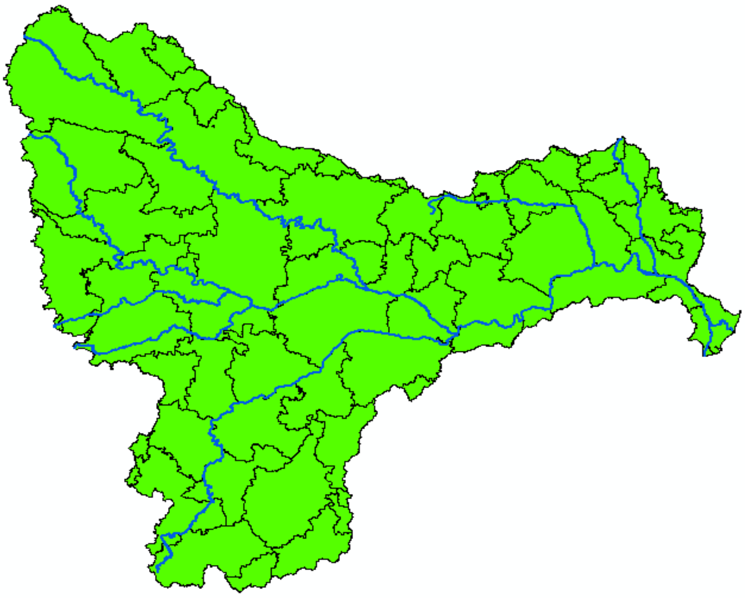
National River Conservation Directorate
Department of Water Resources, River Development & Ganga Rejuvenation
Ministry of Jal Shakti
Government of India

KRISHNA

River Basin Assessment of Gross Agricultural Structure Report



May 2026

Krishna River Basin Assessment of Gross Agricultural Structure Report

National River Conservation Directorate (NRCD)

The National River Conservation Directorate, functioning under the Department of Water Resources, River Development & Ganga Rejuvenation, and Ministry of Jal Shakti providing financial assistance to the State Government for conservation of rivers under the Centrally Sponsored Schemes of 'National River Conservation Plan (NRCP)'. National River Conservation Plan to the State Governments/ local bodies to set up infrastructure for pollution abatement of rivers in identified polluted river stretches based on proposals received from the State Governments/ local bodies.

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Centres for Krishna River Basin Management Studies (cKrishna)

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

www.ckrishna.org

Centre for Ganga River Basin Management and Studies (cGanga)

cGanga is a think tank formed under the aegis of NMCG, and one of its stated objectives is to make India a world leader in river and water science. The Centre is headquartered at IIT Kanpur and has representation from most leading science and technological institutes of the country. cGanga's mandate is to serve as think-tank in implementation and dynamic evolution of Ganga River Basin Management Plan (GRBMP) prepared by the Consortium of 7 IITs. In addition to this, it is also responsible for introducing new technologies, innovations, and solutions into India.

www.cganga.org

Acknowledgment

This report is a comprehensive outcome of the project jointly executed by NIT Warangal (Lead Institute) and NITK Surathkal (Fellow Institute) under the supervision of cGanga at IIT Kanpur. It was submitted to the National River Conservation Directorate (NRCD) in 2025. We gratefully acknowledge the individuals who provided information and photographs for this report.

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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.

Centres for Krishna River Basin Management Studies (cKrishna)

NIT Warangal and NITK, Surathkal

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1. Introduction and Objectives

The Krishna River Basin is one of the major river basins in India, supporting a wide range of socio-economic activities across the states of Maharashtra, Karnataka, Telangana and Andhra Pradesh. Over the years, agricultural activities within the basin have contributed significantly to regional food security, rural livelihoods and economic sustenance for millions of farming households. However, this growth has also led to increased pressure on water resources, both in terms of quantity and quality.

Agriculture within the basin depends heavily on water for various practices such as irrigation, crop processing, and livestock management, resulting in substantial water consumption and agrochemical runoff generation. In many cases, the excessive use of fertilizers and pesticides, combined with inefficient irrigation practices, has emerged as a major concern, contributing to the deterioration of river water quality and posing risks to ecosystems and human health. The dominance of water-intensive crops, particularly in certain districts and canal command areas, further amplifies these challenges.

In this context, it is essential to develop a comprehensive understanding of the gross agricultural structure of the Krishna River Basin, including the spatial distribution of cultivated land, cropping patterns, irrigation practices, resource input trends and the socio-economic profile of farming communities. Such an assessment is crucial for identifying regions of high agricultural water stress, evaluating the agrochemical burden on river systems, and supporting sustainable river basin management. This report aims to systematically analyse the agricultural landscape of the Krishna River Basin by integrating geo-spatial land use mapping, district-level crop and resource data analysis, socio-economic assessment and quantitative evaluation of fertilizer consumption and crop-water productivity across all sub-basins.

2. Agricultural Land Use

Agricultural land use refers to the way land is used for farming activities such as growing crops and raising livestock. It includes fields for cereals, vegetables, fruits and grazing areas for animals. Farmers manage the land to produce food, fiber and other agricultural products needed by people and industries. Agricultural land use depends on factors like climate, soil, water availability and technology. Proper use of agricultural land helps increase food production and supports the economy. It is an important part of human life because it provides the resources needed for survival and development.

2.1 Cropping Pattern and Cropping Intensity

Cropping Pattern refers to the percentage of area that is under different crops at a given time and place. Whereas the cropping Intensity is a crucial input variable for many global climates, land surface and crop models. It is also playing the role in crop yield and food security at the local, regional and national levels.

Cropping Intensity is the number of planting cycles per year which is crucial for exchanging food production and safety at local, regional and national levels. It is computed using formula

$$\boldsymbol{Cropping\ Intensity}\ (\%) = \frac{\boldsymbol{Gross\ Cropped\ Area}}{\boldsymbol{Net\ sown\ Area}} * \mathbf{100}$$

The above formula is useful for determining the intensity of land use for agricultural production, providing information on land utilization and farming efficiency.

The data such as Gross cropped area, Net sown area, Cropping Pattern and Cropping Intensity data used in this study has been obtained from the potential linked credit plan 2025-2026 reports of each district of National Bank for Agriculture and Rural Development. District-wise tables for individual sub-basins are presented in the following tables to illustrate the spatial distribution of Cropping Pattern and Cropping Intensity across the Krishna River basin.

Table 1: Cropping Intensity in the districts of Upper Krishna Basin

Sl.No	Districts	Total Geographical Area (sq.km)	Gross Cropped Area (ha)	Net Sown Area (ha)	Cropping Intensity (%)
1	Satara	10480	8,10,000	6,03,000	134.33
2	Sangli	8588.5	6,12,000	4,88,000	125.41
3	Sindhudurg	5207	2,15,000	2,06,000	104.37
4	Kolhapur	7,685	4,27,00	3,96,000	107.83
5	Dharwad	4260	5,58,000	3,23,000	172.76
6	Belagavi	13433	14,34,000	9,50,000	150.95
7	Bagalkot	6588	7,17,000	5,07,000	141.42
8	Raichur	8,358	8,39,000	6,48,000	129.48
9	Vijayapura	10498	10,90,000	9,34,000	116.7
10	Yadgiri	5160	4,95,000	3,96,000	125
11	Gadag	4657.15	5,00,000	3,40,000	147.06
12	Haveri	4851	5,60,000	3,76,000	148.94
13	Koppal	5,525	5,49,000	4,13,000	132.93

Table 2: Cropping Intensity in the districts of Middle Krishna Basin

Sl.No	Districts	Total Geographical Area (sq.km)	Gross Cropped Area (ha)	Net Sown Area (ha)	Cropping Intensity (%)
1	Prakasam	14323	272000	262000	103.81
2	Palnadu	7300	347000	316000	109.81
3	Nalgonda	7122	346000	311000	111.25
4	Jogulamba Gadwal	2576.54	216574	177116	122
5	Vikarabad	3655	283000	228000	124.12
6	Yadgiri	5160	495000	396000	125
7	Raichur	8358	839000	648000	129.48
8	Rangareddy	5030	231000	172000	134.3
9	Nagarakurnool	6924	338320	250607	135
10	Narayanpet	2336.84	238000	174000	137
11	Mahabubnagar	2751.03	210000	149000	140.94
12	Wanaparthi	2165	193000	122000	157

Table 3: Cropping Intensity in the districts of Lower Krishna Basin

Sl.No	Districts	Total Geographical Area (sq.km)	Gross Cropped Area (ha)	Net Sown Area (ha)	Cropping Intensity (%)
1	Nalgonda	7122	346000	311000	111.25
2	NTR	3315	163600	143300	114
3	Bapatla	3828.84	309000	264000	117.04
4	Bhadradri Kothagudem	7483	200000	163000	122.7
5	Vikarabad	3655	283000	228000	124.12
6	Khammam	4361	360000	273000	131.87
7	Rangareddy	5030	231000	172000	134.3
8	Medchal Malkajgiri	1089.89	20000	11000	137
9	Warangal	1796	167000	121000	138.02
10	Mahabubnagar	2751	210000	149000	140.94
11	Yadadri Bhuvanagiri	3464	189000	134000	141.04
12	Guntur	2440	219000	155900	141.29
13	Jagoan	2188	244000	160000	152.5
14	Siddipet	3652	366000	230000	159.13
15	Hanumakonda	1679	186000	108000	172.22
16	Krishna	3370	302000	171000	177
17	Suryapet	3615	17100000	2498000	687.63

Table 4: Cropping Intensity in districts of Upper Bhima Basin

Sl.No	Districts	Total Geographical Area (sq.km)	Gross Cropped Area (ha)	Net Sown Area (ha)	Cropping Intensity (%)
1	Vijayapura	10498	1090000	934000	116.7
2	Ahmednagar	17143	1352000	1142243	118.37
3	Sangli	8588.5	612000	488000	125.41
4	Solapur	14895	1103000	850000	132
5	Satara	10480	810000	603000	135
6	Pune	15643	108000	78000	138.46
7	Belgaum	13433	1434000	950000	150.95
8	Beed	10693	1348000	844000	159.72

Table 5: Cropping Intensity in districts of Lower Bhima Basin

Sl.No	Districts	Total Geographical Area (sq.km)	Gross Cropped Area (ha)	Net Sown Area (ha)	Cropping Intensity (%)
1	Bidar	5448	478000	415000	115.18
2	Kalaburgi	10941	969588	846041	114
3	Vijayapura	10498	1090000	934000	116.7
4	Vikarabad	3655	283000	228000	124
5	Yadgiri	5160	495000	396000	125
6	Sangareddy	4498	365000	288000	126.74
7	Solapur	14895	1103000	850000	132

Table 6: Cropping Intensity in districts of Upper Tungabhadra Basin

Sl.No	Districts	Total Geographical Area (sq.km)	Gross Cropped Area (ha)	Net Sown Area (ha)	Cropping Intensity (%)
1	Koppal	5,525	5,49,000	4,13,000	132.93
2	Gadag	4657.15	5,00,000	3,40,000	147.06
3	Vijayanagara	5562	4,32,000	3,34,000	129.34
4	Haveri	4851	5,60,000	3,76,000	148.94
5	Davangere	4,489	4,11,000	3,10,000	132.58
6	Uttar Kannada	10277	1,46,000	1,23,000	118.7
7	Shivamogga	8478	3,08,000	2,37,000	129.96
8	Chikkamagaluru	7220.75	4,16,000	2,70,000	154.07

9	Chitradurga	7707	5,79,000	4,46,000	129.82

Table 7: Cropping Intensity in districts of Lower Tungabhadra Basin

Sl.No	Districts	Total Geographical Area (sq.km)	Gross Cropped Area (ha)	Net Sown Area (ha)	Cropping Intensity (%)
1	Raichur	8,358	8,39,000	6,48,000	129.48
2	Ballari	4000	3,23,000	2,51,000	135.71
3	Chitradurga	7707	5,79,000	4,46,000	129.82
4	Tumakuru	10597	3,25,000	2,27,000	143.17
5	Hassan	6814	55971.3	41716.6	134.17
6	Chikkamagaluru	7220.75	4,16,000	2,70,000	154.07
7	Koppal	5,525	5,49,000	4,13,000	132.93
8	Vijayanagara	5562	4,32,000	3,34,000	129.34
9	Davangere	4,489	4,11,000	3,10,000	132.58
10	Kurnool	7977	4,19,000	3,91,000	106.07
11	Ananthapur	10,200	570686	528753	106
12	SriSatyaSai	8925.65	3.23.000	1,72,000	107
13	Nandyal	9681	4,06,000	3,95,000	102.52
14	Jogulamba Gadwal	2576.54	2,16,574	1,77,116	122

2.2 Major Crops and Seasonality

The district-wise crop yield data (from ICRISAT, 2017 and District Environment Plan reports, 2017) reveal pronounced spatial variations across the Krishna River Basin, reflecting the combined influence of irrigation availability, agro-climatic conditions, soil characteristics, and cropping practices. Ignoring missing values, the data highlight clear upstream to downstream contrasts as well as differences between irrigated plains and rainfed uplands.

2.2.1 Cereal Crops

Cereal crops form a major component of the agricultural system in the Krishna River Basin, contributing significantly to food security. Rice is the dominant cereal crop in irrigated regions, especially in canal command areas and delta regions, where assured water supply supports intensive cultivation. It is mainly grown during the Kharif season, with some areas practicing double cropping under sufficient irrigation. Wheat, although less dominant compared to northern India, is cultivated in selected regions during the Rabi season under irrigated conditions. The cultivation of cereals is highly dependent on water availability, making them crucial in understanding irrigation demand and basin water stress.

2.2.2 Coarse cereals and millets

Coarse cereals and millets are widely cultivated in the semi-arid regions of the Krishna Basin, particularly in areas with limited irrigation. Major crops include maize, sorghum (jowar), and pearl millet (bajra), which are well adapted to low rainfall and drought-prone conditions. These crops are generally grown during the Kharif season under rainfed conditions, although maize is also cultivated in the Rabi season in some irrigated areas. Millets require comparatively less water and are more resilient to climatic variability, making them important for sustainable agriculture in the basin.

2.2.3 Pulses and Oil Seeds

Pulses and oilseeds play a vital role in the cropping pattern of the Krishna Basin, contributing to soil fertility and nutritional security. Major pulses include red gram (tur), green gram, and chickpea. These crops are primarily grown under rainfed conditions, especially in dryland areas, and are often cultivated as part of crop rotation systems. Groundnut is mainly grown during the Kharif season, whereas pulses are commonly cultivated in the Rabi season. Their lower water requirement compared to cereals makes them suitable for regions facing water scarcity.

To further analyze the spatial variation in agricultural productivity, district-wise yield trends of major crops such as rice, wheat, maize, and groundnut are presented for different sub-basins of the Krishna River Basin. The following figures illustrate the variation in crop yields across districts, highlighting regional differences in agricultural performance and resource availability.

