisation, extension etc), (ii) incentives (terms of trade), (iii) infrastructure (electricity, roads), and (iv) weather conditions to drive agriculture growth. However, it is difficult to analyse the effect of all variables in a single framework, since many of these variables can be correlated and due to paucity of data. Therefore, we use a parsimonious model to analyse the potential drivers of growth. Table 9 gives the correlation matrix of the variables. It is observed that GDPA shows a significant and positive correlation with irrigation, fertiliser consumption, terms of trade, MSP, procurement of food grains and total road length.

5.1.1 Estimating Equation

In our model, Log GDPA is the dependent variable and the variables mentioned above are independent variables. The equation has been estimated using data from 2000-01 to 2014-15. We have run the model with different variables (south-west monsoon, agriculture credit, fertiliser consumption, terms of trade, etc.,) and have finally presented only those variables that have significant effect on agricultural GDP. The following equation is estimated in Model (1) and (2):

$$Y_t = \beta_0 + \beta_1 X_{1t} + \beta_2 X_{2t} + \beta_3 X_{3t} + u_t \quad (1)$$

where, X_{1t} is the total road length; X_{2t} is the irrigation ratio; and X_{3t} is terms of trade. The results are presented in Table 6.2.

Model 1:

$$Y_t = 0.32 + 0.94^{***}X_{1t} + 0.98^{***}X_{2t} + u_t$$

Model 2:

$$Y_t = 11.4^{***} + 1.05^{***}X_{2t} + 1.7^{***}X_{3t} + u_t$$

In Model 1, it can be seen that, irrigation and roads have a significant and positive effect on agricultural GDP. The two independent variables together explain around 96 per cent of the variation in agricultural GDP for the studied period. Since we have estimated a double log model, the results can be interpreted as follows: *ceteris paribus*, a 1 per cent growth in irrigation ratio increased agriculture growth by 0.98 per cent. Similarly, a 1 per cent growth in road length increases agriculture growth by 0.94 per cent. In Model 2, it is observed that irrigation and terms of trade in favour of agriculture have a significant and positive effect on agricultural GDP. The two independent variables together explain around 94 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 1 per cent growth in the irrigation ratio increased agriculture growth by 1.05 per cent and a 1 per cent change in terms of trade in favour of agriculture increased agriculture growth by 1.7 per cent.

5.1.2 Stationarity and Co-integration

It is important to note that two or more time series may trend in the same or opposite directions leading to incorrect conclusions on the causality between these variables. 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 take into the account the fact that 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 for suspecting that the estimated regression is spurious. From Table 10, we find that $R^2 < d$; therefore, based on this rule of thumb and economic theory of agriculture 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. In Table 11, we have presented the results of the Augmented Dickey Fuller test (ADF). We find that the GDPA, irrigation ratio, road length and terms of trade⁴ are integrated of order 1, i.e., they are stationary in the first difference form, $I(1)$. 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 $I(0)$ in Model1 and Model 2. It is possible that these series contain a common stochastic trend and need not be spurious. In this case, despite the trend, they will

⁴ All variables in Log form

move together over time such that they will be co-integrated. Economically speaking, the three series will be co-integrated if they have a long-term, or equilibrium relationship between them.

5.1.3 Engle-Granger Test for Co-integration

To test for co-integration between the three non-stationary time series, we simply run the OLS regression in Model (1) and Model (2), and then run the ADF test on the residual to determine if it is stationary. This method is similar to the Engel and Granger (1986) two-step residual test. 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 12 presents the Augmented Dickey Fuller Test for the residuals of the two models. We reject the null hypothesis of non-stationarity at 1 per cent level of significance in both the models. Given that we have established that there is co-integration between GDPA, irrigation ratio and road length in Model 1 and between GDPA, irrigation ratio and terms of trade in Model 2, the OLS results presented in Table 10 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 and surfaced road density and between GDPA, irrigation ratio and terms of trade.

5.2 Physical Infrastructure Development

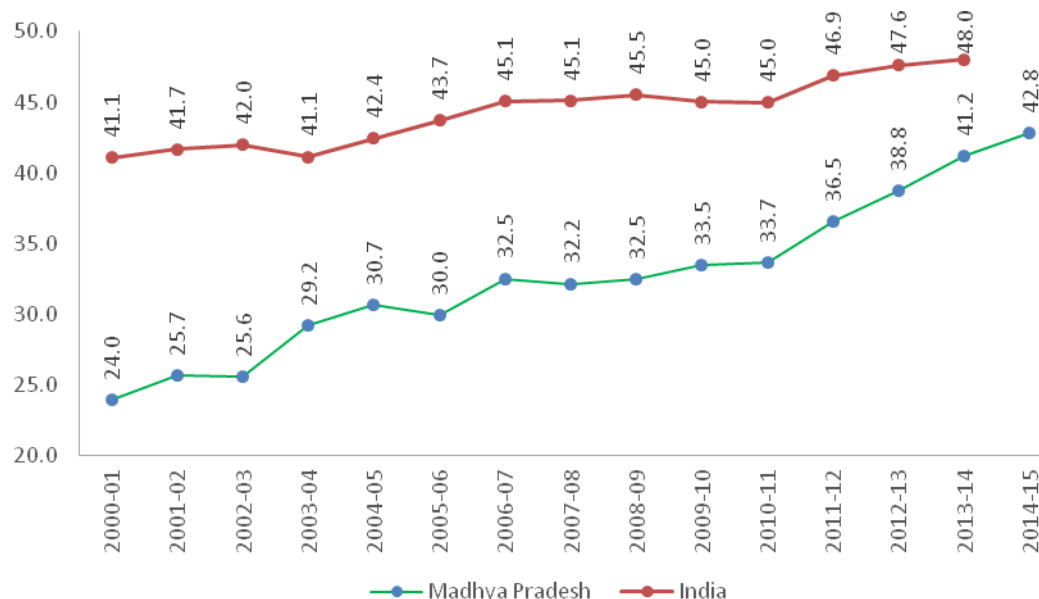
Physical infrastructure such as irrigation, power and roads play an important role in stimulating investment in agriculture and agricultural growth (FAO, 1996). Further, several studies (Antle, 1984; Binswanger et al, 1993; Fan, Gulati and Thorat, 2007; Fan and Zhang 2004) have shown that investment in rural infrastructure has the potential to increase farmer's access to input and output markets, stimulate the rural non-farm economy and vitalise rural towns and increase consumer demand in rural areas. In this section, we discuss the development of infrastructure in MP to understand the reasons for the rapid agriculture growth in the state.

5.2.1 Irrigation

Irrigation has played a vital role in the growth and development of agriculture in the state. Gross irrigated area has increased from 4.3 million hectares in 2000-01 to 10.3 million hectares in 2014-15.

Figure 21 shows the position of MP as compared to the position at the country level during the period 2000-01 to 2013-14. At the outset (2000-01), the irrigation ratio in MP was 24 per cent, which was around 17.2 percentage points lower than the All- India average. By 2013-14, the ratio had moved up to 41.2 per cent, decreasing the gap with the All- India average to 6.2 per cent, which is a commendable achievement for the state. By 2014-15, the irrigation ratio in MP reached 42.8 per cent.

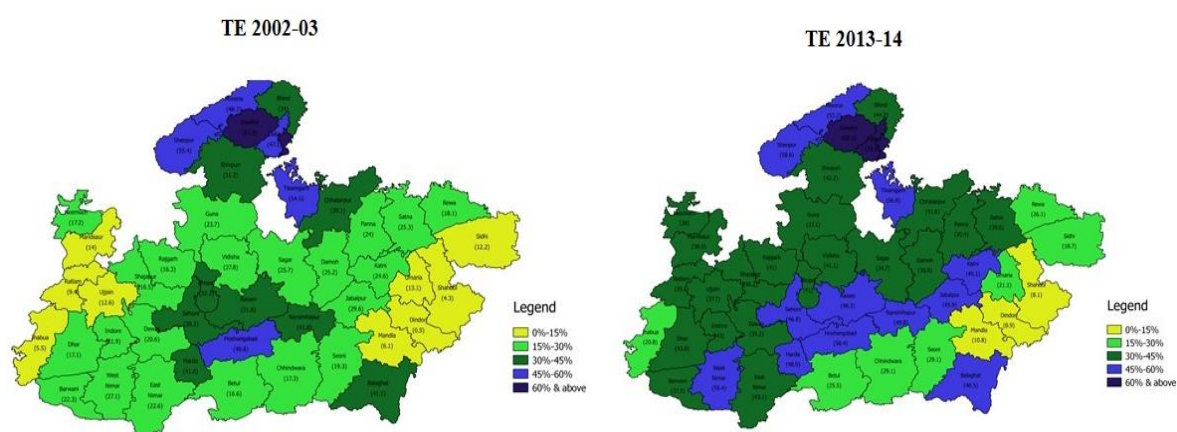
Figure 21: Gross Irrigated Area as a Percentage of Gross Cropped Area



Source: Directorate of Economics & Statistics

Figure 22 shows region-wise expansion of irrigation coverage. The left hand graph presents district-wise irrigation ratio for TE 2002-03 and the right hand side graph gives the irrigation ratio for TE 2013-14. In TE 2002-03, around 42 per cent of districts had an irrigation ratio in the range of 15 to 30 per cent, 18 per cent of districts in the range of 30-45 per cent and 12 per cent of districts above 60 per cent. By TE 2013-14, the proportion of districts with irrigation ratio between 15 to 30 per cent decreased to 14 per cent, while the proportion of districts with irrigation ratio in the range of 30-45 per cent increased to 54 per cent and the proportion of districts with irrigation ratio above 60 per cent increased to 26 per cent. The areas that have benefited from irrigation projects have shown an increase in yields leading to higher agricultural growth, changing cropping patterns and an increase in gross cropped area, moving away from a mono crop regime to double cropping; in some regions, farmers are also encouraged to take a third crop like moong in the summer season (Madhya Pradesh Agriculture Economic Survey, 2016).

