Land Use and Agricultural Dynamics in Deoria District, Utter Pradesh: A Geographical Analysis

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Land Use Change;
Cropping Intensity;
Agricultural
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Abstract

Land use change and agricultural restructuring have emerged as critical concerns in eastern Uttar Pradesh, particularly in Deoria district, where demographic pressure and environmental stress are reshaping agrarian systems. This study examines block-wise changes in land use and agricultural dynamics in Deoria district during 2013–2023 using secondary data from district statistical records and agricultural reports. Comparative and percentage change methods were applied to analyze land utilization, cropping intensity, irrigation coverage, and seasonal cropping patterns (Rabi, Kharif, and Zaid). The findings indicate a decline of about 3–5 percent in net sown area, alongside a noticeable increase in current fallow land and non-agricultural uses. Cropping intensity rose from nearly 150 percent in 2013 to around 165–170 percent in 2023, reflecting agricultural intensification despite uneven irrigation expansion. Seasonal variations show relative stability in Kharif crops, growth of Rabi cultivation in better-irrigated blocks, and fluctuations in Zaid crops. Factors such as urban expansion, recurrent flooding due to proximity to the Ghaghara River basin, groundwater stress, and soil degradation has contributed to spatial disparities. The study underscores growing resource pressure and emphasizes the need for sustainable land and water management to ensure long-term agricultural stability.

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1. Introduction

Land use change is a dynamic process reflecting the interaction between physical environment and human activities. In agrarian regions of northern India, rapid demographic growth, urban expansion, and environmental stress have significantly altered traditional land utilization patterns. Eastern Uttar Pradesh, particularly Deoria district, represents a typical alluvial plain region characterized by high population density, fertile soils, and intensive agriculture. Over the past decade (2013–2023), Deoria district has experienced noticeable changes in land use composition, cropping intensity, irrigation coverage, and seasonal cropping patterns. While agriculture remains the dominant land use, increasing pressure from urbanization, infrastructural development, fragmentation of landholdings, and environmental challenges such as recurrent flooding from the Ghaghara River basin and groundwater stress have reshaped the agrarian landscape. This study attempts a block-wise geographical analysis of land use transformation and agricultural restructuring in Deoria district during 2013–2023, focusing on spatial variations, resource stress, and emerging agrarian challenges.

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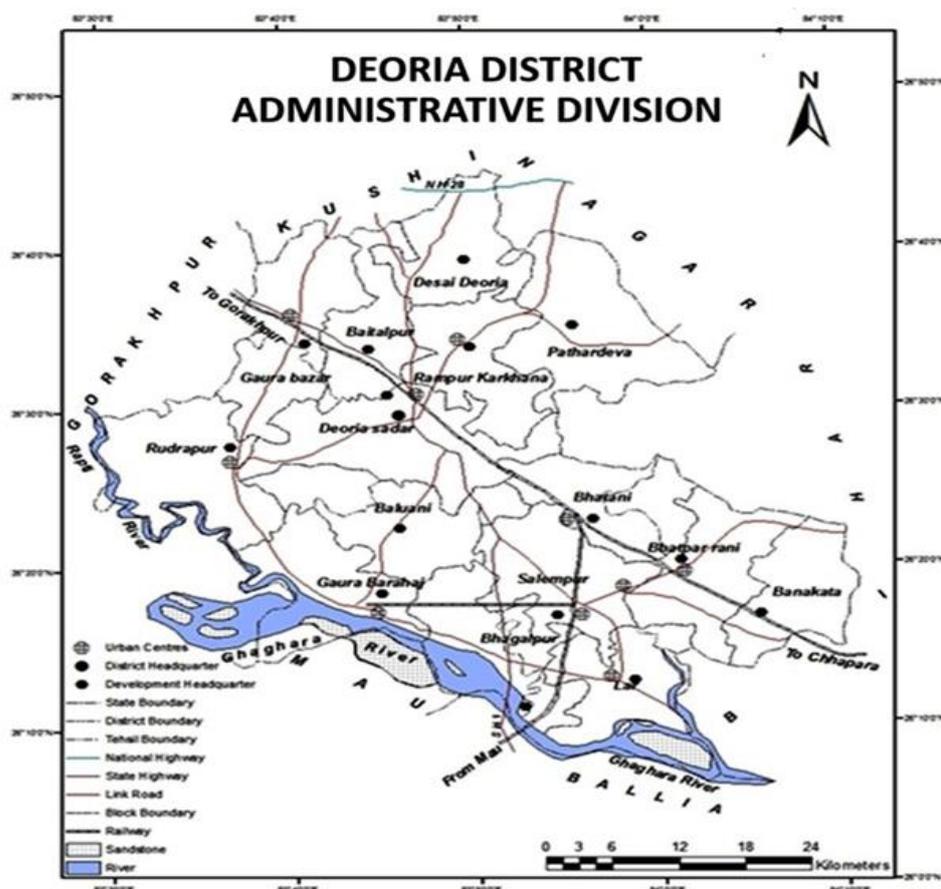
Figure: 1 Administrative Division