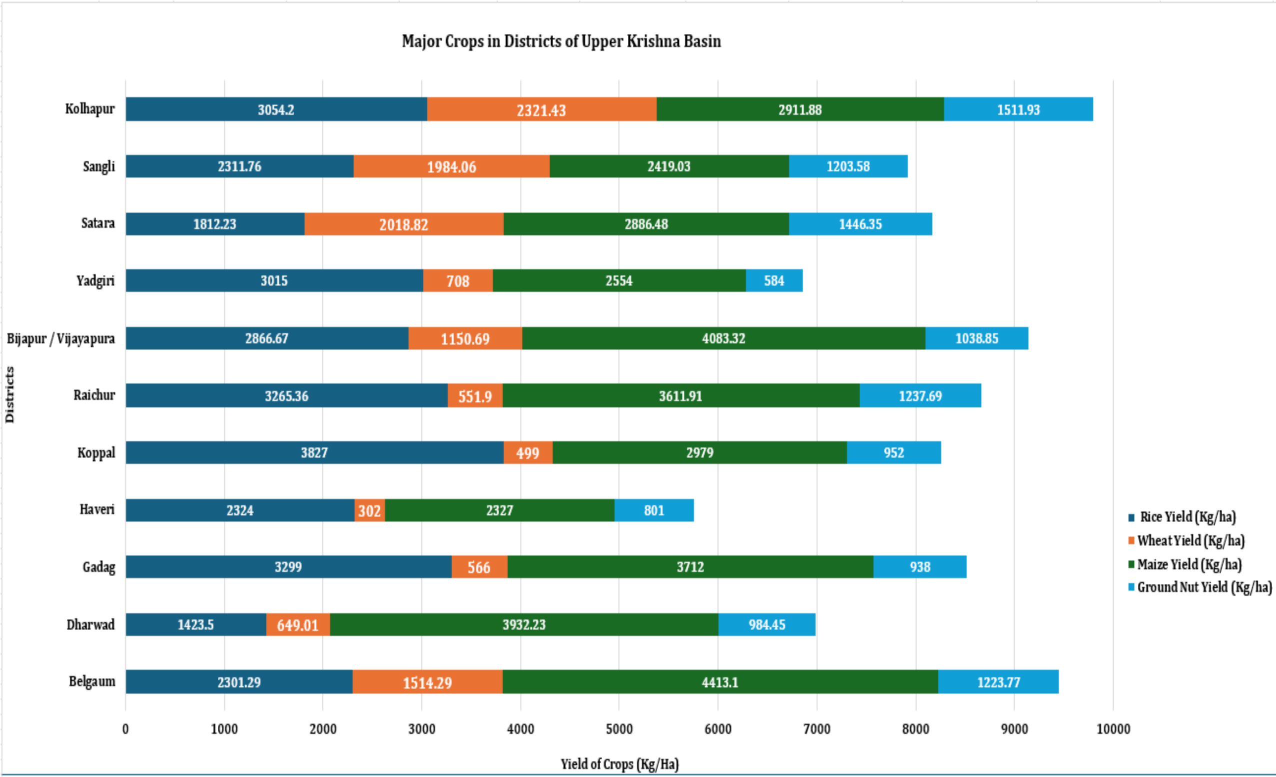

Figure 1: Major Crops in the Districts of Upper Krishna basin

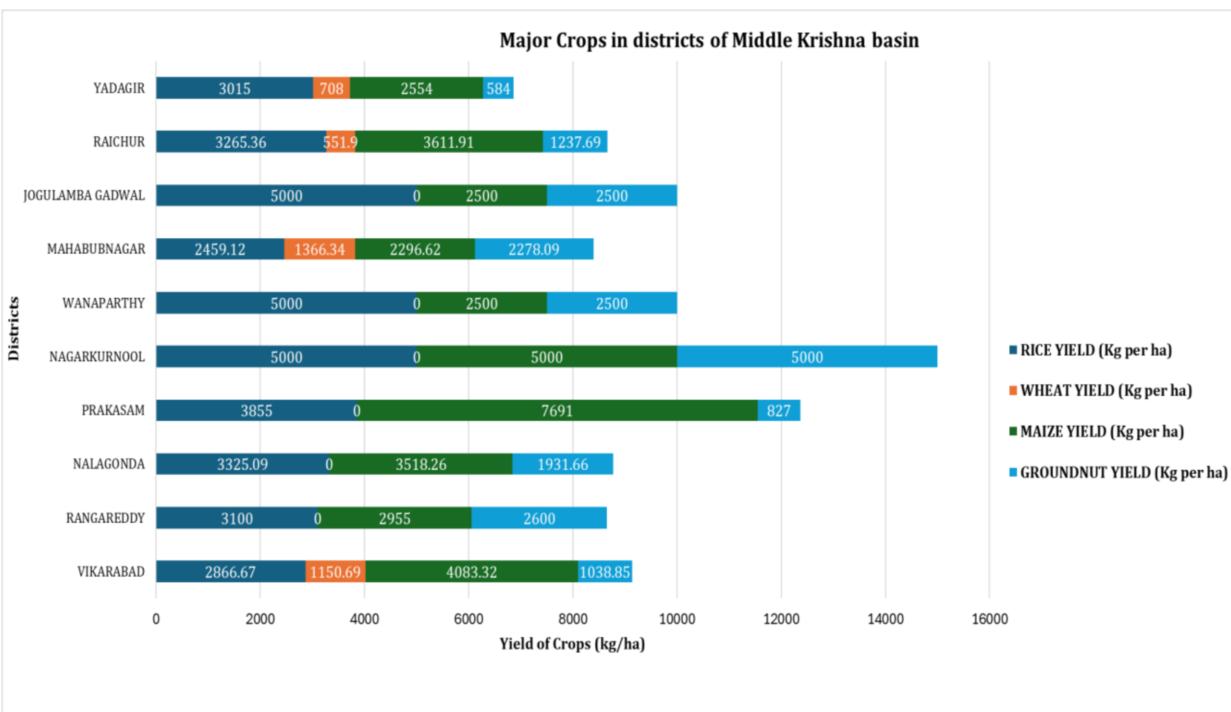

Figure 2: Major Crops in the Districts of Middle Krishna basin

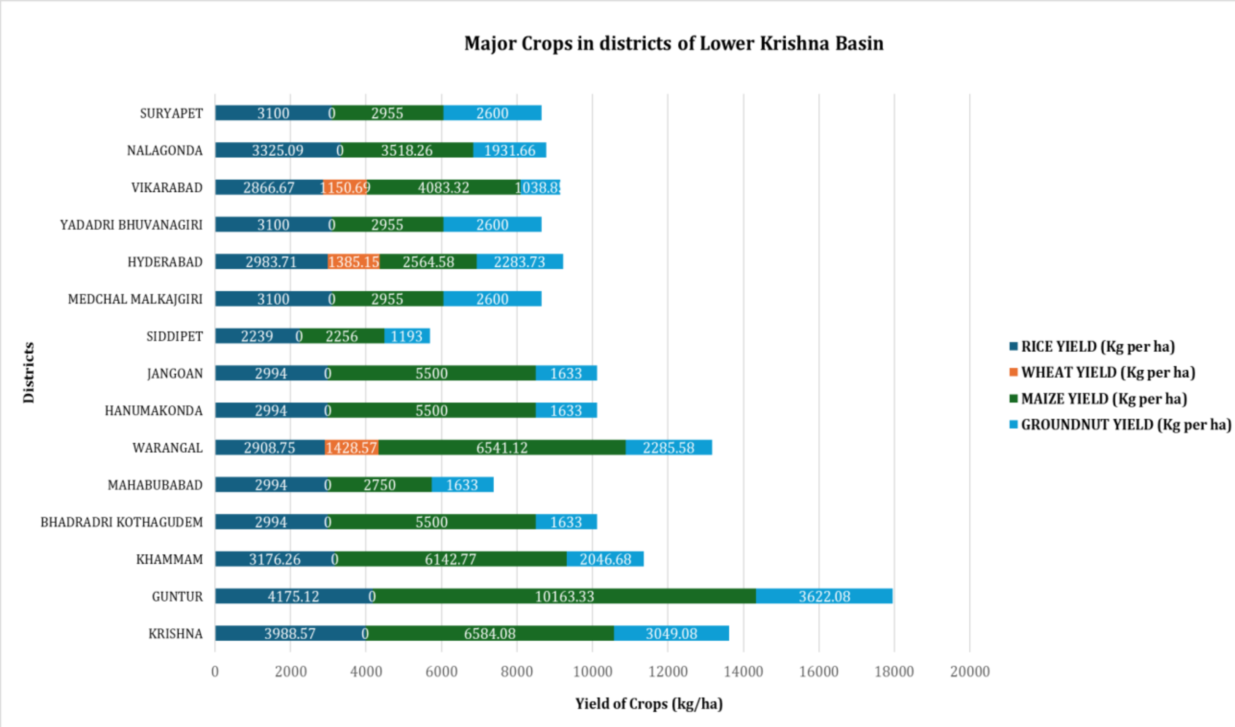

Figure 3: Major Crops in the Districts of Lower Krishna basin

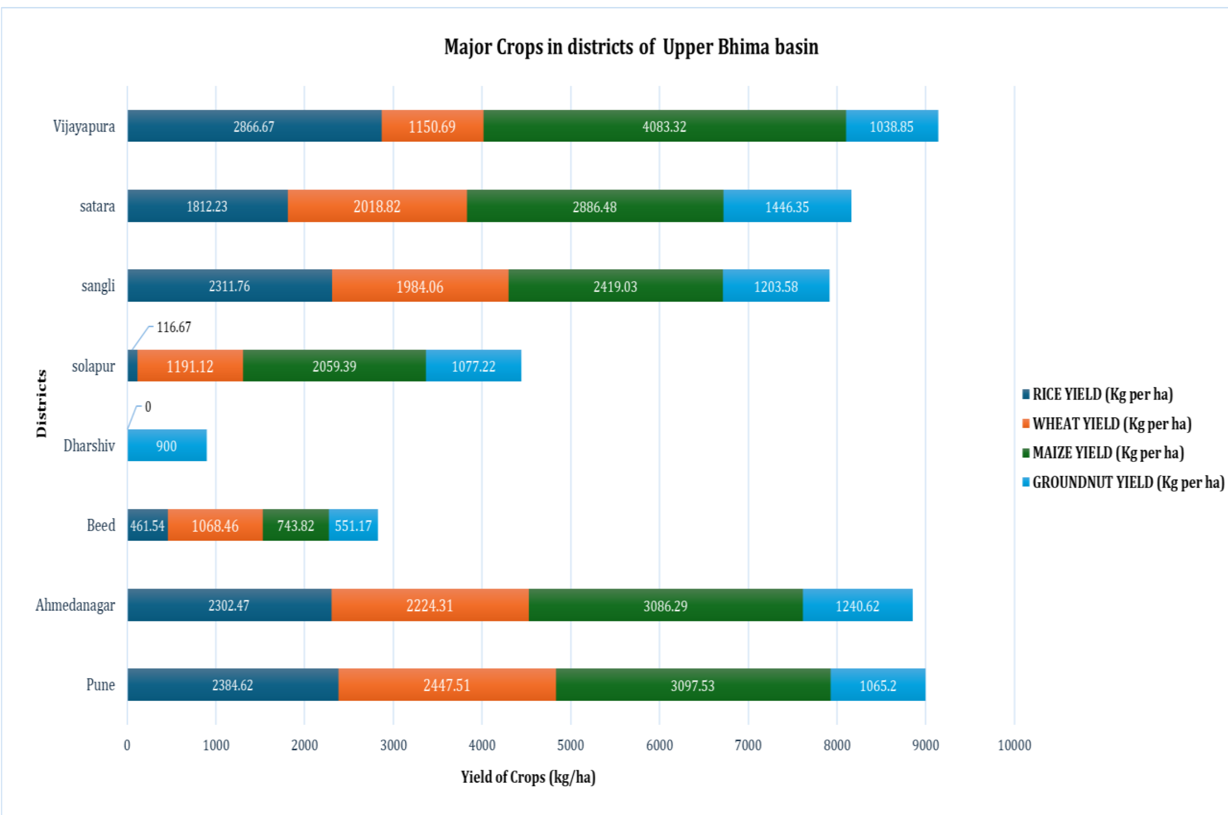

Figure 4: Major Crops in the Districts of Upper Bhima basin

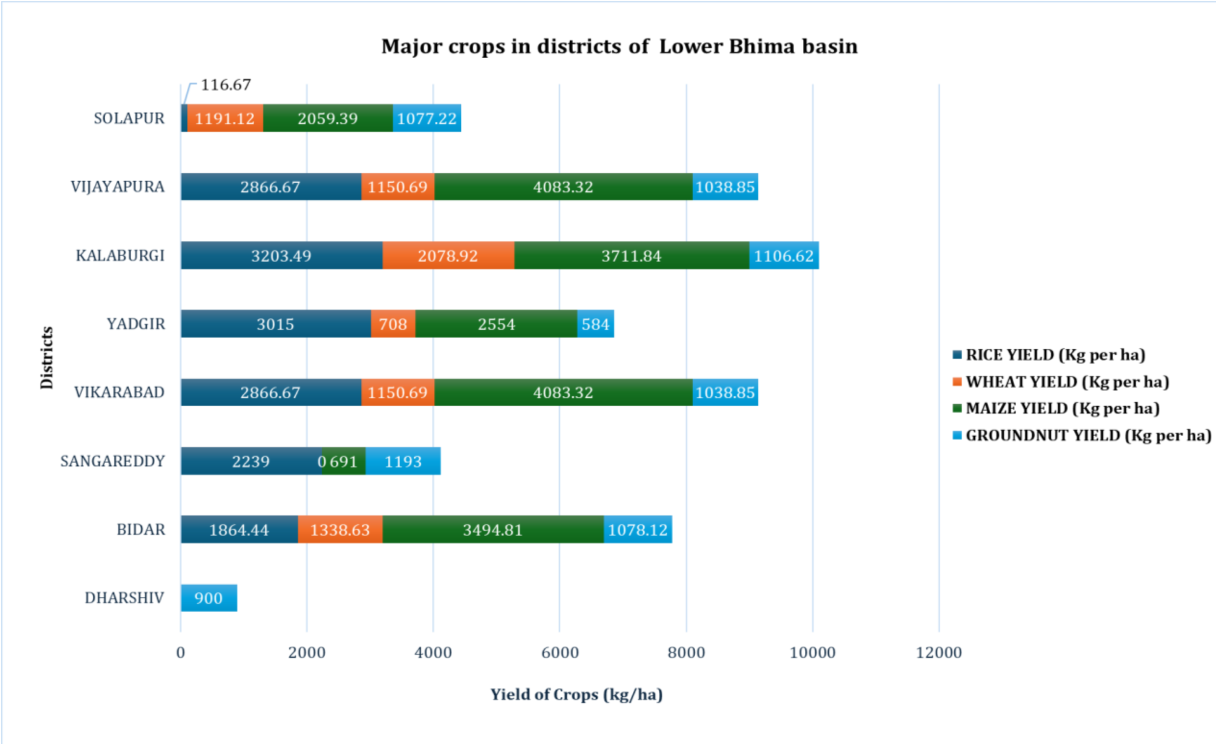

Figure 5: Major Crops in the Districts of Lower Bhima basin

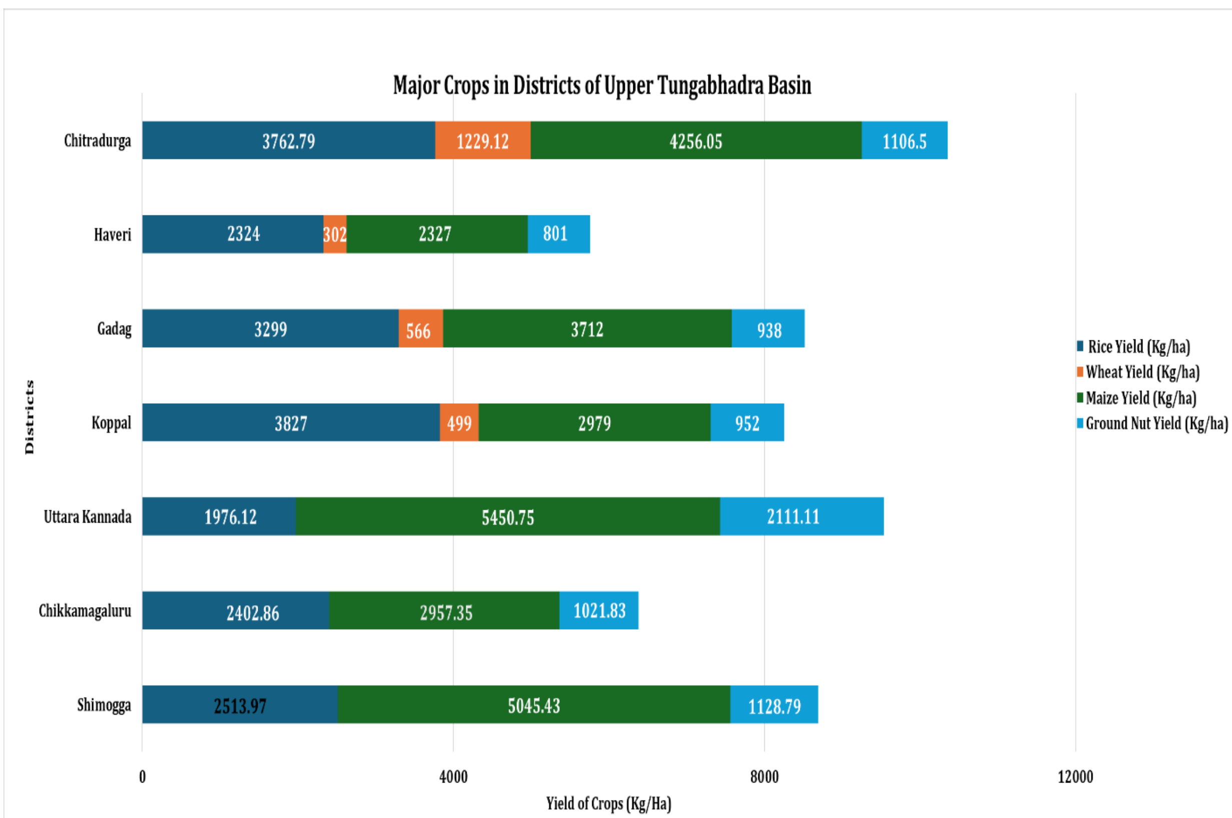

Figure 6: Major Crops in the Districts of Upper Tungabhadra basin

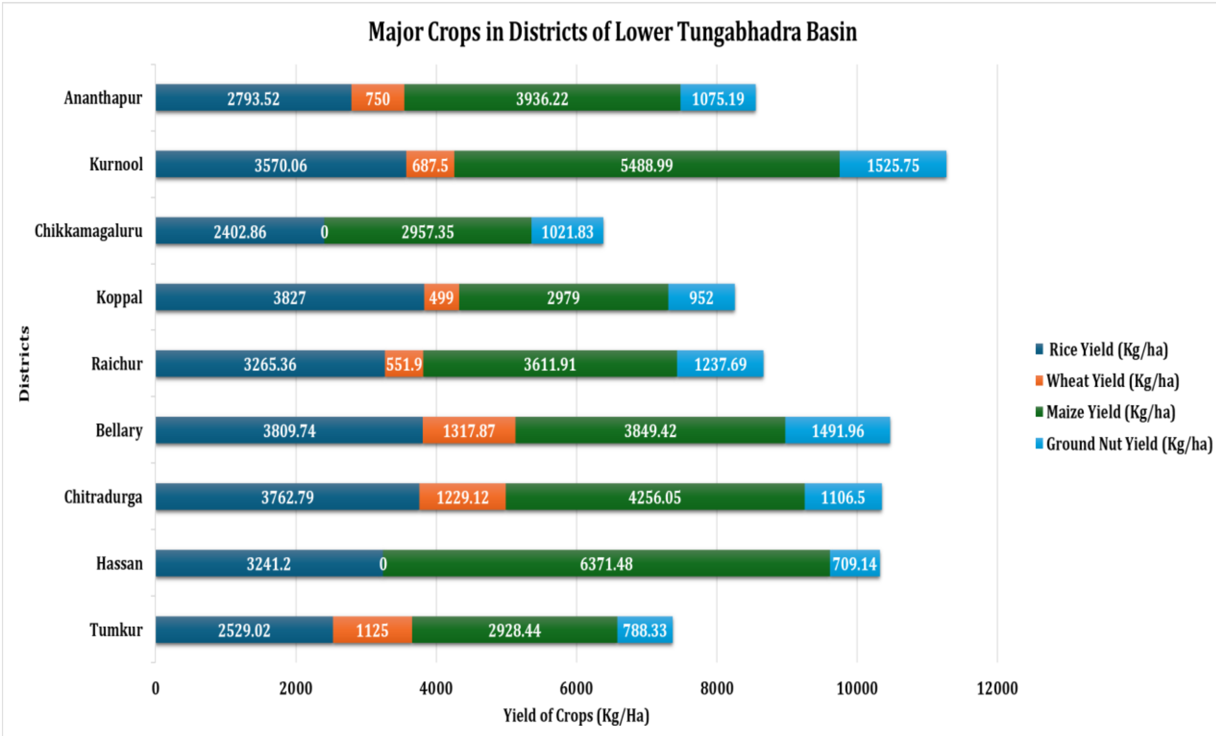

Figure 7: Major Crops in the Districts of Lower Tungabhadra basin

2.3 Spatial and temporary maps of agricultural land use

The spatial and temporal analysis of agricultural land use in the Krishna River Basin is essential to understand the distribution and dynamics of cultivated areas across different regions. Land Use Land Cover (LULC) data for the year 2024 has been derived from Sentinel-2 imagery using the Esri platform. The analysis has been carried out at the district level for each sub-basin to capture variations in agricultural land use. The resulting maps provide insights into the extent of agricultural areas and their spatial distribution, forming the basis for further district-wise assessment within each sub-basin.

