National River Conservation Directorate
Ministry of Jal Shakti,
Department of Water Resources,
River Development & Ganga Rejuvenation
Government of India

Agricultural Profile of

Mahanadi River Basin

November 2025

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Agricultural Profile of

Mahanadi River Basin

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The Centres for Mahanadi River Basin Management Studies (cMahanadi) is a Brain Trust dedicated to River Science and River Basin Management. Established in 2024 by NIT Raipur and NIT Rourkela, under the supervision of cGanga at IIT Kanpur, the centre serves as a knowledge wing of the National River Conservation Directorate (NRCD). cMahanadi is committed to restoring and conserving the Mahanadi River and its resources through the collation of information and knowledge, research and development, planning, monitoring, education, advocacy, and stakeholder engagement.

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Acknowledgment

This report is a comprehensive outcome of the project jointly executed by NIT Raipur (Lead Institute) and NIT Rourkela (Fellow Institute) under the supervision of cGanga at IIT Kanpur. It was submitted to the National River Conservation Directorate (NRCD) in 2024. We gratefully acknowledge the individuals who provided information and photographs for this report.

Disclaimer

This report is a preliminary version prepared as part of the ongoing Condition Assessment and Management Plan (CAMP) project. The analyses, interpretations and data presented in the report are subject to further validation and revision. Certain datasets or assessments may contain provisional or incomplete information, which will be updated and refined in the final version of the report after comprehensive review and verification.

Team

Dr. Samir Bajpai, cMahanadi, NIT Raipur

Dr. Ishtiyaq Ahmad, cMahanadi, NIT Raipur

Dr. Sandeep Soni, cMahanadi, NIT Raipur

Mr. Satyajeet Sahu, cMahanadi, NIT Raipur

Dr. Vinod Tare, cGanga, IIT Kanpur

Dr. Kishanjit Kumar Khatua, cMahanadi, NIT Rourkela

Dr. Angana Sarkar, cMahanadi, NIT Rourkela

Dr. Minakshee Mahananda, cMahanadi, NIT Rourkela

Ms. Arpita Patro, cMahanadi, NIT Rourkela

Preface

In an era of unprecedented environmental change, understanding our rivers and their ecosystems has never been more critical. This report aims to provide a comprehensive overview of our rivers, highlighting their importance, current health, and the challenges they face. As we explore the various facets of river systems, we aim to equip readers with the knowledge necessary to appreciate and protect these vital waterways.

Throughout the following pages, you will find an in-depth analysis of the principles and practices that support healthy river ecosystems. Our team of experts has meticulously compiled data, case studies, and testimonials to illustrate the significant impact of rivers on both natural environments and human communities. By sharing these insights, we hope to inspire and empower our readers to engage in river conservation efforts.

This report is not merely a collection of statistics and theories; it is a call to action. We urge all stakeholders to recognize the value of our rivers and to take proactive steps to ensure their preservation. Whether you are an environmental professional, a policy maker, or simply someone who cares about our planet, this guide is designed to support you in your efforts to protect our rivers.

We extend our heartfelt gratitude to the numerous contributors who have generously shared their stories and expertise. Their invaluable input has enriched this report, making it a beacon of knowledge and a practical resource for all who read it. It is our hope that this report will serve as a catalyst for positive environmental action, fostering a culture of stewardship that benefits both current and future generations.

As you delve into this overview of our rivers, we invite you to embrace the opportunities and challenges that lie ahead. Together, we can ensure that our rivers continue to thrive and sustain life for generations to come.

Centre for Mahanadi River Basin
Management Studies (cMahanadi)
NIT Raipur & NIT Rourkela

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Abbreviations and Acronyms

AERs	Agro-ecological Regions
CAGR	Compound Annual Growth Rate
CAMP	Condition Assessment and Management Plan
CG / OD	Chhattisgarh/ Odisha
CGWB	Central Ground Water Board
cMahanadi	Centre for Mahanadi River Basin Management and Studies
CWC	Central Water Commission
DES	Directorate of Economics and Statistics
FAO	Food and Agriculture Organization
GPM	Gaurela-Pendra-Marwahi
ICAR	Indian Council of Agricultural Research
IIT	Indian Institute of Technology
LGP	Length of Growing Period
LULC	Land Use Land Cover
MCB	Manendragarh-Chirmiri-Bharatpur
MMAC	Mohla-Manpur-Ambagarh-Chouki
MoAFW	Ministry of Agriculture and Farmers Welfare
MoJS	Ministry of Jal Shakti
MRB	Mahanadi River Basin
NBSS & LUP	National Bureau of Soil Survey and Land Use Planning
NFSM	National Food Security Mission
NIT	National Institute of Technology
NPK	Nitrogen (N), Phosphorus (P), and Potassium (K)
NRCD	National River Conservation Directorate
NRSC	National Remote Sensing Centre
NSA	Net Sown Area
PMKSY	Pradhan Mantri Krishi Sinchayee Yojana
RWBCIS	Restructured Weather Based Crop Insurance Scheme
SOD	Stage of Development
WRIS	Water Resources Information System

1. Introduction

Rivers constitute the backbone of India's socio-economic and ecological systems, supporting water supply, agriculture, industry, biodiversity, and cultural practices (CWC, 2018; MoJS, 2021). Rapid population growth, land-use change, agricultural intensification, infrastructure development, and increasing climate variability have led to significant alterations in river flow regimes, sediment dynamics, and water quality across many Indian river basins (NRCD, 2020; CGWB, 2022). In response to these challenges, river basin–scale planning has emerged as a central approach for restoring and sustaining river health while balancing developmental needs.

The Condition Assessment and Management Plan (CAMP) framework represents a systematic, science-based approach for integrated river basin management in India. Developed under the aegis of the National River Conservation Directorate (NRCD), Ministry of Jal Shakti, with technical guidance from the Centre for Ganga River Basin Management and Studies (cGanga), CAMP aims to assess the present condition of river basins through a multi-thematic lens and to identify priority management actions (NRCD, 2020; cGanga, 2021). The framework emphasises an integrated understanding of hydrology, geomorphology, water quality, ecology, land use, and socio-economic drivers, thereby supporting informed and adaptive river basin governance.

Within this integrated framework, land use and agriculture assume particular importance due to their pervasive influence on basin-scale processes. Agricultural activities directly affect surface water and groundwater regimes through irrigation withdrawals, reservoir operations, and return flows, and indirectly influence river health through sediment mobilisation, nutrient enrichment, and agrochemical runoff (FAO, 2017; NRCD, 2020). A robust understanding of agricultural systems is therefore essential for diagnosing pressures on river condition indicators and for designing effective management interventions under CAMP.

The Agricultural Profile of the Mahanadi River Basin has been prepared as a thematic component of the CAMP to support this integrated assessment. It provides a structured overview of agricultural characteristics, practices, and trends across the basin and establishes linkages between agriculture and river basin condition parameters. This chapter introduces the context, relevance, and scope of the Agricultural Profile within the CAMP framework before presenting basin-specific background and objectives.

1.1 Background and Objective

The Mahanadi River Basin (MRB) is one of the major inter-state river basins of India, covering an area of approximately 141,500 square kilometres and extending across the states of Chhattisgarh and Odisha, with smaller portions in Jharkhand, Maharashtra, and Madhya Pradesh (CWC, 2018). The basin supports a large population with a high dependence on agriculture, making the agricultural sector a critical determinant of water use, land management, and river health within the basin.

The preparation of the Condition Assessment and Management Plan (CAMP) for the Mahanadi River Basin is undertaken under the national river basin management framework coordinated by the National River Conservation Directorate (NRCD), Ministry of Jal Shakti, with technical guidance from the Centre for Ganga River Basin Management and Studies (cGanga). The CAMP framework adopts an integrated river basin management approach, wherein the condition of the river is assessed across multiple thematic domains, including hydrology, geomorphology, water quality, ecology, land use, and socio-economic systems (NRCD, 2020; cGanga, 2021). Agriculture is recognised within this framework as a key sector exerting both direct and indirect pressures on river systems through abstraction of surface and groundwater, modification of natural flow regimes, land cover alteration, and non-point source pollution.

Agriculture in the Mahanadi River Basin is predominantly monsoon-dependent, with paddy cultivation forming the backbone of the agrarian economy, particularly during the Kharif season (DES, 2021). The presence of major, medium, and minor irrigation projects, including large reservoirs and canal networks, has enabled expansion of irrigated agriculture in several parts of the basin, especially in the lower reaches. These developments have contributed to increased cropping intensity and seasonal water demand, with implications for river flows, groundwater recharge, and water quality (CWC, 2018; MoJS, 2021).

Within the CAMP framework, the Agricultural Profile is prepared as a foundational assessment to support condition evaluation and management planning. The primary objectives of this component are to establish a basin-wide baseline of agricultural land use, cropping systems, and irrigation practices, and to analyse their interactions with the riverine environment. Specifically, the Agricultural Profile aims to:

- Document the extent and spatial distribution of agroclimatic, agroecological zones within the administrative boundaries of Mahanadi River Basin (MRB);

- Determine the trends in land use patterns to define the area under forest, agriculture, non-agricultural use;
- Assess irrigation and water use with respect to total irrigated area, sources of irrigation (Major, Medium & Minor) and area irrigated by different crops;
- Determine the consumption of fertilisers and pesticides across the districts of MRB;
- Evaluate farm mechanization and power resources
- Assess crop intensity and crop production for dominant crops in MRB like rice, wheat, pulses, maize, oilseed, sugarcane, ragi and potato;
- Provide details of various schemes under central and state (Chhattisgarh & Odisha) government covering the majority of Mahanadi River Basin with respect to the Agriculture Profile.

The Agricultural Profile thus contributes directly to the integrated assessment process prescribed under the NRCD–cGanga CAMP methodology and provides essential evidence for developing management strategies that promote sustainable agriculture while safeguarding river health and basin resilience.

1.2 Datasets Used

In accordance with the CAMP methodological framework, the Agricultural Profile for the Mahanadi River Basin has been developed using harmonised datasets from authoritative national and state-level sources, supported by spatial analysis and field-level validation. Table 1 summarises the key datasets used, their sources, spatial and temporal availability, and their relevance to agricultural condition assessment under CAMP.

Table 1: Summary of Datasets Used for Preparation of Agricultural Profile (CAMP – Mahanadi River Basin)

S. No.	Type of Data	Description	Source
1	Land Use / Land Cover (LULC)	Agricultural land, irrigated and rainfed cropland, fallow land, plantations	National Remote Sensing Centre (NRSC), ISRO
2	Crop Statistics	Crop-wise area, production, yield (Kharif and Rabi)	Directorate of Economics and Statistics (DES), MoAFW; State Agriculture Departments;
3	Irrigation Infrastructure	Major, medium and minor irrigation projects, canal command areas	Central Water Commission (CWC); State Irrigation Departments

4	Irrigation Potential	Potential created and utilised, irrigation intensity	India-WRIS; State Irrigation Departments
5	Groundwater Resources	Groundwater availability, stage of development	Central Ground Water Board (CGWB)
6	Soil Data	Soil texture, depth, drainage, fertility classes	NBSS & LUP (ICAR)
7	Agro-climatic zones, Agro-Ecological Zones	Agro-climatic classification	ICAR / Planning Commission; NBSS & LUP (ICAR)
8	Administrative Boundary	District, Tehsil, Block, Villages	Survey of India (SoI)

The integration of these datasets enables a comprehensive and standardised assessment of agricultural conditions in the Mahanadi River Basin. Together, they support diagnosis of agricultural pressures, identification of vulnerable zones, and formulation of targeted management measures under the CAMP framework.

2. Geographical & Administrative Overview

The Mahanadi River Basin is recognized as a major agricultural corridor in India, spreading across several states and exhibiting a wide range of topographical and climatic diversity. The basin supports over half its area under active cultivation, with agriculture deeply influenced by the distinct soil types, rainfall patterns, and temperature regimes characteristic of its agro-climatic and ecological zones. This zonation is critical for formulating sustainable crop management strategies, optimizing yields, and implementing resource-efficient agricultural practices tailored to local conditions.

2.1 Agroclimatic Zones/Regions

The Mahanadi River Basin encompasses two principal agro-climatic zones, each exhibiting unique climatic, soil, and agronomic characteristics critical for sustainable agricultural development planning.

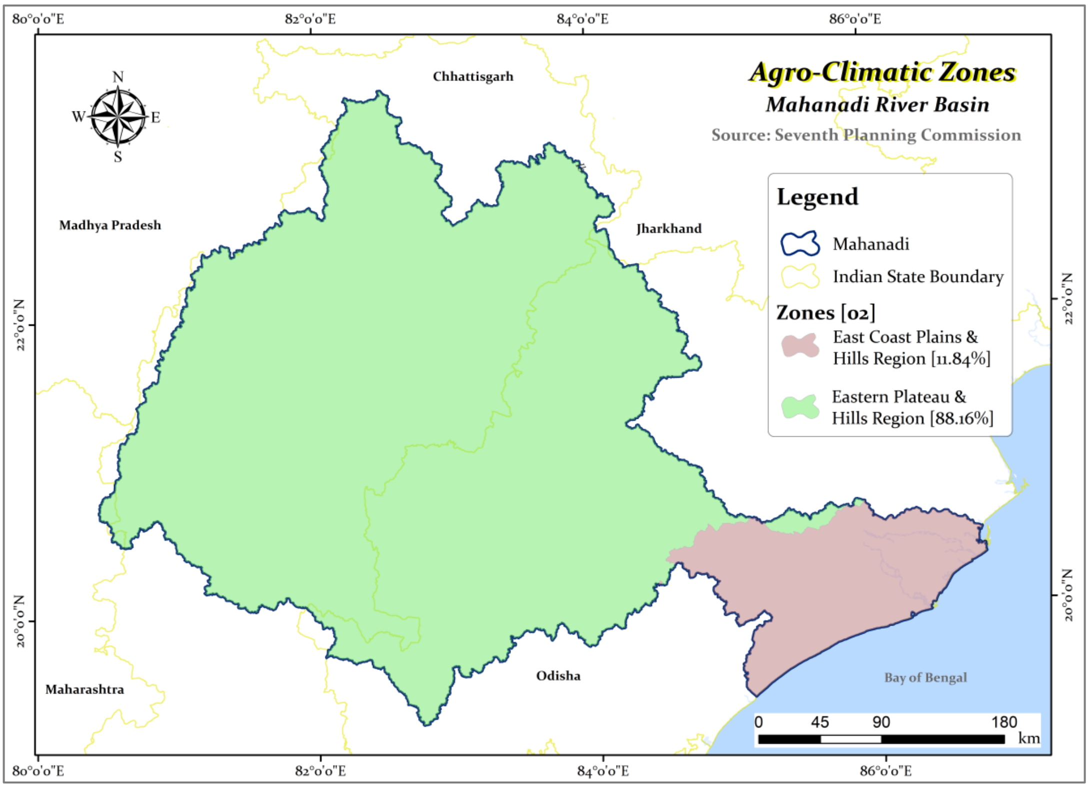


Figure 1: Agro-Climatic Zones under Mahanadi River Basins [Source: Planning Commissions]

Eastern Plateau & Hills Region (Region code 7):

This zone covers a dominant share of the MRB area (approximately 88.16%) and spans multiple states including Chhattisgarh, Jharkhand, Madhya Pradesh, Maharashtra, Odisha, and West Bengal. The region experiences mean January temperatures ranging from 10°C to 27°C and mean July temperatures between 26°C and 34°C, supporting a warm and moderately humid climate favorable for diverse cropping systems. Average annual rainfall ranges from 80 cm to 150 cm, facilitating rainfed and irrigated agriculture. Soils are predominantly red and yellow with occasional patches of laterites and alluviums, offering moderate fertility conducive to cereal-pulse-oilseed cropping patterns. Major crops cultivated include rice, millets, maize, oilseeds, ragi, gram, and potato. The zone also offers potential for developing inland fisheries within permanent water bodies, enhancing livelihood diversity.

East Coast Plains & Hills Region (Region code 11):

Constituting about 11.84% of the basin area, this zone extends across Andhra Pradesh, Odisha, Pondicherry, and Tamil Nadu. It is characterized by slightly warmer conditions with January temperatures between 20°C and 30°C and July temperatures from 25°C to 35°C. Annual rainfall varies from 75 cm to 150 cm, supporting a humid tropical climate suitable for water-intensive and commercial crops. Soils here are alluvial, loam, and clay, known for higher fertility and moisture retention that benefit paddy cultivation and diverse cash crops. Rice forms the staple crop, complemented by jute, tobacco, sugarcane, maize, millets, groundnut, and oilseeds.

2.2 AgroEcological Zones/Regions

The MRB supports diverse agro-ecological regions (AERs) distinguished by their physiography, climate, and soil characteristics. The classification enables targeted management strategies at both region and sub-region levels. The four principal AERs include:

Table 2: Key Attributes of Agro-Ecological Regions and Sub-Regions of MRB [Source: NBSS & LUP]

AER	Sub-region Code	Soil Type	Climate	LGP* (days)	Description	Area (sq.km)	% of MRB
11	11	Red and Yellow Soils	Subhumid (dry-moist)	150–180	Transitional ESR, deep loamy/clayey, medium AWC	70457.08	50.45
12	12.1	Red and lateritic	Subhumid (moist)	180–210	Garjat Hills/Dandakaranya, deep loamy, low–medium AWC	53080.99	38.01
12	12.2	Red and lateritic	Subhumid (moist)	180–210	Eastern Ghats, medium–deep loamy, medium AWC	7568.24	5.42
18	18.4	Coastal/ Deltaic Alluvium	Subhumid (dry)	180–210	Utkal Plain/Delta, deep loamy/clayey, medium AWC	8310.65	5.95
10	10.3	Mixed Red/Black	Subhumid (dry)	150–180	Vindhyan Scarpland, deep loamy/clayey, medium-high AWC	158.21	0.11
10	10.4	Mixed Red/Black	Subhumid (moist)	180–210	Satpura/Waingang a, shallow–deep loamy/clayey, low-medium AWC	76.25	0.05
*LGP - Length of Growing Period							

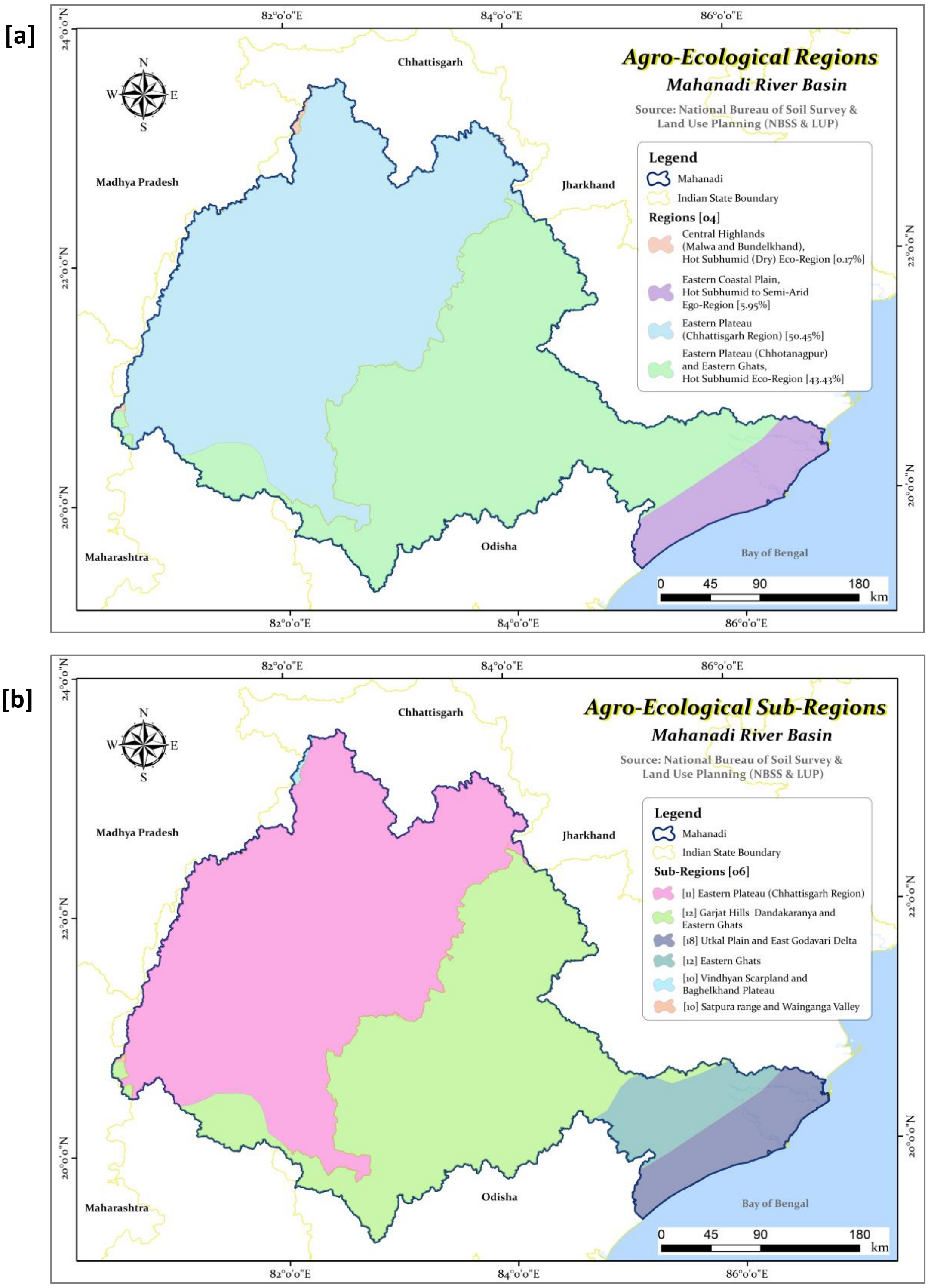


Figure 2: Agro-Ecological [a]Regions and [b]Sub-Regions of MRB [Source: NBSS & LUP]

Conservation priorities in these AERs include promoting sustainable land management to control sedimentation, maintaining riparian buffers, and protecting wetlands that act as natural water filters and flood regulators. Region-specific conservation strategies, such as minimizing soil erosion on red and lateritic landscapes, managing fertilizer use in alluvial tracts, and restoring native vegetation are essential for sustaining water yield and ecological integrity of the Mahanadi and its tributaries.

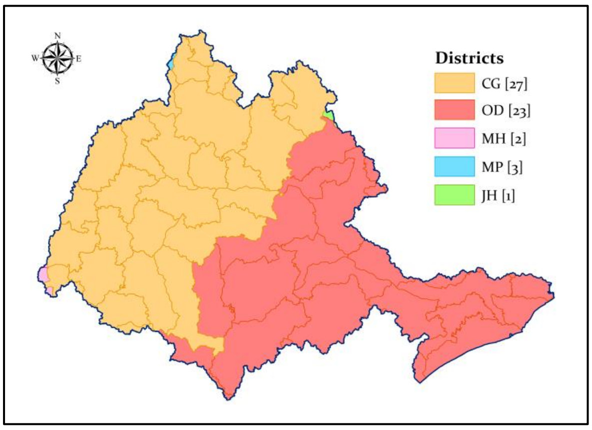
2.3 Administrative boundaries

The Mahanadi River Basin (MRB) spans multiple states and exhibits a complex administrative configuration comprising districts, sub-districts (tehsils), blocks, and villages. Based on the delineation provided by the Survey of India (SOI), the basin encompasses 56 districts, 372 sub-districts, 294 blocks, and 38,094 villages. The detailed administrative hierarchy is shown in Table 3.

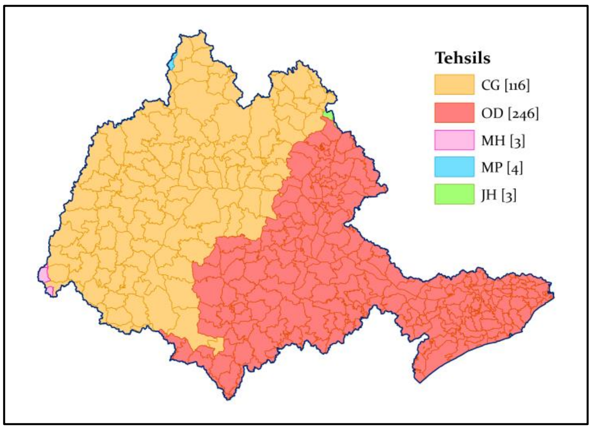
Table 3: State-wise Distribution of Administrative Units under MRB

State	Districts	Tehsils / Sub-Districts	Blocks	Villages
Chhattisgarh (CG)	27	116	113	14,573
Odisha (OD)	23	246	172	23,343
Maharashtra (MH)	2	3	3	131
Madhya Pradesh (MP)	3	4	3	43
Jharkhand (JH)	1	3	3	22

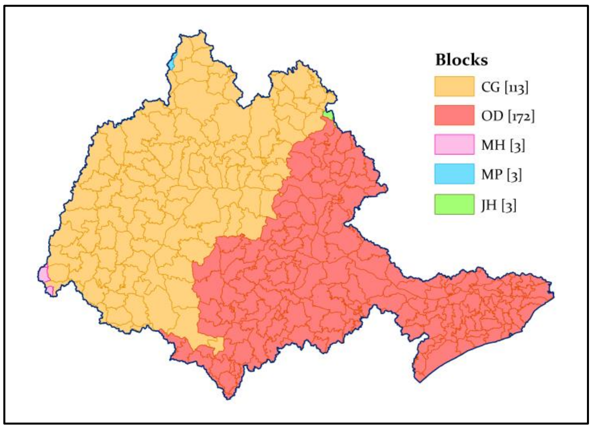
Source: Survey of India (SOI)



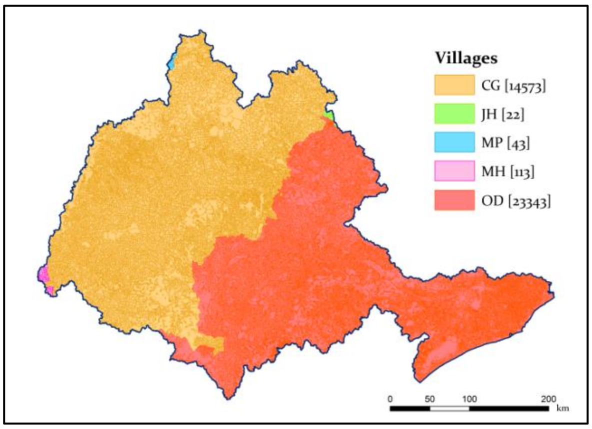
Districts: 56



Sub Districts: 372



Blocks: 294



Villages: 38,094

Figure 3: Mahanadi River Basin: Administrative Boundary

3. Trends in Land Use Patterns

Odisha

Slight variations were observed in the land use pattern of Odisha over the past 20 years. The forest area remained the same until 2018-19 (37.3%) but increased sharply in 2023-24 (39.3%), indicating sustained forest conservation efforts and limited land expansions. Non-agricultural land grew steadily until 2018-2019 (8.33%), before declining to 7.15% in 2023-24, possibly due to urbanisation and infrastructure development. Agricultural land (net sown area) forms the second major portion, following forest area. Net sown area gradually decreased until 2018-19 (8.72%) but slightly recovered in 2023-24 (4.36%). During mid-years, agricultural land experienced dips due to increases in non-agricultural land (1.9%) and fallow land (2.8%) use. Cultivable wasteland remained relatively similar across years but spiked in 2008-09 (5.39%) and 2023-24 (4.62%), likely due to land degradation and improper land use. Fallow land increased gradually, peaking at 5.25 % in 2018-19, but decreased to 3.77% in 2023-24, indicating a partial return of land to productive use **(Fig 4).** Overall, the data suggest a relatively stable land use pattern in the state with minor changes indicating conservation-oriented land management.

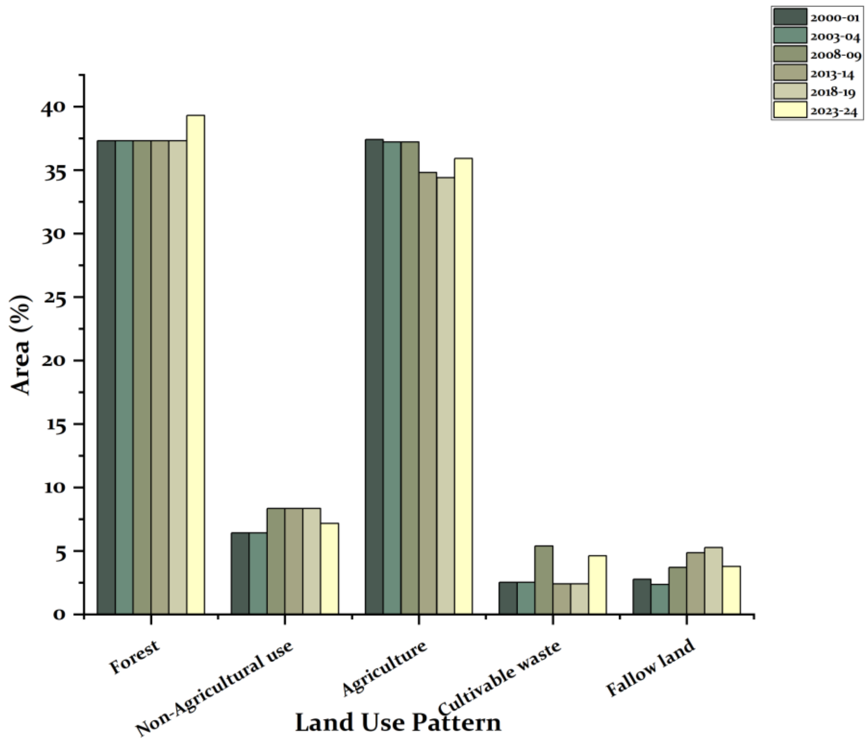


Figure 4: Land Use (%) of Odisha, 2000-01 to 2023-24.
[Source: Odisha Agricultural Statistics Report (2000-01;2003-04;2008-09;2013-14;2018-19; 2023-24)]

Chhattisgarh

The Mahanadi river basin area in Chhattisgarh shows a gradual increase in forest cover from about 40 percent in 2011-2012 to around 41.5 percent in 2023-2024, indicating ongoing stabilization or marginal improvement of forested land. Over the same period, the net area sown has steadily declined from roughly 39.3 percent to about 37.6 percent, suggesting a slow shift of land away from cultivation, possibly towards forestry, non-agricultural uses, or other uncultivated categories.

Non-cultivable land, fallow land, and other uncultivated land excluding fallows are all relatively stable, each changing by less than half a percentage point across the years. The share of land "not available for cultivation" remains close to 8.2 percent, fallow land hovers just below 4 percent, and other uncultivated land stays around 8.7–8.8 percent, implying that the main structural change in land use has been the marginal trade-off between forest area and net sown area rather than large fluctuations in wasteland or fallow categories.

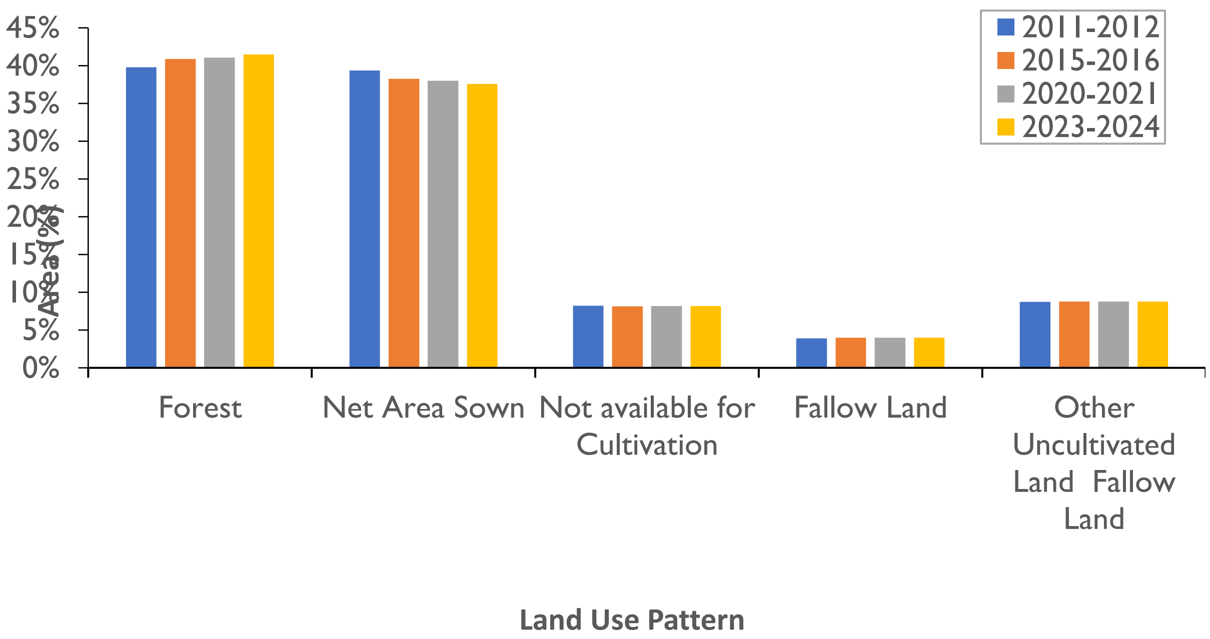


Figure 5: Land Use (%) of MRB (Chhattisgarh Part), 2011-12 to 2023-24.
[Source: Directorate of Economics & Statistics, Dept. of Agriculture & Farmers Welfare, Govt. of India]

3.1 Area under Forest

Odisha

Forest cover plays a key role in maintaining the ecosystem and climate of the region. Forest-rich districts act as vital biodiversity reserves, carbon sinks, and sources of livelihood for local communities. Stable or improving forest cover supports climate resilience and environmental sustainability, while low-cover districts remain vulnerable to soil erosion, biodiversity loss, and climate extremes. Overall, forest cover in most districts has remained stable, with slight increases in recent years, indicating positive impacts of afforestation and forest protection measures. From Fig 2, it is evident that the state has maintained a significant proportion (30% and above) of its area under forest cover for a long time. This is possibly due to hilly terrain, where deforestation poses a significant risk to the livelihood of local communities. Like other states in the country, cultivation is the primary livelihood of Odisha as well.

Over the 23 years, most districts exhibit stable or slightly increasing forest cover, with notable improvements in Boudh (37.1% to 41.29%), Angul (43.6% to 48.7%), Nuapada (from 36.6% to 49.6%) and Sambalpur (54.1% to 60.2%). There are some districts which have higher forest cover than the state (Nayagarh, Sambalpur, Boudh, Sundergarh, Angul, Deogarh, Kalahandi, Dhenkanal, Kandhamal & Nuapada) and some districts which have lower forest cover than the state (Puri, Cuttack, Khordha, Bargarh, Bolangir, Jharsuguda & Kendrapara). Some districts, however, show marginal decline, such as Jajpur(24.9% to 11.03%) and Jagatsinghpur (6.59% to 2.99%). Districts such as Sundargarh, Kandhamal, and Deogarh consistently maintain high forest cover (above 50%), while Puri, Jagatsinghpur, and Kendrapara remain at less than 10%.

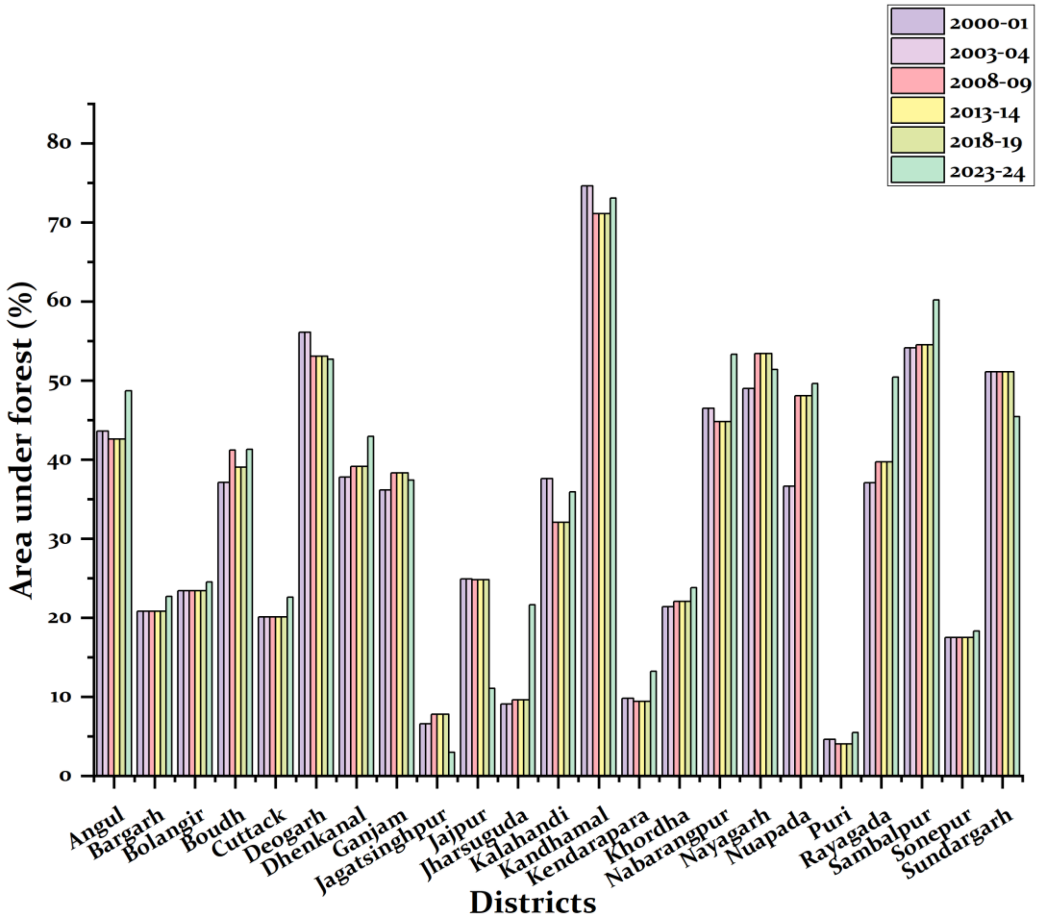
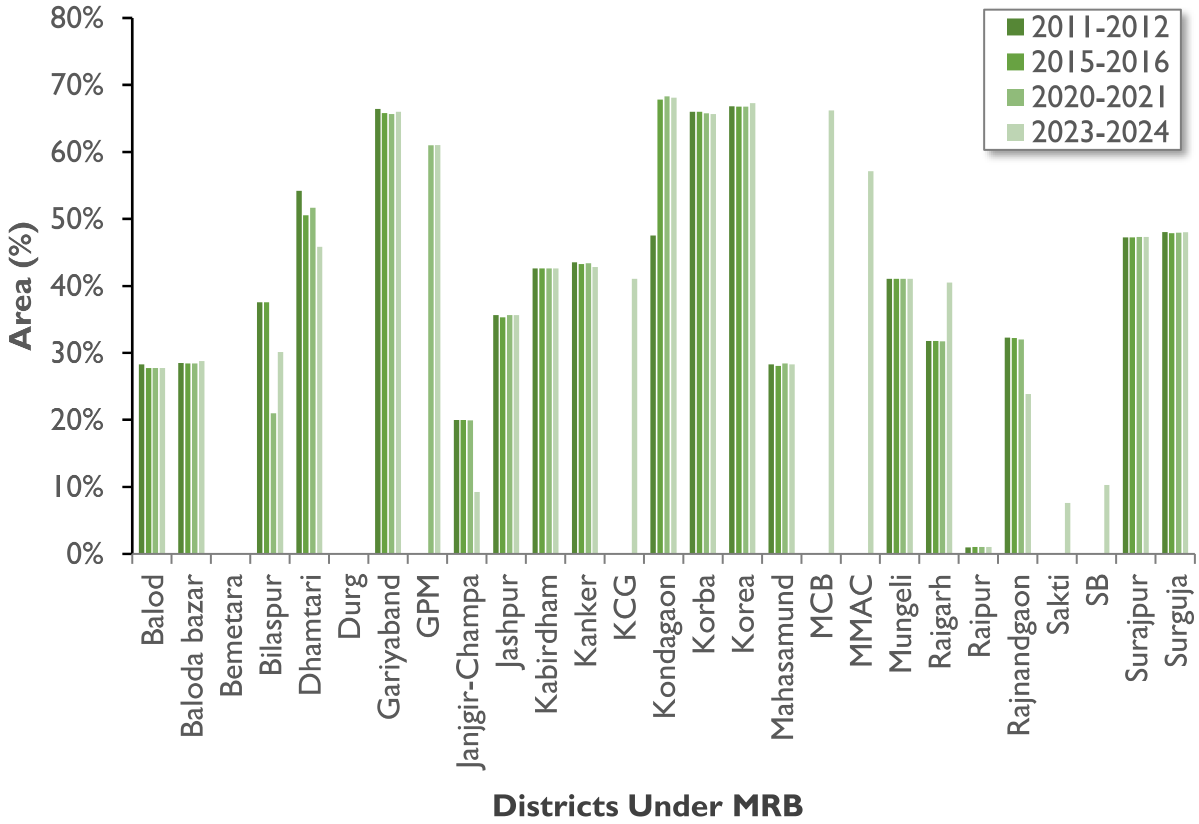


Figure 6: Area under Forest (%) of Odisha, 2000-01 to 2023-24.
[Source: Odisha Agricultural Statistics Report (2000-01;2003-04;2008-09;2013-14;2018-19; 2023-24)]

Chhattisgarh

The district-wise forest cover for the 27 districts within the Mahanadi River Basin in Chhattisgarh for the period 2011–2012 to 2023–2024 indicates substantial spatial variation in forest distribution, with generally stable trends over time. High forest-cover districts such as Gariyaband, Kondagaon, Korea and Korba consistently maintain forest percentages in the range of approximately 60–68 percent, reflecting the concentration of dense forests in the northern and central hilly belt of the basin. In contrast, the central alluvial and intensively cultivated plains—represented by districts such as Raipur, Bemetara, Durg and

Janjgir-Champa—exhibit very low forest shares, often close to zero, underscoring their predominantly agricultural and settlement-oriented land use.