Figure 22: Region-wise Irrigation Coverage



Source: Created by authors

Source-wise irrigation data reveals that of the various sources of irrigation, dug wells and tube wells occupy the maximum share with 67 per cent, followed by government canals with 17 per cent, followed by other sources with 13 per cent and tanks/ponds with 3 per cent. Figure 23 shows that irrigation coverage via all sources has expanded between 2000-01 and 2013-14. Specifically, area under tube well irrigation increased from 0.9 million hectares in 2000-01 to 3.2 million hectares in 2013-14, dug wells increased from 1.9 million hectares to 3.3 million hectares, irrigation coverage via government canals increased from 0.9 million hectares in 2000-01 to 1.8 million hectares in 2013-14, and irrigation via tanks increased from 0.1 million hectares to 0.3 million hectares. The sharpest increase in irrigation coverage was via tube wells, followed by canals. Private sector investment in the expansion of irrigation through tube wells, wells and ponds and tanks were incentivised through the development of a strong procurement system as well as assured electricity provided by the government.

Further, canal irrigation in MP showed robust expansion in all river basins. A study by Shah et al (2016) highlights the following reasons for this rapid increase.

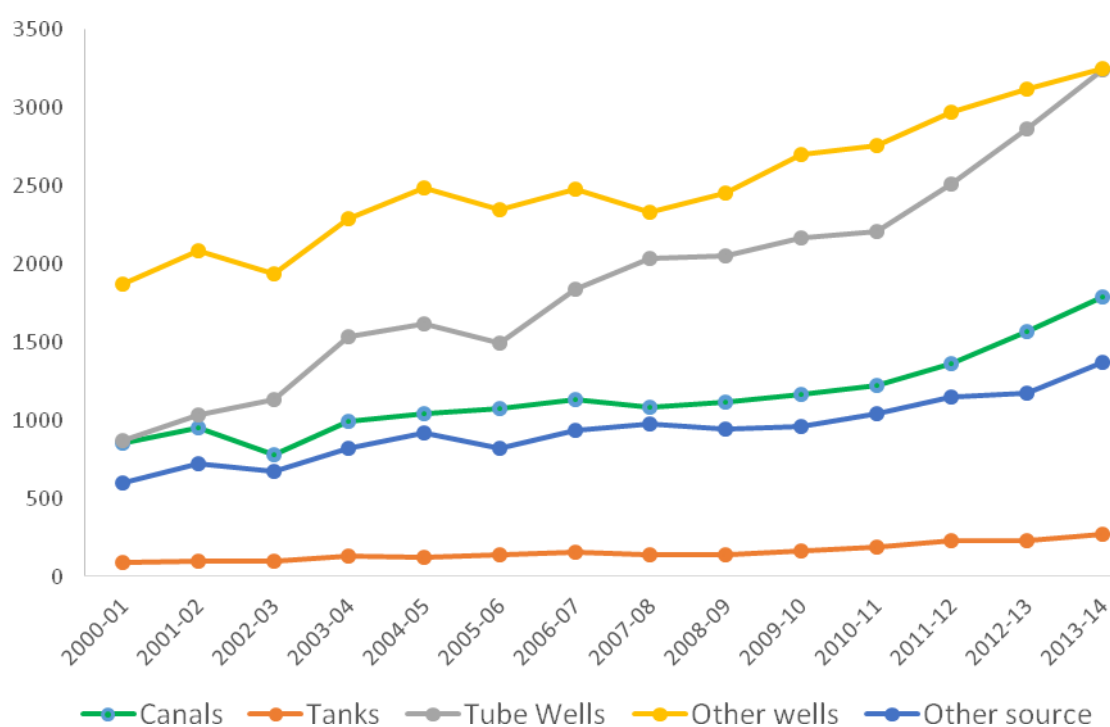
1) Restoring Canal Management Protocol: Obsolete irrigation schedules were revised; water allowance was adjusted to reflect new cropping patterns; areas served by lift irrigation from surface and groundwater in command areas began to get counted as canal irrigated areas. Irrigating tail-end first removed the head-tail inequity endemic to canal irrigation. Full Supply Level (FSL)⁵ canal operation meant that water reached the tail-end and then it could be distributed in an orderly manner; enforcing osarabandi (operating canals by strict rotation) ensured that distributaries could be operated at FSL during their rotations. Further, Shah et al (2016) point out that, earlier when canals ran non-stop at low supply, it was a winner take all game for head-end farmers, who were under no pressure to time planting or save water. Now, osarabandi delivers full supply for specific pre-determined time slots that drives farmers to manage water better.

⁵ Full supply level (FSL): The normal maximum operating water level of a canal when not affected by floods

2) Last mile investment – A World Bank loan and internal resources were utilised to prioritise and quickly complete last-mile projects with high potential. Further, lining on big earthen canals on old systems made it possible for water to reach the tail end quickly. The Central Government in November 2009, approved a special Bundelkhand package for implementing drought mitigation strategies in Bundelkhand region at a cost of Rs 72.7 billion comprising Rs.35.1 billion for Uttar Pradesh and Rs.37.6 billion for Madhya Pradesh, to be implemented over a period of three years starting 2009-10. It was envisaged to provide an additional central assistance (ACA) to the tune of Rs.34.5 billion for implementation of the package. The share of Uttar Pradesh and Madhya Pradesh in ACA was envisaged to be Rs. 16.0 billion and Rs.18.5 billion respectively. It seems that MP utilized the funds made available by the centre for completing a number of dam projects which had been under construction for several years. Moreover the state gave priority to completion of command area works which resulted in increase in irrigated area in the state. This is an important lesson for other developing states, rather than starting new irrigation projects, they should complete the ongoing projects on priority.

3) Resources for Management, Operations and Maintenance (MO&M) and Monitoring: Resources were made available to undertake MO&M. Prior to the irrigation season, canals, sub-minors and field channels were desilted and cleaned and canal breaches were fixed within a stringent time limit. Further, there was relentless monitoring by senior officers to ensure watering of tail-end areas.

Figure 23: Source-wise Gross Irrigated Area ('000 hectares)



Source: Directorate of Economics & Statistics

5.2.2 *Energy for Agriculture*

As mentioned in the previous section, one of the main reasons for the rapid expansion for tube-well irrigation in MP was the government's conscious efforts to ensure assured power for agriculture. The state government started with the unbundling of the power business to bring efficiencies in 2005, and it has made special efforts to ensure separate feeder for power supply to rural areas. The main reason to undertake feeder separation was that rural feeders in MP earlier provided power supply to mixed load for an average of approximately twelve hours. There was no supply during the rest of the day due to constraints in generation. Consequently, the agriculture sectors faced several bottlenecks, which are listed below.

- Agricultural pumps during the 'pre-feeder separation' period usually received three phase supply for six to eight hours; for the rest of the period, one phase supply was available.
- Villages did not get power supply round the clock
- Unbalanced loading on distribution transformers (DTR) and power transformers (PTR)
- Load shedding and high technical losses

Subsequently, the government made the following interventions to improve the electricity situation for agriculture use in the state:

- Ensured twenty-four hour power supply in the state, out of which eight hours power supply was exclusively for agriculture purpose.
- Provided power to agriculture on a flat rate of Rs 1,200 per year, with the facility to pay in two instalments
- Provided separate rural feeders for agriculture; 43,517 villages have been provided with a separate feeder of 11KW line comprising 71,688 Km and 1,516 transformers of 21 KW, which are the country's largest agriculture feeders.

The Deen Dayal Upadhaya Gram Jyoti Yojana (DDUGJY) is a centrally sponsored scheme, which was initiated in 2014 with a component on feeder separation. The scheme makes funds available to the state governments to take up works to strengthen the distribution system and the separation of feeders for agricultural and non-agricultural consumers. Under DDUGJY a sum of Rs.28.7 billion has been sanctioned for MP so far, out of which Rs.15.8 billion is to strengthen the system and Rs.8.2 billion is for the segregation of feeders.

The objective of the programme is to separate domestic load from irrigation in rural areas and to provide uninterrupted, quality power supply to domestic rural consumers. In other words, feeder separation refers to the supply of electricity to agricultural consumers and to non-agricultural consumers (domestic-non-domestic) separately through dedicated feeders. This arrangement allows the distribution company to regulate power supply to agriculture consumers as and when needed for effective demand side management (DSM). The separation of feeders helps in flattening the load curve by shifting the agricultural load to off-

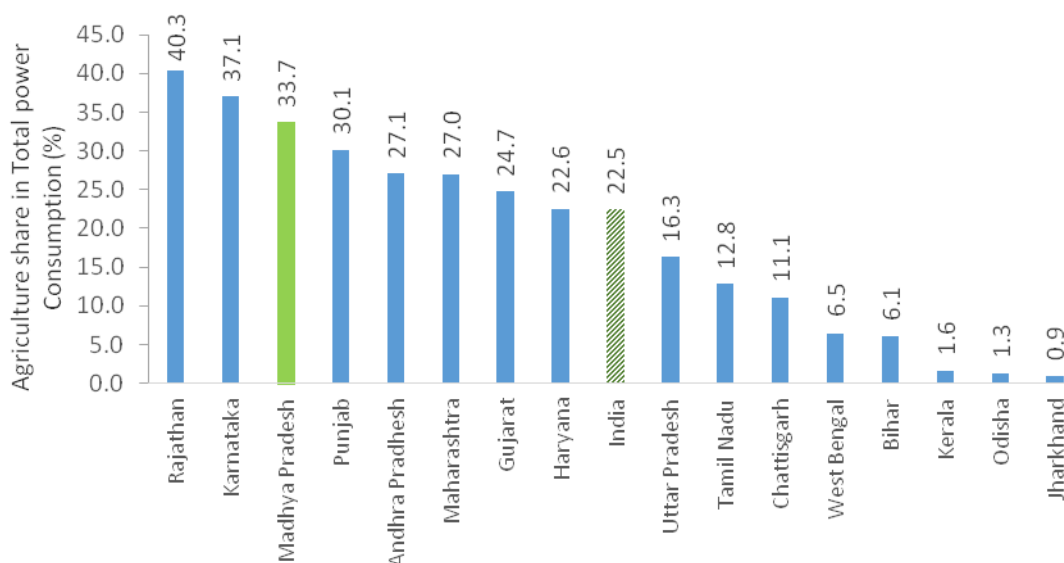
peak hours and thus facilitates peak load supply to agricultural consumers and continuous power supply to non-agricultural consumers in rural area (DDUGJY, 2014).