Upper Krishna Basin: The distribution of agricultural land across districts in the Upper Krishna sub-basin, revealing significant variation in land use patterns. Districts such as Vijayapura (95.1%) and Dharwad (93.39%) have very high agricultural land percentages, indicating intensive farming and strong dependence on agriculture. Similarly, Yadgir, Raichur, Koppal and Gadag all show high values above 84%, reflecting a predominantly agrarian landscape. Sangli (81.21%), Belagavi (79.76%) and Bagalkot (78.57%) also maintain substantial agricultural coverage. In contrast, Satara (55.31%) and Kolhapur (51.62%) have moderate levels, suggesting a mix of agriculture with other land uses. Notably, Sindhudurg has a very low percentage (6.52%), which may be due to forest cover, hilly terrain, or coastal geography limiting agricultural expansion. Overall, the data highlights strong regional dependence on agriculture, with variations shaped by physical geography and resource availability. The agricultural land use distribution in districts of Upper Krishna basin is shown in figure 8 below.

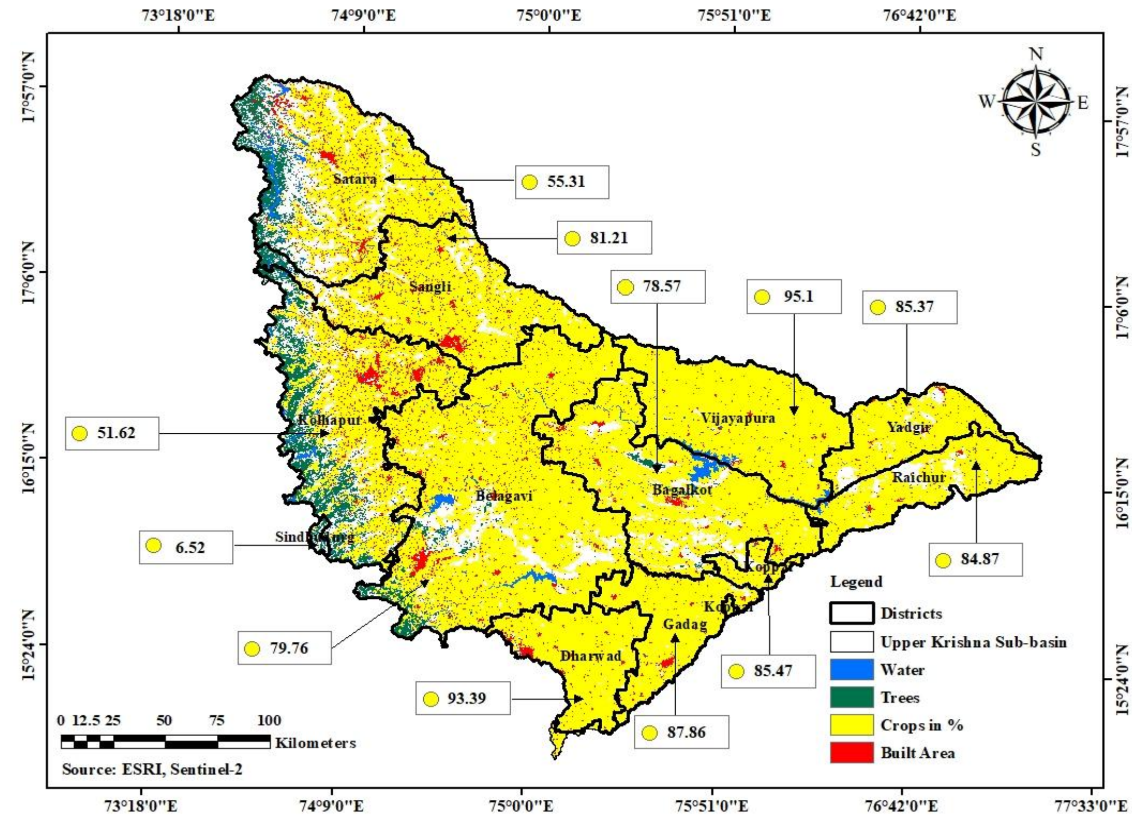

Figure 8: Agriculture Land Use in Districts of Upper Krishna basin

Middle Krishna Basin: The agricultural land across districts in the Middle Krishna sub-basin, showing significant variation in land use patterns. Districts like Jogulamba Gadwal (89.38%), Raichur (84.87%), Yadgir (85.37%), and Narayanpet (83.48%) have very high proportions of land under agriculture, indicating strong dependence on farming activities. Similarly, Wanaparthy, Nalgonda, and Vikarabad also show high agricultural utilization, all above 75%. In contrast, districts such as Nagarkurnool and Nandyal have moderate levels, with just over half of their land used for agriculture. A striking outlier is Prakasam, with only 1.18%, suggesting either different land use priorities or geographical constraints. Overall, the data highlights a predominantly agrarian landscape in most districts, with a few exceptions that may require further investigation. The agricultural land use distribution in districts of Middle Krishna basin is shown in figure 9 below.

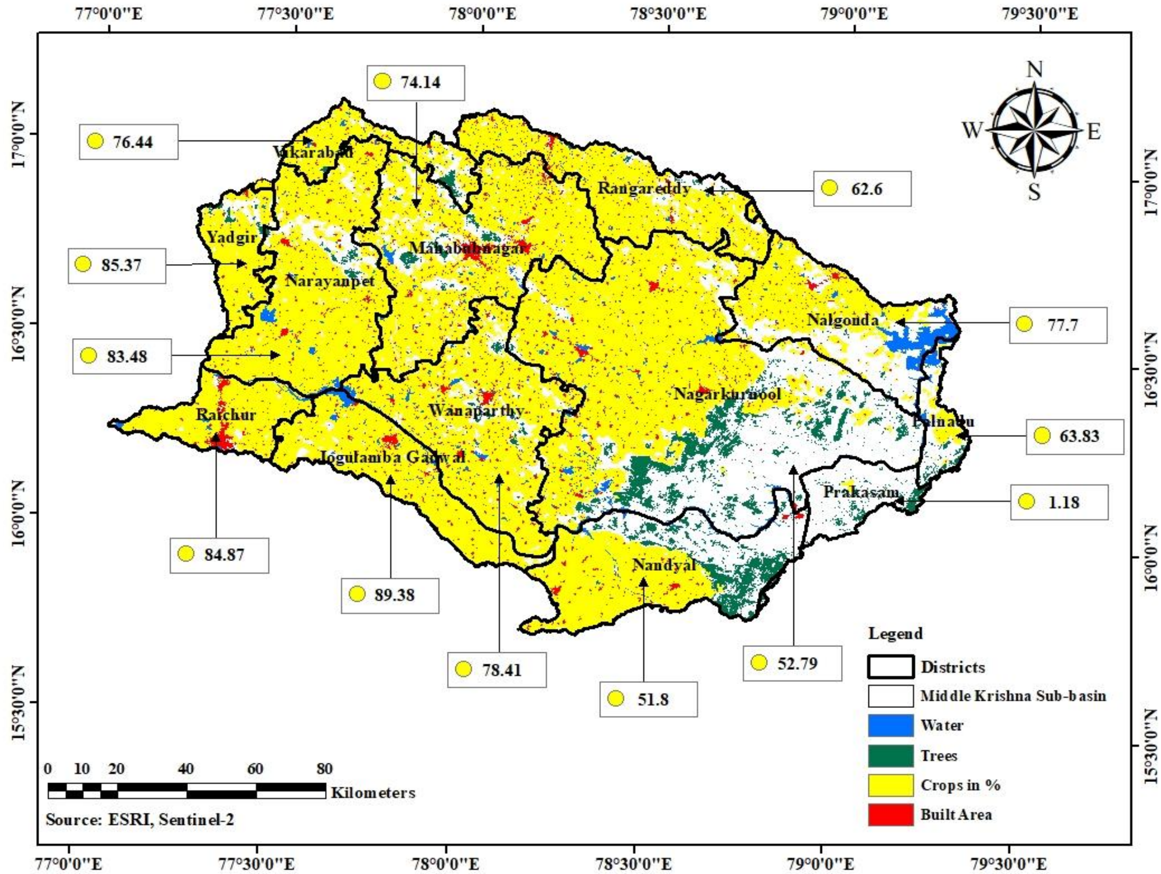

Figure 9: Agriculture Land Use in Districts of Middle Krishna basin

Lower Krishna Basin: The map shows the percentage of agricultural land across districts in the Lower Krishna sub-basin, revealing a wide range of land-use patterns. Several districts such as Hanumakonda (89.85%), Warangal (86.75%), Jangaon (86.73%), Suryapet (85.27%), and Khammam (82.16%) have very high agricultural land percentages, indicating strong reliance on farming. Districts like Guntur, Nalgonda, Yadadri Bhuvanagiri, and Vikarabad also show substantial agricultural activity, all above 75%. Moderate levels of agricultural land are observed in Krishna, Bapatla, NTR, Palnadu, Siddipet, and Rangareddy, generally ranging between 50% and 70%. In contrast, Bhadradri Kothagudem and Medchal Malkajgiri have lower agricultural shares, suggesting more forested, industrial, or urban land use. Hyderabad stands out as an extreme outlier with only 0.04%, reflecting its highly urbanized nature. Overall, the data highlights a predominantly agrarian region with significant variation influenced by urbanization and geographical factors. The agricultural land use distribution in districts of Lower Krishna basin is shown in figure 10 below.

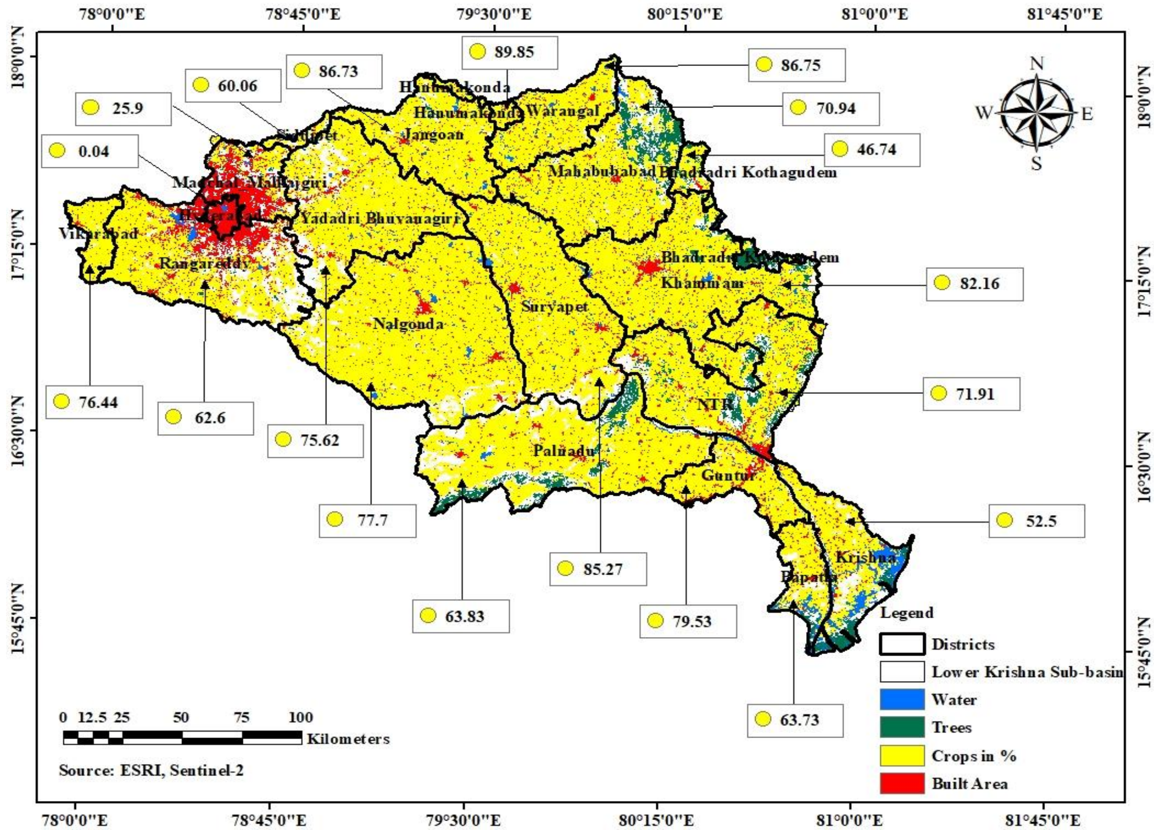

Figure 10: Agriculture Land Use in Districts of Lower Krishna basin

Upper Bhima Basin: The agricultural land across districts in the Upper Bhima sub-basin, showing notable variation in land use patterns. Districts like Vijayapura (95.1%), Solapur (91.66%), and Dharashiv (91.51%) have a very high proportion of land dedicated to agriculture, indicating strong dependence on farming activities. Similarly, Beed (82.49%), Sangli (81.21%), and Ahmednagar (80.96%) also exhibit significant agricultural land coverage. In contrast, Pune (54.33%) and Satara (55.31%) have comparatively lower percentages, suggesting a more diversified land use that may include urbanization, industry, or forest areas. Overall, the data highlights that most districts in the basin are predominantly agrarian, with agriculture playing a central role in their economy. The variation also reflects differences in geography, water availability, and development patterns across the region. The agricultural land use distribution in districts of Upper Bhima basin is shown in figure 11 below.

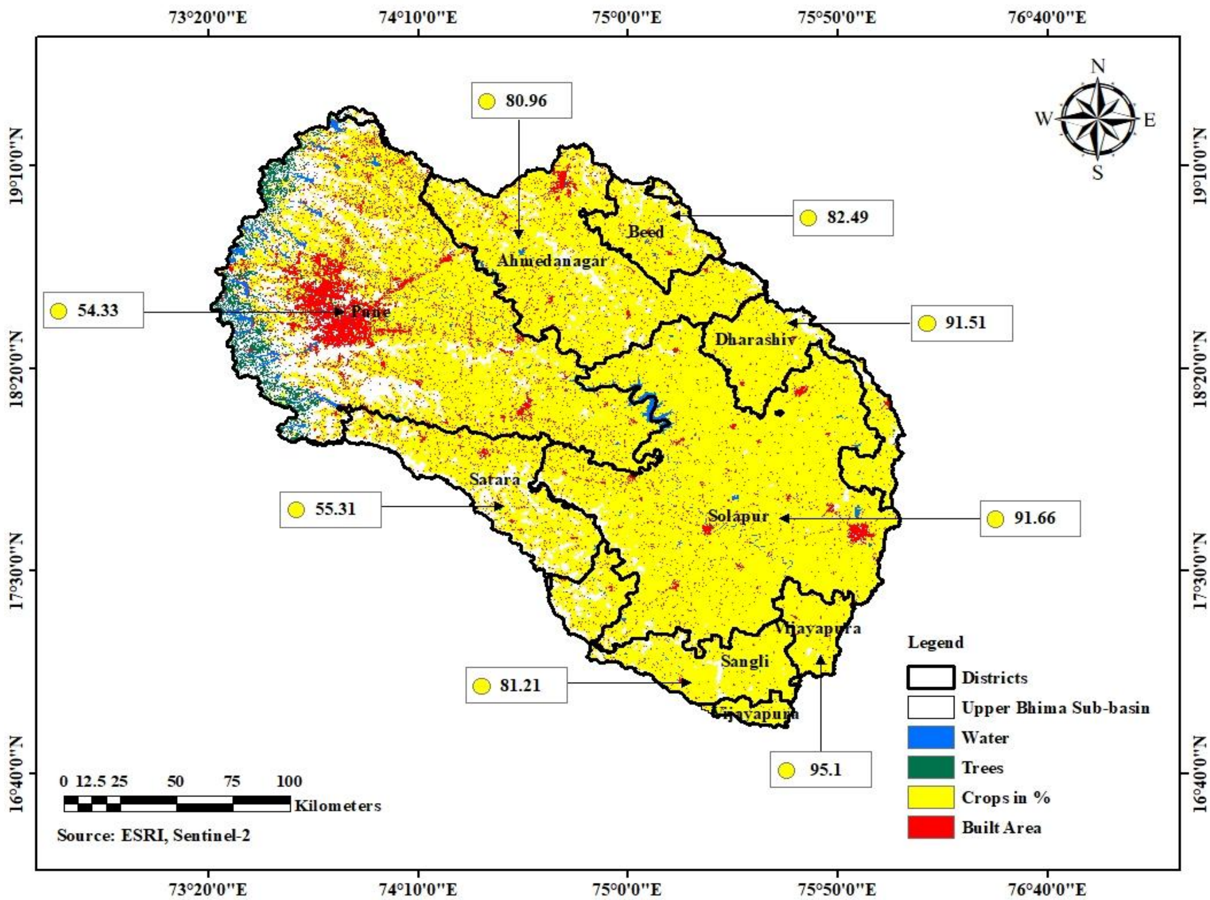

Figure 11: Agriculture Land Use in Districts of Upper Bhima basin

Lower Bhima basin: The agricultural land across districts in the Lower Bhima sub-basin, indicating a predominantly agriculture-based landscape. Districts such as Vijayapura (95.1%), Solapur (91.66%), and Dharashiv (91.51%) have very high agricultural land coverage, reflecting intensive farming practices and strong reliance on agriculture. Kalaburagi (89.43%) and Yadgir (85.37%) also demonstrate substantial agricultural presence. Meanwhile, Vikarabad (76.44%) and Sangareddy (74.75%) have moderately high agricultural land percentages, suggesting a balance between farming and other land uses. Bidar (72.1%) has the lowest among the listed districts, though agriculture still occupies a significant portion of land. Overall, the data highlights that the Lower Bhima sub-basin is largely agrarian, with slight regional variations likely influenced by factors such as soil type, irrigation availability, and urban development. The agricultural land use distribution in districts of Lower Bhima basin is shown in figure 12 below.

