# Performance of Agriculture in
# UTTAR PRADESH
## REGION - WISE ANALYSIS

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| | |
|---|---|
| AIBP | Accelerated Irrigation Benefits Programme |
| AMUL | Anand Milk Union Limited |
| APEDA | Agricultural and Processed Food Products Export Development Authority |
| APMC | Agriculture Produce Market Committee |
| CAGR | Compound Annual Growth Rate |
| CGWB | Central Ground Water Board |
| CWC | Central Water Commission |
| DBT | Direct Benefit Transfer |
| DES | Directorate of Economics and Statistics |
| EBP | Ethanol Blending Programme |
| e-NAM | National Agriculture Market |
| ESY | Ethanol Supply Year |
| FCI | Food Corporation of India |
| FMD | Foot and Mouth Disease |
| FHP | Farm Harvest Price |
| FRP | Fair and Remunerative Prices |
| FSSAI | Food Safety and Standards Authority of India |
| FY | Financial Year |
| GCA | Gross Cropped Area |
| GCMMF | Gujarat Co-operative Milk Marketing Federation |
| GDDP | Gross District Domestic Product |
| GDDPA | Gross District Domestic Product Agriculture |
| GDP | Gross Domestic Product |
| GOI | Government of India |
| GoUP | Government of Uttar Pradesh |
| GSDP | Gross State Domestic Product |
| GSDPA | Gross State Domestic Product Agriculture |
| GSI | Global Subsidies Initiative |
| GVOA | Gross Value of Output in agriculture and allied activities |
| HYV | High Yielding Variety |
| IPC | Irrigation Potential Created |
| IPU | Irrigation Potential Utilised |
| IQF | Individual Quick Freezer |

| | |
|---|---|
| ISO | International Organisation for Standardization |
| ISMA | Indian Sugar Mills Association |
| KMS | Kharif Marketing Season |
| MFPS | Mega Food Parks Scheme |
| MoFPI | Ministry of Food Processing Industries |
| MSP | Minimum Support Price |
| NABARD | National Agricultural Bank for Rural Development |
| NAFED | National Agricultural Co-operative Marketing Federation of India Ltd |
| NCR | National Capital Region |
| NCDC | National Co-operative Development Corporations |
| NDDB | National dairy development Board |
| NFSM | National Food Security Mission |
| NFPM | National Food Processing Mission |
| NPK | Nitrogen Phosphorus Potassium |
| NSSO | National Sample Survey Organisation |
| PCDF | Pradeshik Co-operative Dairy Federation |
| PDMC | Per Drop More Crop |
| PM Kisan | Pradhan Mantri Kisan Samman |
| PM-AASHA | Pradhan Mantri Annadata Aay Sanrakshan Abhiyan |
| PMGSY | Pradhan Mantri Gram Sadak Yojana |
| PMKSY | Pradhan Mantri Krishi Sinchai Yojana |
| PPP | Public-Private-Partnerships |
| PSS | Price Support Scheme |
| RKVY | Rashtriya Krishi Vikas Yojana |
| RMS | Rabi Marketing Season |
| SAP | State Advised Price |
| TE | Triennium Ending |
| UDAY | Ujwal DISCOM Assurance Yojana |
| UP | Uttar Pradesh |
| UPA | United Progressive Alliance |
| UPLDB | Uttar Pradesh Livestock Development Board |
| UPPCB | Uttar Pradesh Pollution Control Board |
| WPI | Wholesale Price index |

# Foreword

Uttar Pradesh (UP) is the most populous state with a projected population of 234 million in 2022 (MoH&FW, 2019). As per the latest data available the state still employs more than half of its workforce (51.5 per cent) in the agricultural sector (PLFS, 2019-20). The state is also characterised by a high level of malnutrition (39.7 per cent) as compared to the all-India average of 35.5 per cent in 2019-21(NFHS-5).

While India recorded agricultural growth of 3.3 per cent per annum in the period from 2000-01 to 2020-21 (at 2011-12 constant prices), agriculture in Uttar Pradesh grew at a slower pace (2.5 per cent per annum). UP has a great potential to improve agricultural growth and farm income, however, the large inter-regional disparities dampen the state's overall agricultural growth rate. Against this backdrop, the study clusters districts in UP into four administrative regions – western, eastern, central, and Bundelkhand. These regions are diverse in agro-climatic characteristics, landholding structures, topography as well as institutional and socio-economic conditions. The present study attempts to evaluate the sources and drivers of agricultural growth across the state's four regions and thereby, formulate region-specific policies as one size fits all solutions are not enough to revitalise the state's overall agriculture sector. These policies aim to bring agricultural performance in the laggard regions at par with the other developed regions in UP.

The study finds that the livestock sector, particularly dairy is the major source of agricultural growth in the state as well as across the four regions. However, the processing of milk in the organised sector is very low despite UP being the largest producer of milk in the country (50 per cent produced in the western region in TE 2016-17). The state needs to set up processing capacity in the organised sector and encourage investments by private players to set up more processing units across all major milk-producing districts. UP is also the largest producers of sugarcane (mostly cultivated in western and some parts of the central region) and ethanol, and can significantly gain from ethanol production from sugarcane, particularly in eastern Uttar Pradesh where the water table is replenished every two years with a light flood. The eastern and western regions of the state are relatively well connected through rural roads and have higher access to adequate power which are important drivers of agricultural growth, while the central and, in particular, the Bundelkhand regions have lagged behind. In Bundelkhand, the leading sources of agricultural growth were livestock followed by vegetables, cereal and pulses, and oilseeds. Farmers in Bundelkhand predominantly grow pulses and oilseeds, given the low irrigation ratio in the region. However, the inadequacy of procurement operations under the price support scheme (PSS) limits farmers from receiving remunerative prices for their produce, therefore, the state government could incentivise private players in setting up processing units for pulses and oilseeds, particularly in the Bundelkhand region.

The findings of the study will hopefully attract the attention of policymakers and persuade them to introduce policy interventions at the regional level to deliver the best outcomes for farming households in the state. It is also hoped that the disaggregated analysis will lead to an informed debate among various stakeholders and help identify region-specific strategies to augment farm income and improve the state's overall agricultural performance.

Deepak Mishra,

Director& Chief Executive, ICRIER

# Preface

Uttar Pradesh, known as the 'granary of the nation', is the largest producer of wheat and the second-largest producer of rice in the country. The state is also the largest producer of sugarcane, mangoes, watermelon, gooseberry, potatoes, peas, milk and meat in 2016-17. Despite its contribution to the country's food security, agriculture in the state is characterised by low productivity, which demands targeting policies toward raising crop yields. The agricultural sector in Uttar Pradesh has been growing at a slower pace (2.5 per cent over 2000-01 to 2020-21) as compared to most other states. It is also one of the poorest states in India with 29.4 per cent of its population below the poverty line (Tendulkar Poverty Line, 2011-12).UP has more than 234 million people in 2022, only less than China (1.43 billion), India (1.42 billion), USA (338.3 million), Indonesia (275.5 million) and Pakistan (235.8 million) as per the UN population projections for 2022.

Against this backdrop, the report contributes to the existing literature on stimulating agricultural growth and augmenting farm income in UP. What differentiates the report from past studies is that the study delves into district-level data to look for factors limiting agricultural growth and development at the regional level as each region has its own uniqueness and requires a differentiated strategy to transform UP's agricultural growth trajectory. For the purpose of this study, UP has been divided into four regions: western, central, eastern and Bundelkhand. Based on the disaggregated analysis, we recommend region-specific policy interventions for balanced agricultural development across the four regions and also focus on reducing the backwardness of the Bundelkhand region.

The study evaluates the drivers and sources of agricultural growth across the state's four regions and formulates differentiated strategies for each region. We found that the shares of livestock, cereals and pulses, and sugarcane were dominant in the sources of growth in the western and central regions. In the Bundelkhand region, the share of livestock, vegetables, cereal and pulses, and oilseeds were the leading sources of agricultural growth. In the eastern region, the major sources of growth were livestock, cereals and pulses, and fruits and vegetables, followed by sugarcane. Evidently, the future of UP's agricultural prosperity lies in the high-value sectors of agriculture, particularly the livestock sector. Despite UP being the largest producer of milk, contributing 17.3 per cent to the total production in the country with the western region producing 50 per cent of the state's milk production in TE 2016-17, the productivity of milch animals and the proportion of output processed in the organised sector is quite low compared to other states such as Gujarat. Another major constraint faced by the dairy sector has been the inadequate budgetary support for increasing the dairy cold chain infrastructure in the state, particularly in the western region. Consequently, the enormous potential in the dairy sector remains unutilised in the major milk-producing regions of the state.

The study ran panel data regressions at both state and regional-level to identify the drivers of agricultural growth. Based on these findings, the report puts forth region-specific strategies to revitalise and overcome sluggishness in the state's agricultural sector. We found that the eastern and western regions of the state are comparatively well-connected through rural roads, having higher access to adequate power as well as water conservation technologies, while the central and, in particular, the Bundelkhand regions have lagged behind in these aspects. The lack of road connectivity in these regions restricts input delivery and the marketing of output, limiting both

agricultural growth as well as diversification to higher-value products. Particularly, Bundelkhand region with low investments in infrastructure and low access to assured irrigation, inadequate marketing and processing network contributes only 6 per cent to state's agricultural GDP, albeit the agricultural growth was highest in the region during 2002-03 to 2015-16. Moreover, this growth is characterised by high volatility due to recurring droughts and scanty rainfall in the region. In the water-scarce regions such as Bundelkhand and western UP, micro-irrigation techniques like drip and sprinkler systems of irrigation need to be promoted and incentivised by the state government under 'per drop more crop' scheme. According to the latest Ground Water Resource Assessment (2013) carried out jointly by the Central Ground Water Board (CGWB) and state governments, it was found that out of the 820 blocks assessed in Uttar Pradesh, 45 were semi-critical, 59 were critical and 113 were over-exploited (Lok Sabha Questions, 2017). Therefore, drip irrigation techniques need to be prioritised to promote efficient use of water resources, enhance productivity, and reduce irrigation cost and electricity consumption in these water scarce regions.

Importantly, the procurement of food grains by state agencies ensures good returns on wheat and rice production and works as an incentive to increase their production. During 2017-18 and 2018-19, the UP government succeeded in increasing wheat and rice procurement, but the procurement of pulses at MSP continues to be inadequate and inconsistent across the four regions. In regions with inconsistent procurement operations, the state needs to incentivise private players to invest in efficient value-chains that can provide remunerative prices for the small and marginal farmers. For instance, Bundelkhand farmers growing pulses and oilseeds can gain from agro-processing units in the region. Additionally, Bundelkhand farmers can gain by introducing short-duration and improved varieties of oilseeds and pulses to increase the production and yield of oilseeds and pulses.

Another important cash crop in UP is sugarcane, cultivated mostly in the western and central regions of the state. However, the state has not been able to realise its potential in the sugarcane sector due to the technological obsolescence of sugar mills and distortionary pricing policies. In recent years, sugarcane farmers in UP have been facing problems relating to the realisation of their dues from sugar factories on time. Mounting sugarcane dues have become the Achilles heel for the state and central governments. The report has suggested implementing the recommendation based on the Rangarajan committee (2012) to address the problem of sugarcane pricing in the state. Additionally, the sugarcane cultivation can be shifted from western to eastern UP which has a conducive agro-climatic zone for large-scale ethanol production on a sustainable basis. This will also help the country achieve 20 per cent of ethanol blending by 2025.

UP's agricultural sector strategy requires focused and targeted policy interventions to ensure access to basic infrastructure, particularly in the Bundelkhand and central regions of the state. The state has a large and diverse production base encompassing a wide range of fruits, vegetables and livestock products. Agro-processing and value-chain development are important areas that can help UP's agricultural sector diversify towards high-value agriculture such as vegetables, fruits and livestock and provide opportunities to farmers to sell their produce at competitive prices. In order to tap these opportunities, the state needs to strengthen commodity-specific value chain infrastructure according to each region's key sources of agricultural growth. We are confident that, with the region-specific strategy towards diversification, reforms in sugarcane pricing, and investments in rural infrastructure, particularly in Bundelkhand and Central regions, Uttar Pradesh can take a giant leap to achieve a much higher and sustainable agricultural growth.

Authors

# Acknowledgments

This report 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 agri-growth in the recent period. Gujarat and Madhya Pradesh have shown some extraordinary growth in their agriculture sectors (almost three times the all India agriculture growth) in the last decade or so. The key idea was to look for policy lessons from each other within the Indian context, and see how to propel growth in agriculture for faster alleviation of poverty.

Since UP is the fourth largest (240,928 square kilometres) and most populous state (234 million projected population in 2022) with substantial importance on India's food production, therefore, we try to study in greater detail the factors limiting agricultural growth in the state using district-level data. This report aims to provide a better understanding of how to improve agricultural performance at the regional level and put forth region-wise policy recommendations based on our findings.

We gratefully acknowledge the financial support provided by Bill and Melinda Gates Foundation (BMGF) for this important project. In particular, we would like to thank Mr. Hari Menon, Mr. Brantley Browning and Dr. Purvi Mehta from 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

The agricultural sector in Uttar Pradesh has a significant impact on the food security of the country. During 2002-03 to 2015-16 (at 2011-12 constant prices), the state registered an agricultural growth of 2.3 per cent per annum. Within the state, there are large regional variations in the growth pattern. For instance, Bundelkhand, a water-scarce region with poor soil quality, registered agricultural growth of 3.7 per cent per annum during the same period, followed by the western region (2.7 per cent per annum), central region (2.6 per cent per annum) and eastern region (1.6 per cent per annum). Although Bundelkhand registered a high growth during the study period, the growth rate has been volatile (measured by the coefficient of variation) due to recurring droughts and scanty rainfall.

The average income of the farming household in the state was the lowest in the country at Rs.6,668 per month in 2015-16, indicating the dismal agricultural scenario in the state (NABARD, 2018). Therefore, in the present paper, we examine the region-wise sources and drivers of agricultural growth and recommend region-specific policies to revitalise the agricultural sector and improve farm income across the four regions as well as the entire state. Specifically, using the panel data regressions for the state as well as the four regions during the period from 2004-05 to 2014-15, the study examines what are the key drivers that can stimulate the agricultural growth in the state and the regions towards a high trajectory.

Region-wise analyses highlight that the agricultural growth in the western, central and Bundelkhand regions significantly depend upon the basic infrastructure including adequate power to the agricultural sector, better road network, and irrigation development, though the variable power to agriculture was insignificant in Bundelkhand. For the eastern region, apart from basic infrastructure, the region's progress in diversifying into livestock, sugar and horticulture sectors was also one of the key drivers of agricultural growth. Agricultural research and development in the state need to encourage diversification towards high valued commodities for sustaining farm income and improving agricultural performance. The policies for diversification need to incentivise private players to set up efficient commodity-specific value-chains, particularly, in underdeveloped and low performing regions of the state, thereby, bringing parity in agricultural development across the four regions.

During 2017-18 and 2018-19, the state government succeeded in increasing wheat and rice procurement in the state, however, the procurement pulses and oilseeds at MSP continued to be low, which acted as a disincentive for investments by farmers in increasing their productivity. The study recommends that higher incentives may be required to attract investment in agro-processing of pulses and oilseeds, especially in Bundelkhand, to enhance agricultural growth and farm income in the region. Additionally, the collectivisation of producers, especially small and marginal farmers, into FPO can address many of the challenges farmers face, including improved access to inputs, investments, technology, and markets. To ensure the sugar sector's long-term financial health, particularly for farmers in the western region, the state needs to implement reforms in sugar pricing based on the Rangarajan Committee's (2012) recommendations.

# Executive summary

Spread over 240,928 square kilometres, Uttar Pradesh (UP) is the fourth largest state in the country by area. UP contributed 12 per cent to the country's agriculture gross state domestic product (GSDPA) in TE 2017-18 and one-fifth of the total food grain production in the country in TE 2016-17. Over 44.0 million tonnes of food grains were produced in an area of 19.9 million hectares in TE 2016-17 with a low food grain productivity of 2.2 tonnes/ha. Despite the state being in the fertile Indo-Gangetic plains with high soil fertility, and rich surface and groundwater resources, it still lags behind in agricultural growth and productivity.

Furthermore, the state is one of the poorest in India, with 29.4 per cent of the population below the poverty line, a level higher than the all-India poverty level of 21.9 per cent in 2011-12 (Planning commission, 2013). What is even more worrying is that the malnutrition level among children was as high as 39.5 per cent, higher than the national average of 35.8 per cent in 2015-16 (NFHS, 2015-16).

Given the importance of the agricultural sector in the state and the high incidence of poverty among farming households, the present study will delve into district-level data to examine what are the sources and drivers of agriculture growth across the different regions in the state. Based on the empirical analysis, we also propose policy recommendations and strategies to revitalise the agricultural sector at the regional and state level.

For the purpose of this study, we have divided the state into four administrative regions: western (30 districts), eastern (28 districts), central (10 districts) and Bundelkhand (7 districts). The population of the state in 2022 has been projected at 234 million. As per Census 2011, the eastern region is densely populated accounting for 40 per cent of the state's population, followed by the western region (37 per cent ), the central region (18 per cent )and the Bundelkhand region (5 per cent).

The examination of the agricultural profile of the state reveals that the western region accounts for half the state's agricultural GDP. It is followed by the eastern and central regions, with the Bundelkhand region's share being the lowest. The dominance of the western region in the state's agricultural output has been due to its distinct agrarian structure and better infrastructure and better irrigation facilities due to investment in private tube wells. However, the average annual agricultural growth rate of Bundelkhand, which has the lowest share in agricultural GDP among all the regions, has been 3.7 per cent in the period from 2002-03 to 2015-16 followed by the western region ( 2.7 per cent), central region (2.6 per cent) and eastern region (1.6 per cent). The agrarian distress in the Bundelkhand region, primarily because of recurring droughts and a low irrigation ratio, has led to high volatility in the region's agricultural growth.

The present study also decomposed the growth of the agricultural value of output to identify the sources of agricultural growth for the period from 2005-06 to 2015-16. The largest source of agricultural growth in UP was the livestock sector, which accounted for 41.1 per cent, followed by cereals and pulses (16.5 per cent), fruits and vegetables (11.5 per cent), sugarcane (9.0 per cent), fisheries (1.01 per cent) and oilseeds (0.69 per cent). Forestry, logging and other crops accounted for 20.3 per cent of the growth of the value of output in agriculture and allied activities. The shares of livestock, cereals and pulses, and sugarcane were dominant in the sources of growth in the western and central regions. In the Bundelkhand region, the share of livestock, vegetables, cereal and pulses, and oilseeds were the leading sources of agricultural growth. In the eastern region, the major sources of growth were livestock, cereals and pulses, and fruits and vegetables, followed by sugarcane.

The livestock sector, particularly dairy farming, has been a prominent source of growth in all four regions. Despite being the largest producer of milk (26.38 million tonnes in TE 2016-17) in the country, the processing of milk in the organised sector is very low in UP, which forces farmers to sell their produce in the unorganised sector at lower prices. Not just that, the milk and dairy processing units are located mainly in Agra, Mathura, Allahabad, Bareilly, Kanpur Nagar and Lucknow. Therefore, the state government needs to increase the milk

processing capacity in the state's organised sector and encourage investments by private players to set-up more processing units across all major milk-producing districts. Additionally, the state also needs to invest in extension services and marketing of dairy products in both rural and urban areas. UP has only three deep-frozen semen stations at Lucknow and Lakhimpur Kheri in the central region and Ghaziabad in the western region, which produce quality semen straws and maintain quality bulls for breeding. The state government needs to invest in artificial insemination and animal health facilities in the major milk-producing districts so that the facility is available at the doorstep of milk producers.

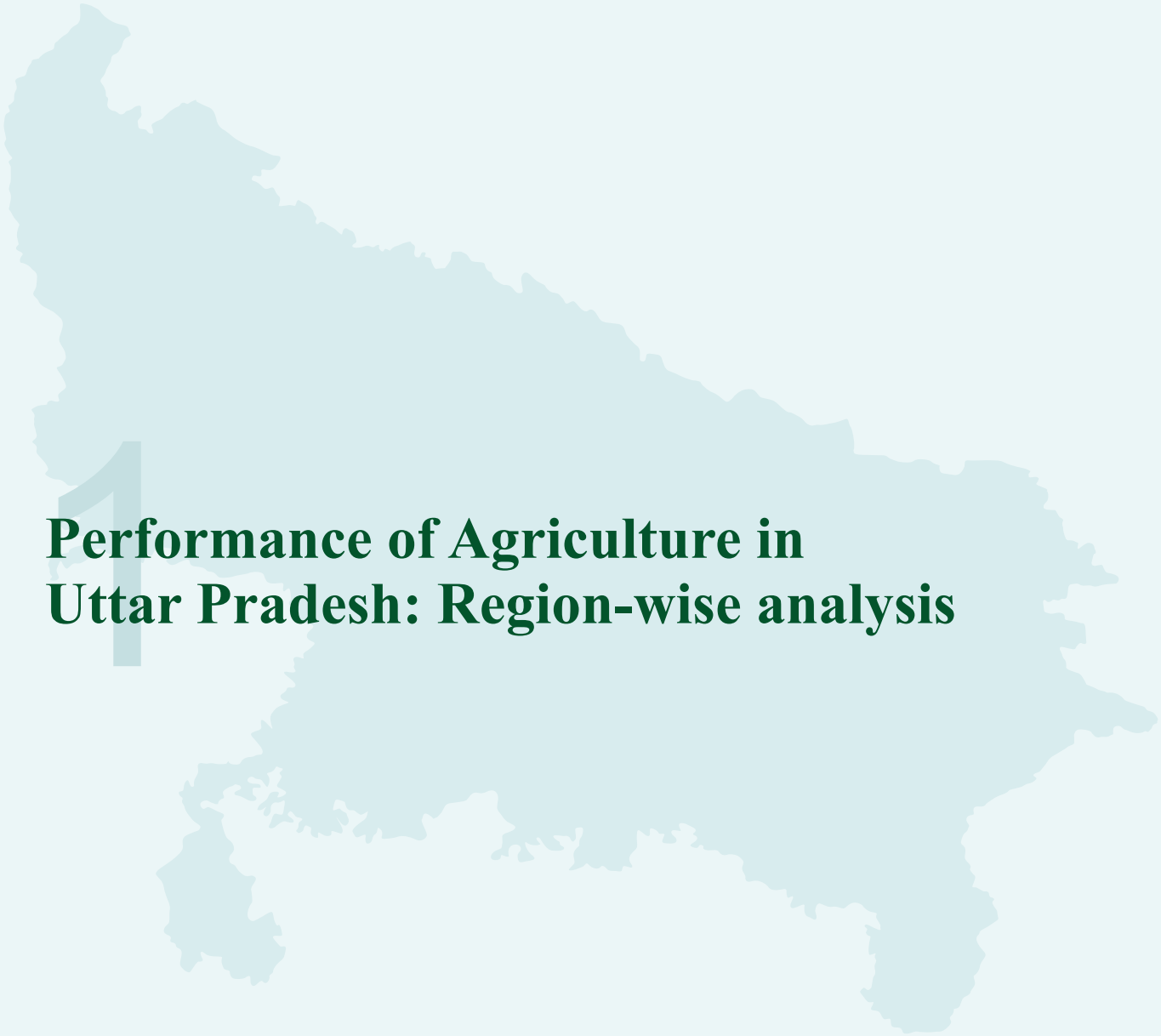
Another important concern in the state as well as the centre is the non-realisation of the value of the sugarcane crop, cultivated mostly in the western region and some parts of the central region of the state, In this regard, the state government needs to implement the recommendations of the Rangarajan Committee (2012) on sugarcane prices based on a combination of a minimum guaranteed price (fair and remunerative price) and a revenue-sharing formula.

The present study ran a panel data regression analysis for the period from 2004-05 to 2014-15 across 70 districts in Uttar Pradesh to determine the drivers of agricultural growth for the state. The analysis showed that agricultural growth depends significantly upon the irrigation ratio, surfaced road density and power intensity in the agricultural sector, and on diversification towards livestock. The study also ran fixed-effect models across the four regions to identify the crucial drivers of agricultural growth within each region. Irrigation ratio, surfaced road density, and power intensity in the agricultural sector have a strong impact on the gross value of output in agricultural and allied activities (GVOA) per hectare of gross cropped area in the western and the central region. In the Bundelkhand region, the study found irrigation and surfaced road density to have a strong and positive effect on agricultural growth. In the eastern region, basic infrastructures and diversification towards sugar, livestock, and fruits and vegetables were significant and positively impacted agricultural growth. Although the coefficients of diversification towards high-value agriculture were insignificant in the panel data regression in the western, central and Bundelkhand regions, our analysis of the sources of agricultural growth show agriculture in UP needs to diversify from cereal crops to high-value agriculture such as horticulture and animal husbandry.

Apart from rural infrastructure and diversification, UP's agricultural performance also depends on state agencies' institutional infrastructure, such as procurement operations. Procurement at minimum support prices provides farmers with an incentive to invest in improving agricultural productivity. However, farmers in UP have been facing inadequate and inconsistent procurement operations at the minimum support price. In the last two years (2017-18 and 2018-19), the state government has succeeded in increasing wheat and rice procurement. Still, the procurement of pulses and oilseeds at MSP continues to be low, which acts as a disincentive to invest in productivity yielding measures for farmers. The state government could incentivise private players in setting up processing units for pulses and oilseeds so that farmers can receive remunerative prices for their produce, particularly in the Bundelkhand region.

In addition to inconsistent procurement operations, the state also lacks adequate storage facilities, a robust transportation and marketing infrastructure. The eastern and western regions of the state are relatively well-connected through rural roads and having higher access to adequate power, while the central and, in particular, the Bundelkhand region have lagged behind. The disparity across the four regions has not only impeded agricultural growth but also caused sluggishness in the sector. The state government needs to intervene to ensure that production and marketing work together, which requires revamping the agricultural marketing sector by inviting private investment on a massive scale to upgrade value-chain infrastructure, storage and warehousing network in all four regions.

To conclude, UP has enormous potential to increase farm incomes and accelerate agricultural growth. But to do so, the state needs to focus on region-specific policies for balanced agricultural development across the four regions and focus on reducing the backwardness in the Bundelkhand region. This will be possible only if the state ensures a better road network, adequate power supply to the agricultural sector, investment in agro-processing and value-chains, and completion of irrigation projects, particularly in the state's backward regions.



# 1 Performance of Agriculture in Uttar Pradesh: Region-wise analysis

# Performance of Agriculture in Uttar Pradesh: Region-wise analysis

## 1 Introduction

The agriculture sector dominates Uttar Pradesh's economy, providing employment to 46.9 per cent of the total workforce (GOI, 2016). Around 77.7 per cent of the total population lived in rural areas in the state in 2011, which exceeded the national average of 68.8 per cent. In 2011-12, the poverty ratio in the state was 29.4 per cent, which was higher than the national average of 21.9 per cent. NABARD's (National Agricultural Bank for Rural Development) Financial Inclusion survey revealed that the average income of farming households in the state was only Rs.6,668 per month, lower than the national average of Rs.8,931 per month in 2015-16. In fact, it was the lowest in India, lower than in Jharkhand, Bihar, Odisha and Madhya Pradesh. Not just that, the prevalence of malnutrition among children was as high as 39.5 per cent, higher than the all-India average of 35.8 per cent in 2015-16 (NFHS-4).

The state has a significant impact on agricultural performance at the national level. UP contributed 12 per cent of the country's gross domestic product from agriculture and allied activities (GSDPA) at constant (2011-12) prices in TE 2017-18. The contribution of agriculture and allied activities to the gross state domestic product (GSDP) at constant (2011-12) prices was 21.3 per cent in TE 2017-18. The state's agricultural sector is important in the context of the country's food production and food security. The state had 15.8 per cent of the country's total area under food grain cultivation and contributed 16.9 per cent of its total food grain production in TE 2016-17. In 2016-17, UP was the largest producer of wheat, sugarcane, mangoes, watermelon, gooseberry, potatoes, peas, milk and meat.

The state needs focused attention to augment agricultural growth, increase farm incomes, and alleviate the state's high level of poverty. Given the importance of the agricultural sector, it is necessary to evaluate the sources and drivers of agricultural growth across the state's four regions. This is essential to formulate region-specific policies to revitalise the state's agriculture sector. The study is an effort in this direction.

Specifically, the objectives of this study are to:

(i) assess the agricultural landscape of Uttar Pradesh

(ii) study the performance of agriculture across different regions

(iii) examine the sources of agricultural growth across different regions

(iv) identify drivers of agricultural growth through regional analysis

(v) suggest region-specific policies and the way forward to accelerate agricultural growth

[1] *Poverty levels are for 2011-12, based on the Tendulkar poverty line.*

[2] *Malnutrition here is measured by the proportion of underweight children below 5 years of age in 2015-16 (NFHS 4).*

The report has been divided into 9 sections. Section 1 briefly discusses the objectives of the study, the profile of the state and regions, and its agro-climatic zones. Section 2 discusses the data and methodology used in the study. Section 3 examines the land use pattern across different regions in Uttar Pradesh. Section 4 evaluates agricultural performance across regions. Section 5 identifies the sources of agricultural growth as well as the contribution of each sector to the growth of the value of output in agriculture and allied sectors. Section 6 analyses the drivers of agricultural growth. The empirical analysis is discussed in Section 7. Section 8 discusses the summary of the findings, and section 9 gives the policy recommendations and the way forward.

### 1.1 Overview of Uttar Pradesh

Located in Northern India, the state is bound by Uttarakhand in the north, Haryana and Delhi in the north-west, Rajasthan in the west, Bihar and Jharkhand in the east and Chhattisgarh and Madhya Pradesh in the south. It is the fourth largest state in India, covering an area of 240,928 square kilometres, which accounts for 7.33 per cent of the country's total area. At present, it comprises 75 districts, 312 tehsils, 267 census towns and 1.06 lakh villages (Census 2011). The state is diverse in natural resources, climate, soil, topography and institutional and socio-economic conditions.

Based on its diverse topography, terrain and climate, the state is divided into nine agro-climatic zones. These include the Terai Region, western plain region, central-western region, south-western region, central plain region, Bundelkhand region, north-eastern plain region, eastern plain region and Vindhyan Region (see Figure 1.a). The north of the region is characterised by the Indo-Gangetic plains, whereas the south is characterised by the smaller Vindhya Range and the plateau region. The southern region is characterised by hard rock strata and a varied topography of hills, plains, valleys and plateaus. The alluvial plains are divided into three sub-regions: eastern, western and central regions.

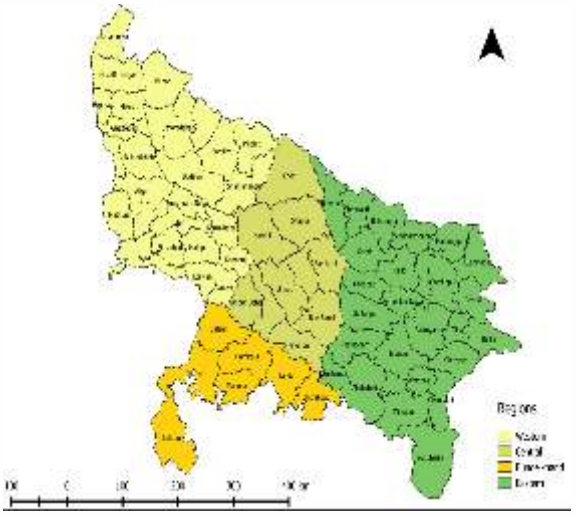
For the purpose of this study, we have divided the state into four administrative regions: western (30 districts), eastern (28 districts), central (10 districts) and Bundelkhand (7 districts) (Figure 1 b).[3] Much of the area in the state is covered by extremely fertile alluvial soils ranging from sandy to clayey loam. The southern part is characterised by mixed red and black to yellow soils. Bundelkhand is semi-arid, facing scarcity of water and has poor soil quality resulting in low crop productivity (Singh, 2001). The state's annual rainfall ranges from 600-1000 mm in the western region to 1000-1200 mm in the eastern region. The western and central regions have better irrigation facilities as compared to the other regions. The eastern region is flood-prone with the highest density of population and low per capita availability of land.