The efforts of the state government to attract investments for power generation and to expedite feeder separation were long term policy reforms. In the short term, the state government strategised to provide temporary winter-session power connections. Irrigation demand for power during winter was high and farmers were willing to pay a premium of Rs.2.7- 3.0 per unit for assured electricity. The state government contracted advance power purchase for the winter months, and began liberally issuing winter-season irrigation connections (Shah et al, 2016). Between 2010 and 2013, the state issued 3.12 million winter connections to farmers increasing the area under wheat cultivation by 1.8 to 2 million hectares per year, leading to increased production.

These efforts have resulted in an increase in the use of electricity for agricultural purposes in MP. It has gradually increased from 4,843 MW in 2003 to 10,231 MW in 2013 (GoMP, 2016). The share of agriculture in total power consumption in MP is around 33.7 per cent, which is much higher than the national average of 20.8 per cent and higher than in states like Karnataka (33.7 per cent), Punjab (30 per cent), Gujarat (23.6 per cent), and Maharashtra (22.0 per cent) (Figure 24).

Although the share of agriculture in total power sales is high (33.7 per cent), total power sales/Gross cropped area (GCA) is low standing at 518 kwh/ha in TE 2012-13 as compared to states such as Tamil Nadu, Andhra Pradesh, Karnataka, Punjab, Haryana, Gujarat and Maharashtra. These states use over 1,000 Kwh/ha for agriculture (Figure 25). Therefore, there is still scope for improvement in power availability.

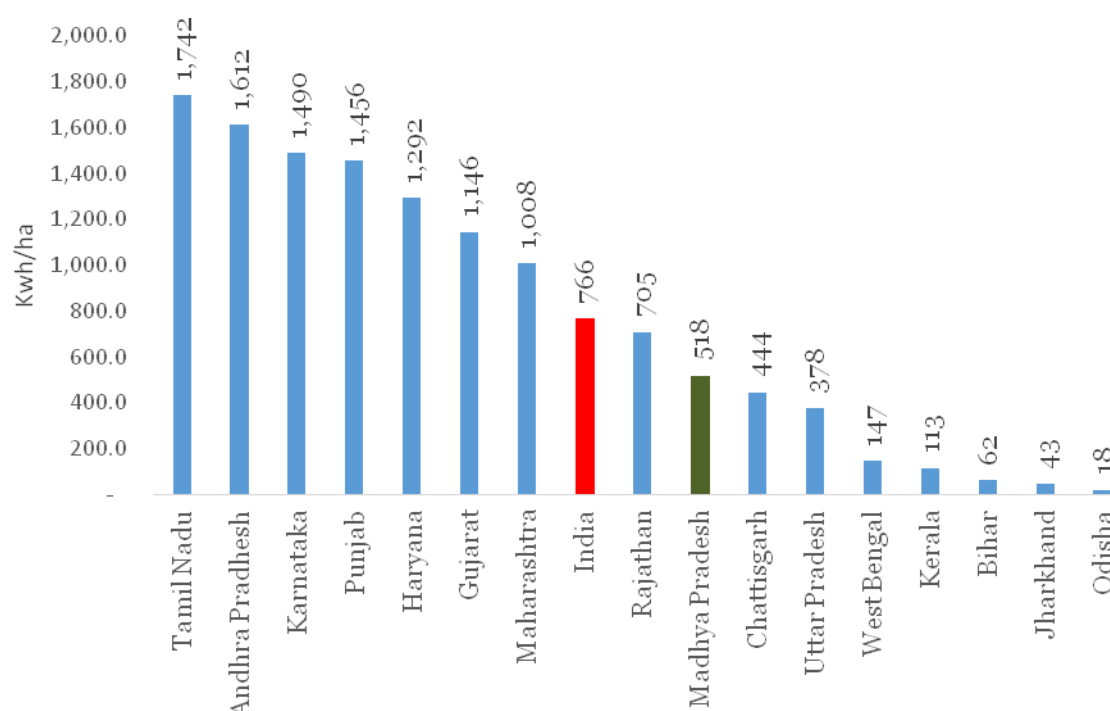
Figure 24: Agriculture Share in Total Power Consumption (2012-13)



Data available for all states up to 2012-13. *MP data taken from Agriculture Survey, 2016

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

Figure 25: Power Intensity (Power Sales/GCA (KWh/ha) TE 2012-13



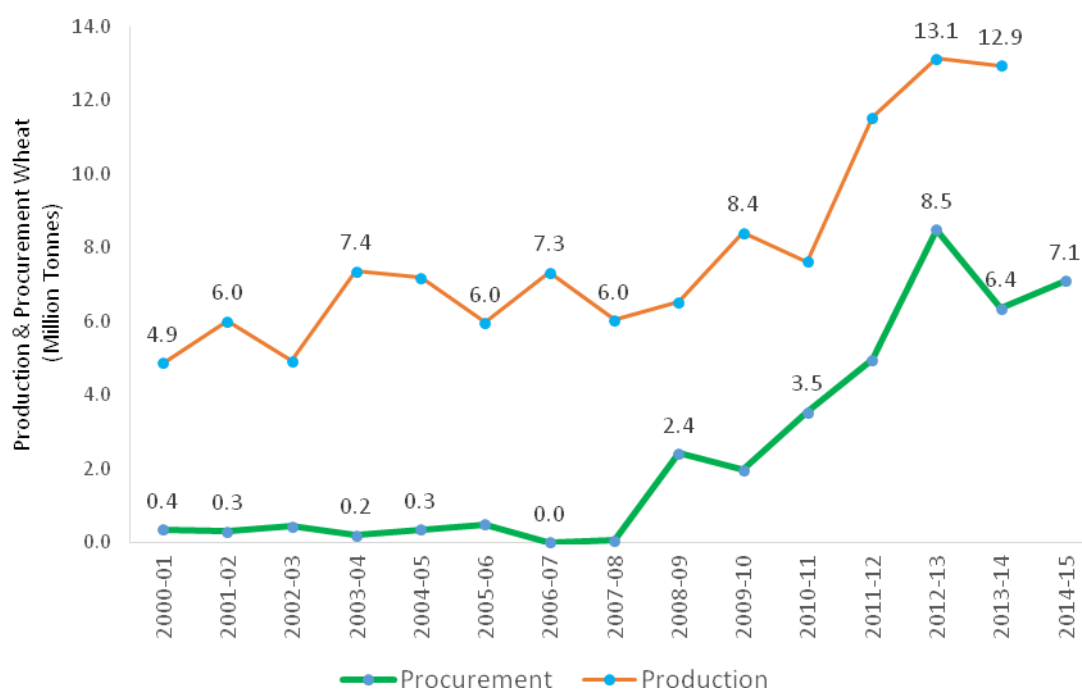
Source: Calculated from Planning Commission, Planning and Energy Division and Directorate of Economics & Statistics

5.2.3 Procurement System

Once assured water was made available for wheat cultivation through assured electricity during the 110 days of the wheat season, acreage and production of the crop increased significantly. Improved irrigation along with the Madhya Pradesh government's bonus policy on the minimum support prices (MSP) for wheat over and above the centre's MSP between 2007-08 and 2014-15 played a significant role in increasing production and procurement of wheat. State bonus on MSP over and above the centre's MSP for wheat between 2007-08 and 2012-13 was Rs 100 per quintal, while in 2013-14 and 2014-15, it was Rs 150 per quintal. Consequently, government purchases from the state swelled from around 2 per cent of total wheat procurement in TE 2002-03 to 24 per cent in TE 2013-14, making MP the second largest contributor to wheat procurement (Figure 27). However, wheat procurement as a percentage of marketed surplus was around 67 percent in MP as compared to 81 per cent in Punjab and 74 per cent in Haryana. This shows that despite giving a bonus on MSP, around 33 per cent of marketed surplus was not procured by public agencies, this means that in MP besides public agencies, even private sector procure wheat. The economic cost of procuring wheat by Food Corporation of India was around 32 to 43 percent higher than MSP during 2008-09 and 2013-14, mainly due to high procurement incidentals (market fees, development cess, arhatia commission, cost of gunny bags, charges to state governments for storage and interest etc.) and distribution cost. A major contribution of increasing procurement incidentals is high rates of statutory levies imposed on the market by states. High statutory levies add to the cost of procurement for FCI which ultimately add to the food subsidy bill.