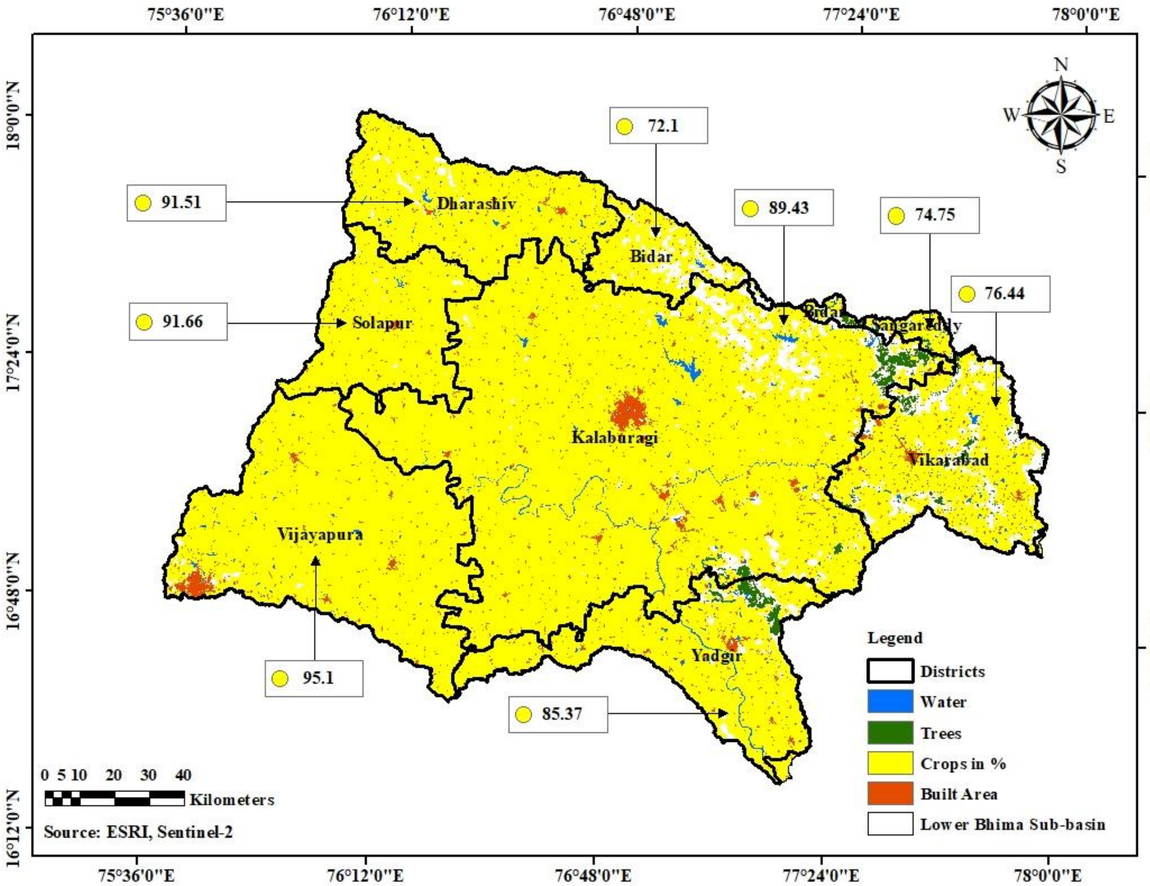

Figure 12: Agriculture Land Use in Districts of Lower Bhima basin

Upper Tungabhadra Basin: The percentage of agricultural land across districts in the Upper Tungabhadra sub-basin, showing notable variation in land utilization. Districts such as Dharwad (93.39%), Gadag (87.86%), Haveri (86.3%), and Koppal (85.47%) have very high agricultural land percentages, indicating intensive farming activities and strong dependence on agriculture. Moderate to high levels are observed in Davangere, Chitradurga, Vijayanagara, and Ballari, where agricultural land ranges between roughly 67% and 76%. In contrast, districts like Shivamogga (42.91%) and Uttar Kannada (33.68%) show lower agricultural land use, possibly due to greater forest cover or different geographical conditions. Chikkamagaluru has the lowest share at 22.98%, suggesting hilly terrain or plantation-based land use rather than extensive agriculture. The agricultural land use distribution in districts of Upper Tungabhadra basin is shown in figure 13 below.

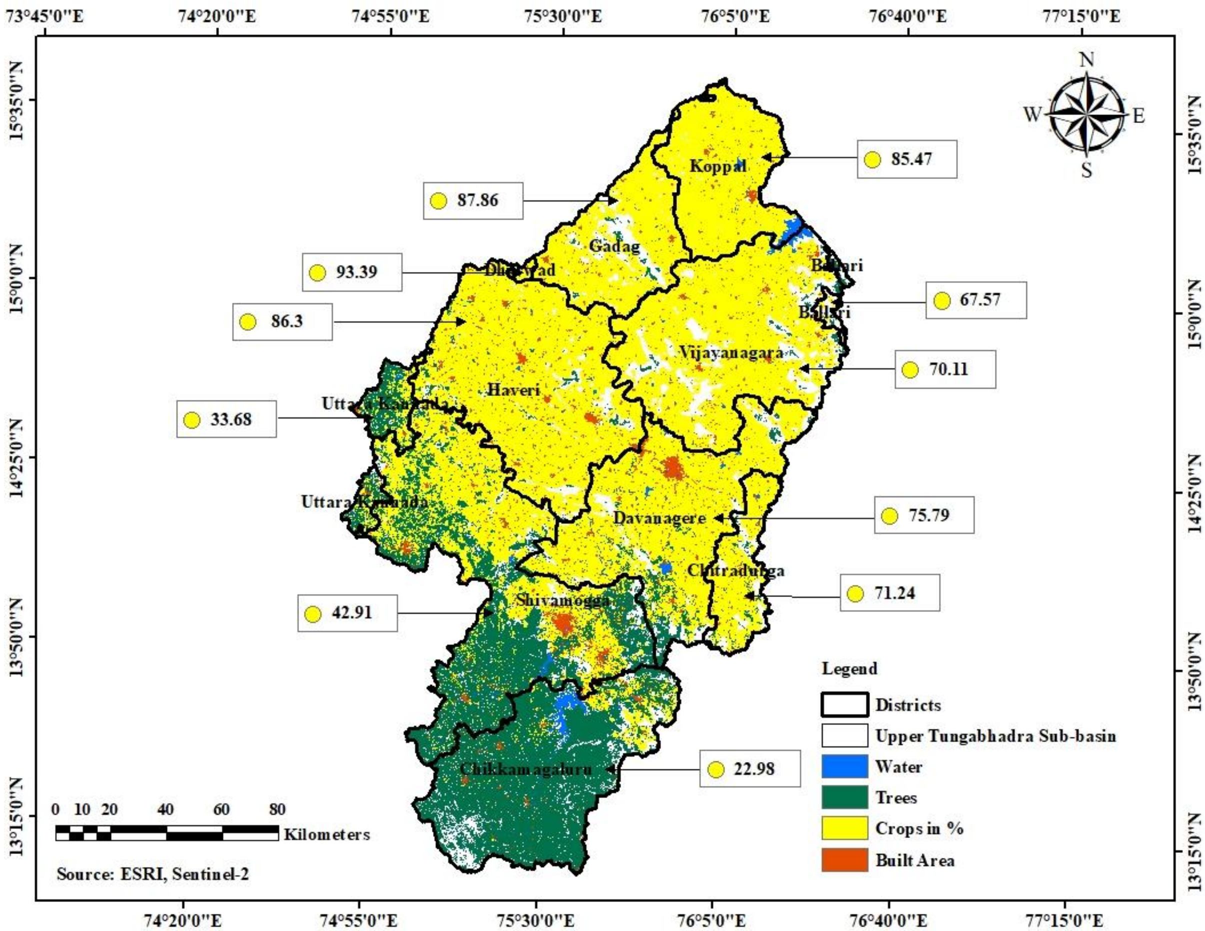

Figure 13: Agriculture Land Use in Districts of Upper Tungabhadra basin

Lower Tungabhadra Basin: The agricultural land across districts in the Lower Tungabhadra sub-basin, indicating a largely agriculture-driven region with some variation. Districts such as Jogulamba Gadwal (89.38%), Ananthapur (87.28%), Koppal (85.47%), and Raichur (84.87%) have very high percentages of agricultural land, reflecting strong dependence on farming. Kurnool and Sri Sathya Sai also show high agricultural usage, both above 75%. Moderate levels are observed in Davangere, Chitradurga, Vijayanagara, and Ballari, where agricultural land ranges between about 67% and 76%. Districts like Tumakuru, Hassan, and Nandyal have comparatively lower shares, around 50–56%, suggesting more diversified land use. Chikkamagaluru stands out with the lowest percentage (22.98%), likely due to hilly terrain and plantation crops rather than extensive agriculture. The agricultural land use distribution in districts of Lower Tungabhadra basin is shown in figure 14 below.

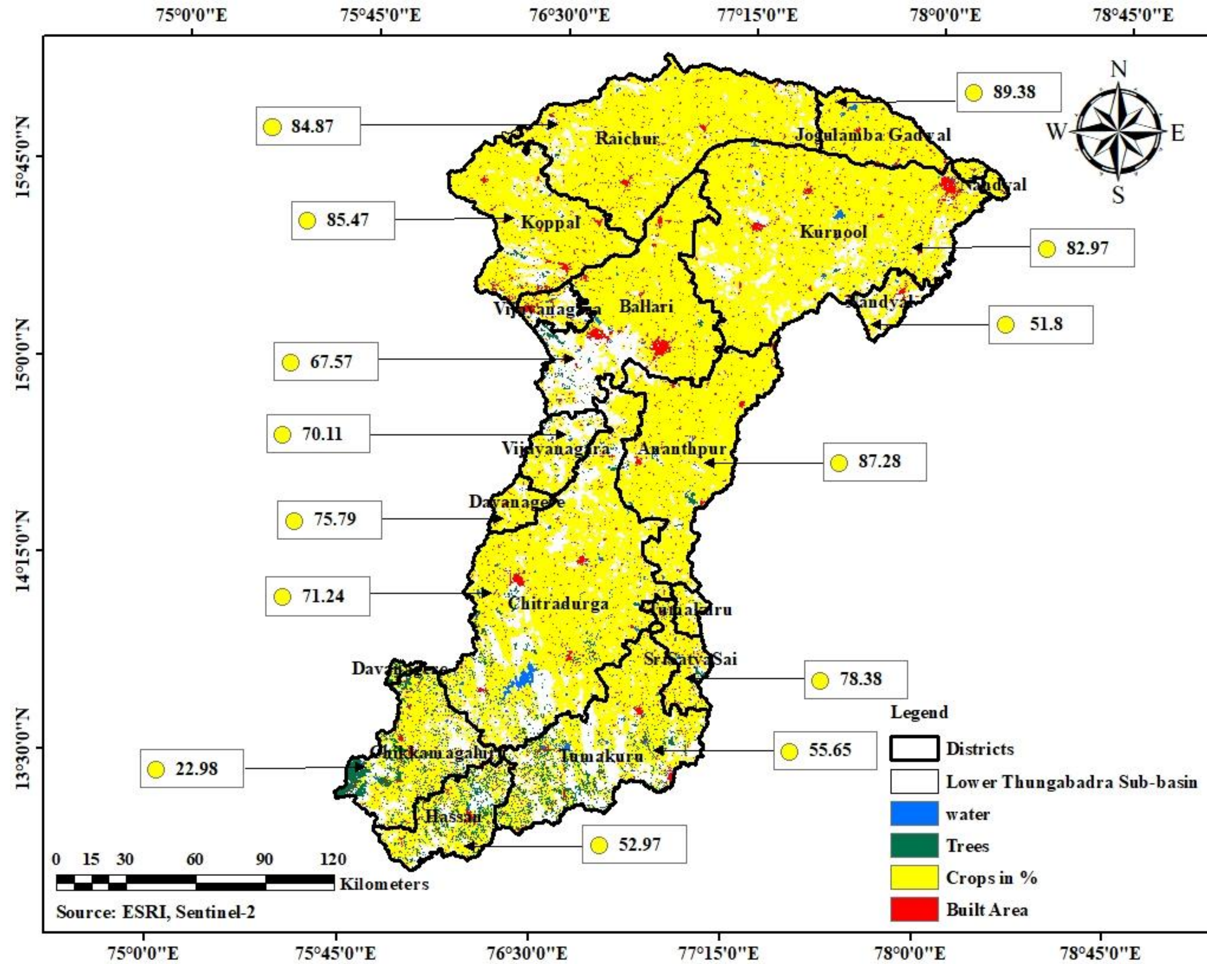

Figure 14: Agriculture Land Use in Districts of Lower Tungabhadra basin

3. Resource Input

Resource input in agriculture refers to the materials and substances applied to crops to enhance productivity and protect them from damage. Fertilizers are essential inputs that supply vital nutrients — primarily nitrogen (N), phosphorus (P), and potassium (K) — to the soil, replenishing what is lost during crop cultivation and boosting plant growth and yield. These can be organic (such as compost, manure, and green manure) or inorganic (chemical fertilizers like urea, DAP and NPK blends), each varying in cost, nutrient availability and environmental impact. Pesticides, on the other hand, are chemical or biological agents applied to control weeds, insects, fungi, and other pests that threaten crop health and reduce output. They include herbicides, insecticides, fungicides and rodenticides, which together help minimize crop losses and ensure consistent production. The judicious and timely application of both fertilizers and pesticides is critical to optimizing agricultural output while managing input costs effectively.

3.1 Fertilizer and Pesticide application

The analysis of fertilizer consumption in the Krishna River Basin between 1970 and 2017 from ICRISAT reveals a pattern of massive agricultural intensification. The data indicates that the basin's productivity growth, particularly the record-breaking wheat and rice yields discussed previously, has been fueled by a multi-fold increase in chemical inputs.

3.1.1 Nitrogen Consumption:

Upper Krishna Basin: Nitrogen consumption showed steady growth across most districts over the study period. Raichur remained the highest consumer, indicating strong dependence on nitrogen fertilizers. Belgaum and Dharwad grew significantly but saw a slight decline in later years. Kolhapur, Vijayapura, Sangli, and Satara recorded consistent increases. Data for Bagalkot, Gadag, Haveri, Sindhudurg, Yadgir and Koppal was unavailable. Overall, nitrogen use increased notably before showing a mild decline in some districts toward the end. The Nitrogen (N) Consumption in districts of Upper Krishna Basin is represented in table 8 below.

Table 8: Nitrogen Consumption in districts of Upper Krishna Basin

Nitrogen (N) Consumption in tons							
SL NO	**District**	**1970**	**1980**	**1990**	**2000**	**2010**	**2017**
1	Bagalkot	—	—	—	—	—	—
2	Belgaum	8126	19200	42069	76410	101487	92878
3	Dharwad	4337	11433	26026	56096	78970	62588
4	Gadag	—	—	—	—	—	—
5	Haveri	—	—	—	—	—	—
6	Kolhapur	7189	25808	56406	53203	65271	70996
7	Koppal	—	—	—	—	—	—
8	Raichur	7517	22000	51302	101582	151135	115832
9	Sangli	5076	13815	37810	37495	74746	54620
10	Satara	4817	12570	32362	34842	50079	49264
11	Sindhudurg	—	—	—	—	—	—
12	Vijayapura	2745	7781	18447	43706	79505	73977
13	Yadgir	—	—	—	—	—	—

Middle Krishna Basin: Nitrogen(N) consumption in the Middle Krishna region shows a strong increase from 1970 to 2010 due to expansion of irrigation and intensive farming practices. Raichur and Nalgonda recorded the highest consumption, while Mahabubnagar showed comparatively moderate levels. The nitrogen consumption data for few districts like Jogulamba gadwal, Nandyal, Nagarkurnool, Narayanpet, Palnadu, Prakasam, Rangareddy, Vikarabad, Wanaparthy and Yadagir are not available. The Nitrogen (N) Consumption in districts of Middle Krishna Basin is represented in table 9 below.

Table 9: Nitrogen Consumption in districts of Middle Krishna Basin

Nitrogen (N) Consumption in tons							
SL NO	District	1970	1980	1990	2000	2010	2017
1	Jogulamba Godwal	—	—	—	—	—	—
2	Mahabubnagar	5967	13529	32255	47532	77259	74046
3	Nadyal	—	—	—	—	—	—
4	Nagarakurnool	—	—	—	—	—	—
5	Nalgonda	5295	13147	34661	83173	141668	33043
6	Narayanpet	—	—	—	—	—	—
7	Palnadu	—	—	—	—	—	—
8	Prakasam	—	—	—	—	—	—
9	Raichur	7517	22000	51302	101582	151135	115832
10	Rangareddy	—	—	—	—	—	—
11	Vikarabad	—	—	—	—	—	—
12	Wanaparthi	—	—	—	—	—	—
13	Yadgiri	—	—	—	—	—	—

Lower Krishna Basin: Nitrogen (N) consumption in Lower Krishna basin districts shows a strong rise from 1970 to 2010 due to intensive irrigation and fertilizer use. Guntur recorded the highest consumption, followed by Krishna and Warangal, while Hyderabad remained relatively lower. The increase is linked to commercial crops and modern agricultural practices. No data found for few districts like Bapatla, Bhadradri Kothagudem, Hanumakonda, Jagoan, Medchal Malkajgiri and NTR etc. The Nitrogen (N) Consumption in districts of Lower Krishna Basin districts is represented in table 10 below.

Table 10: Nitrogen Consumption in districts of Lower Krishna Basin

Nitrogen (N) Consumption in tons							
SL NO	District	1970	1980	1990	2000	2010	2017
1	Bapatla	—	—	—	—	—	—
2	Bhadradri Kothagudem	—	—	—	—	—	—
3	Gunturu	41123	62490	138583	135606	216731	173584
4	Hanumakonda	—	—	—	—	—	—
5	Hyderabad	5940	4353	28897	54623	51967	29965
6	Jagoan	—	—	—	—	—	—

7	Khammam	4727	5181	39093	53544	90586	15181
8	Krishna	16668	33940	88818	104451	136922	84529
9	Mahabubnagar	5967	13529	32255	47532	77259	74046
10	Medchal Malkajgiri	—	—	—	—	—	—
11	Nalgonda	5295	13147	34661	83173	141668	33043
12	NTR	—	—	—	—	—	—
13	Palnadu	—	—	—	—	—	—
14	Rangareddy	—	—	—	—	—	—
15	Siddipet	—	—	—	—	—	—
16	Suryapet	—	—	—	—	—	—
17	Vikarabad	—	—	—	—	—	—
18	Warangal	8286	21934	66283	87128	126371	122203
19	Yadadri Bhuvanagiri	—	—	—	—	—	—

Upper Bhima Basin: In the districts of Upper Bhima basin region nitrogen consumption increased steadily from 1970 to 2010 due to expansion of irrigation and use of chemical fertilizers. Ahmednagar shows the highest consumption throughout, while Beed and Vijayapura remain among the lowest. The rise is linked to adoption of high-yield crops and intensive farming practices. The Nitrogen (N) Consumption in districts of Upper Bhima Basin districts is represented in table 11 below.