*MCB (Manendragarh-Chirimiri -Bharatpur), MMAC (Mohla-Manpur-Ambagarh Chouki), GPM (Gaurella-Pendra-Marwahi), KCG (Khairgarh-Chhuikhadan-Gandai), SB (Sarangarh-Bilaigarh)

Figure 7: District-wise Forest (%) of MRB (Chhattisgarh Part), 2011-12 to 2023-24.
[Source: Directorate of Economics & Statistics, Dept. of Agriculture & Farmers Welfare, Govt. of India]

Temporal comparison shows that most long-established districts experience only minor year-to-year changes in forest cover, generally within ±1 percentage point, indicating that the overall forest extent has remained largely stable over the assessment period. In contrast, a few districts, notably Dhamtari and Bilaspur, register moderate reductions in forest percentage by 2023–2024.

The newly formed administrative districts within the Mahanadi river basin in Chhattisgarh display clearly differentiated levels of forest cover in 2023–2024. Khairgarh-Chhuikhadan-Gandai records forest cover of 41.08 percent, Manendragarh-Chirimiri-Bharatpur 66.19 percent and Mohla-Manpur-Ambagarh-Chouki 57.13 percent, whereas Sakti reports only 7.58 percent and Sarangarh-Bilaigarh 10.26 percent. Together, these patterns reflect the way these units have been carved out of both heavily forested upland tracts and more intensively used plains, and reaffirm that the basin's major forest resources are concentrated in the northern and central highland districts rather than the central valley corridor.

3.2 Area under Agriculture (Net Sown)

Odisha

There is a significant decline in net sown area in certain districts (Puri (22%), Cuttack (8%), Angul (20.5%), Khordha (7.8%), Deogarh (1.7%), Nabarangpur (2.64%), and Jharsuguda (7.3%)) over the last 2 decades. Jajpur showed a sharp decline till 2018-19 (11.2%) but partly recovered in 2023-24 (3.8%). The state has an area sown above 34%, there are districts which has higher net sown area (NSA) than the state (Jagatsinghpur, Kendrapara, Bolangir, Bargarh, Nuapada, Sonepur, Khordha, and Cuttack). In the year 2008-09, there was a decline in the net sown area in all districts except Boudh and Nayagarh, where it increased by 3.4-4.6%, respectively (Fig 8). Most districts show a declining trend in agricultural area from 2000–01 to 2018–19, followed by a partial recovery in 2023–24. Districts such as Bargarh, Bolangir, and Sonepur maintain high agricultural land (>50%), indicating strong agricultural dependency. Some districts, including Puri and Jagatsinghpur, have experienced a sharp reduction, possibly due to urbanisation, industrialisation, and land conversion to non-agricultural uses.

Except for Boudh and Nayagarh, all other district shows a declining trend in net sown area, which is a growing concern for the state. The increasing trend of land being used for other purposes is gradually decreasing the area under the net sown area as a whole. Mid-period declines in agriculture often coincide with increases in fallow land and non-agricultural land use. The slight recovery in recent years suggests improved land management or the reconversion of fallow and degraded lands to cultivation. The higher NSA in these districts reflects a strong agricultural base. In contrast, the declining trend in others may be linked to urbanisation, industrial expansion, land degradation, and conversion of agricultural land to non-agricultural uses.

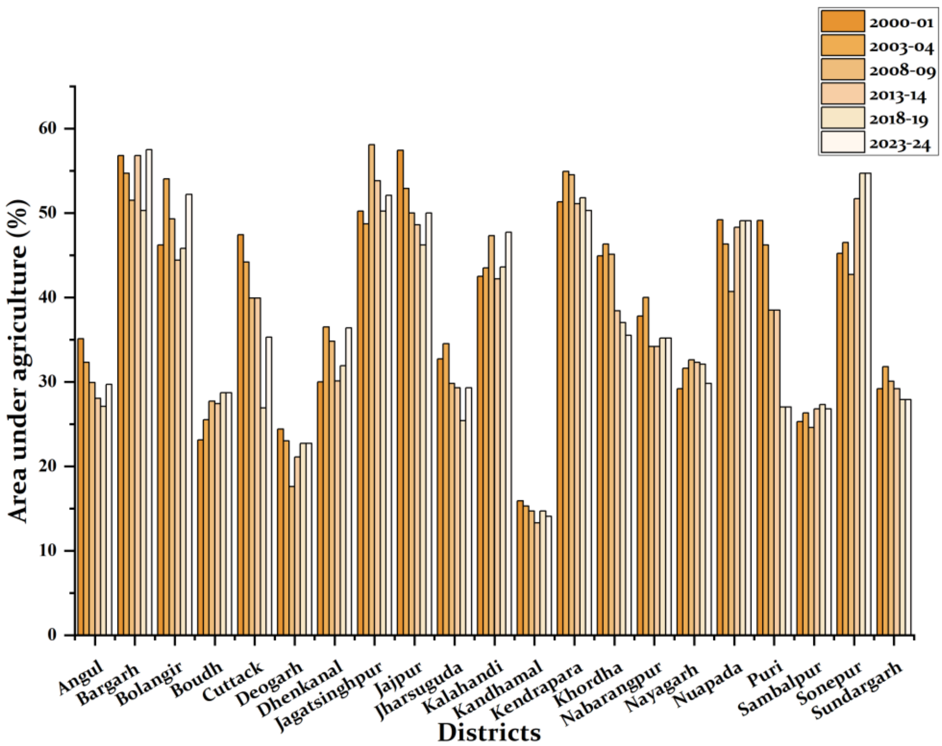


Figure 8: Net Sown Area (%) of Odisha, 2000-01 to 2023-24.
[Source: Odisha Agricultural Statistics Report (2000-01;2003-04;2008-09;2013-14;2018-19; 2023-24)]

Chhattisgarh

Net sown area across the 27 districts of the Mahanadi river basin in Chhattisgarh shows a generally stable to moderately increasing trend in many agriculturally dominant districts between 2011–2012 and 2023–2024. Balod, Baloda Bazar, Bemetara, Durg and Mahasamund maintain very high shares under cultivation (about 50–79 percent), with Bemetara consistently close to 79 percent and Balod and Baloda Bazar slightly increasing above 50 percent, indicating intensive and sustained agricultural land use. Several districts exhibit notable increases, such as Dhamtari (about 33 to 39 percent), Janjgir-Champa (about 58 to 64 percent in 2023–2024), and Rajnandgaon, which rises sharply from around 44 percent to nearly 54 percent, reflecting expansion or consolidation of cultivated area.

In contrast, hill and forest-dominated districts such as Gariyaband, Kondagaon, Korba, Korea, Surajpur and Surguja retain relatively low net sown area (generally below 30 percent), consistent with their larger forest and uncultivated tracts, while some of them (e.g., Kondagaon and Surguja) show either stagnation or slight decline in agricultural share over time. Newly formed units show diverse patterns: GPM (Gaurela-Pendra-Marwahi) reports about 26.42 percent net sown area, Khairgarh-Chhuikhadan-Gandai about 43.36 percent, Manendragarh-Chirimiri-Bharatpur about 13.87 percent, Mohla-Manpur-Ambagarh-Chouki about 25.99 percent, Sakti approximately 70.71 percent, and Sarangarh-Bilaigarh about 63.41 percent, highlighting a strong contrast between highly cultivated plains districts (Sakti, Sarangarh-Bilaigarh) and more mixed or forest-influenced upland districts (GPM, MCB, MMAC).

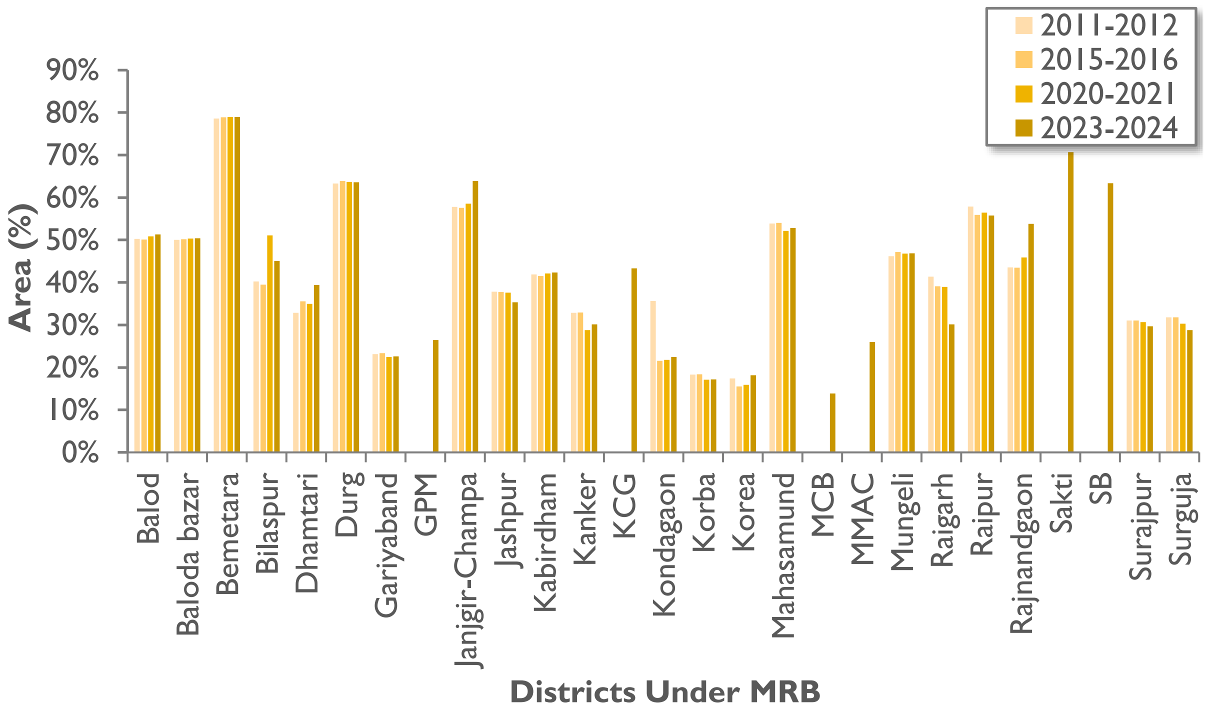


Figure 9: District-wise Net Sown Area (%) of MRB (Chhattisgarh Part), 2011-12 to 2023-24.
[Source: Directorate of Economics & Statistics, Dept. of Agriculture & Farmers Welfare, Govt. of India]

3.3 Area under Non Agricultural Use

Odisha

The decrease in the proportion of net sown area (NSA) in several districts of Odisha appears to have been partially recovered by an increase in land under non-agricultural use. Fig 4 demonstrates the trend in the proportion of area under non-agricultural use (%) across districts from 2000–01 to 2023–24.

During this period, districts such as Puri, Cuttack, Khordha, Kendrapara, and Jagatsinghpur consistently recorded a high portion of area under non-agricultural use, reflecting the demand of urbanisation, industrialisation, and infrastructure development in the coastal belt. For instance, Puri witnessed a sharp increase from 11.7% in 2000–01 to 33.04% in 2008–09, maintaining similar levels up to 2018–19 (33.04%), before a slight decline to 31.6% in 2023–24. Likewise, Cuttack registered an increase from 16.08% in 2000–01 to 21.1% during 2008–09–2018–19, and 18.5% in 2023–24, suggesting expansion of built-up areas and related non-agricultural uses. Khordha, another urban-industrial hub, also showed growth in non-agricultural land from 11.7% in 2000–01 to 16.3% by 2008–09, slightly declining thereafter to 14.6% in 2023–24.

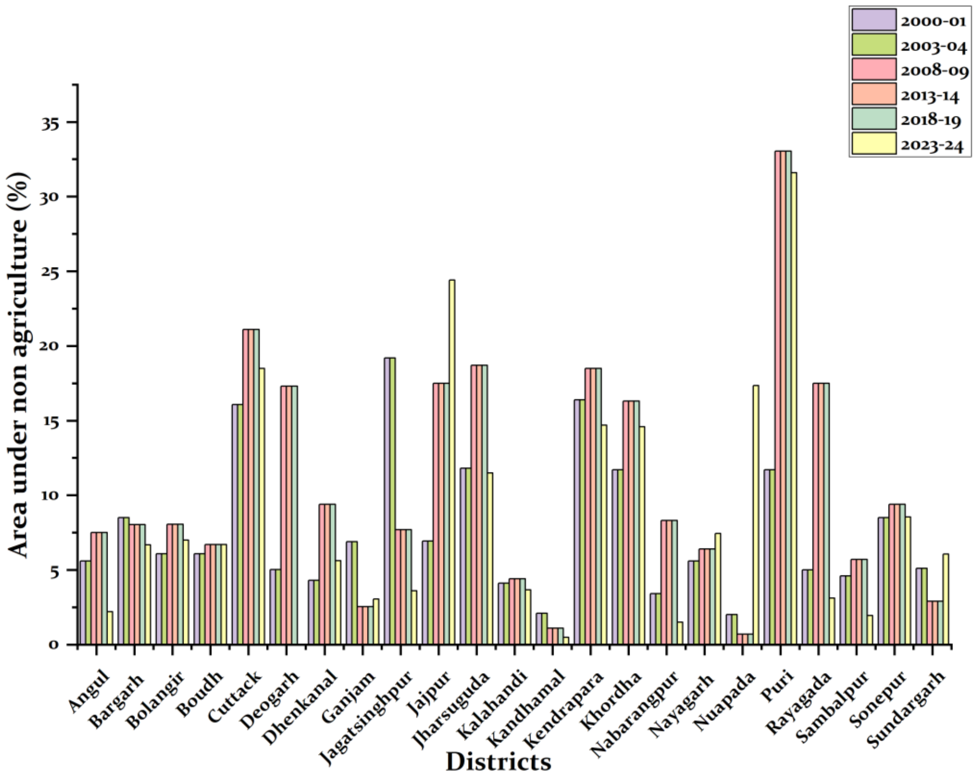


Figure 10: Non-agricultural Area (%) of Odisha, 2000-01 to 2023-24.
[Source: Odisha Agricultural Statistics Report (2000-01;2003-04;2008-09;2013-14;2018-19; 2023-24)]

In contrast, interior districts like Kalahandi, Nuapada, and Kandhamal show consistently low shares of non-agricultural land, reflecting their predominantly rural and agricultural land usage. For instance, Kalahandi fluctuated only slightly between 4.1% in 2000–01 and 3.6% in 2023–24, while Kandhamal declined from 2.09% to just 0.49% during the same period, possibly due to minimal urban development or expansion of cultivated areas.

Interestingly, some western districts, such as Deogarh and Jharsuguda, show sharp increases in non-agricultural areas. Deogarh recorded a jump from 5.03% in 2000–01 to 17.3% in 2008–09 and remained stable till 2023-24 due to its industrial and mining activities. Jharsuguda, another industrially expanding district, rose from 11.8% in 2000–01 to 18.7% in 2008–09, indicating rapid industrialisation.

Similarly, Jajpur shows a substantial rise in the non-agricultural share, increasing from 6.9% in 2000–01 to 24.4% in 2023–24, reflecting industrial growth and infrastructure expansion in the region. Conversely, Angul, which had 7.5% non-agricultural area in 2008–09, witnessed a sharp decline to 2.19% in 2023–24, possibly due to improved utilisation of land in agriculture.

Overall, the data suggest that districts located in the coastal and industrial belts (such as Puri, Cuttack, Khordha, Kendrapara, Jajpur, and Jharsuguda) have experienced considerable land diversion toward non-agricultural uses over the past two decades. In contrast, agricultural-dominated interior and southern districts (like Kalahandi, Kandhamal, and Boudh) continue to maintain relatively low levels of non-agricultural land, emphasising the uneven nature of urban and industrial development across Odisha (Fig 10).

Chhattisgarh

Non-agricultural area (built-up land, infrastructure, and other non-farm uses) within the 27 districts of the Mahanadi river basin in Chhattisgarh generally occupies a modest share of total geographical area, mostly in the range of about 3–9 percent, but with higher values in major urban–industrial districts.

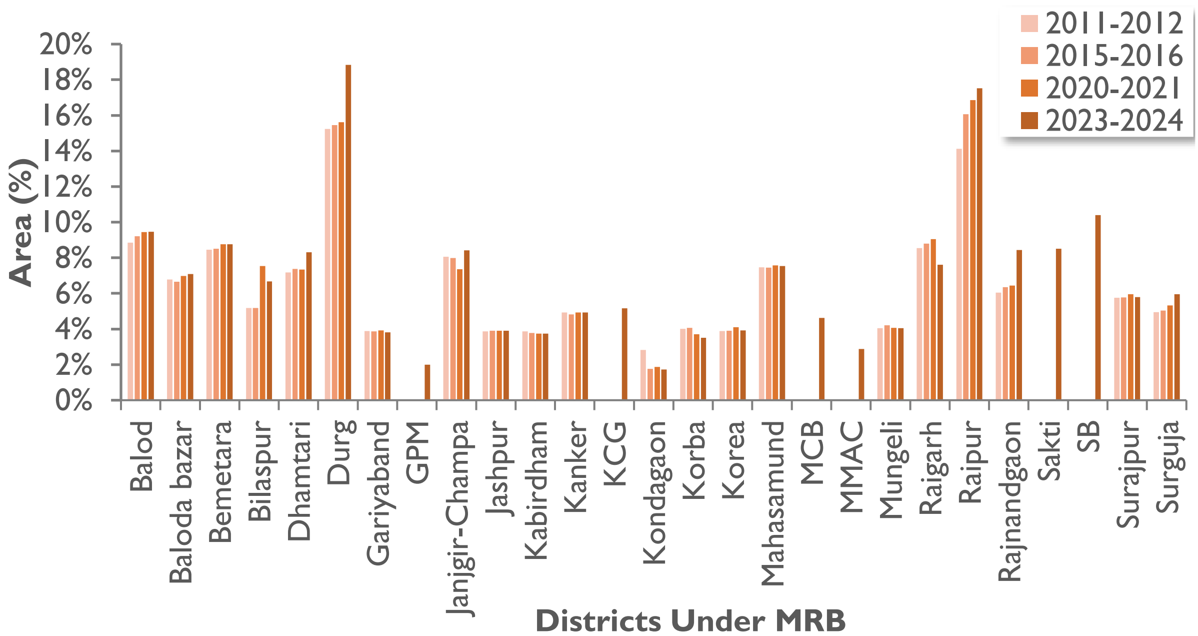


Figure 11: District-wise Non-Agricultural Area (%) of MRB (CG Part), 2011-12 to 2023-24.
[Source: Directorate of Economics & Statistics, Dept. of Agriculture & Farmers Welfare, Govt. of India]

Durg and Raipur consistently record the highest non-agricultural shares, rising from about 15–14 percent in 2011–2012 to nearly 19 percent and 17.5 percent respectively by 2023–2024, indicating continuing urban expansion and growth of transport, industrial and service infrastructure. Rajnandgaon also shows a notable increase, from around 6.0 percent to 8.4 percent over the same period, while Dhamtari's non-agricultural area rises from about 7.2 to 8.3 percent, pointing to gradual land conversion from agricultural or open categories to built-up and related uses.

However, this upward trends should be interpreted in the context of successive administrative re-demarcations and the formation of new districts during the intervening period, which have altered the spatial extent, land-use composition, and urban–industrial concentration of the parent districts. The post-reorganization retention of major urban, industrial, and infrastructure-dominated areas within Durg and Raipur has likely amplified the apparent increase in non-agricultural land shares, partly reflecting boundary effects in addition to actual land-use transitions.

In contrast, predominantly rural and forest-dominated districts such as Gariyaband, Jashpur, Kabirdham, Kanker, Kondagaon, Korba, Korea, Surajpur and Surguja maintain relatively low non-agricultural percentages, mostly between 3 and 6 percent, with only minor fluctuations over time, suggesting limited urban sprawl and a land base still largely under agriculture and forest. Newly created districts such as Gaurela-Pendra-Marwahi (GPM) has about 2.0 percent non-agricultural area, Manendragarh-Chirimiri-Bharatpur (MCB) about 4.6 percent, Mohla-Manpur-Ambagarh-Chouki (MMAC) about 2.9 percent, Sakti around 8.5 percent and Sarangarh-Bilaigarh around 10.4 percent in 2023–2024, illustrating higher levels of built-up development in the central plains (Sakti, Sarangarh-Bilaigarh) relative to the more sparsely developed upland districts.

4. Irrigation and Water Use

4.1 Total Irrigated Area

Odisha

Modern irrigation facilities in Odisha are concentrated in districts located within the plains and agriculturally active regions. During 2023–24, Bargarh recorded the highest gross irrigated area in the state at 398.5 thousand hectares, showing a significant rise from 206.7 thousand hectares in 2000–01. This district alone accounted for a major portion of the total irrigated land in western Odisha. It was followed by Kalahandi, which reached 330.05 thousand hectares in 2023–24, reflecting a substantial rise from 115.2 thousand hectares in 2000–01. Ganjam also shows the highest irrigated area consistently, ranging from 245 to 298.39, suggesting extensive irrigation infrastructure and water availability after Bargarh and Kalahandi (Fig 12).

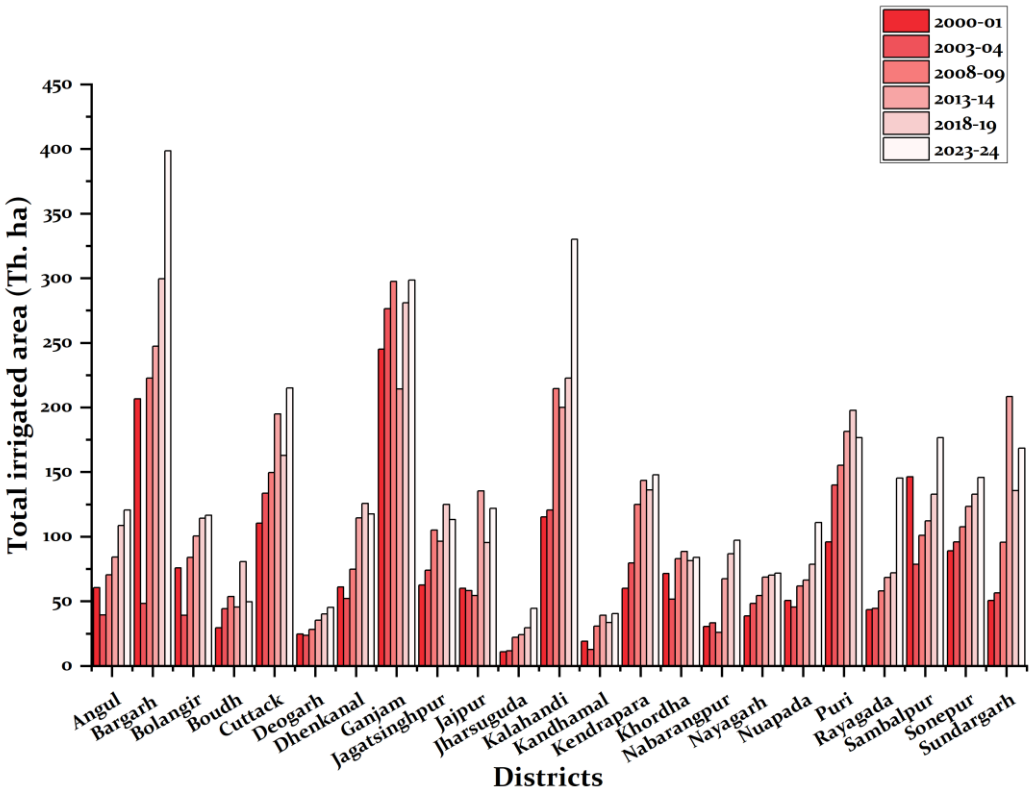


Figure 12: Total (Gross) Irrigated Area of Odisha, 2000-01 to 2023-24.
[Source: Odisha Agricultural Statistics Report (2000-01;2003-04;2008-09;2013-14;2018-19; 2023-24)]

Other districts with a consistently high proportion of irrigated land included Cuttack and Sonepur, both experiencing rapid growth over the years. Cuttack increased from 110.3 thousand hectares in 2000–01 to 215.07 thousand hectares in 2023–24, while Sonepur grew from 88.9 to 145.72 thousand hectares during the same period. On the other hand, districts like Nuapada and Sambalpur made notable gains in irrigation development, with Nuapada more than doubling its irrigated area and Sambalpur increasing from 146.4 to 176.57 thousand hectares between 2000–01 and 2023–24. Rayagada and Jajpur recorded moderate but steady increases, from 43.42 to 148.29 and 60.03 to 121.79 thousand ha, respectively, reflecting ongoing improvement in irrigation infrastructure. Districts like Puri and Boudh showed initial growth but later declined in irrigated area from 197.7 to 176.7 thousand ha and from 80.5 to 49.6 thousand ha, respectively. Kandhamal, Deogarh, and Jharsuguda consistently remained below 50 thousand ha, indicating limited irrigation infrastructure. Nabarangpur improved significantly from about 26 to 97 thousand ha, while Dhenkanal and Jagatsinghpur showed early gains followed by slight declines in 2023–24, suggesting the need for renewed investment in irrigation.

Chhattisgarh

The gross irrigated area across the Chhattisgarh portion of the Mahanadi River Basin (MRB) shows a general expansion from the early 2010s to 2020–21, followed by stabilization or decline in 2023–24, reflecting both infrastructure development and recent climatic or hydrological stresses. Major irrigation-intensive districts such as Janjgir–Champa, Raipur, Dhamtari, Durg, Bemetara, Kabirdham, and Mahasamund consistently record high irrigated extents. Notably, Bemetara and Kabirdham exhibit strong growth between 2011–12 and 2020–21, reaching over 2.18 lakh ha and 1.54 lakh ha respectively, while Raipur maintains a relatively stable irrigated area around 1.5 lakh ha, underscoring its role as a core irrigated agricultural belt of the basin.

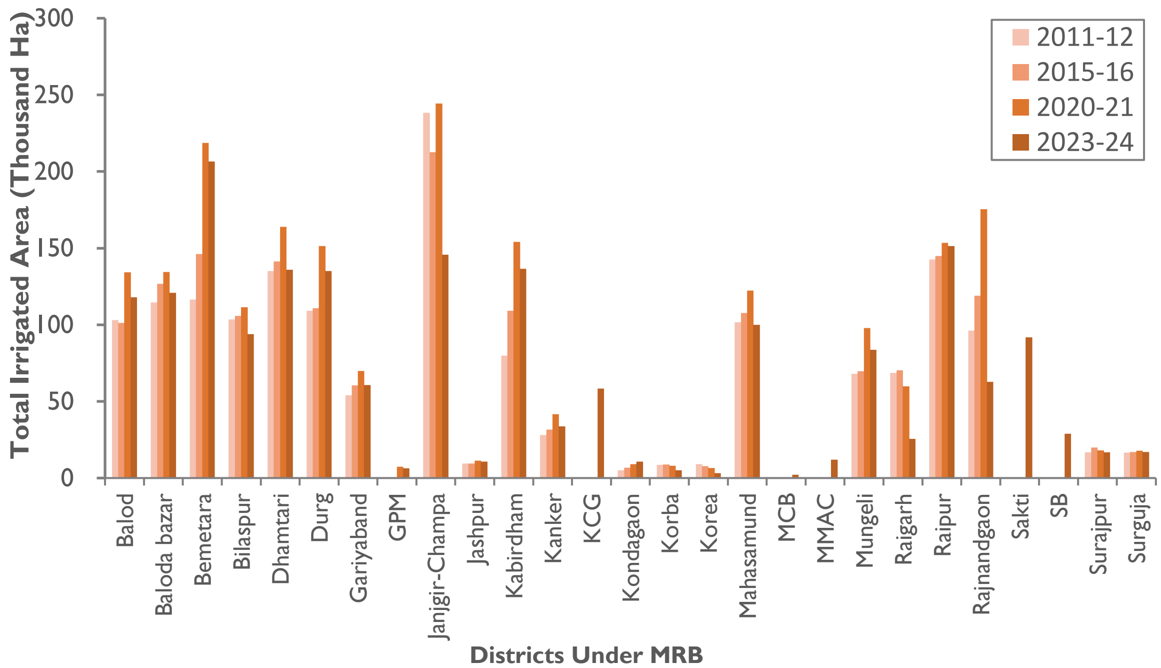


Figure 13: Total (Gross) Irrigated Area of MRB (CG Portion), 2000-01 to 2023-24.
[Source: Directorate of Economics & Statistics, Dept. of Agriculture & Farmers Welfare, Govt. of India]

In contrast, several districts show marked declines by 2023–24, particularly Janjgir–Champa, Rajnandgaon, and Raigarh, suggesting possible impacts of variable monsoon rainfall, surface water availability, cropping shifts, or administrative reorganization. Newly formed districts such as Gaurella–Pendra–Marwahi, Khairgarh–Chhuikhadan–Gandai, Manendragarh–Chirimiri–Bharatpur, Mohla–Manpur–Ambagarh Chouki, Sakti, and Sarangarh–Bilaigarh report moderate irrigated areas in recent years, indicating redistribution of irrigation statistics following district bifurcations rather than net creation of new irrigation. Overall, the temporal pattern highlights an initial phase of irrigation expansion in the MRB (CG) up to 2020–21, followed by consolidation and spatial reallocation in the early 2020s, with important implications for water management and agricultural resilience.

4.2 Sources of Irrigation: Odisha (MRB Part)

Odisha part of MRB

The major sources of irrigation in Odisha are canals, bore wells, shallow tube wells, lift irrigation systems, tanks, and ponds. Canal irrigation dominates in the coastal and deltaic regions, supported by major projects like the Hirakud Dam on the Mahanadi. In the western and southern districts, minor irrigation schemes such as lift points, check dams, and community tanks are more common. Groundwater irrigation through bore wells, shallow and deep tube wells, is significant in districts like Cuttack, Bargarh, and Sambalpur.

Recently, under the Jalnidhi schemes, cluster-based river lift irrigation projects have also been introduced to enhance water availability and ensure sustainable irrigation in water-scarce areas. Overall, Odisha's irrigation system combines large-scale canal networks with localised and river-based lift systems to meet diverse regional needs.

4.2.1 Major and Medium Irrigation

The graph on major and medium sources of irrigation reveals significant variation over the last two decades across Odisha.

Districts like Puri (68.43%), Sambalpur (47%), Sonepur (45.2%), and Kendrapara (53%) consistently reported the highest dependence on major and medium sources in 2023-24, reflecting their strong reliance on canal networks and large-scale irrigation projects. Cuttack, Khordha, Sonepur, Kendrapara, Jagatsinghpur, and Sambalpur also maintain high shares, generally above 40%, indicating well-established infrastructure.

In contrast, districts such as Kandhamal, Nabarangpur, Sundargarh, Bolangir, and Rayagada exhibit minimal dependence, often below 20%, indicating limited access to major and medium-sized projects and a possible reliance on minor or rainfed systems. Jagatsinghpur, Nuapada and Deogarh exhibit moderate shares but fluctuating trends benefiting from canal networks and proximity to the Mahanadi delta systems, while Jharsuguda records zero values across all years, highlighting a complete absence of major and medium irrigation in that district.

Over time, many districts display a slight declining trend, suggesting either a reduction in water availability from large systems or a shift towards alternative irrigation methods such as lift irrigation and groundwater-based irrigation systems across Odisha.

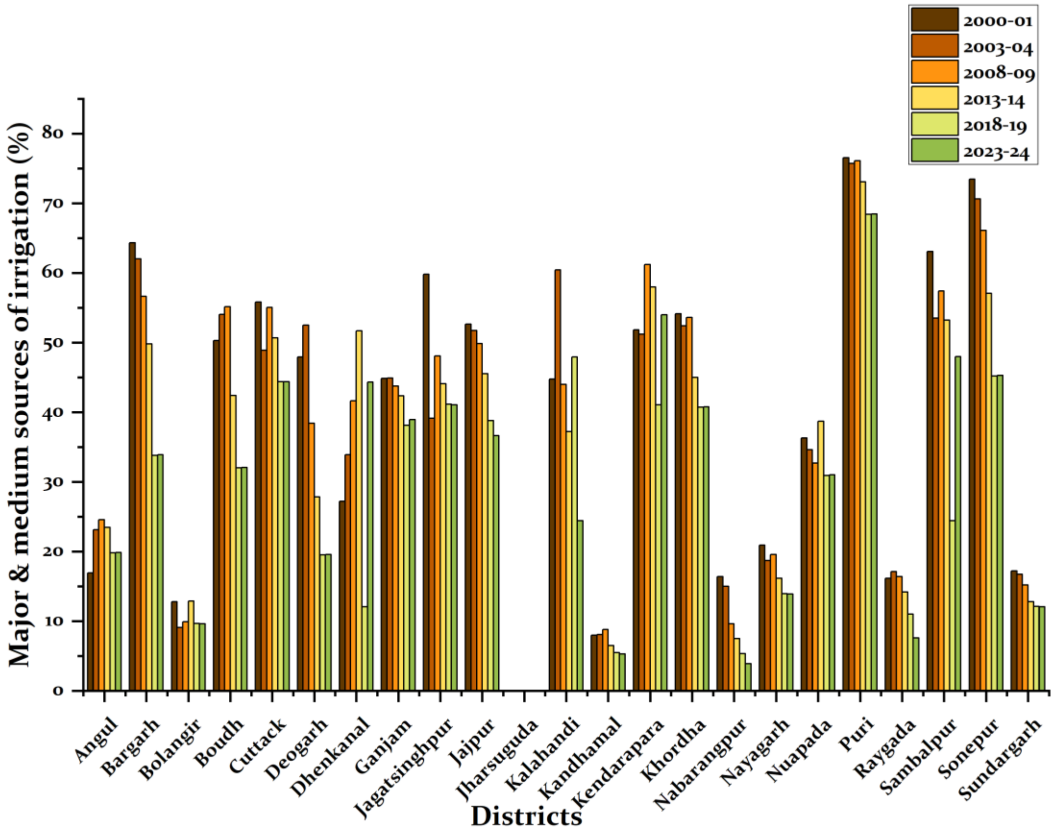


Figure 14: Major and medium irrigation across districts of Odisha, 2000-01 to 2023-24.
[Source: Odisha Agricultural Statistics Report (2000-01;2003-04;2008-09;2013-14;2018-19; 2023-24)]

4.2.2 Minor (Lift) Irrigation

From 2000 to 2023, most districts of Odisha in the Mahanadi basin recorded a steep increase in the lift irrigation to their total irrigated area.

Fig 15 shows that districts such as Rayagada (28.37%), Nabarangpur (26.47%), and Jajpur (31.47%) recorded the highest share of minor lift irrigation in 2023–24, well above the state average. These areas have shown consistent growth since 2000–01, indicating significant development in lift irrigation infrastructure. Districts like Khordha, Nayagarh, Ganjam, Boudh, Sonepur, and Sundargarh also show a gradual increase in lift irrigation since 2000-01, possibly due to improved lift irrigation infrastructure in those districts. Other districts like Kendrapara (29.01%), Jagatsinghpur (22.9%), and Sonepur (25%) also reported a substantial share, reflecting their dependence on lift irrigation for agricultural activities.

Fluctuation in the use of lift irrigation was observed in Puri, Cuttack, Bargarh, Dhenkanal, Nuapada, Sambalpur, Jagatsinghpur, and Nabarangpur, suggesting a gradual shift towards other irrigation methods, such as canal or tube wells.

These trends indicate a shift in the irrigation pattern, with many districts expanding lift irrigation through initiatives like the Jalnidhi scheme, which promotes cluster-based river lift systems to enhance water access in water-scarce areas.

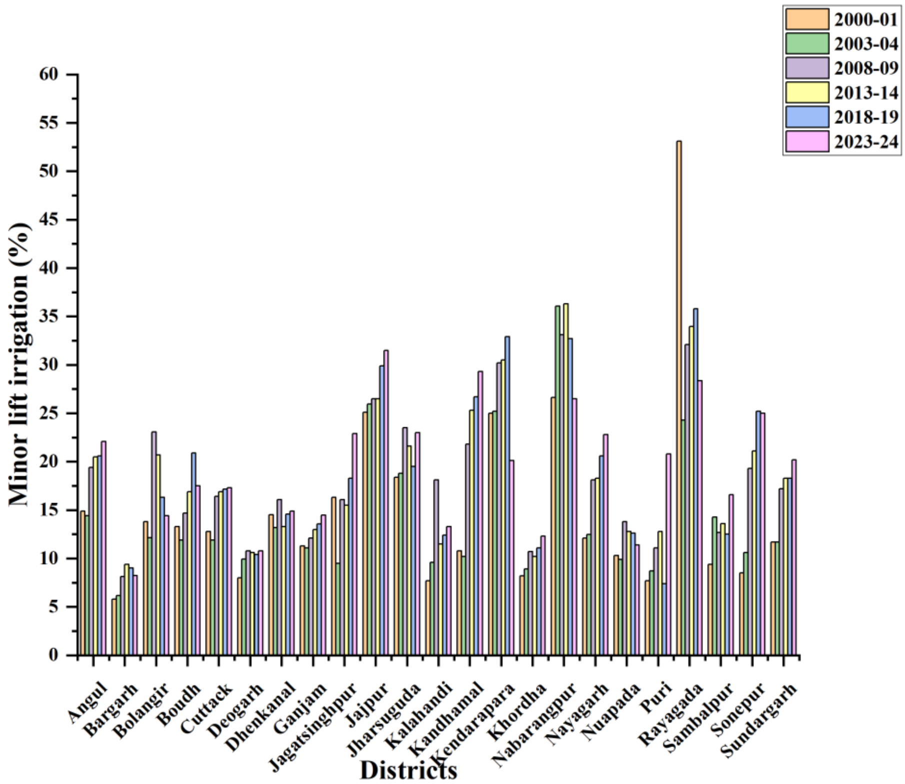


Figure 15: Lift Irrigation of Odisha, 2000-01 to 2023-24.
[Source: Odisha Agricultural Statistics Report (2000-01;2003-04;2008-09;2013-14;2018-19; 2023-24)]

4.2.3 Minor (Flow) Irrigation

Minor flow irrigation across districts in Odisha shows a mixed trend from 2000–01 to 2023–24 **(Fig 16).**

Few districts, such as Rayagada, Ganjam, Kandhamal, and Nayagarh, consistently maintain high proportions of minor irrigation throughout the period, reflecting strong and stable infrastructure. In contrast, districts like Cuttack, Nuapada, Sonepur, and Kandhamal have shown remarkable growth, moving from relatively low coverage in the early 2000s to much higher levels by 2018-19 and 2023-24, indicating successful development interventions. Some areas, including Sundargarh, Bolangir, Dhenkanal, Deogarh and Kalahandi, showed a fluctuating trend, with peaks in 2008-09 followed by a steady decline in subsequent years. Jharsuguda shows significant growth with a sharp increase over time (0%-26.6%), while districts such as Boudh, Dhenkanal, Angul, Bargarh, and Jajpur exhibit a gradual decrease over the years. Sambalpur, Nabarangpur, and Khordha remained stable during the period. Some districts like Puri, Kendrapara, Jajpur, and Jagatsinghpur have experienced a rapid decline since 2000-01. The recent years (2018–19 to 2023–24) indicate a slight overall reduction in minor flow irrigation percentages across many districts, possibly due to shifting irrigation practices, changes in water availability, or increased reliance on other irrigation sources. These recent variations underline the need for district-specific strategies to sustain and further enhance minor irrigation flow coverage.

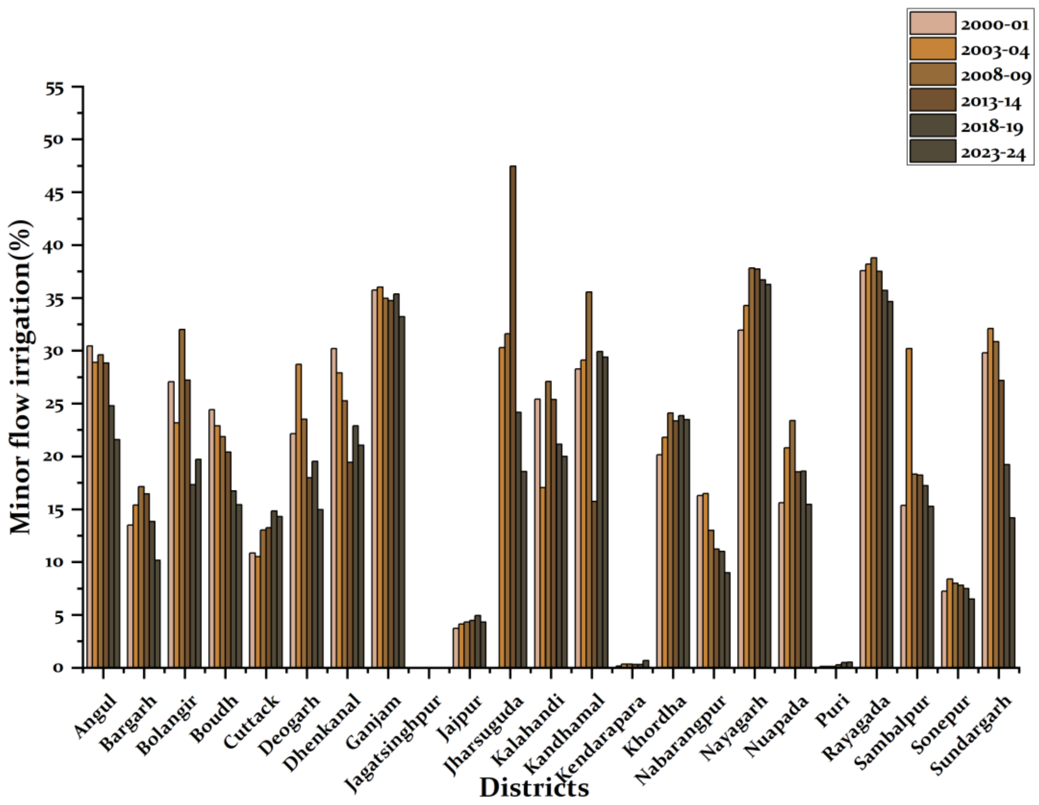


Figure 16: Flow irrigation across districts of Odisha, 2000-01 to 2023-24.
[Source: Odisha Agricultural Statistics Report (2000-01;2003-04;2008-09;2013-14;2018-19; 2023-24)]

4.2.4 Other Sources of Irrigation

From 2000 to 2023, most districts in the Mahanadi basin of Odisha show a steady decline in indicating a possible reduction in agricultural intensity, irrigated area, or crop cover.