[3] *The detailed description of these four regions and their agro-climatic zones is given in Appendix (Table A1).*

## Figure 1: Agro-climatic Zones and Regions in Uttar Pradesh

**1.a. Agro climatic zones**


**1.b. Regions in UP**



*Source: Author's compilation*

*Note: Some districts name have changed in the later years such as Allahabad to Prayagraj and Faizabad to Ayodhya*

Uttar Pradesh is the most populous state in India, with a projected population of more than 234 million in 2022.[4] As per Census 2011, it had a population of 199.8 million, accounting for 16.5 per cent of India's total population.[5] The eastern region has 40 per cent of the state's population, followed by 37 per cent in the western region, 18 per cent in the central region and 5 per cent in the Bundelkhand region. The state has a population density of 829 persons per square kilometre, leading to heavy pressure on land. The western region has a population density of 930 persons inhabiting every square kilometre. The population density in the central, eastern and Bundelkhand regions is 785, 931 and 329 persons per square km, respectively (Census 2011). The share of the rural population is 68.6 per cent in the western region, 74.27 per cent in the central region, 87.81 per cent in the eastern region and 77.33 per cent in Bundelkhand. Appendix 2 illustrates region-wise demographic characteristics (see Table A2).

[4] *Population Projection for UP, Census 2001*

[5] *Only five countries in the world i.e. China, India, USA, Indonesia and Pakistan are more populous than UP as per the UN population projections for 2022.*

# 2 Data and Methodology

# Data and Methodology

In the present study, we examine the regional performance of the agricultural sector in UP along with the sources and drivers of agricultural growth. The study uses secondary data from the Directorate of Agriculture, Government of Uttar Pradesh; Statistical Abstracts of Uttar Pradesh; Directorate of Economics and Statistics, Government of Uttar Pradesh; District-wise Development Indicators, Uttar Pradesh, and Statistical Diary, Uttar Pradesh. We use district-level data on the gross value of output in agriculture and allied activities (GVOA) provided by the Economics and Statistics Division, State Planning Institute, Planning Department, Government of Uttar Pradesh to analyse the sources of agricultural growth. The data on district-wise road statistics are provided by the Public Works Department, Uttar Pradesh.

The study also uses data from the Ministry of Agriculture and Farmers' Welfare, the Directorate of Economics and Statistics (DES) of the Government of India, the Census of India, National Accounts Statistics, Central Statistical Organisation, Fertiliser Association of India and the Agricultural Census 2000-01 and 2015-16.

To identify the sources of agricultural growth across the four regions in UP, we decompose the gross value of the output of agriculture and allied activities into different sectors across the four regions in Uttar Pradesh. We deflate the current series of the gross value of output in agriculture and allied activities by the WPI of all commodities at 2011-12 prices to calculate the sources of agricultural growth. We then calculate the year-on-year growth of each segment as a proportion of the previous year's GVOA from agriculture and allied activities.

The study evaluates the drivers of agricultural growth using panel data regression analysis across 70 districts[6] from 2004-05 to 2014-15. A fixed-effects model has been used to see the effect of different drivers of agricultural growth on the gross value of output per hectare. We run the Hausman test to determine whether the random effect or fixed-effect model fits the panel data. To identify the drivers within each region, the study has run different sets of panel data regression separately for each region. The variables have been selected by analysing the Karl Pearson correlation matrix.

[6] *Shamli, Amethi, Sambhal and Kansanj have not been included for the panel data analysis as the data for these newly formed districts is not available from 2004-05 onwards.*

# 3 Land Use Pattern in Uttar Pradesh: Regional Variation

# Land Use Pattern in Uttar Pradesh: Regional Variation

Uttar Pradesh's economy is predominantly agrarian, covering a sizeable part of the highly fertile Upper Gangetic Plains. The state's gross cropped area increased from 25.02 million hectares in TE 2002-03 to 25.95 million hectares in TE 2014-15. About 75 per cent of the total land available in the state was used for agriculture in the western region, 67 per cent in the central region, 68 per cent in the Bundelkhand region and 63 per cent in the eastern region in TE 2014-15. The total land unavailable for cultivation was around 13.8 per cent in the western region, 14.3 per cent in the central region, 12.5 per cent in the Bundelkhand and 15.4 per cent in the eastern region in TE 2014-15. There has been a marginal increase in land unavailable for cultivation in the period from TE 2002-03 to TE 2014-15 across all the regions in the state. The area under forest ranged from 4.8 per cent in the western region to 9.0 per cent in the eastern region in TE 2014-15 (see Table 1).

**Table 1: Land-use in Uttar Pradesh: TE 2002-03 and TE 2014-15**

| Regions | Forests (%) | Not Available For Cultivation (%) | Other Uncultivated Land Excluding Fallow Land (%) | Fallow Land (%) | Net Sown Area (%) | Reporting Area For LUS (%) |
|---|---|---|---|---|---|---|
| **TE 2014-15** | | | | | | |
| Western Region | 4.8 | 13.8 | 2.1 | 4.3 | 75.1 | 100 |
| Central Region | 5.4 | 14.3 | 3.7 | 10.0 | 66.7 | 100 |
| Bundelkhand | 8.2 | 12.5 | 4.7 | 5.6 | 68.9 | 100 |
| Eastern Region | 9.0 | 15.4 | 3.8 | 8.3 | 63.4 | 100 |
| State Total | 6.9 | 14.3 | 3.3 | 7.0 | 68.6 | 100 |
| **TE 2002-03** | | | | | | |
| Western Region | 4.5 | 12.5 | 2.6 | 4.7 | 75.7 | 100 |
| Central Region | 5.7 | 12.8 | 4.7 | 10.8 | 66.1 | 100 |
| Bundelkhand | 9.1 | 11.5 | 5.4 | 7.0 | 67.0 | 100 |
| Eastern Region | 9.3 | 13.6 | 4 | 7.6 | 65.5 | 100 |
| State Total | 7.0 | 12.8 | 3.9 | 7.2 | 69.2 | 100 |

*Source: Directorate of Economics and Statistics (DES), GOI*

The state's gross cropped area per 100 persons has declined from 15.1 ha per 100 persons in TE 2002-03 to 13 ha per 100 persons in TE 2014-15. In the western region, GCA per 100 persons declined from 15.6 ha per 100 persons to 13.3 ha per 100 persons. It declined from 14.7 ha per 100 persons to 12.7 ha per 100 persons in the central region and from 13.1 ha per 100 persons to 10.9 ha per person in the eastern region in the same period. However, GCA per 100 persons increased from 28.3 ha to 29.2 ha in the Bundelkhand region. The declining

GCA per 100 persons underscores the increasing pressure of population on agricultural land in the state and the declining ability to generate surpluses from area expansion. Table 2 highlights the fact that the eastern region has the least land available per person for cultivation. For the state, the cropping intensity increased from 149.4 in TE 2002-03 to 156.6 in TE 2014-15, highlighting the efficient use of agricultural inputs and increase in cropping intensity. The cropping intensity was the highest in the western region (163.6) followed by the eastern region (157.1) and central region (154.3). It was the lowest in the Bundelkhand region (138.3). Table 2 highlights an increase in cropping intensity across all regions in the state for the period. Given the declining availability of land per person, increasing cropping intensity is a good measure to increase production in the state. Increasing cropping intensity requires eliminating the problems of the excessive soil moisture in surface irrigated areas, the inadequacy of power supply in the well-irrigated area, and water stress in rain-fed areas.

**Table 2: Agricultural Land-Use in Uttar Pradesh**

| Regions | Total GCA (million Ha) | Cropping intensity | GCA per 100 persons (ha/100 persons |
|---|---|---|---|
| **TE 2014-15** | | | |
| Western Region | 9.87 | 163.6 | 13.3 |
| Central Region | 4.58 | 154.3 | 12.7 |
| Bundelkhand | 2.82 | 138.3 | 29.2 |
| Eastern Region | 8.68 | 157.1 | 10.9 |
| State Total | 25.95 | 156.6 | 13.0 |
| **TE 2002-03** | | | |
| Western Region | 9.54 | 156.0 | 15.6 |
| Central Region | 4.45 | 148.1 | 14.7 |
| Bundelkhand | 2.33 | 117.6 | 28.3 |
| Eastern Region | 8.71 | 154.2 | 13.1 |
| State Total | 25.02 | 149.4 | 15.1 |

*Source: Directorate of Economics and Statistics (DES), GOI*

Table 3 shows the region-wise operational holding and area by size in the state. In 2015-16, 92.8 per cent of landholdings were small and marginal, accounting for 65.7 per cent of the area. In 2015-16, 90.4 per cent of the landholdings were small and marginal, accounting for 61.5 per cent of the area in the western region. In the central region, 94.3 per cent of the landholdings were small and marginal, accounting for 72.1 per cent of the area. In Bundelkhand, 79.3 per cent of the landholdings were small and marginal landholdings, accounting for 40.9 per cent of the area. In the eastern region, 95.8 per cent of landholdings were small and marginal, accounting for 75.4 per cent of the area. Due to fragmentation of holdings, the area under small and marginal holdings increased in 2015-16 as compared to 2000-01. The eastern region has a comparatively higher share of small and marginal landholdings, and Bundelkhand a higher share of larger landholdings across the four regions.

## Table 3: Region-wise Operational Holdings, Area by Size Group & Average Holding Size in U.P

| Region | Number of land Holdings (%) | | | | | | Area of the land holdings (%) | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Marginal Holding (less than 1 ha) | Small holdings (1-2 ha) | Semi-Holdings Holdings (2-4 ha) | Medium medium (4-10 ha) | Large Holdings (Above 10 ha) | Total Holdings | Marginal holdings (less than 1 ha) | Small holdings (1-2 ha) | Semi-Holdings holdings (2-4 ha) | Medium medium (4-10 ha) | Large Holdings (Above 10 ha) | Total Holdings | Holdings Size (ha) |
| **2000-01** | | | | | | | | | | | | | |
| Western Region | 70.72 | 17.50 | 8.78 | 2.86 | 0.14 | 100 | 30.08 | 26.06 | 25.42 | 16.33 | 2.10 | 100 | 0.96 |
| Central Region | 77.71 | 14.58 | 6.00 | 1.63 | 0.07 | 100 | 41.40 | 25.72 | 20.34 | 11.11 | 1.43 | 100 | 0.80 |
| Bundelkhand Region | 53.82 | 23.60 | 14.25 | 7.51 | 0.83 | 100 | 16.79 | 22.00 | 25.34 | 28.49 | 7.37 | 100 | 1.56 |
| Eastern Region | 84.18 | 10.47 | 4.20 | 1.07 | 0.09 | 100 | 48.73 | 22.47 | 17.38 | 9.08 | 2.34 | 100 | 0.65 |
| Uttar Pradesh | 76.88 | 14.25 | 6.59 | 2.14 | 0.15 | 100 | 36.97 | 24.28 | 21.72 | 14.35 | 2.69 | 100 | 0.83 |
| **2015-16** | | | | | | | | | | | | | |
| Western Region | 74.87 | 15.57 | 7.48 | 2.01 | 0.08 | 100 | 35.50 | 25.98 | 24.24 | 12.87 | 1.41 | 100 | 0.84 |
| Central Region | 81.95 | 12.31 | 4.59 | 1.10 | 0.05 | 100 | 47.07 | 25.05 | 18.05 | 8.68 | 1.14 | 100 | 0.68 |
| Bundelkhand Region | 56.35 | 22.91 | 13.54 | 6.60 | 0.60 | 100 | 18.56 | 22.36 | 26.28 | 26.91 | 5.90 | 100 | 1.43 |
| Eastern Region | 86.53 | 9.23 | 3.40 | 0.78 | 0.06 | 100 | 53.65 | 21.77 | 15.65 | 7.33 | 1.60 | 100 | 0.58 |
| Uttar Pradesh | 80.18 | 12.63 | 5.51 | 1.58 | 0.10 | 100 | 41.82 | 23.92 | 20.40 | 11.89 | 1.97 | 100 | 0.73 |

*Source: Agricultural Census 2000-01 & 2015-16*

It is evident from Table 3 that the average landholding size between 2000-01 and 2015-16 has declined for the state as well as across regions. At the state level, the average landholding size has fallen from 0.83 hectares in 2000-01 to 0.73 hectares in 2015-16. Table 3 reiterates the fact that per capita land availability is the lowest in the eastern region, and has declined from 0.65 hectares in 2000-01 to 0.58 hectares in 2014-15.

## 3.1 Cropping Pattern in Uttar Pradesh

The varied agro-climatic conditions and fertility of soil in different regions has enabled a highly diversified basket of farm produce in the state. A large part of the western, central, and eastern regions are located in the alluvial Indo-Gangetic belt. The Bundelkhand region, on the other hand, is located in the Central Plateau region and has rocky terrain and low rainfall.

In Uttar Pradesh, around 69 per cent of the cropped area in TE 2014-15 was under cereals and millets, which included 23 per cent under rice cultivation and 38 per cent under wheat. Given the irrigation facilities, mechanised farming operations and assured access to the market, farmers in Uttar Pradesh, especially in the Indo-Gangetic plains, stick to a rice and wheat cycle. Pulses accounted for 9.1 per cent of the gross cropped area. Gram and tur (arhar) occupied a major portion of the area under pulse cultivation in the state. An important cash crop of the state is sugarcane, accounting for about 8.6 per cent of the cropped area. Over the years, sugarcane cultivation has increased with the expansion of irrigation and assured prices. Fruits and vegetables occupied 4.3 per cent of the area under cultivation. Potato is widely grown and the state is the largest producer of potato. Around 4.4 per cent of the area was under oilseed cultivation in TE 2014-15. Among oilseeds, rapeseed, mustard, groundnut, sesame and linseed are the most important crops in the state (Figure 2).

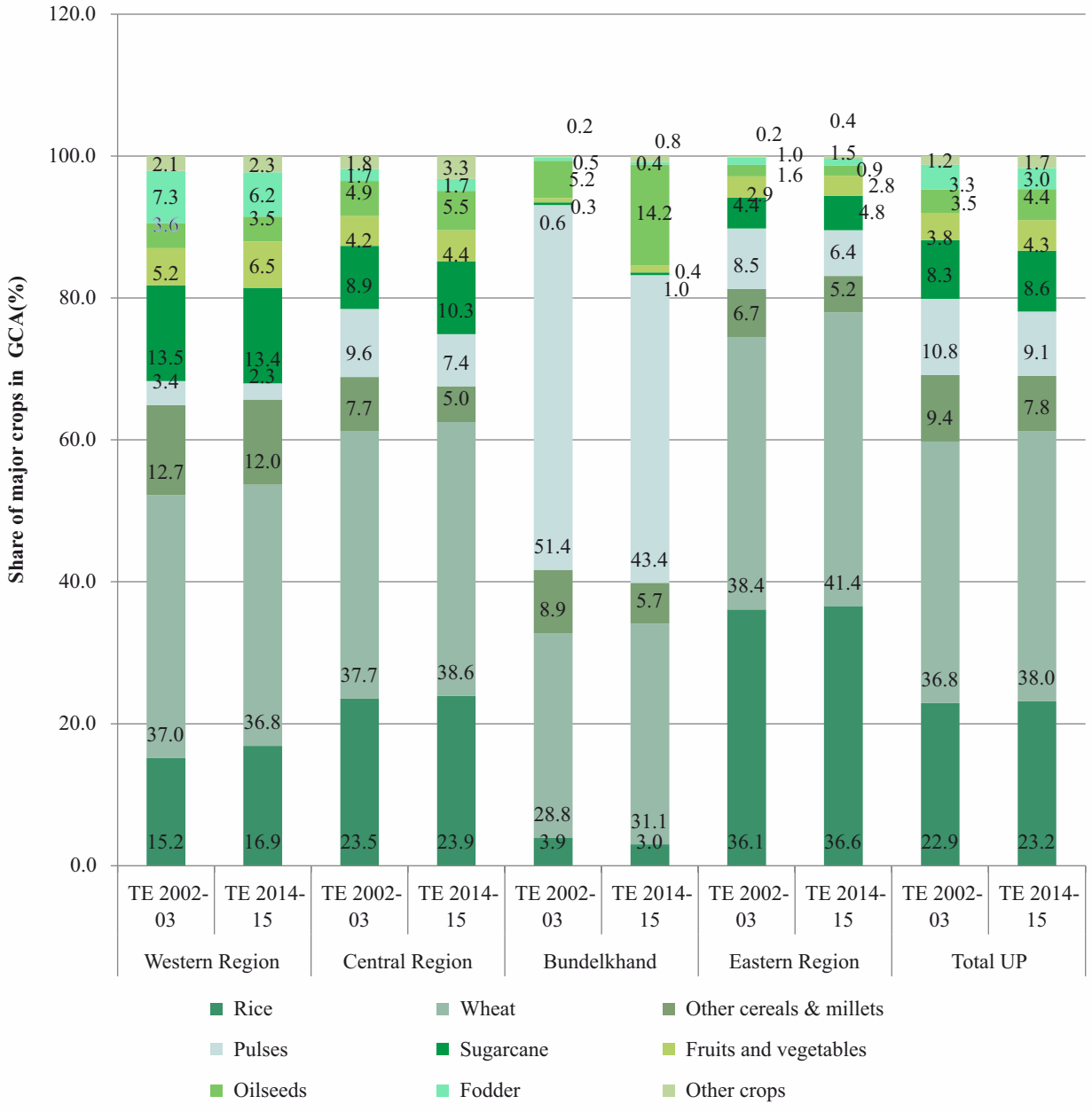
In the western region, 65.7 per cent of the gross cropped area was under cereals and millets of which 16.9 per cent was under rice and 36.8 per cent was under wheat, 2.3 per cent under pulses, 13.4 per cent under sugarcane, 6.5 per cent under fruits and vegetables and 3.5 per cent under oilseeds in TE 2014-15. Food grains accounted for 6.7 million hectares of area in the western region. As compared to 2002-03, there has hardly been any significant change in the cropping pattern in the western region.

In the central region, in TE 2014-15, 67.5 per cent of GCA was under cereals and millets, with 23.9 per cent under rice and 38.6 per cent under wheat, 7.4 per cent under pulses, 10.3 per cent under sugarcane, 4.4 per cent under fruits and vegetables and 5.5 per cent under oilseeds.

The gross cropped area in the Bundelkhand region is mainly under cereal and millets (39.8 per cent) with 3.0 per cent of the area under rice and 31.1 per cent under wheat cultivation. Pulses accounted for 43.4 per cent of the gross cropped area and oilseeds 14.2 per cent in TE 2014-15. There was significant diversification in the cropping pattern away from cereals and pulses in favour of the oilseeds between TE 2002-03 to TE 2014-15.The area under oilseeds has increased as a result of a number of programmes that were initiated by the government to increase oilseed production. Poor rainfall, scarce groundwater and surface water limit the region's cultivation to pulses and oilseed crops.

The eastern region is located in the fertile Indo-Gangetic plains. The region is predominantly a food grain growing region. Around 83.1 per cent of the cropped area was under cereal and millets. Around 36.6 per cent was under rice cultivation and 41.1 per cent under wheat, 6.4 per cent under pulses, 4.8 per cent under sugarcane, 2.8 per cent fruits and vegetables and 1.5 per cent under oilseeds in TE 2014-15. Rapeseed and mustard are the major oilseeds grown in the region.

**Figure 2: Share of Major Crops, Fruits and Vegetables in Gross Cropped Area in UP (%)**




Source: *Directorate of Economics and Statistics (DES), GOI*

Maps 1-5 shows the changing cropping pattern across districts in the period between TE 2002-03 and TE 2014-15 for rice, wheat, pulses, sugarcane and fruits and vegetables. There is considerable change across districts in the percentage share of gross cropped area under different crops between TE 2002-03 and TE 2014-15. In 2017-18, the National Food Security Mission (NFSM)[7] covered all the districts of Uttar Pradesh, of

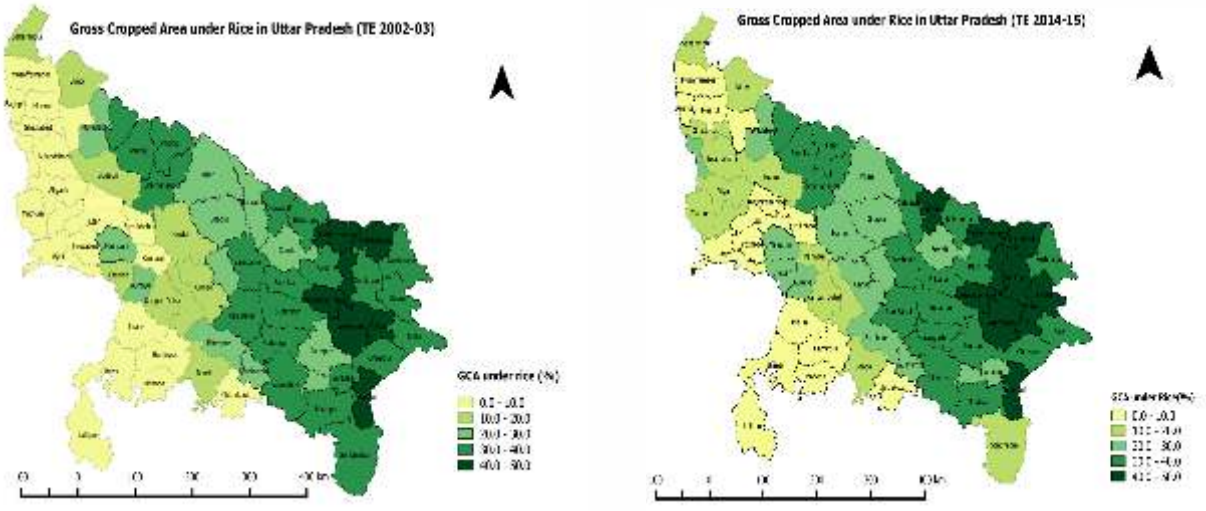
[7] *The National Food Security Mission was launched in October 2007 to increase the production of rice, wheat and pulses. Appendix 3 discusses the districts covered under NFSM in the state.*

which 23 districts were identified for rice, 31 for wheat, 75 for pulses and 20 for coarse cereals. The implementation of the centrally sponsored scheme has implications for the cropping pattern in UP, which is evident in the maps. Rice is mostly cultivated in the eastern region of the state (Map 1). However, many of the eastern districts show a higher share of cropped area under wheat cultivation in TE 2014-15 as compared to TE 2002-03, particularly Rae Bareli, Pratapgarh, Sant Kabir Nagar, Allahabad, Jaunpur, Azamgarh, Deoria and Mau (see Map 2).

Map 3 shows that the area under pulses has declined during the period from TE 2002-03 to TE 2014-15. Jhansi, Lalitpur, Jalaun and Hamirpur in the Bundelkhand region show a considerable decline in the area under pulses. Sugarcane is cultivated mostly in the western (Terai region) and eastern regions (Map 4). It is evident that the area under sugarcane has increased, particularly in districts such as Balrampur, Gonda, Moradabad and Basti.

As pointed out earlier, the area under fruits and vegetables has increased in the state during the period. Agra, Aligarh, Bulandshahr, Hathras, Firozabad, Mainpuri, Etawah, Lucknow and Sultanpur are some of the districts in UP which have shown a significant increase in the area under fruits and vegetables (see Map 5).

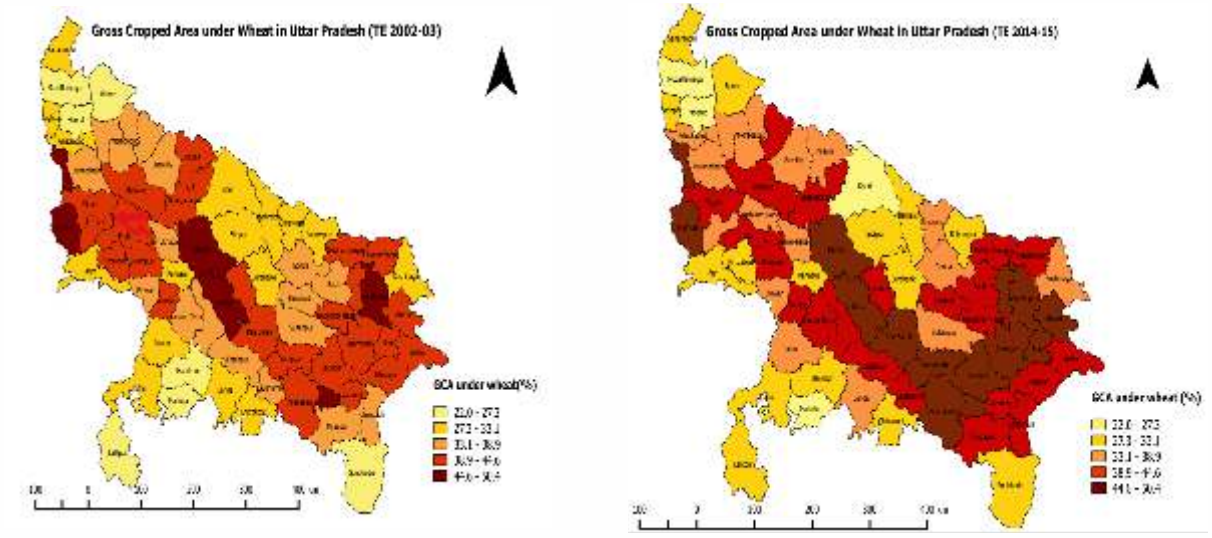
## Map 1: Share of Gross Cropped Area under Rice in Uttar Pradesh TE 2002-03 to TE 2014-15




*Source: Directorate of Economics and Statistics (DES), GOI*

*Note: Some districts name have changed in the later years such as Allahabad to Prayagraj and Faizabad to Ayodhya*

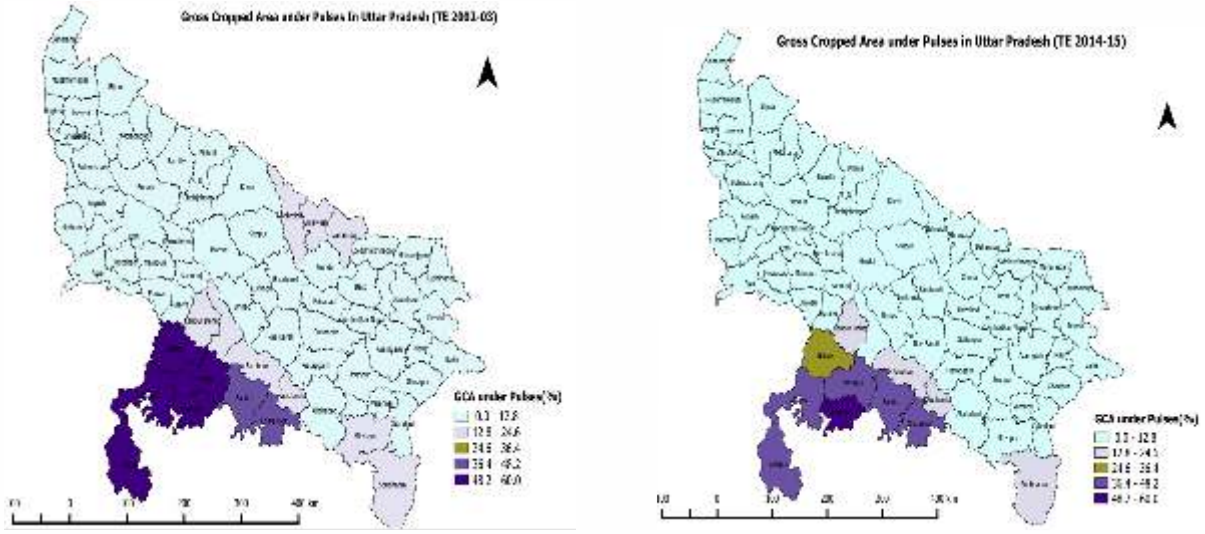
## Map 2: Share of Gross Cropped Area under Wheat in Uttar Pradesh TE 2002-03 to TE 2014-15




*Source: Directorate of Economics and Statistics (DES), GOI*

*Note: Some districts name have changed in the later years such as Allahabad to Prayagraj and Faizabad to Ayodhya*

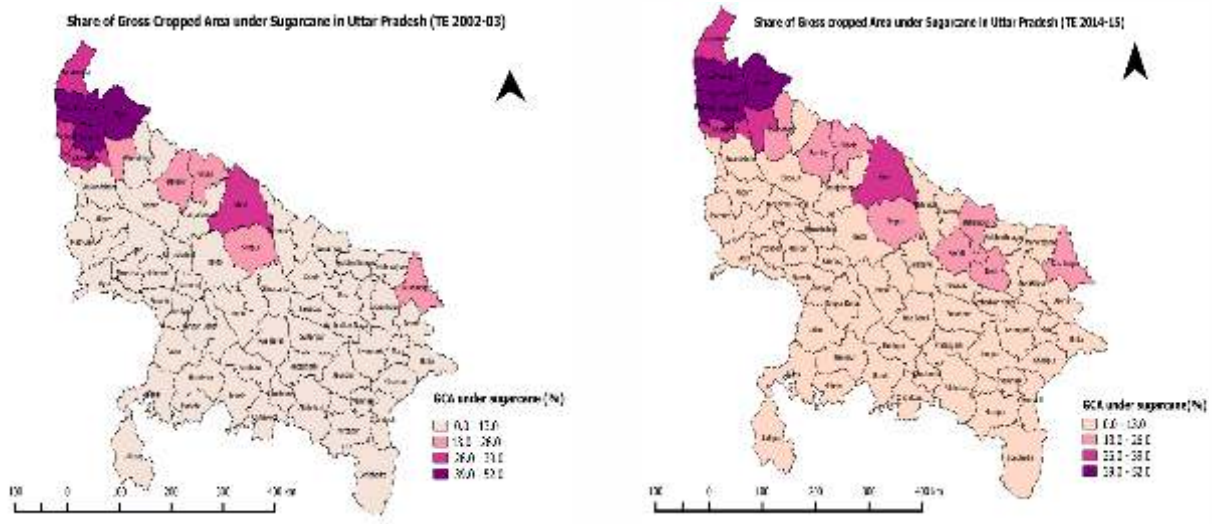
## Map 3: Share of Gross Cropped Area under Pulses in Uttar Pradesh TE 2002-03 to TE 2014-15




*Source: Directorate of Economics and Statistics (DES), GOI*

*Note: Some districts name have changed in the later years such as Allahabad to Prayagraj and Faizabad to Ayodhya*

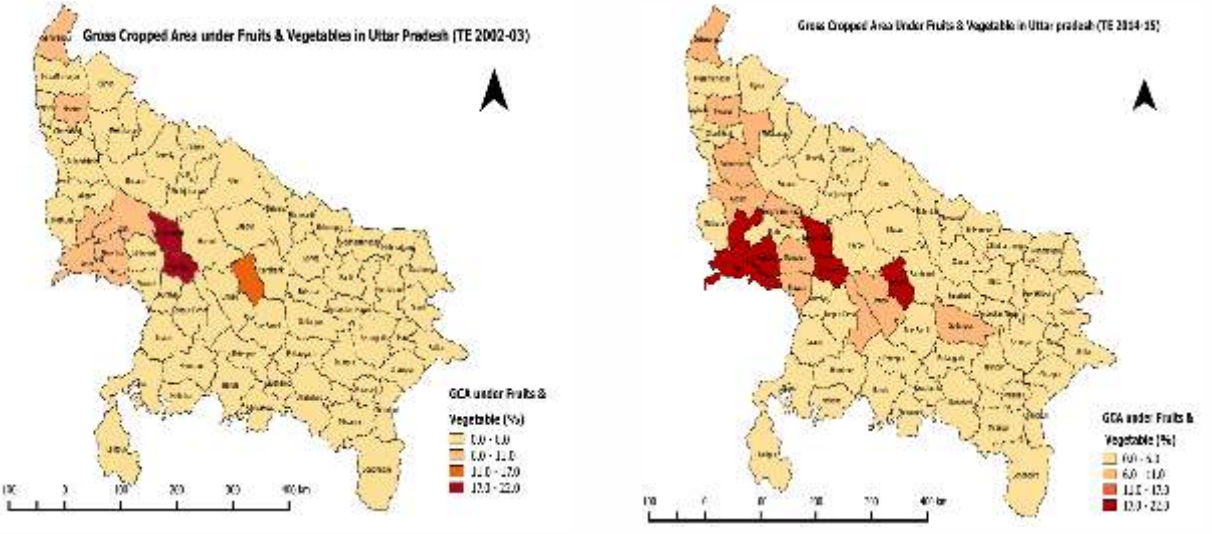
## Map 4: Share of Gross Cropped Area under Sugarcane in Uttar Pradesh TE 2002-03 to TE 2014-15




*Source: Directorate of Economics and Statistics (DES), GOI*

*Note: Some districts name have changed in the later years such as Allahabad to Prayagraj and Faizabad to Ayodhya*

## Map 5: Share of Gross Cropped Area under Fruits and Vegetables in Uttar Pradesh TE 2002-03 to TE 2014-15




*Source: Directorate of Economics and Statistics (DES), GOI*

*Note: Some districts name have changed in the later years such as Allahabad to Prayagraj and Faizabad to Ayodhya*

# 4

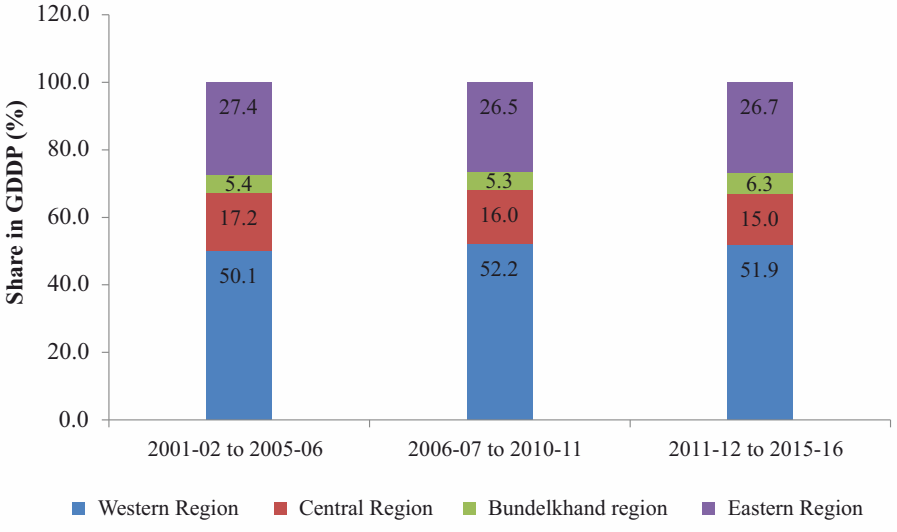
# Agricultural Performance in Uttar Pradesh

# Agricultural Performance in Uttar Pradesh

Successful land reforms, abolition of intermediaries and consolidation of landholdings led to the success of the green revolution in the state in the 1970s and 1980s, initially in the western region and later in the central and eastern regions. The performance of the agricultural sector has varied across the four regions given the historical differences in government investment in irrigation, agro-climatic characteristics, landholding structure and pressure of population on agriculture land.