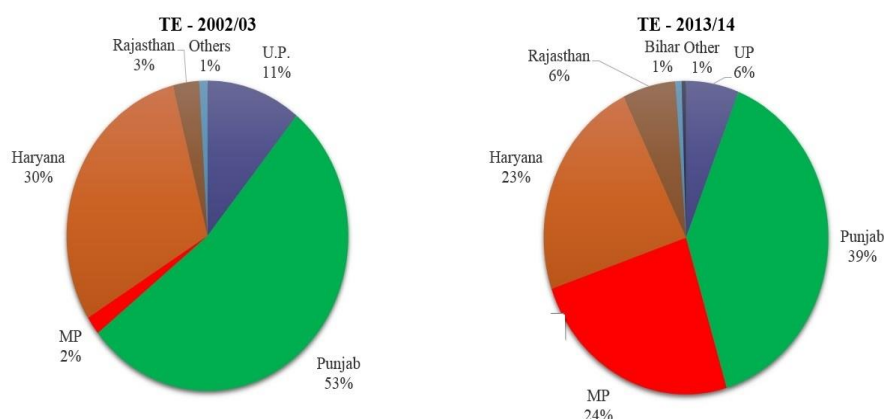
However, the revenues from the taxes/levies accrue to state governments account. Therefore, states have an incentive to keep these levies high. On the flip side, higher taxes deters private sector procurement and makes the state the largest buyer in the wheat market. Interestingly, of the three main contributor to the wheat procurement pool, Punjab and Haryana levies a tax of around 14.5 percent of MSP and 11.6 per cent of MSP respectively, while MP's rate of taxes was around 7 percent. The lower taxes in MP may have persuaded private trade to buy wheat from MP rather than Punjab or Haryana. Moreover, in Punjab and Haryana wheat procurement is mainly through Arhatiyas while in MP it is through cooperative societies. MP has been successful in organizing its procurement as a decentralised procurement system where wheat is procured by the state agencies and only the surplus wheat stocks over and above the state's requirement under Targeted Public Distribution System/National Food Security Act and other welfare schemes are taken over by FCI for dispatch to other consuming regions. In comparison, Punjab and Haryana follow a centralized procurement system, wherein state agencies procure wheat and then preserve the stocks under their custody for which carry over charges are paid to them. Later, FCI takes over the stocks for dispatch to consuming states as per requirement/movement plan.

Figure 26: Wheat Production and Procurement in MP



Source: Department of Food and Public Distribution and Directorate of Economics & Statistics (DES)

Figure 27: State-wise Wheat Procurement (%)



Source: Department of Food and Public Distribution and DES

While there was an increase in the production of wheat in the upstream segment of the value chain, markets in MP had poor market infrastructure to make correct forecast of the production levels and expected procurement. Consequently, once procurement started, markets were crowded with long queues of farmers wanting to sell their produce, leading to overcrowding and choking of roads leading to the markets and creating chaos. Moreover, manual payments to farmers through cheques led to delay, losses and corruption. In order to deal with these problems, the MP government re-modelled the procurement through digitisation. The 'e-Uparajan' initiative was conceptualised with the idea of regulating the number of farmers bringing their produce by maintaining records of farmers willing to sell at the MSP and allocating a date to each farmer through SMS. This programme's primary objective was to enable a smooth, regulated and efficient process of procurement.

Further, to facilitate procurement of food-grains, the Madhya Pradesh State Civil Supplies Corporation Ltd (MPSCSC) and MP State Co-operative and Marketing Federation in consultation with the state government made necessary procurement arrangement in the allotted procurement areas. Each district collector appoints societies to open their centres for procurement operation. The numbers of centres and their locations are decided by the district collector. For example, for wheat procurement, 2,967 procurement centres were in operation in Rabi 2015-16 while there were for paddy procurement 884 procurement centres in the same year.

The other related aspect of procurement is storage. In MP, there has been a steady increase in the average capacity and utilisation of warehousing services. In 1999-2000, the average owned capacity of the Madhya Pradesh Warehousing and Logistics Corporation (MPWLC) was 1,245.3 thousand MT; this had increased to 1,496.6 thousand MT in 2013-14. Despite this, in 2013-14, the total average hired capacity of MPWLC remained at 4,361.5 thousand MT and around 81 per cent of the total capacity was occupied. Thus, even though the storage

needs of the state were partially met, MPWLC has to establish enough storage capacity in order to rely less on hired capacity. The latest figures reveal that MP has created in total 181.3 lakh MT of storage capacity. The state government has introduced the “Warehousing and Logistics Policy 2012”, to promote the establishment of silos. Under this policy, the following incentives were provided.

- The state government will provide land on a licence basis for 30 years (extendable by mutual consent for another 5 years at a time subject to a maximum period of 10 years).
- The state government will also provide viability gap funding (VGF) up to a maximum of 20 per cent, if required, in addition to the 20 per cent VGF by the Government of India under the VGF Policy. However, projects availing of the benefit will not be eligible for capital investment subsidy and the interest subsidy. Moreover, the projects are mandated to be awarded through a transparent bidding process and are eligible for business guarantee for 10 years.

Besides, to increase storage capacity, the state has started building steel silos for food-grain storage in nine districts of Madhya Pradesh. Currently, steel silos account for 4.5 lakh MT of storage capacity in the state. MPWLC has also undertaken the building of steel silos through public-private partnerships on a design, build, finance, operate and transfer (the “DBFOT”) basis. For this purpose, global engineering, development and management consultants, Mott MacDonald, has been appointed by MPWLC to prepare the feasibility report for setting up of steel silos in the state.

The Madhya Pradesh government has also started using silo bags to provide temporary buffer capacity for the state’s crops during years of bumper harvest. This was in the wake of the unanticipated shortage of jute bags, despite a meticulously prepared plan for their purchase, to buy and store wheat during the wheat procurement period in 2012. Mechanised equipment is currently being used to fill grain into large bags which are then sealed shut on both ends to create dry and near-airless storage that acts as a barrier to pests and insects. Such sealed bags can be left on flat and open land for around 18-24 months. Currently, there are two companies in India that offer silo bags – Panama Agritech and Silobag India – both currently operating in Madhya Pradesh.⁶ Silo bags in MP are offered as an on-demand, pay per use service. Unlike warehouses or conventional silos where storage capacity needs to be bought and paid for in the long term, regardless of actual usage, silo bags are rented on a per ton, per month basis. Other benefits of silo bags that have been documented are the following

1) Silo bags allow farmers to deposit their loose grain directly for storage, eliminating the need to transport and weigh the grain several times, and reduces losses due to pilferage and wastage. In Madhya Pradesh, silo bag sites are temporarily declared as ‘mandis’ by the state government, so that farmers can directly bring their grain to the sites from farms.

⁶ <http://www.forbesindia.com/blog/enterprise/in-madhya-pradesh-a-different-kind-of-cloud-storage/>

2) Customers, whether government or private, can buy storage capacity in 2-4 weeks compared to the months and years that it takes to plan and erect warehouses or conventional silos.

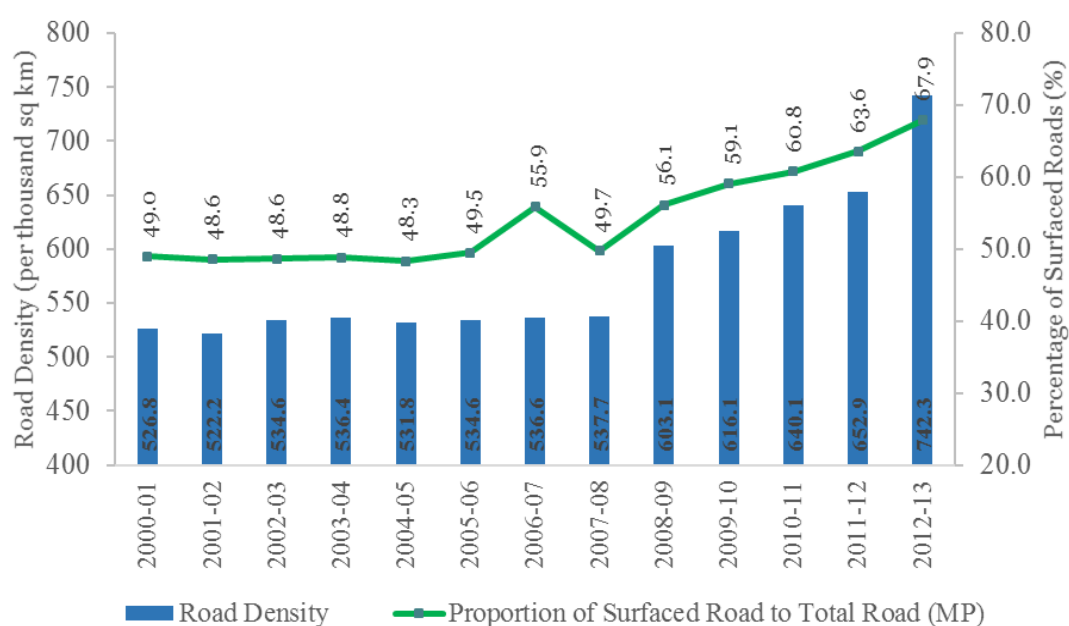
In MP, there is a pressing need to increase storage capacity due to the increasing procurement of food grains. Moreover, with the growing importance of horticulture in the state, there is also an urgent need to build storage infrastructure for fruits and vegetables because they are highly perishable. Before launching the National Horticulture Mission, the total capacity of multi-purpose cold storage facilities was over 7 lakh tonnes, of which over 50 per cent capacity was used for potatoes. Currently, the state has around 144 cold storages with storage capacity of 8.05 lakh MT.