Table 11: Nitrogen Consumption in districts of Upper Bhima Basin

Nitrogen (N) Consumption in tons							
SL NO	**District**	**1970**	**1980**	**1990**	**2000**	**2010**	**2017**
1	Ahmednagar	9849	16991	55021	61860	99902	105164
2	Belgaum	8126	19200	42069	76410	101487	92878
3	Beed	2311	2481	16547	34176	61270	60321
4	Osmanabad	3517	5874	26118	41050	65704	57017
5	Pune	7094	10074	43112	53890	99667	97238
6	Sangli	5076	13815	37810	37495	74746	54620
7	Satara	4817	12570	32362	34842	50079	49264
8	Solapur	4714	11376	35590	51219	96340	101756
9	Vijayapura	2745	7781	18447	43706	79505	73977

Lower Bhima Basin: Nitrogen (N) consumption in Lower Bhima basin districts shows a steady increase from 1970 to 2010 due to expansion of irrigation and use of chemical fertilizers. Solapur and Kalaburgi recorded the highest consumption, while Bidar had lower levels and districts like sangareddy, vikarabad and Yadgir has no data available. The Nitrogen (N) Consumption in districts of Lower Bhima Basin districts is represented in table 12 below.

Table 12: Nitrogen Consumption in districts of Upper Bhima Basin

Nitrogen (N) Consumption in tons							
SL NO	District	1970	1980	1990	2000	2010	2017
1	Bidar	1481	3070	6836	11238	15799	10275
2	Kalaburgi	1050	1805	15609	27825	82629	70290
3	Osmanabad	3517	5874	26118	41050	65704	57017
4	Sangareddy	—	—	—	—	—	—
5	Solapur	4714	11376	35590	51219	96340	101756
6	Vijayapura	2745	7781	18447	43706	79505	73977
7	Vikarabad	—	—	—	—	—	—
8	Yadgiri	—	—	—	—	—	—

Upper Tungabhadra Basin: Nitrogen usage across these districts exhibits a gradual upward pattern, reflecting expanding agricultural practices. Chitradurga stands out with the highest level of consumption, followed by Shivamogga showing considerable usage. Chikkamagaluru maintains a moderate level, indicating balanced fertilizer application. Uttara Kannada records comparatively lower usage among the listed districts. A number of districts have missing data, suggesting limitations in data collection or reporting. The Nitrogen (N) Consumption in districts of Upper Tungabhadra Basin districts is represented in table 13 below.

Table 13: Nitrogen Consumption in districts of Upper Tungabhadra Basin

Nitrogen (N) Consumption in tons							
SL NO	District	1970	1980	1990	2000	2010	2017
1	Chikkamangaluru	2062	4830	12940	21714	28664	28833
2	Chitradurga	8261	13697	26822	58986	76814	63447
3	Davangere	—	—	—	—	—	—
4	Gadag	—	—	—	—	—	—
5	Haveri	—	—	—	—	—	—
6	Koppal	—	—	—	—	—	—
7	Shivamogga	4606	12033	21378	25369	39171	29018
8	Uttara Kannada	650	1196	2808	4305	7517	8781
9	Vijayanagar	—	—	—	—	—	—

Lower Tungabhadra Basin: Nitrogen consumption shows an overall increasing trend across the districts over time. Among the available data, Kurnool and Raichur show the highest consumption levels, followed by Ballari and Chitradurga. Moderate consumption is observed in Ananthapur, Hassan, Chikkamagaluru, and Tumkur. The lowest consumption levels are seen in Chikkamagaluru and Tumkur compared to other districts. Several districts have no available data, indicating gaps in reporting. The Nitrogen (N) Consumption in districts of Lower Tungabhadra Basin districts is represented in table 14 below.

Table 14: Nitrogen Consumption in districts of Lower Tungabhadra Basin

Nitrogen (N) Consumption in tons							
SL NO	**District**	**1970**	**1980**	**1990**	**2000**	**2010**	**2017**
1	Ananthapur	3124	5789	24837	32955	60705	38288
2	Ballari	7165	19668	39325	63741	88074	70669
3	Chikkamangaluru	2062	4830	12940	21714	28664	28833
4	Chitradurga	8261	13697	26822	58986	76814	63447
5	Davangere	—	—	—	—	—	—
6	Hassan	3917	10425	18994	32056	35723	32894
7	Jogulamba Godwal	—	—	—	—	—	—
8	Kurnool	17467	20129	46616	86752	127189	140564
9	Koppal	—	—	—	—	—	—
10	Nadyal	—	—	—	—	—	—
11	Raichur	7517	22000	51302	101582	151135	115832
12	Sri Satya Sai	—	—	—	—	—	—
13	Tumkur	3013	6850	12725	27927	27684	24548
14	Vijayanagara	—	—	—	—	—	—

3.1.2 Phosphate Consumption:

Upper Krishna Basin: Phosphate consumption increased significantly across districts of Upper Krishna Basin. Raichur recorded the highest usage, while Vijayapura and Belgaum showed steady growth from lower levels. Dharwad, Kolhapur, Sangli, and Satara maintained moderate consumption. Data for Bagalkot, Gadag, Haveri, and Koppal was unavailable. Overall, usage peaked around 2010 and declined by 2017. The phosphate (PO_4) Consumption in districts of Upper Krishna Basin districts is represented in table 15 below.

Table 15: Phosphate Consumption in districts of Upper Krishna Basin

Phosphate (PO_4) Consumption in tons							
SL NO	**District**	**1970**	**1980**	**1990**	**2000**	**2010**	**2017**
1	Bagalkot	—	—	—	—	—	—

2	Belgaum	2446	5405	19478	27675	64120	39229
3	Dharwad	1221	7393	23591	41200	58408	31066
4	Gadag	—	—	—	—	—	—
5	Haveri	—	—	—	—	—	—
6	Kolhapur	2892	13913	23812	21143	39649	31024
7	Koppal	—	—	—	—	—	—
8	Raichur	3111	8435	25809	49136	103845	62617
9	Sangli	2474	3488	18926	18170	47620	27950
10	Satara	2609	3123	14679	13639	33493	25804
11	Sindhudurg	—	—	—	—	—	—
12	Vijayapura	1330	2255	10740	20100	49953	37407
13	Yadgir	—	—	—	—	—	—

Middle Krishna Basin: Phosphate (PO_4) consumption in Middle Krishna increased steadily from 1970 to 2010 due to growing fertilizer use and expansion of irrigated farming. Raichur recorded the highest consumption, followed by Nalgonda, while Mahabubnagar remained moderate. The rise reflects adoption of improved crop varieties and commercial agriculture. Data for districts like Jogulamba Gadwal, Nandyal, Nagarkurnool, Palnadu, Prakasam, Rangareddy, Vikarabad, Wanaparthi, yadgiri are not available. The phosphate (PO_4) Consumption in districts of Middle Krishna Basin districts is represented in table 16 below.

Table 16: Phosphate Consumption in districts of Middle Krishna Basin

Phosphate (PO_4) Consumption in tons							
SL NO	**District**	**1970**	**1980**	**1990**	**2000**	**2010**	**2017**
1	Jogulamba Gadwal	—	—	—	—	—	—
2	Mahabubnagar	1049	4888	20365	26612	48593	35010
3	Nadyal	—	—	—	—	—	—
4	Nagarakurnool	—	—	—	—	—	—
5	Nalgonda	2434	5393	18759	37666	74875	14763
6	Narayanpet	—	—	—	—	—	—
7	Palnadu	—	—	—	—	—	—
8	Prakasam	—	—	—	—	—	—
9	Raichur	3111	8435	25809	49136	103845	62617
10	Rangareddy	—	—	—	—	—	—
11	Vikarabad	—	—	—	—	—	—
12	Wanaparthi	—	—	—	—	—	—
13	Yadgiri	—	—	—	—	—	—

Lower Krishna Basin: Phosphate (PO_4) consumption in Lower Krishna districts increased markedly from 1970 to 2010 due to expanding irrigation and greater reliance on chemical fertilizers. Guntur recorded the highest usage, followed by Krishna and Warangal, while Hyderabad remained lower. The growth reflects commercial agriculture and adoption of improved crop varieties. The phosphate (PO_4) Consumption in districts of Lower Krishna Basin districts is represented in table 17 below.

Table 17: Phosphate Consumption in districts of Lower Krishna Basin

Phosphate (PO_4) Consumption in tons							
SL NO	District	1970	1980	1990	2000	2010	2017
1	Bapatla	—	—	—	—	—	—
2	Bhadradri Kothagudem	—	—	—	—	—	—
3	Gunturu	10911	19055	55156	63194	138440	89900
4	Hanumakonda	—	—	—	—	—	—
5	Hyderabad	1648	1523	14144	45923	32325	15280
6	Jagoan	—	—	—	—	—	—
7	Khammam	2072	1585	15969	22114	38922	8795
8	Krishna	7118	9322	37906	53168	70715	39105
9	Mahabubnagar	1049	4888	20365	26612	48593	35010
10	Medchal Malkajgiri	—	—	—	—	—	—
11	Nalgonda	2434	5393	18759	37666	74875	14763
12	NTR	—	—	—	—	—	—
13	Palnadu	—	—	—	—	—	—
14	Rangareddy	—	—	—	—	—	—
15	Siddipet	—	—	—	—	—	—
16	Suryapet	—	—	—	—	—	—
17	Vikarabad	—	—	—	—	—	—
18	Warangal	3031	5934	27297	26604	42748	31481
19	Yadadri Bhuvanagiri	—	—	—	—	—	—

Upper Bhima Basin: Phosphate (PO_4) consumption in the districts of Upper Bhima basin increased from 1970 to 2010 due to greater use of fertilizers and intensive farming. Ahmednagar and Solapur recorded the highest use, while Vijayapura and Beed had lower consumption. The growth is linked to high-yield crops and irrigation expansion. The phosphate (PO_4) Consumption in districts of Upper Bhima Basin districts is represented in table 18 below.

Table 18: Phosphate Consumption in districts of Upper Bhima Basin

Phosphate (PO_4) Consumption in tons							
SL NO	**District**	**1970**	**1980**	**1990**	**2000**	**2010**	**2017**
1	Ahmednagar	2364	6794	27574	29384	72618	66273
2	Belgaum	2446	5405	19478	27675	64120	39229
3	Beed	1964	1400	9819	15947	40248	41388
4	Osmanabad	2119	1970	17563	27180	55999	50445
5	Pune	2358	3545	18905	24369	63938	48290
6	Sangli	2474	3488	18926	18170	47620	27950
7	Satara	2609	3123	14679	13639	33493	25804
8	Solapur	2494	3757	16863	22057	76135	49267
9	Vijayapura	1330	2255	10740	20100	49953	37407

Lower Bhima Basin: Phosphate (PO_4) use in Lower Bhima basin districts shows a clear upward trend from 1970 to 2010 as farmers increasingly depended on fertilizers to improve crop productivity. Solapur and Kalaburagi emerge as major consumers, whereas Bidar remains relatively low. This pattern reflects the shift toward commercial farming and better access to agricultural inputs. The phosphate (PO_4) Consumption in districts of Lower Bhima Basin districts is represented in table 19 below.

Table 19: Phosphate Consumption in districts of Lower Bhima Basin

Phosphate (PO_4) Consumption in tons							
SL NO	**District**	**1970**	**1980**	**1990**	**2000**	**2010**	**2017**
1	Bidar	371	838	4217	5840	16214	8497
2	Kalaburgi	174	1030	15634	25909	62315	46001
3	Osmanabad	2119	1970	17563	27180	55999	50445
4	Sangareddy	—	—	—	—	—	—
5	Solapur	2494	3757	16863	22057	76135	49267
6	Vijayapura	1330	2255	10740	20100	49953	37407
7	Vikarabad	—	—	—	—	—	—
8	Yadgiri	—	—	—	—	—	—

Upper Tungabhadra Basin: Phosphate consumption across the districts reflects a progressive rise, indicating increased use of fertilizers in agriculture. Chitradurga emerges as the leading district in terms of consumption, followed by Shivamogga with considerable usage levels. Chikkamagaluru shows moderate consumption, suggesting balanced agricultural practices. Uttara Kannada records comparatively lower levels of usage. Several districts have no recorded data, highlighting gaps in data availability or reporting. The phosphate (PO4) Consumption in districts of Upper Tungabhadra Basin districts is represented in table 20 below.

Table 20: Phosphate Consumption in districts of Upper Tungabhadra Basin

Phosphate (PO_4) Consumption in tons							
SL NO	**District**	**1970**	**1980**	**1990**	**2000**	**2010**	**2017**
1	Chikkamangaluru	764	2480	9281	12852	20846	17782
2	Chitradurga	3497	6385	18257	32375	54844	36388
3	Davangere	—	—	—	—	—	—
4	Gadag	—	—	—	—	—	—
5	Haveri	—	—	—	—	—	—
6	Koppal	—	—	—	—	—	—
7	Shivamogga	2258	6020	15537	16138	25692	17441
8	Uttara Kannada	256	599	1433	3160	5084	4050
9	Vijayanagar	—	—	—	—	—	—

Lower Tungabhadra Basin: Phosphate consumption across the districts shows a gradual increasing trend, indicating growing reliance on fertilizers. Kurnool and Raichur record the highest consumption levels, followed by Ballari and Chitradurga. Ananthapur and Hassan display moderate usage, reflecting stable agricultural activity. Lower levels of consumption are seen in Chikkamagaluru and Tumkur compared to other districts. A few districts have no available data, suggesting gaps in data collection or reporting. The phosphate (PO_4) Consumption in districts of Lower Tungabhadra Basin districts is represented in table 21 below.

Table 21: Phosphate Consumption in districts of Lower Tungabhadra Basin

Phosphate (PO_4) Consumption in tons							
SL NO	**District**	**1970**	**1980**	**1990**	**2000**	**2010**	**2017**
1	Ananthapur	910	2640	16766	19773	42480	26127
2	Ballari	2410	7821	28884	29021	54774	37463
3	Chikkamangaluru	764	2480	9281	12852	20846	17782
4	Chitradurga	3497	6385	18257	32375	54844	36388
5	Davangere	—	—	—	—	—	—
6	Hassan	1604	6018	12303	16540	25271	19091
7	Jogulamba Godwal	—	—	—	—	—	—

8	Kurnool	8756	9899	29717	53880	101451	80498
9	Koppal	—	—	—	—	—	—
10	Nandyal	—	—	—	—	—	—
11	Raichur	3111	8435	25809	49136	103845	62617
12	Sri Satya Sai	—	—	—	—	—	—
13	Tumkur	1056	3094	10781	14352	18593	13290
14	Vijayanagara	—	—	—	—	—	—

3.1.3 Potash Consumption:

Upper Krishna Basin: Potash consumption showed strong growth across districts over the Upper Krishna basin. Belgaum and Raichur recorded the highest usage, while Kolhapur and Sangli showed moderate growth. Dharwad, Satara, and Vijayapura remained at lower levels with gradual increases. Data for Bagalkot, Gadag, Haveri, Koppal, Sindhudurg and Yadgir was unavailable. The potash (K_{20}) Consumption in districts of Upper Krishna Basin districts is represented in table 22 below.

Table 22: Potash Consumption in districts of Upper Krishna Basin

Potash (K_{20}) Consumption in tons							
SL NO	**District**	**1970**	**1980**	**1990**	**2000**	**2010**	**2017**
1	Bagalkot	—	—	—	—	—	—
2	Belgaum	431	4243	9156	18337	46713	33264
3	Dharwad	545	5132	14448	15945	24660	12903
4	Gadag	—	—	—	—	—	—
5	Haveri	—	—	—	—	—	—
6	Kolhapur	1614	10038	22897	20447	35657	30580
7	Koppal	—	—	—	—	—	—
8	Raichur	1044	5758	14747	29088	46026	22756
9	Sangli	1589	2767	17955	16644	32254	24678
10	Satara	1479	2997	9480	11724	24774	19926
11	Sindhudurg	—	—	—	—	—	—
12	Vijayapura	232	1360	4868	10462	29966	23520
13	Yadgir	—	—	—	—	—	—

Middle Krishna Basin: Potash (K_{20}) consumption in Middle Krishna increased from 1970 to 2010, showing growing use of balanced fertilizers in agriculture. Raichur recorded the highest consumption, while Mahabubnagar and Nalgonda showed moderate levels. The rise is linked to improved farming practices and crop diversification. The potash (K_{20}) Consumption in districts of Middle Krishna Basin districts is represented in table 23 below.

Table 23: Potash Consumption in districts of Middle Krishna Basin

Potash (K_2O) Consumption in tons							
SL NO	**District**	**1970**	**1980**	**1990**	**2000**	**2010**	**2017**
1	Jogulamba Gadwal	—	—	—	—	—	—
2	Mahabubnagar	418	1345	4988	6289	17739	8556
3	Nadyal	—	—	—	—	—	—
4	Nagarakurnool	—	—	—	—	—	—
5	Nalgonda	502	1171	3584	8636	22918	5605
6	Narayanpet	—	—	—	—	—	—
7	Palnadu	—	—	—	—	—	—
8	Prakasam	—	—	—	—	—	—
9	Raichur	1044	5758	14747	29088	46026	22756
10	Rangareddy	—	—	—	—	—	—
11	Vikarabad	—	—	—	—	—	—
12	Wanaparthi	—	—	—	—	—	—
13	Yadgiri	—	—	—	—	—	—

Lower Krishna Basin: Potash (K_2O) consumption in Lower Krishna basin districts, Guntur recorded the highest consumption, followed by Krishna and Warangal, while Hyderabad and Khammam remained lower. The increase reflects crop diversification and improved agricultural inputs. The potash (K_2O) Consumption in districts of Lower Krishna Basin districts is represented in table 24 below.