The share of each region in gross domestic product (GDP) for agriculture and allied activities is shown in Figure 3. The region-wise share in agricultural GDP has been estimated using the data on gross district domestic product (GDDP) for agriculture and allied activities. The western region contributes half of the state's agricultural GDP followed by the eastern region and central region. The share of Bundelkhand region is 6.3 per cent between 2011-12 and 2015-16, which was the lowest among all the regions. The sustained agricultural progress achieved by the western region is primarily due to its distinct agrarian structure, good infrastructure, relatively successful land consolidation and access to assured irrigation due to investment in private tube wells (Srivastava and Ranjan, 2016; Lieten and Srivastava 1999).

**Figure 3: Region-wise Share in the Agricultural GDP**




*Source: Economics and Statistics Division, State Planning Institute, Planning Department, GoUP*

*Note: The contribution of districts in the different regions to gross domestic product for agriculture and allied activities has been estimated using the data on GDDP provided by State Planning Institute, GoUP.*

Agricultural growth in Uttar Pradesh is estimated using the annual average growth rate of agricultural GDDP. The agriculture growth in the state at 2.3 per cent per annum in the period from 2002-03 to 2015-16 (at 2011-12 prices) has been lower than the national average growth rate of 2.8 per cent per annum. The region wise agricultural growth rates in the state is shown in Table 4.

The annual agricultural growth rate of Bundelkhand, which has the lowest share in GSDPA among all the regions, has been 3.7 per cent in the period from 2002-03 to 2015-16 followed by the western region with a 2.7 per cent growth rate (Table 4). However, the growth rate has been relatively less volatile in the western, central and eastern regions as compared to the Bundelkhand region, where recurring droughts and scanty rainfall led to volatility in the growth rate.

Another indicator to measure agricultural growth is gross value of output in agriculture and allied sectors (GVOA) per hectare of gross cropped area (GCA). During the period 2002-03 to 2014-15, UP registered an average annual growth of 4.9 per cent in the GVOA per hectare at 2011-12 prices. The growth rate of GVOA per hectare in the western region was 5.4 per cent while the growth rate in the Bundelkhand and the eastern region was 5.2 per cent and 4.9 per cent respectively. Action is called for to curb the high volatility in growth rate in the Bundelkhand region.

**Table 4: Region-wise Annual Average Growth Rate of Gross value of Output in Agriculture per hectare of Gross Cropped Area and Agricultural GDP in UP**

| Region wise growth rate | GVOA per hectare of GCA 2002-03 to 2014-15 | | Agricultural GDP ( at 2011-12 prices) 2002-03 to 2015-16 | |
|---|---|---|---|---|
| | Annual average growth rate | Coefficient of variation of growth of GVOA/ha | Annual average growth rate | Coefficient of variation of growth of agricultural GDP |
| Western Region | 5.4 | 0.9 | 2.7 | 1.0 |
| Central Region | 4.5 | 2.4 | 2.6 | 3.6 |
| Bundelkhand | 5.2 | 2.7 | 3.7 | 5.0 |
| Eastern Region | 4.9 | 0.7 | 1.6 | 3.9 |
| Uttar Pradesh | 4.9 | 0.7 | 2.3 | 1.1 |

*Source: Economics and Statistics Division, State Planning Institute, Planning Department, GoUP*

# 5

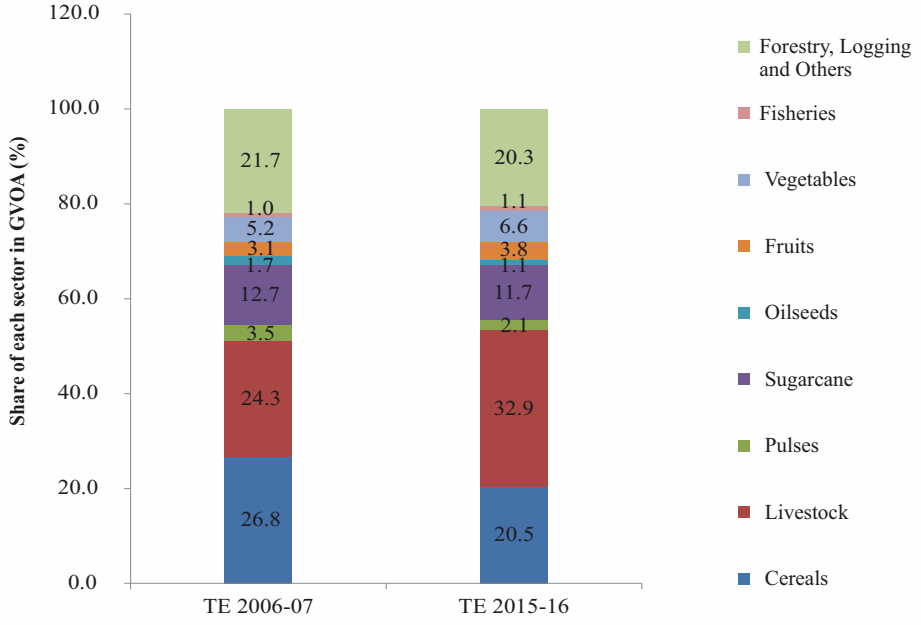
# Sources of Agricultural Growth in Uttar Pradesh

# Sources of Agricultural Growth in Uttar Pradesh

In this section, we examine the composition and sources of agricultural growth in Uttar Pradesh. To identify the sources of agricultural growth in UP, the study decomposes year-on-year growth in GVOA by taking absolute year-on-year differences in GVOA from each sector as a proportion of the previous year's GVOA, which gives the contribution of different sectors to agricultural growth. This helps determine the sub-sectors that drive agricultural growth in Uttar Pradesh.

To evaluate the composition of agricultural growth, first we calculate the share of the value of output of different segments as a percentage of the total value of output from agriculture and allied activities (at current prices). In TE 2006-07, the value of output from cereals constituted the largest share in the state. In recent years, although agriculture (crop) continues to be the largest sector, the share of livestock in the total value of output in agriculture and allied activities has increased from 24.3 per cent in TE 2006-07 to 32.9 per cent in TE 2015-16. The share of cereals in the GVOA declined from 26.8 per cent to 20.5 per cent in the same period (Figure 4). The share of sugarcane in GVOA also declined marginally in the period from 12.7 per cent in TE 2006-07 to 11.7 per cent in TE 2015-16 as did the share of pulses from 3.5 per cent to 2.1 per cent. Between TE 2006-07 and TE 2015-16, the share of fruits and vegetables in GVOA increased from 8.3 per cent to 10.4 per cent, that of fisheries from 1.0 per cent to 1.1 per cent and of forestry, logging and other crops from 21.7 per cent to 20.3 per cent.

**Figure 4: Shares of Sectors in the Value of Output of Agriculture and Allied Activities (at current prices)**




*Source: Economics and Statistics Division, State Planning Institute, Planning Department, GoUP*

The study also examines the share of each sub-sector in the value of agricultural allied activities' output across the four regions for the two periods TE 2006-07 and TE 2015-16 (See Figure 5 and Figure 6).

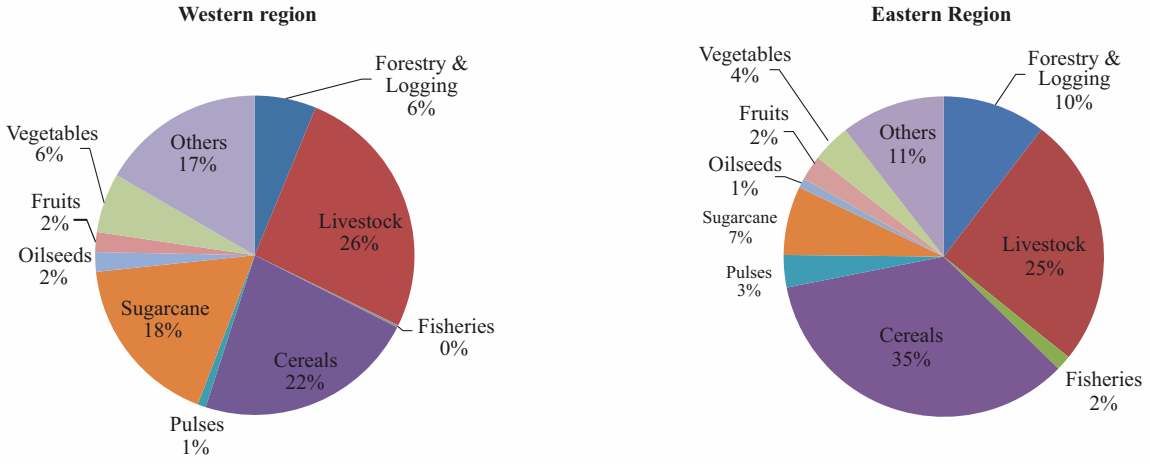
In the western region, there is a significant increase in the share of livestock in the value of agricultural output from 26 per cent to 34 per cent during the period. Consequently, the share of food grains in the value of output declined from 23 per cent to 17 per cent with the share of cereals declining from 22 per cent to 16 per cent and that of sugarcane from 18 per cent to 15 per cent. The share of fruits and vegetables increased in the total value of output of agriculture from 8 per cent to 10 per cent. The share of oilseeds and forestry and logging declined from 2 per cent to 1 per cent and 6 per cent to 4 per cent while the share of fisheries remained stagnant. The share of other crops increased from 17 per cent to 19 per cent in the same period.

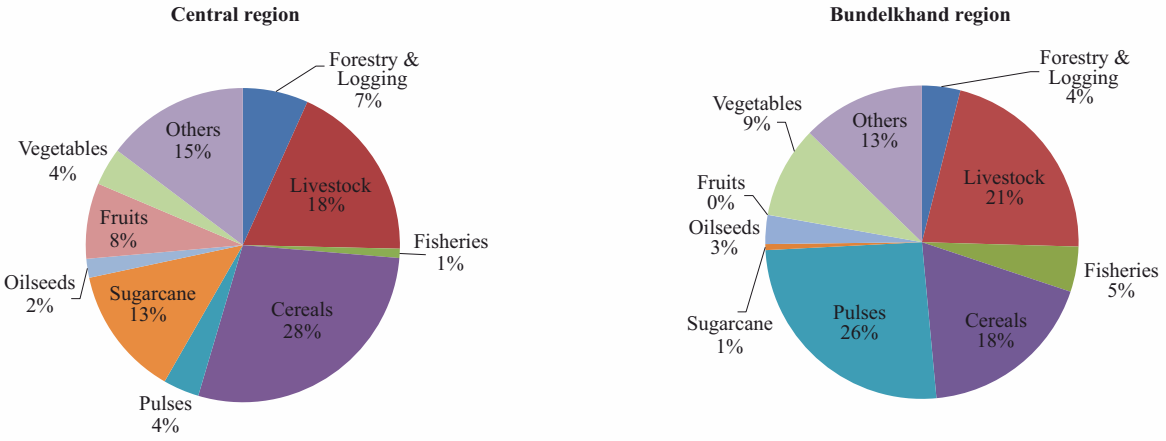
In the eastern region, the share of the livestock sector in value of output increased from 25 per cent in TE 2006-07 to 35 per cent in TE 2015-16. During the same period, the share of food grains in GVOA declined from 38 per cent to 30 per cent while the share of pulses, fisheries and sugarcane remained stagnant around 3 per cent, 2 per cent and 7 per cent respectively. The share of fruits and vegetables increased from 6 per cent in TE 2006-07 to 10 per cent in TE 2015-16. The share of oilseeds declined to less than one per cent while the share of forestry and logging and the share of other crops declined from 10 per cent to 6 per cent and from 11 per cent to 10 per cent respectively.

In the central region, between 2006-07 and 2015-16, the share of the value of output contributed by the livestock sector increased from 18 per cent to 27 per cent, the share of fisheries remained stagnant at around 1 per cent and the share of food grains declined from 32 per cent to 24 per cent. The share of sugarcane in GVOA increased from 13 per cent to 16 per cent during the same time period. The share of fruits and vegetables remained static at around 12 per cent. The share of oilseeds, and forestry and logging declined from 2 per cent and 7 per cent respectively to 1 per cent and 6 per cent respectively.

Unlike in the other regions, the share of cereals in the value of agricultural output in the Bundelkhand region rose marginally from 18 to 19 per cent in the 2006-07 to 2015-16 period. The share of livestock and oilseeds too increased from 21 per cent and 3 per cent to 27 per cent and 4 per cent respectively. However, there was a dramatic fall in the share of pulses from 26 per cent to 12 per cent while the share of fisheries declined more modestly from 5 per cent to 4 per cent. Fruits contribute a negligible share of the value of output. The share of vegetables in the total value of output of agriculture, however, increased from 9 per cent to 12 per cent as did the share of other crops from 13 per cent to 19 per cent. The share of forestry and logging declined from 4 per cent to 2 per cent.

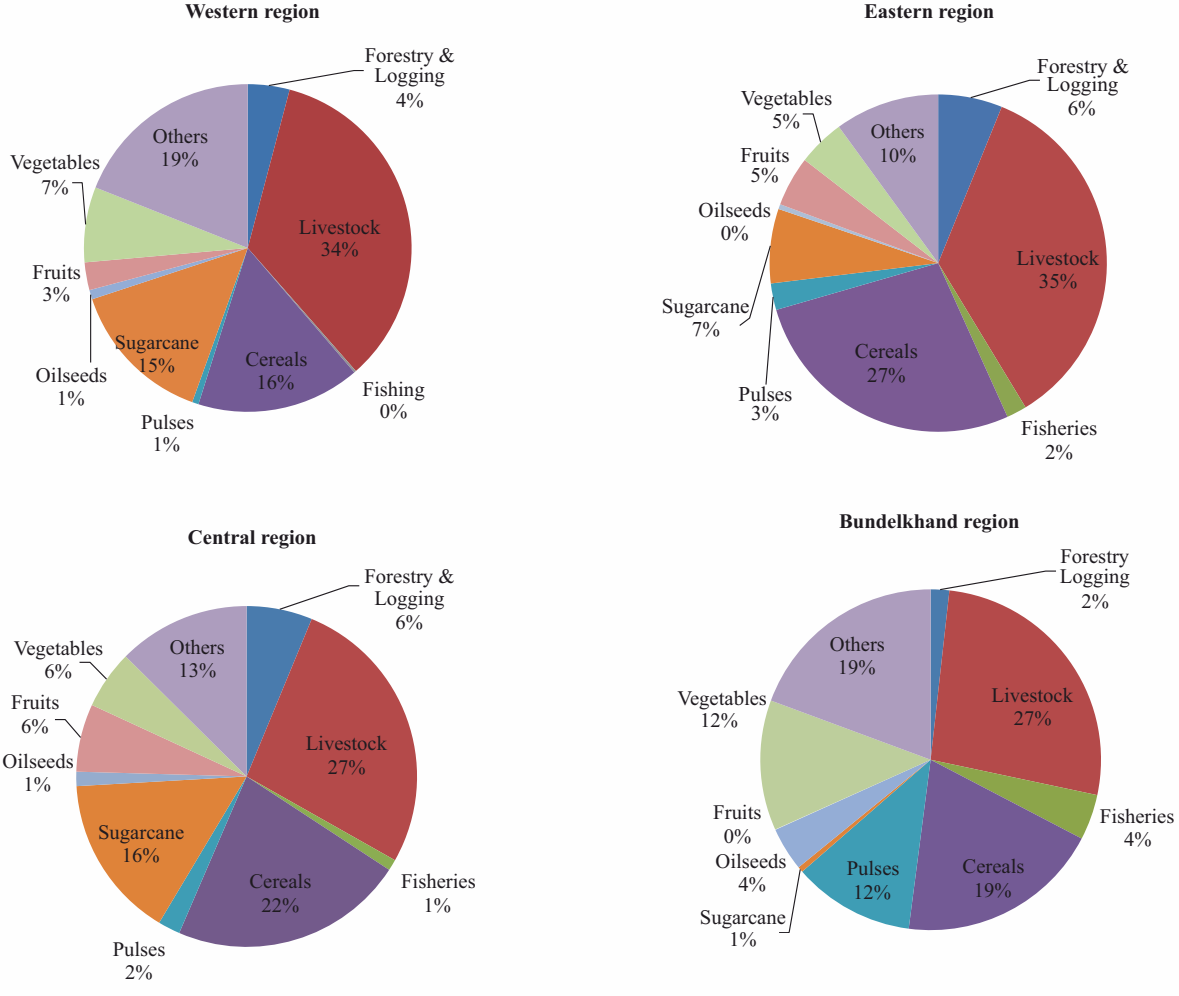
**Figure 5: Sector-wise Shares in Total Value of Output from Agriculture and Allied Activities (at current prices) in TE 2006-07**






*Source: Economics and Statistics Division, State Planning Institute, Planning Department, GoUP*

## Figure 6: Sector-wise Shares in Total Value of Output from Agriculture and Allied Activities (at current prices) in TE 2015-16




*Source: Economics and Statistics Division, State Planning Institute, Planning Department, GoUP*

The study decomposes the growth in the value of output of agriculture and allied activities across the state's different regions to identify the sources of agricultural growth. During the period 2005-06 to 2015-16, the value of output in agriculture and allied activities in the state grew at an annual average growth rate of 6.7 per cent at 2011-12 constant prices. The decomposition of the growth of GVOA into various sub-sectors is shown in Figure 7. Livestock was the largest contributor to growth of GVOA accounting for 41.1 per cent of the total growth, followed by cereal and pulses which contributed 16.5 per cent. Fruits and vegetables contributed 11.5 per cent to the total value of agriculture and allied activities and sugarcane contributed 9.0 per cent. Forestry, logging and others contributed 20.3 per cent whereas the fisheries contributed only 1.01 per cent. Oilseeds contribute a meagre 0.7 per cent to agricultural growth.

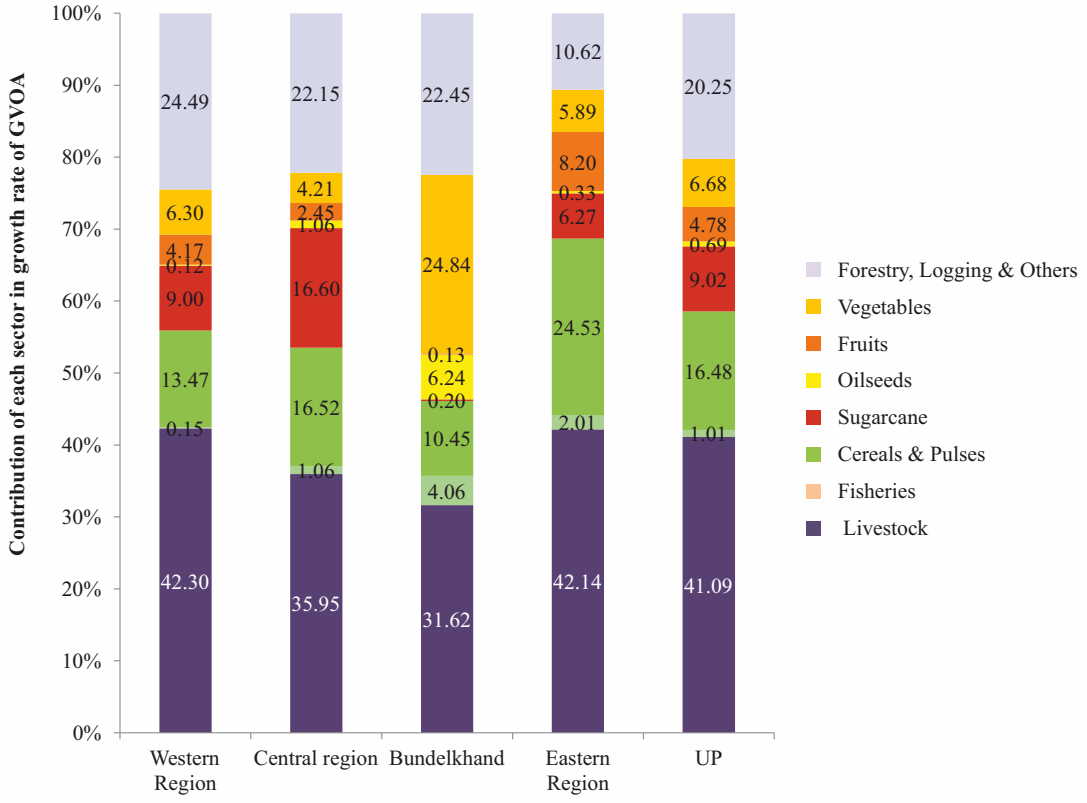
In the western region, the growth rate of the value of output between 2005-06 and 2015-16 was 7.2 per cent. The share of livestock to the annual growth in the value of output in agriculture and allied activities was 42.3 per cent, while cereal and pulses contributed 13.5 per cent to the growth rate. Sugarcane contributed 9.0 per cent to the growth rate during the period from 2005-06 to 2015-16. Fruits and vegetables together contributed 10.5 per cent to the growth rate. Forestry, logging and other crops contributed 24.5 per cent to the annual growth rate.

The annual growth rate of GVOA in the 11-year time period in the central region was 6.2 per cent. Decomposing the growth rate into various sectors, the largest share was contributed by the livestock sector (36.0 per cent), followed by sugarcane (16.6 per cent) and cereal and pulses (16.5 per cent). Fruits and vegetables together contributed 6.7 per cent to the growth rate during this period and oilseeds around 1.1 per cent. Forestry, logging and others together contributed 22.2 per cent to the total growth rate (Figure 7).

The value of agriculture and allied activities in the Bundelkhand region grew at an average annual rate of 6.9 per cent between 2005-06 and 2015-16. Decomposing the growth rate into different sectors shows that the livestock sector contributed 31.6 per cent to the growth, followed by vegetables (24.8 per cent), cereal and pulses (10.5 per cent), and oilseeds (6.2 per cent, which was higher than the state average of 0.7 per cent). Fisheries contributed 4.1 per cent to the growth rate of GVOA, while forestry, logging and others together accounted for 22.5 per cent of the growth rate.

The annual growth rate of the value of agricultural output in the eastern region was around 6.6 per cent. On decomposing the annual average growth rate, it is evident that the livestock sector was the largest contributor (with a share of 42.1 per cent), followed by cereal and pulses (24.5 per cent) fruits and vegetables (14.1 per cent) and sugarcane (6.3 per cent). The share of forestry, logging and others together accounted for 10.6 per cent in the growth rate.

**Figure 7: Region-wise Shares of Sectors in Average Annual Growth of Value of Output of Agriculture and Allied Activities (2005-06 to 2015-16)**



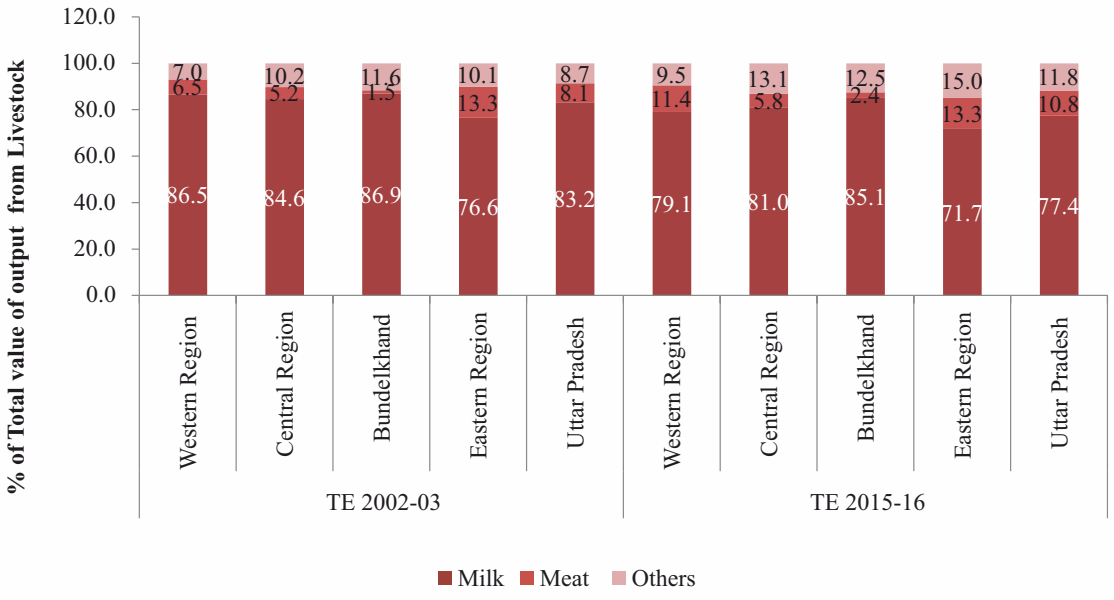

*Source: Economics and Statistics Division, State Planning Institute, Planning Department, GoUP*

## 5.1 Livestock

Animal husbandry is an important sub-sector of UP's agrarian economy. Given the existing landholding structure in the state, small and marginal farmers can combine livestock farming with growing crops to supplement their farm income.

UP is well endowed with a large livestock population. The region-wise livestock population is shown in the Appendix 4 (Table A4). The livestock sector has been the largest contributor to the growth in the value of output in the agriculture and allied sectors for the period from 2005-06 to 2015-16, accounting for 41.1 per cent. Figure 8 shows the composition of the value of output in the livestock sector across all the state's regions between TE 2002-03 and TE 2015-16. Within the livestock sector, milk accounts for the largest share in the value of output in the period TE 2002-03 to TE 2015-16. However, the share of milk in the value of livestock output has declined in the same time period from 83.2 per cent to 77.4 per cent while that of meat has increased from 8.1 per cent to 10.8 per cent.

**Figure 8: Shares of Components of Livestock in Value of Output of Livestock**



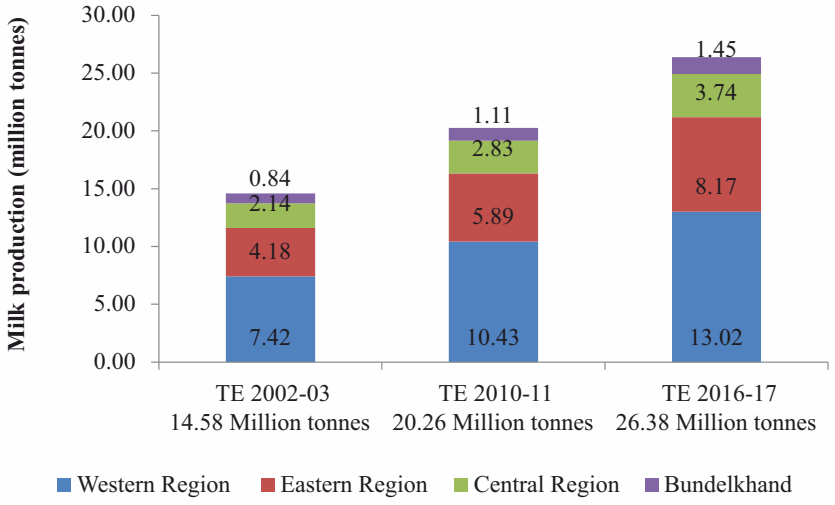

*Source: Economics and Statistics Division, State Planning Institute, Planning Department, GoUP*

We observe a similar trend in the share of milk across the four regions. In the western region, the share of milk in the value of output in livestock sector declined from 86.5 per cent in TE 2002-03 to 79.1 per cent in TE 2015-16 and in the central region from 84.6 per cent to 81.0 per cent. The lowest decline in the share of milk was registered in the Bundelkhand region where it declined from 86.9 per cent to 85.1 per cent in the same period. In the eastern region, the decline has been from 76.6 per cent to 71.7 per cent.

### *5.1.1 Milk*

Uttar Pradesh is the largest producer of milk in India. Milk production in the state has increased enormously from 14.6 million tonnes in TE 2002-03 to 26.4 million tonnes in TE 2016-17 contributing 17.3 per cent to the total production in the country in TE 2016-17.

**Figure 9: Region-wise Milk Production in UP**




*Source: Department of Animal Husbandry, Uttar Pradesh*

In TE 2016-17, the western region produced 13.0 million tonnes of milk while the central region produced 3.7 million tonnes (Figure 9). Milk production was 1.5 million tonnes in the Bundelkhand region and 8.2 million tonnes in the eastern region in TE 2016-17. In TE 2016-17, Bulandshahr district registered the highest milk production with 1.32 million tonnes followed by Meerut (0.8 million tonnes), Muzaffarnagar (0.7 million tonnes) and Agra (0.7 million tonnes). All these districts are located in Western UP with close proximity to the NCR region.

Although UP is the largest milk producing state in the country, productivity of in-milk animals in UP is less than in Punjab, Haryana and Gujarat. Average milk productivity in Uttar Pradesh was 1.0 tonne per lactating animal as against a productivity of 2.4 tonnes per lactating animal in Punjab and 1.1 tonnes per lactating animal in Gujarat (Hoda et al. 2017). In 2016-17, the average yield of a cross-bred cow was 7.5 kg/per day of milk at the all-India level. However, in UP, the cross-bred yield was about 7.2 kg/per day while in Punjab, it was 12.72 kg/per day. Although buffalo milk contributes three-fourths of the milk produced in the state, the yield from buffalos are also lower in UP as compared to other states (Table 5).Thus, there is a need for policy intervention to increase milk productivity in UP.