5.2.4 Road Development

Roads play a very important role in the development of rural areas as it reduces transportation cost, increases competition, reduces marketing margins, connects input and output markets and improves farm incomes. Figure 28 shows that road density in MP has increased from 526.8 per thousand sq km in 2000-01 to around 742.3 per thousand sq km in 2012-13. Further, surfaced road as a percentage of total roads have increased from 49 per cent to 67.9 per cent in the same period. In the case of rural roads, the Mukhya Mantri Gramin Sadak Karyakrama (popularly known as the CMGSY) was launched to supplement the Prime Minister's Rural Roads Programme (PMGSY) in order to expedite connectivity of villages with urban areas. The CMGSY originated in order to provide road connectivity to each village of MP within the range of population between 250 and 500 which are not covered by the PMGSY till the year 2013. Mahatma Gandhi National Rural Employment Scheme (MGNREGA-MP), Backward Regional Grant Fund and state plan head are the three functional components for running the scheme of CMGSY. The scheme aims to provide employment under MGNREGA and also create durable assets in the rural areas of the state. This initiative by the state will result in an additional 19,386 km length of gravel roads in the state.

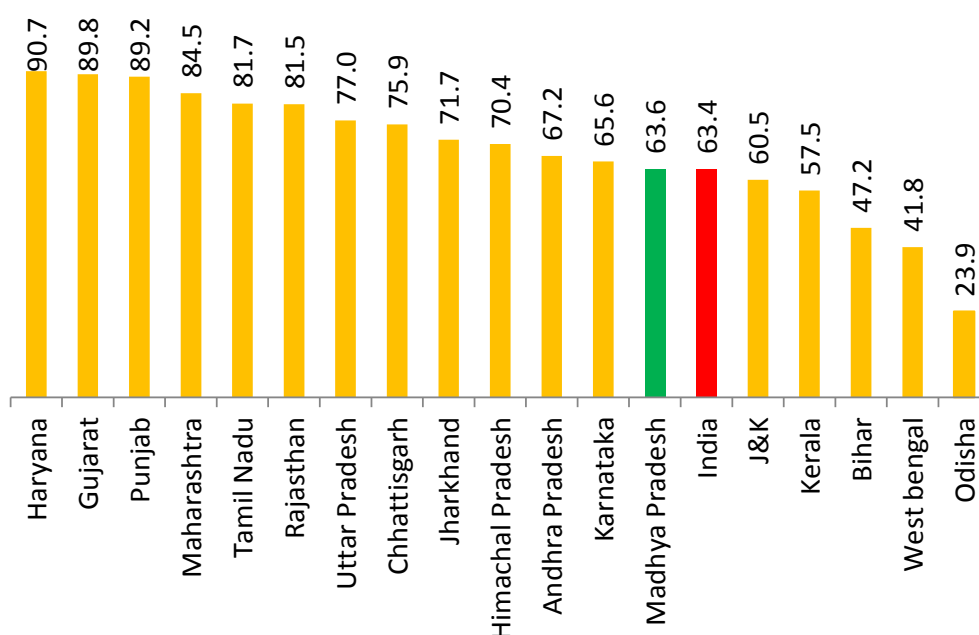
Despite making progress in rural road development, the state's road density is still lower than the national average of 1,317.8 per thousand sq km (2012-13). Moreover, surfaced roads as a percentage of total roads is much higher (above 89 per cent) in states like Haryana, Punjab, Gujarat amongst others (Figure 30); therefore, MP has potential to improve its road network further. In an attempt in this direction, the state has initiated a master plan for rural road construction, up gradation and maintenance. Under this master plan, the state has undertaken a 'District Rural Road Plan (DRRP)', which is a compendium of the existing and proposed road network system in a district. Through the DRRP, the state government is able to clearly identify proposed networks to connect unconnected habitations to already connected habitations.

Figure 28: Road Development in MP



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

Figure 29: Surfaced Roads-2011-12 (% of Total road length)



Source: Ministry of Roads, Transports & Highway, Several issues of Basic Road Statistics of India⁷

⁷ **Note: As per discussion with the Ministry of Roads, Transports & Highway, the Government of Odisha has reported 1,71,070 km road length as on 31st March 2011 to the Ministry of Road Transport & Highways under zilla parishad and panchayat samiti roads, without providing the category wise details, i.e., surfaced

5.2.5 Other Important Drivers of Agriculture Development

(i) Agriculture Mechanization

It is well accepted that the use of mechanised agricultural tools not only reduces the drudgery faced by farmers but also speeds up agricultural processes, saves costs and enhances agricultural productivity. Despite these benefits, farm mechanisation can become economically unviable if farm holdings are fragmented. In order to reap the benefits of mechanisation and, at the same time, address the problems of small farmers, the government of MP used a two-pronged strategy to increase the use of farm machinery in the state. The yantradoot village scheme and a scheme to incentivise rural youth to establish custom hiring centres have both contributed significantly to increased mechanisation in agriculture.

The yantradoot village scheme was started initially with district level officers of the Department of Agricultural Engineering periodically demonstrating the use of farm implements to farmers in 25 villages spread across 25 districts in the state and making these implements available on hire for the agricultural community at nominal prices. These 25 villages were selected on the basis of a baseline survey conducted to study farming practices, potential for introducing small cost incurring changes in current practices and identifying areas where the new agricultural equipment could be introduced. Once villages were identified, village meetings were organised and a community level plan was formulated to gradually introduce advanced machinery for various stages of farming. Village demonstrations in each of the 25 villages were conducted and appropriate agricultural tools for the particular season were displayed in the village common area. Agricultural officers provide direct information to farmers about various tools available and the associated benefits. This scheme currently has been scaled up to cover 139 villages as yantradoot gram (fully mechanised villages). The yantradoot village scheme aims to make each of these villages into models of agriculturally mechanised villages by using modern farm tools for each stage in the production of crops, starting from soil preparation for cultivation, removing weeds and destroying insect habitats from the field by deep ploughing, improving the fertility of the soil, maintaining the correct distance between rows of crops, promoting seed treatment and proper harvesting and threshing procedures.

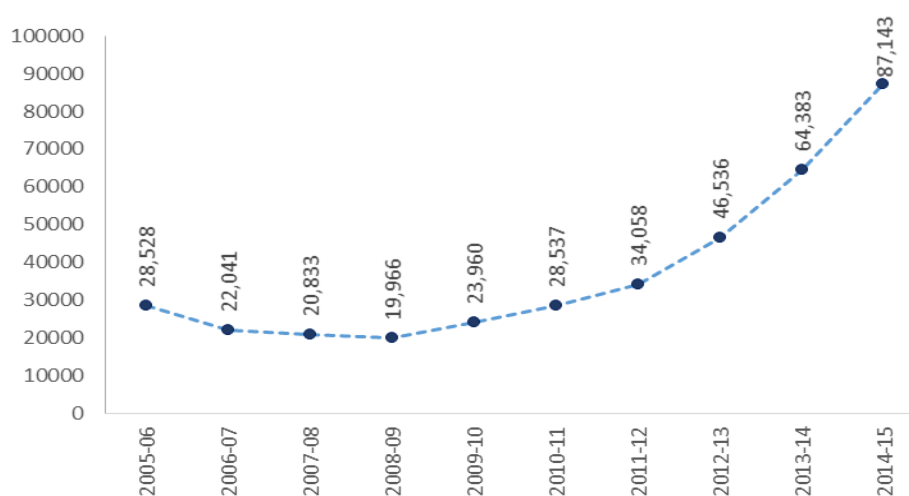
Further, to make costly farm equipment available to small farmers, the state government has been helping rural youth under 40 years with an undergraduate degree to set up custom hiring centres (CHC). It takes around Rs.25 lakh to establish a CHC. The government subsidises 40 per cent of the total cost, i.e., to a maximum amount of 10 lakh. Applicants are required to raise margin money of Rs.5 lakh and the rest is financed through bank loans. The applicant has to purchase a mandatory set of equipment required for farm activities from ploughing to

and un-surfaced road length. As the information was received late, the data was not incorporated in the Basic Road Statistics of India 2010-11. Since the Government did not provide data on panchayati raj roads in the subsequent years, the figure of 1,71,070 km was repeated in the Basic Statistics of India 2011-12, 2012-13, 2013-14 and 2014-15. In the absence of the surfaced and un-surfaced break-up, it got inadvertently incorporated in the surfaced category of roads in the 2012-13, 2013-14 and 2014-15 issues of Basic Road Statistics of India. Therefore, we have limited our analysis to 2011-12.

harvesting. Each centre is designed and developed to cover around 300 farmers in a radius of 10 kilometres. In the first year of the scheme (2012-13), around 286 CHCs were set up; the number increased to 475 in 2015-16.