In 2000-01, several districts such as Kandhamal (53.12%), Jharsuguda (53.19%), Bolangir (45.55%), Nabarangpur (40.66%), and Sundargarh (40.43%) recorded a high proportion of irrigation from other sources, depicting substantial dependence on local or conventional irrigation systems. With passing time, these values gradually decreased by 2023-24. Moderate decline was observed in Cuttack (20.3% to 15.6%), Nayagarh (34.9% to 16.5%) and Deogarh (22.5% to 19.1%). Districts such as Jharsuguda, Kandhamal, Nuapada, and Sundargarh experienced a steep decline, losing more than half of their initial share over the period. Districts like Puri (15.5% to 10.7%), Boudh (11.8% to 5.5%), and Sonepur (10.7% to 4.8%) consistently remained at low values due to limited usage of this irrigation in recent years. In contrast, Jajpur stands out as the only district showing a significant and consistent rise, increasing from 18.54% in 2000-01 to 21.3% in 2018-19. Several districts experienced notable declines, particularly due to urban area expansion and land diversification **(Fig 17).**

The data suggest that factors such as urban expansion, industrial projects, changes in cropping patterns, or water availability may be influencing the reduction in agricultural intensity or irrigated share in most districts. On the other hand, targeted irrigation expansion or agricultural interventions might explain the growth seen in Jagatsinghpur.

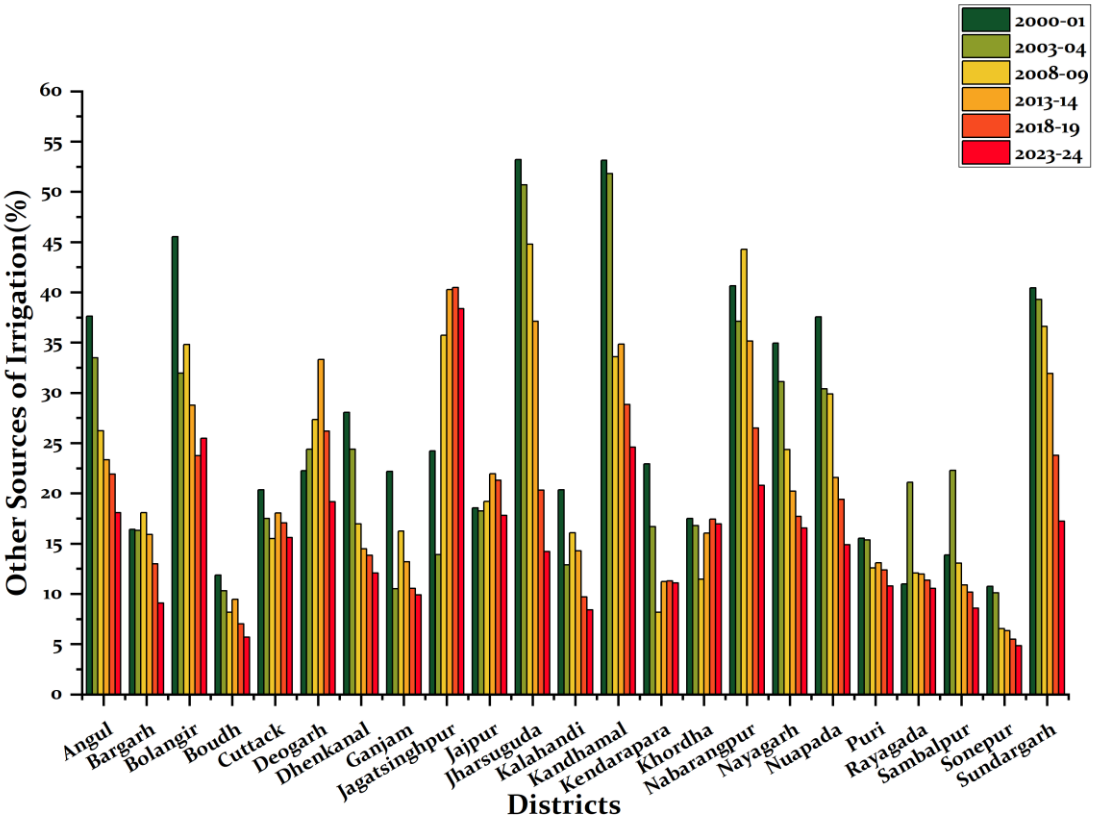


Figure 17: Other sources of irrigation across districts of Odisha, 2000-01 to 2023-24.
[Source: Odisha Agricultural Statistics Report (2000-01;2003-04;2008-09;2013-14;2018-19; 2023-24)]

4.3 Sources of Irrigation: Chhattisgarh (MRB Part)

Chhattisgarh part of MRB

In the Chhattisgarh portion of the Mahanadi River Basin, irrigation is predominantly supported by surface water systems, anchored by the Mahanadi Reservoir Complex (MRC), which forms the core of irrigation and water regulation in the upper basin. The complex comprises major storages including Ravishankar Sagar (Gangrel) Dam on the Mahanadi, Sondur Dam on the Sondur River, Dudhawa Dam on the Dudhawa River, and Pairi Dam on the Pairi River, along with feeder links that integrate their operations. Together, these reservoirs feed the Mahanadi Main Canal system, irrigating large parts of Raipur, Durg, Dhamtari, Balod, Mahasamund, and Gariyaband districts and sustaining the rice-based agrarian economy of the central plains. In addition, large and medium projects such as Hasdeo Bango (Korba), Tandula and Kharkhara (Balod–Durg region), and Minimata (Hasdeo) canal systems further strengthen surface irrigation in the basin.

Beyond the major systems, irrigation in the upland and tribal districts—Kanker, Kondagaon, Jashpur, Surguja, Korea, and parts of Raigarh—relies more on minor irrigation tanks, anicuts, check dams, lift irrigation from rivers and streams, and groundwater sources such as dug wells and shallow tube wells. Recent state initiatives promoting river lift schemes, tank renovation, and micro-irrigation have enhanced water access in undulating and water-scarce areas. Overall, the Chhattisgarh segment of the MRB exhibits a surface-water–dominated irrigation regime centered on the Mahanadi Reservoir Complex, complemented by decentralized minor and groundwater-based systems adapted to the basin's diverse physiography.

4.3.1 Major, Medium and Minor Irrigation

Between 2005–06 and 2018–19, the irrigation structure of Chhattisgarh State remained consistently dominated by major irrigation projects, with their share fluctuating narrowly between 50 and 56 percent of the total irrigated area. The contribution of major irrigation increased from 50 percent in 2005–06 to a peak of 56 percent during 2008–09 and 2009–10, before stabilising around 51–52 percent in the later years. This trend reflects the continued reliance on large canal-based systems and reservoir-fed irrigation networks developed across the state, which form the backbone of irrigated agriculture, particularly in command areas supporting paddy cultivation.

In contrast, medium irrigation projects contributed a relatively small and declining share, remaining within a narrow range of 10–15 percent throughout the period and stabilising at about 10 percent after 2012–13. Minor irrigation, comprising tanks, tube wells, dug wells, and lift irrigation schemes, showed a gradual but steady increase, rising from 34 percent in 2005–06 to about 38–39 percent by 2016–17 to 2018–19. The growing share of minor irrigation indicates increasing farmer dependence on decentralised and groundwater-based sources to supplement canal supplies, especially in rainfed and tail-end areas. Overall, the data highlight a structural shift toward minor irrigation within a largely stable major irrigation framework, with important implications for groundwater sustainability and future irrigation planning in the state.

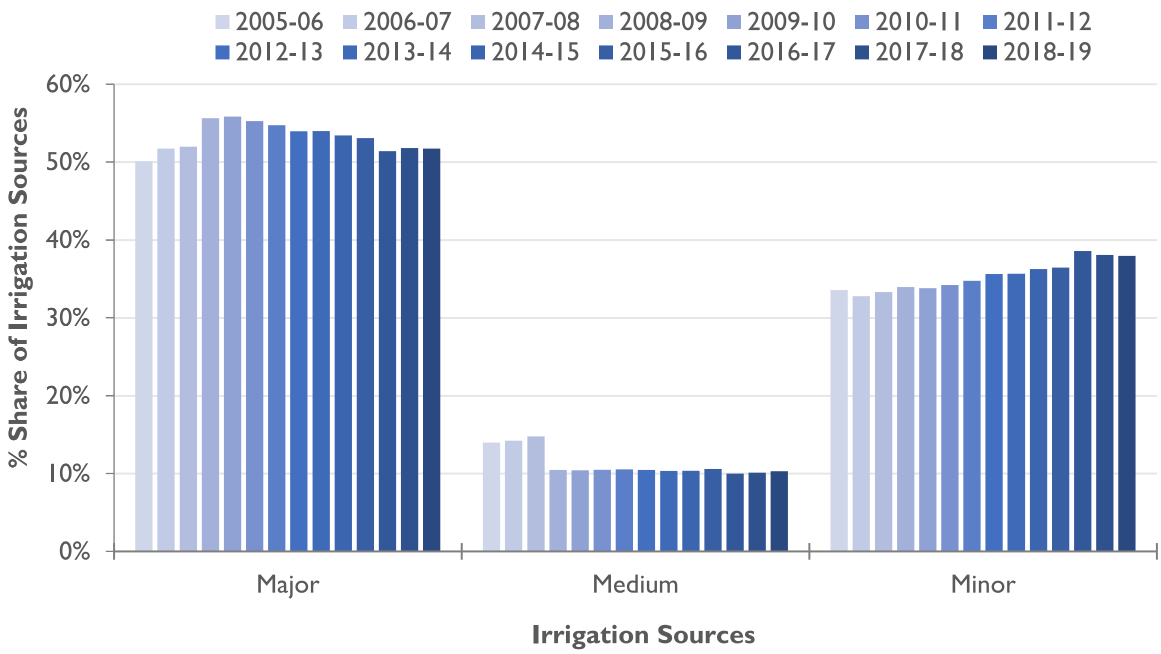


Figure 18: % Share of the Major, Medium and Minor Irrigation in Chhattisgarh [MRB Part], 2005-06 to 2018-19

[Source: Chhattisgarh Statistical Abstract Report, Directorate, Agriculture, Govt. of C.G.]

4.4 Area Irrigated by Different Crops

Odisha

The irrigation scenario in Odisha shows a significant transformation over the last two decades. The irrigated area rose steadily from 37.8% in 2000–01 to a peak of 59.4% in 2018–19, before slightly reducing to 49.9% in 2023–24. This expansion reflects both improvements in irrigation infrastructure and policy focus on agricultural intensification (Fig 19).

Crop-wise analysis reveals that rice consistently dominates irrigation use, occupying about 77.0% of the gross irrigated area in 2000–01, though this share gradually declined to 55.8% in 2023–24. This decline is not indicative of reduced irrigation for rice but rather a reflection of increased irrigation allocation to other crops. Among these, pulses and maize show the most striking growth. Pulses expanded from 2.9% in 2000–01 to 11.9% in 2023–24, while maize rose sharply from 0.7% to 11.4% during the same period, signalling a clear diversification trend in area irrigated for agriculture across Odisha. Wheat also registered a modest rise, increasing from 0.68% to 2.99% of irrigated area between 2000–01 and 2023–24. Oilseeds, in contrast, showed a fluctuating pattern: increasing from 2.4% in 2000–01 to 8.0% in 2013–14, then falling to 4.0% in 2018–19, before rebounding to 11.4% in 2023–24. Sugarcane and potato consistently accounted for less than 2% each of the gross irrigated area across the years, with only marginal variations.

Overall, the findings highlight that while rice continues to dominate irrigation use in Odisha, its proportional share has reduced over time, making way for the expansion of irrigation to crops like pulses, maize, and oilseeds.

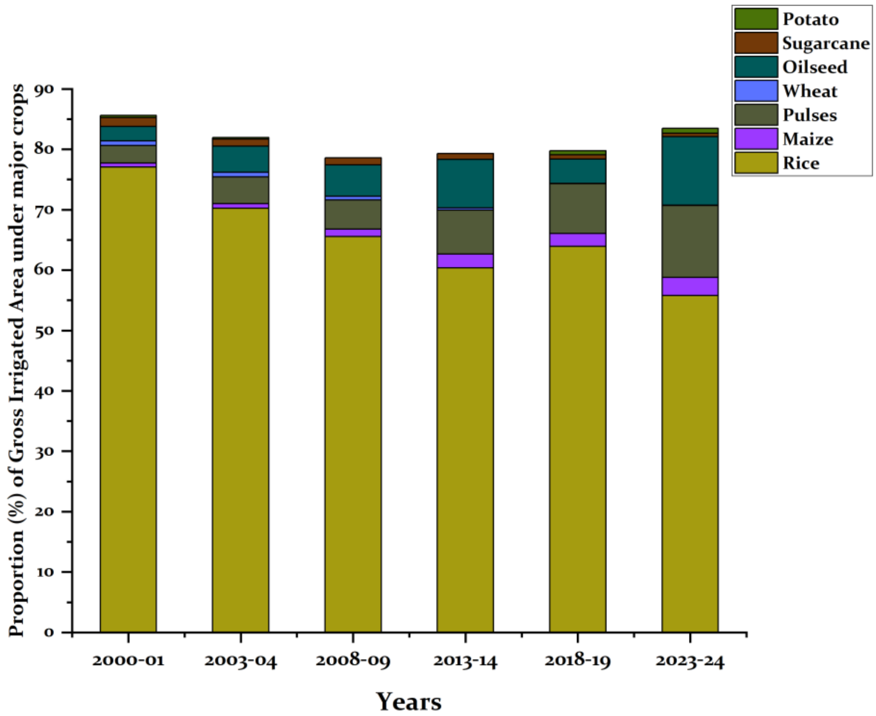


Figure 19: Proportion (%) of Gross Irrigated Area under Major Crops, 2000-01 to 2023-24.
[Source: Odisha Agricultural Statistics Report (2000-01;2003-04;2008-09;2013-14;2018-19; 2023-24)]

Chhattisgarh

Across the Chhattisgarh portion of the Mahanadi River Basin, the gross irrigated area is overwhelmingly dominated by rice, reaffirming the basin's status as the rice bowl of central India. During 2011–12 to 2023–24, rice consistently accounts for about 75–83% of the gross irrigated area, with a slight dip around 2017–18 followed by recovery to nearly 79–80% in recent years. Wheat emerges as the second most important irrigated crop, showing a gradual increase from about 4% in the early 2010s to 6–7% after 2020, indicating expanding rabi irrigation and diversification in parts of the basin. In contrast, maize and oilseeds occupy very small shares (generally <1% each), reflecting their limited dependence on irrigation in the region.

The share of pulses exhibits notable variability, rising sharply to over 12% in 2017–18 before stabilizing around 6–9% in subsequent years, suggesting episodic policy or climatic influences on pulse cultivation under irrigation. Sugarcane, though minor in overall share, shows a steady increase from about 1% to over 2.3% by 2023–24, pointing to localized intensification in suitable pockets. Meanwhile, the gross irrigated area expanded from about 1.62 million ha in 2011–12 to a peak of over 2.11 million ha in 2020–22, before moderating to ~1.87 million ha in 2023–24, mirroring recent fluctuations in water availability and cropping choices. Overall, the pattern highlights a strongly rice-centric irrigation regime with gradual diversification toward wheat, pulses, and sugarcane within the MRB of Chhattisgarh.

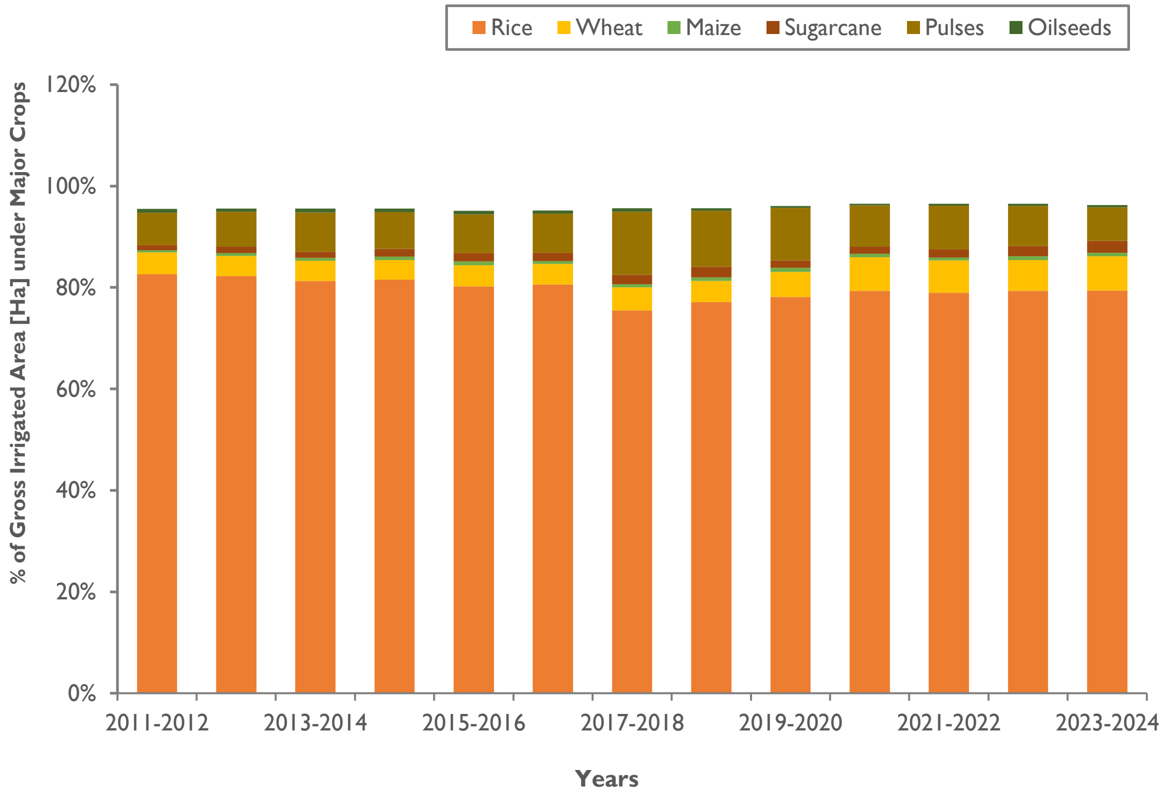


Figure 20: Total (Gross) Irrigated Area of MRB (CG Portion), 2011-12 to 2023-24.
[Source: Directorate of Economics & Statistics, Dept. of Agriculture & Farmers Welfare, Govt. of India]

4.4.1 Area Irrigated by Rice Across Districts

Odisha

Fig 21 illustrates the proportion of agricultural land under rice that was irrigated across the districts of Odisha from 2000–01 to 2023–24.

The data reveal that coastal districts such as Puri (85.3%), Boudh (86.8%), Cuttack (79.6%), and Kendrapara (76.3%) maintained a relatively higher percentage of irrigated area under rice during 2000–01. Over the years, however, a gradual decline was observed across most districts, with the latest values in 2023–24 showing reduced irrigation coverage in districts like Puri (69.8%), Boudh (45.1%), and Cuttack (50.0%). Districts in southern and western Odisha, such as Rayagada (78.1%), Nabarangpur (80.2%), and Sonepur (84.2%), also exhibited high irrigation levels during the early 2000s, though these too showed declining trends in recent years. In contrast, upland districts like Kandhamal, Nuapada, and Sundargarh recorded comparatively lower irrigation percentages throughout the period, reflecting dependence on rainfed conditions and limited irrigation infrastructure.

Overall, the data indicate that while irrigation under rice was widespread in the early 2000s, a notable decrease occurred by 2023–24, especially in western and interior districts, suggesting changing water availability and climatic influences on cropping patterns, or irrigation infrastructure efficiency over the two decades.on rice cultivation in Odisha.

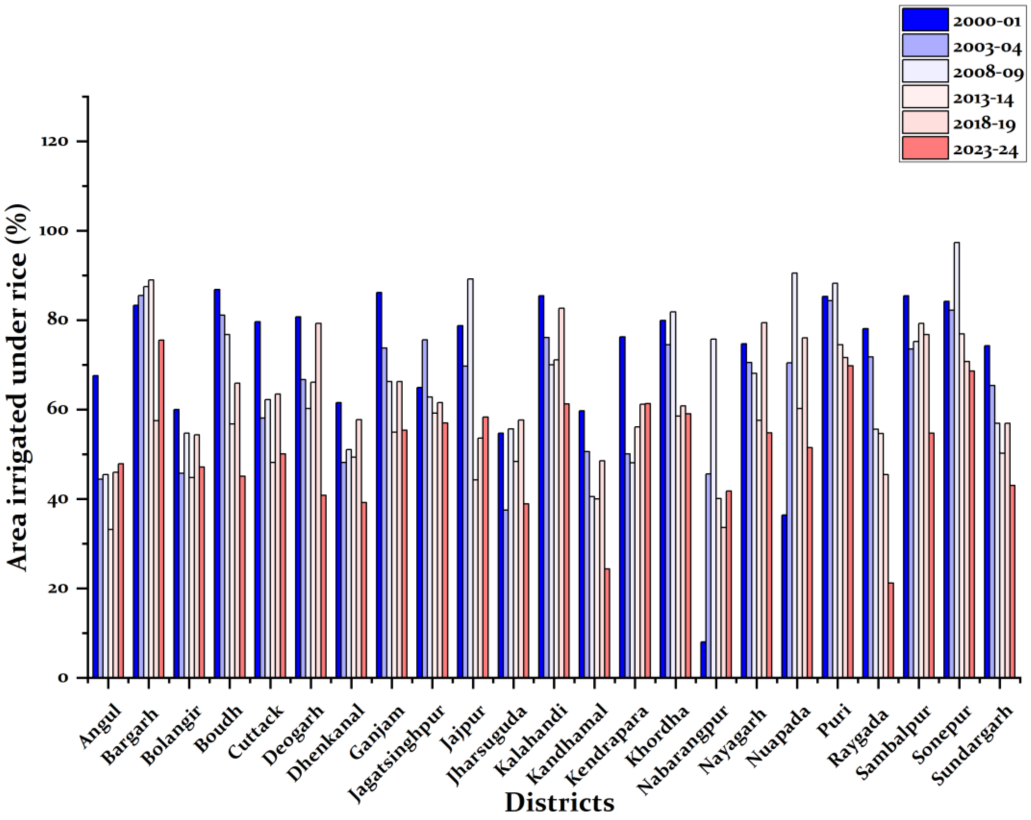


Figure 21: Area irrigated under rice across districts of Odisha, 2000-01 to 2023-24.
[Source: Odisha Agricultural Statistics Report (2000-01;2003-04;2008-09;2013-14;2018-19; 2023-24)]

Chhattisgarh

Districts such as Janjgir–Champa, Gariyaband, Mahasamund, Dhamtari, Raipur, Balod, Baloda Bazar, and Bilaspur consistently report very high shares, with around 90–99% of their irrigated area under rice during 2011–12 to 2023–24. These districts largely fall within the command of major canal networks linked to the Mahanadi Reservoir Complex and associated storages, where assured surface water supports intensive paddy-based systems. In several cases, including Gariyaband and Janjgir–Champa, the rice share further increases by 2023–24, indicating strengthening specialization in irrigated paddy.

In contrast, lower and more variable rice shares characterize upland and tribal districts such as Kondagaon, Surajpur, Surguja, Korea, Jashpur, and Kabirdham, where rice often accounts for less than 50% of irrigated area and drops below 15–30% in districts like Surajpur and Surguja. These areas depend more on minor irrigation and groundwater and exhibit greater crop diversification toward pulses, millets, and oilseeds.

Overall, the pattern underscores a highly rice-dominated irrigated core in the MRB plains, contrasted with more diversified and constrained irrigation regimes in the plateau and hilly fringes.

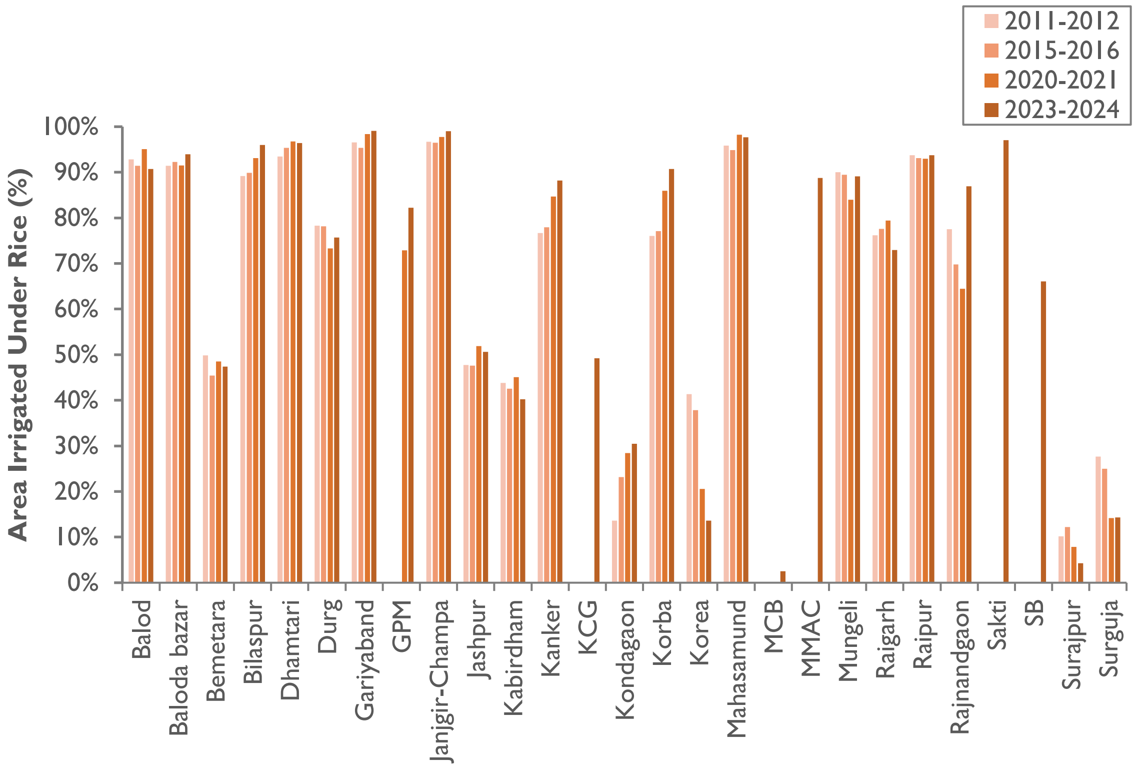


Figure 22: Area irrigated under rice across districts of MRB (CG Portion), 2011-12 to 2023-24.
[Source: Directorate of Economics & Statistics, Dept. of Agriculture & Farmers Welfare, Govt. of India]

4.4.2 Area Irrigated by Maize Across Districts

Odisha

The **Fig 23**shows the percentage of area irrigated under maize across various districts of Odisha from 2000–01 to 2023–24, revealing significant spatial and temporal variations.

The data indicate a gradual increase in irrigation coverage under maize in most districts over the years, though the rate of increase differs considerably across regions. The highest irrigation levels are consistently observed in Nabarangpur, where the irrigated area surged from 2.50% in 2000–01 to a peak of 27.43% in 2008–09, later stabilising around 25.65% in 2018–19 and 10.84% in 2023–24. Similarly, Kandhamal shows a steep rise from 6.96% in 2000–01 to 11.38% in 2013–14, before slightly declining to 7.05% in 2023–24. These districts clearly dominate in irrigated maize cultivation, likely due to favourable topography and focused irrigation development.

Moderate irrigation growth is evident in Kalahandi, where the irrigated share increased from 0.71% in 2000–01 to nearly 3% by 2013–14 and 2.54% in 2023–24. Other western Odisha districts, such as Bolangir, Nuapada, and Boudh, also show noticeable improvements over the years, reaching between 1.8–2.3% by 2023–24. Ganjam and Sundargarh display a similar upward pattern, each surpassing 3% by 2023–24, reflecting expanding irrigation networks in central and western regions.

Coastal districts such as Puri, Khordha, Cuttack, Kendrapara, Jagatsinghpur and Bargarh consistently exhibit very low irrigation under maize (<1%), indicating limited adoption of irrigated maize cultivation due to reliance on rainfed conditions. Sonepur and Sambalpur show minor but steady improvements, both around 1.5–1.7% in recent years.

Overall, the data reveal a regional disparity, with southern and western Odisha (notably Nabarangpur, Kandhamal, and Kalahandi) achieving substantial irrigation expansion under maize, while coastal districts remain largely rainfed. The period between 2008–09 and 2018–19 marks the most pronounced growth phase across the state, possibly linked to targeted irrigation schemes and agricultural diversification initiatives. However, slight declines in 2023–24 in some districts suggest emerging challenges such as water stress or changing crop priorities.

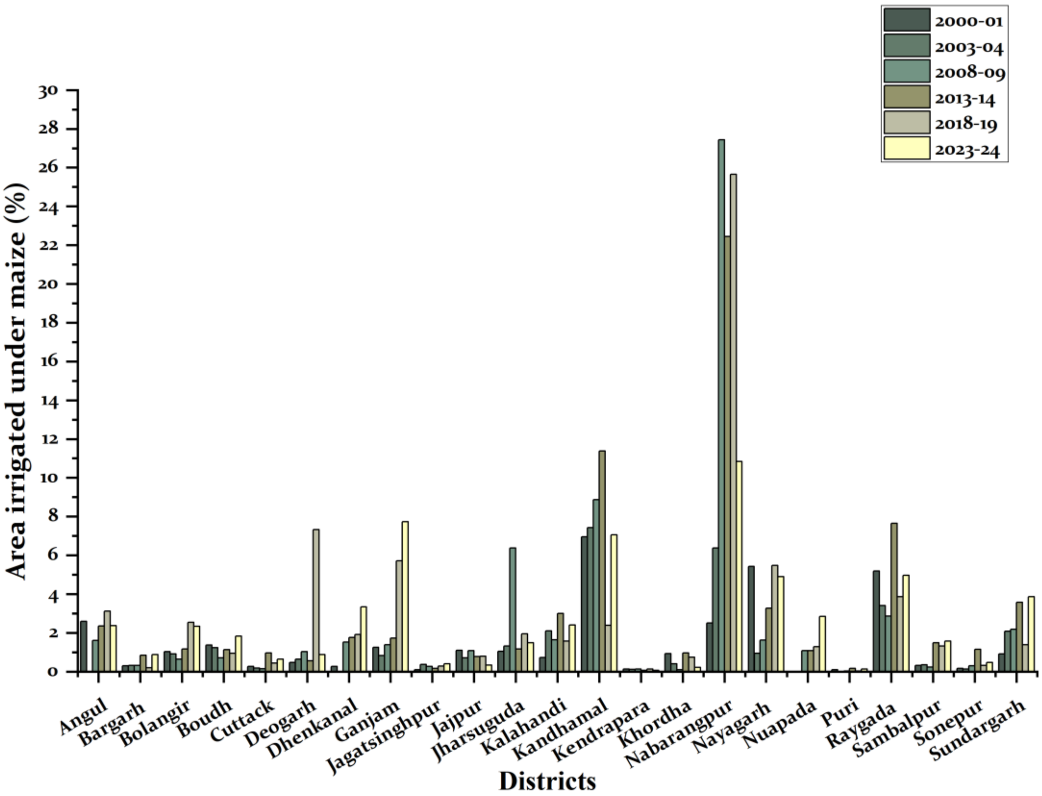


Figure 23: Area irrigated under maize across districts of Odisha, 2000-01 to 2023-24.
[Source: Odisha Agricultural Statistics Report (2000-01;2003-04;2008-09;2013-14;2018-19; 2023-24)]

Chhattisgarh

The share of irrigated area under maize across districts of the Chhattisgarh portion of the Mahanadi River Basin remains marginal overall, but with clear spatial concentration in a few upland and tribal districts. Most central plain districts—such as Balod, Baloda Bazar, Bemetara, Bilaspur, Janjgir–Champa, Raipur, and Mahasamund—consistently report negligible maize shares, typically well below 0.1%, reflecting the dominance of rice- and wheat-based irrigation systems. In these areas, maize is largely rainfed and plays a limited role within irrigated agriculture.

In contrast, Kondagaon stands out as the primary maize-growing district under irrigation, with maize accounting for around 47–55% of irrigated area across all years, indicating strong specialization linked to agro-climatic suitability and local dietary and market preferences. Kanker also shows a notable maize share, though declining slightly from about 13% to 10% between 2011–12 and 2023–24. Smaller but gradually increasing shares are observed in Surajpur and Surguja, where maize reaches nearly 1% of irrigated area by 2023–24, reflecting limited but growing rabi or supplemental irrigation use. Overall, the pattern highlights maize as a highly localized irrigated crop in the MRB (CG), concentrated in specific plateau and tribal districts, while remaining peripheral in the rice-dominated central plains.

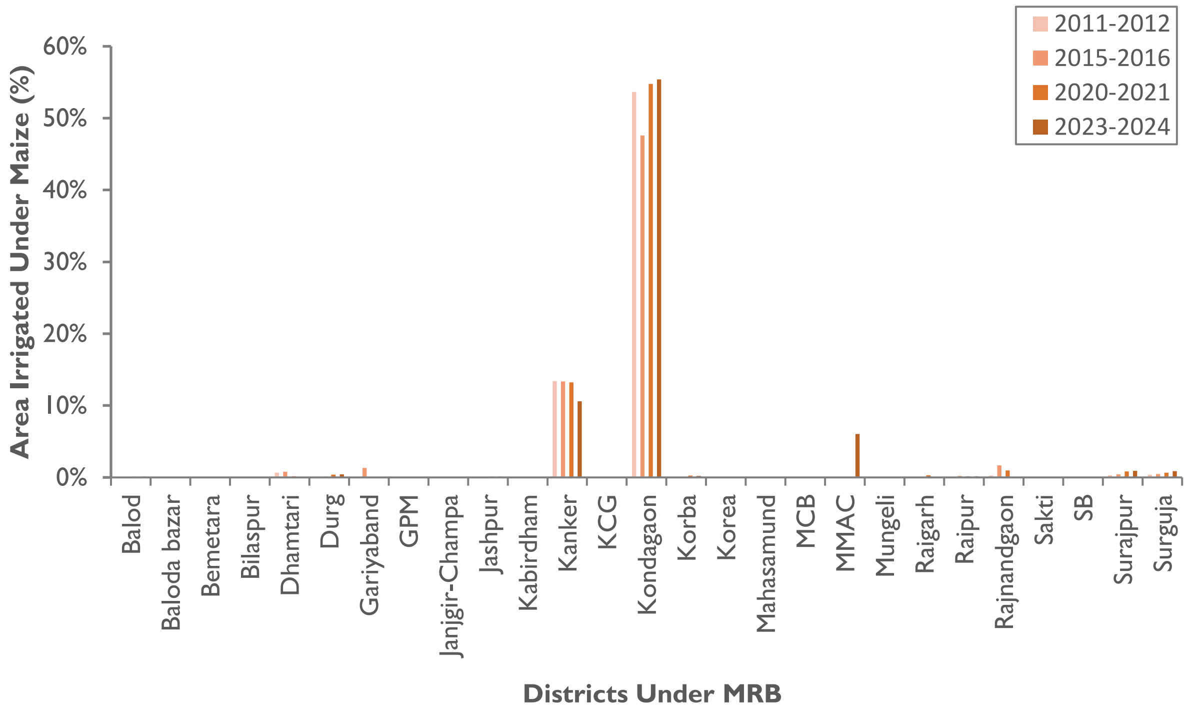


Figure 24: Area irrigated under maize across districts of MRB (CG Portion), 2011-12 to 2023-24.
[Source: Directorate of Economics & Statistics, Dept. of Agriculture & Farmers Welfare, Govt. of India]

4.4.3 Area Irrigated by Oil seeds Across Districts

Odisha

Varieties of oilseeds such as groundnut, sunflower, til, castor, safflower, and soybean are cultivated across different parts of Odisha. The graph shows the proportion of irrigated area under oilseeds in various districts of Odisha, indicating a slight variation over the last two years. During 2000–01, the highest share of irrigated land under oilseeds was observed in Ganjam (26.6%) and Boudh (9.8%), followed by Jagatsinghpur and Puri (9.7%). Over time, several districts such as Angul, Khordha, Deogarh, and Dhenkanal recorded a substantial increment in the irrigated share by 2013–14, reaching their peaks above 10–20%, indicating improved irrigation coverage for oilseed. But in recent years (2023–24), the percentage of irrigated area under oilseeds has decreased across most districts, with notable reductions in Puri, Khordha, and Ganjam. Districts such as wDhenkanal (6.3%), Sundargarh (10%) Kendrapara(14%) and Deogarh (12.82%) continue to maintain relatively higher irrigation coverage compared to others, while regions like Bolangir, Nabarangpur, Nuapada, and Boudh recorded much lower shares below 3%. The overall trend indicates that intermittent improvements in irrigation facilities and the extent of irrigated area under oilseeds in Odisha remain uneven and relatively modest in recent years (Fig 25).

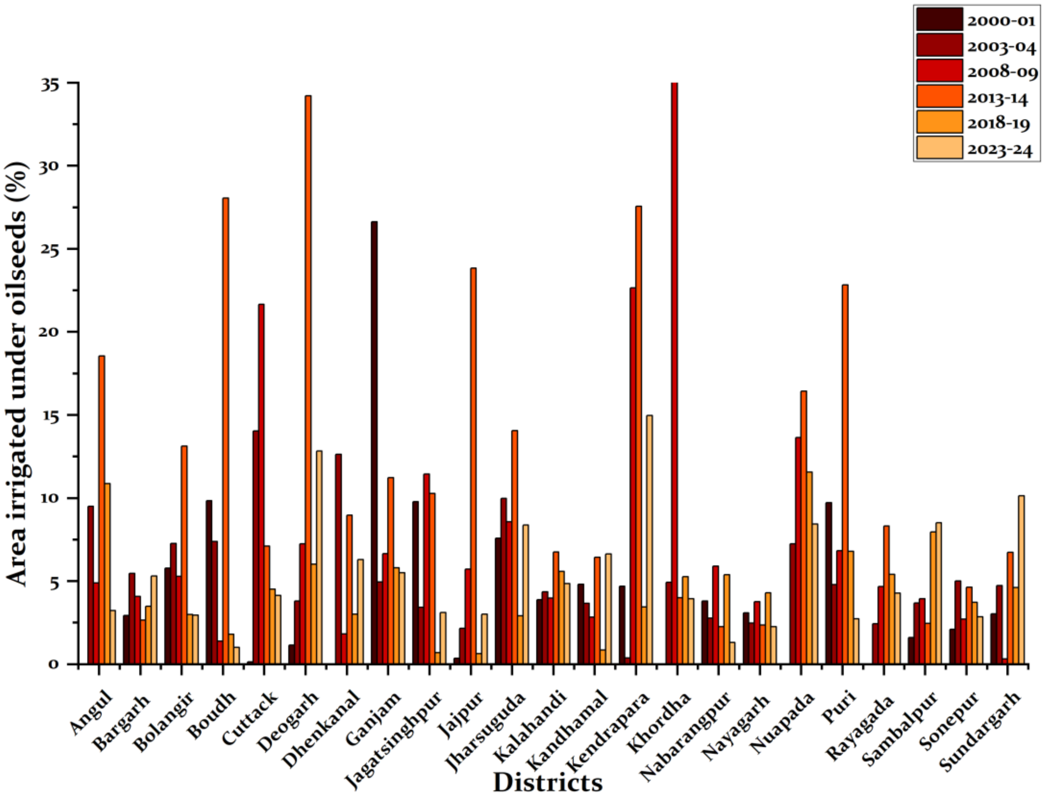


Figure 25: Area irrigated under oilseed across districts of Odisha, 2000-01 to 2023-24.
[Source: Odisha Agricultural Statistics Report (2000-01;2003-04;2008-09;2013-14;2018-19; 2023-24)]

Chhattisgarh

The share of irrigated area under oilseeds across the Chhattisgarh portion of the Mahanadi River Basin remains very limited overall, indicating that oilseeds continue to be largely rainfed crops in the region. In most central plain and canal-command districts—such as Balod, Baloda Bazar, Bemetara, Bilaspur, Dhamtari, Janjgir–Champa, Raipur, Rajnandgaon, and Mungeli—oilseeds typically account for less than 1% of irrigated area throughout the study period. Even where small increases are observed, such as in Durg and Raipur, the overall contribution remains marginal compared to rice and wheat, reflecting crop preference, irrigation priorities, and agro-economic considerations.

In contrast, a few districts show localized concentration and recent expansion of irrigated oilseeds. Raigarh consistently stands out, with oilseeds occupying a relatively high share of irrigated area (around 7–8% in 2011–12 and 2023–24), while Surajpur and Surguja display a marked increase in recent years, reaching about 6–7% and 3% respectively by 2023–24. Korea and SB (Sarangarh–Bilaigarh) also show emerging pockets of oilseed irrigation, suggesting diversification under improved rabi irrigation or market-driven shifts. Overall, irrigated oilseed cultivation in the MRB (CG) is highly localized, functioning as a supplementary crop in select districts rather than a basin-wide irrigated system.

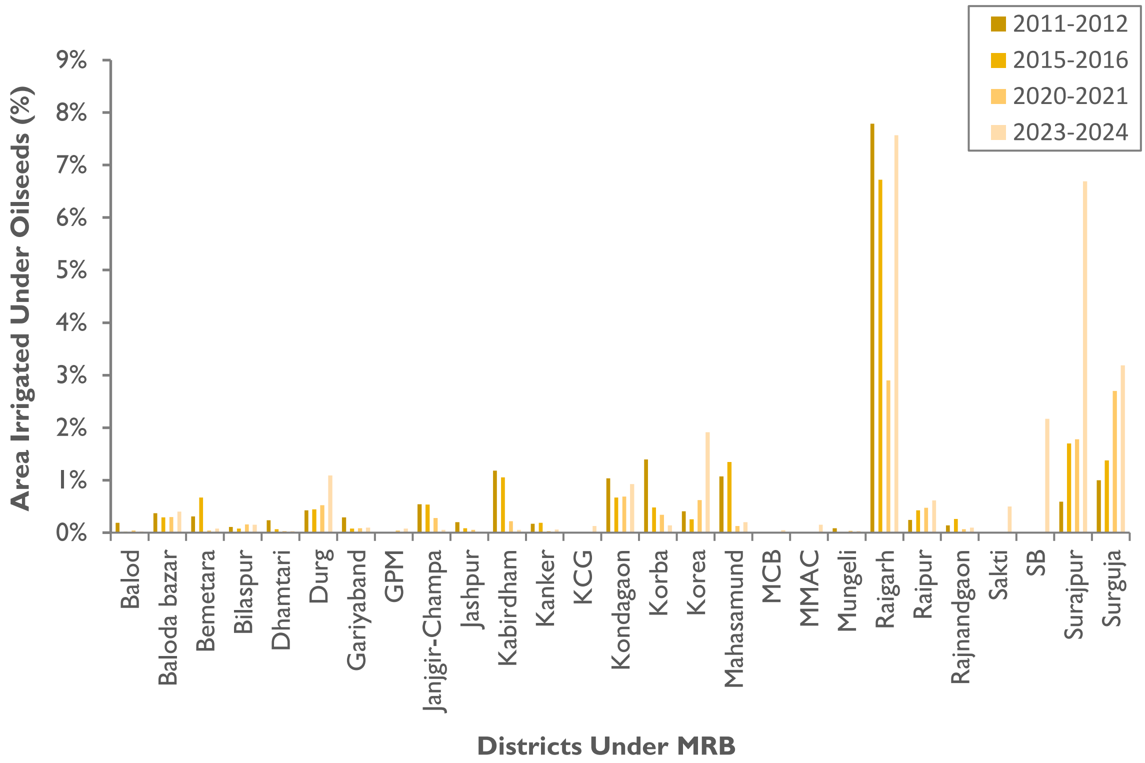


Figure 26: Area irrigated under Oil seeds across districts of MRB (CG Portion), 2011-12 to 2023-24.
[Source: Directorate of Economics & Statistics, Dept. of Agriculture & Farmers Welfare, Govt. of India]

4.4.4 Area Irrigated by Pulses Across Districts

Odisha

During the period from 2000–01 to 2023–24, the area irrigated under pulses in the state exhibited slight variation across districts.