The low productivity of milch animals in the state is attributable to a lower proportion of genetically superior cattle. The exotic/cross bred female cattle population in UP[8] was only 20 per cent of the total female cattle population while the proportion of cross-bred cattle in Punjab was 91.5 per cent in 2012. Moreover, the indigenous cattle population[9] in the state account for 80 per cent of the total female cattle population.

[8] *In 2012, of the total cross-bred female cattle above two and a half years of age in UP, around 44 per cent were in the eastern region, 21 per cent in the central region, 20 per cent in the western region and 15 per cent in the Bundelkhand region.*

[9] *According to the 19th Livestock Census (2012), of the total indigenous female cattle above two and a half years in UP, around 46 per cent was in the eastern region, 45 per cent in the western region, 8 per cent in the central region and less than 1 per cent in Bundelkhand.*

**Table 5: Species-wise Yield of In-milk Animals (Kg/Day) in Selected States**

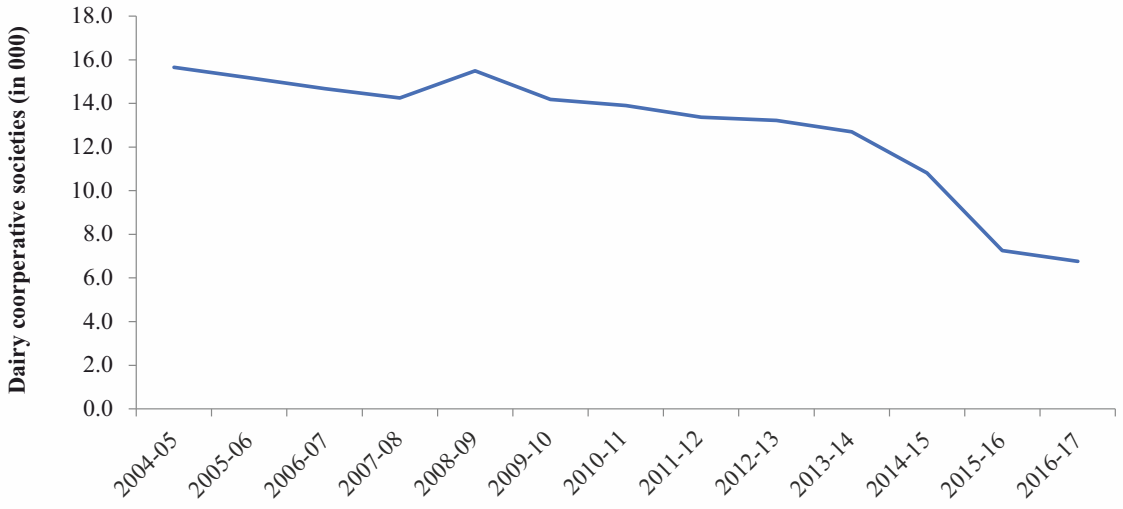
| | 2007-08 (in kg/per day) | | | 2016-17 (in kg/per day) | | |
|---|---|---|---|---|---|---|
| | Crossbred | Local cow | Buffalo | Crossbred | Local cow | Buffalo |
| Gujarat | 8.23 | 3.48 | 4.39 | 8.96 | 4.22 | 4.95 |
| Uttar Pradesh | 7.00 | 2.51 | 4.35 | 7.15 | 2.99 | 4.44 |
| Haryana | 7.05 | 4.60 | 6.32 | 8.26 | 5.49 | 8.39 |
| Punjab | 9.01 | 4.24 | 7.81 | 12.72 | 6.59 | 8.21 |
| All India | 6.47 | 2.11 | 4.41 | 7.51 | 2.84 | 5.23 |

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

Despite the significance of the dairy sector in UP, it is faced with numerous challenges. The co-operative sector in UP has not been doing very well. In 2016-17, only 0.5 per cent of the milk produced was procured by co-operative societies in UP, which is lower than the national average of 9.5 per cent. In Gujarat, the co-operative sector procured 52 per cent of the milk produced in the state. Besides, in 2016-17, the average producer price of milk paid by dairy co-operatives in UP was Rs.27.19 per litre as compared to Rs.35.48 per litre in Gujarat and Rs.29.52 per litre in Punjab. The average producer price of buffalo milk paid by co-operatives in UP was Rs.29.39 per litre, lower than that in Gujarat at Rs.41.32 per litre and Punjab at Rs.41.66 per litre. State intervention is needed in the area of milk processing through organised dairies.

The Pradeshik Co-operative Dairy Federation (PCDF) has seen a decline in the number of dairy co-operatives from 15,661 in 2004-05 to 6768 in 2016-17 (Figure 10). Farmer's membership in village dairy co-operatives has also come down from 5.9 lakh in 2006-07 to 3.1 lakh in 2015-16. PCDF has been incurring huge losses in recent years.

**Figure 10: Number of Dairy Co-operative Societies in Uttar Pradesh**




*Source: Statistical Abstract of Uttar Pradesh, various years*

In January 2018, the state government announced a new policy to increase the processing of milk in the organised sector to 30 per cent to help increase the production of processed milk and milk products, provide remunerative prices to dairy farmers and increase their income. The policy also aims to improve infrastructure to attract private investment, create greater awareness of the quality of milk and milk products, develop marketing facilities and increase investment in research and development in the milk sector. Besides, it provides for a 25 per cent subsidy (with a cap of Rs.50 lakh) for the establishment, expansion and modernisation of milk processing units, apart from providing for interest subsidy to tiny and small milk processing units on loans for plant and machinery, civil works etc.

The state's dairy development programme also aims to improve rural infrastructure facilities needed by the dairy industry. Under this programme, the state will invest in bulk milk coolers. Another initiative under this scheme is the setting up of automatic milk collection units in rural areas to ensure transparent milk weighing and testing, based on a modern scientific system. This will provide information about milk prices to the milk producer. The state also announced a Gokul Puraskar to provide incentives to members of milk producer co-operatives. At the district level, the Uttar Pradesh government aims to strengthen, re-organise and expand milk societies by providing financial assistance and a transport subsidy and by setting up dairy plants. Under the programme, producers are also provided technical inputs relating to animal breeding and animal health. Besides, the state provides training to farmers for clean milk production in the state.

As PCDF is not in a position to make any substantial investment, the state government may support private players, along with the other co-operative giants like AMUL, to process dairy products and set up the dairy value chains. Increasing private investments in the production of a large variety of processed value added milk products will provide a more profitable avenue unlike the co-operative sector, which largely produces milk-based indigenous products. It will also help increase competition in the demand for milk and consequently, help dairy farmers realise better prices. In recent years, UP has had some success in attracting a number of

dairy projects in the private sector. MoFPI has sanctioned grants to six dairy projects in UP under its cold chain scheme. Since the co-operative sector is on the decline in UP, the state needs to aggressively pursue private investment in the dairy sector. The Gujarat Co-operative Milk Marketing Federation (GCMMF) has already commissioned milk processing units at Lucknow and Kanpur with a capacity of 5 lakh litres per day. GCMMF also proposes to increase milk procurement in the state to 20 lakh litres per day by 2021.

### *5.1.2 Meat*

UP is the largest meat producer in the country with a production of 13.5 lakh tonnes in 2016-17, accounting for 18.2 per cent of the total meat production in the country (GOI, 2017). The state accounts for more than 60 per cent of the country's meat exports (UP Plan Document 2016-17).

The meat industry in UP has been facing some serious challenges in recent years. In the last three years, several cases of violence against cattle traders have been reported from UP. The production of meat in the state declined from 14.17 lakh tonnes in 2015-16 to 13.46 lakh tonnes in 2016-17. The production of buffalo meat in the state fell from 8.46 lakh tonnes in 2015-16 to 6.94 lakh tonnes in 2016-17. The restrictions on the transportation of animals and violence against animal traders are likely to have affected the income of small and marginal farmers by lowering the market price of animals.

Moreover, after the formation of the Yogi Adityanath-led BJP government in 2017, slaughterhouses running without a licence have faced a ban. Even municipal slaughterhouses run by municipal corporations and local bodies have been closed. As a result, farmers have suffered losses both due to their crops being damaged and because they are not able to realise a good price for out-of-milk and aged cows and buffaloes. This increases the cost to farmers due to the additional cost of feed incurred in feeding unproductive cattle.

Although UP has more than half of the 80 export-oriented abattoirs (in January 2019) registered with the Agricultural and Processed Food Products Export Development Authority (APEDA), all the approved 42 export-oriented abattoirs are in the private sector. The Ministry of Food Processing Industries (MoFPI) had started a scheme in the 11th Five Year Plan to provide grants to new abattoirs and modernise existing ones so that they meet the norms of pollution control and supply hygienic meat to the local population. The scheme provided grants of up to Rs.15 crore and allows public-private partnerships. An amount of Rs.27.4 crore has been utilised under this scheme by various municipal bodies in various states. In most other states, governments have been investing funds to modernise and upgrade slaughterhouses. However, Uttar Pradesh has not availed any grant under this scheme. Besides, the scheme was transferred to the state governments for implementation through National Mission on Food Processing (NMFP) for the 12th Five Year Plan. However, NMFP has been delinked from central support with effect from April 1, 2015 and only committed liabilities will be met by MoFPI.

The state government can invite private investment for the modernisation and up-gradation of abattoirs in the public-private partnership (PPP) mode. Under this model, the private investor is allowed to use one shift of the abattoir for export while another shift is used to cater to local needs. For instance, in Bareilly, the municipal corporation modernised its abattoir in the PPP mode at a cost of Rs.23.62 crore.

Since Uttar Pradesh is the largest meat exporting state, with the industry worth Rs 2600 crore and providing employment opportunities to more than 2.5 million (Alam, 2017), the state government needs to build a detailed road map to transform existing municipal abattoirs to more compliant and regulated ones that follow the norms pertaining to pollution control and disposal of animal waste, and maintain health and hygiene.

### *5.1.3 Poultry*

The state has vast potential and a conducive environment for poultry development. The total number of poultry birds in the state was 187 lakhs in 2012. In TE 2016-17, nearly 2186.4 million eggs were produced in the state, accounting for 2.6 per cent of the total eggs produced in the country (GoI, 2017). In spite of its large potential, the state is not able to meet the demand for eggs and chicken and procures 1 crore eggs daily and 972 lakh broiler chicken annually from other states including Andhra Pradesh, Haryana and Punjab (UP Plan Document, 2016-17). In 2013, the state government proposed the UP Poultry Development Scheme to establish 123 lakh commercial layer bird units to produce 365 crore eggs to make the state self-sufficient in egg production. The state government gave a 10 per cent interest subsidy on bank loans to encourage the establishment of layer farms with a capacity of 30,000 birds; this was subsequently changed to 10000 birds to bring down the capacity requirement under the commercial layer scheme. The scheme also proposed establishing 6 lakh parent broiler farms to make broiler farming profitable and organised, and to make the state become self-sufficient in the production of broiler chicks. The scheme aimed to produce 972 lakh chicks in the state.

The UP poultry development policy seems to have met with some success and the state produced 28.0 lakh eggs per day and generated self-employment of about 11640 in 2016-17.

## 5.2 Food grains

Food grains in Uttar Pradesh constituted around 22.6 per cent of GVOA; cereals had a larger share (20.5 per cent) than pulses (2.1 per cent) in GVOA in TE 2015-16. As mentioned earlier, although the share of food grains in GVOA has declined consistently, it still contributed 16.5 per cent to the growth of GVOA between 2005-06 and 2015-16. Within cereals, rice and wheat are the most important cereals in UP.

Wheat continues to be a dominant crop in the state. The area under wheat cultivation increased from 92.2 lakh hectares to 97.9 lakh hectares between TE 2002-03 and TE 2016-17; however, the productivity of wheat improved only marginally in UP. The average yield of wheat in the state was 2.69 tonnes/ha, which increased to 2.79 tonnes/ha in TE 2016-17. There is considerable variation in terms of wheat production and productivity across the four regions of the state.

In the western region, the area under wheat cultivation increased marginally from 35.3 lakh hectare in TE 2002-03 to 36.12 lakh hectares in TE 2016-17. Similarly, wheat production went up from 112.4 lakh tonnes to 114.2 lakh tonnes during the same period. However, the productivity of wheat in the western region declined from 3.18 tonnes/ha in TE 2002-03 to 3.16 tonnes/ha in TE 2016-17 (Table 6). The expansion of area contributed more than the increase in yield to higher production of wheat during the last decade. The yield of wheat in the region was lower than that in neighbouring states such as Haryana and Punjab where average yields were 4.2 tonnes/ha and 4.5 tonnes/ha respectively in TE 2016-17. The growth rate in the yield of wheat in the western region was negative, -0.05 per cent in the period from TE 2002-03 to TE 2016-17 (Table 7). The decline in wheat productivity is surprising given the fact that the western region was far ahead in the adoption of improved technology and has 90 per cent of gross cropped area under irrigation as compared to the other regions.

In the central region, the productivity of wheat increased from 2.61 tonnes per hectare to 2.74 tonnes per hectare in TE 2002-03 to TE 2016-17, a CAGR of 0.37 per cent. The productivity of wheat increased from 2.32

tonnes/ha to 2.60 tonnes/ha in the eastern region, a CAGR of 0.88 per cent. However, the yield was lower than the state average in both regions. The increase in wheat production in the central as well as in the eastern region can be attributed to both area expansion as well as an increase in yield. The area under wheat increased in the Bundelkhand region from 6.73 lakh hectares from TE 2002-03 to 8.26 lakh hectares in TE 2016-17. However, the productivity of wheat in Bundelkhand region experienced a negative growth rate of -0.18 per cent in the same period. The region lags behind in irrigation development as well as in the application of fertilisers.

The highest production and area under wheat cultivation was reported from Hardoi district in the central region with production of 9.5 lakh tonnes in an area of 3.2 lakh hectares and a productivity of 2.9 tonnes/ha in TE 2016-17. The highest productivity in wheat was reported by Baghpat district in the western region with a productivity of 4.1 tonnes/ha. The production of wheat in Baghpat was 2.1 lakh tonnes in an area of 0.5 lakh hectares in TE 2016-17. The district, carved out of Meerut, had a high irrigation ratio (100 per cent) as well as significantly high fertiliser consumption (211.9 kg/ha) in TE 2014-15.

Rice is another important cereal in the state. In TE 2017-18, UP was the second largest producer of rice in the country. The area under rice production in the state increased from 57.1 lakh hectares in TE 2002-03 to 59.1 lakh hectares in TE 2016-17. The yield of rice in the state increased from 1.9 tonnes/ha to 2.3 tonnes/ha in the same period. In the western region, the productivity of rice increased from 2.20 tonnes per hectare in TE 2002-03 to 2.51 tonnes per hectare in TE 2016-17. The increase in rice production in the state is mainly due to the rise in yield in the western region. Rice yield in both the central and western regions was higher than the state average in TE 2016-17. In the last decade, area expansion under rice cultivation has been negligible in the central region. However, the yield of rice in the central region increased from 1.87 tonnes/ha in TE 2002-03 to 2.38 tonnes/ha in TE 2016-17. The impressive performance was mainly on account of irrigation development, which facilitated the adoption of HYV seeds and fertilisers. Around 83 per cent of the area in the central region was under irrigation in TE 2014-15 as compared to 74.6 per cent in TE 2002-03.

The green revolution took place in the eastern region much later than in the other regions as the adoption of improved technology such as HYV seeds, chemical fertilisers, and the development of irrigation facilities took place much later, mainly in the 1990s. The eastern region is flood prone and is characterised by acute poverty (Pandey and Reddy, 2012). Around 90 per cent of agricultural land is allocated to food grain cultivation as household food security is the primary concern. The area under rice remained stagnant in the period between TE 2002-03 and TE 2016-17; it was 31.4 lakh hectares in TE 2016-17. However, production increased from 61.3 lakh tonnes in TE 2002-03 to 67.0 lakh tonnes in TE 2016-17, which is mainly attributable to an increase in yield from 1.9 tonnes/ha to 2.1 tonnes/ha, a CAGR of 1.02 per cent during the period. The yield, however, is lower than the state average of 2.27 tonnes/ha in TE 2016-17.

The area under rice cultivation declined marginally in Bundelkhand between TE 2002-03 and TE 2016-17. However, production increased from 0.9 lakh tonnes to 1.2 lakh tonnes, a CAGR of 1.7 per cent, during the period.

The highest rice production was reported in Shahjahanpur district in the western region with 5.6 lakh tonnes in an area of 1.9 lakh hectares and a productivity of 2.9 tonnes/ha in TE 2016-17. The highest area under rice cultivation was reported in Azamgarh district in the eastern region with an area of 2.1 lakh hectares in TE 2016-17 and a production of 4.2 lakh tonnes. The productivity of rice across all the districts of Uttar Pradesh ranged from 3.0 tonnes/ha in Auraiya district in the western region to 0.6 tonnes/ha in Lalitpur in TE 2016-17. The irrigation ratio in Auraiya district was around 83 per cent of the gross cropped area with average fertiliser consumption of 144.3 kg/ha.

## Table 6: Area, Production and Yield of Wheat, Rice and Pulses

| Region/crop | TE 2002-03 | | | TE 2016-17 | | |
|---|---|---|---|---|---|---|
| **Wheat** | Area (lakh Hectare) | Production (lakh Tonnes) | Yield (Tonnes/ Hectare) | Area (lakh Hectare) | Production (lakh Tonnes) | Yield (Tonnes/ Hectare) |
| Western Region | 35.30 | 112.39 | 3.18 | 36.12 | 114.23 | 3.16 |
| Central Region | 16.75 | 43.74 | 2.61 | 17.66 | 48.36 | 2.74 |
| Bundelkhand | 6.73 | 14.38 | 2.14 | 8.26 | 17.23 | 2.09 |
| Eastern Region | 33.42 | 77.53 | 2.32 | 35.87 | 93.18 | 2.60 |
| Total state | 92.19 | 248.04 | 2.69 | 97.92 | 273.00 | 2.79 |
| **Rice** | TE 2002-03 | | | TE 2016-17 | | |
| Western Region | 14.49 | 31.95 | 2.20 | 16.24 | 40.72 | 2.51 |
| Central Region | 10.46 | 19.52 | 1.87 | 10.67 | 25.38 | 2.38 |
| Bundelkhand | 0.91 | 0.93 | 1.02 | 0.75 | 1.16 | 1.54 |
| Eastern Region | 31.44 | 61.37 | 1.95 | 31.43 | 67.04 | 2.13 |
| Total state | 57.31 | 113.77 | 1.99 | 59.09 | 134.29 | 2.27 |
| **Pulses** | TE 2009-10 | | | TE 2015-16 | | |
| Western Region | 2.42 | 2.05 | 0.85 | 2.23 | 1.74 | 0.78 |
| Central Region | 3.93 | 3.28 | 0.84 | 3.24 | 1.85 | 0.57 |
| Bundelkhand | 11.45 | 8.13 | 0.71 | 10.91 | 5.12 | 0.47 |
| Eastern Region | 6.00 | 5.26 | 0.88 | 5.27 | 3.96 | 0.75 |
| **Total state** | 23.80 | 18.73 | 0.79 | 21.66 | 12.66 | 0.58 |

*Source: Directorate of Economics and Statistics (DES), GOI; Statistical Abstract of Uttar Pradesh, GoUP, various years*

*Note: Data for wheat and rice have been taken from the Directorate of Economics and Statistics (DES), GOI while for the data for pulses have been taken from the Statistical Abstract of Uttar Pradesh, GoUP*

## Table 7: Annual Compound Average Growth Rate of Area, Production and Yield of Wheat, Rice and Pulses (%)

| Region/Crop | Annual CAGR for TE 2002-03 to TE 2016-17(%) | | |
|---|---|---|---|
| **Wheat** | Area | Production | Yield |
| Western Region | 0.18 | 0.12 | -0.05 |
| Central Region | 0.41 | 0.78 | 0.37 |
| Bundelkhand Region | 1.59 | 1.40 | -0.18 |
| Eastern Region | 0.55 | 1.42 | 0.88 |
| Total state | 0.46 | 0.74 | 0.28 |
| **Rice** | | | |
| Western Region | 0.88 | 1.88 | 1.02 |
| Central Region | 0.15 | 2.04 | 1.87 |
| Bundelkhand Region | -1.48 | 1.71 | 3.22 |
| Eastern Region | 0.00 | 0.68 | 0.68 |
| Total state | 0.24 | 1.28 | 1.02 |
| **Pulses** | **Annual CAGR for TE 2009-10 to TE 2015-16(%)** | | |
| Western Region | -1.3 | -2.7 | -1.4 |
| Central Region | -3.1 | -9.2 | -6.2 |
| Bundelkhand Region | -0.8 | -7.4 | -6.7 |
| Eastern Region | -2.2 | -4.6 | -2.5 |
| Total state | -1.6 | -6.3 | -4.8 |

*Source: Directorate of Economics and Statistics (DES), GOI; Statistical Abstract of Uttar Pradesh, GoUP, various years*

The major pulses grown in Uttar Pradesh are chickpea (gram) and pigeon pea (tur). The production of pulses declined from 18.7 lakh tonnes in TE 2009-10 to 12.6 lakh tonnes in TE 2015-16 (Table 6), mainly because of a decline in the area under pulses, which fell from 23 lakh hectares in TE 2009-10 to 21 lakh hectares in TE 2015-16.Yields too declined at an annual rate of -4.8 per cent in the same period. With the development of irrigation facilities, the area under chickpea, which is a rain-fed crop, declined drastically in Uttar Pradesh. Due to its lower irrigation ratio, pulse production is preferred in the Bundelkhand region; despite this, the region recorded a decline in area under, and production and yield of pulses. Besides, the other three regions in Uttar Pradesh also registered a decline in production as well as yields.

## 5.3 Fruits and Vegetables

The wide ranging agro-climatic conditions across UP makes it conducive for growing a variety of horticultural crops. In 2016-17, UP was the largest producer of mangoes, watermelon, gooseberry and muskmelon among fruits and potatoes and peas among vegetables. Of the total production in India, the state produced 23.6 per cent of mangoes, 25.7 per cent of watermelon, 30.9 per cent of potatoes and 50.0 per cent of peas in TE 2016-17. It was also a major producer of guava, banana, carrot, bottle gourd, pointed gourd and pumpkin.

Fruits and vegetables together accounted for 11.46 per cent of the growth in the value of output in agriculture and allied activities between TE 2006-07 to TE 2015-16. In 2014-15, around 8.4 lakh hectares of the area was under vegetable cultivation. Across the four regions, 63.0 per cent of the total area under vegetables was in the western region, followed by 19.5 per cent in the eastern region, 2.7 per cent in the Bundelkhand region and 14 per cent in the central region.

Around 2.97 lakh hectares of area in UP was under fruit cultivation in 2014-15. Of the total gross cropped area under fruit cultivation, around 47 per cent was in the western region, 26.9 per cent in the central region, 0.13 per cent in the Bundelkhand and 25 per cent in the eastern region.[10]

Potato is an important vegetable in the state. Table 8 shows the area, production and yield of potato between TE 2002-03 and 2016-17. It is evident that the area, production and productivity of potato in the state have increased between TE 2002-03 and TE 2016-17. In the western region, the productivity of potato has declined marginally from 25.7 tonnes/ha in TE 2002-03 to 24.6 tonnes/ha in TE 2016-17. The productivity in the central region increased marginally from 19.02 tonnes/ha TE 2002-03 to 19.38 tonnes/ha in TE 2016-17. There has been an increase in productivity in both the eastern and Bundelkhand regions with an increase in yield from 19.6 tonnes/ha in TE 2002-03 to 20.9 tonnes/ha and from 23.02 tonnes/ha to 24.4 tonnes/ha respectively in TE 2016-17.

Among the districts in the state, Agra, Firozabad and Hathras located in the western region have a higher concentration of potato production as well as higher area under cultivation. Since 2000, Agra, Hathras, Aligarh and Firozabad together have set up around 780 cold stores with storage capacity of 65 lakh tonnes, which can preserve agricultural produce for about eight to nine months (Damodaran, 2019).

[10] *Data for total fruits and vegetables have been taken from the Statistical Abstract of Uttar Pradesh as the data was not available in Directorate and Economic Statistics, GoI*

**Table 8: Area, Production and Yield of Potato**

| Potato | TE 2002-03 | | | TE 2016-17 | | |
|---|---|---|---|---|---|---|
| | Area (lakh Hectare) | Production (lakh Tonnes) | Yield (Tonnes/ Hectare) | Area (lakh Hectare) | Production (lakh Tonnes) | Yield (Tonnes/ Hectare) |
| Western Region | 2.36 | 60.59 | 25.72 | 4.06 | 99.87 | 24.62 |
| Central Region | 0.64 | 12.09 | 19.02 | 0.77 | 14.97 | 19.38 |
| Bundelkhand | 0.01 | 0.3 | 23.02 | 0.02 | 0.47 | 24.36 |
| Eastern Region | 1.08 | 21.1 | 19.57 | 1.03 | 21.54 | 20.90 |
| Total state | 4.08 | 94.08 | 23.05 | 5.88 | 136.85 | 23.28 |

*Source: Directorate of Economics and Statistics (DES), GOI*

India contributes nearly 80 per cent of the global production of mentha oil. Large scale commercial cultivation of mentha is done in UP mainly in the western region and the Terai districts of Bilaspur, Rampur, Chandausi, Sambhal, Barabanki, Bareilly and Sitapur. Around 90 per cent of India's mentha crop is grown in the state. Barabanki, Sitapur, Faizabad, Gonda and Bahraich account for 60 per cent of India's mentha cultivation.

Although the state has huge potential for growing horticultural crops, agricultural diversification into this sector remains limited. For diversifying towards horticulture crops, there is a need for cold storage infrastructure along with reliable power in rural areas because horticultural crops have a relatively short shelf life. For tapping the full potential of this sector, the state requires efficient commodity specific value chains and agro-processing units for fruits and vegetables.

## 5.4 Sugarcane

Sugarcane is an important crop in the state, which accounted for 41 per cent of the country's production in TE 2016-17. Around 90 per cent of the area under sugarcane is irrigated in UP. The area under sugarcane cultivation remained more or less stagnant during the period from TE 2006-07 to TE 2016-17; however, its production increased considerably from 1270.58 lakh tonnes to 1496.3 lakh tonnes at a compound annual growth rate of 1.8 per cent. The increase in production was mainly due to an increase in productivity from 59.5 tonnes/ha to 68.5 tonnes/ha during the period (Table 9). The increase in sugarcane productivity is attributed to the development of a new variety of sugarcane, Co-0238.[11] Although there has been remarkable increase in sugarcane productivity in the state, it was still less than in other states like Tamil Nadu, Maharashtra[12] and Karnataka. In the western region, the production of sugarcane increased from 824.7 lakh tonnes in TE 2006-07 to 935.5 lakh tonnes in TE 2016-17. The region contributes 63 per cent of the total sugarcane produced in the

[11] *Co-0238 variety of sugarcane is early maturing with higher yield (80-90 tonnes per hectare) as compared to popular varieties such as CoS 767, Co Se 92423 and other varieties that were grown in UP till recently.*

[12] *The sub-tropical climate of UP and shorter duration of the crop (9 to10 months versus 14 months in Maharashtra) is attributed to the lower yield of sugarcane in Uttar Pradesh (Verma et al. 2017).*

state. Increase in production was mainly due to an increase in yield from 63.4 tonnes/ha to 71.76 tonnes. The productivity of sugarcane also increased in the central region from 56.07 tonnes/ha to 67.4 tonnes/ha at a compound annual growth rate of 2.74 per cent between TE 2006-07 and TE 2016-17, higher than in the western region (Table 10). This can be attributed to an increase in the irrigation ratio of land under sugarcane in the region from 78.1 per cent in TE 2002-03 to 94.79 per cent in TE 2014-15. The eastern region produced around 16 per cent of the total sugarcane produced in the state. The eastern and Bundelkhand regions also experienced an increase in production as well as productivity of sugarcane during the period. Lakhimpur Kheri district in the central region had the highest area (2.6 lakh hectares) as well production (180 lakh tonnes). Shamli district (carved out of Muzaffarnagar) had the highest productivity of 81 tonnes/ha in TE 2016-17 with a high irrigation ratio of 100 per cent and fertiliser consumption at 170 kg/ha in TE 2014-15.

**Table 9: Area, Production and Yield of Sugarcane**

| | Area (lakh Hectare) | Production (lakh Tonnes) | Yield (Tonnes/ Hectare) | Area (lakh Hectare) | Production (lakh Tonnes) | Yield (Tonnes/ Hectare) |
|---|---|---|---|---|---|---|
| **Sugarcane** | TE 2006-07 | | | TE 2016-17 | | |
| Western Region | 13.00 | 824.78 | 63.45 | 13.04 | 935.49 | 71.76 |
| Central Region | 4.15 | 232.81 | 56.07 | 4.69 | 316.00 | 67.37 |
| Bundelkhand | 0.09 | 3.47 | 37.81 | 0.10 | 3.85 | 39.41 |
| Eastern Region | 4.11 | 209.52 | 51.03 | 4.03 | 241.02 | 59.77 |
| Total state | 21.35 | 1270.58 | 59.52 | 21.86 | 1496.37 | 68.46 |

*Source: Directorate of Economics and Statistics (DES), GOI*

**Table 10: Annual Compound Average Growth Rate of Area, Production and Yield of Sugarcane (%)**

| **Sugarcane** | **Annual CAGR for TE 2006-07 to TE 2016-17(%)** | | |
|---|---|---|---|
| | Area | Production | Yield |
| Western Region | 0.03 | 1.41 | 1.38 |
| Central Region | 1.37 | 3.45 | 2.06 |
| Bundelkhand Region | 1.18 | 1.16 | 0.46 |
| Eastern Region | -0.22 | 1.57 | 1.77 |
| Total state | 0.26 | 1.83 | 1.57 |

*Source: Directorate of Economics and Statistics (DES), GOI*

The sugar industry is an important sector in the state, particularly in the western region which is also known as the sugar basket of the state. Until 1979-80, the state had 90 sugar mills with an installed capacity of 14.95 lakh tonnes, which included 16 co-operatives, 39 state-owned units (public sector) and 35 private sector units. By March 2018, there were 119 sugar mills – 48 in the central region, 38 in the eastern region and 33 in the western region (Table 11). The installed capacity in the state increased to 94.6 lakh tonnes in 2017-18 with 84.52 lakh tonnes of the capacity being in the private sector, 2.38 lakh tonnes in the public sector and 7.78 lakh tonnes in the co-operative sector. The total capacity in UP was, however, lower than in Maharashtra, which has a total capacity of 109.65 lakh tonnes.

The new variety of sugarcane, Co-0238, has not only resulted in an increase in yield but also in the average recovery rates. The recovery rate in Uttar Pradesh improved from 8.9 per cent in 2008-09 to 10.8 per cent by 2017-18 (Table 12). The increase was spread across all four regions with the central region having the highest recovery rate. However, the recovery rate of sugar from sugarcane is still lower than that in Maharashtra (11.2 per cent in 2017-18).

Total crushing capacity in the state also recorded a considerable increase from 454 lakh tonnes in 2008-to 1111 lakh tonnes in 2017-18. The increase in the crushing capacity of sugarcane across the regions is given in Appendix 4 (Table A5).

**Table 11: Distribution of Existing and Working Sugar Mills in Uttar Pradesh, 2017-18**

| Region | Existing Sugar Mills | | | | Working Sugar Mills | | | |
|---|---|---|---|---|---|---|---|---|
| | Private sector | Public Sector | Co-operative sector | Total | Private sector | Public Sector | Co-operative sector | Total |
| East UP | 38 | 19 | 8 | 65 | 33 | | 5 | 38 |
| West UP | 28 | 2 | 6 | 36 | 26 | 1 | 6 | 33 |
| Central UP | 38 | 5 | 14 | 57 | 35 | | 13 | 48 |

*Source: Handbook of Sugar Statistics, ISMA, 2017-18*

**Table 12: Average Recovery Rate of Sugarcane in Uttar Pradesh (%)**

| Region | 2008-09 | 2012-13 | 2017-18 |
|---|---|---|---|
| Central UP | 9.0 | 9.2 | 10.9 |
| East UP | 8.9 | 9.4 | 10.6 |
| West UP | 8.8 | 8.9 | 10.8 |
| Total UP | 8.9 | 9.2 | 10.8 |
| Maharashtra | 11.4 | 11.4 | 11.2 |
| All India | 10.0 | 10.0 | 10.7 |

*Source: Handbook of Sugar Statistics, ISMA, 2017-18*

Sugar mills also produce valuable by-products such as molasses, bagasse and press mud. Molasses is an end-product of the sugar refining process, which is processed to make ethanol and spirit, among other products. Bagasse produced by sugar mills in the state could potentially produce an additional 1500 megawatts of power generation through co-generation. Details of the production of molasses and ethanol are discussed below.