Table 24: Potash Consumption in districts of Lower Krishna Basin

Potash (K_2O) Consumption in tons							
SL NO	**District**	**1970**	**1980**	**1990**	**2000**	**2010**	**2017**
1	Bapatla	—	—	—	—	—	—
2	Bhadradri Kothagudem	—	—	—	—	—	—
3	Gunturu	4550	6930	22456	19317	48170	25004
4	Hanumakonda	—	—	—	—	—	—
5	Hyderabad	1115	509	3302	15797	22820	10357
6	Jagoan	—	—	—	—	—	—
7	Khammam	546	415	3338	6885	21131	3643
8	Krishna	1879	4679	13052	34417	37400	20768

9	Mahabubnagar	418	1345	4988	6289	17739	8556
10	Medchal Malkajgiri	—	—	—	—	—	—
11	Nalgonda	502	1171	3584	8636	22918	5605
12	NTR	—	—	—	—	—	—
13	Palnadu	—	—	—	—	—	—
14	Rangareddy	—	—	—	—	—	—
15	Siddipet	—	—	—	—	—	—
16	Suryapet	—	—	—	—	—	—
17	Vikarabad	—	—	—	—	—	—
18	Warangal	311	1434	3501	7048	25698	16202
19	Yadadri Bhuvanagiri	—	—	—	—	—	—

Upper Bhima Basin: Potash (K_{20}) consumption in Upper Bhima shows a steady increase from 1970 to 2010 due to rising fertilizer use and intensive agriculture. Ahmednagar and Solapur recorded the highest consumption, while Vijayapura and Beed had lower levels. The growth is linked to adoption of high-yield crops and irrigation expansion. The potash (K_{20}) Consumption in districts of Upper Bhima Basin districts is represented in table 25 below.

Table 25: Potash Consumption in districts of Upper Bhima Basin

Potash (K_{20}) Consumption in tons							
SL NO	**District**	**1970**	**1980**	**1990**	**2000**	**2010**	**2017**
1	Ahmednagar	1784	4929	15001	16277	51638	41883
2	Belgaum	431	4243	9156	18337	46713	33264
3	Beed	1110	977	3127	6566	26118	21125
4	Osmanabad	1093	1272	6531	13225	25817	19119
5	Pune	1704	2274	11912	14665	43864	34456
6	Sangli	1589	2767	17955	16644	32254	24678
7	Satara	1479	2997	9480	11724	24774	19926
8	Solapur	1668	2691	10492	15918	53373	38343
9	Vijayapura	232	1360	4868	10462	29966	23520

Lower Bhima Basin: Potash (K_{20}) consumption in Lower Bhima basin districts shows gradual growth from 1970 to 2010, indicating increasing awareness of balanced fertilization in agriculture. Solapur and Kalaburagi recorded higher consumption, while Bidar remained comparatively low. The rise reflects diversification of crops and improved farming inputs over time. The potash (K_{20}) Consumption in districts of Lower Bhima Basin districts is represented in table 26 below.

Table 26: Potash Consumption in districts of Lower Bhima Basin

Potash (K_{20}) Consumption in tons							
SL NO	**District**	**1970**	**1980**	**1990**	**2000**	**2010**	**2017**
1	Bidar	117	340	812	2383	3717	2388
2	Kalaburgi	142	226	2164	4720	18499	12551
3	Osmanabad	1093	1272	6531	13225	25817	19119
4	Sangareddy	—	—	—	—	—	—
5	Solapur	1668	2691	10492	15918	53373	38343
6	Vijayapura	232	1360	4868	10462	29966	23520
7	Vikarabad	—	—	—	—	—	—
8	Yadgiri	—	—	—	—	—	—

Upper Tungabhadra Basin: Potash consumption across Karnataka's districts in Upper Tungabhadra basin has shown a general rising trend over the decades. Chikkamagalur emerged as the highest consumer, reflecting its intensive agricultural practices. Chitradurga and Shivamogga also grew significantly but experienced a slight decline in later years. Uttara Kannada maintained comparatively lower consumption throughout the entire period. Several districts lack recorded data, likely due to administrative reorganization or inadequate records. The potash (K_{20}) Consumption in districts of Upper Tungabhadra Basin districts is represented in table 27 below.

Table 27: Potash Consumption in districts of Upper Tungabhadra Basin

Potash (K_{20}) Consumption in tons							
SL NO	**District**	**1970**	**1980**	**1990**	**2000**	**2010**	**2017**
1	Chikkamangaluru	841	1863	8076	14785	20613	20329
2	Chitradurga	1994	2850	10427	12736	27091	13890
3	Davangere	—	—	—	—	—	—
4	Gadag	—	—	—	—	—	—
5	Haveri	—	—	—	—	—	—
6	Koppal	—	—	—	—	—	—
7	Shivamogga	2464	4819	10895	12519	18804	14377
8	Uttara Kannada	325	848	2248	2338	4506	3845
9	Vijayanagar	—	—	—	—	—	—

Lower Tungabhadra Basin: Potash consumption across the districts shows a steady upward trend, indicating increasing dependence on fertilizers in agriculture. Kurnool and Raichur record the highest levels of consumption among the districts. Ballari and Chitradurga also demonstrate relatively higher usage patterns. Anantapur and Hassan reflect moderate consumption, suggesting stable agricultural practices. Lower consumption is observed in Chikkamagaluru and Tumkur, while several districts have no available data, indicating possible gaps in reporting. The potash (K_{20}) Consumption in districts of Lower Tungabhadra Basin districts is represented in table 28 below.

Table 28: Potash Consumption in districts of Lower Tungabhadra Basin

Potash (K_{20}) Consumption in tons							
SL NO	**District**	**1970**	**1980**	**1990**	**2000**	**2010**	**2017**
1	Ananthapur	154	1732	6734	8562	25911	12070
2	Ballari	818	7644	19787	16483	26674	13491
3	Chikkamangaluru	841	1863	8076	14785	20613	20329
4	Chitradurga	1994	2850	10427	12736	27091	13890
5	Davangere	—	—	—	—	—	—
6	Hassan	1191	3196	9579	13407	22081	15439
7	Jogulamba Gadwal	—	—	—	—	—	—
8	Kurnool	1730	3320	8886	15850	34935	24777
9	Koppal	—	—	—	—	—	—
10	Nandyal	—	—	—	—	—	—
11	Raichur	1044	5758	14747	29088	46026	22756
12	Sri Satya Sai	—	—	—	—	—	—
13	Tumkur	638	1759	3252	6225	8175	6346
14	Vijayanagara	—	—	—	—	—	—

4. Socio – Economics

Socioeconomics in an agricultural profile refers to the study of the social and economic conditions of farmers and rural communities. It includes factors such as land ownership, income, education, occupation, farming practices and access to resources like water, credit and markets. Socio-economic conditions influence the productivity and livelihood of farmers and determine their standard of living. Understanding the socio-economics of agriculture helps in planning better farming policies, improving rural development and increasing agricultural sustainability.

4.1 Farmer Demographics

Farmer demographics refer to the characteristics and composition of the farming population in a particular area or region. It includes information such as age, gender, education level, family size, farming experience, and occupation of farmers. Farmer demographics also provide insights into labor availability, adoption of modern farming techniques, and decision-making patterns in agriculture. Studying farmer demographics is important for designing effective agricultural policies, training programs, and rural development initiatives.

The Farmer Demographics data used in this study has been obtained from Secondary data like District at a Glance Reports and International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) 2011. District-wise tables for individual sub-basins are presented in the following sections to illustrate the spatial distribution of farmer demographics pattern across the Krishna River basin. The farmer demographics in below tables are calculated as Agricultural Cultivator population ratio per 1000 persons and total Agricultural Labours ratio per 1000 persons

Upper Krishna Basin: The Upper Krishna basin's farmer demographics reveals a varied distribution of agricultural and non-agricultural labor across 12 districts. Belagavi leads in total agricultural cultivators, followed closely by Kolhapur and Dharwad, reflecting their strong farming base. In terms of agricultural laborers, Dharwad records the highest with Belagavi and Vijayapura also showing substantial labor presence. Non-agricultural labor is most prominent in Belagavi, Dharwad and Kolhapur, indicating a relatively diversified rural economy in these districts. Notably, several districts including Sindhudurg, Bagalkot, Yadgiri, Gadag and Koppal report zero values across all categories, likely due to incomplete data records or administrative boundary considerations. The farmer demographics data of the Upper Krishna basin districts is represented in the table 29 below.

Table 29: Farmer Demographics in districts of Upper Krishna Basin

Sl.No	Districts	Total Agricultural Cultivators /1000 numbers	Total Agricultural Labours /1000 numbers	Non-Agricultural Labours
1	Satara	585.88	297.24	1648.79
2	Sangli	480.55	290.69	1607.04
3	Sindhudurg	0	0	0
4	Kolhapur	660.87	266.03	2171.95
5	Dharwad	494.78	719.21	2498.64
6	Belagavi	711.98	649.52	2673.99
7	Bagalkot	0	0	0
8	Raichur	408.71	656.55	1760.55
9	Vijayapura	458.42	654.84	0
10	Yadgiri	0	0	0
11	Gadag	0	0	0

12	Koppal	0	0	0

Middle Krishna Basin: The Middle Krishna basin's farmer demographics presents a sparse distribution of agricultural activity across its 13 districts. Mahabubnagar stands out as the dominant district with the highest total agricultural cultivators and the largest agricultural labour force, indicating a strong agrarian economy within the basin. Nalagonda follows as the second most active district, reflecting considerable farming engagement. The remaining districts like Raichur, Yadgir, Vikarabad, Rangareddy, Palnadu, Prakasam, Nagarkurnool, Nandyal, Wanaparthy, Jogulamba Gadwal and Narayanpet report either zero or no recorded values across all categories, suggesting either data unavailability or minimal agricultural activity within the basin boundary. The farmer demographics in the districts of Middle Krishna basin is represented in the table 30 below.

Table 30: Farmer Demographics in districts of Middle Krishna Basin

Sl.No	Districts	Total Agricultural Cultivators/1000 numbers	Total Agricultural Labours /1000 numbers
1	Raichur	-	-
2	Yadgir	0	0
3	Vikarabad	0	0
4	Rangareddy	0	0
5	Nalagonda	325.22	863.13
6	Palnadu	0	0
7	Prakasam	0	0
8	Nagarkurnool	0	0
9	Nandyal	0	0
10	Wanaparthy	0	0
11	Mahabubnagar	569.14	931.08
12	Jogulamba Gadwal	0	0
13	Narayanpet	0	0

Lower Krishna Basin: The Lower Krishna basin's farmer demographics reflects a highly uneven distribution of agricultural workforce across the districts. Guntur emerges as the most agriculturally active district, recording the highest agricultural cultivators and the largest agricultural labour force, signifying its pivotal role in the basin's farming economy. Krishna district follows with a notably high agricultural labour despite a relatively modest cultivator, suggesting a labour-intensive farming structure. Warangal, Nalagonda, Hyderabad and Khammam also contribute meaningfully to the basin's agricultural workforce. The remaining districts like Bapatla, NTR, Palnadu, Badradri Kothagudem, Mahabubabad, Hanumakonda, Jangoan, Siddipet, Medchal Malkajgiri, Yadadri Bhuvanagiri, Vikarabad and Suryapet report zero values, likely attributable to data gaps or partial inclusion within the basin boundary. The farmer demographics in the districts of Lower Krishna basin is represented in the table 31 below.

Table 31: Farmer Demographics in districts of Lower Krishna Basin

Sl.No	Districts	Total Agricultural Cultivators/1000 numbers	Total Agricultural Labours/1000 numbers
1	Krishna	150.17	1006.98
2	Bapatla	0	0
3	Guntur	431.15	1637
4	NTR	0	0
5	Palnadu	0	0
6	Khammam	224.97	804.54
7	Badradri kothagudem	0	0
8	Mahabubabad	0	0
9	Warangal	401.65	758.09
10	Hanumakonda	0	0
11	Jangoan	0	0
12	Siddipet	0	0
13	Medchal Malkajgiri	0	0
14	Hyderabad	299.24	372.06
15	Yadadri Bhuvanagiri	0	0
16	Vikarabad	0	0
17	Nalagonda	325.22	863.13
18	Suryapet	0	0

Upper Bhima Basin: The Upper Bhima basin's farmer demographics reveals a relatively well-distributed agricultural workforce across the districts. Ahmednagar leads with the highest cultivators, followed by Pune, reflecting their dominant agrarian presence in the basin. Solapur, Beed and Dharashiv also record substantial cultivator and labour figures, with Dharashiv notably exhibiting a higher labour count relative to its cultivator base, indicating greater dependence on hired agricultural labour. Vijayapura contributes meaningfully with 458.42 cultivators and 654.84 labourers, further reinforcing its agricultural significance within the basin. Sangli and Satara report no recorded data, likely due to partial inclusion within the basin boundary or administrative data gaps. The farmer demographics in the districts of Upper Bhima basin is represented in the table 32 below.

Table 32: Farmer Demographics in districts of Upper Bhima Basin

Sl. No	Districts	Total Agricultural Cultivators/1000 numbers	Total Agricultural Labours/1000 numbers
1	Ahmednagar	1013.05	559.01
2	Pune	886.53	414.46
3	Solapur	637.25	558.33
4	Beed	606.28	373.57
5	Dharashiv	629.14	716.11
6	Sangli	-	-
7	Vijayapura	458.42	654.84
8	Satara	-	-

Lower Bhima Basin: The Lower Bhima basin's farmer demographics highlights a moderate but unevenly distributed agricultural workforce across the districts. Solapur leads with the highest cultivator, closely followed by Dharashiv, both reflecting a strong cultivator presence in the basin. In terms of agricultural labourers, Kalaburagi records the highest, followed by Vijayapura and Dharashiv indicating considerable labour dependency in these districts. Bidar contributes moderately, while Sangreddy, Vikarabad and Yadgir report zero values across all categories, likely due to data unavailability or minimal inclusion within the basin boundary. The farmer demographics in the districts of Lower Bhima basin is represented in the table 33 below.

Table 33: Farmer Demographics in districts of Lower Bhima Basin

Sl.No	Districts	Total Agricultural Cultivators /1000 numbers	Total Agricultural Labours/1000 numbers
1	Dharashiv	629.14	716.11
2	Sangareddy	0	0
3	Vikarabad	0	0
4	Solapur	637.25	558.33
5	Bidar	141.3	280.09
6	Kalaburagi	379.53	649.93
7	Yadgir	0	0
8	Vijayapura	458.42	654.84

Upper Tungabhadra Basin: The Upper Tungabhadra basin's farmer demographics reveals a stark contrast in agricultural activity across its 11 districts. Dharwad leads with the highest cultivator count at 494.78 and a substantial agricultural labour force of 719.21, alongside the second highest non-agricultural workforce, reflecting a well-diversified rural economy. Chitradurga follows with 517.10 cultivators and 590.21 labourers, recording the highest non-agricultural workforce at 1873.16, indicating a growing non-farm employment base. Ballari and Shivamogga also contribute meaningfully with moderate cultivator and labour figures, supported by considerable non-agricultural worker counts of 1335.72 and 972.16 respectively. In contrast, Koppal, Gadag, Vijayanagara, Haveri and Davangere report zero values across all categories, likely due to data unavailability or their minimal spatial inclusion within the basin boundary. The farmer demographics in the districts of Upper Tungabhadra basin is represented in the table 34 below.

Table 34: Farmer Demographics in districts of Upper Tungabhadra Basin

Sl.No	District	Total Agricultural Cultivators /1000 numbers	Total Agricultural Labours /1000 numbers	Non-Agricultural Workers
1	Koppal	0	0	0
2	Gadag	0	0	0
3	Vijayanagara	0	0	0
4	Haveri	0	0	0
5	Davangere	0	0	0
6	Uttar Kannada	111.58	116.34	828.64
7	Ballari	258.08	406.09	1335.72
8	Shivamogga	204.49	246.46	972.16
9	Dharwad	494.78	719.21	2498.64
10	Chikkamagaluru	155.39	126.6	572.19
11	Chitradurga	517.1	590.21	1873.16

Lower Tungabhadra Basin: The Lower Tungabhadra basin's farmer demographics displays a diverse and unevenly distributed agricultural workforce across its 14 districts. Kurnool stands out with the highest agricultural labour force and the largest non-agricultural workforce, despite a moderate cultivator indicating a highly labour-intensive farming structure. Chitradurga leads in cultivator count at 517.10 with 590.21 labourers and a significant non-agricultural workforce of 1873.16, followed closely by Tumakuru and Ananthapur, reflecting strong agrarian and diversified economies. Raichur and Hassan also contribute notably, with Raichur recording 408.71 cultivators and a substantial non-agricultural workforce of 1760.55, while Hassan maintains moderate figures across all categories. Bagalkot, Koppal, Vijayanagara, Davangere, SriSatyaSai and Jogulamba Gadwal report zero values across all categories, likely attributable to data gaps or minimal spatial inclusion within the basin boundary. The farmer demographics in the districts of Lower Tungabhadra basin is represented in the table 35 below.

Table 35: Farmer Demographics in districts of Lower Tungabhadra Basin

Sl.No	Districts	Total Agricultural Cultivators/1000 numbers	Total Agricultural Labours/1000 numbers
1	Raichur	408.71	656.55
2	Ballari	258.08	406.09
3	Chitradurga	517.1	590.21
4	Tumakuru	505.91	352.29
5	Hassan	437.03	165.91
6	Chikkamagaluru	155.39	126.6
7	Bagalkot	0	0
8	Koppal	0	0
9	Vijayanagara	0	0
10	Davangere	0	0
11	Kurnool	355.75	1179.58
12	Ananthapur	413.25	879.54
13	SriSatyaSai	0	0
14	Jogulamba Gadwal	0	0

4.2 Land holdings

Landholding patterns within the Krishna River Basin exhibit considerable variation across districts and sub-basins, reflecting differences in agricultural practices, population pressure, and resource availability. The region is predominantly characterized by marginal and small landholdings, resulting in fragmented agricultural landscapes in many areas. Landholding size plays an important role in influencing cropping choices, irrigation practices, mechanization, and investment capacity of farmers. Smaller holdings often limit the adoption of advanced irrigation systems and efficient farm management practices, whereas medium and large landholders generally possess better access to financial resources and irrigation infrastructure.

The agricultural land holding data used in this study has been obtained from secondary sources, primarily the National Bank for Agriculture and Rural Development (NABARD) Rural Infrastructure and Agricultural Reports (2025–2026). The landholdings are classified into marginal, small, medium, and large farmer categories for each district within the respective sub-basins of the Krishna River Basin. District-wise tables for individual sub-basins are presented in the following sections to illustrate the spatial distribution of agricultural landholding patterns across the basin.