In 2000–01, the average irrigated area under pulses was 4.23%, with districts such as Puri (18.20%), Cuttack (18.30%), and Boudh (8.70%) showing relatively higher irrigation coverage, while several others, including Angul, Nuapada, and Rayagada recorded negligible irrigation. By 2003–04, irrigation increased markedly to an average of 11.41%, with significant contributions from Cuttack (37.07%), Nayagarh (17.24%), and Kendrapara (60.13%). However, in 2008–09, the overall irrigation declined to 8.71%, though districts like Kendrapara(80%), Cuttack (35.10%), Jagatsinghpur (31.65%), and Jajpur (17.4%) maintained relatively high irrigation levels. The situation improved again in 2013–14, averaging 10.72%, led by Nayagarh (35.07%), Puri (17.47%), Khordha (19.11%), and Jharsuguda (17.70%) **(Fig 27).**

The peak was observed in 2018–19, when the average irrigated area reached 15.52%, with remarkable irrigation expansion in Kendrapara (48.16%), Jagatsinghpur (45.11%), Puri (39.40%), and Nayagarh (31.77%). In 2023–24, irrigation coverage slightly decreased to 12.72%, yet districts such as Cuttack (22.97%), Dhenkanal (15.87%), Jagatsinghpur (19.02%), Kendrapara (17.40%), and Sambalpur (16.11%) continued to show strong irrigation performance, reflecting persistent regional disparities but gradual progress in irrigated pulse cultivation across the state. From 2018–19 to 2023–24, most districts show a rising trend, especially in Bargarh, Sambalpur, and Kandhamal, indicating possible diversification toward pulses in irrigated areas. Coastal districts largely remain low irrigated areas for pulses, suggesting that other crops like rice continue to dominate.

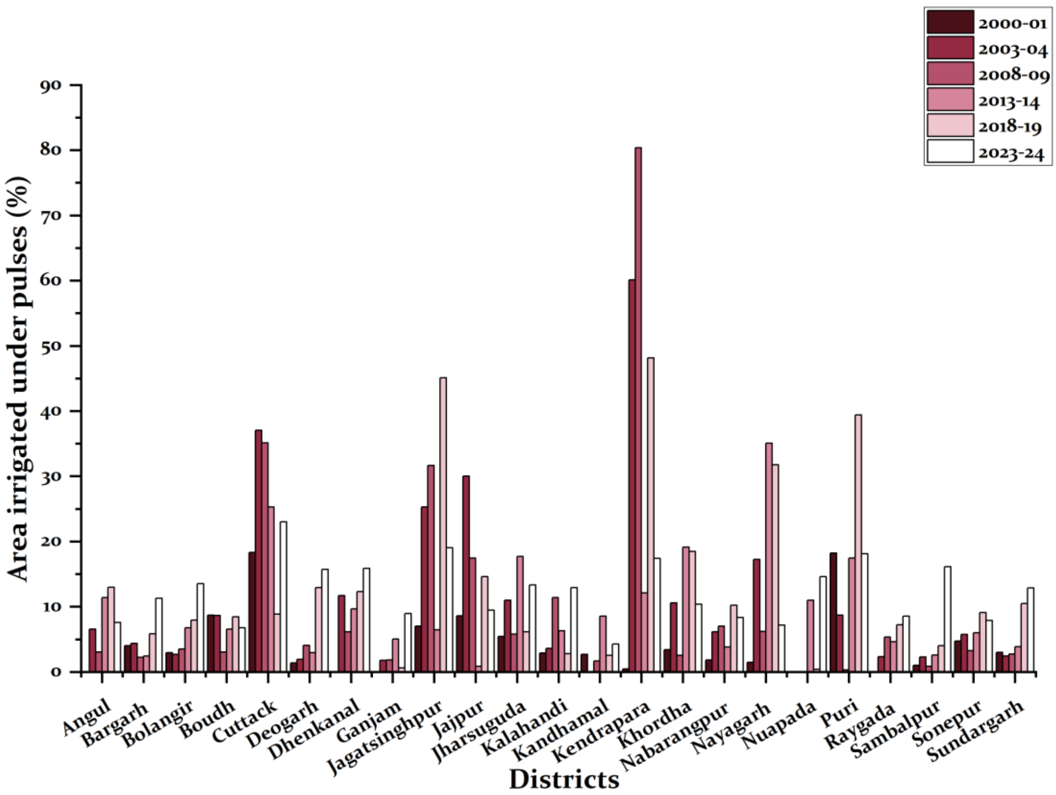


Figure 27: Area irrigated under pulses across districts of Odisha, 2000-01 to 2023-24.
[Source: Odisha Agricultural Statistics Report (2000-01;2003-04;2008-09;2013-14;2018-19; 2023-24)]

Chhattisgarh

The share of irrigated area under pulses across districts of the Chhattisgarh portion of the Mahanadi River Basin shows pronounced spatial variability, reflecting differences in agro-climatic conditions, irrigation reliability, and crop diversification strategies. High pulse shares are observed in districts such as Kabirdham, Bemetara, Rajnandgaon, and Mungeli, where pulses account for a substantial proportion of irrigated land. Kabirdham consistently records the highest shares (about 27–37%), while Bemetara shows a gradual decline from ~36% in 2015–16 to ~19% by 2023–24, suggesting partial reversion toward cereals. Rajnandgaon exhibits a sharp rise up to ~19% in 2020–21, followed by a marked decline by 2023–24, indicating sensitivity to market incentives, rainfall, and irrigation availability.

In contrast, most central plain and canal-command districts—Janjgir–Champa, Raipur, Mahasamund, Bilaspur, Gariyaband, and Kanker—maintain very low pulse shares, typically below 2–5%, as irrigated land remains dominated by rice. Moderate and stable shares are evident in Durg, Balod, Jashpur, and Surajpur, reflecting pulses as a complementary irrigated crop within diversified systems. Overall, pulses under irrigation in the MRB (CG) function largely as a diversification and risk-management option, expanding in districts with suitable soils and flexible irrigation, while remaining marginal in the rice-intensive canal commands.

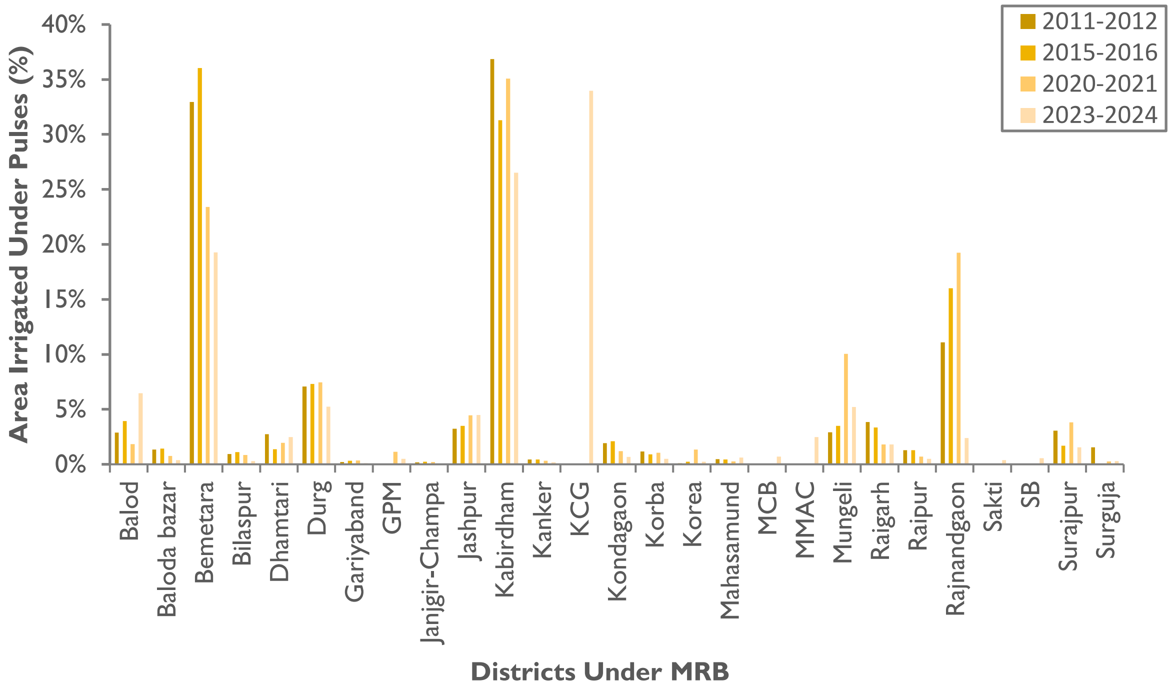


Figure 28: Area irrigated under pulses across districts of MRB (CG Portion), 2011-12 to 2023-24.
[Source: Directorate of Economics & Statistics, Dept. of Agriculture & Farmers Welfare, Govt. of India]

4.4.5 Area Irrigated by Wheat Across Districts

Odisha

The irrigated area under wheat in Odisha reveals distinct regional and temporal patterns. Western districts such as Nuapada, Bolangir, and Jharsuguda consistently record the highest shares, making them the major wheat-growing hubs. Moderate contributions come from districts like Bargarh, Dhenkanal, Deogarh, Angul, Sambalpur, and Kalahandi, where irrigation support has enabled wheat cultivation to expand steadily. On the other hand, coastal districts including Puri, Kendrapara, Jagatsinghpur, Khordha, and Cuttack show negligible irrigation under wheat, as these regions are largely dominated by paddy and other crops.

Over the years, the irrigated wheat area has shown an increasing trend from 2000–01 to 2013–14, followed by relative stabilisation up to 2023–24. Overall, the analysis highlights that irrigated wheat cultivation is concentrated in western Odisha, with limited spread across the coastal belt.

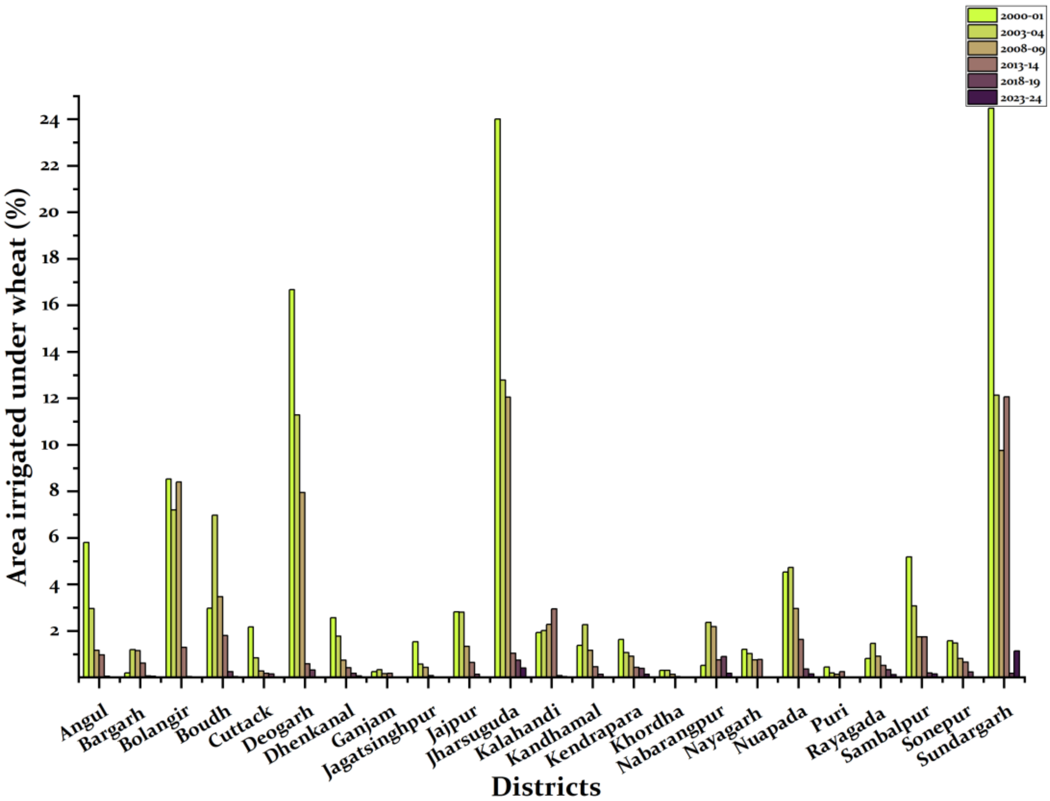


Figure 29: Area irrigated under wheat across districts of Odisha, 2000-01 to 2023-24.
[Source: Odisha Agricultural Statistics Report (2000-01;2003-04;2008-09;2013-14;2018-19; 2023-24)]

Chhattisgarh

In contrast, the central plain districts—Dhamtari, Janjgir–Champa, Gariyaband, Raipur, Balod, and Mahasamund—show very low wheat shares, mostly below 2–4%, as irrigated land here remains overwhelmingly devoted to rice. However, districts such as Bemetara, Durg, Rajnandgaon, Raigarh, and Kabirdham display a gradual increase in wheat's share, with Bemetara rising sharply to over 25% by 2023–24, indicating diversification toward rice–wheat rotations where canal and groundwater supplies support rabi irrigation. Overall, the pattern highlights a dual structure within the MRB (CG): wheat as a major irrigated rabi crop in the cooler northern and plateau districts, and a minor, supplementary crop in the rice-dominated central plains.

In contrast, the central plain districts—Dhamtari, Janjgir–Champa, Gariyaband, Raipur, Balod, and Mahasamund—show very low wheat shares, mostly below 2–4%, as irrigated land here remains overwhelmingly devoted to rice. However, districts such as Bemetara, Durg, Rajnandgaon, Raigarh, and Kabirdham display a gradual increase in wheat's share, with Bemetara rising sharply to over 25% by 2023–24, indicating diversification toward rice–wheat rotations where canal and groundwater supplies support rabi irrigation. Overall, the pattern highlights a dual structure within the MRB (CG): wheat as a major irrigated rabi crop in the cooler northern and plateau districts, and a minor, supplementary crop in the rice-dominated central plains.

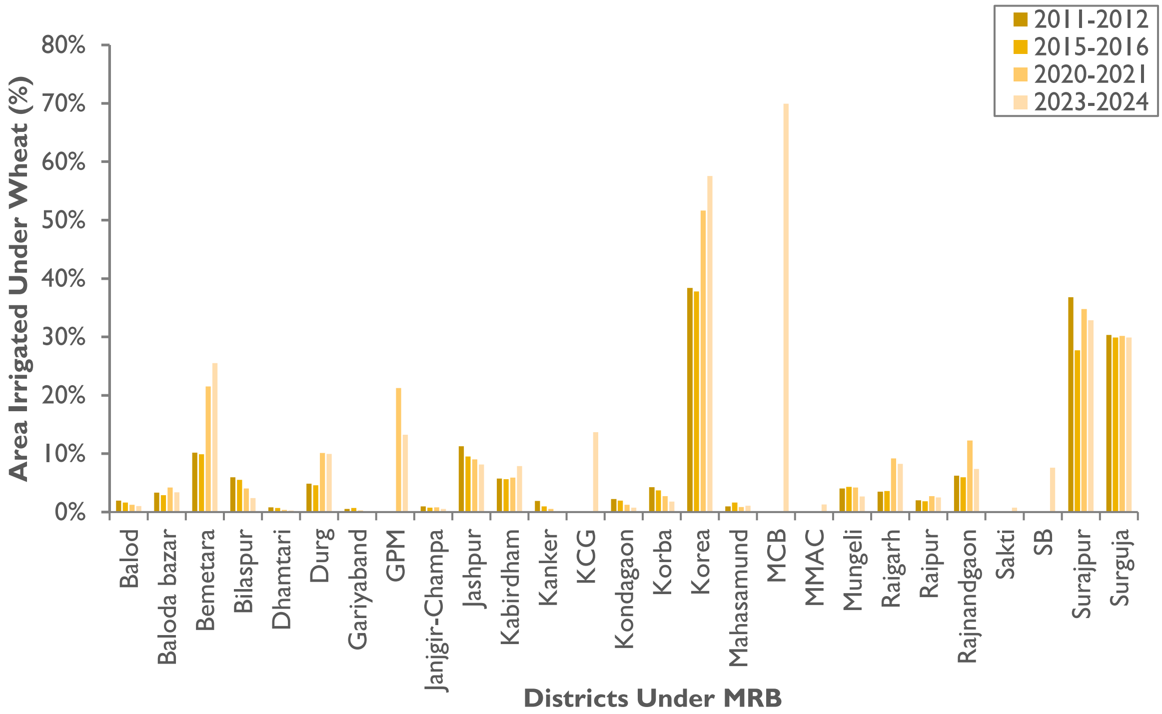


Figure 30: Area irrigated under Wheat across districts of MRB (CG Portion), 2011-12 to 2023-24.
[Source: Directorate of Economics & Statistics, Dept. of Agriculture & Farmers Welfare, Govt. of India]

4.4.6 Area Irrigated by Sugarcane Across Districts

Odisha

The analysis of district-wise irrigation under sugarcane (%) from 2000–01 to 2023–24 shows clear regional variations.

Nayagarh and Nabarangpur consistently recorded the highest irrigation coverage, with values peaking across the years, indicating a strong dominance of irrigated sugarcane cultivation. Districts such as Bolangir, Deogarh, Ganjam, and Cuttack also maintained moderate to high levels of irrigation, reflecting their importance in sugarcane farming. In contrast, districts including Sambalpur, Sundargarh, Kandhamal, and Puri reported very low irrigation % throughout the period, showing limited emphasis on sugarcane irrigation. Large number of districts, notably Nabarangpur, Sambalpur, Jagatsinghpur, Kalahandi,and Khordha, exhibited decreasing and fluatuating irrigation trends in recent years, whereas Angul, Bargarh, Rayagada, and Boudh remained relatively stable at low to moderate levels

Overall, the trend highlights a concentration of irrigated sugarcane in specific districts, with notable inter-district disparities persisting over time **(Fig 31).**

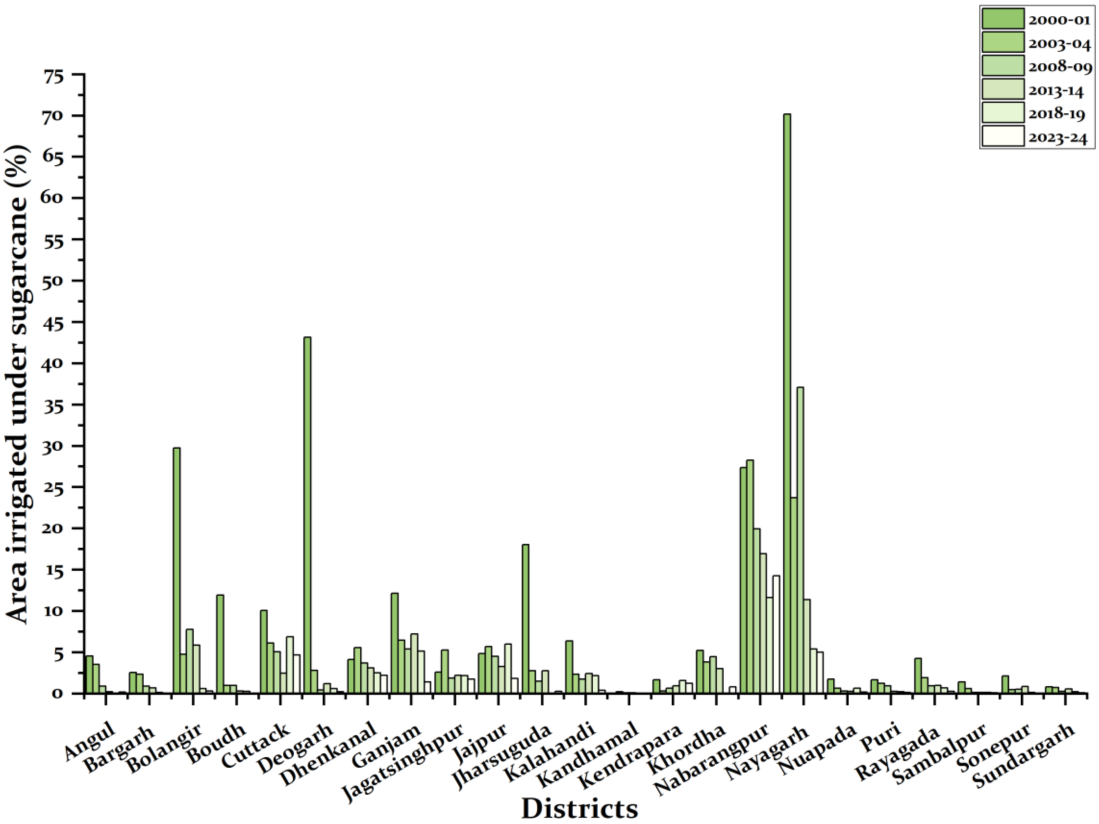


Figure 31: Area irrigated under sugarcane across districts of Odisha, 2000-01 to 2023-24.
[Source: Odisha Agricultural Statistics Report (2000-01;2003-04;2008-09;2013-14;2018-19; 2023-24)]

Chhattisgarh

The share of irrigated area under sugarcane in the Chhattisgarh portion of the Mahanadi River Basin remains limited across most districts but exhibits strong spatial concentration and recent intensification in a few well-defined pockets. Central plain districts such as Raipur, Janjgir–Champa, Dhamtari, Mahasamund, Bilaspur, and Baloda Bazar consistently record very low sugarcane shares (generally below 1%), reflecting the dominance of rice-based canal irrigation systems and the relatively high water and management requirements of sugarcane. Modest but stable shares are observed in districts like Balod, Durg, Mungeli, and Raigarh, where sugarcane persists as a supplementary irrigated crop linked to local demand and limited processing capacity.

In contrast, Kabirdham, Surajpur, and Surguja stand out as major sugarcane-growing districts under irrigation, with shares rising sharply over time. Kabirdham records the highest concentration, exceeding 22% of irrigated area by 2023–24, supported by a dense cluster of cooperative processing units, including the Lauh Purush Sardar Vallabhbhai Patel Sahkari Shakkar Karkhana Maryadit (Pandariya) and the Bhoramdeo Sahakari Shakkar Utpadak Karkhana Maryadit (Kawardha). Similarly, high and increasing shares in Surajpur and Surguja—reaching about 21% and 13%, respectively—are closely linked to the presence of the Maa Mahamaya Sahakari Shakkar Karkhana Maryadit (Kerta, Ambikapur region), which provides assured procurement and price stability. In the southern-central plains, localized expansion in Balod corresponds with the Danteshwari Maiya Sahakari Shakkar Karkhana

Maryadit (Karkabhat). Overall, the pattern highlights that sugarcane irrigation in the MRB (CG) is driven less by basin-wide irrigation availability and more by proximity to cooperative sugar mills, assured markets, and localized irrigation reliability, resulting in sharply defined commercial sugarcane belts within an otherwise rice-dominated irrigated landscape.

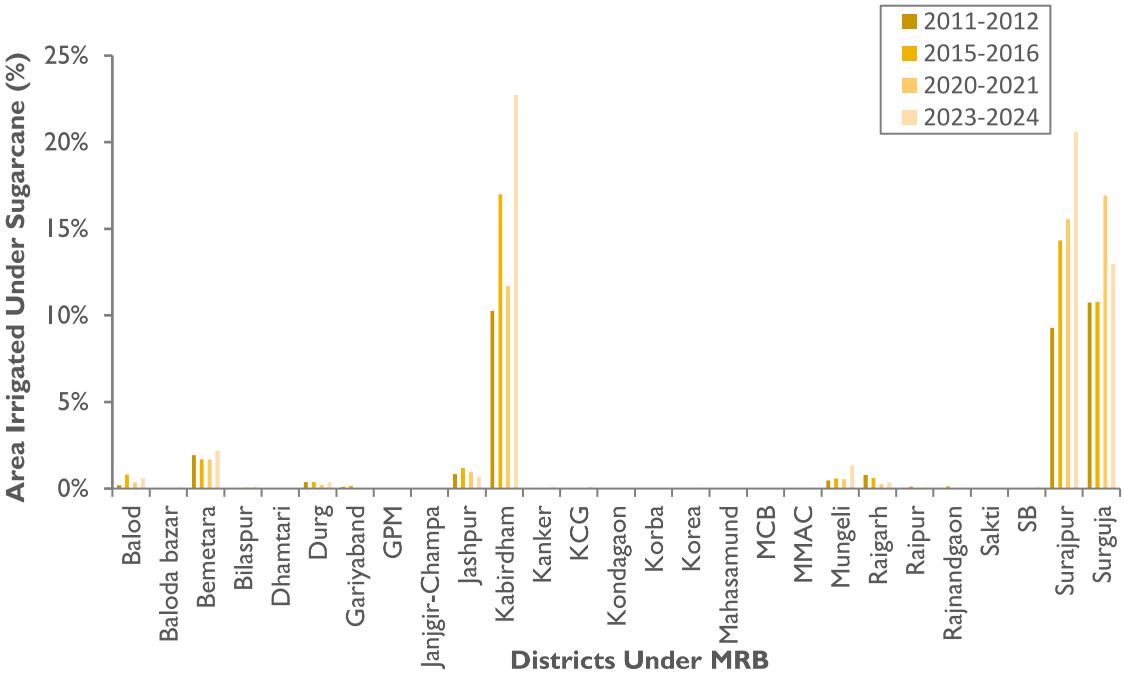


Figure 32: Area irrigated under Sugarcane across districts of MRB (CG Portion), 2011-12 to 2023-24. [Source: Directorate of Economics & Statistics, Dept. of Agriculture & Farmers Welfare, Govt. of India]

5. Consumption of Pesticides and Fertiliser

5.1 Consumption of Pesticides

Odisha

The graph shows the trend of pesticide consumption (in metric tons, MT) across different categories such as Insecticides, Fungicides, Weedicides, Rodenticides, Plant Growth Regulators, and Neembase pesticides/biopesticides/biocides from 2008–09 to 2023–24.

Insecticides consistently dominate overall pesticide use, peaking around 2018–19 at roughly 850 MT before declining sharply by 2023–24. Fungicides show a steady increase over time, surpassing 250 MT by the end of the period. Weedicides also rise until 2018–19 but decline afterward. In contrast, Neembase pesticides, biopesticides, and biocides start relatively high but fluctuate, with a peak near 2018–19 followed by a sharp drop in 2023–24. Rodenticides and Plant Growth Regulators remain at much lower levels throughout the period, showing only minimal variation.

Overall, the data suggest a general rise in pesticide consumption until around 2018–19, followed by a decline in most categories, possibly reflecting changing agricultural practices or increased awareness of sustainable pest control.

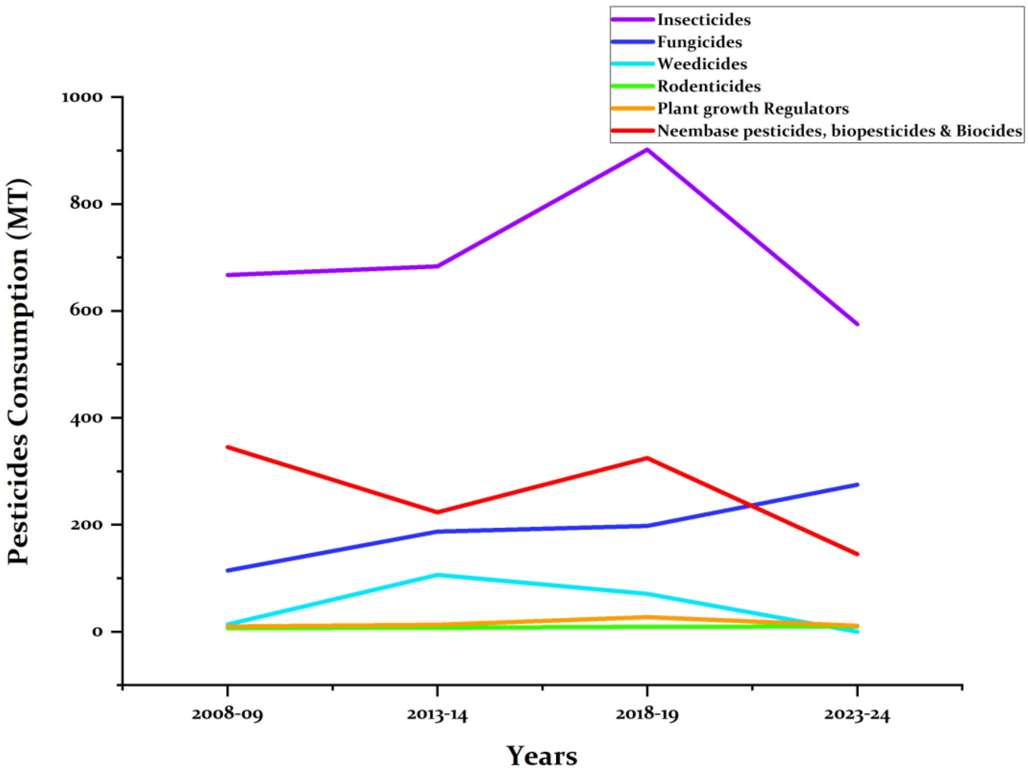


Figure 33: Consumption of pesticides in Odisha, 2008-09 to 2023-24

5.2 Consumption of Fertiliser

Odisha

Between 2000–01 and 2023–24, the total consumption of chemical fertilisers in Odisha rose significantly from 319.21 thousand tonnes to 602.28 thousand tonnes, marking an overall increase of nearly 89% over two decades. This consistent upward trend reflects the growing intensification of agriculture and the expansion of fertiliser use across the state

. The nutrient composition, however, displays notable shifts. The share of nitrogenous fertilisers (N) declined marginally from 65.03 %to 61.91%, suggesting a gradual movement toward more balanced nutrient application. In contrast, the share of phosphatic fertilisers (P) increased substantially from 22.32% to 30.98%, indicating a stronger emphasis on correcting phosphorus deficiencies or changing crop nutrient requirements. The share of potassic fertilisers (K), however, fluctuated throughout the period, peaking at 16.67% in 2008–09 before falling sharply to 7.09 % in 2023–24. This decline could be linked to limited potash availability, higher prices, or a lack of awareness of its agronomic importance.

Overall, while Odisha has witnessed a clear expansion in fertiliser use, the N:P: K ratio has become increasingly imbalanced, underscoring the need to promote more balanced nutrient management practices for sustainable soil health and long-term crop productivity.

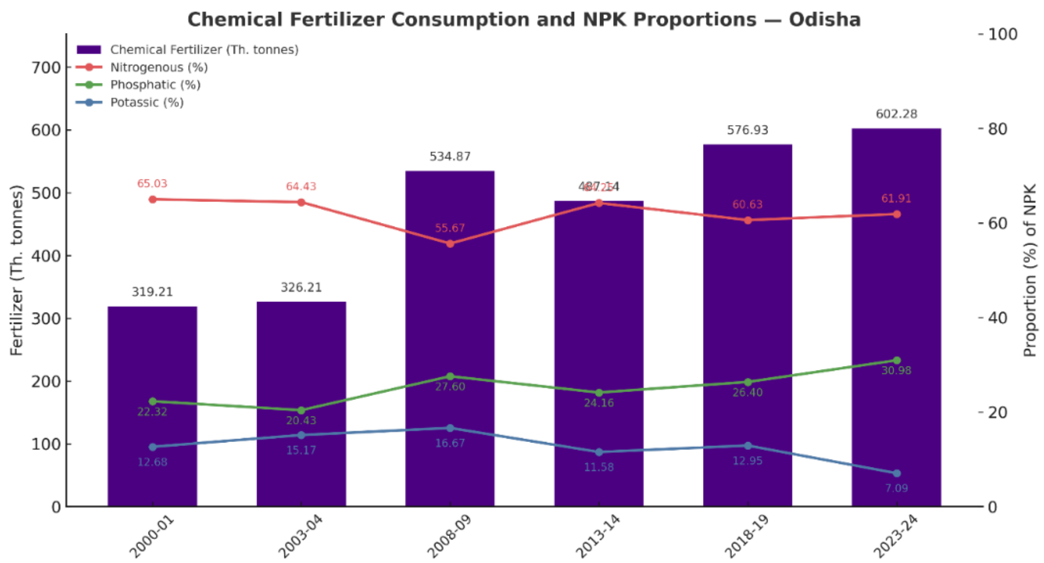


Figure 34: Consumption of Fertiliser in Odisha, 2000-01 to 2023-24

Chhattisgarh

Fertiliser consumption in the MRB portion of Chhattisgarh remained relatively stable from 2019–20 to 2021–22, increasing gradually from 121.38 kg/ha to 134.23 kg/ha, before witnessing a sharp jump to 296.68 kg/ha in 2022–23. This sudden escalation reflects a phase of accelerated agricultural intensification rather than a gradual structural change. A key driver behind this surge has been the strong policy push by the Chhattisgarh government to enhance crop productivity and farmer income, particularly through expanded coverage of input subsidies, timely fertiliser availability at controlled prices, and assured procurement mechanisms. Schemes such as the Rajiv Gandhi Kisan Nyay Yojana, which provides direct income support linked to area under cultivation, have encouraged farmers to increase input use to maximise yields. In parallel, continued Minimum Support Price (MSP) procurement of paddy and incentives for rabi and horticultural crops have reinforced the tendency toward higher fertiliser application, especially in irrigated and semi-irrigated blocks of the basin.

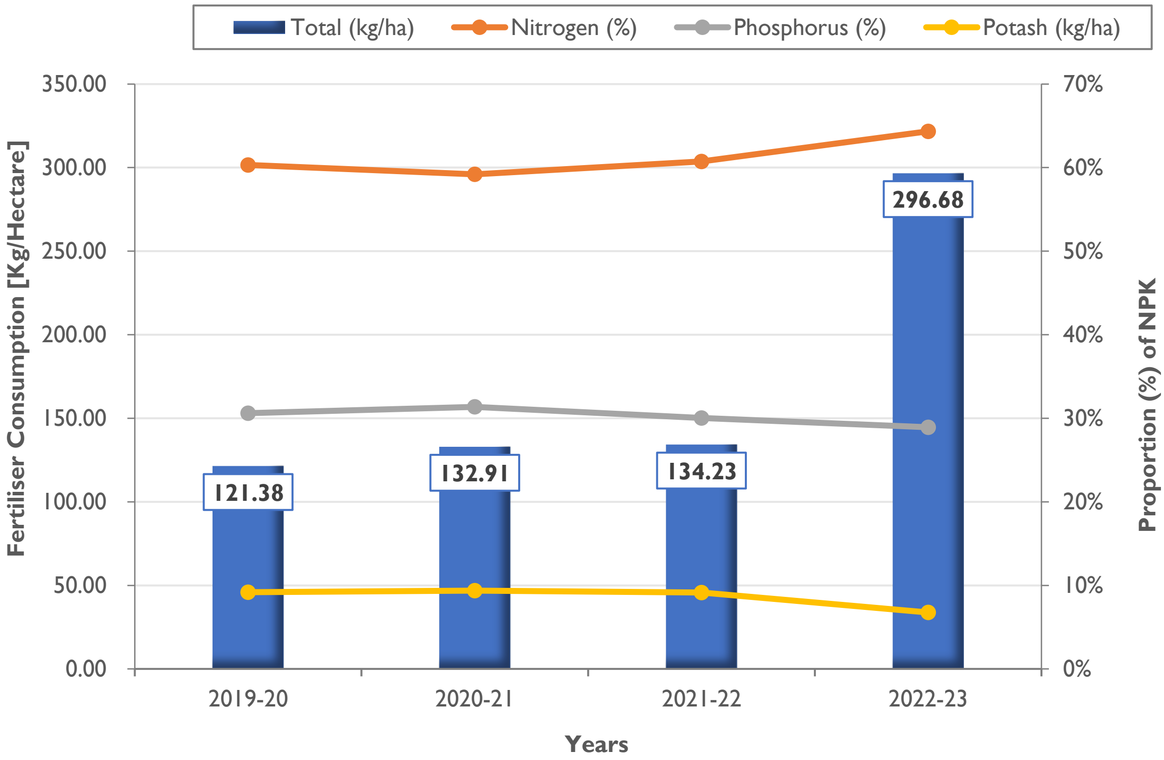


Figure 35: Consumption of Fertiliser in Chhattisgarh [MRB Part], 2019-20 to 2022-23.

[Source: Chhattisgarh Statistical Abstract Report, Directorate, Agriculture, Govt. of C.G.]

The nutrient use pattern continues to be dominated by nitrogen (59–64%), with phosphorus contributing about 29–31% and a declining share of potash (down to 7% in 2022–23). Government subsidies under the central fertiliser pricing and nutrient-based subsidy framework, combined with state-level facilitation of urea availability, have made nitrogenous fertilisers relatively cheaper and more accessible than balanced NPK formulations. Additionally, the expansion of irrigation infrastructure and electrification of agriculture, along with incentives for pumpsets and shallow tubewells, has enabled more intensive cropping, further increasing fertiliser demand. While these policy measures have supported short-term productivity gains, the sharp rise in fertiliser use coupled with an imbalanced nutrient ratio, raises concerns about soil degradation, declining fertiliser-use efficiency, and pressure on groundwater systems, highlighting the need for greater emphasis on soil health cards, balanced nutrient application, and convergence of input subsidies with sustainable agriculture objectives in the MRB.

5.3 Consumption of Fertiliser Across Districts

Odisha

Across Odisha, the consumption of fertilisers varies regionally from 2000-0 to 2023-24. In coastal districts such as Puri, Khordha, Cuttack, and Ganjam, nitrogenous fertilisers dominate, accounting for about 70%, due to intensive paddy cultivation and better irrigation access. Western districts like Bargarh, Bolangir, Sambalpur, and Kalahandi show high nitrogen use (65–68%) but also a relatively larger share of phosphatic fertilisers (25–30%), indicating efforts toward balanced nutrient management. The central districts like Dhenkanal, Angul, and Deogarh maintain a moderate fertiliser mix, with nitrogen around 65%, phosphorus 25%, and potassium below 10%. Southern and hilly districts such as Rayagada, Nabarangpur, and Kandhamal have slightly lower overall fertiliser use, though nitrogen remains predominant. Phosphorus consumption (%) has increased moderately in districts like Dhenkanal, Angul, and Boudh, reflecting improved awareness and use of phosphatic fertilisers to enhance soil fertility. Potassium consumption (%) remains relatively low overall but has improved notably in Bargarh, Bolangir, and Nayagarh during 2018–19 and 2023–24, showing a growing focus on balanced NPK usage.

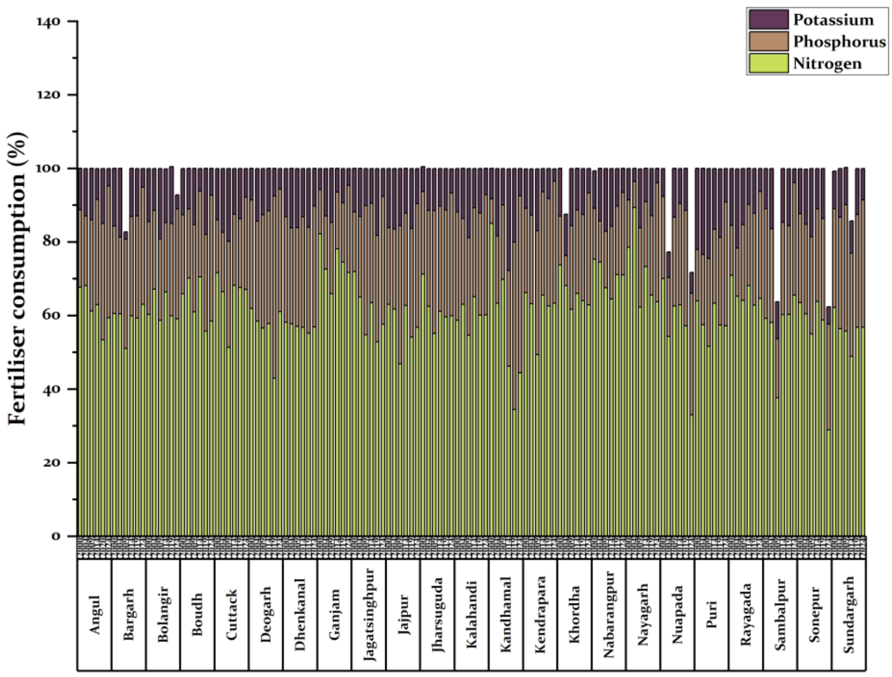


Figure 36: Fertiliser consumption across the Districts of Odisha, 2000-01 to 2023-24.
[Source: Odisha Agricultural Statistics Report (2000-01;2003-04;2008-09;2013-14;2018-19; 2023-24)]

Overall, while nitrogen use is becoming more regulated, the gradual rise in phosphorus and potassium consumption across major districts reflects a positive trend toward sustainable fertiliser use and emphasises the need for promoting balanced nutrient application to sustain soil fertility in the long term.