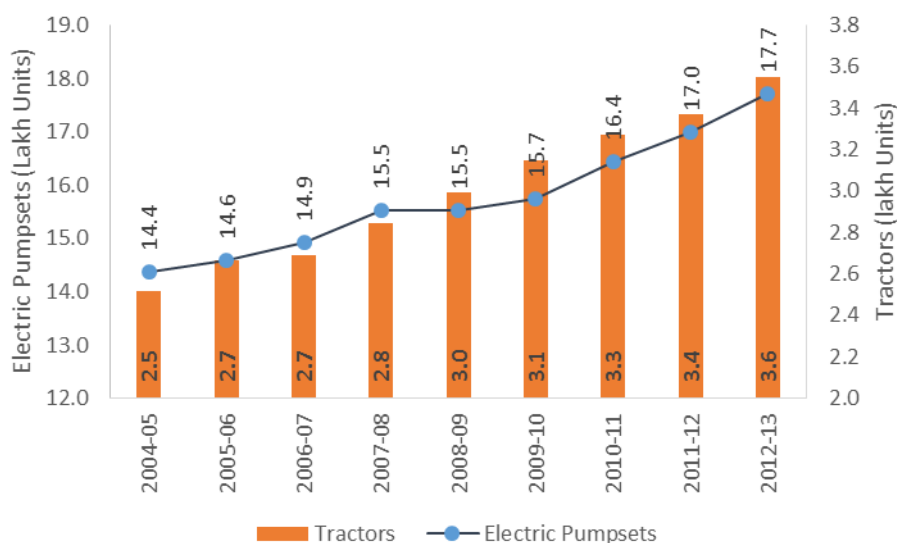
Consequently, the annual sales of tractors in MP increased by almost four fold during 2008-09 to 2014-15, from about 20,000 tractors a year in 2008-09 to more than 87,000 tractors in 2014-15 (Figure 30). Figure 31 also shows the spurt in the cumulative use of tractors from 2.5 lakh units in 2005-06 to 3.6 lakh units in 2012-13. Similarly, the number of electric pump-sets being used cumulatively, increased from 14.4 lakh units to 17.7 lakh units in the same period. Besides tractors and electric pump-sets, other machinery such as diesel pump-sets, power-driven sugarcane crushers, iron ploughs and bullock driven ploughs increased in MP.

Figure 30: Annual Tractor Sales in MP



Source: Tractors Manufacturers Association

Figure 31: Agriculture Machinery Cumulative use in MP



Source: GoMP, 2016

Besides the yantradoot village scheme and the scheme to incentivise the establishment of custom hiring centres, other state government schemes have also helped in increasing farm mechanisation in the state. Under the seed quality improvement programme, around 20,000 villages were provided with spiral graders and seed treating drums free of cost under RKVY. Further, to save the kharif crop from heavy rains, the ridge-furrow method of sowing is encouraged and 5000 seed drills equipped with ridge furrow attachments were distributed. The state government aims to provide spiral graders and seed treating drums in all 52000 villages for community use on a free of cost basis through Kisan Mitra/Didi (Madhya Pradesh Agriculture Economic Survey, 2016).

(ii) Agriculture Credit

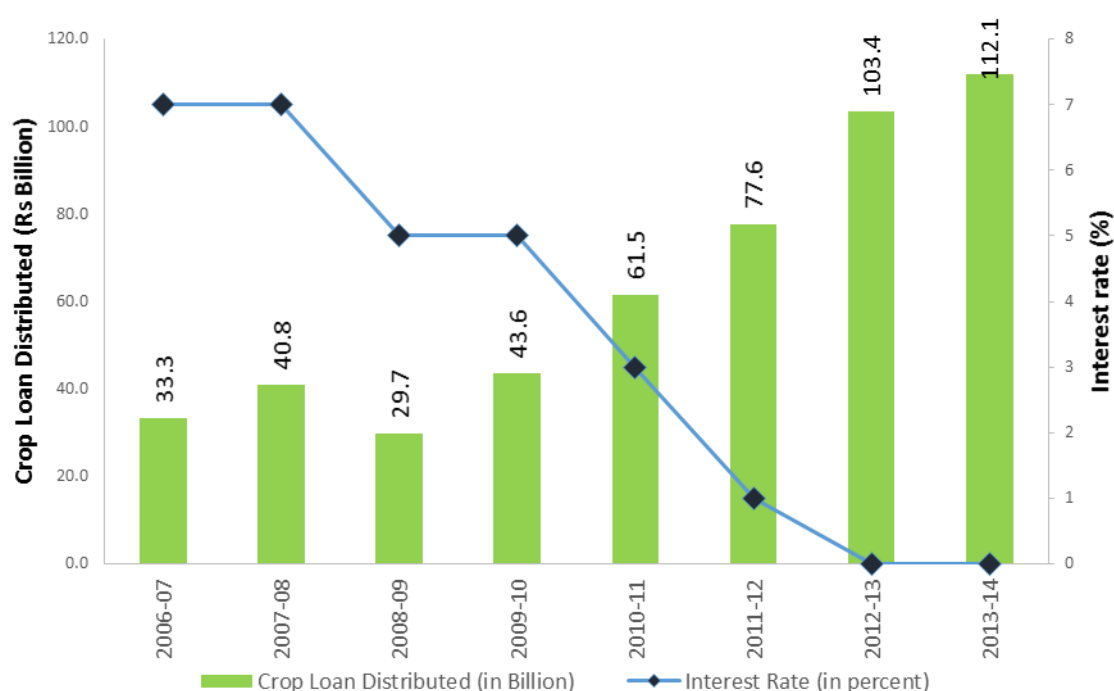
To create an efficient agricultural production base, farmers at the bottom of the agriculture value chain require well-timed working and investment capital. For example, farmers require timely working capital during the production season to buy inputs and hire labour and investment capital for farm equipment, buildings, storage facilities and transport. The inability to access finance at the right time can adversely affect the quantity and quality of output, ability to diversify production to stay competitive and to increase the farmer's share in the final value of the product (UNCTAD, 2004). However, banks are usually reluctant to finance agriculture due to commercial and systemic risks (or covariant risks, due to natural calamities, pests and diseases) associated with it, which could result in large scale losses. From a bank's perspective, demand-side constraints (e.g., repayment capacity, poor credit track record) and supply-side constraints (e.g., lack of information on the borrower, high transaction costs) further widen the agricultural financing gap (Subbarao, 2012). In order to address this financing gap and to meet the financing needs of farmers, the MP state government initiated a zero per cent interest rate scheme for the short term loans in 2012-13 through state owned co-operative banks. As on 2014-15, MP had one state co-operative bank (MPSCB), 38 district central cooperative Bank (DCCB), one state co-operative agriculture and rural development bank (MPSCARDB), and 38 district co-operative agriculture and rural development banks (DCARDBs). Further, it has 37 commercial banks and three regional rural banks (RRB). These banks have around 5,949 branches in the state (2012-13). Moreover, 4,530 primary agriculture credit societies (PACS) are also operational in the state.

As per the norm, while a farmer gets a crop loan at 0 per cent interest rate, the co-operative bank actually charge 11 percent interest, but 6 per cent of this is subsidised by the state government and remaining 5 per cent by the National Bank for Agriculture and Rural Development (NABARD). Before 2006-07, the interest rate chargeable to farmers was 16 to 17 per cent; it was reduced to 7 per cent in 2006-07, 5 per cent in 2008-09, 3 per cent in 2011-12 and finally to 0 per cent in 2012-13 (Figure 32). Consequently, disbursement of crop loans increased from Rs.33.3 billion in 2006-07 to Rs.112.1 billion in 2013-14. In 2012-13, interest subsidy of Rs.3.3 billion was made available to co-operative institutions by

the state government for around 30 million farmers. Further, a provision of Rs 5 billion was made in the departmental budget for interest subsidy in the year 2013-14.⁸

Additionally, the centrally sponsored kisan credit card (KCC) scheme provides agricultural credit to farmers at an interest rate of 7 per cent through commercial banks, co-operative banks and RRBs. Under this scheme, all farmers including small and marginal farmers, share croppers, oral lessees and tenant farmers are eligible for KCCs. Banks assess a farmer's eligibility on the basis of the cultivable land in their own names. This is a severe limitations for landless agriculture labourers, who often farm on leased land.

Figure 32: Short Term Agriculture Credit



Source: GoMP, 2016

5.3 Budgetary Allocation to Key Sectors

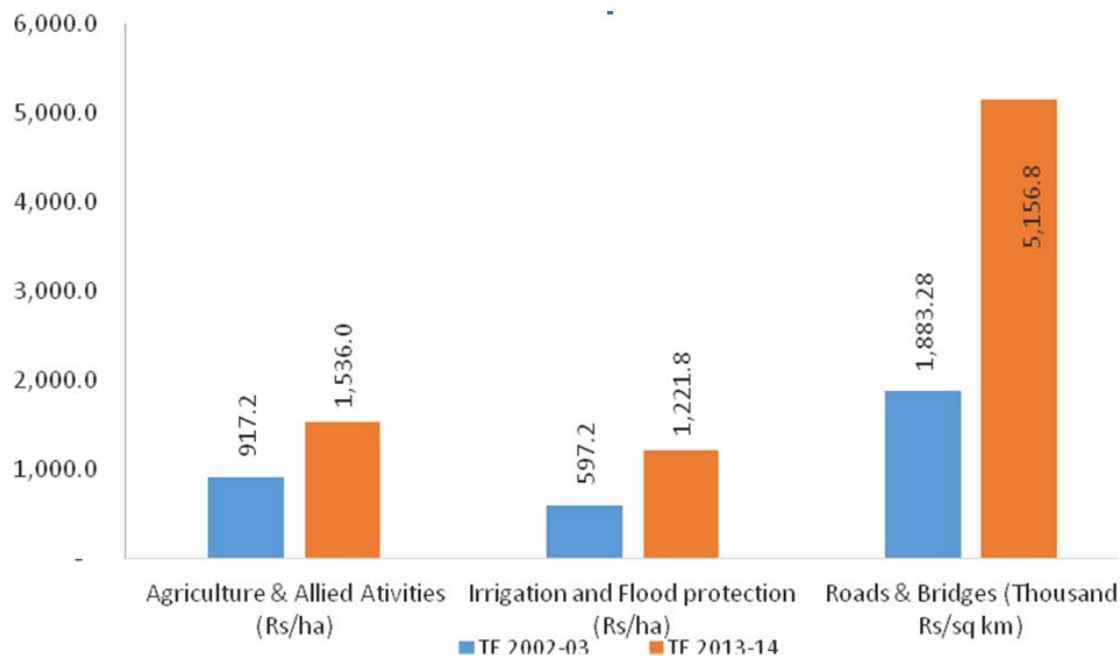
From the above discussion, it can be surmised that expansion of irrigation, both from surface sources, i.e. canal irrigation, and groundwater; improved availability and access to power for agricultural pump sets; strengthening the procurement machinery and expansion of storage facilities for food grains; a phenomenal expansion of the rural roads network to ensure connectivity; focus on farm mechanisation and the expansion of credit for purchase of agricultural inputs were the principle drivers of Madhya Pradesh's rise as one of the most agriculturally important states in the country. Further an analysis of the state's budget since the early 2000s shows that there was substantial increase in budgetary allocation to the agriculture sectors specifically irrigation, roads and food-storage and warehousing.