### *5.4.1 Molasses*

The production of molasses increased from 22 lakh tonnes in 2008-09 to 53 lakh tonnes in 2017-18. Table 13 shows the production of molasses across the different regions in UP. Production of molasses was higher in the central region as compared to the other regions. The recovery of molasses from cane in the state decreased from 4.9 per cent in 2008-09 to 4.8 per cent in 2017-18.

The sale of molasses by sugar mills is tightly regulated by the state government. Sugar millers, until recently, had to reserve a fifth of the molasses produced for sale to country liquor manufacturers.

**Table 13: Molasses Production in Uttar Pradesh (000 tonnes)**

| Region | 2008-09 | 2012-13 | 2017-18 |
|---|---|---|---|
| Central UP | 750 | 1550 | 2154 |
| East UP | 714 | 1416 | 1656 |
| West UP | 761 | 1206 | 1565 |
| Total UP | 2225 | 4172 | 5375 |
| All India | 6542 | 11744 | 14063 |

*Source: Handbook of Sugar Statistics, 2017-18, ISMA*

### *5.4.2 Ethanol*

Ethanol and co-generation units have been set up by sugar mills to improve their viability. The ethanol blending programme (EBP) was launched by GoI in January 2003 to supply 5 per cent ethanol blended petrol. Although the central government had fixed a target of blending 10 per cent of ethanol under the ethanol blending programme by 2016, it was able to blend only 2.07 per cent in the ethanol supply year (ESY) 2016-17 and 4.2 per cent in ESY 2017-18, leading to its pushing back the timeline to achieve the 10 per cent blending target to 2022. According to the Parliamentary Standing Committee on Petroleum and Natural Gas, the blending of ethanol was 6.2 per cent at the national level in ESY 2018-19 (until April 19, 2019).

Table 14 shows ethanol blending in UP in comparison to other states. Given that UP is the largest producer of ethanol, it is also the largest contributor to the ethanol blending programme. UP was able to blend 9.5 per cent of ethanol in petrol under EBP, higher than the national average of 6.2 per cent in ESY 2018-19. Since UP now produces more molasses than Maharashtra, there is scope for further increasing the production of ethanol in UP. According to the Indian Sugar Mills Association (ISMA), the annual installed capacity of ethanol production in the state in 2017-18 was 894.4 million litres from 42 units, whereas in Maharashtra, it was 927.0 million litres from 73 units. Following the central government's policy (2018) of providing interest subvention for setting up distilleries manufacturing ethanol, a number of units in UP have applied for bank loans and interest subsidy to set up ethanol manufacturing units..

Besides, in March 2019, the central government announced a concessional loan of Rs.15,500 crore to boost ethanol capacity in sugar mills. The government will bear an expenditure of Rs. 3,355 crore as interest subvention. It will help the sugar industry diversify into ethanol production by creating 300-400 crore litres of ethanol production capacity in the country. This will give a significant fillip to the state as it is the largest supplier of ethanol in the country. Of the total Rs.15,500 crore, a soft loan of Rs.2,600 crore will be provided to molasses-based standalone distilleries to augment capacity and set up new units (Mukherjee, 2019). This multi-pronged strategy will improve the financial health of the sugar industry that is reeling under the pressure of sugarcane arrears.

**Table 14: Ethanol Blending in UP and other Major States**

| States | ESY 2018-19 (Dec 18 To Apr 19) | | ESY 2017-18 (Dec 17 To Nov 18) | | ESY2016-17 (Dec 16 To Nov 17) | |
|---|---|---|---|---|---|---|
| | EBP% | Ethanol (billion litres) | EBP% | Ethanol (billion litres) | EBP% | Ethanol (billion litres) |
| Maharashtra | 9.3 | 0.2 | 8.3 | 0.4 | 1.8 | 0.1 |
| Uttar Pradesh | 9.5 | 0.2 | 8.9 | 0.3 | 8.0 | 0.3 |
| Karnataka | 9.0 | 0.1 | 6.7 | 0.2 | 2.1 | 0.1 |
| Gujarat | 7.5 | 0.1 | 3.1 | 0.1 | 0.9 | 0.0 |
| All India | 6.2 | 1.0 | 4.2 | 1.5 | 2.0 | 0.7 |

*Source: Oil Marketing Companies (HPC/BPC/IOC combined)*

*Note: ESY- Ethanol Supply Year, EBP-Ethanol Blending Programme*

## 5.5 Oilseeds

Although oilseeds contribute only 0.69 per cent of the growth in GVOA in UP, it is a prominent crop in the Bundelkhand region, where it contributes 6.2 per cent to the growth in GVOA of that region. Table 15 shows the region-wise area, production and yield of oilseeds in UP. The area under oilseeds has increased in the state from 10.22 lakh hectares in TE 2009-10 to 11.97 lakh hectares in TE 2015-16. However, the production of oilseeds declined from 8.02 lakh tonnes to 7.87 lakh tonnes in the same period at a negative CAGR of -0.3 per cent. The decline in production can be attributed to the decline in oilseeds yield, which registered a negative CAGR of -2.9 per cent (Table 16).

The production of oilseeds increased from 0.84 lakh tonnes in TE 2009-10 to 1.56 lakh tonnes in TE 2015-16 in Bundelkhand. This increase was due to an increase in cropping area as well as an increase in yield. It is the only region in Uttar Pradesh that registered a positive compound annual growth rate of 10.9 per cent in the production of oilseeds between TE 2009-10 to TE 2015-16. The western, central and eastern regions registered a decline in production and productivity of oilseeds during the same period.

**Table 15: Area, Production and Yield of Oilseeds**

| | TE 2009-10 | | | TE 2015-16 | | |
|---|---|---|---|---|---|---|
| **Oilseeds** | **Area (lakh Hectare)** | **Production (lakh Tonnes)** | **Yield (Tonnes/ Hectare)** | **Area (lakh Hectare)** | **Production (lakh Tonnes)** | **Yield (Tonnes/ Hectare)** |
| Western Region | 3.66 | 4.56 | 1.25 | 3.39 | 3.81 | 1.12 |
| Central Region | 2.26 | 1.71 | 0.76 | 2.65 | 1.66 | 0.63 |
| Bundelkhand | 3.03 | 0.84 | 0.28 | 4.64 | 1.56 | 0.34 |
| Eastern Region | 1.27 | 0.91 | 0.71 | 1.29 | 0.84 | 0.65 |
| Total state | 10.22 | 8.02 | 0.78 | 11.97 | 7.87 | 0.66 |

*Source: Statistical Abstract of Uttar Pradesh, various years.*

*Note: Data for total oilseeds have been taken from Statistical Abstract of Uttar Pradesh as data for total oilseeds were not available in Directorate and Economic Statistics, GoI.*

**Table 16: Annual Compound Average Growth Rate of Area, Production and Yield of Oilseed (%)**

| | Annual CAGR for TE 2009-10 to TE 2015-16(%) | | |
|---|---|---|---|
| **Oilseeds** | **Area** | **Production** | **Yield** |
| Western Region | -1.3 | -2.9 | -1.7 |
| Central Region | 2.7 | -0.5 | -3.2 |
| Bundelkhand Region | 7.3 | 10.9 | 3.3 |
| Eastern Region | 0.3 | -1.3 | -1.6 |
| Total state | 2.7 | -0.3 | -2.9 |

*Source: Statistical Abstract of Uttar Pradesh, various years.*

## 5.6 Fisheries

The share of the fisheries sector in agriculture and allied activities increased from 1.0 per cent in TE 2006-07 to 1.1 per cent in TE 2015-16. It contributed 1.01 per cent to the overall growth in GVOA between 2005-06 and 2015-16. Fish production in the state increased from 3.06 lakh tonnes in 2006-07 to 6.18 lakh tonnes in 2016-17 (Figure 11). In 2016-17, fish production in the state accounted for 5.4 per cent of all-India production. The state has immense scope for fisheries development due to the vast Gangetic riverine system. The state is endowed with 28500 km of rivers and canals, and 4.32 lakh hectares of inland water resources such as flood plains and derelict water bodies, tanks and ponds, and reservoirs, according to Water and Related Statistics (2019). However, fish production in the state does not correspond to the potential offered by the state's water resources.

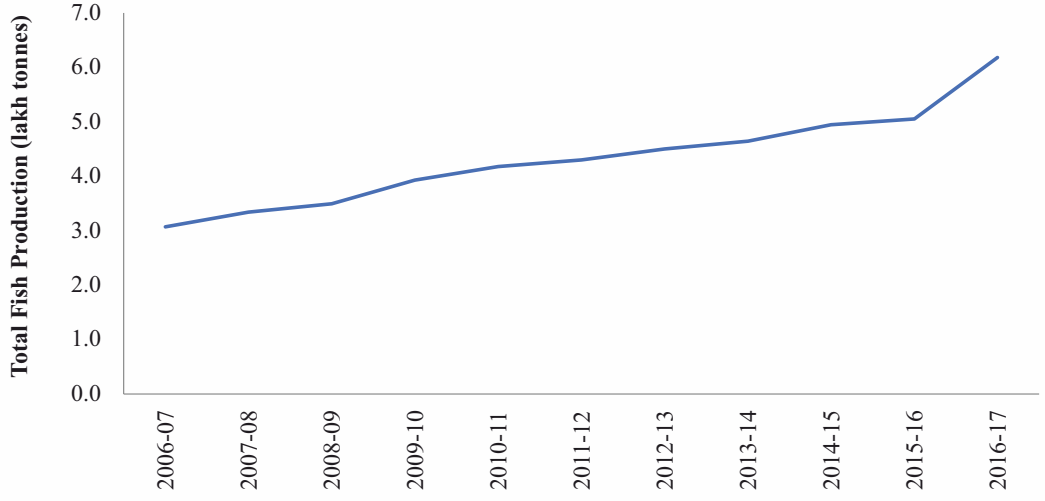
Fisheries contributed 0.15 per cent to the overall growth in GVOA in the western region and 1.06 per cent in the central region between 2005-06 and 2015-16. The contribution of the fisheries sector to the growth of GVOA was 4.06 per cent in the Bundelkhand region and 2.01 per cent in the eastern region during the period. Both regions have considerable scope to develop fisheries but this will require investing in optimum utilisation of water resources as well as promoting integrated fish farming, and fish processing and marketing to create additional income sources for agricultural households.

The state government needs to focus on the development of fisheries by promoting modern technology for optimum utilisation of water resources. The sector has huge potential to add to the income of fishing communities and provide employment in the rural areas of the state. To generate employment in rural areas along with fisheries development, the state government had announced the Fishery Development Policy in 2013. In addition to developing reservoir fishery through river-ranching and seed stocking programmes, the policy also aimed to increase the production of quality fish seed and promotion of fish processing technology and value addition of fish products for income generation.

In October 2018, the Union Cabinet has approved the setting up of a Fisheries and Aquaculture Infrastructure Development Fund (FIDF) of Rs.7522 crore. The GoUP can submit projects for fish seed farms, fish feed mills, cold chain infrastructure and fish processing. From this fund, the state government can also obtain interest subvention of up to 3 per cent from NABARD, commercial banks and the National Co-operative Development Corporation. This can provide the impetus for farmers to diversify towards rearing fish in UP. Fish cultivation requires expertise. The state government could provide training and include fisheries under the skill development programme.

The other initiatives that have been taken by the GoI along with the state government to promote fish farming and aquaculture in the state include the Kisan Credit Card (KCC) facility for fish farmers, apart from the provision of credit for inputs ranging from Rs.1.5 lakh to Rs.2.0 lakh per annum at an interest rate of 4 per cent to fish farmers. These measures can incentivise small and marginal farmers to adopt aquaculture in an organised way. Additionally, the state government also announced a Fishermen Development Fund of Rs.100 crore in 2017 but it is yet to be operationalised.

**Figure 11: Fish Production in Uttar Pradesh**




Source: *Statistical Abstract of UP, various years*

# 6 Drivers of Agricultural Growth in Uttar Pradesh:

# Drivers of Agricultural Growth in Uttar Pradesh:

The performance of the agricultural sector depends upon several supply side factors that affect agricultural growth and productivity. These include physical inputs (such as the HVY adoption ratio, and fertiliser consumption), rural infrastructure (irrigation facilities, road connectivity and power supply) and sound institutional infrastructure (procurement mechanisms and agricultural markets) (Verma, Gulati and Hussain, 2017). In this section, we will first discuss these supply side factors and the challenges that limit the state's agriculture from reaching its true potential and later, identify the potential drivers of agricultural growth using econometric analysis.

## 6.1 Rural Infrastructure

### *6.1.1 Irrigation*

Assured irrigation is one of the important drivers of agricultural growth, which enables increased use of fertilisers and HYV seeds (Verma, Gulati and Hussain, 2017; Gulati and Banerjee, 2018). The state has approximately 28 major and medium lift canals, 249 minor lift canals, 69 reservoirs/budhis and about 32,047 running tube wells (UP Plan Document, 2016-17).

The state had a high irrigation ratio of 79.1 per cent, well above the national average of 48.3 per cent in TE 2014-15. However, there are huge variations in irrigation coverage across regions. All four regions experienced a significant increase in the irrigation ratio between TE 2002-03 and TE 2014-15, which can be attributed to the public and private investments made in irrigation including canal irrigation. Irrigation is more developed in the western region, which had an irrigation ratio of 89.0 per cent in TE 2014-15. The irrigation ratio in the central region was 83.6 per cent, while it was 49.3 per cent in Bundelkhand and 75.1 per cent in the eastern region in TE 2014-15.

Deficient rainfall in the Bundelkhand region has adversely affected the development of irrigation. The agricultural sector in the region is highly dependent on rainfall as the irrigation ratio in the region is only 49.3 per cent in TE 2014-15. Bundelkhand has been experiencing recurring droughts, which has led to the seasonal migration of labourers (Gupta et al. 2014). Several field reports from the region have documented the agricultural distress in the region due to deficient rainfall and lack of employment opportunities in the agricultural sector.

Table 17 shows the region-wise irrigation ratio across major crops in Uttar Pradesh. It is evident that a major part of the area under irrigation was under sugarcane, fruits and vegetables, and cereals. The irrigation ratio of the area under pulses was lower. The area under almost all crops in the western region was irrigated, while a larger proportion of the area under cereals, sugarcane, and fruits and vegetables were irrigated in the central region. In the eastern region, cereals and sugarcane are largely cultivated in irrigated areas. Cereals, sugarcane and fruits and vegetables have high irrigation coverage in the Bundelkhand region. It is evident from the table that the cropping pattern in the state has changed towards crops requiring large quantities of water, e.g., paddy and sugar cane.

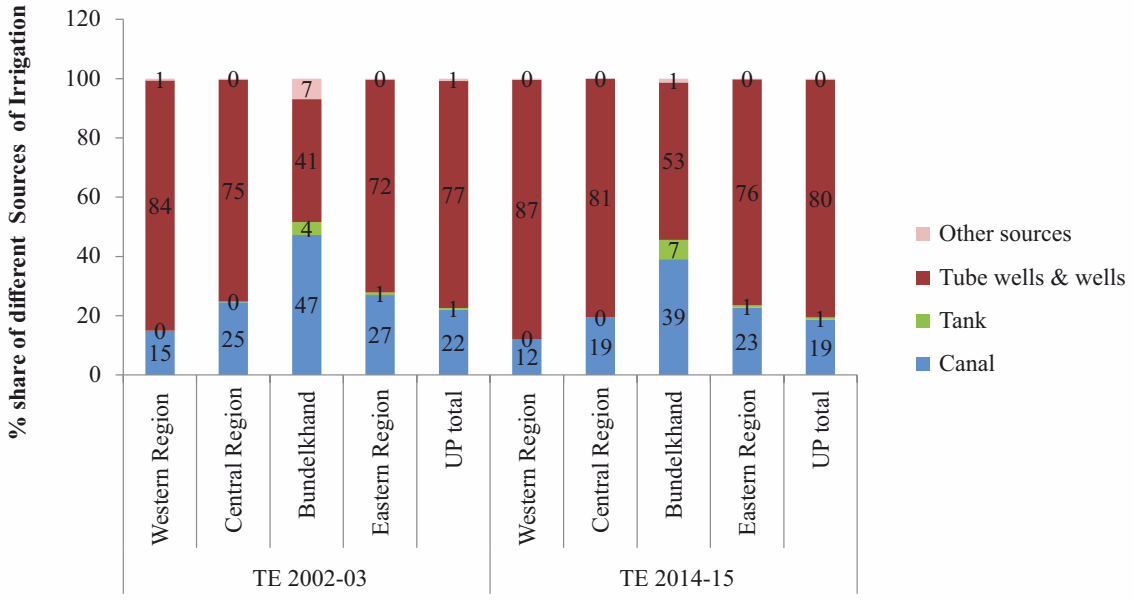
**Table 17: Region-wise Irrigation Ratio across Major Crops in Uttar Pradesh**

| Year | Region | Cereals | Pulses | Sugar | Fruits & Vegetables | Oilseed | Others | Total Irrigation Ratio |
|---|---|---|---|---|---|---|---|---|
| TE 2014-15 | Western Region | 88.4 | 49.1 | 98.7 | 97.9 | 85.8 | 87.6 | 89.0 |
| | Central Region | 92.5 | 10.2 | 94.8 | 83.7 | 56.8 | 85.0 | 83.6 |
| | Bundelkhand | 84.4 | 28.8 | 96.9 | 89.4 | 7.9 | 55.3 | 49.3 |
| | Eastern Region | 80.5 | 19.6 | 75.8 | 65.8 | 45.9 | 76.4 | 75.1 |
| | UP Total | 85.7 | 25.9 | 93.6 | 88.1 | 47.1 | 78.7 | 79.1 |
| TE 2002-03 | Western Region | 86.0 | 52.3 | 96.5 | 94.8 | 77.1 | 85.9 | 85.4 |
| | Central Region | 85.2 | 12.1 | 78.1 | 77.5 | 46.2 | 76.9 | 74.6 |
| | Bundelkhand | 66.6 | 21.8 | 97.0 | 83.0 | 5.7 | 42.0 | 40.3 |
| | Eastern Region | 68.1 | 19.9 | 71.6 | 62.7 | 37.9 | 63.7 | 63.2 |
| | UP total | 77.5 | 23.4 | 88.4 | 82.6 | 51.5 | 70.2 | 71.5 |

*Source: Directorate of Economics and Statistics (DES), GOI*

The main sources of irrigation in the state have been tube wells and canals, which accounted for 80 per cent and 19 per cent of irrigation coverage respectively in TE 2014-15. Tanks as a source of irrigation accounted for one per cent in TE 2014-15 (see Figure 12). In TE 2015-16, tube wells and canals accounted for 87 per cent and 12 per cent of irrigation respectively in the western region, 81 per cent and 19 per cent respectively in the central region, and around 76 per cent and 23 per cent respectively in the eastern region. In Bundelkhand, tube wells accounted for 53 per cent of irrigation, canals for 39 per cent and tanks for 7 per cent of irrigation coverage.

## Figure 12: Region-wise Source of Irrigation in Uttar Pradesh




*Source: Directorate of Economics and Statistics (DES), GOI*

It is not surprising that the western region has high irrigation coverage as the region has a high share of private tube wells. In comparison, the eastern region has a higher percentage of government tube wells. Bundelkhand has the lowest share of both private and government tube wells (Table 18). Private tube wells have emerged as a crucial driver for increasing agricultural productivity in the state. In 2014, private minor irrigation was the main source in around 77 per cent of the irrigated area (UP Plan Document, 2016-17).

## Table 18: Region-wise Percentage Distribution of Total Pumping Sets/Tube Wells

| Region | Private pumping set/tube wells (%) | | | Government tube wells (%) | | |
|---|---|---|---|---|---|---|
| | 2000-01 | 2011-12 | 2016-17 | 2000-01 | 2011-12 | 2016-17 |
| Western Region | 41.00 | 40.94 | 40.51 | 36.4 | 36.83 | 36.19 |
| Central Region | 18.20 | 19.35 | 19.84 | 14.7 | 13.64 | 14.75 |
| Bundelkhand Region | 3.00 | 2.19 | 2.15 | 5.5 | 5.97 | 6.03 |
| Eastern Region | 37.80 | 37.52 | 37.50 | 43.4 | 43.56 | 43.03 |

*Source: District Development Indicators, Uttar Pradesh 2013, 2017*

Until 2011-12, the irrigation potential created (IPC) through major, medium and minor irrigation projects in the state was 34.61 million hectares whereas the irrigation potential utilised (IPU) was only 27.99 million hectares (CWC, 2015), which is only for 80 per cent of the IPC, indicating the gap between the irrigation potential created and irrigation potential utilised in UP. According to the latest Water Related Statistics (2019), IPC in UP had increased to 35.7 million hectares by August 2018, but recent estimates for IPU are not available.[13]

The state has been facing challenges in completing ongoing irrigation projects, which is necessary to bring parity in irrigation coverage across regions. Since 2014, the central government has accorded priority to 99 ongoing major/medium irrigation projects under the Pradhan Mantri Krishi Sinchayee Yojana (PMKSY); these were earlier sanctioned under the accelerated irrigation benefits programme (AIBP). These projects have been divided into three priority lists – I, II, III – to be completed by 2016-17, 2017-18 and December 2019 respectively (Lok Sabha Question, 2018). Of the 99 projects, one project in priority list II and three projects in priority III have been identified in Uttar Pradesh. The Bansagar canal in Allahabad with an irrigation potential of 1.5 lakh hectares was in priority list II. Under priority list-III, there are three projects namely, Arjun Sahayak in Bundelkhand with a targeted irrigation potential of 0.4 lakh hectares, Madhya Ganga canal phase II with a targeted irrigation potential of 1.5 lakh hectares and Saryu Nahar with a targeted irrigation potential of 4.7 lakh hectares. Of the four projects identified in UP, the Bansagar canal project, started in 1978, was finally inaugurated by Prime Minister on July 15, 2018, in Mirzapur.

In 2009, to implement drought mitigation strategies and to complete ongoing and incomplete irrigation projects in the Bundelkhand region,[14] the central government had approved a Bundelkhand Special Package at a cost of Rs.7266 crore. Of the total fund, Rs.3506 crore was allocated for the Bundelkhand region of Uttar Pradesh and the remaining Rs.3760 crore for the Bundelkhand region of Madhya Pradesh. The package accorded the highest priority to water management in the region. On May 19, 2011, the central government approved an additional amount of Rs.100 crore to provide drinking water to UP's Bundelkhand region.

Provided under additional central assistance, which requires no matching resources from the state government, the grant has been utilised for the development of water resource projects in Bundelkhand, including the Central Jalaun Pump Canal in Lalitpur district, two canals under the Rasin Dam project in Chitrakoot district, the Augasi Pump Canal in Banda district and six lift irrigation schemes in Jalaun district. The Rajghat dam and distributaries have also brought some relief to the region in recent years. Apart from the major, medium and minor irrigation projects, approximately 1,250 check dams and 15,000 dug wells have been constructed under the Bundelkhand package (Mishra and Tayal, 2018). Between 2009-10 and 2014-15, Rs.1845.83 crore was released by the central government to the Bundelkhand region of Uttar Pradesh, of the total Rs.3,506 crore allocated under the Bundelkhand package. Thus, around 47.4 per cent of the funds allocated under the package remained unutilised until March 2015 (Lok Sabha Questions, 2015).

The state government has also proposed a surface pump set scheme for the benefit of farmers in the Bundelkhand region and the trans-Yamuna blocks of the Vindhyan Region. The government has proposed a subsidy of Rs.4,500, Rs.6,000 and Rs.9,000 for small marginal farmers belonging to general categories, scheduled castes and scheduled tribes respectively. This scheme was also extended to Mirzapur, Sonbhadra and Chandauli districts in the Eastern region (UP plan Document, 2016-17).

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[13] *Central Water Commission has not released the data of IPU after 2011-12.*

[14] *Bundelkhand region is spread across both Uttar Pradesh and Madhya Pradesh.*

Many states such as Maharashtra, Madhya Pradesh and Karnataka have constructed farm ponds to store rainwater accumulated during monsoon for drought proofing. In April 2017, the UP government announced a farm pond scheme under the Rashtriya Krishi Vikas Yojana (RKVY) through which farmers were to be provided a subsidy of 50 per cent of the cost to construct farm ponds in the seven districts of Bundelkhand. In the last three years, more than 10,000 farm ponds have been built in the region (Damodaran, 2019). These farm ponds can be potential game-changers in the parched region of Bundelkhand as the ponds can provide protective irrigation to boost the production of chickpea, masur, and green peas in the rabi season. The farm ponds can also help the region to diversify into fish farming.

#### *6.1.1.1 Micro Irrigation*

Inequitable and unplanned development of groundwater has resulted in over-exploitation of groundwater in many districts of UP. According to the latest Ground Water Resource Assessment (2013) carried out jointly by the Central Ground Water Board (CGWB) and state governments, it was found that out of the 820 blocks assessed in Uttar Pradesh, 45 were semi-critical, 59 were critical and 113 were over exploited (Lok Sabha Questions, 2017).[15] Micro-irrigation techniques like drip and sprinkler system of irrigation need to be promoted and incentivised by the UP government in water scarce regions, particularly in the western and Bundelkhand regions. These techniques not only promote efficient use of water resources but also enhance productivity, reduce irrigation cost and electricity consumption.

The 'per drop more crop' (PDMC) under the centrally sponsored Pradhan Mantri Krishi Sinchai Yojana (PMKSY) was launched in 2015, which focuses on the efficient use of water through the adoption of precision/micro irrigation technologies, viz., drip and sprinkler irrigation systems. Drip irrigation[16] can effects savings of up to 50 to 60 per cent of water and enhance the yield of various crops by up to 40 per cent. Andhra Pradesh, Gujarat, Maharashtra, Karnataka and Rajasthan have availed of grants available under the scheme. UP's performance in developing drip irrigation under PMKSY-PDMC has been poor. Details are shown in Table 19.

India has added 16.89 lakh hectares under micro irrigation. Of this, the state's share has been a meagre 8216 hectares since 2015-16. A relatively larger proportion of area has been under drip irrigation in the western and eastern region, where 3881 hectares and 3042 hectares of area were brought under drip irrigation (in Table 19). Bundelkhand has lagged behind in the adoption of these techniques. Greater priority needs to be accorded to increase the area under drip irrigation in the Bundelkhand region.

**Table 19: Region-wise Area Covered under Drip Irrigation under PMKSY-PDMC, 2015-16 to 2018-19 (as on 11-12-2018)**

| Region | Area under drip Irrigation (ha) |
|---|---|
| Western Region | 3881 |
| Central Region | 860 |
| Bundelkhand | 433 |
| Eastern Region | 3042 |
| Uttar Pradesh | 8216 |

*Source: Rajya Sabha Unstarred Question No. 487, answered on 14.12.2018, Implementation of Drip-Irrigation Technologies*

[15] *See Appendix 5 for detailed discussion on groundwater depletion in UP.*

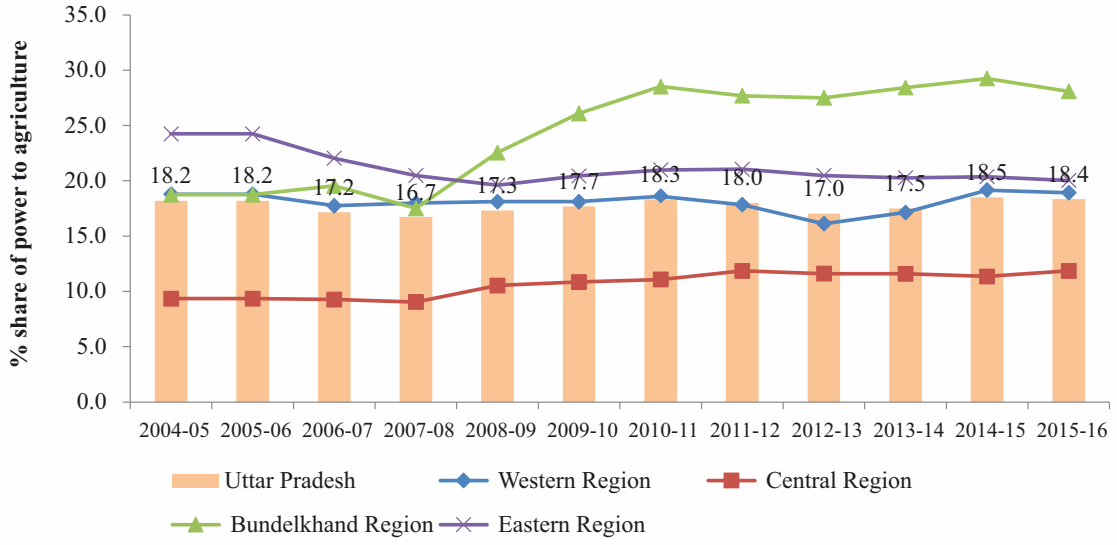
[16] *It facilitates the maintenance of optimum moisture level in root zone areas, which prevents moisture stress or shock associated with other traditional method of irrigation, resulting in higher yields, improved quality, early maturity, water saving, management of insect pests and diseases, etc.*

### *6.1.2 Power Supply to Agriculture in Uttar Pradesh*

The state requires a healthy and sustainable power sector to accelerate agricultural growth and productivity. UP has the largest number of people without electricity, accounting for 49 per cent of the state's 38.2 million households (GSI, 2018). The per capita power consumption in the state was 524 kWh in 2016-17, much lower than the national average of 1075 kWh (GoUP, 2017a). The share of agriculture in total power consumption in the state has remained stagnant between 2004-05 and 2015-16. However, there are wide variations in power supply to the agricultural sector across the regions (Figure 13).

The share of agriculture in power consumption in the eastern region was the highest among the regions in the early 2000s, but its share has come down from 24.2 per cent in 2004-05 to 20.2 per cent in 2015-16. There was no significant change in power consumption in the western region in the period from 2004-05 to 2015-16 while in the central region, which has the lowest power consumption among all the regions, power consumption in the agricultural sector increased from 9.3 per cent in 2004-05 to 15.5 per cent in 2015-16. The Bundelkhand region has shown a significant increase in the share of agriculture in power consumption from 18.8 per cent in 2004-05 to 28.1 per cent in 2015-16. Since 2008-09, agriculture accounted for the highest share of power consumption in the Bundelkhand region.