Chhattisgarh

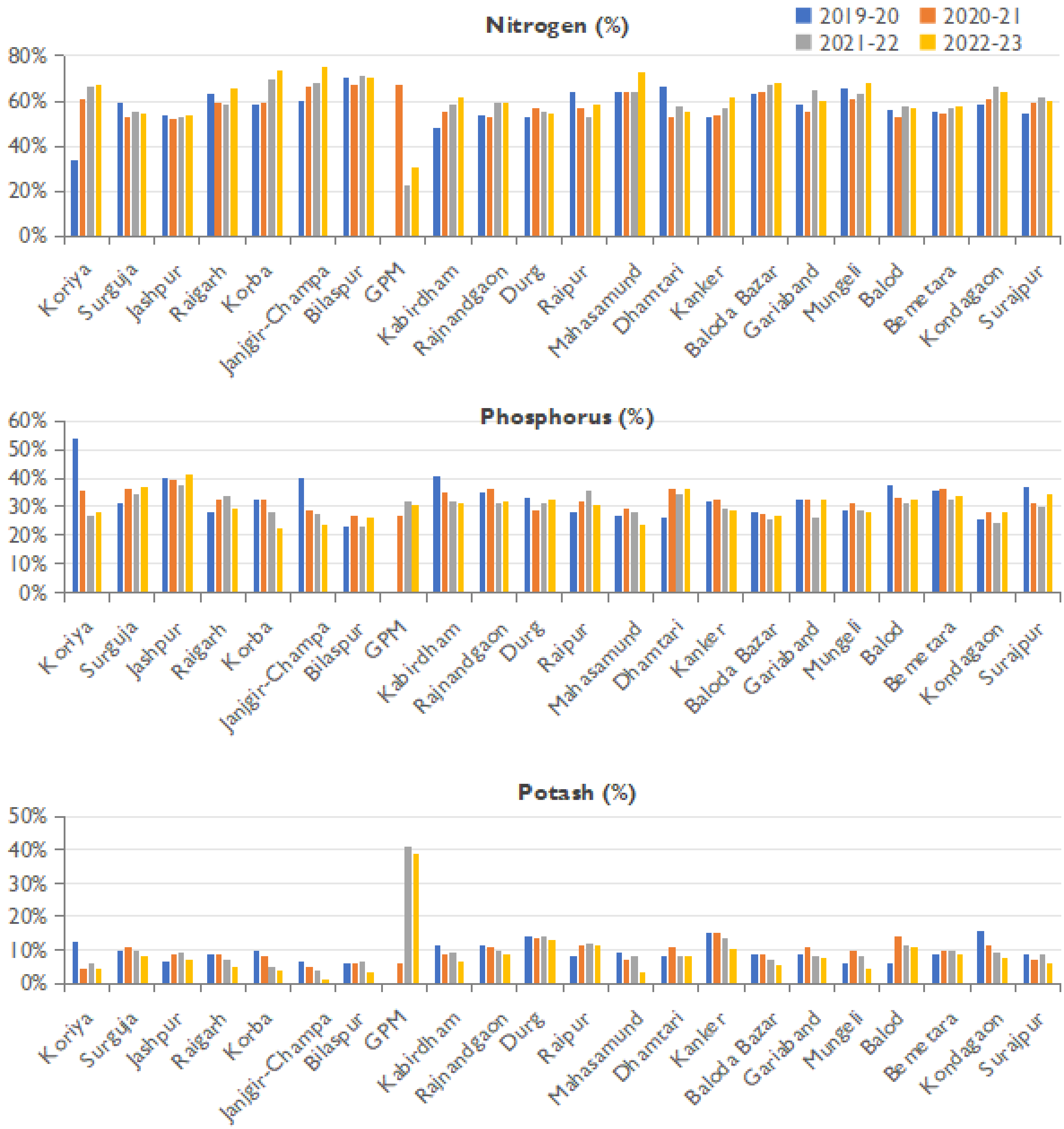


Figure 37: District-Wise Consumption of Fertiliser in Chhattisgarh [MRB Part], 2019-20 to 2022-23.
[Source: Chhattisgarh Statistical Abstract Report, Directorate, Agriculture, Govt. of C.G.]

Across the MRB districts of Chhattisgarh, fertiliser use over 2019–20 to 2022–23 shows a clear and consistent dominance of nitrogen (N) in the nutrient mix, reflecting paddy-centric and yield-oriented cultivation systems. In 2022–23, nitrogen shares exceeded 70% in several agriculturally intensive districts such as Korba (~73%), Janjgir–Champa (~75%), Mahasamund (~73%), Bilaspur (~70%), and Balodabazar (~68%), while remaining above 55–65% in Raipur, Durg, Rajnandgaon, Bemetara, and Dhamtari. This pattern strengthened gradually over time, indicating increasing reliance on nitrogenous fertilisers in irrigated command areas supported by tubewells and canal networks. In contrast, forested and tribal-dominated districts such as Surguja, Jashpur, and Koriya show relatively lower but steadily rising nitrogen shares, suggesting gradual intensification of agriculture even in traditionally low-input systems.

Phosphorus (P) consumption remains comparatively stable across districts, generally ranging between 25–35%, with marginally higher shares in rainfed or mixed-cropping districts such as Jashpur, Surguja, and parts of Gariaband and Dhamtari. Potash (K), however, shows a systematic decline across most districts, falling below 10% in many high-intensity agricultural districts by 2022–23, and reaching critically low levels in districts such as Janjgir–Champa, Korba, Mahasamund, and Bilaspur. This increasing N-skewed nutrient imbalance highlights a production strategy focused on short-term yield gains rather than balanced soil nutrition. The trend mirrors state-wide fertiliser subsidy structures, crop procurement assurances, and irrigation expansion, but also raises concerns regarding long-term soil fertility degradation, declining nutrient-use efficiency, and heightened environmental stress in intensively farmed blocks of the MRB.

6. Farm Mechanization and Power Resources

Odisha

Across the districts of Odisha, there is a clear rise in the adoption of agricultural machinery, though the rate of increase significantly differs among equipment types **(Fig 38)**.

Power tillers show the highest numbers throughout the period, increasing sharply up to 2013–14, when they peaked around 16,000 units, followed by some fluctuations in later years. Tractors also expanded significantly till 2013–14 before declining slightly in 2018-19, followed by reaching their maximum units (6332) in 2023-24. The use of rotavators grew rapidly after 2008–09, peaking around 2013–14, while power threshers demonstrated steady growth over time. Combine harvesters, self-propelled reapers, and transplanters started at low levels but have shown gradual and consistent increases, reflecting a shift toward more advanced and specialised mechanisation in agriculture.

Overall, the data indicates a strong movement toward mechanised farming, with tractors and power tillers leading the trend and other machines gradually gaining importance.

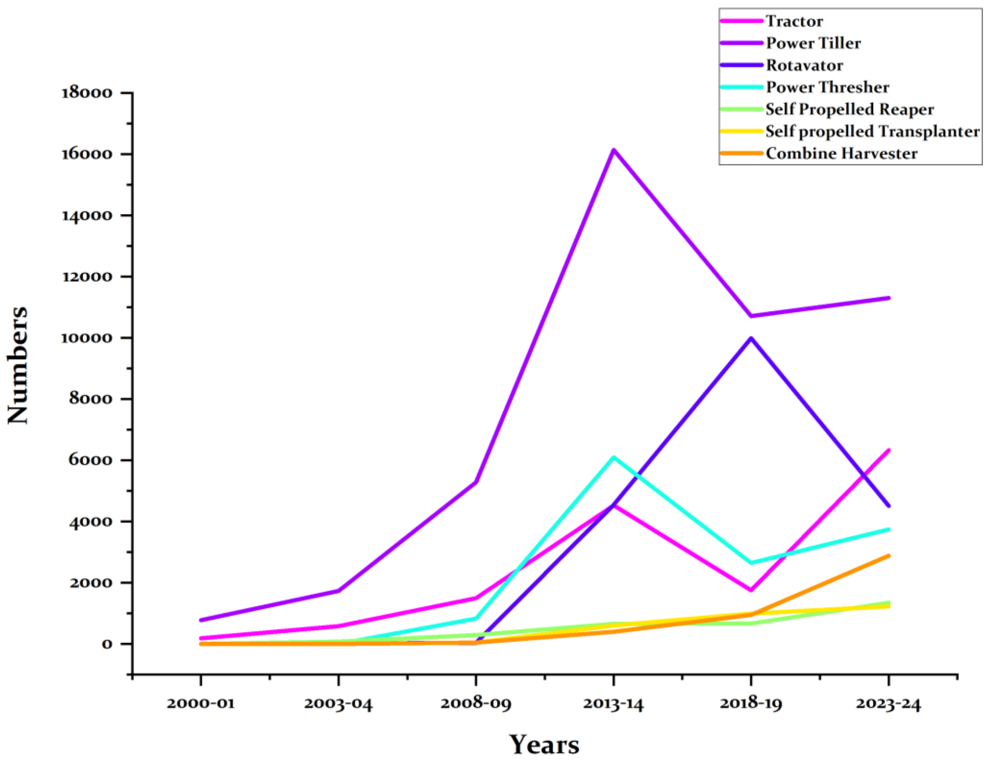


Figure 38: Number of tractors, power tillers, and improved farming machines utilised in Odisha, 2000-01 to 2023-24.
[Source: Odisha Agricultural Statistics Report (2000-01;2003-04;2008-09;2013-14;2018-19; 2023-24)]

Chhattisgarh

The profile of agricultural machinery in Chhattisgarh shows a clear transition from traditional animal-driven implements to mechanized and power-based equipment over the period 2007–08 to 2022–23. Traditional tools such as wooden ploughs and bullock carts dominate the early years but display a consistent long-term decline. Wooden plough numbers fall from about 2.05 million in 2007–08 to nearly 1.51 million by 2022–23, while bullock carts reduce from about 0.70 million to 0.34 million over the same period. This trend reflects gradual disuse of animal traction due to rising mechanization, labour shortages, and increasing access to modern farm equipment.

In contrast, mechanized and power-based machinery expands steadily. The number of tractors nearly triples, increasing from about 42,000 to over 1.20 lakh, highlighting rapid adoption of mechanized tillage and transport. Similarly, electric pumps show strong growth, rising from around 80,000 to over 2.40 lakh, indicating expansion of irrigation infrastructure and greater reliance on groundwater and lift irrigation. Iron ploughs, oil engines, and power-driven crushers also register overall increases, despite short-term fluctuations. Together, these patterns underline a structural shift in Chhattisgarh's agriculture toward capital-intensive, mechanized systems, even as traditional implements continue to play a residual role, particularly among small and marginal farmers.

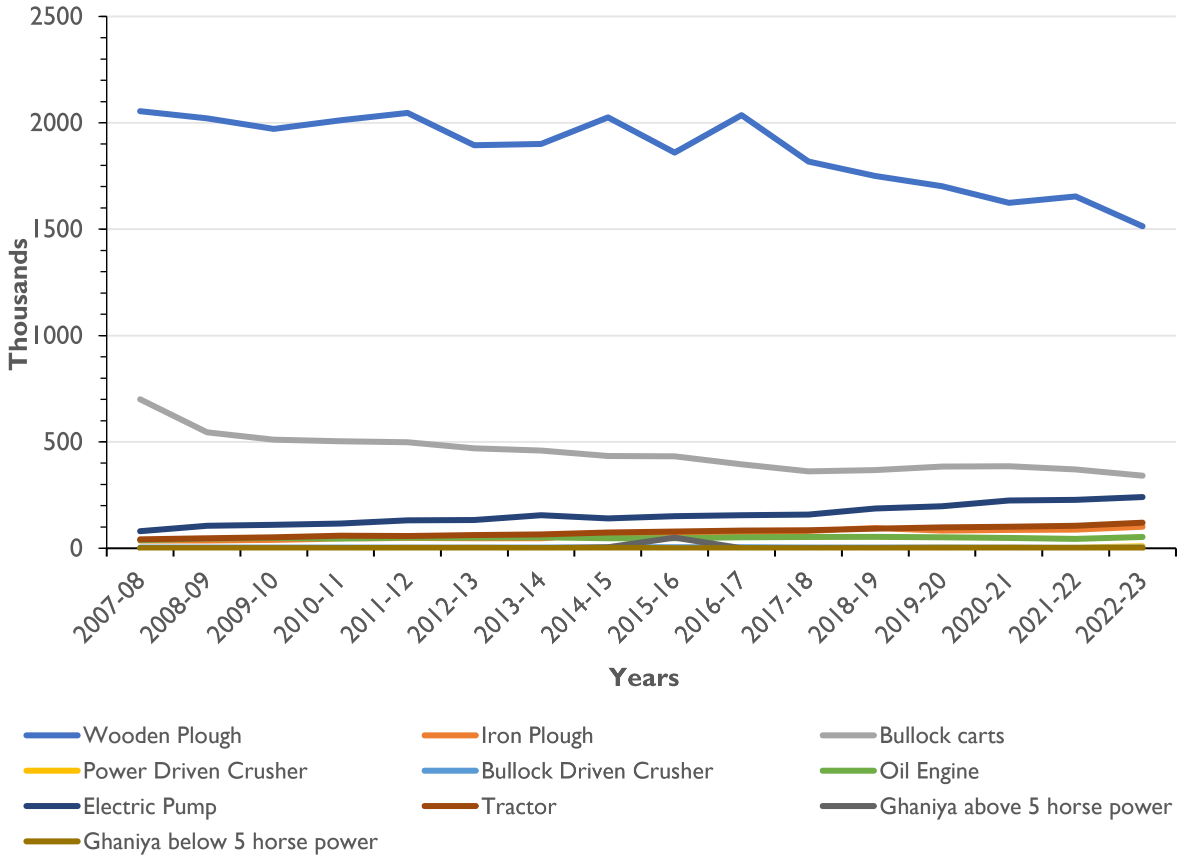


Figure 39: Number of agricultural implements, and improved farming machines utilised in Chhattisgarh, 2007-08 to 2023-24.

[Source: Commissioner, Land Record, Govt. of C.G.]

6.1 Operation of Irrigation Power Resources: Odisha (MRB Part)

The graph illustrates the number of irrigation sources used from 2000–01 to 2023–24. The usage of all sources shows fluctuations over the years, with some experiencing sharp rises and falls.

Pump sets show the most dramatic change, with a steep increase peaking around 2013–14 at nearly 45,000 units, followed by a sharp decline in subsequent years. Shallow tube wells also show a notable rise up to 2008–09, reaching about 18,000 units, then gradually decreasing. Borewells and surface lifts display moderate increases until around 2013–14, but then decline similarly in later years. Dugwells, on the other hand, remain consistently low throughout the entire period.

Overall, the data indicate that pump sets and shallow tube wells were the dominant sources of irrigation during the peak years; however, their usage has declined in recent years. This downward trend may be attributed to factors such as groundwater depletion, the adoption of improved irrigation technologies, and changing agricultural practices aimed at more sustainable water management **(Fig 40)**.

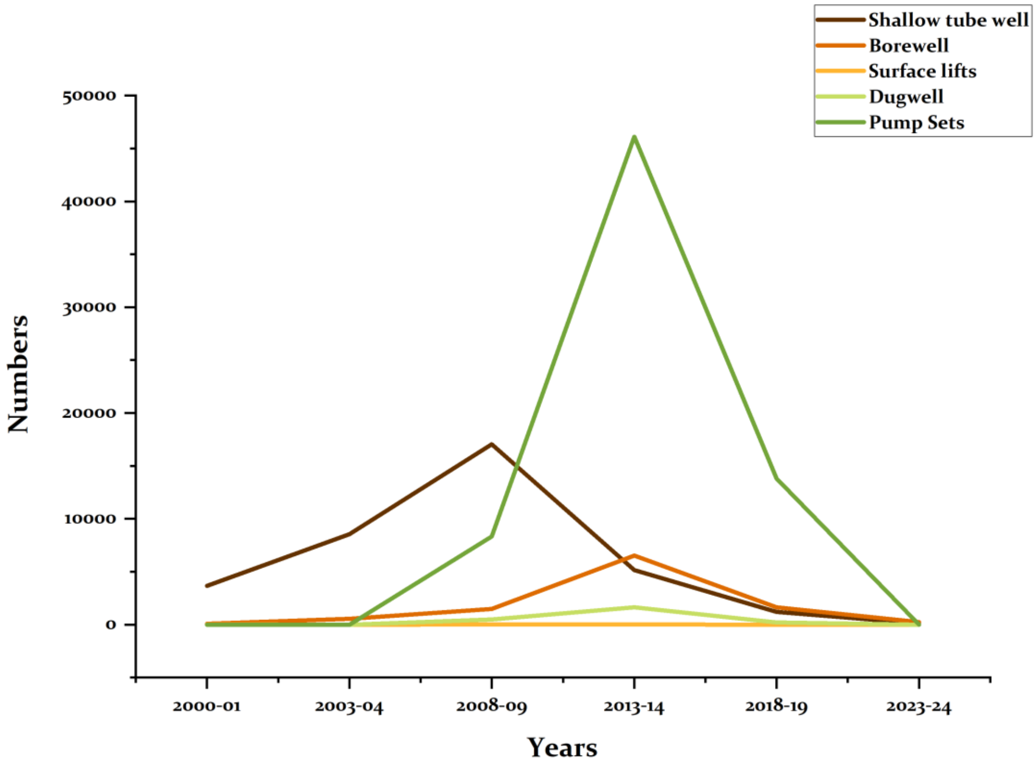


Figure 40: Use of tubewells, borewells, and pump sets in Odisha, 2000-01 to 2023-24.

[Source: Odisha Agricultural Statistics Report (2000-01;2003-04;2008-09;2013-14;2018-19; 2023-24)]

6.1.1 Operation of Borewell

From the graph, it was clearly seen that the districts of the plain region, such as Bargarh, Bolangir, and Dhenkanal, reported the highest number of borewells. Among them, Bargarh consistently recorded the maximum borewell installations, peaking at 605 borewells in 2013–14, confirming its prominence in groundwater-based irrigation, and has also seen a decline in recent years. Bolangir followed a similar pattern, with a sharp rise to 483 borewells in 2013–14, before declining considerably in recent years.

Nuapada and Dhenkanal also showed significant variations, with Nuapada rising from 27 in 2003–04 to 301 in 2013–14, and Dhenkanal peaking at 322 borewells in 2018–19. In contrast, Angul maintained a relatively high count across multiple years, especially during 2013–14 (391 borewells), though it dropped sharply by 2023–24.

On the other hand, several districts such as Sonepur, Rayagada, Sambalpur, and Ganjam recorded consistently low borewell numbers, reflecting limited dependence on this irrigation source. Similarly, Jharsuguda and Nabarangpur showed moderate but fluctuating trends, with small peaks in recent years (notably 30 borewells in Jharsuguda and 20 in Nabarangpur during 2023–24).

Overall, the data illustrate that borewell irrigation remains concentrated in the districts of Bargarh, Bolangir, Dhenkanal, and Nuapada, where groundwater extraction has historically been higher. Most other districts, especially those with hilly or undulating topography, show a relatively low and declining trend in borewell development over the two-decade period.

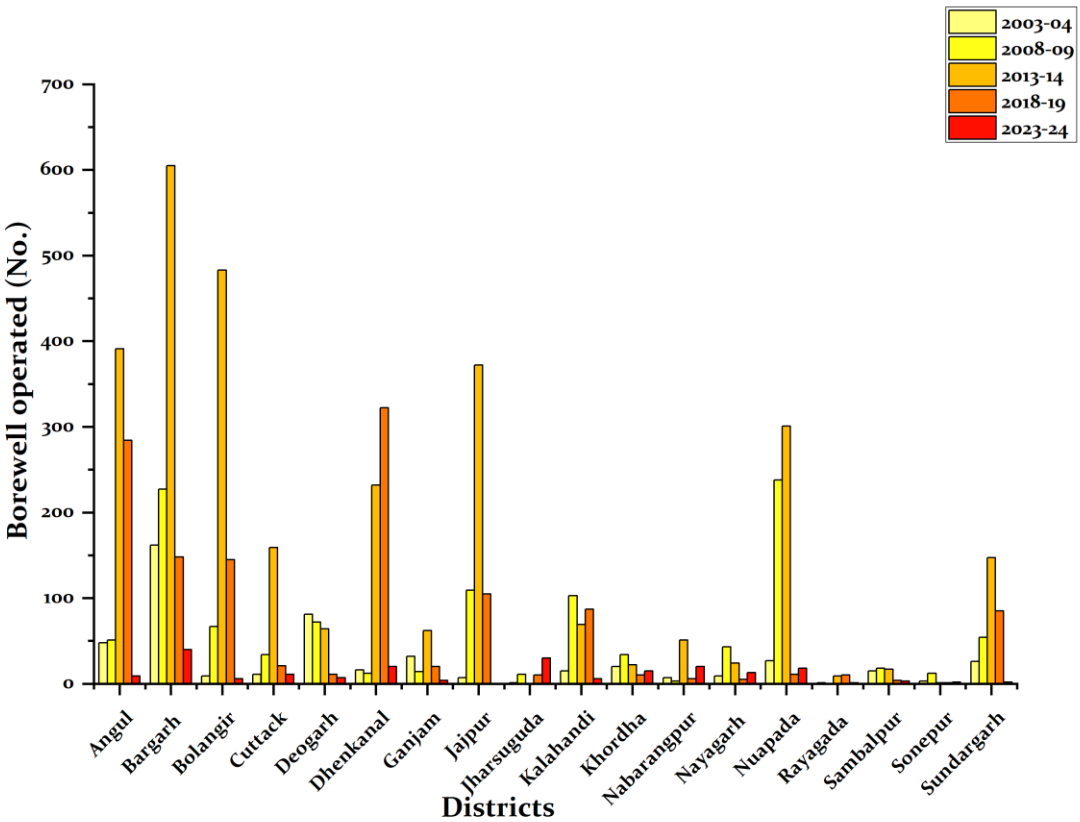


Figure 41: Borewells operated (No.) across the Districts of Odisha, 2003-04-2023-24.

6.1.2 Operation of Shallow Tube Well

The bar chart illustrates the trend in the number of shallow tube wells operated across various districts from 2003–04 to 2023–24. The number of operated shallow tube wells has declined significantly over the years in almost all districts. During 2003–04 and 2008–09, districts such as Cuttack, Jagatsinghpur, and Jajpur recorded the highest numbers, exceeding 3,000 to 5,000 wells, reflecting intensive groundwater extraction for irrigation. Khurda and Kendrapara also reported a moderate number of operating wells (1,000–1,500), while Puri, Bolangir, Nayagarh, and Rayagada had comparatively fewer installations. However, a significant reduction in operational shallow tube wells is observed from 2013–14 onwards, continuing sharply through 2018–19 and 2023–24, with only a few districts like Cuttack and Jagatsinghpur maintaining minimal operational numbers. Cuttack district consistently recorded the highest number of shallow tube wells, peaking above 5000 in 2008–09, followed by Jagatsinghpur, which also showed a substantial count during the same period. Districts such as Khordha and Rayagada maintained moderate numbers, while others like Puri, Bolangir, Nayagarh, Kendrapara, Ganjam, and Jajpur operated relatively fewer wells. The data indicate a consistent downward trend after 2013–14, with a sharp decline by 2023–24, possibly due to groundwater depletion, changing irrigation practices, or policy interventions promoting alternative water management systems.

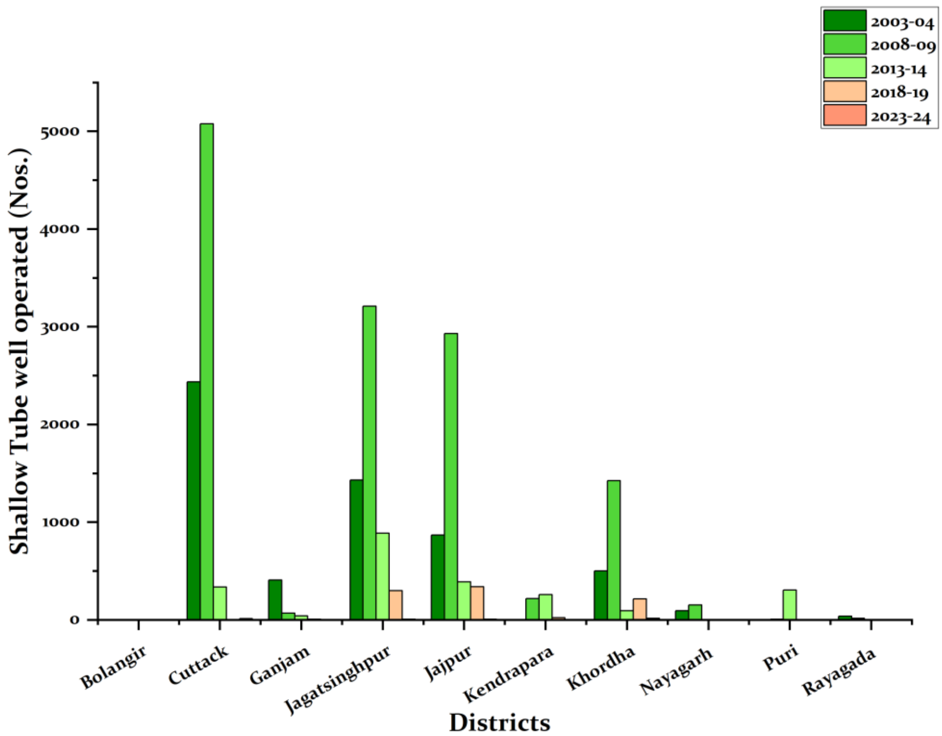


Figure 42: Shallow Tubewells operated (Nos.) across the Districts of Odisha, 2008-09 to 2023-24.

Overall, the data reflects a progressive decline in shallow tube well dependency across Odisha, signaling changes in irrigation infrastructure and groundwater management practices over the last two decades.

6.1.3 Operation of Dug Wells

The bar chart compares the number of dugwells operated across various districts during three different time periods between 2008–09 to 2018–19. It shows a clear variation in dugwell operation trends over the years.

In most districts, the number of operating dugwells increased substantially between 2008–09 and 2013–14, indicating an expansion in groundwater usage during that period. However, by 2018–19, some districts such as Cuttack, Bolangir, and Kalahandi show a decline or stabilisation, suggesting either reduced dependence on dugwells or depletion of groundwater resources. Sambalpur exhibits the highest number of dugwells operated in 2018–19, with a significant rise compared to earlier years, while districts like Deogarh, Kandhamal, and Gajapati maintain consistently low values throughout.

Overall, the chart highlights regional disparities in groundwater utilisation, with some districts showing rapid growth while others remain stagnant or experience a drop in dugwell operation over time.

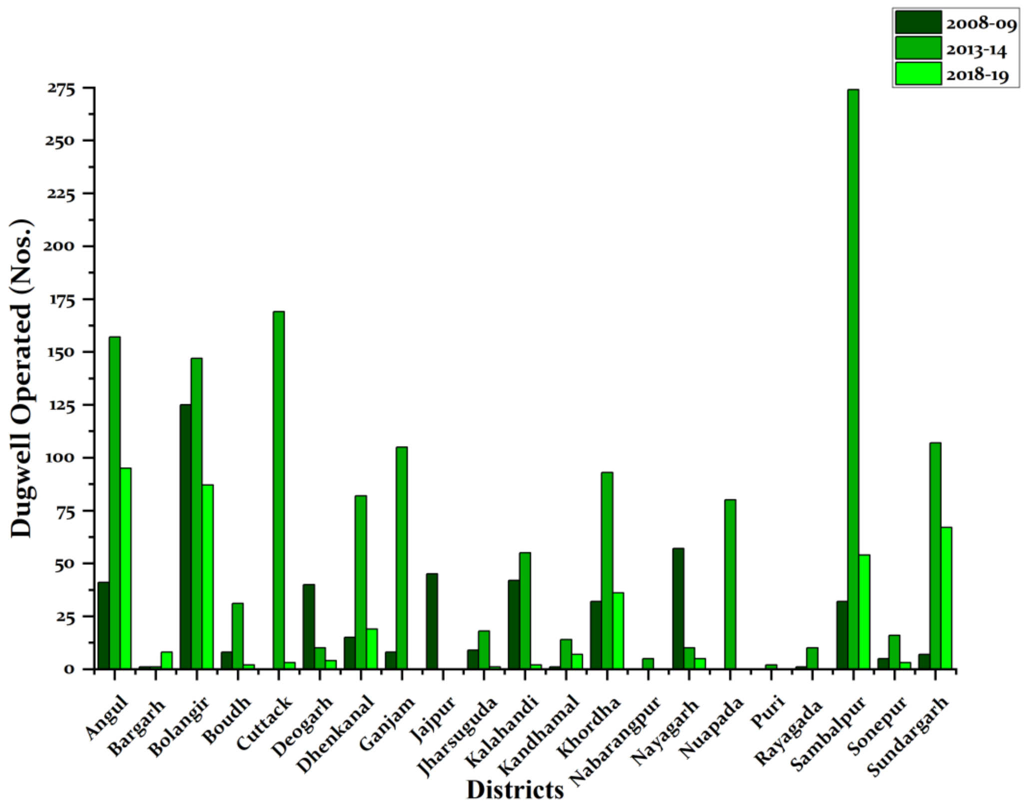


Figure 43: Dugwells operated (Nos.) across the Districts of Odisha, 2008-09 to 2018-19.

6.1.4 Operation of Pumpsets

The bar chart illustrates the number of pumpsets operated across various districts of Odisha over four time periods—2008–09, 2013–14, 2018–19, and 2023–24. There is a clear increasing trend in the number of pumpsets operated over the years, indicating a growing adoption of irrigation facilities across districts.

Districts such as Cuttack, Puri, Bolangir, Sambalpur, and Rayagada show significantly higher numbers compared to others, with Cuttack leading prominently, especially in 2018–19, where it recorded the highest number of operated pumpsets (4800). Districts like Angul, Nayagarh, Sonepur, and Kalahandi also show a consistent increase with fluctuation in later years. In contrast, some districts, such as Nabarangpur and Jajpur, have relatively lower values throughout the years.

The most recent period, 2023–24, represented by the light green bars, indicates a moderate increase or stabilisation in most districts compared to 2018–19. This pattern suggests that while the rate of growth has slowed in some regions, overall mechanised irrigation has expanded steadily across the state over the past 15 years.

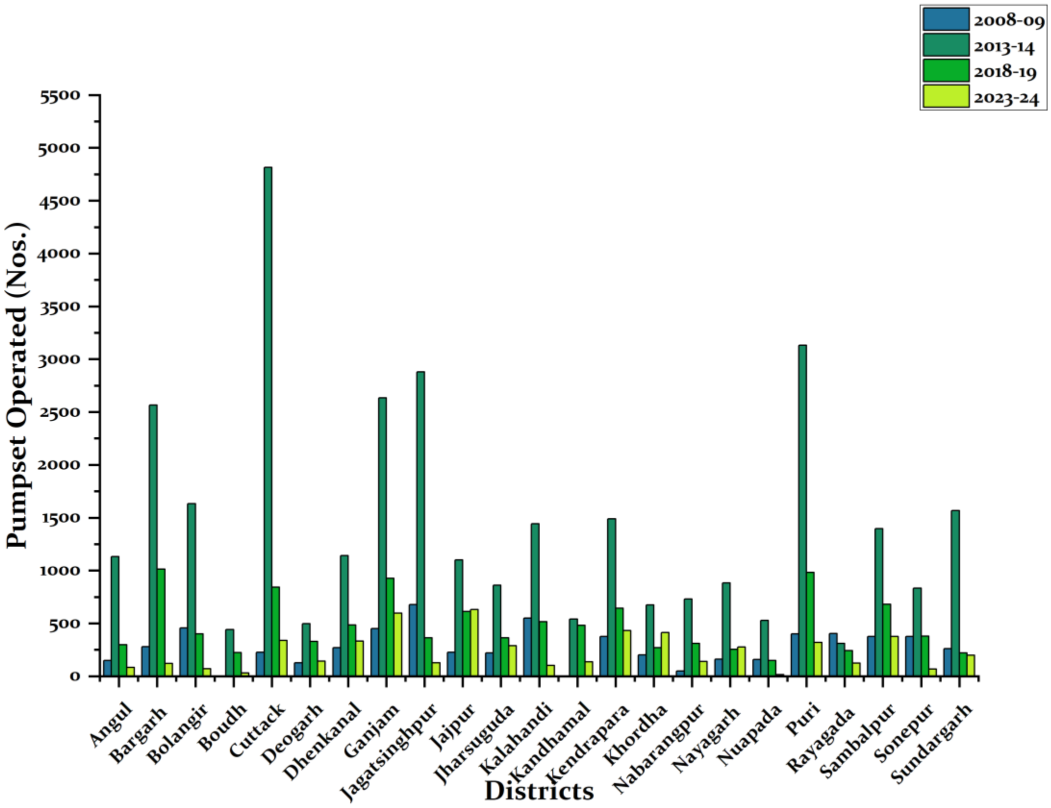


Figure 44: Pumpsets operated (Nos.) across the Districts of Odisha, 2008-09 to 2023-24.

6.1.5 Operation of Cluster micro river lifts

The bar chart shows the number of Cluster Micro River Lifts operated across various districts of Odisha during 2018–19, 2019–20, and 2023–24. Overall, there is a clear and consistent upward trend in all districts, reflecting the significant expansion of river lift irrigation schemes over time. The data show that in 2023–24, the number of operational lifts is markedly higher than in previous years, indicating successful implementation and scaling of micro-lift irrigation projects.

Districts such as Sambalpur, Nabarangpur, Kalahandi, Bargarh, and Bolangir exhibit the highest numbers, with Sambalpur recording nearly 800 lifts, the highest among all. Moderate growth is also seen in Sundargarh, Dhenkanal, Khordha, Ganjam, and Rayagada, while districts like Puri, Boudh, and Nayagarh have relatively fewer operating units.

The sharp rise between 2019–20 and 2023–24 highlights enhanced efforts toward decentralised irrigation development, improving water accessibility for agriculture in both western and southern Odisha regions.

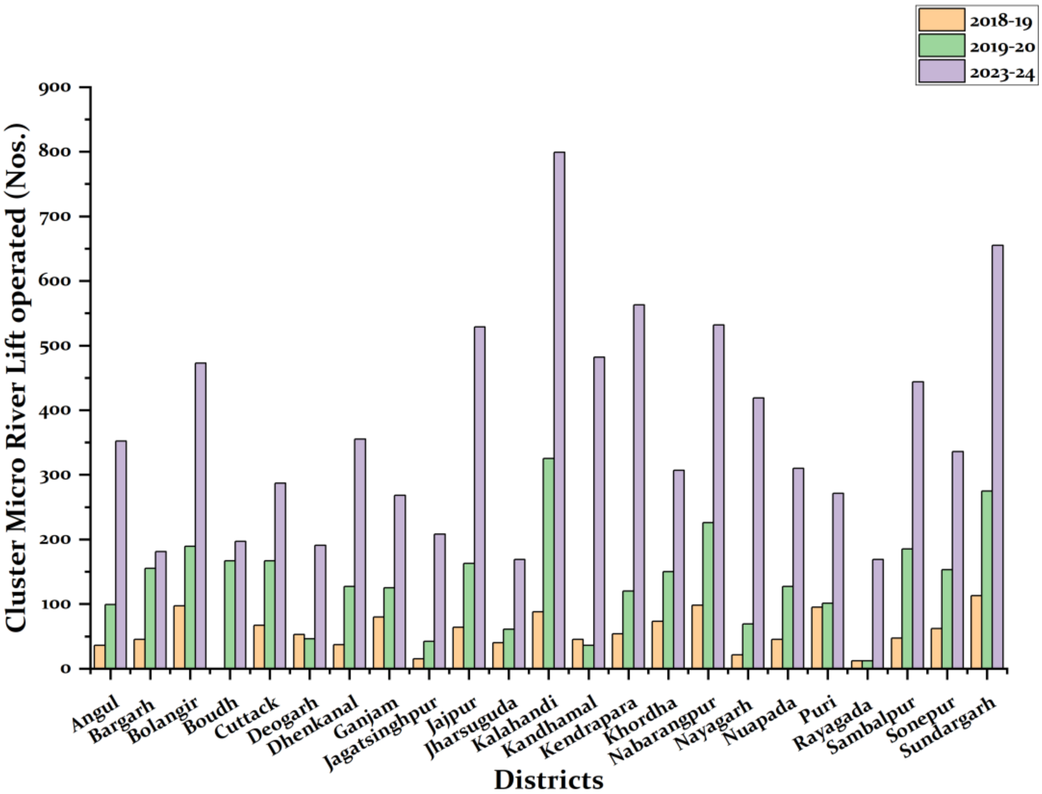


Figure 45: Cluster micro river lift operated (Nos.) across the Districts of Odisha, 2008-09 to 2023-24

6.1.6 Operation of Cluster Solar River Lifts

Odisha

The graph depicts the operation of cluster solar river lifts across districts of Odisha during 2023–24, showing variations among districts.

The highest number of installations is observed in Sundargarh (230), followed by Kalahandi (183) and Nabarangpur (138), indicating strong adoption of solar-powered irrigation in regions with extensive river networks and active lift irrigation programmes. Districts such as Bolangir (127), Nayagarh (102), Jajpur (108), and Jharsuguda (119) also report considerable operations, reflecting growing preference for renewable energy-based irrigation systems in both western and coastal regions. Moderate adoption is seen in Nayagarh, Dhenkanal, and Kendrapara (60–72 units), while comparatively lower figures occur in coastal and central districts like Puri (21), Cuttack (24), and Khordha (20), possibly due to greater dependence on canal irrigation.

Southern districts such as Rayagada (58) and Nabarangpur (122) show steady progress, likely driven by government-supported solar lift initiatives in tribal and rainfed zones.

Overall, the data highlights a growing shift toward solar-based irrigation systems, with western and southern districts emerging as key adopters under cluster-based river lift schemes, reducing pressure on groundwater resources and promoting sustainable irrigation practices.

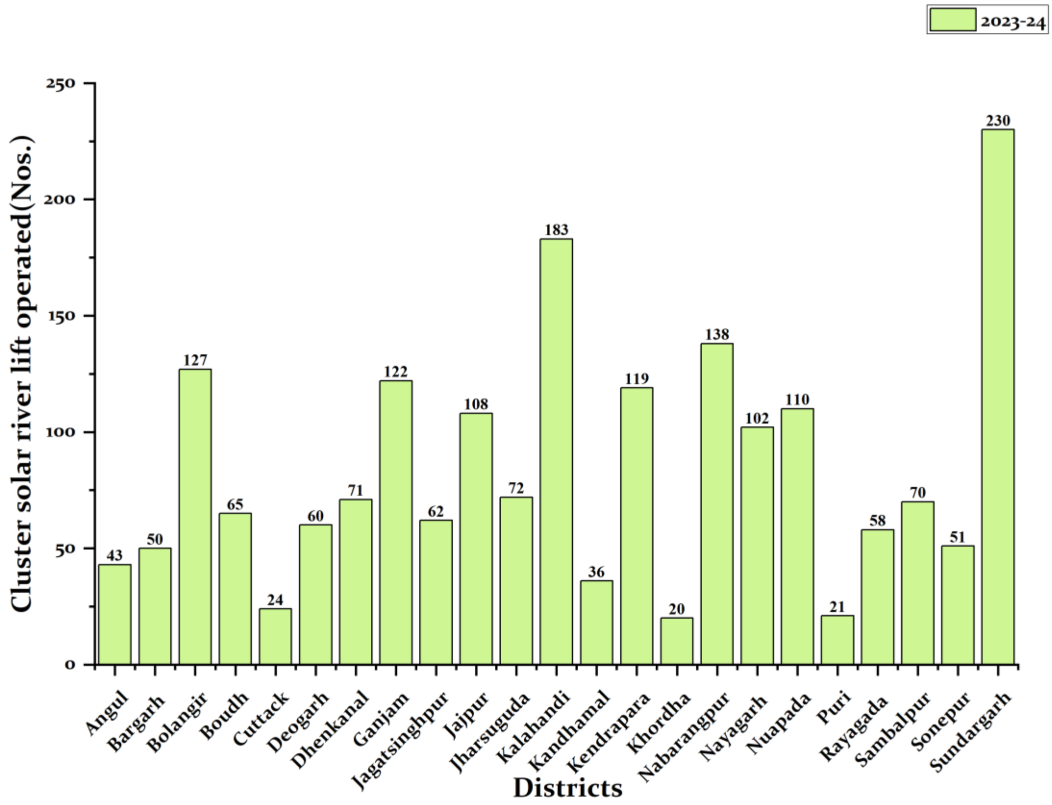


Figure 46: Cluster solar river lift operated (Nos.) across the districts of Odisha, 2023-24

6.2 Operation of Irrigation Power Resources : Chhattisgarh (MRB Part)

The operation of irrigation power resources in Chhattisgarh shows a clear structural shift toward groundwater-based and electrified irrigation systems over the past two decades. Tube-wells have expanded rapidly, increasing nearly fourfold from about 90,700 units in 2005–06 to over 3.44 lakh units by 2022–23, highlighting their growing dominance as the primary irrigation source. This rise reflects farmers' increasing reliance on assured, on-demand irrigation, particularly in areas where surface water supply is seasonal or unreliable. In contrast, the number of traditional open wells has steadily declined, falling from around 1.57 lakh units in 2005–06 to about 1.04 lakh units in 2022–23, indicating a gradual replacement of shallow, manually operated sources by deeper and more efficient tube-well systems.

A parallel transition is evident in irrigation power mechanisms. Electric engines have increased sharply, from about 65,500 units in 2005–06 to over 2.40 lakh units in 2022–23, underscoring the growing electrification of irrigation infrastructure across the state. While oil engines remain important, their numbers show only moderate growth with notable inter-annual fluctuations, suggesting a relative decline in preference compared to electric pumps.

Overall, the data point to a decisive move toward energy-intensive, groundwater-dependent irrigation, improving short-term irrigation reliability but also increasing pressure on aquifers, making long-term groundwater sustainability and energy-water management critical policy concerns for the state.