Upper Krishna Basin: The pattern of land holdings in the Upper Krishna Basin reflects significant regional disparities in farm size distribution across districts. Among marginal land holdings, Satara has the highest concentration while Haveri records the lowest. In small land holdings, Belgaum stands out as the highest, whereas Haveri again shows the lowest presence. For medium land holdings, Koppal has the highest share, while Haveri records the least. In large land holdings, Kolhapur has the highest dominance, whereas Haveri shows the lowest. Overall, the pattern indicates that most districts are dominated by smaller and marginal farmers, while large holdings are limited and concentrated in a few districts. The agricultural land holdings in the districts of Upper Krishna basin are represented below in Table 36.

Table 36: Agricultural land holdings in the districts of Upper Krishna basin

Sl.no	District	Marginal <=1 ha		Small >1 to < = 2ha		Medium >4 to < = 10ha		Large > 10ha	
		Nos	Area	Nos	Area	Nos	Area	Nos	Area
1	Bagalkot	89615	51318	84788	122532	21541	123116	2149	31822
2	Belgaum	294982	141465	170553	243289	44991	256264	5196	87227
3	Dharwad	49097	29237	57524	83798	17705	103133	2204	30231
4	Gadag	46349	28444	68571	99393	_	_	_	_
5	Haveri	39	39	37	37	6	6	1	1
6	Kolhapur	504117	168114	105492	128903	1634	38260	39416	96908
7	Koppal	83131	47101	79083	112565	212486	295809	_	_
8	Raichur	110208	62743	92290	130884	29695	172499	4848	81258
9	Sangli	335037	144203	121394	160337	24913	142922	3114	50940
10	Satara	674344	241696	127574	175638	_	_	_	_
11	Sindhudurg	244765	58945	39692	48244	3100	52522	30228	87854
12	Vijayapura	63100	40237	132545	192390	53714	314346	7461	101620
13	Yadgir	80151	44849	81160	117839	18753	106712	1971	26453

Middle Krishna Basin: The agricultural landholding pattern in the Middle Krishna sub-basin indicates a dominance of marginal and small farmers, reflecting fragmented land ownership and dependence on agriculture. In the marginal category, Palnadu has the highest number of holdings, while Nalgonda has the highest area, and Narayanpet records the lowest number and area. In small holdings, Prakasam has the highest number, whereas Nalgonda has the highest area, with the lowest values observed in Wanaparthi and Narayanpet respectively. For medium holdings, Raichur has the highest number and area, while Vikarabad has the lowest number and lowest area and data is not available for Jogulamba Gadwal, Nagarakurnool, and Wanaparthi. In large holdings, Nalgonda ranks highest in both number and area, while Narayanpet has the lowest number and lowest area, data is not available for Jogulamba Gadwal, Nagarakurnool, and Wanaparthi. Overall, some districts have more large farms, while others have many small and divided farms, showing differences in land distribution. The agricultural land holdings in the districts of Middle Krishna basin are represented below in Table 37.

Table 37: Agricultural land holdings in the districts of Middle Krishna basin

SL NO	Districts	Marginal < = 1ha		Small >1 to <=2 ha		Medium >4 to <=10 ha		Large >10 ha	
		Number	Area	Number	Area	Number	Area	Number	Area
1	Jogulamba Gadwal	89074	76414	44601	39038	—	—	—	—
2	Mahabubnagar	114266	53385	45050	63204	3251	17818	308	4522
3	Nandyal	178063	90704	95328	135134	13725	77546	858	16299
4	Nagarakurnool	166294	32363	82463	47035	—	—	—	—
5	Nalgonda	231153	277947	115289	402968	755	24957	46711	298837
6	Narayanpet	70554	15431	45756	26515	4628	10191	300	1617
7	Palnadu	281559	129180	82569	115693	7747	40375	310	8270
8	Prakasam	262344	124824	128584	184336	18776	103291	1327	18988
9	Raichur	110208	62743	92290	130884	29695	172499	4848	81258
10	Rangareddy	156355	177131	56853	196537	5585	19051	25888	168448
11	Vikarabad	126007	154538	59245	206763	733	24670	28162	183219
12	Wanaparthi	98083	41485	38399	54570	—	—	—	—
13	Yadgiri	80151	44849	81160	117839	18753	106712	1971	26453

Lower Krishna Basin: The Lower Krishna region shows a clear dominance of marginal and small farmers, indicating widespread land fragmentation and dependence on small-scale agriculture. In marginal holdings, Palnadu has the highest number, while Nalgonda has the highest area, Medchal Malkajgiri records the lowest values, and data is not available for Hyderabad. In small holdings, Nalgonda has the highest area and number of holdings, Medchal Malkajgiri shows the lowest values and data is not available for Hyderabad and NTR. For medium holdings, Suryapet has the highest medium holdings, and data is not available for Krishna, NTR, Hyderabad, Khammam and Siddipet in this category. In large holdings, Nalgonda shows the highest area and number of holdings, while Rangareddy also has a significant number of large holdings, and the lowest values are observed in districts Warangal, data is not available for Siddipet Hyderabad, Krishna and NTR. This reflects differences in agricultural development and land use patterns across the districts. The agricultural land holdings in the districts of Lower Krishna basin are represented below in Table 38.

Table 38: Agricultural land holdings in the districts of Lower Krishna basin

SL NO	Districts	Marginal < = 1ha		Small >1 to <=2 ha		Medium >4 to <=10 ha		Large >10 ha	
		Number	Area	Number	Area	Number	Area	Number	Area
1	Bapatla	269252	110372	58616	82889	4830	25232	197	3093
2	Bhadradri Kothagudem	54568	34671	37349	52263	4695	24854	189	2431
3	Gunturu	210545	81894	33221	46885	2027	10610	89	1738
4	Hanumakonda	104340	101798	25380	82908	2115	20534	705	4112
5	Hyderabad	0	0	0	0	0	0	0	0
6	Jagoan	88035	36444	29407	41391	224	3085	11838	31427
7	Khammam	207983	91817	58254	79966			31491	106390
8	Krishna	248315	93205	44278	61877	0	0	0	0
9	Mahabubnagar	114266	53385	45050	63204	3251	17818	308	4522
10	Medchal Malkajgiri	15070	13505	3369	11571	662	9338	78	3242
11	Nalgonda	231153	277947	115289	402968	755	24957	46711	298837
12	NTR	193202	107752	0	0	0	0	0	0
13	Palnadu	281559	129180	82569	115693	7747	40375	310	8270
14	Rangareddy	156355	177131	56853	196537	5585	19051	25888	168448
15	Siddipet	203697	90480	64909	90316	—	—	—	—
16	Suryapet	153300	171355	54957	190441	14387	220562	1165	1328
17	Vikarabad	126007	154538	59245	206763	733	24670	28162	183219
18	Warangal	192000	70636	32000	43932	250	2514	50	988
19	Yadadri Bhuvanagiri	101825	210618	47424	96135	310	3220	27500	55067

Upper Bhima Basin: The Lower Krishna region shows a clear dominance of marginal and small farmers, The agricultural landholding pattern in the Upper Bhima sub-basin is mainly characterized by a large number of marginal and small farmers, showing that land is highly fragmented and agriculture is largely practiced on a small scale. In marginal holdings, Satara has the highest number and area, while Vijayapura records the lowest values. In small holdings, Pune has the highest number, whereas Solapur has the highest area, and Ahmednagar shows the lowest values. For medium holdings, Vijayapura has the highest holdings, Solapur is the lowest holdings, and data is not available for Ahmednagar, Osmanabad and Satara. In large holdings, Solapur stands out with the highest number and area, while very low values are observed in district Beed, data is not available for Ahmednagar, Osmanabad and Satara. Overall, this reflects variations in agricultural development and landholding structure across the districts within the Upper Bhima sub-basin. The agricultural land holdings in the districts of Upper bhima basin are represented below in Table 39.

Table 39: Agricultural land holdings in the districts of Upper Bhima basin

SL NO	Districts	Marginal < = 1ha		Small >1 to <=2 ha		Medium >4 to <=10 ha		Large >10 ha	
		Number	Area	Number	Area	Number	Area	Number	Area
1	Ahmednagar	171170	62168	53947	77031	—	—	—	—
2	Beed	433643	176789	196151	266219	27295	151275	1555	24651
3	Belgaum	294982	141465	170553	243289	44991	256264	5196	87227
4	Osmanabad	158261	77622	141393	192218	—	—	—	—
5	Pune	485204	195639	289578	249303	40787	228596	5828	97077
6	Sangli	335037	144203	121394	160337	24913	142922	3114	50940
7	Satara	674344	241696	127574	175638	—	—	—	—
8	Solapur	3,25,387	1,43,158	2,26,400	3,00,786	5,015	80,496	1,64,427	4,36,185
9	Vijayapura	63100	40237	132545	192390	53714	314346	7461	101620

Lower Bhima Basin: The Lower Bhima basin is largely characterized by the dominance of marginal and small farmers, indicating fragmented land distribution and dependence on small-scale farming. In marginal holdings, Solapur has the highest number and Vikarabad highest area, while Sangareddy records the lowest values. In small holdings, Solapur again has the highest number and area, whereas Sangareddy shows the lowest. For medium holdings, Vijayapura has the highest Holdings. while Vikarabad records the lowest values, data is not available for Osmanabad and Sangareddy. In large holdings, Solapur stands out with the highest number and area, while Sangareddy has the lowest values, data is not available for Osmanabad. The agricultural land holdings in the districts of Lower bhima basin are represented below in Table 40.

Table 40: Agricultural land holdings in the districts of Lower Bhima basin

SL NO	Districts	Marginal < = 1ha		Small >1 to <=2 ha		Medium >4 to <=10 ha		Large >10 ha	
		Number	Area	Number	Area	Number	Area	Number	Area
1	Bidar	94038	51939	99037	139551	15720	89054	1629	21969
2	Kalaburgi	106374	60699	154013	223449	43871	250641	5681	78424
3	Osmanabad	158261	77622	141393	192218	—	—	—	—
4	Sangareddy	180	81	74	103	—	—	35	121
5	Solapur	3,25,387	1,43,158	2,26,400	3,00,786	5,015	80,496	1,64,427	4,36,185
6	Vijayapura	63100	40237	132545	192390	53714	314346	7461	101620
7	Vikarabad	126007	154538	59245	206763	733	24670	28162	183219
8	Yadgiri	80151	44849	81160	117839	18753	106712	1971	26453

Upper Tungabhadra Basin: The pattern of agricultural land in districts of Upper Tungabhadra Basin shows a varied distribution from marginal to large categories, reflecting differences in land ownership. Shivamogga has the highest marginal holdings, while Haveri has the lowest. Chitradurga leads in small holdings, whereas Haveri is the lowest. Koppal has the highest medium holdings, with Haveri the lowest. Chitradurga records the highest large holdings, while Haveri has the least. The agricultural land holdings in the districts of Upper Tungabhadra basin are represented below in Table 41.

Table 41: Agricultural land holdings in the districts of Upper Tungabhadra basin

Sl.no	District	Marginal <=1 ha		Small >1 to < = 2ha		Medium >4 to < = 10ha		Large > 10ha	
		Nos	Area	Nos	Area	Nos	Area	Nos	Area
1	Chikkamagaluru	134046	62582	55867	76814	123	53780	1804	46261
2	Chitradurga	119385	65090	97044	137698	24632	141109	3651	54831
3	Davangere	120564	59388	65375	90353	9848	54156	758	10946
4	Gadag	46349	28444	68571	99393	_	_	_	_
5	Haveri	39	39	37	37	6	6	1	1
6	Koppal	83131	47101	79083	112565	212486	295809	_	_
7	Shivamogga	146306	71256	57199	78865	6906	38688	736	10787
8	Uttara Kannada	151335	46715	31351	43319	3560	19497	234	3144
9	Vijayanagara	95450	46241	64881	89997	14836	82925	1505	21581

Lower Tungabhadra Basin: Land holdings in the Lower Tungabhadra Basin vary across districts, showing a mixed agrarian structure. Marginal holdings are highest in Hassan and lowest in Ballari. Small holdings are highest in Tumkur and lowest in Jogulamba Gadwal. Medium holdings are highest in Koppal and lowest in Chikkamagaluru, while large holdings are highest in Raichur and minimal in Sri satya sai, where only the number of holdings is given and area is not mentioned. The agricultural land holdings in the districts of Lower Tungabhadra basin are represented below in Table 42.

Table 42: Agricultural land holdings in the districts of Lower Tungabhadra basin

Sl.no	District	Marginal <=1 ha		Small >1 to < = 2ha		Medium >4 to < = 10ha		Large > 10ha	
		Nos	Area	Nos	Area	Nos	Area	Nos	Area
1	Ananthapur	136299	136111	58002	57941	_	_	_	_
2	Ballari	69825	33881	44046	59976	13787	77267	1581	21979
3	Chikkamagaluru	134046	62582	55867	76814	123	53780	1804	46261
4	Chitradurga	119385	65090	97044	137698	24632	141109	3651	54831
5	Davanagere	120564	59388	65375	90353	9848	54156	758	10946
6	Hassan	393407	149419	103184	143325	8382	46550	986	22255
7	Jogulamba Gadwal	89074	76414	44601	39038	_	_	__	__
8	Koppal	83131	47101	79083	112565	212486	295809	_	_
9	Kurnool	188189	102496	118104	168196	21337	118255	1443	23346
10	Nandyal	178063	90704	95328	135134	13725	77546	858	16299
11	Raichur	110208	62743	92290	130884	29695	172499	4848	81258
12	Sri satya sai	158870	_	120008	_	11802	_	952	_
13	Tumkur	301432	133908	123216	172508	22926	128408	2725	40772
14	Vijayanagara	95450	46241	64881	89997	14836	82925	1505	21581

6. Crop -Water Productivity Analysis

Crop-water Productivity (CWP) is an important indicator used to evaluate the efficiency of water utilization in agricultural systems. It represents the amount of crop yield produced per unit of water consumed by the crop through Evapotranspiration. In this study crop water productivity is assessed for the crops such as Rice, Soybean, Sugarcane, cotton, Groundnut and Maize using ratio of crop yield to actual evapotranspiration (AET), which reflects actual quantity of water utilized by crops during their growth period. Higher crop-water productivity indicates more efficient utilization of available water resources. Whereas lower values suggest inefficient water use and greater water demand for crop production. The formula to calculate crop-water productivity is

$$\boldsymbol{Crop\ Water\ Productivity(kg/m^3) = \frac{Crop\ Yield}{Actual\ Evapotranspiration}}$$

For this study, the datasets such as crop yield and the Actual Evapotranspiration is collected from International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) for the year 2019 for the major crops such as Rice, Soybean, Sugarcane, cotton, Groundnut and Maize and represented crop-wise for entire Krishna basin through tabular representation.

Table 43: Crop-Water Productivity of Rice in Krishna River Basin

SL.NO	State Name	District Name	Rice Yield (Kg /ha)	Evapotranspiration (ETA)	Crop-Water Productivity (kg/m^3)
1	Karnataka	Tumkur	3127	46.733	66.913
2		Hassan	2943	53.366	55.148
3		Shivamogga	2761	61.799	44.677
4		Chikkamagaluru	2562	38.661	66.269
5		Chitradurga	2551	51.902	49.151
6		Bellary	4216	56.698	74.358
7		Dharwad	1237	58.625	21.100
8		Belgaum	2517	59.132	42.566
9		Bijapur	3152	60.114	52.434
10		Bidar	1180	56.295	20.961
11		Raichur	3354	56.873	58.973
12		Gulbarga	3476	88.462	39.294
13		Dakshina Kannada	2820	70.063	40.249
14		Uttara Kannada	2282	57.573	39.637
15		Bagalkote	3110	48.112	64.641
16		Davanagere	3322	55.816	59.517
17		Gadag	2627	57.828	45.428
18		Haveri	1665	86.401	19.271
19		Udupi	2846	50.768	56.059
20		Yadgiri	3494	58.199	60.035
21	Andhrapradesh	Krishna	4004	65.941	60.721
22		Guntur	3985	58.434	68.196
23		Kurnool	3961	54.106	73.208
24		Anantapur	3400	44.879	75.759
25		Prakasam	3772	56.753	66.463
26	Telangana	Hyderabad	0	58.285	0.000
27		Mahabubnagar	3380	57.038	59.259
28		Nalgonda	3445	54.116	63.660
29		Warangal	3593	68.768	52.249
30		Khammam	3753	70.337	53.358
31		Rangareddy	3010	55.944	53.804
32		Bhadradri	3562	75.934	46.909
33		Jogulamba	3179	53.512	59.408
34		Nagarkurnool	3407	55.052	61.887
35		Wanaparthy	3306	57.917	57.082
36		Sangareddy	3658	61.173	59.797
37		Siddipet	3772	60.393	62.458
38		Suryapet	3584	62.139	57.677
39		Yadadri Bhuvanagiri	3633	58.598	61.999
40		Vikarabad	3383	57.028	59.322
41		Janagaon	3408	61.748	55.193
42		Hanumakonda	3658	64.536	56.682
43		Mahabubabad	3366	68.538	49.111
44		Narayanpet	3255	58.010	56.111
45	Maharashtra	Ahmednagar	1123	50.888	22.068
46		Pune	1809	53.438	33.853
47		Satara	1438	52.406	27.440
48		Sangli	1268	56.248	22.543
49		Solapur	157	57.403	2.735
50		Kolhapur	2437	57.822	42.147
51		Beed	125	55.613	2.248
52		Osmanabad	114	57.723	1.975
53		Sindhudurg	2500	67.509	37.032