**Figure 13: Region-wise Power Consumption in the Agricultural Sector, 2004-05 to 2016-17**

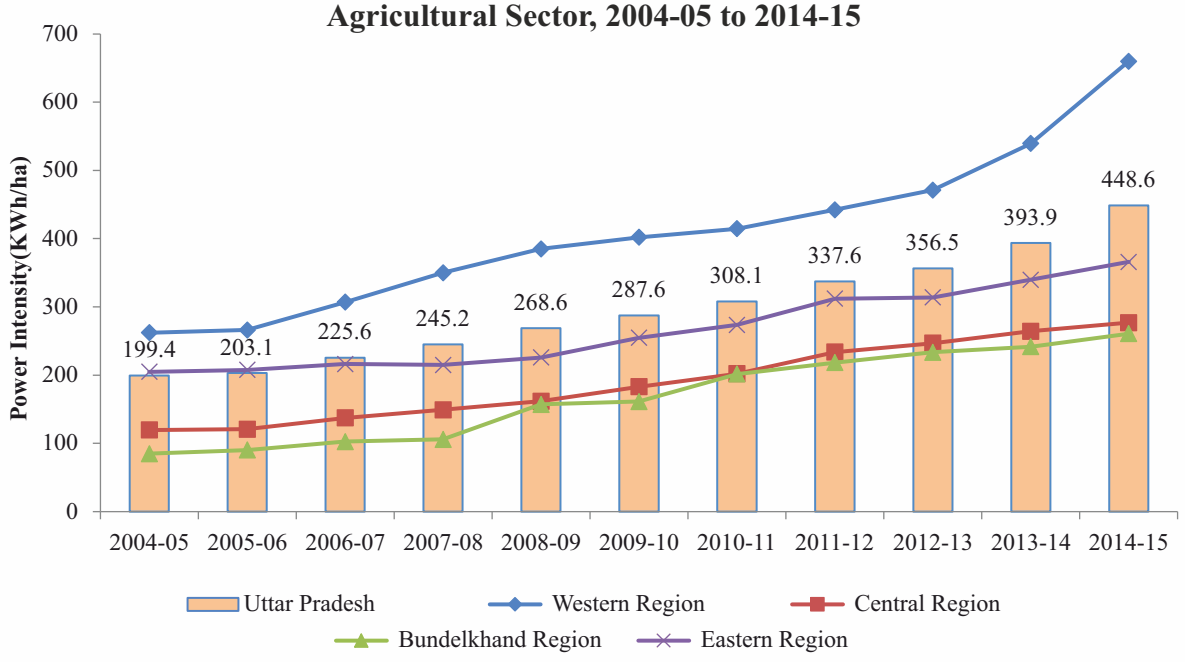



*Source: Statistical Abstract of Uttar Pradesh, various years*

To measure per hectare power consumption in agriculture, one needs to calculate the power intensity across the four regions. The power intensity of agriculture in the state increased from 199 kWh/ha in 2004-05 to 449 kWh/ha in the 2014-15; yet, it was lower than the national average of 851 kWh/ha. Power intensity in the agricultural sector in UP was about one-fifth the power intensity in Tamil Nadu, which had a power intensity of 2069.6 kWh/ha in 2014-15, and about one third that in Haryana (1477 kWh/ha) and Karnataka (1468 kWh/ha).

The trend in the power intensity of agriculture across regions is shown in Figure 14. The power intensity in the western region, which increased from 262 kWh/ha from 2004-05 to 660 kWh/ha in 2014-15, is higher than the state average. Between 2004-05 and 2014-15, power intensity increased from 205 kWh/ha in 2004-05 to 366 kWh/ha in 2014-15 in the eastern region, from 120 kWh/ha to 277 kWh/ha in the central region and from 85 kWh/ha to 261 kWh/ha in the Bundelkhand region. Although the share of power consumption in agriculture is comparatively high in the Bundelkhand region (figure 13), it must be noted that power intensity in Bundelkhand is lower than in other regions.

**Figure 14: Region-wise Power intensity (kWh/ha) in the Agricultural Sector, 2004-05 to 2014-15**




*Source: Statistical Abstract of Uttar Pradesh, various years*

Erratic power supply is a major reason for the poor performance of public tube wells. The decline in the quality of power supplied by power utilities to the agricultural sector has increased farmers' dependence on diesel operated tube wells, which has resulted in the irrigation potential not being fully utilised.

Revenue shortfalls pose a major challenge to the power sector in Uttar Pradesh. The state's electricity distribution companies (discoms) incurred losses of Rs.21,486 crore by 2016. In FY 2017, around 40 per cent of households in Uttar Pradesh were still unmetered (GSI, 2018). According to a study by Global Subsidies Initiative (GSI, 2018), successive state governments in Uttar Pradesh have kept electricity prices low for political gain, leading to losses for distribution companies and impeding their ability to expand access to electricity.

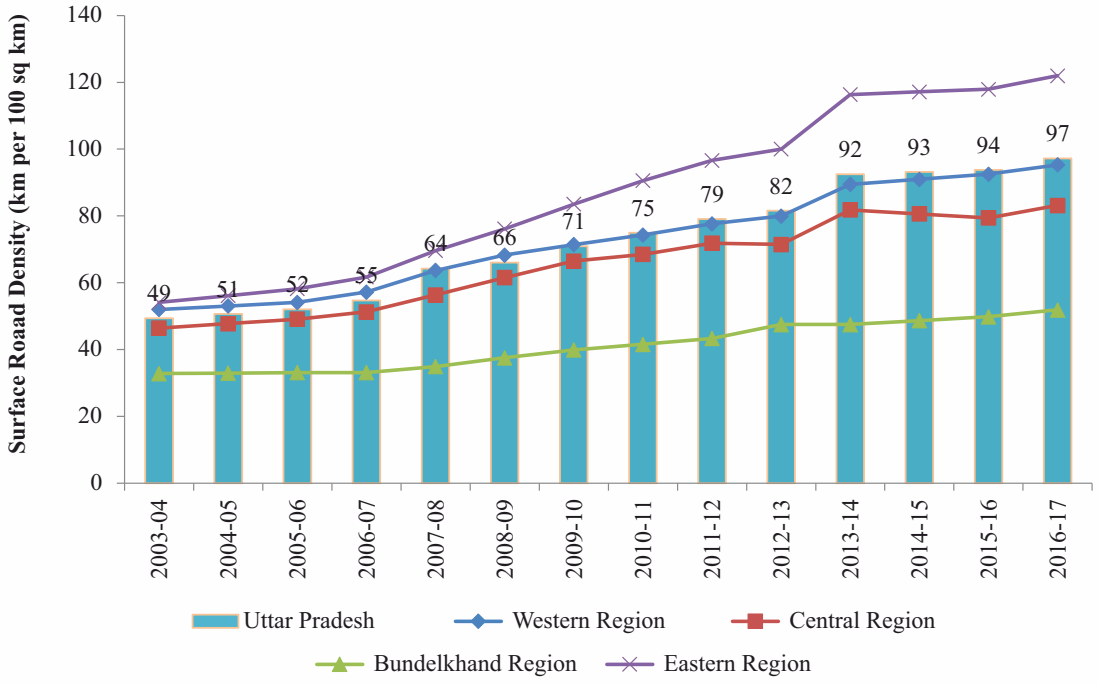
Further, the geographical distribution of connected load is skewed in the state. The bulk of installed generation capacity is in the eastern region of the state owing to the region's vast coal deposits. The load distribution in the state is concentrated in the western region that has led to challenges in transmission. Transmission and distribution losses in the state, which amounted to 24.5 per cent in 2015-16, are high. The state requires a strong distribution and transmission network to meet the growing demand for power by the agricultural sector.

### *6.1.3 Road Connectivity in Uttar Pradesh*

Road connectivity is closely related to agricultural growth as it facilitates trade, connects farmers to markets, promotes the development of backward regions and improves farm incomes. According to Basic Road Statistics (2015-16), the share of surfaced road length in total road length in the state was 83.3 per cent in 2015-16,which was much lower than that of Punjab (91 per cent), Haryana (88 per cent) and Gujarat (87 per cent).The total road density in the state was101 km per 100 square km 2003-04; this increased to 175 km per 100 square km in 2015-16, higher than the national average of 139 km per 100 square km of area. The state has made remarkable progress in reducing kaccha road length from 4335 km in 2003-04 to 81 km in 2015-16

Secondary data provided by Public Work Department (PWD), UP, shows that the surfaced road density in the state has increased from 49 km per 100 square km of area in 2003-04 to 97 km per 100 square km of area in 2016-17. The data reveals that the eastern region has the highest surfaced road density, which increased from 54 km per 100 square km of area in 2003-04 to 122 km per 100 square km of area in 2016-17 (Figure 15). Comparatively, the central and western regions had lower surfaced road density. The Bundelkhand region has performed poorly with respect to road connectivity. In fact, road density in the region is less than half that in the eastern region.

**Figure 15: Region-wise Surfaced Road Density in Uttar Pradesh**



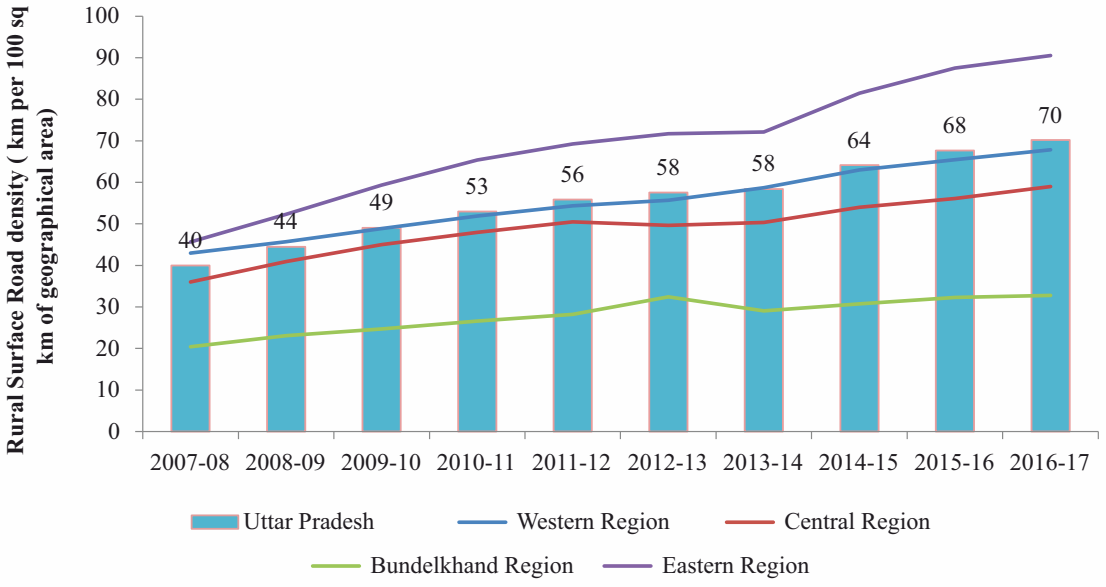

*Source: Statistical Abstract of Uttar Pradesh, various years*

*Note: Calculated using District wise surface road length maintained by P.W.D in UP*

For rural road connectivity, the central government launched the Pradhan Mantri Gram Sadak Yojana (PMGSY) in 2000-01. The farms to market roads are needed for sustainable and inclusive development. The rural surfaced road density increased from 40 km per 100 square km in 2007-08 to 70 km per 100 square km in

2016-17. Rural areas of the eastern region are better connected as compared to other regions whereas the Bundelkhand region has the least rural road connectivity (Figure 16). The poor rural road network restricts input delivery and the marketing of output. Poor road connectivity in Bundelkhand is the principal impediment to diversification into livestock, high value crops and agro-processing.

**Figure 16: Region-wise Rural Surfaced Road Density in Uttar Pradesh**




*Note: Calculated using district wise rural surface road length maintained by P.W.D in UP*
*Source: Statistical Abstract of Uttar Pradesh, various years*

## 6.2 Agricultural Inputs

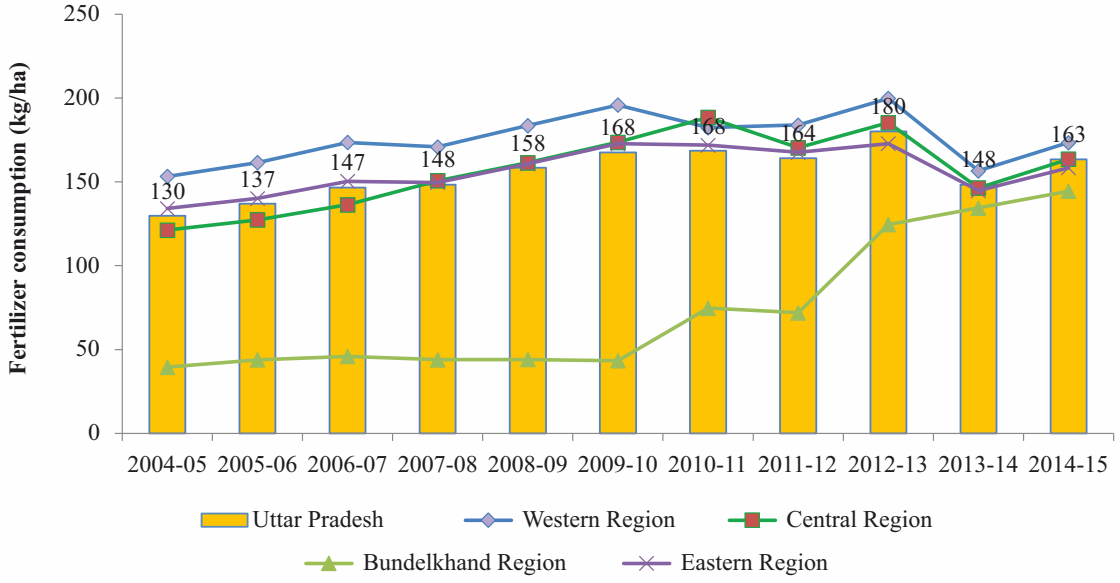
Adoption of new technology and modern inputs coupled with investments in physical and institutional infrastructure are crucial to improve the state's agricultural performance. In the next section, we will discuss the region-wise fertiliser consumption in Uttar Pradesh.

### *6.2.1 Fertiliser Consumption in Uttar Pradesh*

The data available from the Fertiliser Association of India shows that the consumption of fertilisers per hectare in the state was around 163 kg per hectare, higher than the national average of 127 kg per hectare in 2014-15. The fertiliser consumption in the state increased from 2004-05 to 2012-13; thereafter, it declined from 180 kg/ha in 2012-13 to 148 kg/ha in 2013-14 and picked up again in 2014-15 (Figure 17).

There are large variations in fertiliser consumption across the different regions in the state. Fertiliser consumption is highest in the western region followed by the central and eastern regions. It was the lowest in the Bundelkhand region, although usage in the region has increased substantially since 2011-12. In recent years, the variation across regions with respect to fertiliser consumption has shown a declining trend.

**Figure 17: Fertiliser Consumption in Uttar Pradesh**




*Source: Fertiliser Association of India, various years*

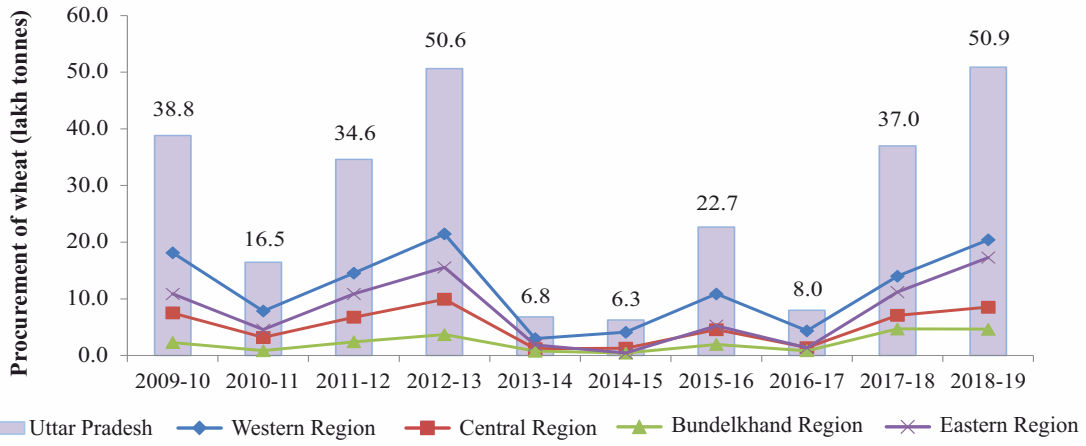
## 6.3 Institutional Infrastructure

### *6.3.1 Procurement Mechanism*

Procurement of food grains produced in the state is a measure of the extent to which the minimum support price (MSP) is provided to farmers. Procurement at MSP was adopted mainly for cereals such as wheat and rice to ensure that farmers get remunerative prices for their produce. MSP ensures that prices do not fall below a certain level. This also works as an incentive to invest in improving production and productivity. The procurement of wheat and paddy in UP has been poor and inconsistent because of which farmers in UP are not getting remunerative prices for their produce. It is crucial to examine the state procurement machinery to address the challenges faced by wheat and paddy farmers in the state.

The procurement of wheat in the state has been inconsistent over the years, though it improved significantly during 2017-18 and 2018-19. The share of wheat procured was the highest in the western region followed by the eastern and the central regions (Figure 18). The procurement of wheat in Bundelkhand was the lowest in the state. For the crop year 2018-19, the minimum support price (MSP) of wheat was fixed at Rs.1840 per quintal. In TE 2017-18, total wheat production was 324.9 lakh tonnes whereas the share of wheat procured in the state to total production was 8.2 per cent. This is very low as compared to other states such as Punjab where the share of procurement to total wheat produced was 72.7 per cent in TE 2017-18.

**Figure 18: Region-wise Wheat Procurement in Uttar Pradesh**

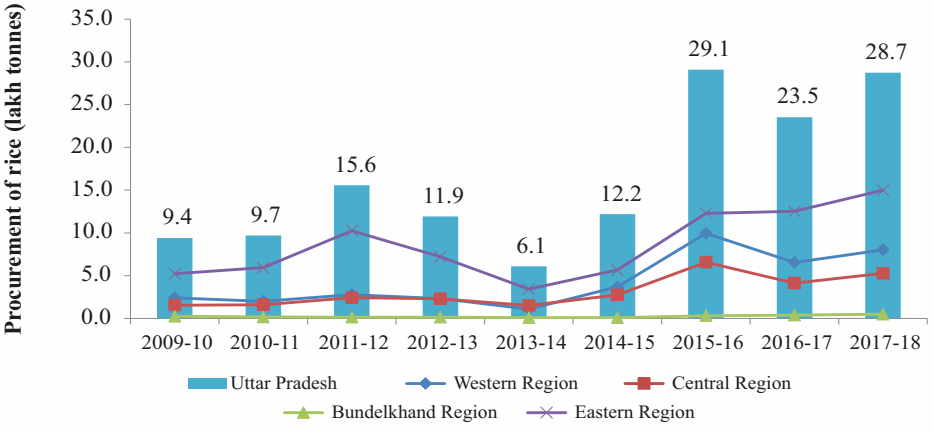



*Source: Food Corporation of India, UP Region, Note: Figures for 2018-19 are till June 2018*

Wheat procurement in UP accounted for only 14.3 per cent of total wheat produced for 2018-19. The share of wheat procured to total wheat produced was around 14 per cent in the western region, 13.5 per cent in the central region, 19 per cent in the Bundelkhand region and 13.6 per cent in the eastern region in 2018-19 (Appendix 6, Table A7). The state performed better in the procurement of wheat in 2017-18 as well as 2018-19 as compared to the year 2016-17 when the share of total wheat procured was only 3 per cent of the total wheat produced in the state. Although the state is the largest wheat producer in the country, procurement operations undertaken by the state government have remained erratic over the years. Unlike Madhya Pradesh and Chhattisgarh where procurement is primarily through co-operatives, a substantial quantity of procurement in UP is through agencies other than co-operatives.

Figure 19 shows the region-wise procurement of rice in the state. As in the case of wheat, the procurement of rice by state agencies has been low in Uttar Pradesh. In 2018-19, the MSP for common variety of paddy was fixed at Rs.1,750 per quintal while the same for Grade A paddy was fixed at Rs 1,770 per quintal. In the kharif marketing season for TE 2017-18, total procurement of rice in the state was 27.1 lakh tonnes. The share of rice procured was the highest in the eastern region followed by the western and central regions. The procurement of rice was the lowest in the Bundelkhand region during the year.

**Figure 19: Region-wise Rice Procurement in Uttar Pradesh**




*Source: Food Corporation of India, UP region*

In TE 2017-18, the state government procured 20 per cent of the total rice produced in the state. However, there are large variations in the proportion of total rice production procured not only across regions but also over time. In the year 2017-18, the state government procured 32.6 per cent of the total rice produced in the Bundelkhand region while 20 per cent was procured in the central, eastern and the western regions each in the same year (Appendix 6, Table A8). The high proportion of production procured in Bundelkhand is mainly because of the comparatively low rice production as compared to the other regions.

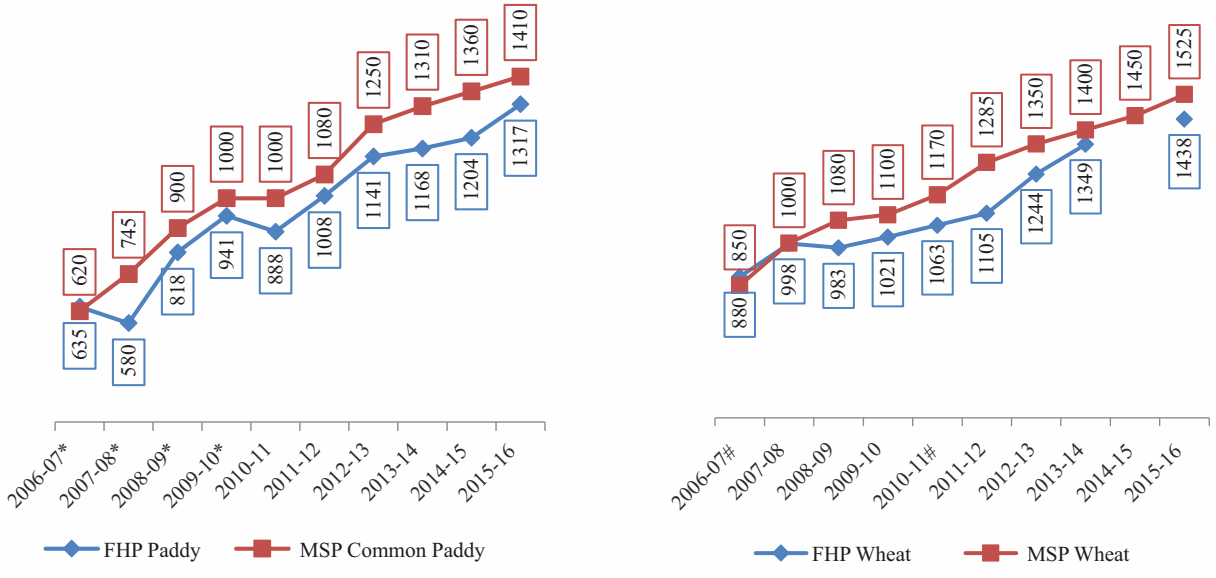
The low level of procurement has a significant impact on farm harvest prices (FHP). Figure 20 shows that the farm harvest price (FHP) of paddy had been significantly lower than MSP consistently over the years from 2007-08 to 2015-16. The FHP of wheat was higher than the MSP of wheat in the state in 2006-07. Since 2007-08, it has been lower than the MSP. This is due to inadequate infrastructure for marketing and the failure of the state government to consistently procure wheat and paddy at MSP.

For the crop year 2015-16, the minimum support price of wheat was fixed at Rs.1525 per quintal. In comparison to the MSP of wheat, the farm harvest prices of wheat in Baghpat in the western region was Rs.1582 per quintal, Rs.1374 per quintal in Sitapur in the central region, Rs.1394 per quintal in Lalitpur in the Bundelkhand region and Rs.1413 per quintal in Azamgarh district in the eastern region. The slightly higher level of FHP as compared to the MSP in the western region could be due to its proximity to the NCR market.

Similarly, the MSP of paddy was fixed at Rs.1410 per quintal in 2015-16. The FHP of paddy in Baghpat in the western region was Rs.1650 per quintal, Rs.1330 per quintal in Azamgarh district in the eastern region, Rs.1080 per quintal in Sitapur in the central region and Rs.1140 per quintal in Jhansi district in the Bundelkhand region.

The failure of the state government to ensure timely payment of MSP to farmers through procurement impedes agricultural growth and prosperity in the eastern, central and Bundelkhand regions.

**Figure 20: Farm Harvest Price (FHP) of Paddy and Wheat Compared to MSP (crop year) in Uttar Pradesh (Rs. per Quintal)**




*Source: Directorate of Economics and Statistics, GoI and CACP*

*Note: FHP for wheat in UP for 2014-15 is not available. MSP of wheat and paddy is for the crop year. * Including bonus for paddy: Rs 40 per quintal in 2006-07, Rs 100 per quintal in 2007-08, Rs 50 per quintal in 2008-09 and Rs 50 per quintal in 2009-10. # Including bonus for wheat: Rs 100 per quintal in 2006-07 and Rs 50 per quintal in 2010-11.*

The large fluctuation in the quantity of wheat and paddy procured by the government at MSP indicates that a substantial quantity of agricultural produce is sold outside the mandis. In the rabi marketing season 2017-18, around 47.36 lakh tonnes of wheat arrived in the mandis according to the Agmarknet portal; wheat production in 2016-17 was 349.7 lakh tonnes. There is a possibility that small and marginal farmers prefer to sell their produce in the village itself because high transportation costs make it less remunerative for them to take their produce to mandis.

Another major issue with the procurement operations in Uttar Pradesh is the fact that arrival data is not accurately recorded in the Agmarknet portal by mandi personnel. The farmers are more likely to be exploited by middleman if data on arrival and prices are not regularly recorded. Many procurement centres are not located inside mandis and no information is sent to farmers when to bring their produce. In kharif marketing season 2016-17, there were 115 purchase centres of FCI, 2400 centres of state government and 205 centres of private agencies in UP. In comparison, West Bengal had operated 48133 purchase centres (Lok Sabha Question, 2017a).

The performance of UP in the procurement of pulses and oilseeds as compared to other states also has been poor under the price support scheme (PSS). In kharif 2018-19, total procurement of pulses and oilseeds under PSS was 38,505.55 tonnes in UP. This includes 29,742.95 tonnes of urad and 8,762.60 tonnes of groundnut (until February 2019). The total number of farmers who benefited from the scheme was 33,248, which includes 26,941 for urad and 6,307 for groundnut. The number of farmers who benefited under PSS was around 2.2 lakhs in Gujarat, 2.9 lakhs in Rajasthan and 3.4 lakhs in Madhya Pradesh. The procurement operation carried by the state agencies under PSS is inadequate in UP. Farmers in Bundelkhand predominantly grow pulses and oilseeds, given the low irrigation ratio in the region. The inadequacy of procurement operations under the PSS forces farmers, particularly in Bundelkhand, to sell their crops below the MSP.

### *6.3.2 Agricultural Marketing*

The Union Government launched the National Agriculture Market (e-NAM) in 2016 to network the existing APMC mandis to create a unified national market for agricultural commodities. The idea was to bring transparency to the operations of mandis, which are seen as cartels operated by commission agents who collude with each other and keep prices down. UP is the second-largest participant in the e-NAM project after Rajasthan, with 125 regulated wholesale markets out of 1000 wholesale markets in the country with the e-NAM platform (as of March 29th, 2021).

Since most of India's farmers are small and marginal, they cannot transport their produce to far off mandis. They are, therefore, forced to sell their crop to local traders or at the nearest village haat or mandi at whatever price is offered by the commission agent or the trader. It was envisaged that a national digital platform would enable intra-state and inter-state trading of agricultural produce, which will help the farmers realise better prices in mandis. Quality assurance in mandis will also ensure that farmers are adequately paid if they bring better quality products to market.

Since the provisions of the Model APMC Act 2003 were not in sync with changing marketing dynamics and market ecosystem, the government released a new model act, 'The Agricultural Produce and Livestock Marketing (Promotion & Facilitation) Act, 2017' in April 2017. The Model APLM Act provided the development of a state-level single unified market dispensing with the concept of a notified market area. It promoted free trade of agricultural produce, including commercial crops, livestock, fisheries and poultry across India. It provides an alternative marketing channel other than APMCs to have the freedom to sell their produce to buyers through marketing channels of their choice.

Another model act, the Agricultural Produce and Livestock Contract Farming and Services (Promotion and Facilitation) Act, 2018, sought to remove contract farming from the APMC domain into a separate act proposed by the Ministry of Agriculture Farmers' Welfare. The model act has done away with market fees and commission that buyers had to pay earlier, resulting in saving 5 to 10 per cent of the transaction cost (Singh 2018). Permitting contract farming is a much-needed intervention for the diversification of agriculture, introducing modern technologies and providing assured markets for farmers to ensure sustainable and inclusive agricultural development.

In mandis in UP, e-NAM is yet to be fully operationalised as it requires trained manpower and commitment on the part of the management of the UP Mandi Parishad to ensure greater transparency of operations in APMCs. The UP Mandi Parishad inability to effectively implement the e-NAM has been a significant reason why the farmers remain unaware of its benefits. Since arrivals during the peak season are heavy, the bigger mandis have to establish sufficiently large assaying laboratories to deliver test results quickly. The commission agents and traders also have to be brought on board as information about them would become public if e-NAM is implemented and the business would leave a digital trail. Although UP has been one of the pioneer states to adopt the Model APLM Act, 2017, it has not implemented the act in true spirit.

Since 2019, a few inter-state transactions between e-NAM mandis in Uttarakhand and Uttar Pradesh have taken place in potatoes, brinjal and cauliflower. In the Union Budget for 2019-20, the government enhanced the grant to mandis selected to implement e-NAM from Rs.30 lakh to Rs.75 lakh. The UP government should avail the grant to increase the participation of mandis in e-NAM, given the state's rather poor record in reforming its mandi operations.

However, in the wake of the Covid-19 pandemic, the Ministry of Agriculture and Farmers' Welfare introduced some new features in the e-NAM platform, such as contactless remote bidding and mobile-based any time payment in April 2020. This was launched to limit farmers' need to physically come to wholesale mandis for selling their harvested produce, thereby maintaining social distancing. Subsequently, the ministry issued an advisory to states for facilitating direct marketing of agricultural produce, enabling the direct purchase of the produce from farmers, farmer producer organisations, cooperatives by bulk buyers, big retailers, and processors.

UP along with Madhya Pradesh and Gujarat amended its mandi act to facilitate direct procurement from farmers. The Uttar Pradesh Krishi Utpadan Mandi (Amendment) Ordinance was approved on May 6th, 2020, allowing the farmer to directly sell 46 fruits and vegetables without bringing them to mandis. This reform will promote private mandis, increasing investments in cold storages and warehouses, thus ensuring remunerative price for farmers.

Further, a major step was taken in June 2020 to reform agricultural marketing to directly link farmers to the markets for barrier-free inter-state and intra-state trade. The government brought three ordinances to amend Essential Commodities Act to enable better price realisation for farmers, Agriculture Marketing Reforms to provide marketing choices to farmers and Agriculture Produce Price and Quality Assurance to provide a framework for contract farming. Subsequently, the Farmers' Produce Trade and Commerce (Promotion and Facilitation) Act, 2020; the Farmer (Empowerment and Protection) Agreement on Price Assurance and Farm Service Act, 2020; and the Essential Commodities (Amendment) Act, 2020 (ECA), were passed by Parliament in September 2020. These legislations removed restrictions on trading within APMCS and allowed anyone with a PAN card to trade in agricultural commodities outside the APMC's physical

jurisdiction. It was to provide more choices to farmers to sell the produce to exporters, processors and bulk buyers. The ECA Amendment Act removed restrictions on stocking and movement except price rise to the extent of 100 per cent in case of perishables and 50 per cent in non-perishable produce. These policies had claimed to correct the extensive government control in agricultural marketing and help build competitive value chains by reducing marketing cost, improving better price discovery, enabling remunerative price for farmers and containing the seasonal price volatility (Gulati, 2020). These reforms could have encouraged private players to invest in storage infrastructures, decreasing the wastage of agricultural produce and enhancing agricultural diversification, however, these three Acts were repealed by the government in November 2021.

Given that more than 90 per cent of the farmers in UP are small and marginal, they have little individual bargaining capacity in the open market for the low volumes that they sell. In such a situation, aggregation of their produce through farmer producer organisations (FPOs) can help them realise remunerative prices. The collectivisation of producers, especially small and marginal farmers, into FPOs can address many of the challenges farmers face, including improved access to inputs, investments, technology, and markets. FPOs would have greater bargaining power because of their volume and ability to improve agricultutral produce quality through primary processing and storage facilities. Uttar Pradesh has around 51 FPOs promoted by the Small Farmers' Agri-Business Consortium (SFAC) and 116 FPOs promoted by NABARD. The FPOs promoted by SFAC were able to mobilise 54,079 out of 56,000 targeted farmers as of June 30, 2019. In 2011, NABARD also set up the 'Producer Organisation Development Fund' with an initial corpus of Rs.50 crore. The government needs to utilise the fund to promote FPOs in mission mode to strengthen agricultural marketing.