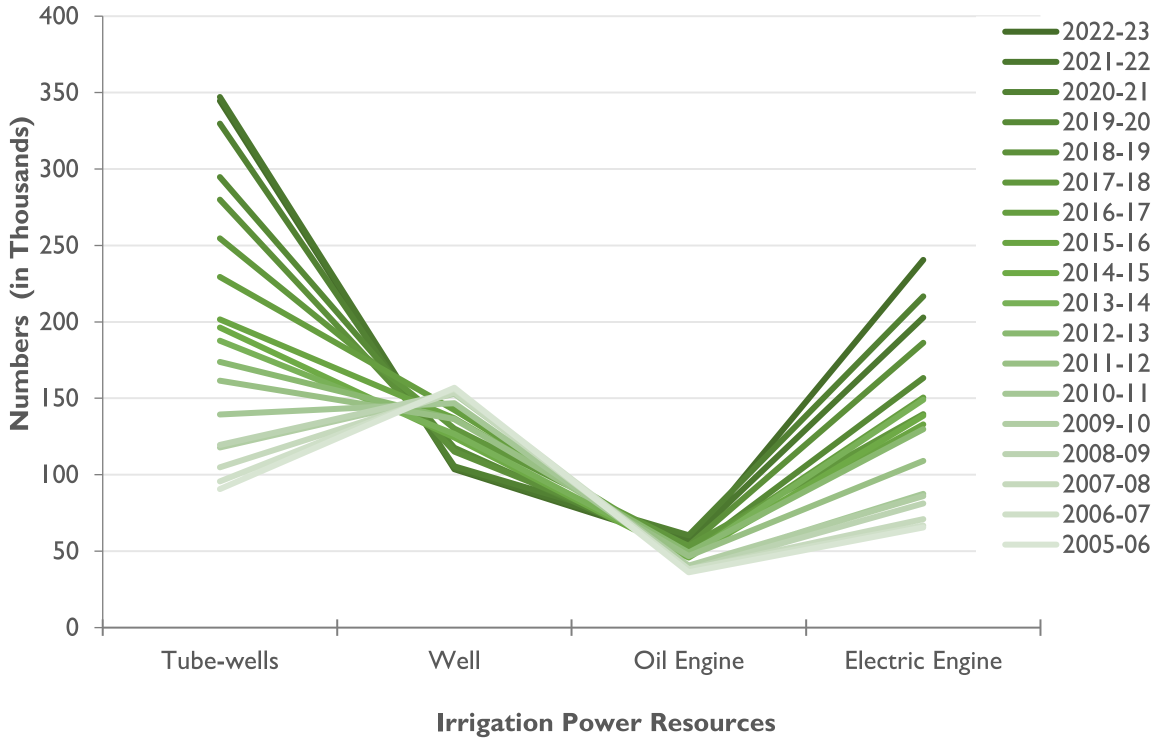


Figure 47: Number of Irrigation Power Resources in Chhattisgarh, 2005-06 to 2022-23.
[Source: Chhattisgarh Statistical Abstract Report, Commissioner, Land Record, Govt. of C.G.]

6.2.1 Operation of Tube Well

The district-wise operation of tube-wells across the Mahanadi River Basin (MRB) districts of Chhattisgarh indicates a strong and continuing shift toward groundwater-based irrigation. Between 2019–20 and 2022–23, several districts record very high and, in some cases, sharply increasing numbers of tube-wells, notably Bemetara (40,616), Mahasamund (27,477), Dhamtari (29,193), Balod (23,735), Raipur (16,908), Durg (18,138), and Rajnandgaon (15,122). These figures underline the growing dependence of agriculture on private groundwater abstraction, particularly in the central plains of the MRB, where canal coverage is uneven and supplemental irrigation through tube-wells has become essential for sustaining rabi crops and multiple cropping cycles.

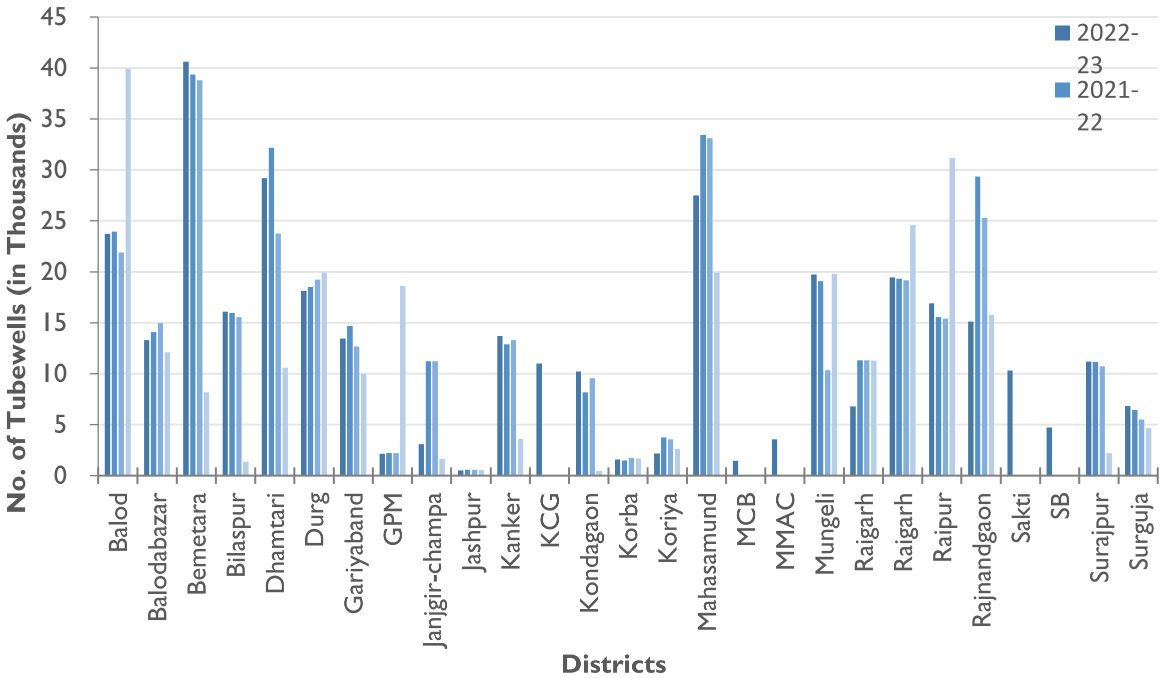


Figure 48: Number of Tube well in operation Chhattisgarh [MRB Part], 2019-20 to 2022-23.
[Source: Chhattisgarh Statistical Abstract Report, Commissioner, Land Record, Govt. of C.G.]

This expansion closely overlaps with CGWB-identified groundwater stress zones. As per the Dynamic Ground Water Resources Assessment (2024), Balod, Bemetara, Dhamtari, and Durg districts record Stage of Groundwater Development (SOD) values exceeding 70%, placing multiple blocks within these districts in the Semi-Critical category, with Nawagarh block of Bemetara reaching ~97% SOD, the highest in the state. In Raipur, Rajnandgaon, Mahasamund, and Janjgir–Champa, although district-average SOD remains lower, several blocks are classified as Semi-Critical, reflecting localized over-extraction driven by dense tube-well concentrations.

For instance, Mahasamund shows persistently high tube-well numbers (33,416 in 2021–22 and 27,477 in 2022–23), while Dhamtari and Balod combine high tube-well density with already stressed aquifer conditions. This spatial concurrence strongly suggests that the growth of tube-wells is a key driver of rising groundwater stress in MRB districts.

Overall, the evidence points to a groundwater-centric intensification pathway in the MRB that is becoming increasingly unsustainable in Semi-Critical blocks. Without targeted interventions—such as regulation of new tube-wells in stressed blocks, crop diversification away from water-intensive systems, improved surface-groundwater conjunctive use, and active recharge measures—the continued proliferation of tube-wells in districts like Bemetara, Dhamtari, Balod, Raipur, Mahasamund, and Rajnandgaon risks pushing several blocks toward Critical status, undermining long-term irrigation security and agricultural resilience in the basin.

6.2.2 Operation of DugWells

The district-wise pattern of dugwell operation across the Mahanadi River Basin (MRB) part of Chhattisgarh between 2019–20 and 2022–23 reflects a mixed but generally declining reliance on traditional shallow groundwater sources, particularly in the central and plain districts. Several MRB districts—such as Balod, Bemetara, Mahasamund, Raipur, and Rajnandgaon—

show a consistent reduction in the number of dugwells over the period. For example, Balod declines from 1,107 dugwells in 2019–20 to 975 in 2022–23, while Bemetara falls from 649 to 509 and Mahasamund from 1,323 to 425. This trend suggests a gradual replacement of dugwells by tube-wells and mechanized pumping systems, especially in areas experiencing agricultural intensification and higher irrigation demand.

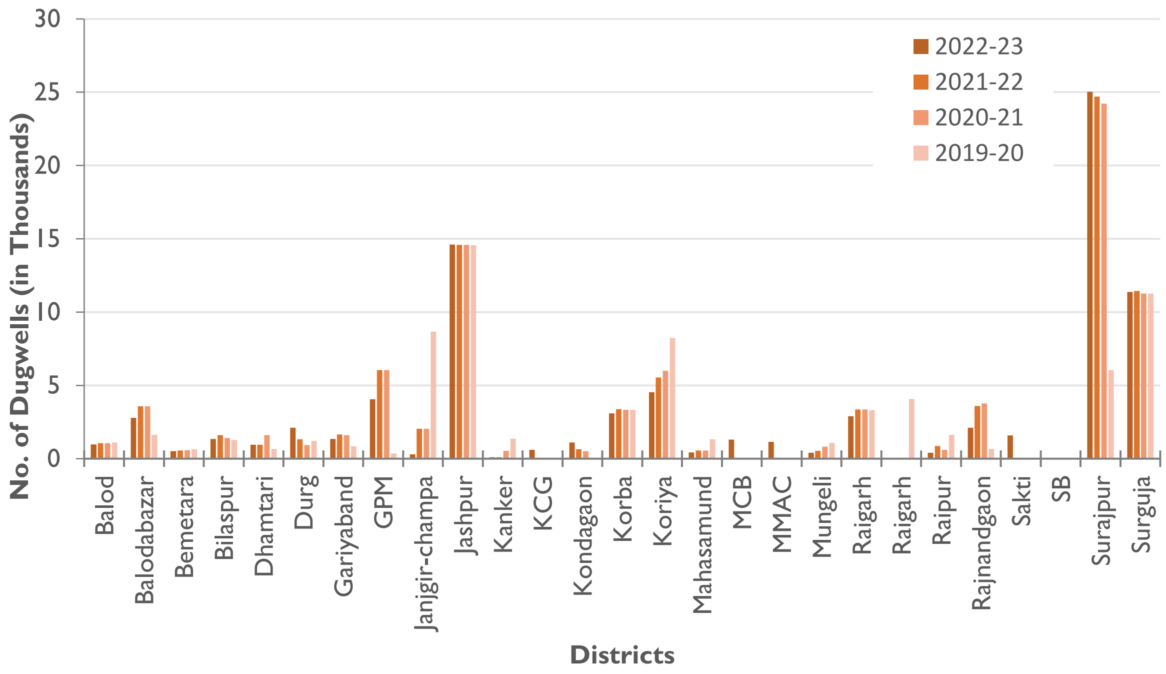


Figure 49: Number of Dugwells in operation Chhattisgarh [MRB Part], 2019-20 to 2022-23.

[Source: Chhattisgarh Statistical Abstract Report, Commissioner, Land Record, Govt. of C.G.]

In contrast, tribal and northern hill districts exhibit persistently high or even rising dugwell numbers, underscoring their continued dependence on shallow aquifers and traditional irrigation practices. Surajpur (25,041), Jashpur (14,605), Surguja (11,376), and Koriya (4,533) remain dominant dugwell users in 2022–23, reflecting limited tube-well penetration, hard-rock hydrogeology, and smaller-scale irrigation systems. Notably, districts such as GPM and Janjgir–Champa show sharp inter-annual fluctuations, indicating administrative reclassification effects and transitional irrigation shifts. Overall, the spatial pattern highlights a dual groundwater regime in the MRB—where dugwells continue to play a critical role in upland and forested regions, while their importance is steadily diminishing in the agriculturally intensive plains that are increasingly reliant on deeper groundwater abstraction.

6.2.3 Operation of Pumpsets

i. Operation of Pumpsets: Fuel Based

The district-wise distribution of oil-operated pumpsets in the Mahanadi River Basin (MRB) districts of Chhattisgarh during 2019–20 to 2022–23 indicates a gradual but uneven transition in irrigation energy use. Several districts show a declining or fluctuating trend in oil pumpset numbers, reflecting partial substitution by electric pumps where grid connectivity has improved. For instance, Bilaspur records a decline from 3,798 units in 2021–22 to 3,368 in 2022–23, while Durg and Raipur show marked reductions compared to their 2019–20 levels. This pattern is consistent with state-level efforts to promote electrification of irrigation and reduce dependence on costlier diesel-based pumping systems in agriculturally intensive plains.

Conversely, tribal, forested, and relatively remote districts continue to exhibit high or increasing reliance on oil pumpsets. Jashpur stands out with persistently high numbers (over 9,500 units in 2022–23), followed by Surajpur, Surguja, Kanker, and Mahasamund, where oil pumps remain critical due to limited or unreliable electricity supply and dispersed irrigation sources. Districts such as Janjgir–Champa and Rajnandgaon show sharp inter-annual fluctuations, suggesting sensitivity to fuel prices, rainfall variability, and cropping decisions. Overall, the spatial pattern underscores a dual energy regime in irrigation, with electric pumps increasingly dominant in the central MRB plains, while oil-operated pumps continue to play a vital role in ensuring irrigation access in the peripheral and upland districts of Chhattisgarh.

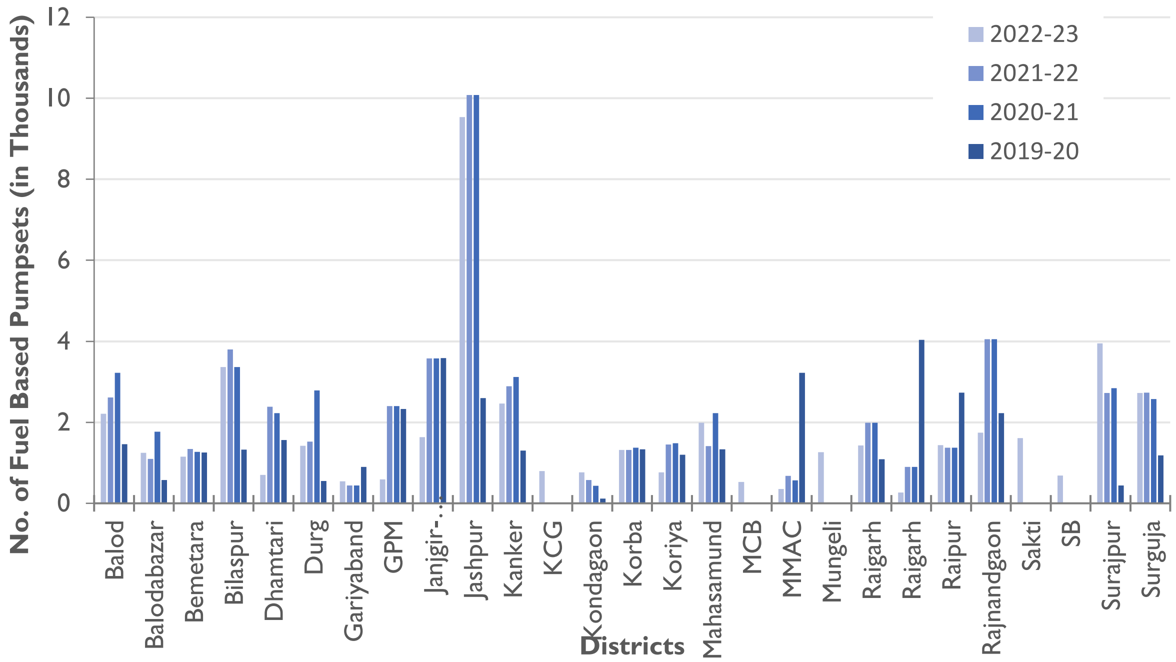


Figure 50: Number of Fuel Based Pumpsets in Chhattisgarh [MRB Part], 2019-20 to 2022-23.

[Source: Chhattisgarh Statistical Abstract Report, Commissioner, Land Record, Govt. of C.G.]

ii. Operation of Pumpsets: Electricity Based

The distribution of electric pumpsets across the Mahanadi River Basin (MRB) districts of Chhattisgarh shows a strong concentration in agriculturally intensive and better-electrified districts, with notable inter-annual variability between 2019–20 and 2022–23. Districts such as Balodabazar, Bilaspur, Raipur, Surajpur, Kanker, Rajnandgaon, and Durg consistently record high numbers of electric pumpsets, reflecting a gradual shift toward electrified groundwater abstraction. In 2022–23, Balodabazar (≈34,800), Bilaspur (≈29,200), Raipur (≈16,500), Surajpur (≈19,400), and Kanker (≈13,700) emerge as major users, indicating both irrigation intensification and improved access to rural power supply. Some districts, such as Janjgir–Champa, show relatively stable numbers across years, suggesting saturation or regulated growth.

At the same time, sharp year-to-year fluctuations in districts like Dhamtari, Mahasamund, Rajnandgaon, and Balod indicate sensitivity to policy shifts, electrification drives, replacement of diesel pumps, or reporting differences. The rising dominance of electric pumpsets in several MRB districts—many of which overlap with CGWB-identified Semi-Critical and Critical groundwater blocks—raises concerns about long-term groundwater sustainability. Compared to oil pumpsets, electric pumps typically enable longer pumping durations and higher abstraction volumes, potentially accelerating groundwater depletion where recharge is limited. Overall, the data point to a clear structural transition toward electric-powered irrigation in the MRB, underscoring the need to align rural electrification and irrigation expansion with groundwater regulation, demand management, and recharge enhancement, especially in stressed aquifer zones.

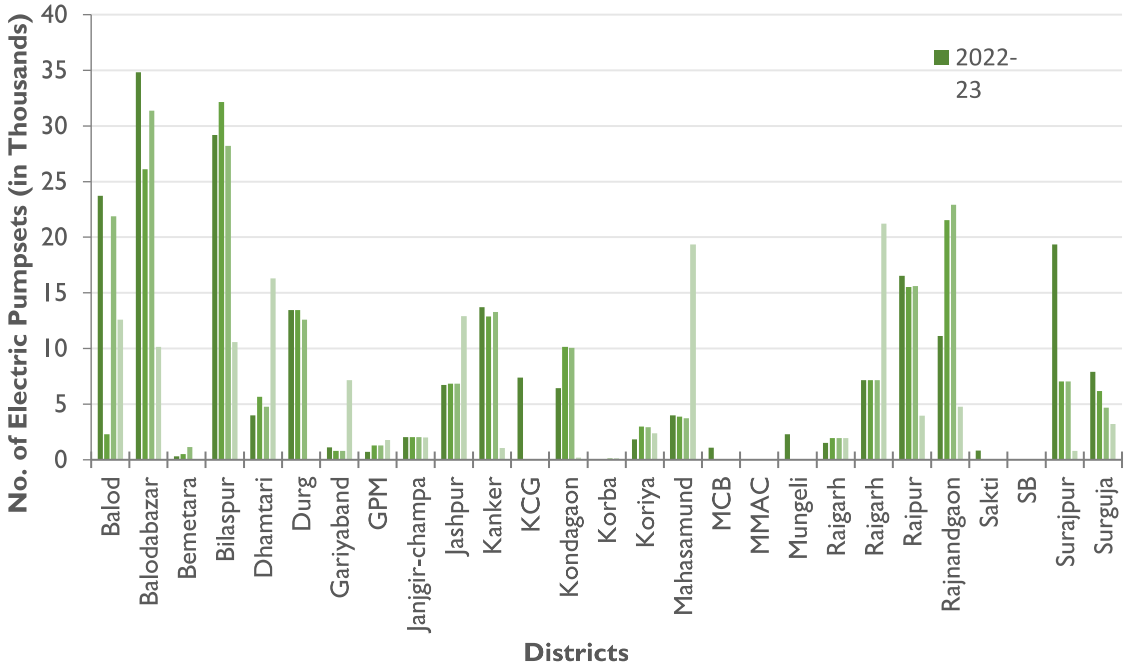


Figure 51: Number of Electric Pumpsets in Chhattisgarh [MRB Part], 2019-20 to 2022-23.

[Source: Chhattisgarh Statistical Abstract Report, Commissioner, Land Record, Govt. of C.G.]

7. Cropping Intensity

Odisha

The bar chart illustrates the crop intensity across various districts over multiple years, ranging from 2000-01 to 2023-24. The data shows a general upward trend in crop intensity for most districts, with some variability over time.

In the earlier years (2000-2004), the crop intensity was relatively lower compared to the recent years (2018-19 and 2023-24), where there is a noticeable increase in most districts. For instance, districts like Puri, Boudh, and Angul exhibit a significant rise in crop intensity from the beginning to the end of the time series. However, some districts, such as Kalahandi and Nabarangpur, show a more gradual increase in cropping intensity, indicating that agricultural practices in these areas have evolved more slowly.

The overall trend suggests improvements in agricultural practices, possibly due to better crop management techniques or increased adoption of high-yield varieties over the years. This graph effectively highlights the shifting trends over time, offering a clear visual of how cropping intensity has changed in each district.

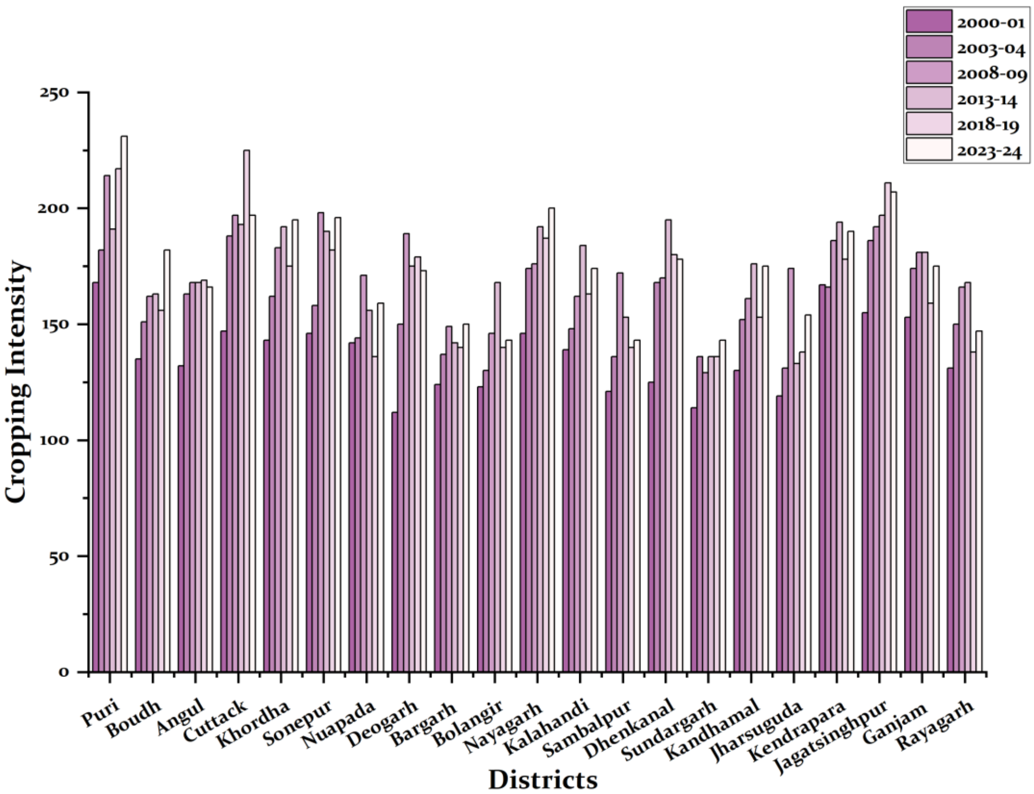


Figure 52: Crop Intensity across districts of Odisha, 2000-01 to 2023-24.

[Source: Odisha Agricultural Statistics Report (2000-01;2003-04;2008-09;2013-14;2018-19; 2023-24)]

Chhattisgarh

Cropping intensity across the MRB districts of Chhattisgarh shows a differentiated but largely stable pattern over the last decade, reflecting contrasts in irrigation access, land capability, and agrarian intensification. Traditionally intensive agricultural districts such as Bemetara, Kabirdham, Mungeli, Dhamtari, and Rajnandgaon consistently record the highest cropping intensities, well above 150% in multiple years. Bemetara, in particular, shows a sharp rise from 151% (2011–12) to 176% (2020–21), sustaining a high level at 172% in 2023–24, indicating strong double-cropping supported by assured irrigation and input use. Kabirdham and Mungeli follow similar trajectories, peaking above 160–170% before a marginal moderation in the most recent period, while Dhamtari and Rajnandgaon display fluctuations linked to seasonal water availability and cropping choices.

In contrast, urban-influenced and forested districts—including Raipur, Bilaspur, Korba, Jashpur, Kondagaon, and Korea—exhibit lower and often declining cropping intensity, generally stabilising around 105–115% by 2023–24. Several districts such as Balod, Raipur, Bilaspur, and Janjgir–Champa show a gradual decline over time, pointing to land-use diversification, groundwater constraints, and increasing non-agricultural pressures. Overall, the spatial pattern highlights a consolidation of intensive multi-cropping in the central agrarian belt of the MRB, alongside stagnation or mild contraction in peripheral and urbanising districts—underscoring the growing importance of sustainable water and soil management to maintain high cropping intensity in the long term.

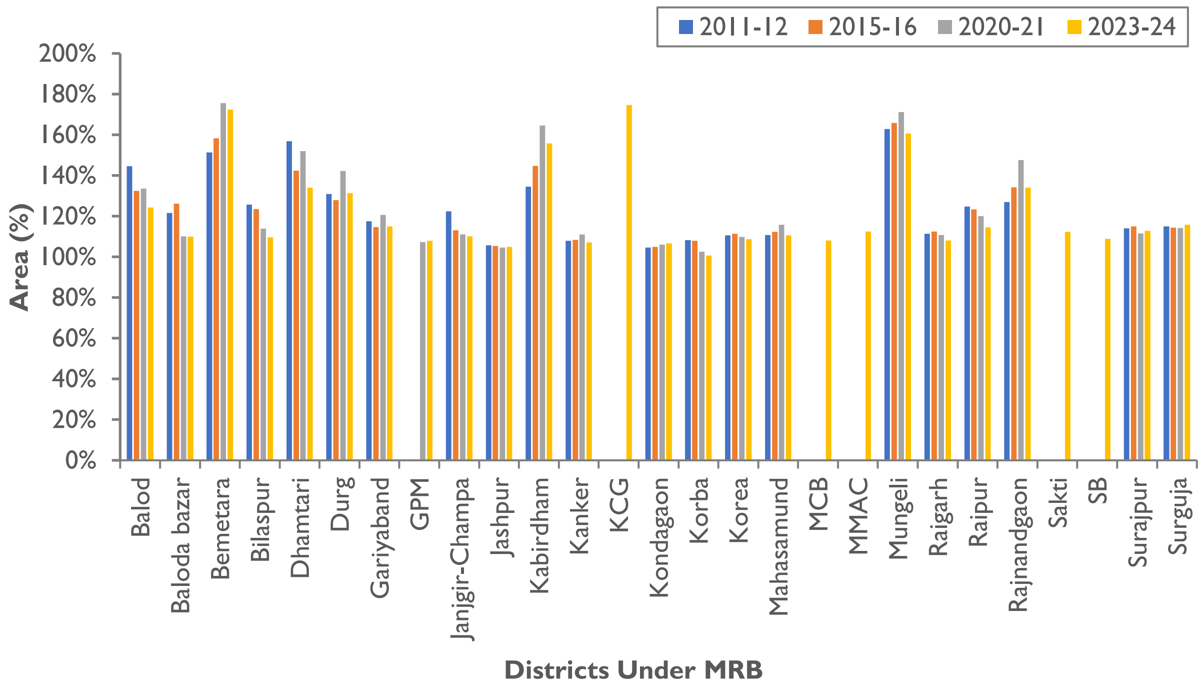


Figure 53: Crop Intensity (%) across districts of Chhattisgarh [MRB Part], 2011-12 to 2023-24.

[Source: Chhattisgarh Statistical Abstract Report, Commissioner, Land Record, Govt. of C.G.

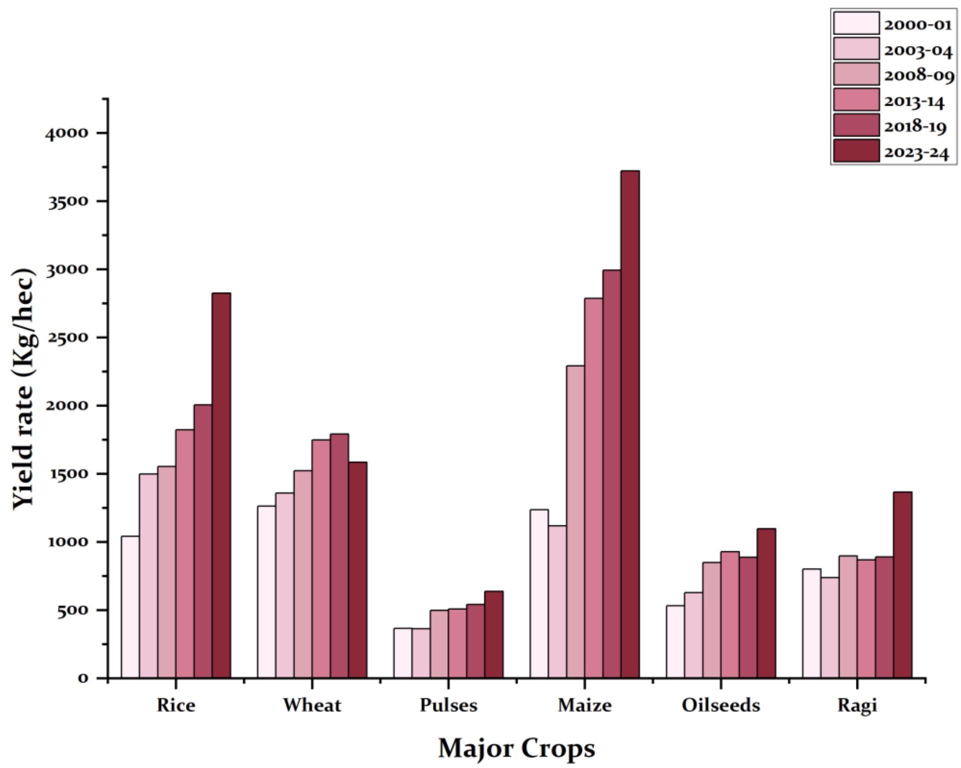
8. Crop Production

Odisha

From 2000–01 to 2023–24, Odisha's crop yield trends exhibit a distinct pattern of steady gains in most major crops, with rice recording the most consistent growth, increasing from 1,041 kg/ha to 2,823 kg/ha, reflecting significant productivity improvements.

Maize yield surged sharply, especially after 2008–09, rising from 1,235 kg/ha to 3,720 kg/ha, indicating the successful adoption of high-yielding hybrids and better agronomic practices. Pulses, though lower-yielding, showed gradual gains from 365 kg/ha to 636 kg/ha, suggesting moderate improvement in legume cultivation. Oilseeds and ragi recorded modest increases overall, with ragi showing a notable jump in 2023–24. Wheat yields initially rose but have declined slightly after 2018–19, possibly due to climatic stress or reduced cultivation focus. Sugarcane yield fluctuated but remained consistently high, peaking in 2018–19 at 73,119 kg/ha.

Overall, the data reflect a clear technological and management-driven boost in cereal productivity, particularly in rice and maize, while pulses and oilseeds continue to lag in yield growth



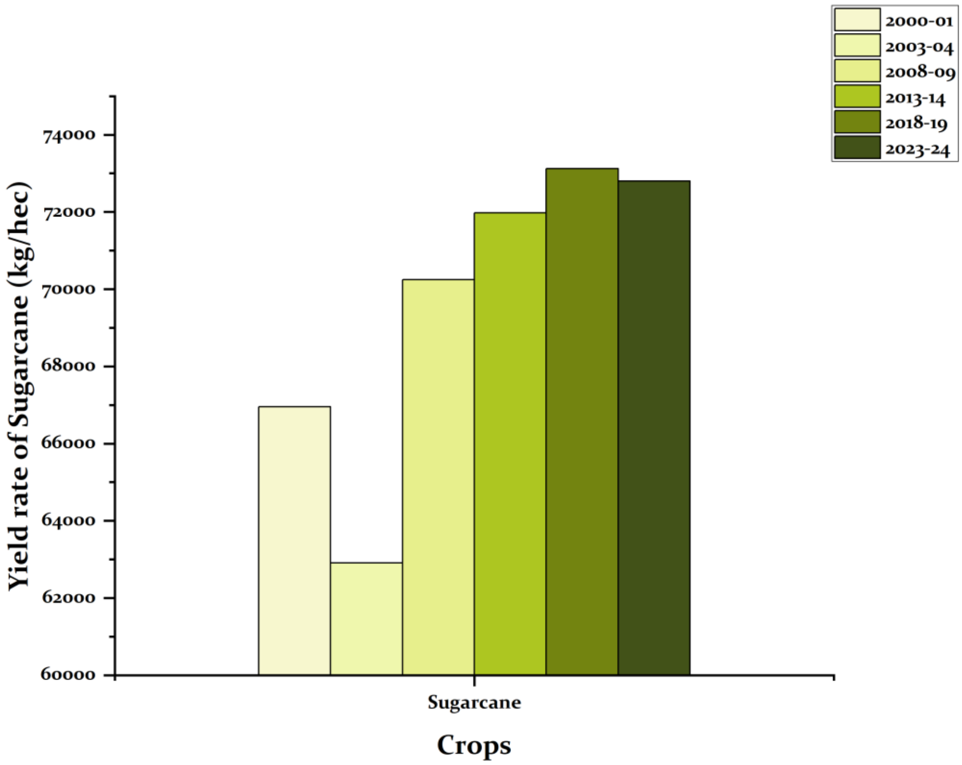


Figure 54: Yield rate of major crops and sugarcane in Odisha from 2000–01 to 2023–24.

[Source: Odisha Agricultural Statistics Report (2000-01;2003-04;2008-09;2013-14;2018-19; 2023-24)]

Chhattisgarh

The yield performance of principal crops in the MRB part of Chhattisgarh between 2011–12 and 2022–23 indicates an overall improvement in foodgrain productivity, with notable crop-wise contrasts. Rice, the dominant crop of the basin, shows a steady and substantial rise from about 1.61 t/ha in 2011–12 to 2.53 t/ha in 2022–23, reflecting gains from improved varieties, wider irrigation coverage, and better agronomic practices. Maize records the most pronounced growth, with yields more than doubling from 1.43 t/ha to 3.78 t/ha over the period, indicating increasing adoption of high-yielding hybrids and improved input management. Wheat yields remain relatively stable, improving modestly from 1.46 t/ha to 1.72 t/ha, though with an intervening dip in 2019–20, likely linked to climatic variability and water stress during the rabi season.

In contrast, pulses and oilseeds exhibit greater volatility, underscoring their sensitivity to rainfall variability and lower input intensity. Pulse yields peak in 2014–15 but decline sharply by 2019–20 before partially recovering to 0.63 t/ha in 2022–23, while oilseed yields fluctuate within a narrower band around 2.3 - 2.6 t/ha. Overall, the yield trends suggest strengthening cereal productivity—particularly rice and maize—while highlighting persistent vulnerabilities in pulses, oilseeds, and water-intensive crops within the MRB.

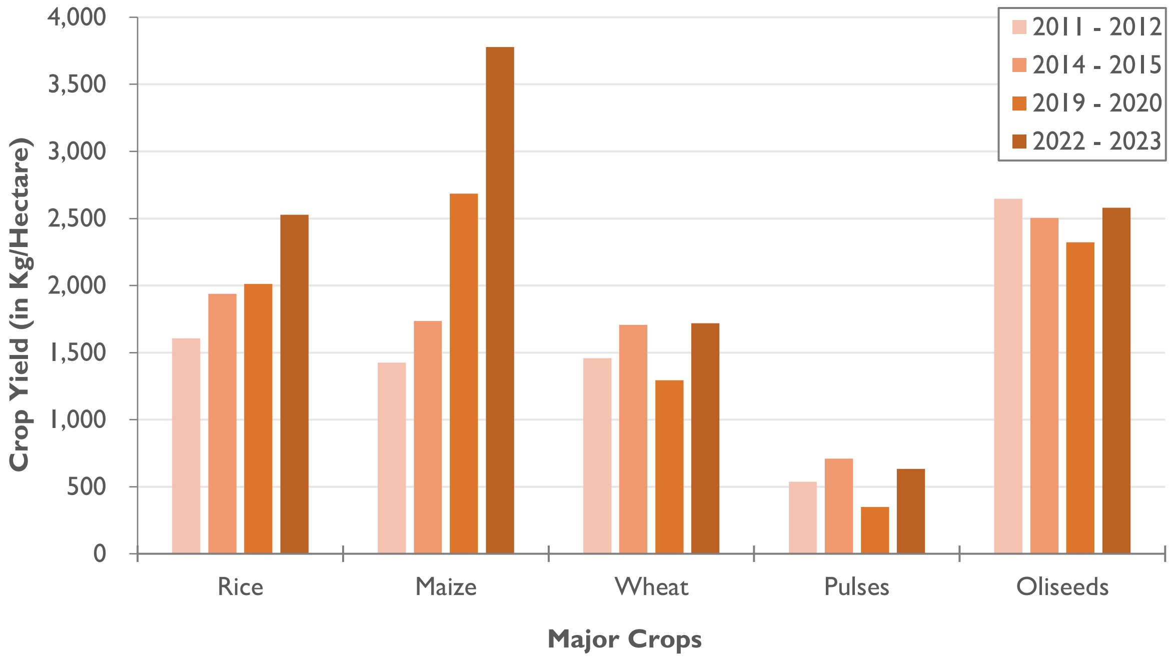


Figure 55: Yield (Kg/Ha) of Major Crops in Chhattisgarh [MRB Part] from 2011–12 to 2022–23

[Source: Directorate of Economics & Statistics, Dept. of Agriculture & Farmers Welfare, Govt. of India]

8.1 Rice

Odisha

The bar chart illustrates the yield rate of rice (kg/ha) across various districts for six different years (2000–01, 2003–04, 2008–09, 2013–14, 2018–19, and 2023–24). There is a clear upward trend in rice yield over time in almost all districts, indicating improvements in agricultural productivity, possibly due to better farming practices, irrigation, seed varieties, and technology adoption. In the early 2000s (2000–01 and 2003–04), the yields were generally below 1500 kg/ha, whereas by 2023–24, most districts achieved yields between 2500 and 3500 kg/ha. Districts such as Bargarh, Bolangir, Sonepur, Dhenkanal, Jharsuguda, Kalahandi, Angul, Boudh, Puri, Rayagada and Sambalpur show particularly high yield, exceeding 3000 kg/ha in the most recent year. Conversely, districts like Kandhamal and Sundargarh maintain comparatively lower yields, reflecting possible disparities in resources or growing conditions. Overall, the data demonstrate substantial progress in rice productivity across districts over the past two decades **(Fig 56).**

By 2023–24, the state's average yield lies close to the higher-performing districts, suggesting that overall agricultural progress has been robust, though uneven development persists. The general trend emphasises successful state-level interventions in rice cultivation but highlights the need for targeted support in lagging districts to ensure balanced agricultural growth.

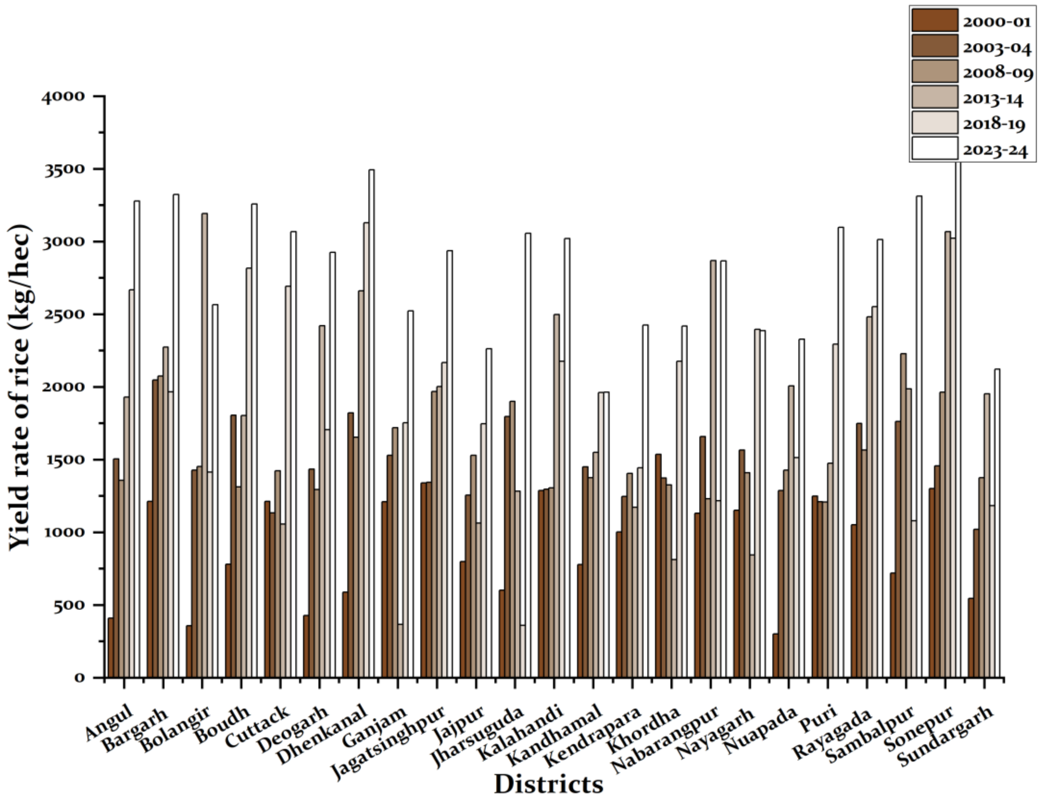


Figure 56: Yield rate of rice across districts in Odisha from 2000–01 to 2023–24.

[Source: Odisha Agricultural Statistics Report (2000-01;2003-04;2008-09;2013-14;2018-19; 2023-24)]

Chhattisgarh

Rice yields across the MRB part of Chhattisgarh show a clear upward trajectory between 2011–12 and 2022–23, though with strong inter-district variability. In 2011–12, yields ranged widely from about 1.05–2.63 t/ha, with relatively higher productivity in traditionally irrigated districts such as Dhamtari, Janjgir-Champa, Balod, Bilaspur, and Mungeli, and lower yields in upland and tribal districts like Kondagaon, Gariyaband, Jashpur, and Surguja. By 2014–15, most districts recorded moderate gains, reflecting improved varietal adoption and better crop management, particularly in Dhamtari (over 3.1 t/ha) and Janjgir-Champa (about 3.16 t/ha), while some districts such as Kabirdham and Durg experienced stagnation or slight declines.