Table 44: Crop-Water Productivity of Soyabean in Krishna River Basin

SL.NO	State Name	District Name	Soyabean Yield (Kg /ha)	Evapotranspiration (ETA)	Crop-Water Productivity (kg/m^3)
1	Karnataka	Gulbarga	1450	56.873	25.495
2		Bidar	1183	60.114	19.679
3		Davanagere	1167	48.112	24.256
4		Chikkamagaluru	1133	54.622	20.743
5		Koppal	1133	57.452	19.721
6		Chitradurga	1125	38.661	29.099
7		Bijapur	1125	59.132	19.025
8		Gadag	1125	55.816	20.156
9		Hassan	1122	53.366	21.025
10		Bellary	1121	51.902	21.599
11		Raichur	1118	56.295	19.860
12		Uttara Kannada	1111	70.063	15.857
13		Tumkur	1091	46.733	23.346
14		Dharwad	1017	56.698	17.937
15		Belgaum	1002	58.625	17.092
16		Shivamogga	1000	61.799	16.181
17		Yadgiri	1000	58.199	17.182
18		Bagalkote	716	57.573	12.436
19		Haveri	504	57.828	8.716
20		Dakshina Kannada	0	88.462	0.000
21	Andhrapradesh	Kurnool	1762	54.106	32.566
22		Anantapur	533	44.879	11.876
23		Krishna	0	65.941	0.000
24		Guntur	0	58.434	0.000
25		Prakasam	0	56.753	0.000
26	Telangana	Vikarabad	2224	57.028	38.999
27		Mahabubnagar	2000	57.038	35.065
28		Mahabubabad	1833	68.538	26.744
29		Warangal	1800	68.768	26.175
30		Hanumakonda	1778	64.536	27.551
31		Siddipet	1769	60.393	29.292
32		Sangareddy	1458	61.173	23.834
33		Nalgonda	0	54.116	0.000
34		Khammam	0	70.337	0.000
35		Hyderabad	0	58.285	0.000
36		Rangareddy	0	55.944	0.000
37		Bhadradri	0	75.934	0.000
38		Jogulamba	0	53.512	0.000
39		Nagarkurnool	0	55.052	0.000
40		Wanaparthy	0	57.917	0.000
41		Suryapet	0	62.139	0.000
42		Yadadri Bhuvanagiri	0	58.598	0.000
43		Janagaon	0	61.748	0.000
44		Narayanpet	0	58.010	0.000
45	Maharashtra	Kolhapur	1996	57.822	34.520
46		Satara	1441	52.406	27.497
47		Osmanabad	1205	57.723	20.875
48		Sangli	857	56.248	15.236
49		Pune	813	53.438	15.214
50		Beed	775	55.613	13.936
51		Solapur	636	57.403	11.079
52		Ahmednagar	571	50.888	11.221
53		Sindhudurg	0	67.509	0.000

Table 45: Crop-Water Productivity of Sugarcane in Krishna River Basin

Sl.No	State Name	District Name	Sugarcane Yield (Kg/ha)	Evapotranspiration(ETA)	Crop-Water Productivity(kg/m^3)
1	Karnataka	Tumkur	118215	46.73	2529.61
2		Hassan	68507	53.37	1283.72
3		Shivamogga	106365	61.80	1721.14
4		Chikkamagaluru	89838	54.62	1644.73
5		Chitradurga	84857	38.66	2194.91
6		Bellary	101049	51.90	1946.93
7		Dharwad	60480	56.70	1066.70
8		Belgaum	93380	58.63	1592.84
9		Bijapur	69524	59.13	1175.75
10		Bidar	27728	60.11	461.26
11		Raichur	83997	56.30	1492.09
12		Gulbarga	80490	56.87	1415.25
13		Dakshina Kannada	90600	88.46	1024.17
14		Uttara Kannada	57921	70.06	826.69
15		Bagalkote	70196	57.57	1219.26
16		Davanagere	104864	48.11	2179.60
17		Gadag	47326	55.82	847.90
18		Haveri	47684	57.83	824.59
19		Koppal	84079	57.45	1463.47
20		Yadagiri	84110	58.20	1445.21
21	Andhrapradesh	Krishna	92729	65.94	1406.25
22		Guntur	91717	58.43	1569.58
23		Kurnool	86478	54.11	1598.31
24		Anantapur	99715	44.88	2221.85
25		Prakasam	75610	56.75	1332.26
26	Telangana	Rangareddy	76125	55.94	1360.73
27		Hyderabad	0	4.66	0.00
28		Mahabubnagar	84032	5.39	15590.35
29		Nalgonda	82855	6.03	13740.46
30		Warangal	0	11.54	0.00
31		Khammam	56837	14.20	4002.61
32		Bhadradri	84701	75.93	1115.45
33		Jogulamba	76547	53.51	1430.47
34		Nagarkurnool	94000	55.05	1707.49
35		Wanaparthy	78844	57.92	1361.34
36		Sangareddy	75817	61.17	1239.38
37		Siddipet	94000	60.39	1556.48
38		Suryapet	94006	62.14	1512.83
39		Yadadri Bhuvanagiri	74000	58.60	1262.85
40		Vikarabad	77020	57.03	1350.58
41		Janagaon	0	61.75	0.00
42		Hanumakonda	0	64.54	0.00
43		Mahabubabad	88143	68.54	1286.04
44		Narayanpet	84340	58.01	1453.89
45	Maharashtra	Ahmednagar	71948	50.89	1413.86
46		Pune	103257	53.44	1932.29
47		Satara	106866	52.41	2039.20
48		Sangli	100054	56.25	1778.79
49		Solapur	91529	57.40	1594.49
50		Kolhapur	81035	57.82	1401.46
51		Beed	54629	55.61	982.30
52		Osmanabad	54053	57.72	936.42
53		Sindhudurg	0	67.51	0.00

Table 46: Crop-Water Productivity of Cotton in Krishna River Basin

Sl.No	State Name	District Name	Cotton Yield (Kg/ha)	Evapotranspiration(ETA)	Crop-Water Productivity(kg/m^3)
1	Karnataka	Tumkur	348	46.73	7.45
2		Hassan	513	53.37	9.61
3		Shivamogga	517	61.80	8.37
4		Chikkamagalur	341	54.62	6.24
5		Chitradurga	312	38.66	8.07
6		Bellary	546	51.90	10.52
7		Dharwad	361	56.70	6.37
8		Belgaum	388	58.63	6.62
9		Bijapur	366	59.13	6.19
10		Bidar	519	60.11	8.63
11		Raichur	433	56.30	7.69
12		Gulbarga	675	56.87	11.87
13		Dakshina Kannada	0	88.46	0.00
14		Uttara Kannada	475	70.06	6.78
15		Bagalkote	466	57.57	8.09
16		Davanagere	307	48.11	6.38
17		Gadag	432	55.82	7.74
18		Haveri	248	57.83	4.29
19		Koppal	306	57.45	5.33
20		Yadgiri	877	58.20	15.07
21	Andhra Pradesh	Krishna	140	65.94	2.12
22		Guntur	165	58.43	2.82
23		Kurnool	101	54.11	1.87
24		Anantapur	54	44.88	1.20
25		Prakasam	99	56.75	1.74
26	Telangana	Rangareddy	489	55.94	8.74
27		Hyderabad	-1	4.66	-0.21
28		Mahabubnagar	573	5.39	106.31
29		Nalgonda	471	6.03	78.11
30		Warangal	508	11.54	44.02
31		Khammam	631	14.20	44.44
32		Bhadradri	615	75.93	8.10
33		Jogulamba	552	53.51	10.32
34		Nagarkurnool	604	55.05	10.97
35		Wanaparthy	610	57.92	10.53
36		Sangareddy	578	61.17	9.45
37		Siddipet	615	60.39	10.18
38		Suryapet	591	62.14	9.51
39		Yadadri Bhuvanagiri	557	58.60	9.51
40		Vikarabad	521	57.03	9.14
41		Janagaon	518	61.75	8.39
42		Hanumakonda	479	64.54	7.42
43		Mahabubabad	400	68.54	5.84
44		Narayanpet	583	58.01	10.05
45	Maharashtra	Ahmednagar	166	50.89	3.26
46		Pune	6	53.44	0.11
47		Satara	334	52.41	6.37
48		Sangli	339	56.25	6.03
49		Solapur	83	57.40	1.45
50		Kolhapur	0	57.82	0.00
51		Beed	176	55.61	3.16
52		Osmanabad	93	57.72	1.61
53		Sindhudurg	0	67.51	0.00

Table 47: Crop-Water Productivity of Groundnut in Krishna River Basin

SL.NO	State Name	District Name	Groundnut Yield (Kg /ha)	Evapotranspiration (ETA)	Crop-Water Productivity (kg/m^3)
1	Karnataka	Gulbarga	1238	56.873	21.768
2		Bidar	1016	60.114	16.901
3		Davanagere	1250	48.112	25.981
4		Chikkamagaluru	1061	54.622	19.425
5		Koppal	878	57.452	15.282
6		Chitradurga	692	38.661	17.899
7		Bijapur	651	59.132	11.009
8		Gadag	790	55.816	14.154
9		Hassan	424	53.366	7.945
10		Bellary	1352	51.902	26.049
11		Raichur	1113	56.295	19.771
12		Uttara Kannada	2224	70.063	31.743
13		Tumkur	892	46.733	19.087
14		Dharwad	963	56.698	16.985
15		Belgaum	936	58.625	15.966
16		Shivamogga	992	61.799	16.052
17		Yadgiri	1279	58.199	21.976
18		Bagalkote	1514	57.573	26.297
19		Haveri	683	57.828	11.811
20		Dakshina Kannada	0	88.462	0.000
21	Andhra Pradesh	Kurnool	1755	54.106	32.436
22		Anantapur	841	44.879	18.739
23		Krishna	4145	65.941	62.859
24		Guntur	3638	58.434	62.258
25		Prakasam	3111	56.753	54.816
26	Telangana	Vikarabad	2745	57.028	48.135
27		Mahabubnagar	2104	57.038	36.888
28		Mahabubabad	1838	68.538	26.817
29		Warangal	3295	68.768	47.915
30		Hanumakonda	2388	64.536	37.003
31		Siddipet	1862	60.393	30.832
32		Sangareddy	2364	61.173	38.644
33		Nalgonda	1793	54.116	33.133
34		Khammam	1570	70.337	22.321
35		Hyderabad	0	58.285	0.000
36		Rangareddy	3995	55.944	71.410
37		Bhadradri	2570	75.934	33.845
38		Jogulamba	2577	53.512	48.158
39		Nagarkurnool	2156	55.052	39.163
40		Wanaparthy	3030	57.917	52.317
41		Suryapet	2748	62.139	44.223
42		Yadadri Bhuvanagiri	2612	58.598	44.575
43		Janagaon	1705	61.748	27.612
44		Narayanpet	2114	58.010	36.442
45	Maharashtra	Kolhapur	1212	57.822	20.961
46		Satara	988	52.406	18.853
47		Osmanabad	677	57.723	11.728
48		Sangli	829	56.248	14.738
49		Pune	1254	53.438	23.467
50		Beed	693	55.613	12.461
51		Solapur	1091	57.403	19.006
52		Ahmednagar	617	50.888	12.125
53		Sindhudurg	1788	67.509	26.485

Table 48: Crop-Water Productivity of Maize in Krishna River Basin

SL.NO	State Name	District Name	Maize Yield (Kg /ha)	Evapotranspiration (ETA)	Crop-Water Productivity (kg/m^3)
1	Karnataka	Tumkur	2727	46.733	58.353
2		Hassan	4154	53.366	77.840
3		Shivamogga	3722	61.799	60.227
4		Chikkamagaluru	3004	38.661	77.701
5		Chitradurga	3401	51.902	65.528
6		Bellary	3549	56.698	62.594
7		Dharwad	3321.98	58.625	56.665
8		Belgaum	3604	59.132	60.949
9		Bijapur	2606	60.114	43.351
10		Bidar	2299	56.295	40.838
11		Raichur	4841	56.873	85.119
12		Gulbarga	3764	88.462	42.550
13		Dakshina Kannada	0	70.063	0.000
14		Uttara Kannada	4197	57.573	72.899
15		Bagalkote	3835	48.112	79.710
16		Davanagere	3352	55.816	60.055
17		Gadag	2647	57.828	45.774
18		Haveri	1828	86.401	21.157
19		Udupi	3444	50.768	67.838
20		Yadgiri	4241	58.199	72.870
1	Andhrapradesh	Krishna	5809	65.941	88.094
2		Guntur	10455	58.434	178.919
3		Kurnool	5297	54.106	97.901
4		Anantapur	3578	44.879	79.725
5		Prakasam	7395	56.753	130.301
1	Telangana	Hyderabad	0	58.285	0.000
2		Mahabubnagar	3133	57.038	54.929
3		Nalgonda	5807	54.116	107.307
4		Warangal	6537	68.768	95.059
5		Khammam	7285	70.337	103.573
6		Rangareddy	3331	55.944	59.542
7		Bhadradri	5515	75.934	72.629
8		Jogulamba	4655	53.512	86.990
9		Nagarkurnool	2898	55.052	52.641
10		Wanaparthy	5290	57.917	91.338
11		Sangareddy	4411	61.173	72.107
12		Siddipet	4489	60.393	74.330
13		Suryapet	6719	62.139	108.128
14		Yadadri Bhuvanagiri	2186	58.598	37.305
15		Vikarabad	5333	57.028	93.516
16		Janagaon	6461	61.748	104.636
17		Hanumakonda	6601	64.536	102.284
18		Mahabubabad	5627	68.538	82.100
19		Narayanpet	5007	58.010	86.313
1	Maharashtra	Ahmednagar	1725	50.888	33.898
2		Pune	3751	53.438	70.194
3		Satara	2075	52.406	39.595
4		Sangli	1950	56.248	34.668
5		Solapur	1961	57.403	34.162
6		Kolhapur	2740	57.822	47.387
7		Beed	530	55.613	9.530
8		Osmanabad	893	57.723	15.470
9		Sindhudurg	3171	67.509	46.971

6.Conclusion

The assessment of the Gross Agricultural Structure of the Krishna River Basin highlights the dominant role of agriculture in shaping the basin's economy, land use, and water resource utilization. Most districts across the Upper Krishna, Bhima, and Tungabhadra sub-basins exhibit high agricultural land coverage and cropping intensities above 120%, indicating intensive cultivation practices. Irrigated regions are characterized by the widespread cultivation of water-intensive crops such as rice and sugarcane, while semi-arid areas predominantly grow millets, pulses, and oilseeds that require comparatively less water. Fertilizer consumption, particularly nitrogen, phosphate, and potash, increased substantially between 1970 and 2010, reflecting agricultural intensification and the adoption of high-yielding crop varieties. Districts such as Raichur, Guntur, Krishna, Kurnool, Ahmednagar, and Solapur emerged as major consumers of agrochemicals, suggesting higher risks of nutrient runoff and water quality degradation. Crop-water productivity analysis indicates significant variability among crops and regions, emphasizing the need for improved water-use efficiency. The predominance of small and marginal farmers in many districts further underscores the importance of sustainable and economically viable agricultural practices. Overall, the basin faces the dual challenge of maintaining agricultural productivity while conserving water resources and protecting river ecosystems. Promoting efficient irrigation methods, balanced fertilizer application, climate-resilient crops, and integrated watershed management will be essential for achieving long-term agricultural and environmental sustainability in the Krishna River Basin.

7. Recommendations and role of Stakeholders

Recommendations: The assessment of the Krishna River Basin highlights the need for sustainable agricultural and water management practices. Adoption of micro-irrigation systems such as drip and sprinkler irrigation can significantly improve water-use efficiency and reduce wastage. Integrated nutrient management and balanced fertilizer application should be encouraged to minimize excessive nitrogen, phosphate and potash usage that contributes to soil degradation and river pollution. Promotion of organic farming and bio-fertilizers can further improve soil health and reduce agrochemical runoff. Crop diversification and crop rotation practices should be strengthened to enhance productivity and climate resilience. Real-time monitoring of groundwater extraction and irrigation efficiency is essential for sustainable basin management. Capacity-building programs and awareness campaigns should be conducted to educate farmers on scientific farming practices. Overall, an integrated basin-level planning approach combining water conservation, efficient agriculture, and ecological protection is necessary for long-term sustainability of the Krishna River Basin.

Role of Stakeholders: Stakeholders play a crucial role in ensuring sustainable agricultural development and river basin management in the Krishna River Basin. Government agencies should formulate effective policies, regulate groundwater extraction and provide financial support for water-efficient technologies and sustainable farming practices. Agricultural departments and research institutions must conduct studies, develop climate-resilient crop varieties and provide technical guidance to farmers. Local bodies and water user associations should monitor irrigation practices, maintain water infrastructure and encourage community participation in water conservation programs. Farmers are the key stakeholders responsible for adopting efficient irrigation methods, balanced fertilizer use and eco-friendly agricultural practices. Non-governmental organizations (NGOs) can support awareness creation, farmer training and community mobilization for sustainable agriculture initiatives.

7.1. Strategy for shifting to water-efficient crops

The dominance of water-intensive crops such as paddy and sugarcane across large parts of the Krishna River Basin has placed immense and unsustainable pressure on the basin's water resources. Districts within the Upper Bhima, Lower Bhima, Upper Krishna and Upper Tungabhadra sub-basins, which are predominantly semi-arid and drought-prone, continue to cultivate paddy under canal and groundwater irrigation despite severe seasonal water deficits. A strategic and incentive-driven shift towards water-efficient crops is therefore central to reducing irrigation water demand, improving crop-water productivity ratios, and building resilience against climatic variability across the basin.

Millets such as pearl millet (bajra) and sorghum (jowar), pulses including red gram (tur), green gram, and chickpea, and oilseeds such as groundnut are crops that are inherently well-adapted to the semi-arid agro-climatic conditions of the basin. These crops require significantly less water compared to paddy and sugarcane, are more resilient to erratic rainfall, and contribute positively to soil health through nitrogen fixation and organic matter addition. Their cultivation should be actively promoted through revision of minimum support prices, development of dedicated procurement mechanisms, and creation of agro-processing clusters to ensure remunerative market access for farmers making this transition.

Crop diversification programs should be implemented in a spatially targeted manner, prioritizing districts in each of the sub-basins where water scarcity is most acute and where the current cropping pattern imposes the greatest burden on river flows and groundwater reserves. Pilot demonstration plots showcasing the productivity and profitability of alternative crops under local agro-climatic conditions should be established in partnership with Krishi Vigyan Kendras and agricultural universities. These demonstrations, supported by robust extension services and peer-to-peer farmer learning networks, are essential to building farmer confidence in transitioning away from familiar but water-intensive cultivation systems.

The long-term success of crop diversification efforts will depend on a supportive policy environment that aligns agricultural subsidies, power pricing for irrigation pump sets, insurance schemes, and credit availability with water-saving objectives. Presently, several policy instruments unintentionally incentivize the cultivation of water-intensive crops by providing free or subsidized electricity for groundwater pumping and procurement guarantees primarily for paddy. A recalibration of these incentive structures, in consultation with state governments, district levels and farmer organizations, is a prerequisite for achieving a meaningful and durable shift in the basin's cropping pattern towards greater water efficiency.

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