⁸ <http://www.cooperatives.mp.gov.in/en/achievements>

Allocation of resources to agriculture and allied activities in real terms (2004-05 prices) increased from Rs 16.8 billion in TE 2002-03 to Rs 35.7 billion in TE 2013-14, a CAGR of 3.4 per cent for the period 2000 and 2014. Consequently, the intensity as measured by expenditure on agriculture and allied activities as a percentage of GCA increased from Rs 917.2 per hectare in TE 2002-03 to Rs 1,536 per hectare. Moreover, in order to complete canal networks right to the tail end, budgetary allocation for irrigation and flood protections increased from Rs 10.9 billion in TE 2002-03 to Rs 28.4 billion in TE 2013-14 (in 2004-05 prices), a CAGR of 11.3 per cent for the given period. The intensity of irrigation expenditure per GCA almost doubled from Rs 597.2 per hectare to Rs 1,221.8 per hectare. Similarly, to prioritise road development, financial resources to this segment increased from Rs 5.8 billion in TE 2002-03 to Rs 15.9 billion in TE 2013-14 (in 2004-05 prices), a CAGR of 9.2 per cent. As a result, expenditure intensity for the roads and bridges increased from 1.9 million Rs per sq km in TE 2002-03 to 5.2 million Rs per sq km. Further, to expand storage facilities for food grains, the state government increased allocation for food storage and warehousing from Rs 2.8 billion in TE 2002-03 to Rs 9.4 billion in TE 2013-14 (in 2004-05 prices), a CAGR of 5.8 per cent for the aforementioned period.

It is clear from the above discussion that strategizing priority areas and backing it up with increased budgetary allocation was another crucial factors in bolstering agriculture development in MP.

Figure 33: Expenditure Intensity (in 2004-05 prices)



Note: ** Current prices were deflated using the WPI series at 2004-05 prices

Source: RBI, *State Finances: A Study of Budgets (several issues)*

6. Conclusion and Policy Implications

As mentioned in the previous section, the five main factors that have contributed to agricultural growth in Madhya Pradesh are (i) expanded irrigation through tube wells and canals; (ii) increased power supplies to agriculture; (iii) assured and remunerative price for wheat (including bonus over MSP) by strengthening wheat procurement system; (iv) expansion of all-weather roads and (v) suitable incentives and signals for the private sector for increasing the level of investments to reap the benefits of trunk infrastructure and improved services. Public investment in the development of infrastructure in the state (especially roads, power supplies and canal irrigation) has also played a vital role in transforming agriculture in MP. These findings have important policy implications for many other states like Bihar, Odisha, Uttar Pradesh, etc, which have ample scope to accelerate growth in their agriculture sector. While initiatives in each state will have to be designed to cater to local needs and priorities, the major take away from Madhya Pradesh's experience in agricultural development for moderate performing states can be summed up as follows.

- (i) Expansion of ground-water and surface water irrigation through assured power supplies to rural areas through power feeder separation.
- (ii) Establishment of a strong procurement system so that farmers can reap the benefit of the government minimum support price scheme.
- (iii) Investment in all-weather surfaced roads for efficient movement of products and inputs to and from rural areas; and linking farmers to processing units and consumers
- (iv) Public investments in key infrastructure such as improved power supply and better road connectivity to incentivise and attract private investment at the farm level in the form of increased investment in tube wells the expansion of area under horticulture, especially the adoption of high value crops such as seasonal vegetables, and the setting up of dairy units.

To sustain agricultural growth in Madhya Pradesh, the following points are worth considering:

1. Up to the XIth plan, irrigation potential created (IPC) as a percentage of ultimate irrigation potential (UIP) was 22.3 per cent for micro irrigation projects and 51.5 per cent for major and medium projects. There is still scope for investment in order to bridge the gap between IPC and UIP.
2. It is also noteworthy that MP has significant under-utilised sub-soil water resources in almost all regions, especially in the eastern part. There is a case for addressing power infrastructure and supply gaps in the eastern part on a priority basis to attract farm level investment in private tube wells to exploit available water resources. This is likely to result in an expansion in assured irrigation and promote both productivity growth in existing crops and diversification into horticulture.

3. Although road density in MP has increased over the years from 526.8 per thousand sq km in 2000-01 to around 742.3 per thousand sq km in 2012-13, it remains lower than the national average of 1,318 per thousand sq km. Besides surfaced road as a percentage of total roads in MP at 67.9 per cent is much lower than in states like Haryana, Punjab, Gujarat where the percentage of surfaced roads is over 89 per cent. Therefore, MP has the potential to improve its road network further.
4. The share of agriculture in total power sales is high (33.7 per cent) but total power sales/GCA is low, standing at 518 kwh/ha in TE 2012-13 as compared to states such as Tamil Nadu, Andhra Pradesh, Karnataka, Punjab, Haryana, Gujarat and Maharashtra that use over 1,000 Kwh/ha for agriculture. Therefore, there is still scope for improvement in power availability, which will increase up take of private irrigation.
5. With the increasing importance of the horticultural sector, there is a need to expand and strengthen infrastructure such as cold storage, warehouses, processing units and organized retail for value chain development. In particular, MP has emerged as the second largest producer of onions after Maharashtra in recent years but has been unable to fully leverage its proximity to the major consuming markets of northern India due to inadequate storage capacity. Addressing this gap through incentives to create storage facilities both at the farm level as well as organized cold storages based on solar power, will significantly enhance the capacity of the state's farmers to benefit from price differentials during lean supply months.
6. MP was among the first of the major states to remove horticultural produce from the monopoly of the Agriculture Produce Marketing Committee (APMC) controlled mandis in 2012. It needs to follow up this decision with policy incentives to attract private market yards offering electronic and sample based trading. This will bring bulk buyers, processors, exporters etc., to the state to source fresh produce and provide greater marketing choice to farmers. At present, MP is a net exporting state for fruits and vegetables, given its low urban population. Its favourable location, enabling quick access to both major northern and western urban markets, could be leveraged successfully with appropriate policy incentives.
7. A related issue in the agricultural marketing policy is the roll-out of the Government of India's e-NAM electronic marketing portal, where MP has been a relatively low key participant so far. Given the wide range of crops offered by the state and its location in the centre of the country, accelerated expansion of the e-NAM platform could benefit the farmers in due course in terms of increased selling choices. MP pioneered the e-chaupal initiative over a decade and a half ago with a private sector partner (ITC) and saw improved price realisation for soybean farmers. e-NAM is a public initiative and could bring benefits to a much larger number of farmers across a larger area, if patronised by the state and implemented after due assaying, grading of produce, and setting up an effective dispute settle mechanism between buyers and sellers.

8. We have already commended the role played by public procurement of wheat in incentivising area expansion, higher returns to farmers and other spin-off benefits. MP is well placed to replicate the model in the case of pulses, which is of critical importance to the rain-fed regions of the state, especially Bundelkhand and Baghelkhand regions and is the mainstay of smallholder agriculture in these regions. With the Government of India announcing a policy decision to create a buffer stock of 2 million MTs of pulses, MP can deploy its tested e-Uparjan initiative for the benefit of pulse farmers. Even if no bonus is paid over and above the MSP, it will result in large gains for the average cultivator of pulses by reducing their market risk. Public procurement of pulses is likely to see a repetition of some of the favourable outcomes witnessed in the case of wheat and is a low hanging fruit ready to be plucked.
9. Although milk production has increased from 4.8 million tonnes in 2000-01 to 10.8 million tonnes in 2014-15, milk productivity in the state is lower than in some of the other states. For example while MP's productivity in milk production stood at 0.8 MT per female animal per year, productivity in Punjab was 2.4 MT per female animal per year, Gujarat 1.1 MT, and UP 1.0 MT per female animal per annum. One of the factors for this low milk productivity could be the lower proportion of genetically superior cattle (crossbred). In Punjab, exotic/crossbred female cattle population as a proportion of the total female cattle population was around 91.5 per cent, while in MP, it was only 6.0 percent in 2012. The state needs to significantly scale up the population of crossbred/exotic female cattle population to improve milk productivity.
10. MP recently passed legislation to legalise agriculture tenancies, based on the model draft circulated by the Government of India. This is a major reform measure in a state that hitherto did not permit legal leasing of land. Implementation guidelines to follow up on the law have still to be issued. These should be released expeditiously to enable registration of tenancy under the new legal provisions. The new law should be publicised widely and a transparent dispute resolution mechanism put in place to build public confidence in this measure. Implemented fairly, the land leasing law could help increase investments in better technology and irrigation, as stable tenures and fair rents will encourage tenants to invest in productivity enhancing measures.
11. A large number of farmer producer organisations (FPOs) have emerged in the state in the past decade, thanks to progressive policies to encourage their growth. Some of these FPOs are now doing impressive work in agricultural production, marketing and value addition. The state has put in place a set of incentives to strengthen these farmer owned organisations through financial support, infrastructure building and relaxation of the provisions of the APMC Act. However, ready access to affordable working capital remains a challenge for many FPOs, given their weak equity base. Given that equity concerns are well addressed by such bodies, there is a justifiable case to enhance the level of public support to registered FPOs. Among the most effective measures would be a state level credit guarantee fund, which would provide comfort to all institutional lenders licensed by RBI for loans advanced to FPOs up to a limit (say Rs. 200 lakh).