The period up to 2022–23 marks a significant productivity leap, with several districts crossing or approaching 3.0 t/ha, including Bilaspur (≈3.39 t/ha), Bemetara (≈3.29 t/ha), Dhamtari (≈3.27 t/ha), Raipur (≈3.48 t/ha), Balod (≈3.01 t/ha), and Sakti (≈3.03 t/ha). Even districts that earlier lagged - such as Kondagaon, Gariyaband, Surajpur, and Surgujashow substantial improvements. These yield gains have been reinforced by strong price support. At the national level, the Minimum Support Price (MSP) for common paddy in 2022–23 was ₹2,183 per quintal, as notified by the Government of India. Chhattisgarh further enhanced farmer returns through a state input subsidy of ₹310 per quintal, resulting in an effective procurement price of ₹2,493 per quintal, among the highest realised prices for paddy in the country during that period. This assured procurement price, combined with extensive procurement infrastructure and timely payments, has strengthened the economic viability of rice cultivation across the MRB.

However, the convergence of rising yields, intensive input use, and expanding irrigation also underscores emerging challenges related to nutrient balance and groundwater sustainability, particularly in canal- and tube-well-dominated rice belts.

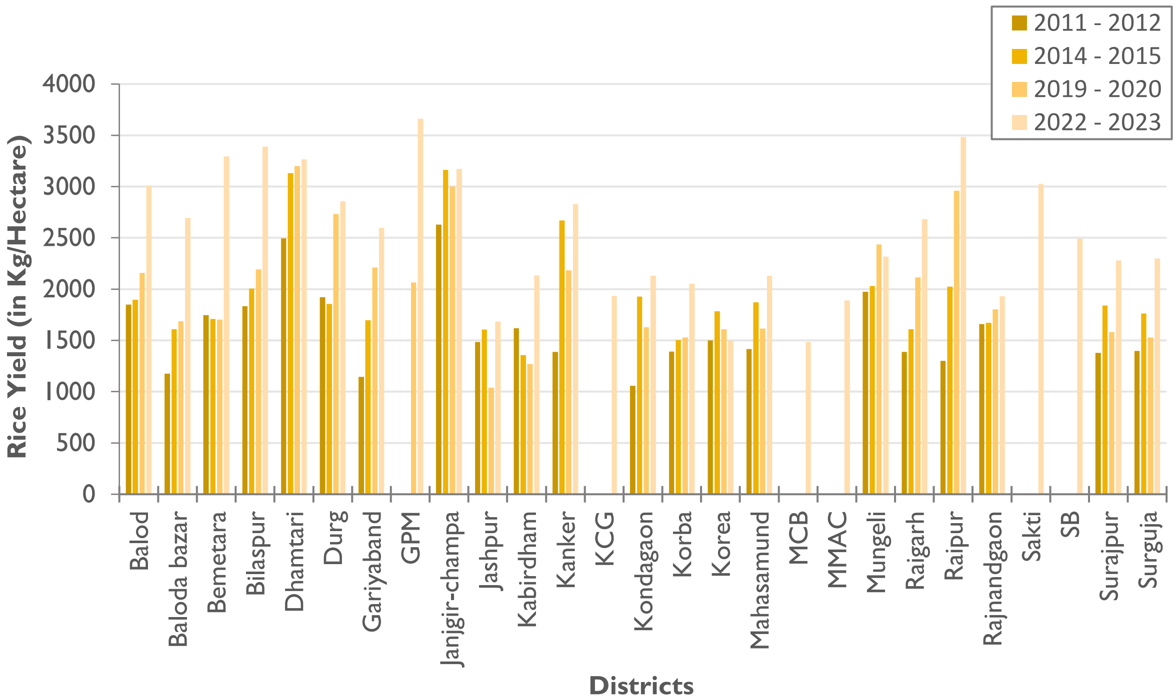


Figure 57: Yield (Kg/Ha) of Rice in Chhattisgarh [MRB Part] from 2011–12 to 2022–23

[Source: Directorate of Economics & Statistics, Dept. of Agriculture & Farmers Welfare, Govt. of India]

8.2 Wheat

Odisha

The bar graph illustrates the yield rate of wheat (in kg/hectare) across various districts over six time periods: 2000–01, 2003–04, 2008–09, 2013–14, 2018–19, and 2023–24. The data show a consistent upward trend in wheat yield across all districts, indicating significant agricultural improvements over the years. In the early 2000s (2000–01 and 2003–04), the yield rates were relatively low, typically below 1000 kg/ha in most districts. By 2008–09 and 2013–14, the yields increased substantially, reflecting advancements in farming techniques, irrigation, and possibly the adoption of high-yield wheat varieties. The years 2018–19 and especially 2023–24 show the highest yield rates, often exceeding 1800–2000 kg/ha in most districts, suggesting enhanced productivity and better resource management **(Fig 58).**

Districts such as Cuttack, Jharsuguda, Bargarh, Bolangir, Sambalpur, and Sundargarh record the highest wheat yield rates, often exceeding 1800–2000 kg/hectare in the most recent period (2023–24). These western Odisha districts benefit from relatively better irrigation infrastructure and more favourable agro-climatic conditions for wheat cultivation. On the other hand, districts like Kandhamal, Ganjam, and Jagatsinghpur exhibit comparatively lower yields, though they too show gradual improvement over time, reflecting enhanced adoption of improved crop management practices even in hilly or tribal regions.

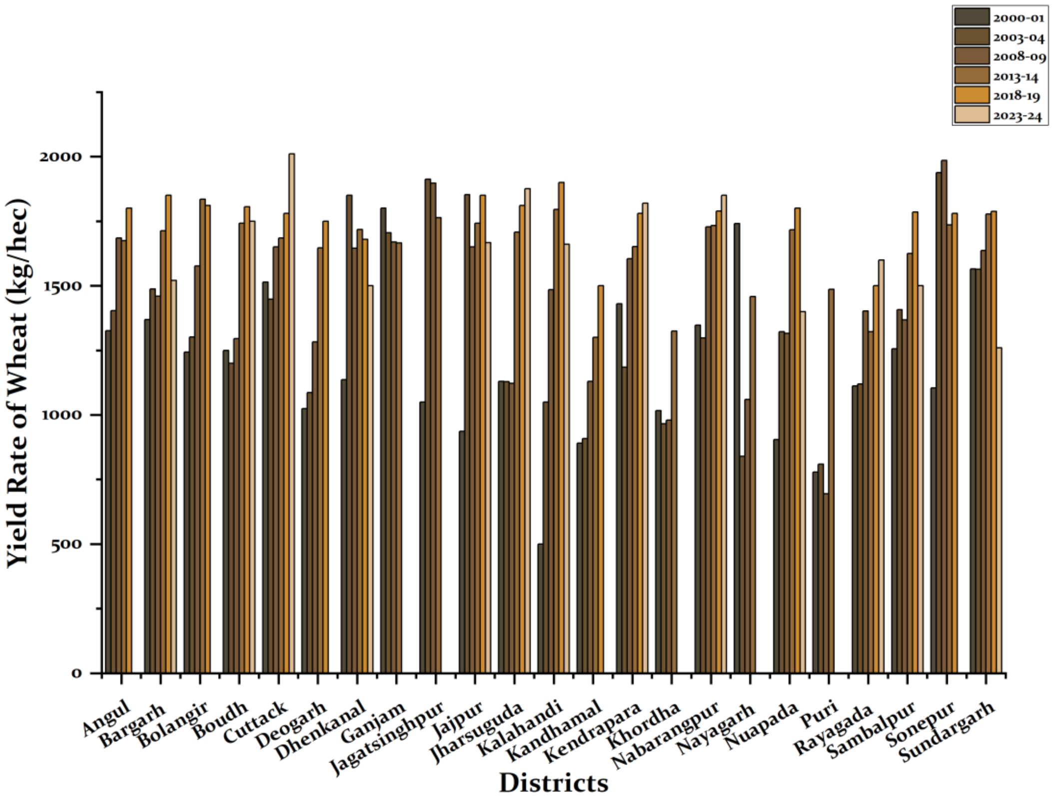


Figure 58: Yield rate of Wheat across districts in Odisha from 2000–01 to 2023–24.

[Source: Odisha Agricultural Statistics Report (2000-01;2003-04;2008-09;2013-14;2018-19; 2023-24)]

The overall pattern demonstrates a clear and steady improvement in wheat yield performance across the region with western and northern regions leading in productivity. The increasing trend over the years points to advancements in irrigation facilities, the use of high-yielding varieties, timely sowing, and better extension services, contributing to the state's growing wheat production efficiency.

Chhattisgarh

Wheat productivity in the Mahanadi River Basin (MRB) part of Chhattisgarh shows a pattern of moderate long-term improvement with notable inter-period fluctuations between 2011–12 and 2022–23. During the early period (2011–12), district-wise yields largely ranged between 1.0 and 1.8 t/ha, reflecting the secondary status of wheat in a predominantly rice-based system. Several districts—such as Kanker, Kondagaon, Mahasamund, Gariyaband, Raipur, and Raigarh—recorded relatively higher baseline yields, benefiting from better winter irrigation access and residual soil moisture. A general improvement was observed by 2014–15, followed by a dip in 2019–20 across many districts, likely linked to climatic variability, moisture stress, and reduced winter irrigation reliability.

By 2022–23, wheat yields recovered and improved across most MRB districts, indicating renewed intensification and better management. High-performing districts included Dhamtari (~2.08 t/ha), Surguja (~2.10 t/ha), Janjgir–Champa (~2.02 t/ha), Mungeli (~2.02 t/ha), Raipur (~1.95 t/ha), Raigarh (~1.94 t/ha), and Kondagaon (~1.80 t/ha). Even traditionally moderate-yield districts such as Balod, Bemetara, Bilaspur, and Rajnandgaon showed substantial gains compared to earlier years. Overall, the trend suggests a gradual strengthening of wheat productivity in the MRB, supported by expanded rabi irrigation (tube-wells and pumpsets), improved varieties, and fertiliser use, though yields remain sensitive to groundwater availability and winter-season climatic conditions.

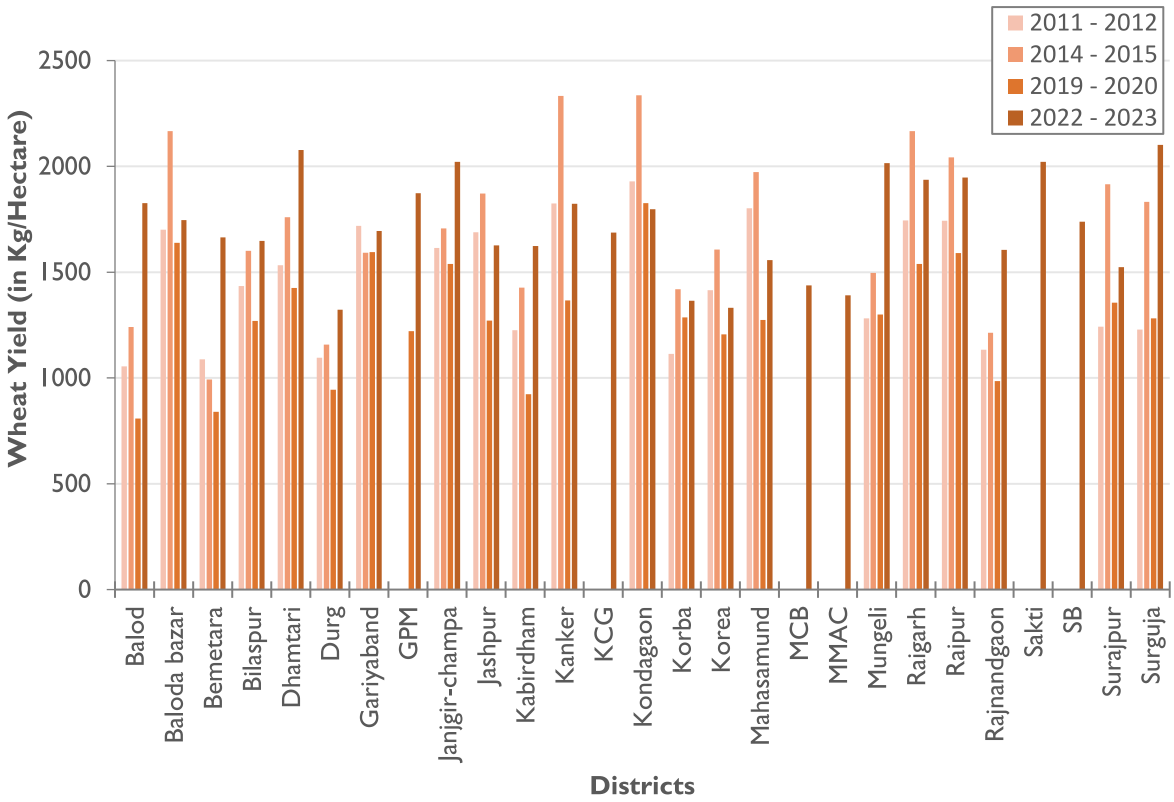


Figure 59: Yield (Kg/Ha) of Wheat in Chhattisgarh [MRB Part] from 2011–12 to 2022–23

[Source: Directorate of Economics & Statistics, Dept. of Agriculture & Farmers Welfare, Govt. of India]

8.3 Pulses

Odisha

The bar graph illustrates the yield rate of pulses (in kg/hectare) across various districts of Odisha over six agricultural years 2000–01, 2003–04, 2008–09, 2013–14, 2018–19, and 2023–24. The data reveal a steady and consistent rise in pulses yield across most districts, though the rate of improvement varies among districts (**Fig 60).**

In the early years (2000–01 and 2003–04), districts such as Puri, Boudh, Cuttack, and Khordha recorded relatively lower yields, typically between 200–400 kg/ha. Over time, districts including Bolangir, Bargarh, Sonepur, and Kalahandi, primarily located in western Odisha, showed remarkable growth, surpassing 660 kg/ha by 2023–24. Similarly, Deogarh, Nayagarh, Sambalpur, Ganjam, and Sundargarh also exhibited steady improvements, reflecting better adaptation of pulses crops and enhanced farming practices.

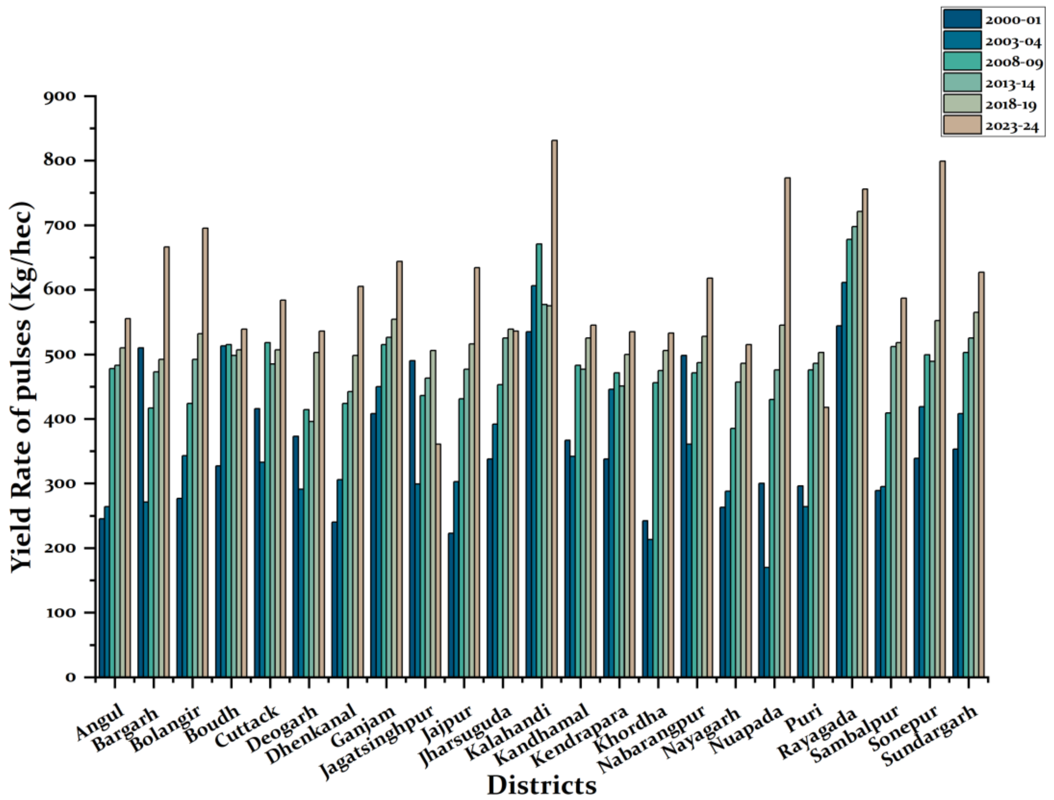


Figure 60: Yield rate of Pulses across districts in Odisha from 2000–01 to 2023–24.

[Source: Odisha Agricultural Statistics Report (2000-01;2003-04;2008-09;2013-14;2018-19; 2023-24)]

By 2018–19 and 2023–24, districts such as Bolangir, Bargarh, Ganjam, Nuapada, Sonepur, Rayagada, and Sonepur emerged as leading performers with yields approaching or exceeding 660 kg/ha, while even traditionally moderate-performing districts like Cuttack, Jharsuguda, Deogarh, Khordha, and Nayagarh displayed notable progress. Overall, the graph highlights Odisha's substantial advancement in pulse cultivation, with western and northern districts leading in productivity gains and the entire state showing consistent improvement in yield performance over the years.

Chhattisgarh

The yield performance of pulses in the Chhattisgarh part of the Mahanadi River Basin (MRB) from 2011–12 to 2022–23 shows considerable spatial and temporal variability, reflecting differences in rainfall sensitivity, soil conditions, and management practices. In 2011–12, most districts recorded moderate yields, generally ranging between 300–800 kg/ha, with relatively higher productivity in districts such as Bemetara, Kabirdham, Mungeli, and Dhamtari. A broad improvement was visible in 2014–15, when many districts—especially Bilaspur, Raipur, Baloda Bazar, Janjgir-Champa, and Dhamtari—crossed 900–1,000 kg/ha, indicating a favourable production year for pulses across the basin.

This upward trend, however, was not sustained. 2019–20 marked a sharp decline in yields across most districts, with several areas falling below 400 kg/ha, pointing to heightened vulnerability of pulses to climatic stress and moisture deficits. Districts such as Bemetara, Durg, Mahasamund, and Raipur experienced particularly low productivity during this period.

By 2022–23, a partial recovery is evident, with many districts regaining yields in the 600–900 kg/ha range. Notably, Mungeli, Kanker-Gaurela–Pendra–Marwahi (GPM region), Kabirdham, Dhamtari, and Rajnandgaon showed strong rebounds, and select districts exceeded 1,000 kg/ha, highlighting improved conditions or management interventions. Overall, the data underline the high inter-annual instability of pulse yields in the MRB, reinforcing the need for climate-resilient varieties, improved moisture management, and targeted district-specific interventions.

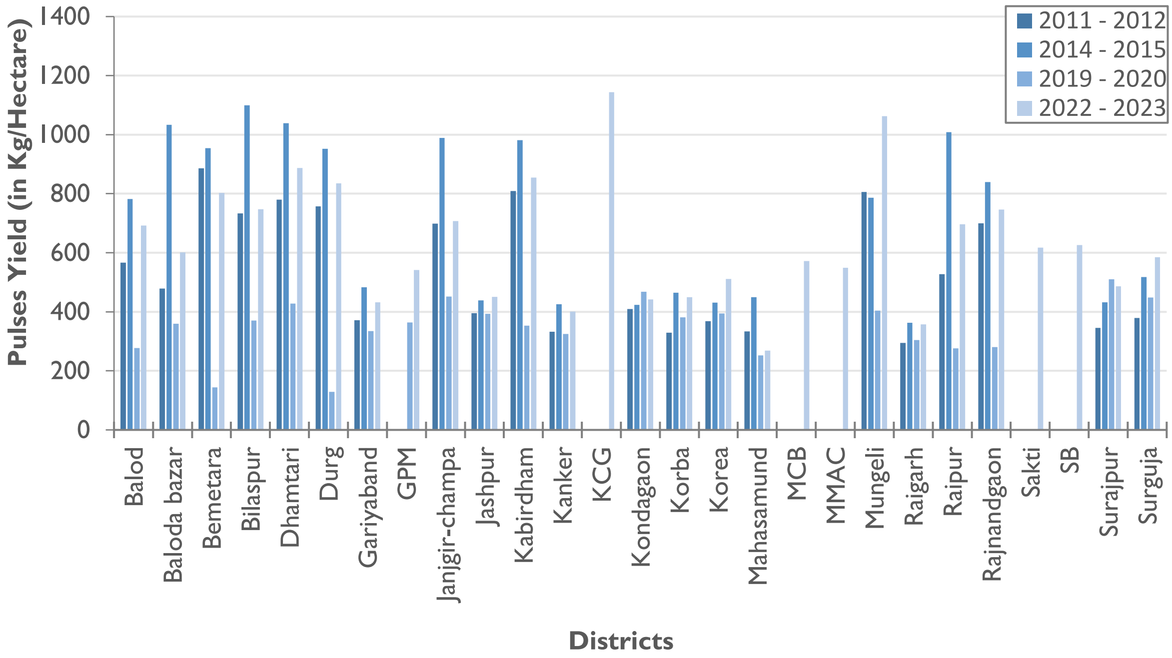


Figure 61: Yield (Kg/Ha) of Pulses in Chhattisgarh [MRB Part] from 2011–12 to 2022–23

[Source: Directorate of Economics & Statistics, Dept. of Agriculture & Farmers Welfare, Govt. of India]

8.4 Maize

Odisha

The maize yield rate across districts shows a consistent upward trend from 2000–01 to 2023–24, indicating significant overall improvement in yield. Districts such as Puri, Boudh, Angul, Cuttack, Khordha, Sonepur, Nuapada, Deogarh, and Bargarh exhibit steady progress while Bolangir, Nayagarh, Kalahandi, and Dhenkanal also show strong and sustained increment. Sambalpur, Bargarh, Nayagarh, Nuapada, Sundargarh, Jharsuguda, Kendrapara, Jagatsinghpur, and Nabarangpur demonstrate high performance, maintaining above-average yields in recent years. Rayagada, Ganjam, and Nabarangpur stand out for substantial growth, reflecting significant advancements in maize cultivation. Nabarangpur records the highest yield, showing a dramatic rise and emerging as the top performer. In 2000–01, nearly all districts were below or near the state's average maize yield, reflecting a low productivity phase across Odisha. By 2023–24, most districts achieved maize yields matching or surpassing the state average, reflecting strong overall growth. Bargarh and Kandhamal emerged as top performers, far exceeding state yields due to improved agronomic practices and favourable conditions. Boudh and Dhenkanal maintained yields near the state average, while Nuapada and Kalahandi showed rapid catch-up from low baselines. Overall, Odisha's maize productivity rose steadily, with district-level gains especially in Bargarh and Kandhamal driving much of the state's progress. It highlights consistent yield enhancement across all districts, driven by improved agricultural practices and productivity over the two-decade period **(Fig 62).**

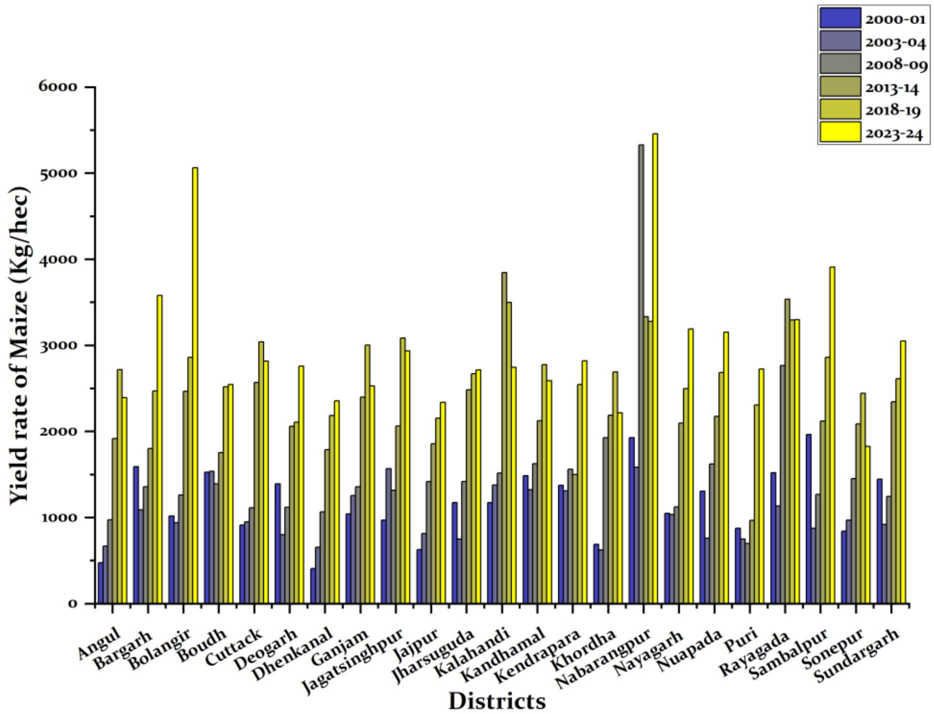


Figure 62: Yield rate of Maize across districts in Odisha from 2000–01 to 2023–24.

[Source: Odisha Agricultural Statistics Report (2000-01;2003-04;2008-09;2013-14;2018-19; 2023-24)]

Chhattisgarh

The yield rate of maize in the Chhattisgarh part of the Mahanadi River Basin (MRB) shows a clear and consistent upward trajectory from 2011–12 to 2022–23, reflecting expanding adoption of improved varieties, better crop management, and increasing suitability of maize as an alternative to paddy in several districts. In 2011–12, maize yields were largely moderate, mostly ranging between 1,100–1,600 kg/ha, with comparatively higher productivity in districts such as Dhamtari, Kanker, and Kondagaon. By 2014–15, yields improved across almost all districts, commonly reaching 1,700–2,000 kg/ha, indicating broad-based gains in productivity.

A substantial jump is observed in 2019–20, when many districts crossed the 2,500–3,000 kg/ha mark, particularly Bilaspur, Janjgir-Champa, Jashpur, Kanker, Kondagaon, Surajpur, and Raipur. The upward trend strengthened further in 2022–23, with several districts recording very high yields above 3,500 kg/ha, and Dhamtari emerging as a clear outlier with exceptionally high productivity (over 7,700 kg/ha). Districts such as Kanker, Kondagaon, Rajnandgaon, Raigarh, Raipur, and Janjgir-Champa also demonstrated strong performance during this period. Overall, the data indicate that maize has transitioned from a moderate-yield crop to a high-productivity option within the MRB, showing greater yield stability and growth compared to several other rainfed crops, and highlighting its increasing agronomic and economic importance in the basin.

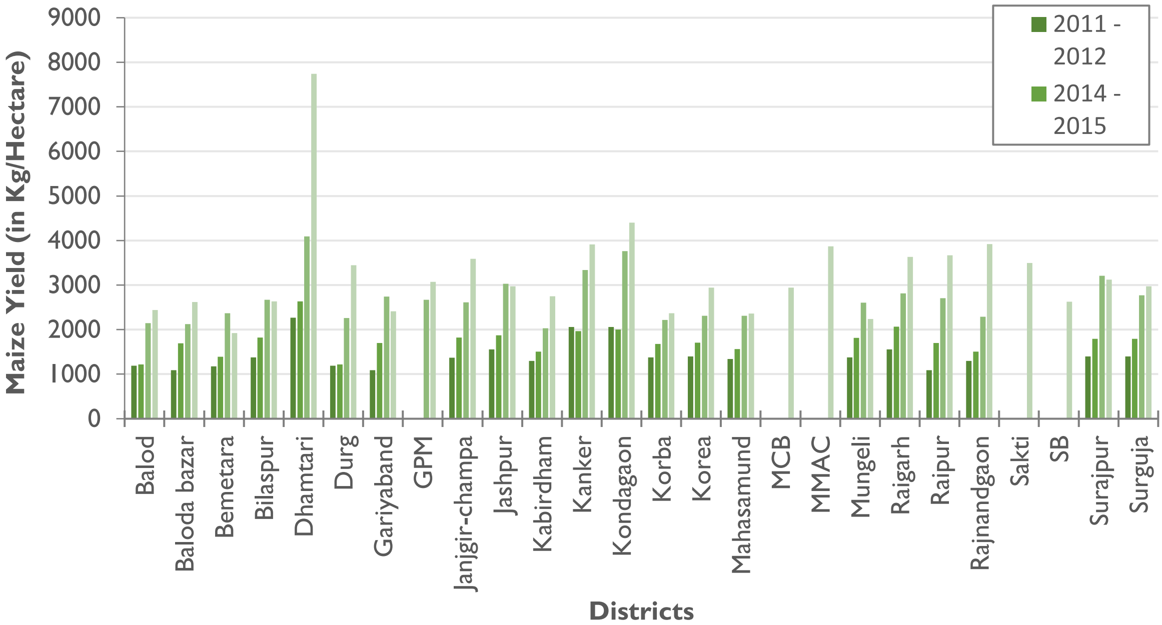


Figure 63: Yield (Kg/Ha) of Maize in Chhattisgarh [MRB Part] from 2011–12 to 2022–23

[Source: Directorate of Economics & Statistics, Dept. of Agriculture & Farmers Welfare, Govt. of India]

8.5 Oilseed

Odisha

The chart illustrates the yield rate of oilseeds (kg/ha) across Odisha's districts from 2000–01 to 2023–24, showing a strong upward trend in productivity across the state. Most districts recorded steady yield improvements, though the pace of progress varied. Puri and Bolangir achieved the highest yields in 2023–24, reflecting significant yield gains likely driven by improved crop management and technology adoption **(Fig 40).** Boudh, Cuttack, and Khordha maintained moderate yet consistent growth, while Nuapada, Deogarh, and Nayagarh showed notable improvement from lower baselines, indicating successful local interventions. Kandhamal, Dhenkanal, and Kalahandi exhibited gradual but steady progress, and Rayagada, Ganjam, and Nabarangpur reached near the upper-middle range by the latest period.

Comparatively, Bolangir, Jajpur, Jagatsingpur, Bargarh and Puri consistently outperformed the state average, emerging as key oilseed-producing districts due to high yield and effective adoption of modern practices. Boudh and Cuttack closely followed state trends, while Nuapada and Kandhamal made remarkable strides, steadily approaching the state average from earlier low yields. By 2023–24, most districts recorded yields equal to or higher than the state average, highlighting Odisha's overall success in enhancing oilseed productivity. High-performing regions like Bargarh, Puri, and Jajpur have become major contributors to the state's oilseed yield growth.

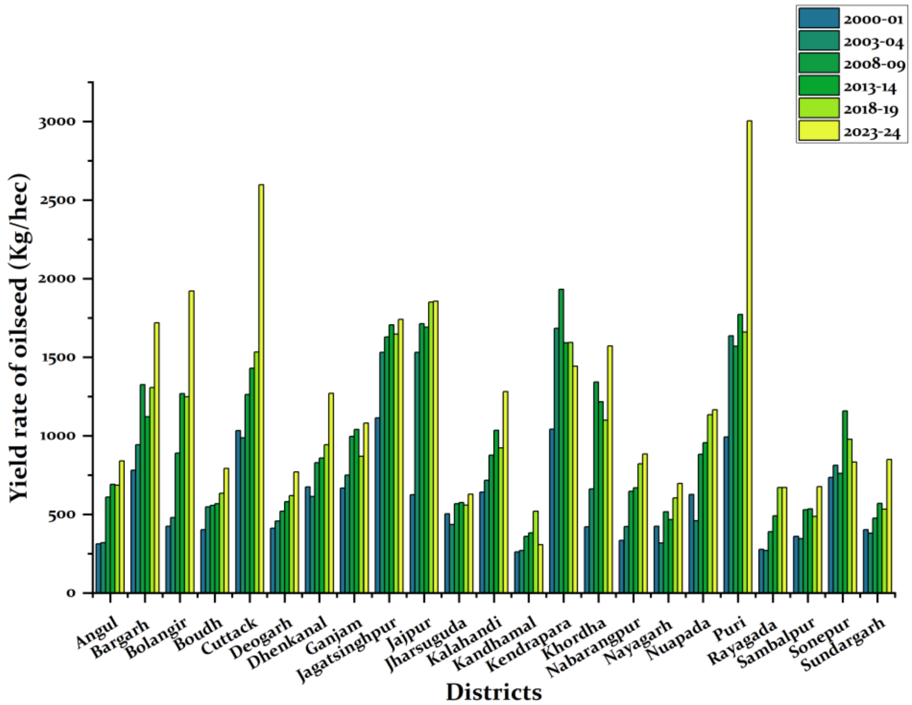


Figure 64: Yield rate of oilseed across districts in Odisha from 2000–01 to 2023–24.

[Source: Odisha Agricultural Statistics Report (2000-01;2003-04;2008-09;2013-14;2018-19; 2023-24)]

Chhattisgarh

The yield rate of oilseeds in the Chhattisgarh part of the Mahanadi River Basin (MRB) during 2011–12 to 2022–23 exhibits high spatial variability and notable inter-temporal fluctuations across districts. In 2011–12, oilseed yields were relatively high in several districts, commonly exceeding 2,500 kg/ha, with particularly strong performance in Gariyaband, Kabirdham, Mahasamund, Janjgir-Champa, Rajnandgaon, and Baloda Bazar. By 2014–15, yields remained robust in many areas, though signs of divergence emerged—districts such as Kanker, Mahasamund, Raigarh, and Raipur recorded substantial gains, while others like Dhamtari and Gariyaband experienced noticeable declines, indicating sensitivity of oilseeds to climatic variability and input conditions.

A pronounced dip in yields during 2019–20 is evident across several districts, particularly Janjgir-Champa, Dhamtari, Gariyaband, Jashpur, and Surajpur, reflecting stress conditions likely linked to rainfall variability or crop management constraints. However, 2022–23 marks a strong recovery phase, with several districts achieving very high productivity, notably Rajnandgaon, Raipur, Mahasamund, Durg, Mungeli, and Kanker, where yields exceeded 3,500 kg/ha. Overall, oilseed yields in the MRB show greater volatility than cereals such as maize, underscoring their dependence on timely rainfall, soil moisture, and management practices, while the strong rebound in recent years suggests improving agronomic conditions and growing emphasis on oilseed intensification in select districts.

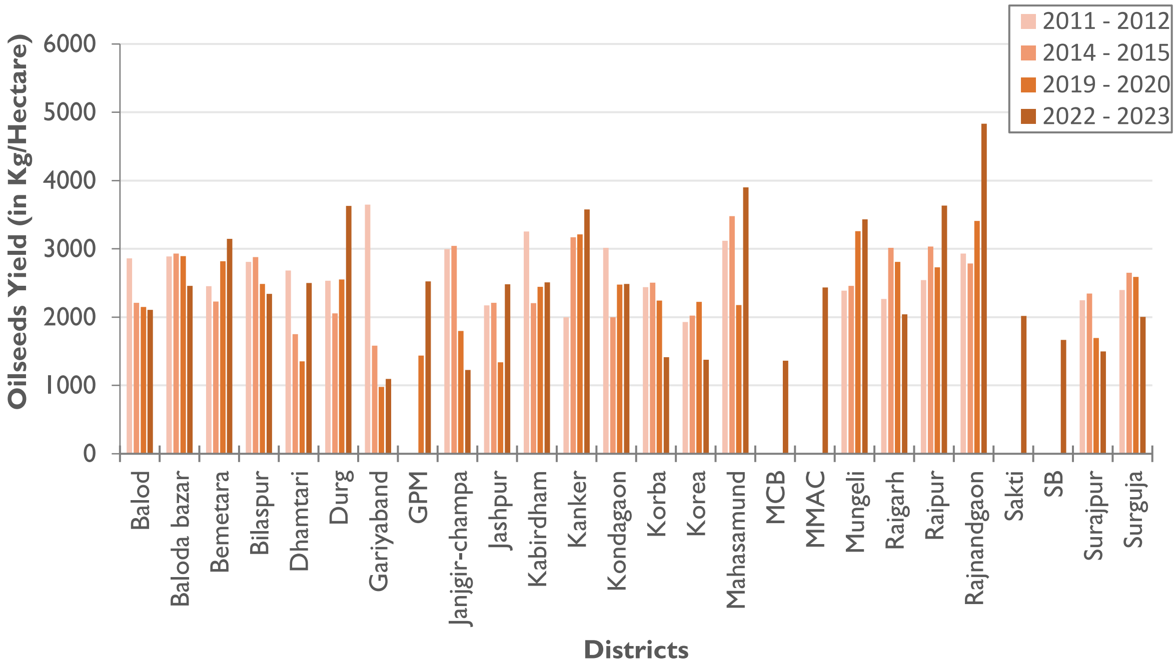


Figure 65: Yield (Kg/Ha) of Oilseeds in Chhattisgarh [MRB Part] from 2011–12 to 2022–23

[Source: Directorate of Economics & Statistics, Dept. of Agriculture & Farmers Welfare, Govt. of India]

8.6 Sugarcane

Odisha

The yield rate of sugarcane across various districts of Odisha exhibits noticeable spatial and temporal variations, as illustrated in **Fig 66.** The state records a sugarcane yield ranging between 60,000 and 80,000 kg/ha, with a gradual improvement over the years from 2000–01 to 2023–24. The recent data for 2023–24 indicate that Kalahandi district achieved the highest yield, nearly 117500 kg/ha, followed by Bargarh, Ganjam and Dhenkanal, each maintaining yield levels around 90,000–1,00,000 kg/ha. Districts such as Puri, Cuttack, Deogarh, Kendrapara, Bolangir, Jharsuguda and Dhenkanal also demonstrated consistent and stable yields throughout the study period. In contrast, comparatively lower productivity was observed in districts like Jagatsinghpur, Kandhamal, and Nuapada, where the yield generally remained below 65,000 kg/ha.

A noticeable upward trend is evident in most districts, especially during 2018–19 and 2023–24, reflecting improved agricultural practices, enhanced irrigation facilities, and adoption of better-quality planting materials. The steady rise in sugarcane yield across several districts indicates the state's potential for expanding sugarcane cultivation beyond the current half of the districts where it is concentrated. However, the observed inter-district disparities highlight the need for region-specific interventions to ensure uniform productivity gains across Odisha.

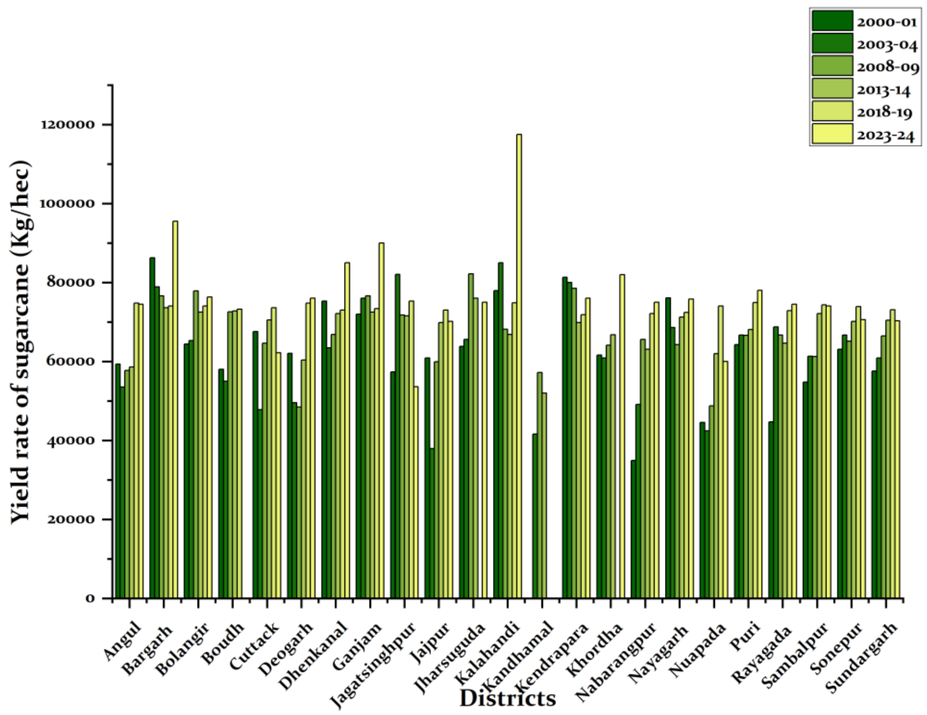


Figure 66: Yield rate of sugarcane across districts in Odisha from 2000–01 to 2023–24.

[Source: Odisha Agricultural Statistics Report (2000-01;2003-04;2008-09;2013-14;2018-19; 2023-24)]

Chhattisgarh

The yield pattern of sugarcane in the Chhattisgarh part of the Mahanadi River Basin (MRB) from 2011–12 to 2022–23 shows very high inter-district variability and a declining–fragmented cultivation footprint over time. In 2011–12, sugarcane yields were exceptionally high in several districts, reflecting localized intensive cultivation, with Bilaspur (≈26.7 t/ha), Dhamtari (≈20.5 t/ha), Mahasamund, Balod, Durg, and Kanker recording strong productivity. This period represents the peak of sugarcane performance in the MRB, likely supported by better irrigation access and active mill-linked cultivation in select pockets.

By 2014–15, yields declined sharply in many districts, although a few areas such as Mungeli, Kondagaon, Raipur, Bemetara, and Surajpur showed relatively high or improved yields, indicating spatial shifts in sugarcane viability. A pronounced contraction is evident in 2019–20, with several districts reporting very low or zero yields (e.g., Baloda Bazar, Korba, Raigarh, Korea, GPM), pointing to crop discontinuation or negligible area under sugarcane. The 2022–23 data suggest only a partial and uneven recovery, with moderate yields in districts like Kabirdham, Surguja, Balod, Mungeli, and Jashpur, while large parts of the MRB continue to record zero or marginal production. Overall, sugarcane in the MRB has transitioned from a high-yield but spatially concentrated crop to a highly localized and declining one, reflecting constraints related to water availability, market linkage, and competition from less water-intensive crops.