Another measure that has huge potential to create a national market for agricultural commodities by enabling farmers and traders access to each other is the warehousing receipts system. The Warehousing (Development and Regulation) Act (WDRA), 2007, was enacted to develop and regulate warehouses and make provisions to make warehouse receipts negotiable. Out of the 1485 warehouses registered by WDRA as on June 30, 2019, only 44 warehouses were in UP; this is very low as compared to 358 warehouses in Madhya Pradesh and 204 warehouses in Rajasthan. At present, it is not mandatory for warehouse owners to register their godowns with the WDRA. Bank pledge-finance is available against stock kept in un-registered warehouses also. As a result, the warehouse ecosystem envisaged by the government while enacting the WDRA Act 2007 has not developed satisfactorily. The UP government should take the lead in bringing more warehouses under the ambit of WDRA so that farmers can seek loans from banks against negotiable warehouse receipts to avoid distress sales of agricultural produce during the peak marketing season and to avoid post-harvest storage losses. Some concessions and preference in the interest rate on loans against stocks kept in registered godowns will incentivise more warehouses to register with WDRA. This will formalise the state's agricultural economy, and farmers can benefit from remunerative prices in the off-season.

# 7 Empirical Estimation: Drivers of Agricultural Growth in Uttar Pradesh

# Empirical Estimation: Drivers of Agricultural Growth in Uttar Pradesh

Hitherto, we discussed the sources and drivers of agricultural growth across the four regions in UP. Large variations in the use of production inputs, development of rural infrastructure, the efficacy of procurement operations and accessibility to agricultural markets directly impact the agricultural performance of the state. This section determines the drivers of agricultural growth in a panel data regression analysis for 70 districts in Uttar Pradesh for an 11-year period from 2004-05 to 2014-15. Analysing all these important drivers of agricultural growth in a simple framework is difficult as all these variables would affect agricultural growth in different ways. Hence, first, we checked the significant drivers of agricultural growth using a correlation matrix.

Table 20 illustrates the correlation matrix of the selected variables that have a significant impact on the gross value of output in agriculture and allied activities per hectare of the gross cropped area. The matrix highlights a strong and positive correlation between the dependent variable ($GVOA/GCA_{it}$) and drivers of agricultural growth. Across the districts in Uttar Pradesh, power intensity in the agricultural sector, surfaced road connectivity and irrigation ratio have a strong impact on agricultural performance. Different variables for diversification were identified in the state based on past trends and literature. The study uses diversification towards livestock as the diversification variable since it has a positive and significant correlation with GVOA per hectare of the state's gross cropped area. We hypothesise that basic infrastructure and diversification towards high-value agriculture have a significant effect on agricultural growth.

**Table 20: Correlation Matrix of Selected Variables**

| | *Log GVOA/ $GCA_{it}$* | *Log $Power_{it}$* | *Log $RD_{it}$* | *Log $IRR_{it}$* | *Log $Diver_{it}$* |
|---|---|---|---|---|---|
| *Log GVOA/ $GCA_{it}$* | *1.00* | | | | |
| *Log $Power_{it}$* | *0.50**** | *1.00* | | | |
| *Log $RD_{it}$* | *0.42**** | *0.39**** | *1.00* | | |
| *Log $IRR_{it}$* | *0.49**** | *0.34**** | *0.46**** | *1.00* | |
| *Log $Diver_{it}$* | *0.24**** | *0.48**** | *0.43**** | *0.15**** | *1.00* |

*Note: *** significant at 1% level of significance (p-value < 0.01); ** significant at 5% level of significance (p-value < 0.05); * significant at 10% level of significance (p-value < 0.1)*

*Source: Based on the calculations of the authors*

Now that we have identified the significant drivers, the model can be specified as:

$$logGVOA/GCA_{it} = b_1 + b_2\ logIRR_{it} + b_3 logRD_{it} + b_4 logDiver_{it} + b_5 logPower_{it} + E_{it}$$

where $i$ = district in UP and $t$ = time period from 2004-05 to 2014-15

In the model, $GVOA/GCA_{it}$ is the dependent variable measured as the log of the gross value of output in agriculture and allied activities per hectare of gross cropped area for district $i$ and time period t. $IRR_{it}$ is the log of irrigation ratio, measured as a ratio of gross irrigated area to gross cropped area (GCA) in district $i$ and time period t. $RD_{it}$ is the log of surfaced road density, calculated as the length of surfaced roads per 100 square km of geographical area in the districts of UP in period $t$ $Diver_{it}$ is diversification towards livestock, calculated as the log of the share of livestock in the total value of output in agriculture and allied activities for district $i$ and time $t$. $Power_{it}$ is the log of power intensity measured as power consumed in the agricultural sector per hectare of GCA for district $i$ and time $t$. Table 21 gives the description of the variables used in the regression analysis.

**Table 21: Variables and Definition Used for the Panel Data Regression**

| Variables | Description |
|---|---|
| *logGVOA/ GCA* | Log of gross value of output of agriculture and allied activities per hectare of gross cropped area |
| *logIRR* | Log of ratio of gross irrigated area (GIA) to gross cropped area (GCA) |
| *logRD* | Log of surfaced road length per 100 sq. km of the geographical area |
| *logPower* | Log of power intensity (kWh/ha) measured as power consumed in the agricultural sector per hectare of gross cropped area |
| *logDiver* | Log of share of livestock in GVOA |
| *logDiver_SFL** | Log of share of sugar, fruits and vegetables and livestock in GVOA |

*Note: * used in regional panel data analysis*

The study ran the Hausman Test to decide between a fixed effect and a random effect model. The Hausman test checks whether the unique errors (*ui*) are correlated with the regressors (Green 2008). The null hypothesis assumes that the unique errors (*ui*) are not correlated and the random effect model can be used against the alternative hypothesis of fixed effect.

$b$= consistent under $H_0$ and $H_1$

$B$= inconsistent under $H_1$, efficient under $H_0$

Test $H_0$: difference in coefficients not systematic

On running the Hausman test, the chi-square was found to be significant, thus rejecting the null hypothesis (Table 22). The differences in coefficients are not systematic and errors are correlated. Hence, we use the fixed effect model. The major difference between random effect and fixed effect model is whether the unobserved individual effects are correlated with regressors in the model (Green 2008).

**Table 22: Hausman Test to Determine Fixed Effect or Random Effect**

| | Fixed (b) | Random (B) | Difference (b-B) | Std Error (V_b-V_B) |
|---|---|---|---|---|
| Log $IRR_{it}$ | 0.36 | 0.29 | 0.07 | 0.07 |
| Log $RD_{it}$ | 0.29 | 0.23 | 0.06 | 0.01 |
| Log $Power_{it}$ | 0.36 | 0.39 | -0.03 | 0.01 |

$H_0$: difference in coefficients not systematic

Chi2 (3)= 45.34, Prob>chi2=0.000

The estimates of the fixed effect model are given in Table 23. As many of these variables are correlated, examining the effect of these variables in a single equation could lead to the problem of multicollinearity, hence, we ran different models with different variables and have presented those that have a significant effect on agricultural performance.

In model 1, the study runs a fixed effect model to examine the impact of irrigation ratio and diversification towards livestock on GVOA per hectare of gross cropped area for the period from 2004-05 to 2014-15. The model results indicate that a one per cent increase in the irrigation ratio increases agricultural growth by 1.3 per cent and a one per cent change in the share of livestock in the total value of output from agricultural and allied activities increases agricultural performance by 0.2 per cent.

In model 2, the study runs a fixed effect model to evaluate the relationship between irrigation ratio, power intensity and surfaced road density on GVOA per hectare of GCA. The model underscores that a one per cent change in the irrigation ratio and surfaced road density increases agricultural growth by 0.4 per cent each. Power intensity also has a significant impact on agricultural performance. A one per cent increase in power intensity increases GVOA per hectare of GCA by 0.3 per cent.

The regression analysis highlights the fact that agricultural growth significantly depends upon the basic infrastructure as well as diversification towards livestock. Surfaced road density increases connectivity to markets, which helps farmers realise better prices for their produce. The irrigation ratio also emerges as an important driver of agricultural growth in the district level analysis. Power intensity in the agricultural sector is another driver that has a considerable impact on agricultural growth. It is thus clear that a better road network, power intensity, and irrigation development can spur agricultural growth in the state. Agricultural research in the state needs to encourage diversification for sustaining farm incomes and improving agricultural performance.

**Table 23: Estimates of Fixed Effect Model to Determine the Drivers of Agricultural Growth in Uttar Pradesh (2004-05 to 2014-15)**

| Log $GVOA/GCA_{it}$ as the dependent variable | Model 1 | Model 2 |
|---|---|---|
| Log $IRR_{it}$ | 1.3*** | 0.4*** |
| Log $RD_{it}$ | | 0.4*** |
| Log $Power_{it}$ | | 0.3*** |
| Log $Diver_{it}$ | 0.2*** | |
| Constant | 5.4*** | 6.7*** |
| R-square | 0.3 | 0.4 |
| Rho (fraction of variance due to $u_i$) | 0.7 | 0.8 |
| Observation | 770 | 758 |
| No of district | 70 | 70 |

*Source: Based on the calculations of the authors*

*Note: *** significant at 1% level of significance (p-value < 0.01); ** significant at 5% level of significance (p-value < 0.05); * significant at 10% level of significance (p-value < 0.1)*

## 7.1 Region-wise Drivers of Agricultural Growth

The study also ran a region-wise regression analysis using a fixed effect model to identify the drivers that were important within each region for agricultural growth from 2004-05 to 2014-15 (Table 24). The correlation matrices for the four regions have been illustrated in Appendix 7 (Table A9, A10, A11 and A12). The study has used different indicators of diversification across different regions based on sources of agricultural growth. Based on the correlation matrix, the variables that have a significant impact on the gross value of output in agriculture and allied activities per hectare of gross cropped area in the state have been used in the panel data regression.

A fixed effect model is used to evaluate the relationship between irrigation ratio, power intensity and surfaced road density on GVOA per hectare of gross cropped area for the 26 districts in the western region for the 11-year period from 2004-05 to 2014-15. It can clearly be seen that irrigation, surfaced road density and power intensity in the agricultural sector have a positive and statistically significant effect on agricultural growth. The coefficient of the irrigation ratio in the western region has the largest positive and statistically significant impact on GVOA per hectare of GCA. It is evident from the estimates that a one per cent increase in the irrigation ratio increases agricultural growth in the region by 1.34 per cent. The western region has a high irrigation ratio of 88 per cent, higher than the state average of 79 per cent in TE 2014-15. The availability of water leads to higher productivity and facilitates multiple cropping. The other driver that has a strong impact on GVOA per hectare of GCA is power intensity. A one per cent increase in power intensity increases agricultural growth by 0.4 per cent and a one per cent increase in surfaced road density increases the GVOA per hectare of GCA by 0.2 per cent. The surfaced road density in the region was around 93 km per 100 square km of the geographical area in TE 2016-17. However, rural surfaced road density was lower in the region at 65 km per 100 square km of geographical area. The results highlight the fact that basic infrastructure is the main driver of agricultural growth in the western region.

The fixed effect estimates in the central region illustrated similar results, i.e., irrigation ratio, surfaced road density and power intensity in the agricultural sector have a positive and significant impact on agricultural growth. A one unit increase in irrigation ratio increases GVOA per GCA by 1.5 per cent. Surfaced road density has a higher impact on the growth of agriculture in the central region as compared to the western region. A one per cent increase in surfaced road density increases the GVOA per hectare of GCA by 0.33 per cent. Comparatively, power intensity had a lower impact in the central region than surfaced road density. A one per cent increase in power intensity in the agricultural sector increases GVOA per hectare by 0.16 per cent.

In the Bundelkhand region, the estimates of the fixed effect model indicate that the irrigation ratio and surfaced road density are the two main drivers of agricultural growth. The largest positive significant effect on GVOA per hectare in the region is that of surfaced road density. Table 24 shows that a one per cent increase in surfaced road density increases GVOA per hectare of GCA by 1.19 per cent whereas a one per cent increase in the irrigation ratio increases GVOA per GCA by 0.4 per cent. The Bundelkhand region has the lowest irrigation ratio among all regions in Uttar Pradesh, which is a major concern. Since 2002, drought has been persistent in the region and water resources are enough for only one crop a year. Around 80 per cent of farmers in the region are debt-ridden, which has led to farmers' suicides and massive migration from villages (Mathur, 2019; Gupta et al. 2014). There is a need for both central and state governments to resolve the water woes of the region. The region is far behind with respect to infrastructure development, which has impeded diversification in the region.

In the eastern region, two models were run to identify the drivers of agricultural growth for 27 districts for the period from 2004-05 to 2014-15. In model 1, the estimates of the fixed effect model underscore that both irrigation and diversification towards sugar, livestock and fruit and vegetables have a significant impact on agricultural growth. A one per cent increase in the irrigation ratio increases GVOA per hectare of GCA by 0.79 per cent whereas a one per cent increase in the diversification variable increases GVOA per hectare of GCA by 0.38 per cent. The irrigation ratio in the region was 75 per cent in TE 2014-15, lower than the state average of 79 per cent. In model 2, the fixed effect estimates underscore that both surfaced road density and power intensity have a significant impact on agricultural growth in the region. A one per cent increase in surfaced road density increases GVOA per hectare of GCA by 0.53 per cent and a one per cent increase in power intensity increases GVOA per hectare of GCA by 0.10 per cent. The surfaced road density in the region was 115 km per 100 square km of geographical area, which was the highest among the regions in the state as well as higher than the state average of 94 km per 100 square km of geographical area in TE 2016-17. Basic infrastructure and diversification towards sugar, livestock and fruits and vegetables have a significant and positive impact on agricultural growth in the region. Horticulture and livestock products require post-harvest storage, transport and processing, which is different from the processing of sugarcane, oilseeds and pulses. The state government needs to incentivise private sector investments in agro-processing to boost agricultural diversification in the region to accelerate agricultural growth.

**Table 24: Estimates of Fixed Effect Model across the Four Regions in Uttar Pradesh (2004-05 to 2014-15)**

| Log $GVOA/GCA_{it}$ as dependent variable | Western Region | Central region | Bundelkhand | Eastern region | |
|---|---|---|---|---|---|
| | | | | Model 1 | Model 2 |
| *Log* $IRR_{it}$ | 1.34** | 1.51** | 0.38* | 0.79*** | |
| *Log* $RD_{it}$ | 0.20*** | 0.33*** | 1.19*** | | 0.53*** |
| *Log* $Power_{it}$ | 0.40*** | 0.16** | | | 0.10*** |
| *Log* $Diver\_SFL_{it}$ | | | | 0.38*** | |
| Constant | 2.41 | 2.50 | 5.04*** | 6.44*** | 8.30*** |
| R-square | 0.6 | 0.4 | 0.2 | 0.1 | 0.3 |
| Rho (fraction of variance due to $u_i$) | 0.60 | 0.89 | 0.71 | 0.71 | 0.75 |
| Observation | 286 | 101 | 77 | 297 | 294 |
| No of district | 26 | 10 | 7 | 27 | 27 |

*Source: Based on the calculations of the authors*

*Note: *** significant at 1% level of significance (p-value < 0.01); ** significant at 5% level of significance (p-value < 0.05); * significant at 10% level of significance (p-value < 0.1).*

Our findings from the panel data regression analysis emphasise that both rural infrastructure and diversification towards livestock have significant effects on agricultural growth in the state.

Although our regional panel data regression analyses were unable to capture the effect of diversification towards high-value agriculture in the western, central and Bundelkhand regions, the analysis of the

decomposition of agricultural growth highlighted that high value agriculture such as livestock, sugarcane, fruits and vegetables are major sources of agricultural growth in the state. The state has a large and diverse production bases encompassing a wide range of fruits, vegetables and livestock products. Diversification towards high value agriculture would not only augment farm income but also sustain high agricultural growth. This requires pro-diversification policies both in production and post-harvest management to optimally utilise the vast production of high value agricultural produce. There is need to develop efficient commodity specific value chains along with building infrastructure such as warehouses, cold-chain, solar-power cold storage and agro-processing plants to encourage farmers to diversify towards high value agriculture. Verma, Gulati and Hussain (2017) in their study have pointed out that Uttar Pradesh has abundant supplies of raw materials that can be utilised effectively by expanding the food processing capacity in the state. UP has immense scope for the promotion and expansion of processing of several agricultural products. Agro-processing industries can increase the shelf life of high value perishable commodities, improving farmers' profitability. This will provide a strong incentive to diversify towards high value commodities.

There have been some important schemes and initiatives by the central and he state government to develop the agro-processing sector in Uttar Pradesh in the last decade. The Ministry of Food Processing Industries (MoFPI), Government of India, has been following a cluster approach to promote the food processing industry in states. Since 2008, the ministry has been providing grants to the private sector to create integrated cold chain and value-added infrastructure, including pre-cooling, grading, waxing, cold storage, controlled atmosphere (CA) storage, individual quick-freezer (IQF), and mobile cooling units to facilitate the distribution of horticultural, organic, marine, dairy, meat and poultry products. Some of the major food processing clusters in UP (identified by MoFPI) are shown in Figure 21.

Grants are also available from the Ministry of Food Processing to set up laboratories to analyse samples from processing industries. Out of 72 projects sanctioned in the country, there are 5 laboratories in UP located in Noida/Ghaziabad and one each in Allahabad and Lucknow.

To provide financial assistance to establish and modernise food processing units, the Uttar Pradesh government had launched the Chief Minister's Food Processing Mission in 2015.[17] The scheme aimed to increase the capacity of food processing units as well as assist self-help groups to become micro and small-scale entrepreneurs in the food processing sector. A unit is eligible to get Rs.50 lakh as interest subsidy over five years. However, the amount provided in the state budget was too meagre at Rs.42.48 lakh in 2017-18.

[17] *UP government renamed the National Food Processing Mission as the Chief Minister's Food Processing Scheme in 2015, after the de-linking of the National Food Processing Mission by the central government.*

**Figure 21: Some Major Food Processing Clusters in UP**


*Source: MoFPI (2017)*

Launched in 2008, the Mega Food Parks Scheme (MFPS) of the MoFPI provides a grant of Rs. 50 crore to set up modern infrastructure for food processing units. It facilitates a reliable supply chain of raw materials for processing units and helps create a cluster of food processing units. Of 42 mega food parks sanctioned across India, 15 had already become operational up to March 31, 2019. Three mega food parks had been given in-principle approval in Mirzapur, Mathura and Gautam Budh Nagar districts in 2017-18 but the promoter of the MFPS at Mirzapur in East UP is yet to complete the formalities for obtaining the final sanction. The other two parks in Western UP are under implementation.

Although there have been numerous schemes and initiatives by the central and state government to develop the agro-processing industry in UP, the state still needs to overcome the reluctance of large food processing units to invest in UP. This requires getting both rural and marketing infrastructure in place to enable farmers to get their produce to mandis. Another important institutional infrastructure is a sound procurement system to ensure timely payment of MSP directly into the bank accounts of the farmers. This will not only encourage farmers to bring their produce to procurement centres but also considerably improve the arrival of their produce at the mandis.

# 8 Summary of findings

# Summary of findings

Agriculture occupies an important place in UP's with 46.9 per cent of the workers in the state employed in the sector in 2015-16. The state contributed 12 per cent of the country's gross domestic product for agriculture and allied activities (GDPA) at constant (2011-12) prices in TE 2017-18. The state is also critical in the context of the country's food production and food security. Given this, increasing productivity and production in the agricultural sector is important to keep up with the rising demand for food. The diverse topography of the state benefits the agricultural sector. The western and central regions have better irrigation facilities as compared to the other regions. The eastern region is flood-prone with the highest density of population and low per capita availability of land. Bundelkhand suffers from scarcity of water and is semi-arid. The cropping intensity in UP has increased from 149.4 in TE 2002-03 to 156.6 in TE 2014-15. The agricultural and allied sector in UP registered an annual growth rate of 2.3 per cent in the period from 2002-03 to 2015-16 (at 2011-12 constant prices). The western region contributed half the agricultural GDDP followed by the eastern and central regions. The share of the Bundelkhand region is the lowest. The western region has been able to sustain higher rates of agricultural growth due to its distinct agrarian structure and infrastructure, the progress of land consolidation and higher access to assured irrigation due to investment in private tube wells.

The state is predominantly a small landholding state but with large variations in average farm size. The eastern region has a comparatively higher share of small and marginal land holdings as compared to other regions. On the other hand, Bundelkhand has a higher share of large land holdings. The scope for area expansion in agriculture is limited in the state. Moreover, the state lags behind in agricultural productivity. This is reflected in the low average income from farming activities. The average monthly income of an agricultural household in UP was Rs.6,668, which was even lower than that in Bihar (Rs.7,175) and Odisha (Rs.7,731 per month) (NABARD, 2018). The poor performance of the state in agricultural productivity is due to several factors including the lack of diffusion of innovation in the state. Thus, agricultural policies must be targeted towards raising yield and intensification of input use to accelerate agricultural growth.

The study aimed to determine the sources and drivers of agricultural growth in UP. The decomposition of GVOA growth into various sub-sectors shows that livestock is the major sources of agricultural growth contributing 41.1 per cent, followed by cereals (16.5 per cent), fruits and vegetables (11.5 per cent) and sugarcane (9.0 per cent).

The panel data regression analysis to identify the drivers of agricultural growth showed that agricultural productivity and growth significantly depend upon basic infrastructure and diversification of agriculture, particularly the expansion of livestock farming in Uttar Pradesh. Surfaced road density increases connectivity to markets, which helps farmers realise remunerative prices for their products. The irrigation ratio also emerges as an important driver of agricultural performance in the district level analysis. Power intensity in the agricultural sector is another driver that has a considerable impact on agricultural performance.

However, the state is characterised by poor rural road connectivity and erratic power supply, which is a major cause of under-utilisation of irrigation facilities. Moreover, disparities across different regions in the availability of physical infrastructure has impeded overall agricultural growth. The other area where UP is lagging behind is in terms of efficient agro-processing and marketing infrastructure, which largely decides the scope of diversification. These are some of the important areas that need policy intervention to improve agricultural performance in UP.

# 9 Policy Recommendations

# Policy Recommendations

Uttar Pradesh has great potential to improve agricultural growth and farm income. Land ownership is characterised by small and fragmented holdings. In the period of the study from 2004-05 to 2016-17, UP was faced with uncertain rainfall, frequent droughts in the Bundelkhand region and floods in the eastern region. Productivity is poor due to the poor management of water and land resources. Given the importance of the agricultural sector in the state and the dismal state of farming households, the UP government needs to focus on region-specific policies for revitalising the agriculture sector in the state. This study suggests areas for policy intervention based on the region-wise analysis of sources and drivers of agricultural growth in UP between 2004-05 and 2015-16. The immediate areas that need policy interventions for increasing agricultural performance in the state are detailed below.

## 9.1 Diversification towards Livestock

Given that the contribution of the livestock sector in the growth of GVOA is the highest in UP, the state government needs to ensure adequate institutional arrangements for the marketing and processing of livestock products. The state government also needs to provide incentives to bring private players to invest in commodity specific supply chains.

### *9.1.1 Dairy in Uttar Pradesh*

The contribution of dairy is the highest in the livestock sector in all the four regions of UP. The state is the largest producer of milk in the country accounting for 17.3 per cent of the total milk produced in the country. The western region leads in milk production as compared to other regions. However, milk processing facilities are not uniformly distributed across regions. Among the seven cold chains projects approved in the dairy sector by MoFPI in UP, three projects are located in the eastern region, 2 in the central region and 2 in the western region. However, there are no projects that were approved in the Bundelkhand region. The Bundelkhand region needs to diversify towards the dairy sector by investing in milk processing units in the region.

#### *9.1.1.1 Increase Processing of Milk in the Organised Sector through Private Players*

One of the major challenges faced by the dairy sector is low procurement of milk by co-operatives, which was only 0.5 per cent of the daily milk produced in the state in 2016-17 (NDDB 2018). The declining number of co-operatives in UP is a major concern and the state government needs to strengthen and revitalise existing dairy co-operative societies and organise new milk unions for adequate procurement of milk at remunerative prices. The procurement of milk is mostly by the unorganised sector in the state.

Another major constraint faced by the dairy sector has been the inadequate budgetary support for increasing the dairy co-operative cold chain infrastructure in the state. UP had around 71 bulk milk coolers, 1633 chilling centres and 3,703 dairy plants in March 2018, which is very low when compared to states like Gujarat with 17,530 bulk milk coolers, 6435 chilling centres and 24,175 dairy plants in 2017-18 (NDDB, 2017-18). The state needs to encourage private players through appropriate policies and incentives to invest in dairy value chains. The marketing of dairy and value-added dairy products can help increase the income of farmers. The state also needs to invest in extension services and marketing of dairy products in both rural and urban area.

The state has provided a financial sanction of Rs. 4379.50 lakh in the financial year 2017-18 to set up a milk powder plant at Kanpur. The state also provided a financial sanction of Rs. 1250 lakh to the Pradeshik Co-operative Dairy Federation (PCDF) to establish new dairy plants and to renovate existing ones under the dairy development programme.

NABARD has sanctioned a project of Rs.1225.01 crore to PCDF to set up 8 new plants and refurbish 4 dairy plants in the state. UP has taken a loan of Rs.983.22 crore from NABARD under RIDF to upgrade/modernise/set up new dairy plants in the co-operative sector. The success of this expansion of PCDF requires support from the state government along with proper training to milk producers to increase milk production.

#### *9.1.1.2 Improve Productivity and Quality of Milk in Uttar Pradesh*

Although the state has been cross-breeding low yielding indigenous cows with high yielding exotic breeds like Holstein Friesian and Jersey bulls, the milk productivity of cross-breds is lower in UP than in other states such as Punjab and Gujarat. Moreover, buffalo milk contributes three-fourths of the milk produced in the state; yet, the share of female buffalos in the total buffalo population in UP is lower than in other states such as Punjab. The state government needs to improve the breed of cattle through artificial insemination using sexed semen, which can increase the probability of female offspring through sex selection and reduce the risk of diseases in the offspring. UP has only three deep-frozen semen stations at Lucknow and Lakhimpur Kheri in the central region and Ghaziabad in the western region, which produce quality semen straws and maintain quality bulls. The state government needs to invest in artificial insemination and animal health facilities in all major milk producing districts so that the facility is available at the doorstep of milk producers. Investments are needed to establish more frozen semen centres. The Uttar Pradesh Livestock Development Board (UPLDB) also needs to improve breeding services and shift from natural breeding to artificial insemination in remote areas.

The dairy sector in the state has also been shown in a bad light with media reports of widespread adulteration of milk. Samples collected from various regions by the FSSAI for the National Milk Safety and Quality Survey 2018 failed to meet FSSAI's safety norms.[18] Although FSSAI has not released the number of failed samples for each state, adulteration of milk is considered rampant in UP. Without strict quality control, UP's dairy sector cannot compete with the onslaught of excess milk supply from Gujarat. Therefore, the state government needs to invest in setting up quality control laboratories in major milk producing districts. MoFPI has approved a scheme for providing grants for such laboratories. The state government should encourage the private sector to set up modern testing facilities in various regions of the state. Stringent and exemplary action needs to be taken against those found guilty of adulteration.

The other important issue that needs urgent attention from the state government is the outbreak of foot and mouth disease (FMD). The UP government needs to check and control FMD, especially in the western and semi-arid regions of the state by a vaccination-based FMD control programme.

### *9.1.2 Poultry Development*

The poultry sector in the state is largely unorganised. Most of the big and small broiler hatcheries are in the unorganised sector. The state has huge potential for poultry development. The poultry production in UP is not

[18] *Several samples were found non-compliant because of the presence of high amounts of antibiotics, and pesticide, and M1 ammonium sulphate and aflatoxin residues.*

able to meet the demand for eggs and chicken. UP procured 1 crore eggs and 972 lakh broiler chicken annually from other states in 2012. To remove this gap, make the state self-sufficient in poultry production and increase entrepreneurship, the state government announced the UP Poultry Development Policy in 2013. In 2016-17, the state was able to increase egg production to 28 lakh eggs per day and generate self-employment (UP Plan Document 2016-17).

The state needs to continue to invest in poultry development as it has wide acceptability among farmers. The sector has huge potential to increase farm income and make UP self-sufficient in poultry products. The state has no facility/plant available to process poultry products. There is immediate need to attract investments in the poultry processing sector in UP.

### *9.1.3 Meat Industry*

The meat industry has huge potential in the state to increase agricultural growth and farm incomes. The industry needs investments to set up food processing units, create cold chain infrastructure, and increase value addition.

Most municipal slaughterhouses in UP are lying closed and the local demand for meat for consumption is being met by slaughtering animals outside approved and UPPCB compliant abattoirs. There are a number of valuable by-products[19] of meat, which can be made available only if slaughtering takes place in hygienic conditions. The state government should modernise municipal abattoirs in all major cities and towns so that slaughtering of animals takes place in hygienic conditions.

## 9.2 Increase Productivity of Food grains and Cash Crops in Uttar Pradesh

Despite the implementation of NFSM in the state, the productivity of wheat has not shown much improvement. In the western region, the productivity of wheat declined marginally between TE 2002-03 and TE 2016-17 even though the region is endowed with fertile soil, adequate irrigation facilities, and has better access to agricultural inputs and rural infrastructure. On the other hand, the eastern and central regions recorded an increase in wheat productivity during the same period. The eastern and central regions can diversify towards wheat production to reap the benefits of improved productivity.

The state performed relatively better in increasing rice productivity as compared to wheat. The NFSM covered 23 districts under rice, which were mainly concentrated in the eastern region, followed by central and western regions. However, the increase in productivity of rice was marginal in the eastern region as compared to the other regions. The panel data regression analysis for the eastern region (see Table 24) also indicates that the region needs to diversify from food grains to high value agriculture such as livestock, sugarcane and fruits and vegetables to augment the agricultural growth rate.

The Bundelkhand region can gain from increasing the production and yield of oilseeds and pulses. Introducing short duration and improved varieties of oilseeds and pulses can increase the yield considerably in the region.[20]

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[19] *Meat by-products include trimming, bones, blood and skin. Albumin is used for the glue, textile and dye industries. Bone meal is used as animal feed and fertiliser. Hides and skin are used for leather, footwear, gloves, belts, saddlery and upholstery. Hair and wool are used for brushes, yarn, fabrics and fibres. Tallow is used for making soaps, glycerine, lubricants and grease. It has also been identified as a raw material for bio-diesel production.*

[20] *The short duration variety of moong matures in 60-70 days and urad matures in 70-80 days whereas in oilseeds, the short duration variety of mustard matures in 110 days and sesame matures in about 90-100 days.*

However, during the study period, the production of pulses has declined in the region as well as in the state. Farmers in Bundelkhand can gain through higher procurement of oilseeds and pulses from the price support scheme. The state government also needs to incentivise private investment in processing units of pulses and oilseeds so that the produce does not have to be transported over long distances. At present processing units of oilseeds and pulses are in Bareilly, Agra, Lucknow, and adjoining districts. Moreover, the private sector needs a stable and long term policy environment to invest in creating required infrastructure. However, sudden policy decisions by the government such as imposition of stock limits under the Essential Commodities Act or reduction of import duties discourages the private investments in procurement, storage and processing infrastructure.

Uttar Pradesh is the largest producer of potato in the country. With adequate investment in developing an efficient value chain and solar powered cold storages, the state government can capitalisese on the benefits of high production of potato by attracting investments in the processing industry. At present, the processing industry is concentrated in Gujarat and Maharashtra as the variety of potato required by the processing industry is not grown in UP.

In kharif 2015, the UP government launched a scheme to provide subsidy on hybrid seeds. Subsequently, the scheme was expanded to include both certified varieties and hybrid seeds during the rabi season 2015-16. This new scheme has generated robust farmer-level data that helped identify beneficiaries in a transparent manner. The amount of subsidy on seeds purchased by farmers was directly transferred into their bank accounts. Since 2016-17, in addition to the seed subsidy, subsidies on farm equipment and micro-nutrients have also been disbursed through direct benefit transfers (DBT). The scheme has benefited more than 19 lakh farmers in UP since 2015. This scheme can facilitate faster and inclusive diffusion of technology to reach small and marginal farmers. It can also help in better tracking of the seed replacement ratio.