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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[2004-05] (2011/12)	[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%	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	15.4%	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: Land-use Pattern

	Gross Cropped Area (Million Ha)		Gross Irrigated Area (Million Ha)		Cropping Intensity (%)	
	TE 1992/93	TE 2012/13	TE 1992/93	TE 2012/13	TE 1992/93	TE 2012/13
Bihar	10.0 (5.4)	7.5 (3.8)	4.1 (6.3)	5.0 (5.5)	132.8	140.8
Odisha	9.6 (5.2)	8.9 (4.6)	2.4 (3.7)	3.2 (3.5)	152.1	166.7
Uttar Pradesh	25.5 (13.8)	25.8 (13.2)	15.4 (23.6)	19.9 (21.9)	147.6	155.4
Gujarat	10.7 (5.8)	12.6 (6.5)	3.0 (4.6)	5.9 (6.5)	113.9	122.8
Punjab	7.5 (4.1)	7.9 (4.0)	7.1 (10.9)	7.7 (8.5)	179.6	190.1
Madhya Pradesh	23.6 (12.8)	22.6 (11.5)	4.7 (7.2)	8.2 (9.0)	121.1	148.1
India	184.5 (100.0)	195.9 (100.0)	65.2 (100.0)	91.1 (100.0)	129.6	139.1

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

For TE 2012-13, Odisha's data has been taken from Agriculture Statistics of Odisha due to inconsistent data in DES

Source: Directorate of Economics & Statistics and Several Issue of Agriculture statistics of Odisha

⁹ East UP 89% and West UP 88%

Table 3: Sources of growth: Sectoral composition of growth in GVO of agriculture and allied activities (2001-02 to 2013-14)

	Food-grains	Fruits & Veg	Oilseeds	Livestock	GVOA
2001-02	8.9	-3.5	2.1	1.4	10.5
2002-03	-7.9	0.9	-1.3	-0.1	-9.5
2003-04	11.5	-0.8	10.8	0.0	25.1
2004-05	-3.9	0.1	-3.9	2.0	2.0
2005-06	0.8	-0.5	2.9	1.6	5.1
2006-07	4.2	0.9	-1.2	-0.2	2.9
2007-08	-1.8	-0.1	2.9	0.4	3.9
2008-09	5.3	2.1	3.5	0.1	11.5
2009-10	4.5	0.7	3.2	1.9	11.4
2010-11	-5.5	0.9	-1.6	1.5	-3.4
2011-12	8.6	10.2	-0.6	1.7	27.5
2012-13	5.6	5.7	3.7	2.0	18.3
2013-14	-0.3	2.7	-4.1	1.7	1.5
Average growth (2001-02 to 2013-14)	2.3	1.5	1.3	1.1	8.2
Share of each segment in total growth in GVO	28.0	17.9	15.4	13.2	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.

Table 4: 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)
Gujarat	8.0 (9.7)	21.7	10.7 (6.7)	19.6	18.7 (7.7)	24.6
Uttar Pradesh	6.0 (7.2)	17.1	18.9 (11.8)	21.6	24.8 (10.2)	22.3
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
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)	15.0

**Figures in parenthesis are percentages of the total production of fruits and vegetables respectively in the country

Source: National Horticulture Database, several issues

Table 5: Livestock Population in MP and selected states (in percentage)

		2007				2012			
		MP	Gujarat	Punjab	Andhra Pradesh	MP	Gujarat	Punjab	Andhra Pradesh
Cattle	Females as a percentage of total cattle	53.0	55.8	75.9	50.2	58.0	67.8	82.1	58.4
	In-milk as a percentage of total female cattle	34.0	38.9	46.5	38.5	33.0	39.1	46.1	39.2
	Exotic crossbred as a % of female cattle	3.2	20.9	79.8	26.4	6.0	25.6	91.5	35.6
	Indigenous as a % of female cattle	96.8	79.1	20.2	73.6	94.0	74.4	8.5	64.4
Buffaloes	Females as a % of total buffaloes	82.6	88.4	89.8	84.1	84.3	92.0	89.7	87.3
	In-milk as a % of female buffalo population	38.3	39.2	45.0	41.9	38.9	37.0	42.4	40.5

Table 6: State-wise Meat production ‘000 tonnes

	2008-09			2011-12			CAGR 2008-09 to 2011-12		
	Poultry	Goat	Total Meat	Poultry	Goat	Total Meat	Poultry	Goat	Total Meat
Bihar	25.7 (1.4)	61.9 (7.9)	209.2 (4.9)	37.0 (1.5)	63.0 (6.9)	227.8 (4.1)	9.6%	0.4%	2.2%
Gujarat	15.5 (0.8)	1.6 (0.2)	19.5 (0.5)	31.0 (1.2)	1.4 (0.1)	35.3 (0.6)	19.0%	-3.9%	16.1%
Madhya Pradesh	10.9 (0.6)	9.6 (1.2)	34.1 (0.8)	13.0 (0.5)	10.8 (1.2)	39.4 (0.7)	4.6%	3.2%	3.7%
Odisha	53.0 (2.8)	46.3 (5.9)	118.3 (2.8)	62.0 (2.5)	52.3 (5.8)	137.9 (2.5)	4.0%	3.1%	3.9%
Uttar Pradesh	202.6 (10.8)	176.3 (22.4)	767.3 (17.9)	175.0 (7.0)	182.0 (20.0)	955.6 (17.3)	-3.6%	0.8%	5.6%
India	1,884.4 (100.0)	785.8 (100.0)	4,279.6 (100.0)	2,483.1 (100.0)	908.4 (100.0)	5,514.3 (100.0)	7.1%	3.7%	6.5%

Source: Basic Animal Husbandry & Fisheries Statistics, 2014

**Figures in parenthesis are share in total production of India's poultry, goat and total meat production respectively

Table 7: State-wise Milk Production ('000 MT)

	TE 2002-03	TE 2010-11	TE 2013-14	CAGR 2000-01 to 2013-14 (%)	Milch Animals 2007 Census [Cows and Buffaloes '000 Number]
Uttar Pradesh	14,597.7 (17.4)	20,257.0 (17.3)	23,360.0 (17.6)	4.10%	18,501.0 (14.5)
Gujarat	5,754.3 (6.9)	8,850.3 (7.6)	10,414.7 (7.8)	5.40%	7,655.0 (6.0)
Punjab	7,960.7 (9.5)	9,399.7 (8.0)	9,758.7 (7.4)	1.80%	3,851.0 (3.0)
Madhya Pradesh	5,129.0 (6.1)	7,178.7 (6.1)	8,862.0 (6.7)	5.10%	12,900.0 (10.1)
Bihar	2,674.0 (3.2)	6,191.7 (5.3)	6,894.7 (5.2)	7.90%	8,544.0 (6.7)
Odisha	915.3 (1.1)	1,640.0 (1.4)	1,768.7 (1.3)	5.50%	4,053.0 (3.2)
India	83,724.0 (100.0)	116,818.7 (100.0)	132,673.3 (100.0)	3.90%	127,390.0 (100.0)

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

Source: National Dairy Development Board

Table 8: 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 9: Correlation Matrix

	GDPA	Irrigation Ratio	Fertilizer Consumption (Kg/Ha)	Total Road	Terms of Trade**	MSP
GDPA	1.00					
Irrigation Ratio	0.93***	1.00				
Fertilizer Consumption (Kg/Ha)	0.80***	0.92***	1.00			
Total Road	0.94***	0.83***	0.72***	1.00		
Terms of Trade##	0.93***	0.85***	0.81***	0.97***	1.00	
MSP	0.88***	0.89***	0.92***	0.88***	0.92***	1.00
Procurement	0.78***	0.75**	0.75**	0.83***	0.84***	0.86***
SW Rain	0.80	0.76	0.77	0.80	0.85*	0.64

Agriculture deflator/non-agriculture deflator

*** Significant at 1% **Significant at 5% * Significant at 10 per cent ## Variables are in log form

All variables in log form

Source: Calculated by Authors

Table 10: OLS Results: Determinants of Agriculture Growth in MP

Period: 2000-01 to 2014-15	Model 1 GDPA	Model 2 GDPA
Irrigation Ratio (%)	0.98*** (0.24)	1.04*** (0.28)
Surfaced Road (%)	0.94*** (0.22)	
Terms of Trade (agriculture deflator/non-agriculture deflator)		1.65*** (0.53)
Constant	0.32 (2.1)	11.4*** (0.96)
R-squared	0.96	0.94
Adjusted R squared	0.96	0.94
Durbin-Watson D Statistics	2.9	2.3

*** Significant at 1 per cent, ** Significant at 5 per cent and * Significant at 10 per cent. Figures in parenthesis are robust standard error

Source: Estimated by Authors

Table 11: Augmented Dickey Fuller test (ADF)

Variable	Augmented Dickey Fuller Test	
	Level (t-stat)	First-Difference (t-stat)
Log(GDPA)	0.33	-6.11***
Log (Irrigation Ratio)	-1.5	-4.3***
Log (Total Road)	1.8	-2.6**
Log(Terms of Trade)	1.3	-3.5**

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

Source: Estimated by Authors

Table 12: 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	-1.76***	-47.34***	-1.33***	-4.22***

Source: Estimated by Authors

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