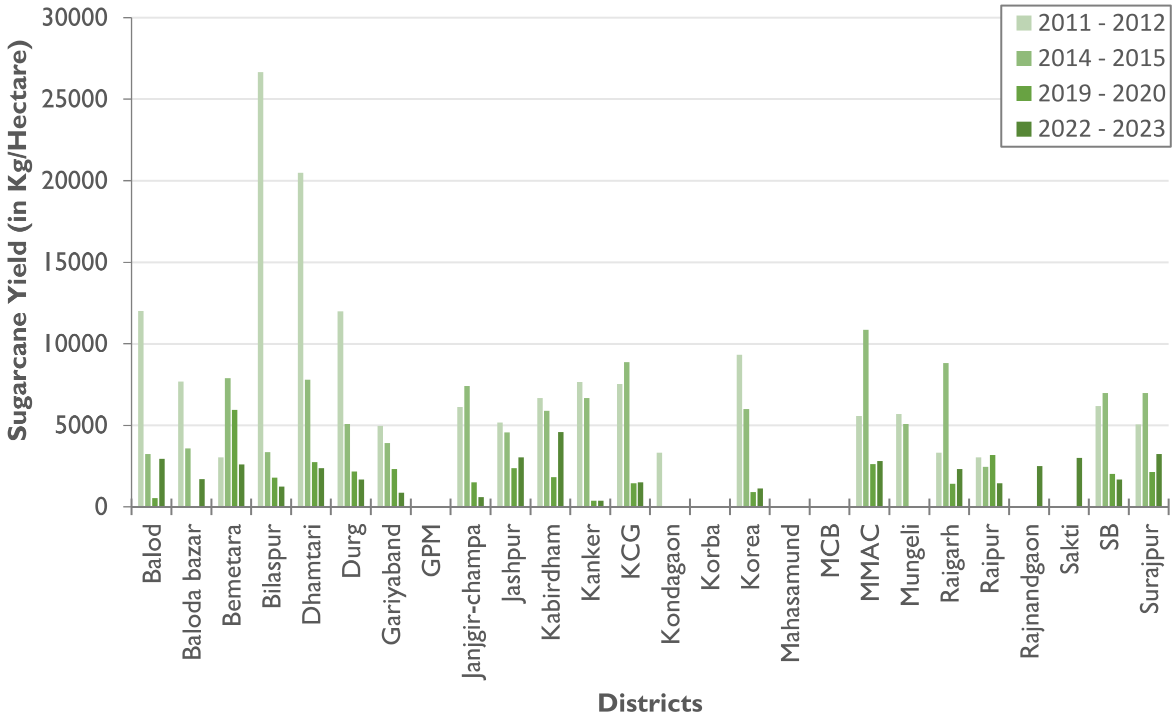


Figure 67: Yield (Kg/Ha) of Sugarcane in Chhattisgarh [MRB Part] from 2011–12 to 2022–23

[Source: Directorate of Economics & Statistics, Dept. of Agriculture & Farmers Welfare, Govt. of India]

8.7 Ragi

Odisha

Based on the graph, the yield rate of ragi (finger millet) shows a consistent improvement across most districts of Odisha from 2000–01 to 2023–24.

During 2023–24, several districts recorded notably higher yields compared to others. Nuapada and Rayagada registered the highest yield rates, exceeding 1,200 kg/ha, indicating strong productivity levels. Districts such as Kalahandi, Ganjam, Dhenkanal, Nabarangpur and Bolangir also reported yield rates above 1,000 kg/ha, performing better than the state average. Moderate yield levels, ranging between 700–900 kg/ha, were observed in Bargarh, Sundargarh, Nayagarh, Boudh, Deogarh, and Keonjhar, while relatively lower yields (below 700 kg/ha) were seen in coastal districts like Puri, Khordha, Cuttack, and Jagatsinghpur.

Overall, the data highlight a significant improvement in ragi yield across time, with western and southern districts emerging as major high-yield zones in the state **(Fig 68)**.

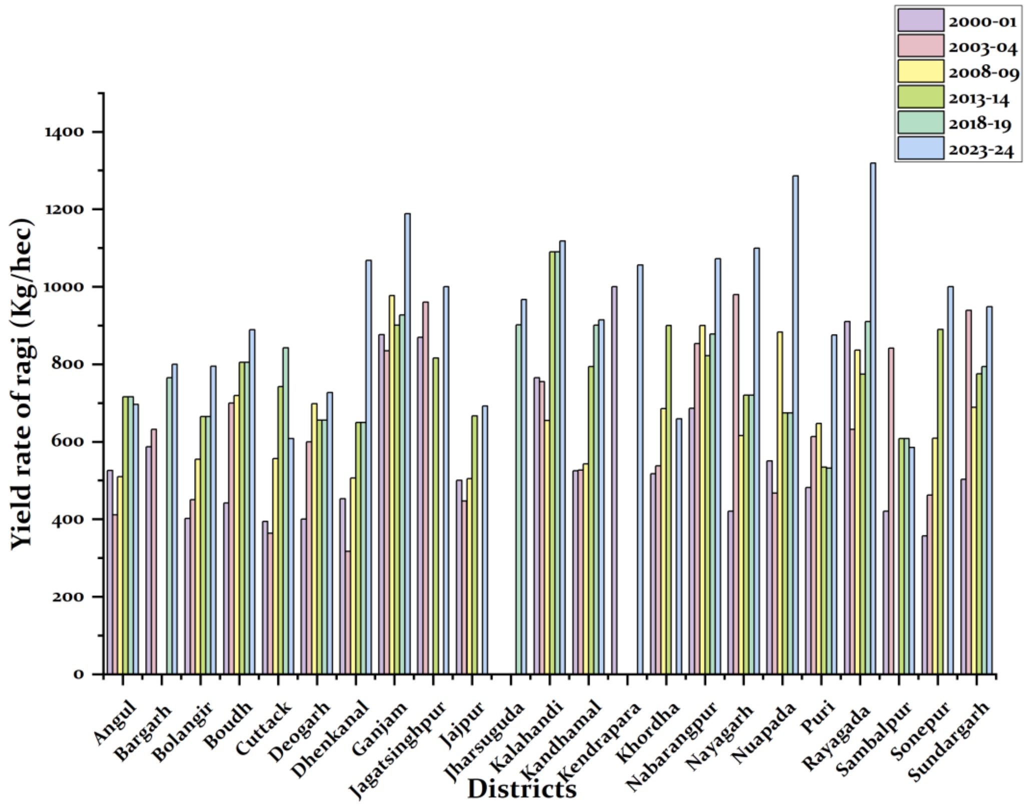


Figure 68: Yield rate of Ragi across districts in Odisha from 2000–01 to 2023–24.

[Source: Odisha Agricultural Statistics Report (2000-01;2003-04;2008-09;2013-14;2018-19; 2023-24)]

Chhattisgarh

The yield pattern of ragi (finger millet) in the Chhattisgarh part of the Mahanadi River Basin (MRB) from 2011–12 to 2022–23 reflects its status as a highly localized, marginal, and discontinuously cultivated crop. In 2011–12, ragi yields were recorded only in a few districts, notably Korea (≈330 kg/ha), Balod (≈250 kg/ha), Surguja (≈90 kg/ha) and small pockets of Dhamtari, Gariyaband, Rajnandgaon, and Kanker, while most districts reported zero production. By 2014–15, overall yields declined further, with measurable production remaining confined to select tribal and forest-fringe districts such as Surguja, Gariyaband, Rajnandgaon, and Dhamtari, underscoring the shrinking spatial footprint of ragi within the MRB.

The ragi cultivation in the MRB is largely confined to rainfed, tribal-dominated uplands where it serves subsistence and nutritional needs rather than commercial production.

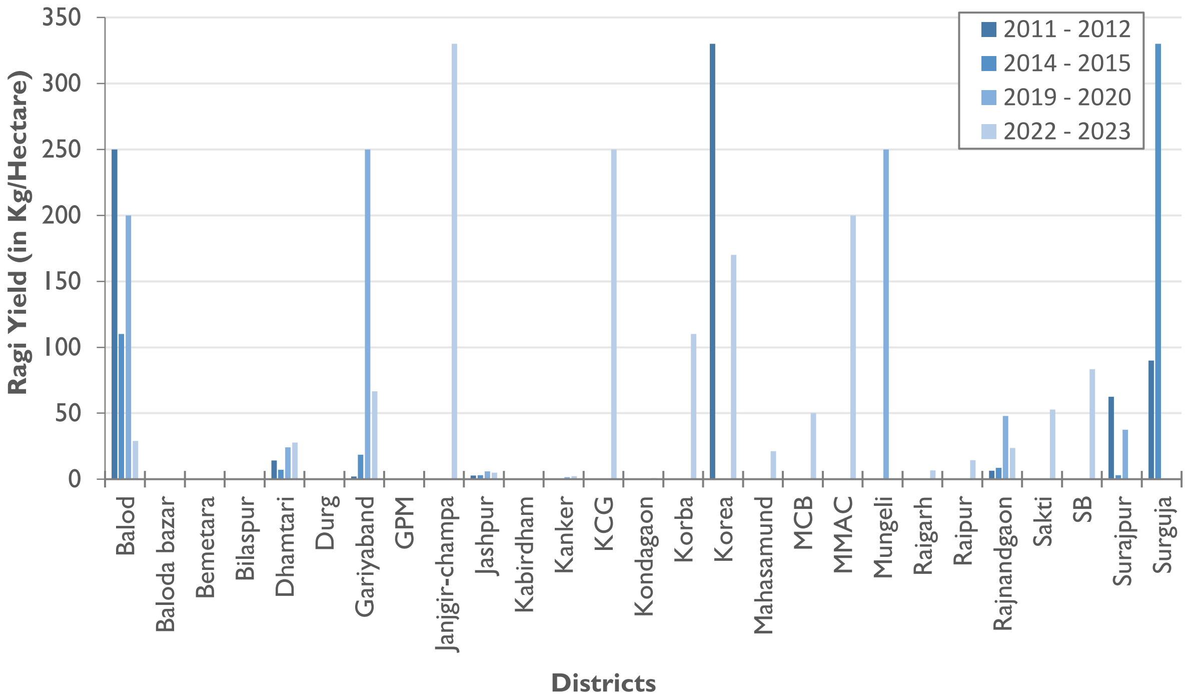


Figure 69: Yield (Kg/Ha) of Ragi in Chhattisgarh [MRB Part] from 2011–12 to 2022–23

[Source: Directorate of Economics & Statistics, Dept. of Agriculture & Farmers Welfare, Govt. of India]

8.8 Potato

Odisha

This bar chart illustrates the yield rate of potatoes (kg/hectare) across various districts over six different agricultural years: 2000–01, 2003–04, 2008–09, 2013–14, 2018–19, and 2023–24. Districts such as Khurda, Cuttack, Dhenkanal, and Jharsuguda have exhibited notably high yield rates throughout the years, particularly in 2023–24, where yields approached or exceeded 18,000 kg/ha. In contrast, districts like Boudh, Nayagarh, Kandhamal, and Nabarangpur show relatively lower yields, generally below 10,000 kg/ha, though still displaying improvement compared to earlier years.

The increase between 2000–01 and 2023–24 is consistent across almost all districts, suggesting significant advancements in agricultural practices, seed quality, and possibly irrigation or fertiliser use. Districts such as Sambalpur, Bolangir, and Sundargarh also demonstrate strong yield gains, indicating regional efforts to enhance potato cultivation efficiency.

Overall, the graph indicates that while disparities among districts persist, there has been a steady and widespread improvement in potato productivity, with the 2023–24 period consistently recording the highest yield rates across all districts **(Fig 70).**

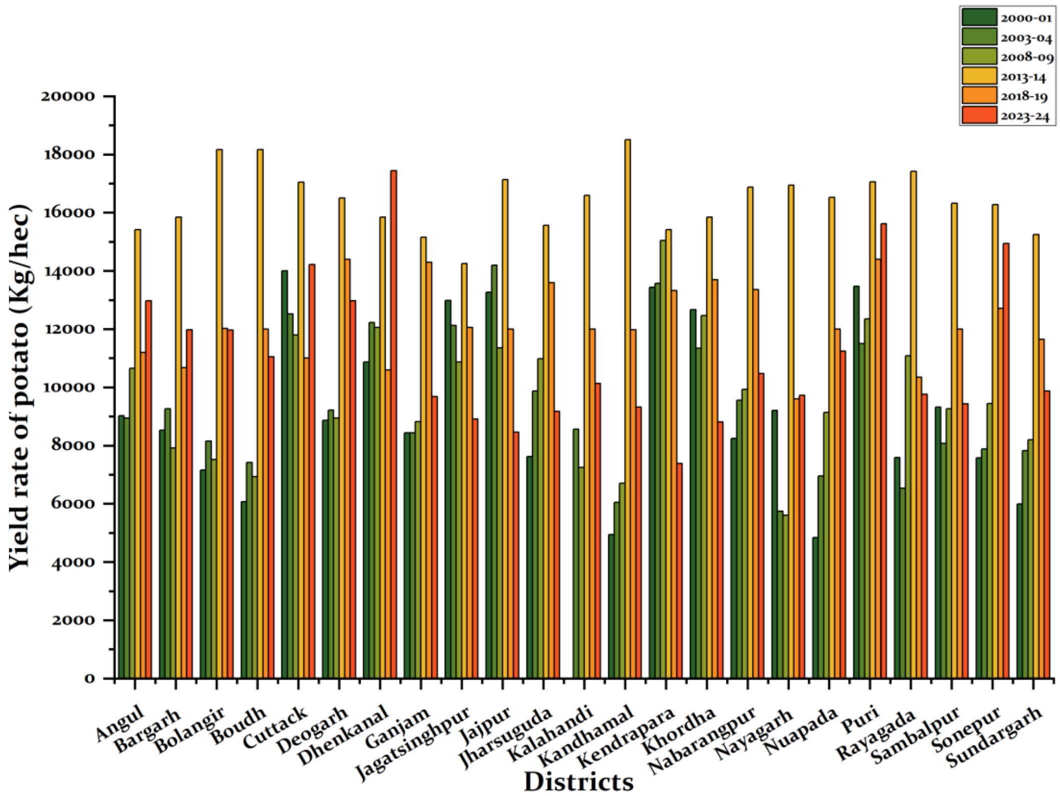


Figure 70: Yield rate of potato across districts in Odisha from 2000–01 to 2023–24.

[Source: Odisha Agricultural Statistics Report (2000-01;2003-04;2008-09;2013-14;2018-19; 2023-24)]

Chhattisgarh

The Mahanadi River Basin (MRB) part of Chhattisgarh exhibits high agro-climatic suitability for potato cultivation, particularly during the rabi season, owing to its loamy to clay-loam soils, residual soil moisture after kharif rice, and expanding access to irrigation from canals, tanks, and shallow groundwater. Districts such as Rajnandgaon, Raipur, Bemetara, Bilaspur, Mahasamund, and Mungeli consistently record relatively higher potato yields, indicating favourable conditions in terms of soil fertility, winter temperature regime, and market proximity. The gradual improvement in yields across several districts between 2011–12 and 2022–23 reflects better varietal adoption, improved agronomic practices, and increasing farmer interest in crop diversification away from rice monoculture, especially in irrigated command and peri-urban areas.

However, when compared with standard or ideal yield levels, potato productivity in the MRB remains well below its attainable potential. Under recommended management practices, the average potato yield in India ranges from 25–35 t/ha, while progressive farmers under optimal irrigation and input use often achieve 40 t/ha or more. In contrast, observed yields in the MRB typically range between 5–11 t/ha, even in the best-performing districts. This indicates that current yields represent only about 20–35 percent of standard potential, pointing to a substantial yield gap. The gap is primarily attributable to limited availability of quality seed tubers, inadequate nutrient and water management, disease incidence, and insufficient cold storage and post-harvest infrastructure. Overall, the MRB possesses strong natural suitability for potato cultivation, and bridging the existing yield gap through focused interventions could significantly enhance farm incomes and strengthen crop diversification in the basin.

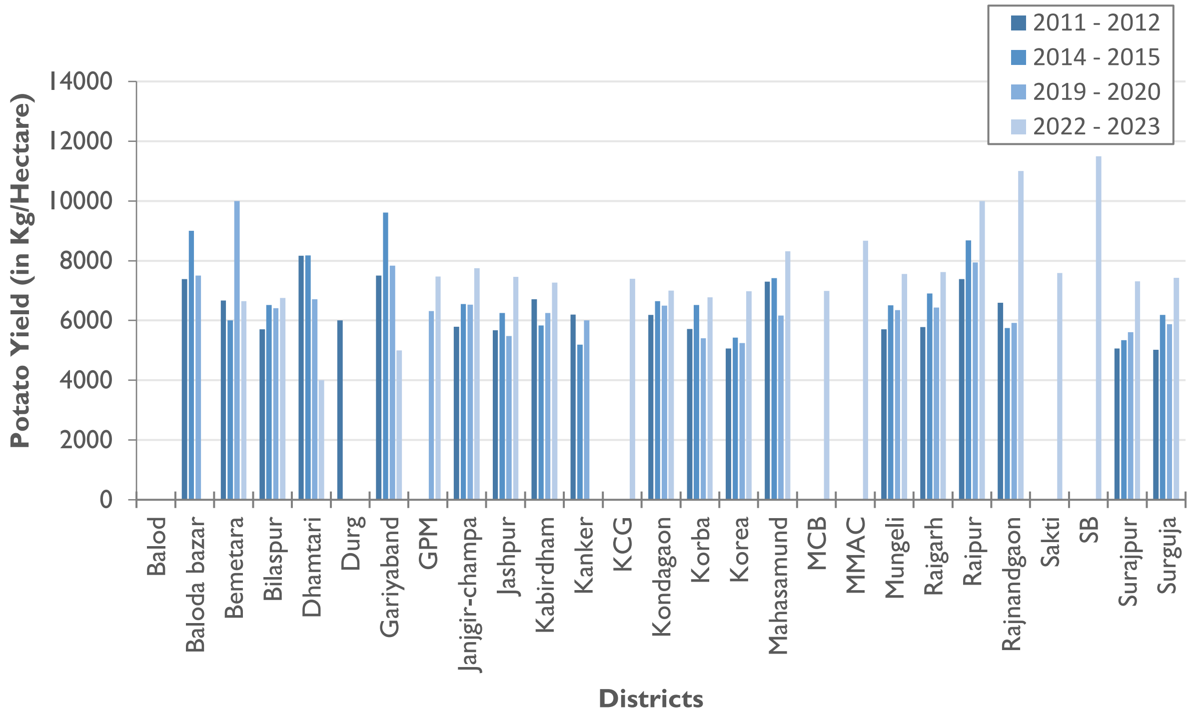


Figure 71: Yield (Kg/Ha) of Potato in Chhattisgarh [MRB Part] from 2011–12 to 2022–23

[Source: Directorate of Economics & Statistics, Dept. of Agriculture & Farmers Welfare, Govt. of India]

9. Government Schemes

9.1 Central Schemes

a. Pradhan Mantri Krishi Sinchayee Yojana (PMKSY)

The central government's PMKSY emphasizes "Har Khet Ko Pani" to expand irrigation coverage across India's river basins, including Mahanadi, through components like AIBP, watershed development, and micro-irrigation. In the Mahanadi Basin, it funds projects such as the Kharung Irrigation Project in Chhattisgarh's Bilaspur district (66,402 ha culturable command area with cement lining and CADWM works) and Lower Indra in Odisha (tributary project irrigating additional areas). Chhattisgarh has proposed 1,802 projects under PMKSY, while Odisha integrates it with schemes like Parvati Giri Mega Lift for 2.63 lakh ha; overall, it has created over 91,621 ha new ayacut and stabilized irrigation via 51,825 water harvesting structures nationwide, boosting basin efficiency amid floods and droughts.

b. Pradhan Mantri Fasal Bima Yojana (PMFBY)

PMFBY, a flagship central crop insurance scheme, provides subsidized premiums (2% for kharif food/oilseeds, 1.5% rabi, 5% horticulture) to cover yield losses from floods, droughts, pests, and post-harvest perils on an area basis using Crop Cutting Experiments. In the Mahanadi Basin's Hirakud-dependent delta areas spanning Odisha and Chhattisgarh, it protects paddy and pulses against inundation risks, with compulsory coverage for loanee farmers and voluntary for others via Aadhaar-linked banks. It stabilizes incomes for millions, sharing risks up to 350% of premiums between insurers and governments, and has enabled quick claims using satellite imagery and mobile tech for yield assessment.

c. National Food Security Mission (NFSM) & Paramparagat Krishi Vikas Yojana (PKVY)

NFSM, a central mission, offers subsidies for pulses, oilseeds, and rice intensification to enhance productivity, while PKVY promotes organic clusters via PGS certification and cluster adoption. In the Mahanadi Basin's irrigated command areas, NFSM supports rabi cropping of pulses/oilseeds on rainfed uplands in Chhattisgarh and Odisha deltas, distributing certified seeds and training for 20-30% yield gains. PKVY aids organic farming through Rs 50,000/ha incentives over three years, forming clusters (50 ha each) for chemical-free paddy/millets, reducing basin pollution and enabling premium markets.

d. Sub-Mission on Agricultural Mechanization (SMAM)

SMAM, under central Rashtriya Krishi Vikas Yojana, establishes Farm Machinery Banks and custom hiring centers with 40-80% subsidies for equipment like tractors and conoweeders, targeting small farmers. In Mahanadi Basin districts (Bilaspur, Raipur), it deploys 1,000+

machines via Krishi Yantra Sewa Kendras, reducing drudgery for paddy transplanting and boosting efficiency on 2 lakh ha amid labor shortages.

e. Krishak Bhagidari - Prakritik Kheti Paddhati (KK-PKP)

This central natural farming initiative provides Rs 12,500/ha incentives over three years for chemical-free practices using Jeevamrut and mulching. In the Mahanadi Basin, it covers 1.5 lakh ha in Chhattisgarh's Raipur and Odisha's Sambalpur, promoting resilient crops against floods and enhancing soil health in eroded catchments for 5 lakh farmers.

f. National Mission on Natural Farming

Launched centrally in 2025, it scales zero-budget natural farming with bio-inputs and farmer training, allocating Rs 2,500 crore nationwide. For Mahanadi Basin farmlands, it supports 10,000 clusters in flood-prone Odisha-Chhattisgarh areas, integrating with PKVY for organic transitions and cutting input costs by 50% for pulses/paddy growers.

g. Kisan Credit Card (KCC) Scheme

The central KCC offers short-term loans up to Rs 3 lakh at 4% interest subvention for crop production, renewable annually. In the basin, it finances 20 lakh farmers for kharif paddy and rabi pulses, linked to PMFBY for insurance, ensuring liquidity in rainfed Seonath-Hasdeo zones.

h. Restructured Weather Based Crop Insurance Scheme (RWBCIS)

RWBCIS, a PMFBY variant, uses weather indices (rainfall, humidity) for payouts, with premiums matching PMFBY rates. Tailored for Mahanadi's variable monsoons, it covers drought-prone uplands in Chhattisgarh, indemnifying via IMD stations for 5 lakh ha without yield data delays.

9.2. State Government Schemes

9.2.1. Chhattisgarh Government

Ahead are the schemes based on implementation and impacts within Chhattisgarh, particularly in basin districts like Raipur, Durg, Korba, Bilaspur, and Raigarh, where rainfed farming, flood risks, and irrigation gaps dominate. Each scheme features details on objectives, basin-specific benefits, farmer reach, and integration with local hydrology and crops like paddy, pulses, and oilseeds.

a. Atal Sinchayi Yojana (2025-26)

Launched with Rs 700 crore, this scheme accelerates irrigation infrastructure in Chhattisgarh's

Mahanadi Basin by fast-tracking projects like the Tandula and Kharkhara reservoirs, which irrigate over 1 lakh hectares in Durg and Raipur districts. It allocates Rs 50 crore to solarize 10,000 agricultural pumps, slashing diesel costs by 70% for smallholders in flood-vulnerable Seonath and Hasdeo sub-basins. By promoting efficient water use amid erratic monsoons, it boosts paddy yields by 20-25% and enables rabi cropping of pulses on 50,000 ha, directly benefiting 2 lakh farmers while aligning with basin master plans for conjunctive groundwater-surface water management.

b. Deendayal Upadhyay Bhoomiheen Krishi Majdoor Kalyan Yojana

This Rs 600 crore initiative provides pensions and poultry kits to 3 lakh landless agricultural laborers across Chhattisgarh's Mahanadi Basin, focusing on upland blocks in Bilaspur and Janjgir-Champa where poverty rates exceed 40%. It integrates basin fisheries development in 5,000 ponds along tributaries like Ib and Mand, stocking them with carp species to generate Rs 5,000-10,000 annual income per family. By linking livelihoods to pond-based aquaculture, the scheme enhances food security and reduces migration from rainfed areas, supporting 1.5 lakh households with training in sustainable fish farming tailored to basin water levels.

c. Fasal Pradarshan

Chhattisgarh's Fasal Pradarshan conducts over 5,000 field demonstrations yearly in Mahanadi Basin districts, promoting System of Rice Intensification (SRI) for paddy with 30% higher yields on 1 lakh ha in Raipur and Mahasamund. It also demonstrates hybrid rice varieties and rabi crops like pigeon pea, gram, and oilseeds on 1.5 lakh ha, replacing low-return summer paddy in water-scarce Hasdeo catchments. Farmers receive on-site training and quality seeds, leading to 15-20% income gains for 2 lakh participants and improved soil health through reduced chemical inputs in flood-prone lowlands.

d. Hasdeo Bango Project Integration

Integrating with PMKSY, this scheme supports the 63,000 ha command area of the Hasdeo Bango Project in Korba district by funding canal lining, farm ponds, and Command Area Development & Water Management (CADWM) works. It enables reliable rabi irrigation for wheat, pulses, and vegetables across 30,000 ha of basin farmlands previously limited to one kharif crop. With Rs 200 crore invested, it benefits 50,000 farmers by cutting water losses by 40% and stabilizing yields amid variable Hasdeo River flows, fostering crop diversification in Korba's coal-adjacent agricultural zones.

e. Jaivik Kheti Mission

The Jaivik Kheti Mission promotes organic farming in Chhattisgarh's Mahanadi Basin through

10 clusters covering 50,000 ha in Raipur, Bilaspur, and Kabirdham, offering Rs 20,000/ha subsidies for vermicompost, FYM, and bio-inputs tied to Hasdeo Bango irrigation. It targets rainfed uplands for certified exports of organic paddy and millets from Raipur blocks, training 1 lakh farmers in pest management suited to basin humidity. This reduces chemical runoff into the Mahanadi, enhances soil fertility in eroded catchments, and boosts premiums by 25% for 25,000 smallholders shifting from conventional methods.

f. Godhan Nyay Yojana (Allied with Krishak Samagra Vikas)

Under this scheme, Chhattisgarh purchases cow dung at Rs 2/kg from 1.5 lakh farmers in Mahanadi Basin blocks like Raigarh and Surguja, processing it into organic manure distributed across 50,000 ha of organic fields. It supports 10,000 gaushalas for dung collection, producing 5 lakh tonnes of manure annually to enrich paddy and pulse soils depleted by flooding. Integrated with livestock hubs, it generates Rs 1,000 crore in farmer payouts, promotes zero-waste farming, and improves basin water quality by curbing synthetic fertilizer use.

g. Krishak Samagra Vikas Yojana

This comprehensive program distributes 2 lakh soil health cards annually to Mahanadi Basin farmers in Durg, Raipur, and Bilaspur, alongside 50% subsidized seeds for pulses/oilseeds and machinery like 5,000 conoweeders and rotavators. It trains 1 lakh farmers via 50 extension hubs on SRI techniques and integrated nutrient management for basin-specific crops. By customizing inputs to local soil types affected by river sediments, it lifts productivity by 18% on 2 lakh ha, empowering women-led groups and reducing post-harvest losses through community storage.

h. Krishak Unnati Yojana (2025-26)

With a Rs 10,000 crore outlay, this scheme ensures 100% MSP procurement of pulses and oilseeds via Price Support Scheme (PSS) for rainfed catchments in Chhattisgarh's Mahanadi Basin, including Seonath and Hasdeo tributaries. It stabilizes incomes for 5 lakh farmers in Janjgir-Champa and Raigarh by guaranteeing minimum prices amid price volatility, with procurement centers handling 10 lakh tonnes yearly. Mobile apps facilitate registrations, boosting cultivation of high-value arhar and soybean on 3 lakh ha and cutting distress sales by 60%.

i. Laghuttam Sinchayi Yojana

This initiative constructs minor irrigation structures like anicuts, check dams, and lift irrigation points to add 3 lakh ha under irrigation in Chhattisgarh's Mahanadi Basin, integrating with the 25-year master plan for conjunctive use on rainfed tributaries such as

Seonath and Hasdeo. Targeting 1,000 sites in Bilaspur and Korba, it harvests runoff from monsoons for rabi crops, benefiting 2.5 lakh marginal farmers with community-managed systems. It enhances groundwater recharge by 30%, enabling year-round vegetable cultivation and reducing flood dependency in upland areas.

j. Mukhyamantri Kisan Durghatna Kalyan Yojana

Providing Rs 5 lakh accident insurance to 40 lakh farmers, this scheme is vital for Chhattisgarh's flood-prone Mahanadi Basin districts like Raipur and Dhamtari, where annual inundations from Hasdeo and Seonath rivers cause 500+ farm injuries. Premiums are state-funded via Aadhaar-linked DBT, covering machinery mishaps, snakebites, and drownings during kharif sowing. It disbursed Rs 1,200 crore in claims last year, offering financial security to 15 lakh basin households and encouraging riskier high-yield practices like SRI paddy.

k. Narwa Garwa Ghurwa Gharwa

Chhattisgarh's Rs 7,400 crore holistic program develops 10,000 garwa (farm ponds) in the Mahanadi Basin for livestock watering, fisheries, and irrigation in Raigarh, Surguja, and Koriya districts. 'Narwa' renovates 5,000 km of streams along tributaries for recharge, while 'Ghurwa' and 'Gharwa' promote biogas and backyard poultry. It integrates 2 lakh ha of farmlands, generating Rs 2,000 crore in allied income through carp culture and fodder, transforming rainfed landscapes into resilient agro-ecosystems.

l. Rajiv Gandhi Kisan Nyay Yojana

Boasting a Rs 13,000 crore outlay, this DBT scheme delivers direct subsidies of Rs 500-3,000 per unit for urea, DAP, and seeds to 25 lakh Aadhaar-linked farmers in Chhattisgarh's Mahanadi Basin, cross-verified with soil health cards. Prioritizing smallholders in flood-affected Bilaspur and Raipur, it cuts input costs by 40% for paddy and pulses on 5 lakh ha. Last year, it transferred Rs 8,000 crore, enabling 20% more fertilizer use without debt traps and promoting balanced nutrition for basin soils.

m. Shakambhari Yojana

Targeted at marginal farmers, Shakambhari provides 50,000 drip and micro-irrigation kits with 75% subsidy for vegetable cultivation (tomato, brinjal, okra) on 1 lakh ha of Mahanadi Basin uplands in Kabirdham and Baloda Bazar. It includes training in fertigation suited to shallow aquifers, yielding Rs 1-1.5 lakh/ha income and nutritional security for 1 lakh families. By conserving 50% water in rainfed zones, it diversifies from mono-cropping, reduces basin erosion, and links produce to Raipur markets via farmer producer organizations.

9.2.2. Odisha Government

a. Samruddha Krushak Yojana

Samruddha Krushak Yojana is an Odisha government initiative launched in 2024 to increase farmers' incomes by offering a high paddy procurement rate of Rs 3,100 per quintal. The various objectives of this scheme include enhancing sustainable foodgrain production in the state, promoting new technologies for crop cultivation, encouraging climate-resilient agricultural practices using stress-tolerant varieties, increasing crop yields and productivity, assisting farmers in investing in fertilisers, pesticides, farm machinery, and other inputs and increasing the income of farmers, thereby improving the socio-economic status of the family.

b. CM Kisan Scheme

In Odisha, agriculture is the primary source of livelihood for the majority of the population. Among them, most belong to marginal and small farmers who face difficulties in carrying out cultivation work. Also, there is a large group of landless agricultural labourers who depend on wages, engaging in agriculture as their main occupation. To alleviate the hardships faced by the farmer community of the state, the Odisha government has implemented a farmer welfare scheme called the CM Kisan Scheme, funded from the state plan. The main objective of the scheme is to promote agricultural prosperity and reduce poverty in the state. The scheme is progressive and inclusive, covering 92% of cultivators, both loanee and non-loanee farmers, as well as landless agricultural households in the state. This scheme provides funding to the small & marginal farmers of Rs. 2000/- per crop season, totalling to Rs. 4000/- per annum for the purchase of different agriculture inputs like seeds, fertiliser, pesticides as well as to meet the expenditure towards labour charges and other investments in the field operations based on the farmers choice.

c. Krushi Bidhi Nidhi Yojana

Krushi Bidya Nidhi Yojana provides financial assistance to the children of beneficiaries under CM KISAN for pursuing Professional/Technical courses. It will lead to better access to higher education for children of small & marginal farmers and landless agricultural households. Krushi Bidya Nidhi Yojana will help improve the socio-economic status of their families.

d. Shree Anna Abhiyan

Shree Anna Abhiyan is a flagship scheme launched by the Department of Agriculture and farmers empowerment in 2017 as a special programme for the promotion of millets in the tribal areas of Odisha. The objective of this scheme is to revive cultivation, consumption and the value chain in millets across Odisha.

e. Biju Krushak Kalyan Yojana

Biju Krushak Kalyan Yojana is a health insurance scheme for farmers in Odisha. This scheme aims to protect households from the financial burden of hospitalisation. Beneficiaries are entitled to coverage of up to Rs. 1,00,000/- for most diseases that require hospitalisation.

f. Development of Potato, Vegetable & Spices Scheme

A new state sector scheme was launched by the government of Odisha to make the state self-sufficient in the production of five vegetables and reduce its dependence on other states for the vegetables, potatoes, onions and seed spices. The scheme will provide financial assistance to farmers for the cultivation of Onions, potatoes, hybrid vegetables and spices, creating job opportunities in rural areas and increasing farmers' income.

g. Animal Husbandry / Livestock Development Schemes

The Fisheries & Animal Resources Development Department of Odisha oversees several state plan initiatives, such as improved animal health services, assistance for layer farming, semi-commercial duck farming, poultry feed mills, etc. These schemes aim to enhance rural livelihoods, improve livestock productivity, and ensure food security.

10. Conclusion and Recommendation

10.1 Conclusion

The Agricultural Profile of the Mahanadi River Basin (MRB) clearly demonstrates that agriculture remains the most dominant land and water-using sector, with strong spatial heterogeneity across the basin that directly influences river condition indicators under CAMP

I. Spatial Concentration of Agricultural Pressure in Central and Lower Basin

The analysis shows that central and lower basin districts form the core agricultural pressure zone of the MRB:

- In Odisha, districts such as Bargarh (≈398.5 thousand ha), Kalahandi (≈330.05 thousand ha), Ganjam (≈298.39 thousand ha), Cuttack (≈215.07 thousand ha) and Sonepur (≈145.72 thousand ha) record the highest gross irrigated areas, indicating intensive surface- and groundwater abstraction from the Mahanadi and its tributaries

- In Chhattisgarh, the central plains districts—Bemetara, Janjgir-Champa, Raipur, Dhamtari, Mahasamund and Kabirdham—consistently show high net sown area (50–79%) and large irrigated extents exceeding 1.0–2.0 lakh ha, identifying them as key zones of hydrological stress within the basin.

II. Decline and Conversion of Agricultural Land in Urban–Industrial Corridors

The report identifies coastal and urban-industrial belts as zones of agricultural land conversion:

- Odisha coastal districts—Puri, Cuttack, Khordha, Kendrapara and Jagatsinghpur—show persistent increase in non-agricultural land, with Puri rising from ~11.7% (2000–01) to over 31% (2023–24) and Jajpur reaching ~24.4% non-agricultural area

- Correspondingly, these districts record sharp declines in net sown area, e.g., Puri (~22% decline) and Angul (~20.5% decline) over the assessment period

III. Expansion of Lift and Groundwater Irrigation in Upper and Tribal Districts

The Agricultural Profile highlights a shift from canal-based irrigation to lift and groundwater systems, especially in upland districts:

- Rayagada (≈28.37%), Nabarangpur (≈26.47%), Jajpur (≈31.47%) and Kendrapara (≈29.01%) exhibit high dependence on minor lift irrigation by 2023–24.

- In Chhattisgarh, increasing numbers of tube wells and pump sets are observed in districts such as Balod, Rajnandgaon, Mahasamund and Dhamtari, reflecting rising reliance on groundwater for agriculture.

IV. Chemical Input Hotspots and Water Quality Risk Zones
The report identifies fertiliser and pesticide consumption hotspots aligned with intensively cultivated districts:

- High fertiliser consumption is concentrated in agriculturally dominant districts of western Odisha (Bargarh, Sonepur, Bolangir) and central Chhattisgarh plains, where rice-based systems dominate

- These districts overlap with areas of high cropping intensity (>150%), increasing the likelihood of nutrient runoff and leaching into surface and groundwater systems.

V. Forested Upper Catchments as Hydrological Buffers
The Agricultural Profile also identifies upper basin districts with high forest cover acting as critical hydrological buffers:

- In Chhattisgarh, districts such as Korea, Korba, Kondagaon and Gariyaband maintain forest cover exceeding 60% with low net sown area (<30%)

- In Odisha, districts like Kandhamal, Sundargarh and Deogarh consistently retain >50% forest cover, limiting agricultural expansion.

In **summary**, the Agricultural Profile reveals that agricultural pressures in the Mahanadi River Basin are spatially concentrated, with:

- Central and lower basin plains acting as zones of maximum irrigation abstraction and agrochemical loading,
- Urban–industrial corridors driving land conversion and hydrological disruption, and
- Upper forested catchments providing essential ecological buffering.

These spatial patterns provide a clear basis for zoning-based management, enabling differentiated strategies for intensive agricultural belts, transitional zones, and conservation-oriented upper catchments. Incorporating these findings allows agricultural management to directly support river flow sustainability, water quality improvement, and long-term basin resilience.

10.2 Recommendations

I. Regulate Irrigation Intensity in High-Abstraction Districts

A. Evidence from the Report

- Highest gross irrigated areas in Odisha are observed in Bargarh (~398.5 thousand ha), Kalahandi (~330.05 thousand ha), Ganjam (~298.39 thousand ha), and Cuttack (~215.07 thousand ha) (Fig. 12)
- Chhattisgarh central plains districts such as Bemetara, Janjgir-Champa, Raipur, Dhamtari, and Mahasamund sustain 50–79% net sown area with irrigated areas exceeding 1–2 lakh ha (Fig. 13)

B. Recommendation

- Introduce irrigation intensity zoning to cap expansion in these districts.
- Integrate environmental flow (e-flow) thresholds into seasonal irrigation scheduling, especially during Rabi.
- Prioritise canal modernisation and conjunctive use planning instead of further expansion.

C. Concerned Agencies

- State Water Resources / Irrigation Departments (Odisha & Chhattisgarh)
- Central Water Commission (CWC)
- NRCD / cMahanadi (CAMP coordination)

II. Promote Crop Diversification in Rice-Dominated Hotspots

A. Evidence from the Report

- Rice dominates irrigated area across Bargarh, Sonepur, Sambalpur, Raipur, Janjgir-Champa, and Mahasamund, with consistently high irrigated rice acreage (Figs. 28–29)
- Several districts show cropping intensity exceeding 150%, achieved largely through water-intensive cereals (Figs. 61–62)

B. Recommendation

- Gradually shift suitable blocks toward pulses, oilseeds, maize, millets (ragi) using agro-ecological zoning already defined in the report.
- Incentivise System of Rice Intensification (SRI) and direct-seeded rice where rice remains essential.
- Link diversification targets with NFSM and state crop diversification schemes.

C. Concerned Agencies

- Department of Agriculture (State)
- ICAR & State Agricultural Universities
- Ministry of Agriculture & Farmers Welfare (MoAFW)

III. Control Groundwater and Lift Irrigation Expansion

A. Evidence from the Report

- Minor lift irrigation dependence exceeds 25–30% in Rayagada (28.37%), Nabarangpur (26.47%), Jajpur (31.47%), and Kendrapara (29.01%) (Fig. 15)
- Rapid increase in borewells, tube wells, and pumpsets observed across Odisha and Chhattisgarh districts (Figs. 49–59)

B. Recommendation

- Prepare block-level groundwater use plans aligned with CGWB Stage of Development (SOD).
- Regulate new lift irrigation points in upper and middle basin tributaries to protect baseflows.
- Promote solar pump schemes with abstraction limits and smart metering.

C. Concerned Agencies

- Central Ground Water Board (CGWB)
- State Groundwater & Minor Irrigation Departments
- Ministry of Jal Shakti (MoJS)

IV. Reduce Non-Point Source Pollution from Fertilisers and Pesticides

A. Evidence from the Report

- High fertiliser consumption is concentrated in western Odisha (Bargarh, Sonepur, Bolangir) and central Chhattisgarh plains (Figs. 45–46)
- Pesticide consumption shows a rising trend in Odisha from 2008–09 to 2023–24 (Fig. 42)

B. Recommendation

- Declare nutrient-sensitive sub-catchments (upstream of reservoirs like Hirakud).
- Enforce soil-test-based fertiliser application and promote Integrated Nutrient Management (INM).
- Scale up Integrated Pest Management (IPM) and bio-inputs in high-intensity districts.

C. Concerned Agencies

- Department of Agriculture
- State Pollution Control Boards (SPCBs)
- NRCD

V.Protect Upper Catchment Forests and Mixed-Use Districts

A. Evidence from the Report

- High forest cover (>60%) persists in Korea, Korba, Kondagaon, Gariyaband (CG) and Kandhamal, Sundargarh, Deogarh (OD) with low net sown area (<30%) (Figs. 6–7)
- These districts act as sediment control and flow regulation zones for the basin.

B. Recommendation

- Classify these districts as “Agriculture-Restricted Conservation Zones”.
- Promote agroforestry, horticulture, and NTFP-based livelihoods instead of irrigation expansion.
- Integrate forest–agriculture convergence projects for soil and moisture conservation.

C. Concerned Agencies

- Forest Departments (State)
- Department of Rural Development / Watershed Missions
- NRCD / cMahanadi

VI. Address Land Conversion in Coastal and Urban Corridors

A. Evidence from the Report

- Non-agricultural land exceeds 30% in Puri, and rises sharply in Cuttack, Khordha, Jajpur, and Jharsuguda (Figs. 10–11)
- These districts also show declining net sown area, reflecting rapid urban-industrial expansion.

B. Recommendation

- Integrate land-use controls and green buffers along river corridors and floodplains.
- Restore peri-urban agriculture and wetlands as hydrological buffers.
- Align district land-use plans with river floodplain zoning.

C. Concerned Agencies

- Urban Development & Town Planning Departments
- State Revenue Departments
- NRCD / State Planning Departments

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