Another scheme implemented by the UP government provides subsidy of up to 80 per cent on agricultural equipment to provide agricultural implements and machines at cheaper rates under the Sub-Mission for Agricultural Mechanisation, a component of RKVY. In order to make available various agricultural implements and machines at cheaper rates, assistance in the form of subsidy at the rate of 25 per cent to 50 per cent of the cost of equipment/machinery within permissible ceiling limits is available to all category of farmers. The UP government has recently decided that farmers should complete their registration online to avail the direct benefit transfer.[21]

## 9.3 Procurement of Food Grains and Direct Income Support to farmers

The large variation in the procurement of wheat and rice over the years in UP has deprived farmers of remunerative prices for their produce. In the last two years, the state performed well in the procurement of wheat, which increased from 8 lakh tonnes in 2016-17 to 37 lakh tonnes in 2017-18 and to 50.9 lakh tonnes in 2018-19. The state is also characterised by regional variation in the procurement of food grains. The share of wheat procured to total wheat produced in 2018-19 was around 14 per cent in the western region, around 13.5 per cent in the central region, 19 per cent in Bundelkhand, and around 13.6 per cent in the eastern region. The

[21] *UP government has issued instruction about new online procedures on June 13, 2019.*

failure of state agencies to procure produce and ensure timely payment of MSP affects farmers' incomes. Besides, it leads to very low arrivals of produce in the mandis, much below the production level, particularly in the case of wheat and rice. State agencies need to ensure timely payments of MSP to incentivise farmers and improve arrivals of agricultural produce in mandis. Further, the state also needs to record price and arrival data accurately in the Agmarknet portal. With a sound database, the state procurement machinery can be strengthened to improve procurement operations and help formulate appropriate regional policies.

Notably, only 6 percent of total farmers in the country have gained from selling wheat and paddy directly to any procurement agency according to Shanta Kumar-headed High-Level Committee on Restructuring of Food Corporation of India (2015). MSP operations tend to benefit bigger farmers (Gulati and Saini 2019). In this regard, the recent policy of the central government, Pradhan Mantri Kisan Samman (PM-Kisan), provides assured income support to small and marginal farmers to alleviate farm distress. The scheme proposed to provide farmers having cultivable land of up to 2 hectares direct income support of Rs.6000 per year. It is expected to benefit around 12 crore small and marginal farmer families. The scheme was launched from Gorakhpur in UP in February 2019, and the first instalment of Rs.2000 was provided through direct benefit transfer. In UP, the first instalment has been released to around 1 crore farmers. The launch of PM-Kisan marked a significant departure in farm policy interventions towards income support that will benefit small and marginal farmers as they find it more difficult to benefit from procurement at MSP. The impact of PM-Kisan in transforming agricultural support and boosting farm income in Uttar Pradesh needs to be researched further. However, the implementation of the scheme marks the beginning of a shift towards income support schemes.

## 9.4 Development of Agro-Processing and Value-chain Development in Uttar Pradesh

The agro-processing sector in the state holds considerable potential to both generate non-farm employment and increase farm incomes. Given that the state is the largest producer of potato, sugarcane, mangoes, peas, watermelon, wheat, milk and meat, the state should have been the first choice of investors to set up processing units. However, states such as Telangana, Maharashtra, Tamil Nadu and Punjab are seen as more attractive destinations for investment. The GoUP should activate Udyog Bandhu and provide the required approvals to the food processing industry in a time-bound manner. For new units, the approval process has to be much simpler. The other significant factors that increase the scope for agro-processing in UP are the availability of a large consumer market, abundant labour and low production costs. Since most agricultural products are perishable in nature, processing surpluses through post-harvest management can cut down losses suffered by farmers. It will also help better price realisation by farmers.

As on March 31, 2019, of 299 projects of cold chain in India, UP received grants for 26 projects. Eleven of these projects have since been completed. The total investment in these projects is Rs.731.16 crore, for which the MoFPI provided grants of Rs.214.83 crore. Fourteen of these projects are located in the western region, 3 are in the eastern region, 7 in the central region and 2 in Bundelkhand. The fruit and vegetable sector has received grants for 15 projects while the dairy sector has received grants for 7 projects. Meat and pickle units were sanctioned grants for one unit each while two irradiation units have been sanctioned grants by the Ministry of Food Processing Industries. The grants received by UP are much smaller than that received by Maharashtra, which produces a much smaller quantity of fruits and vegetables. Maharashtra has received grants of Rs.483.16 crore for 67 projects costing Rs.1801.67 crore. Since cold chains are essential infrastructure for perishable items of food, including dairy products, the state needs to invest in cold chains.

For developing agro-industries, there is also need to raise the standards of food safety and hygiene to globally accepted norms by facilitating the adoption of ISO certification by the food processing industry. Most agro-processing units are in the unorganised sector with outdated technology and know-how. The state government needs to support public-private partnerships (PPP) across the agricultural supply chain to link farmers to the market in an efficient and effective manner.

The state government needs to invest in processing plants for pulses and oilseeds to increase farm incomes and reduce poverty in the rain-fed region of Bundelkhand. High value commodities such as livestock, fruits and vegetables, and other horticultural crops require an efficient and reliable value chain, warehouses, cold storage, cold chains, efficient transport mechanisms and processing facilities. This will encourage farmers to diversify into high-value agriculture, thus ensuring increased production, productivity and agricultural growth in the state.

## 9.5 Reform Agricultural Marketing in Uttar Pradesh

The state government needs to increase the number of mandis under the e-NAM portal to make trading in agricultural commodities more transparent. The UP Mandi Parishad has not been able to implement e-NAM in a meaningful manner as a result of which farmers remain largely unaware of its benefits. UP needs to ensure that an auction is done through the e-NAM portal to deter the formation of cartels among traders.

At the same time, the state government needs to ensure that the infrastructure created in AMPC mandis does not deteriorate so that the farmers can continue to bring their produce to mandis if they can get a better price there.

The state government should also keep the fee and other charges in mandis low so that mandis continue to be attractive to farmers and purchasers. Moreover, the information on quantity traded and prices realised must be meticulously collected and entered into the Agmarknet portal, which is useful to monitor the functioning of agricultural markets.

Further, the infrastructure in mandis needs to be further improved by attracting private investment in warehousing and cold chain.

## 9.6 Sugarcane

The state has huge potential in the sugarcane sector, which has not been realised due to the technological obsolescence of sugar mills and distortionary pricing policies. We put forward some necessary and urgent actions to address these important issues in the sugarcane sector.

### *9.6.1 Pricing of Sugarcane in Uttar Pradesh*

A major problem facing the sugarcane sector is non-realisation of the price of sugarcane by farmers in the state, particularly in the western region. The livelihood of lakhs of farmers is dependent on cane farming. The central government has been announcing fair and remunerative prices (FRP) since 2009. The FRP for 2017-18 was Rs.255 per quintal, linked to a basic recovery rate of 9.5 per cent. Every increase in recovery by 0.1 per cent increases the FRP by Rs.2.68 per quintal. For a long time, the state government in Uttar Pradesh has been announcing a state advised price (SAP) for sugarcane, which is much above the FRP recommended by Commission for Agricultural Costs and Prices. Since SAP is not linked to the market price of sugar, mill

owners complain that they are unable to pay sugarcane price to farmers as their realisation from sugar prices is not enough. Every few years, sugar prices collapse and sugar mills start defaulting on the payment of cane price to farmers. As of April 2019, of the payment of Rs.29,426 crore due to sugarcane farmers, Rs.19,182 crore have been paid. The farmers are yet to be paid Rs.10,244 crore for 2018-19, which accounts for 35 per cent of due arrears in the state. The non-payment of sugarcane dues has led to strikes by farmers and forced the closure of sugar mills. In the western region, mounting sugarcane dues have become the Achilles heel for the state and central governments.

In place of the present arrangement, the state needs to implement the recommendations of Rangarajan Committee on Sugar (2012) to comprehensively address issues related to the regulation of the sugar industry in India to promote efficiency and investment in this sector. The state should encourage market-based long-term contractual arrangements between mills and farmers for sugarcane and phase out the cane reservation area.[22] Such contracts will give more autonomy to farmers to choose mills to sell their produce to. This will also compel sugar mills to pay cane dues on time. The committee also recommended the removal of the minimum radial distance of 15 kilometres between two sugar mills.

Another recommendation of the Rangarajan Committee was regarding the determination of sugarcane prices by sharing revenue generated from sugar and each of the saleable primary by-products in the process of sugar production in the ratio of 70:30 between cane growers and sugar mills. The sugar mills would have to pay fair and remunerative prices to farmers in the first instalment, and the balance payment of cane dues will depend on the final price of sugar realised by sugar mills. Since the estimate of the value of sugar includes return on capital employed, this implies that farmers would also get a share of the profits. With such a system in operation, states should not declare SAP.

The state also needs to set up a price stabilisation fund to generate resources in years of high prices. The UP government needs to accept the recommendations of the Rangarajan Committee, and sugar mills should be required to pay FRP calculated at 75 per cent of prevailing sugar prices. Since the recovery of sugarcane has increased in UP, farmers would have received a higher price if the Rangarajan formula had been accepted. In years of depressed sugar prices, when the payment by sugar mills by this formula would be lower than the FRP, the state government should pay the difference between the FRP and price derived from the Rangarajan committee formula.

The UP government has been providing ad-hoc assistance to sugar factories to enable them to pay farmers' cane dues. During the 2013-14 and 2014-15 crushing seasons, the state government extended several concessions to the sugar industry. The state government had given a concession of Rs.11.03 per quintal, which includes entry tax waiver of Rs.2.73 per quintal, purchase tax waiver of Rs.2.00 quintal and society commission of Rs.6.30 per quintal for crushing operations in 2013-14.

In 2014-15, the UP government paid Rs.20 per quintal as additional financial assistance for payment of cane prices for the crushing season from October to May. Apart from this, the state government had also paid Rs.8.60 per quintal to farmers to cover the differential between the SAP and the average market price of sugar and by-products. This ad-hoc grant of Rs.28.60 per quintal to sugar mill owners was for payment of sugarcane prices.

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[22] *"Every designated mill is obligated to purchase from cane farmers within the cane reservation area, and conversely, farmers are bound to sell to the mill" (Rangarajan Committee, 2012). This reduces the power of farmers to bargain for a better price.*

Rather than resorting to ad-hoc grants to help the sugar industry, the state government needs to develop a long-term and transparent mechanism of cane pricing based on the open market price realisation of sugar.

### *9.6.2 Molasses*

The clout of certain big producers of country liquor has led to molasses being sold at prices that are approximately four times lower than the price it would have fetched if sold freely in the open market. Sugar mills are bound to release a reserved quantity to country liquor producers before selling the remaining molasses in the open market. The UP government exercises a great deal of control on molasses. Table 25 shows the changes in policy on molasses in the last five years.

The new molasses policy had reduced the reservation of molasses for country liquor from 25 per cent in 2015-16 to 12 per cent in 2017-18. Sugar mills are now required to maintain a ratio of 1:7.3 for the sale of molasses to the liquor industry and the open market. Producers are free to sell the remaining 88 per cent of the molasses as per the market requirement. The support to the liquor industry by the state government is on account of its large earning from excise revenues. The sale of molasses by sugar mills outside UP is also tightly regulated by the state government, and sugar mills are required to seek the excise commissioner's permission on a case-to-case basis. Subsidised country liquor production is at the cost of sugarcane farmers. In 2018-19, the state projected an income of Rs.9738.81 crore from country liquor and licence fees, etc. There is an immediate need to deregulate the molasses' sale so that farmers and sugar mill owners in UP can benefit from fair prices.

**Table 25: Reservation of Molasses for Country Liquor and Ratio of Dispatch**

| Year | Reservation of molasses for country liquor (%) | Ratio of dispatch (reserved: free) |
|---|---|---|
| 2013-14 | 20 | 1:9 |
| 2014-5 | 15 | 1:5.66 |
| 2015-16 | 25 | 1:3 |
| 2016-17 | 20 | 1:4 |
| 2017-18 | 12 | 1:7.3 |

*Source: Handbook of Sugar Statistics, ISMA*

*Note: Ratio of dispatch is the ratio between reserved and unreserved molasses, i.e. for every unit of molasses reserved for country liquor, how much molasses a sugar mill can sell in the free market.*

### *9.6.3 Ethanol*

The sugar and distillery industries in UP are in a position to take the lead in ethanol production to meet the requirement for ethanol blending of petrol. There is a need to promote the establishment of ethanol manufacturing units by sugar mills that do not have this facility yet. The government can also gain by removing GST on ethanol used for fuel blending. The state government can protect its revenue interest by reserving a small percentage of ethanol for manufacturing potable liquor.

## 9.7 Increase Road Network in Uttar Pradesh

Rural road connectivity facilitates agricultural trade by connecting farmers to markets and hence, contributes to higher agricultural growth and productivity. Despite the seemingly good performance of the state in rural road connectivity, there are large variations across the four regions of the state. While the eastern and western regions of the state are comparatively well-connected, the central and, in particular, the Bundelkhand region has lagged behind. Road density in Bundelkhand is less than half that in the eastern region. The lack of connectivity in these regions restricts input delivery and the marketing of output, limiting both agricultural growth as well as diversification to higher-value products.

## 9.8 Irrigation

### *9.8.1 Reduce Regional Imbalance in Irrigation Facility*

Regional imbalance is the main issue in irrigation development across different regions in Uttar Pradesh. The eastern region receives a large amount of rainfall for crop production as well as groundwater recharge, whereas Bundelkhand is prone to drought. It is, therefore, necessary to target improvement in water use efficiency in the drier regions and watershed-based programmes to efficiently manage water resources.

The state government needs to promote women-led interventions like Jal Sahelis on a large scale to address the water crisis, especially in the Bundelkhand region. The Jal Saheli Model, started in 2011, is playing a crucial role in reviving water harvesting structures and conserving water bodies through community participation in more than 100 villages in UP.

### *9.8.2 Restructuring UP's Water Sector*

The irrigation system in UP has become obsolete, and its efficiency has deteriorated continuously because of reduction in conveyance, deferred maintenance and the non-existence of modern management tools. This requires close monitoring of modernisation of canal systems, discharge measurement and modernisation of regulation gates. The government needs to achieve the goals proposed in the UP Water Sector Restructuring Project Stage-II, which was approved in August 2013 to promote automation and modernisation of the canal system.

### *9.8.3 Encourage Micro-irrigation Techniques for Efficient Water Usage*

Micro-irrigation systems facilitate the maintenance of optimal moisture level in the root zone areas, improving the fertility of the soil. They also save on the use of water, which is critical to improve productivity in water-scarce areas. The UP government needs to promote drip and sprinkler irrigations systems extensively to bring more areas under micro-irrigation. It will also have to provide training to beneficiaries as well field functionaries to ensure wider adoption of drip and sprinkler irrigation systems.

UP's performance in increasing drip irrigation coverage under the PMKSY-PDMC has been rather poor compared to other states. The area brought under drip irrigation in the state from 2015 to 2018 was 8,216 hectares compared to 4.0 lakh hectares in Andhra Pradesh and 2.4 lakh hectares in Maharashtra. Even within the state, there are significant variations in the area brought under drip irrigation across the four regions. The eastern and western regions have done better in adopting water conservation technologies, but the state government also needs to encourage its usage in the water-scarce regions of the state, especially in

Bundelkhand.

#### *9.8.4 Completion of Major and Medium Irrigation Projects under PMKSY*

The central government (2014-19) has accorded priority to 99 ongoing major/medium irrigation projects, which were earlier sanctioned under Accelerated Irrigation Benefits Programme (AIBP), under the Pradhan Mantri Krishi Sinchayee Yojana (PMKSY). Of these, there are four prioritised projects in Uttar Pradesh with an ultimate irrigation potential of 16.53 lakh hectares. However, only the Bansagar canal project, started in 1978, was finally inaugurated by the Prime Minister on July 15, 2018, in the Mirzapur district. The remaining projects, Arjun Sahayak, Madhya Ganga and Saryu Nahar, which were targeted to be completed in a phased manner by December 2019, have still not been completed. It is necessary to expedite the completion of these projects to increase the state's irrigation potential and reduce regional disparities in irrigation development.

## 9.9 Increase Power Intensity in the Agricultural sector

The UP government needs to effectively implement plans to increase investments to bolster infrastructure for the transmission and distribution of power to meet the growing demand by the agricultural sector. The state government needs to augment generation capacity to ensure power availability by encouraging private participation in the power sector. The state also needs to reduce regional variations in power intensity in the agricultural sector.

The most important use of power for farmers in UP is for pumping water for irrigation. However, a majority of farmers continue to use diesel pumps. The poor performance of public tube wells is attributable to the inadequate and erratic power supply. The high dependence on diesel tube wells and insufficient power supply has resulted in irrigation potential not being fully utilised. Moreover, the state government should increase the metered supply of electricity for rural households and farmers.

Further, the state can utilise solar power's vast potential for powering irrigation pumps to overcome inadequate power supply in the agricultural sector. While the state government has already taken some initiatives, such as providing 4700 solar pump sets in 2016-17, further measures need to be taken to promote solar energy use. Solar energy can be treated as a third crop to augment farmer's income as the state has huge potential for solar power. The UP government needs to mobilise financial resources to make renewable sources of energy easily accessible. The state can also encourage public and private participation in the deployment of renewable energy systems/devices and augment electricity generation through renewable energy sources.

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# APPENDIX

## Appendix 1: Classification of Four Regions and Agro-Climatic Zones in Uttar Pradesh

**Table A1: Classification of the Districts into Four Regions and Agro-Climatic zones**

| Regions | No. of district | Districts | Agro-climatic zones |
|---|---|---|---|
| Western Region | 30 | Saharanpur, Muzaffarnagar, Shamli, Bijnor, Moradabad, Sambhal, Rampur, Amroha, Meerut, Baghpat, Ghaziabad, Hapur, Gautam Buddha Nagar, Bulandshahar, Aligarh, Hathras, Mathura, Agra, Firozabad, Etah, Kasganj, Mainpuri, Badaun, Bareilly, Pilibhit, Shahjahanpur, Farrukhabad, Kannauj, Etawah, Auraiyya | Western Plains Zone, Bhahbar and Terai Zone, South Western Semi-Arid Zone, Mid Western Plain Zone, Central Zone |
| Central Zone | 10 | Kheri, Sitapur, Hardoi, Unnao, Lucknow, Rae Bareilly, Kanpur (R), Kanpur (U), Fatehpur, Barabanki | North Eastern plains, Central zone |
| Bundelkhand | 7 | Jalaun, Jhansi, Lalitpur, Hamirpur, Mahoba, Banda, Chitrakoot | Bundelkhand |
| Eastern Region | 28 | Pratapgarh, Kaushambi, Allahabad, Faizabad, Ambedkar Nagar, Sultanpur, Amethi, Bahraich, Shravasti, Balrampur, Gonda, Siddharth Nagar, Basti, Sant Kabeer Nagar, Maharajganj, Gorakhpur, Kushinagar, Deoria, Azamgarh, Mau, Ballia, Jaunpur, Ghazipur, Chandauli, Varanasi, Sant Ravidas Nagar, Mirzapur, Sonbhadra | Central Zone, Eastern Plain zone, North Eastern plain zone, Vindhyan Zone |

# Appendix 2: Demographic Characteristics

**Table-A2: Population and Head Count Ratio (HCR) for Different Regions in UP**

| Indicators | Western region | Central region | Bundelkhand region | Eastern region |
|---|---|---|---|---|
| Total population (Million) : 2011 | 74.3 | 35.9 | 9.6 | 79.8 |
| % of state's population: 2011 | 37.2% | 18.0% | 4.8% | 40.0% |
| Rural population (%): 2011 | 68.6% | 74.3% | 77.3% | 87.8% |
| % of Persons below poverty line (2011-12)* | 22.37% | 41.93% | 37.84% | 35.58% |
| Population density (persons per sq. Km) :2011 | 930 | 785 | 329 | 931 |

Source: *Census of India, Planning Commission, Statistical Abstract of Uttar Pradesh, UP Plan Document 2016-17*
Note: *Regional poverty line is derived using CPI prepared by DES, UP (Based on State Sample Data of NSS)

# Appendix 3: NFSM in Uttar Pradesh

**Table A3: Number of districts in each region under NFSM in 2017-18**

| NFSM districts | Rice | Wheat | Pulses |
|---|---|---|---|
| Western | 5 | 2 | 30 |
| Central | 4 | 1 | 10 |
| Bundelkhand | 0 | 5 | 7 |
| Eastern | 14 | 23 | 28 |
| UP All | 23 | 31 | 75 |

Source: *NFSM, 2017-18*

# Appendix 4: Sources of Agricultural growth

**Table A4: Region-wise Number of Livestock and Poultry in Uttar Pradesh (in lakhs)**

| Livestock | 2003 | | 2012 | |
|---|---|---|---|---|
| | Total livestock | Poultry | Total livestock | Poultry |
| Western Region | 194 | 31 | 269 | 45 |
| Central Region | 116 | 19 | 122 | 35 |
| Bundelkhand | 48 | 5 | 57 | 7 |
| Eastern Region | 207 | 67 | 239 | 100 |
| Total state | 565 | 122 | 687 | 187 |

Source: *Department of Animal Husbandry, U.P.*

**Table A5: Cane crushing capacity in sugar factories (lakh tonnes)**

| Region | 2008-09 | 2012-13 | 2017-18 |
|---|---|---|---|
| Central UP | 152 | 299 | 445 |
| East UP | 143 | 277 | 334 |
| West UP | 158 | 238 | 332 |
| Total UP | 454 | 815 | 1111 |
| All India | 1449 | 2506 | 3024 |

Source: *Handbook of Sugar Statistics, 2017-18, ISMA*

# Appendix 5: Groundwater Depletion in Uttar Pradesh

Groundwater is the predominant source of irrigation, accounting for 80 per cent of irrigated area in Uttar Pradesh. Overexploitation of groundwater has resulted in deterioration in the quality and quantity of groundwater in the state.

Waterlogging and soil salinization have also become prominent in regions having shallow groundwater levels, affecting crop productivity. This is common in canal command areas such as Sidharth Nagar, Balrampur, Shravasti, Mau and some areas of Ghazipur in the eastern region. In the Bundelkhand-Vindhyan region, groundwater recharge is an issue of concern because groundwater availability is inadequate and there is high run-off of rainwater.

In 2016, 33 districts in Uttar Pradesh faced over-exploitation of groundwater (Dev, 2016). Shamli district in the Western region and Pratapgarh in the Eastern region have groundwater extraction rate exceeding 140 per cent followed by 132 per cent in Saharanpur, 117 per cent in Firozabad and 113 per cent in Agra (Dev, 2016). The state government needs to focus on long term management and planning for overexploited areas, which require conjunctive use of surface and groundwater resources.

Region wise status of availability, utilisation and stages of development of groundwater resources in the state in 2013 is shown in Table A6. As per the Ground Water Board, UP, as on March 2013, around 1.9 million hectare metres of groundwater balance is available for further development of irrigation. To tackle the issue of overexploitation of groundwater, the government needs to introduce a comprehensive groundwater management policy that focuses on groundwater conservation and the recharging of groundwater on a large scale through a participatory management approach, particularly in overexploited areas to bring critical blocks into the safe category in a time bound manner.

## Table A6: Region-wise Groundwater Potential of Uttar Pradesh (as on March 2013) (in million hectare meters)

| Region | Net annual Groundwater availability (million ha m) | Existing groundwater draft for irrigation (million h am) | Draft for industrial & domestic use (million ha m) | Existing gross Ground water Draft for all uses (million ha m) | Allocation for domestic and Industrial requirements supply to next 25 years (million ha m) | Net ground Water availability for future Irrigation Development (million ha m) | Stages of ground water developme nt |
|---|---|---|---|---|---|---|---|
| Western Region | 2.50 | 2.02 | 0.14 | 2.16 | 0.21 | 0.46 | 86.5 |
| Central Region | 1.52 | 0.96 | 0.10 | 1.06 | 0.13 | 0.42 | 69.7 |
| Bundelkha nd Region | 0.44 | 0.21 | 0.02 | 0.24 | 0.03 | 0.20 | 53.4 |
| Eastern Region | 2.70 | 1.64 | 0.18 | 1.82 | 0.28 | 0.82 | 67.6 |
| Uttar Pradesh | 7.16 | 4.84 | 0.44 | 5.28 | 0.65 | 1.90 | 73.8 |

Source: *Ground Water Board, UP (as on 31.03.2013)*

# Appendix 6: Procurement Operations in Uttar Pradesh

### Table A7: Region-wise Share of Wheat Procured to Total Wheat Produced in Uttar Pradesh (%)

| | 2009-10 | 2010-11 | 2011-12 | 2012-13 | 2013-14 | 2014-15 | 2015-16 | 2016-17 | 2017-18 | 2018-19 |
|---|---|---|---|---|---|---|---|---|---|---|
| Western Region | 14.6 | 6.6 | 11.3 | 16.0 | 2.3 | 3.2 | 13.3 | 3.7 | 9.8 | 14.3 |
| Central Region | 13.8 | 6.1 | 11.9 | 16.9 | 2.1 | 2.2 | 12.7 | 3.0 | 11.4 | 13.5 |
| Bundelkhand Region | 12.5 | 5.0 | 12.4 | 15.8 | 3.4 | 2.4 | 15.7 | 7.1 | 16.8 | 19.9 |
| Eastern Region | 11.7 | 5.2 | 10.9 | 14.7 | 1.8 | 0.4 | 7.2 | 1.5 | 9.6 | 13.6 |
| Uttar Pradesh | 13.4 | 5.9 | 11.4 | 15.7 | 2.2 | 2.1 | 11.1 | 3.0 | 10.6 | 14.3 |

Source: *Food Corporation of India, UP Region*

Note: Procurement has been calculated based on the previous year's production of wheat. Procurement figures for 2018-19 are until June 2018

### Table A8: Region-wise Share of Rice Procured to Total Rice Produced in Uttar Pradesh (%)

| | 2009-10 | 2010-11 | 2011-12 | 2012-13 | 2013-14 | 2014-15 | 2015-16 | 2016-17 | 2017-18 |
|---|---|---|---|---|---|---|---|---|---|
| Western Region | 6.6 | 5.6 | 8.3 | 5.8 | 2.6 | 8.8 | 23.7 | 16.3 | 19.4 |
| Central Region | 6.7 | 7.3 | 11.2 | 9.2 | 5.6 | 9.8 | 25.5 | 17.1 | 19.3 |
| Bundelkhand Region | 22.3 | 25.8 | 16.6 | 10.7 | 5.9 | 4.9 | 20.6 | 42.3 | 32.6 |
| Eastern Region | 7.5 | 9.9 | 15.2 | 9.8 | 4.5 | 7.5 | 17.8 | 20.9 | 20.1 |
| Uttar Pradesh | 7.2 | 8.2 | 12.6 | 8.6 | 4.2 | 8.3 | 21.0 | 18.8 | 19.9 |

*Source: Food Corporation of India, UP Region*

Note: Procurement has been calculated based on the previous year's production of rice.

# Appendix 7: Correlation Matrix

**Table A9: Correlation Matrix: Western region**

| | Log GVOA/ GCA | Log Power intensity | Log Surfaced Road Density | Log fertiliser consumption | Log Irrigation Ratio | Log Sugar & fruits and vegetables +livestock share in GVOA |
|---|---|---|---|---|---|---|
| Log GVOA /GCA | 1.00 | | | | | |
| Log Power intensity (kWh/ha) | 0.68*** | 1.00 | | | | |
| Log Surfaced Road Density *(km per 100 sq. km of geographical area)* | 0.27*** | 0.39*** | 1.00 | | | |
| Log fertiliser consumption *(kg per hectare)* | 0.47*** | 0.32*** | -0.04 | 1.00 | | |
| Log Irrigation Ratio (Share of Irrigated Area as a share of Gross cropped area) | 0.45*** | 0.05 | -0.15** | 0.35*** | 1.00 | |
| Log share of sugar + fruits & vegetables + livestock in GVOA | 0.69*** | 0.77*** | 0.21*** | 0.38*** | 0.31*** | 1.00 |

Source: *Based on the calculations of the authors*

Note: *** significant at 1% level of significance (p-value < 0.01); ** significant at 5% level of significance (p-value < 0.05); * significant at 10% level of significance (p-value < 0.1)

## Table A10: Correlation Matrix: Central Region

| | Log GVOA/ GCA | Log Power intensity | Log Surfaced Road Density | Log fertiliser consumption | Log Irrigation Ratio | Log Sugar & fruits and vegetables +livestock share in GVOA |
|---|---|---|---|---|---|---|
| Log GVOA/GCA | 1.00 | | | | | |
| Log Power intensity (kWh/ha) | 0.21** | 1.00 | | | | |
| Log Surfaced Road Density *(km per 100 sq. km of geographical area)* | 0.62*** | 0.23** | 1.00 | | | |
| Log fertiliser consumption *(kg per hectare)* | 0.47*** | 0.11 | 0.31*** | 1.00 | | |
| Log Irrigation Ratio (Share of Irrigated Area as a share of Gross cropped area) | 0.43*** | -0.10 | 0.25** | -0.09 | 1.00 | |
| Log share of sugar + fruits & vegetables+ livestock in GVOA | 0.54*** | 0.13 | 0.12 | 0.14 | 0.29*** | 1.00 |

Source: *Based on the calculations of the authors*

Note: *** significant at 1% level of significance (p-value < 0.01); ** significant at 5% level of significance (p-value < 0.05); * significant at 10% level of significance (p-value < 0.1)

## Table A11: Correlation Matrix: Bundelkhand

| | Log GVOA/ GCA | Log Power intensity | Log Surfaced Road Density | Log fertiliser consumption | Log Irrigation Ratio | Log Sugar & fruits and vegetables +livestock share in GVOA |
|---|---|---|---|---|---|---|
| Log GVOA/GCA | 1.00 | | | | | |
| Log Power intensity (kWh/ha) | 0.29** | 1.00 | | | | |
| Log Surfaced Road Density *(km per 100 sq. km of geographical area)* | 0.50*** | 0.37*** | 1.00 | | | |
| Log fertiliser consumption *(kg per hectare)* | 0.59*** | 0.37*** | 0.55*** | 1.00 | | |
| Log Irrigation Ratio (Share of Irrigated Area as a share of Gross cropped area) | -0.01 | -0.09 | 0.11 | 0.30** | 1.00 | |

Source: *Based on the calculations of the authors*

Note: *** significant at 1% level of significance (p-value < 0.01); ** significant at 5% level of significance (p-value < 0.05); * significant at 10% level of significance (p-value < 0.1)

## Table A12: Correlation Matrix: Eastern Region

| | Log GVOA/ GCA | Log Power intensity | Log Surfaced Road Density | Log fertiliser consumption | Log Irrigation Ratio | Log Sugar & fruits and vegetables +livestock share in GVOA |
|---|---|---|---|---|---|---|
| Log GVOA/GCA | 1.00 | | | | | |
| Log Power intensity (kWh/ha) | 0.21*** | 1.00 | | | | |
| Log Surfaced Road Density (km per 100 sq. km of geographical area) | 0.59*** | 0.47*** | 1.00 | | | |
| Log fertiliser consumption (kg per hectare) | 0.41*** | 0.26*** | 0.48*** | 1.00 | | |
| Log Irrigation Ratio (Share of Irrigated Area as a share of Gross cropped area) | 0.19*** | 0.41*** | 0.64*** | 0.42*** | 1.00 | |
| Log share of sugar + fruits & vegetables+ livestock in GVOA | 0.51*** | 0.14** | 0.39*** | 0.30*** | 0.24*** | 1.00 |

Source: *Based on the calculations of the authors*

Note: *** significant at 1% level of significance (p-value < 0.01); ** significant at 5% level of significance (p-value < 0.05); * significant at 10% level of significance (p-value < 0.1)