2. Literature Review

The study of land use and agricultural transformation has long occupied a central place in geographical research, beginning with the classical agricultural location theory of **Von Thünen (1826)**, which provided a theoretical basis for understanding the spatial organization of agriculture in relation to markets and transport costs. Building upon such foundations, Indian geographers such as **R. L. Singh (1971)** emphasized the influence of physical factors- soil, relief, and climate on regional agricultural patterns, while **Gopal Singh (1976)** advanced agricultural regionalization and land capability classification in the Indo-Gangetic Plain, highlighting the combined role of irrigation and population pressure. The technological transformation associated with the Green Revolution was extensively analyzed by **M. S. Swaminathan (1991)**, who underscored the contribution of high-yielding varieties and irrigation expansion to rising productivity and cropping intensity; however, subsequent studies, notably by **R. B. Singh (2009)**, cautioned that such intensification has also resulted in groundwater depletion, soil degradation, and ecological imbalance in the Indo-Gangetic Plain. In eastern Uttar Pradesh, research indicates that increasing cropping intensity often coexists with stagnation in net irrigated area, suggesting over-exploitation of groundwater resources **(Singh & Yadav, 2014)**, while flood-prone conditions associated with the Ghaghara River basin contribute to expansion of fallow land and seasonal crop instability **(Pandey, 2016)**. Simultaneously, urbanization has accelerated the conversion of fertile agricultural land into residential and infrastructural uses, thereby reducing net sown area (Census of India, 2011; **Sharma, 2018**). Literature on cropping diversification further shows that market integration and irrigation access encourage shifts toward cash crops and short-duration Zaid cultivation (**Bhalla & Singh, 2010; Kumar, 2019**), while climate variability and environmental stress, as highlighted by **ICAR (2020)**, increasingly influence agrarian decision-making in the Middle Gangetic Plain. Despite these extensive macro-level and regional-level studies, micro-level, block-wise analyses remain limited, particularly for Deoria district, where recent decadal transformations in land use, irrigation dynamics, and seasonal cropping patterns have not been comprehensively examined; therefore, the present study addresses this gap by providing a spatially disaggregated assessment of agrarian change during 2013–2023.

3. Study Area

Deoria district is located in the eastern part of Uttar Pradesh along the international border with Bihar. According to the 2011 Census, the district covers a geographical area of 2,540 sq. km and has a population of

3,100,946, comprising 1,537,436 males and 1,563,510 females, with a favorable sex ratio of 1,017 females per 1,000 males. The overall literacy rate is 71.13 percent. Agriculture is the principal source of livelihood in the district. The Labour Force Participation Rate was 56.54 percent during 2023–24, and the per capita income stood at ₹49,166. The total cropped area was 373,752 hectares in 2023–24, reflecting the district's predominantly agrarian character. The district forms part of the Middle Gangetic Plain and is characterized by flat alluvial terrain, fertile loamy soils, and a humid subtropical climate.

4. Objectives

These are the main objectives of the study:

- To examine block-wise changes in land use patterns in Deoria district between 2013 and 2023.
- To analyze changes in cropping intensity, irrigation coverage, and decadal change in the district during the study period.
- To assess variations in seasonal cropping patterns (Rabi, Kharif, and Zaid) and their spatial distribution across blocks between 2013 and 2023.

5. Research Method

The study is based entirely on secondary data obtained from the District Statistical Handbooks (2013 and 2023), Agricultural Department records, and block-level land use statistics. Data were compiled for major land use categories, cropping intensity, irrigation coverage (net and gross irrigated area), and seasonal cropping patterns (Rabi, Kharif, and Zaid) for the period 2013–2023. Methodologically, comparative and percentage change techniques were applied to assess decadal variations in land use, irrigation coverage, and cropping intensity, while block-wise spatial analysis was conducted to identify intra-district disparities within Deoria district. Tabular data were systematically organized and analyzed using MS Office software, and QGIS was utilized for map preparation. Cropping intensity was calculated using the standard formula:

Cropping Intensity= (Gross Cropped Area*100)/ Net Sown Area

6. Results and Analysis

6.1: Land use Classification

Table 1 shows that land use in Deoria district in 2013 was overwhelmingly agrarian, with a very high proportion of net sown area (around 79% for the district and above 80% in several blocks such as Baitalpur and Deoria Sadar), reflecting fertile alluvial soils, flat topography, and intense population pressure that promotes intensive cultivation. Forest area is almost negligible across all blocks due to long-term agricultural expansion and settlement growth.

Table 1: Block-wise Land Use in Deoria District, 2013

Block	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10
1. Gauri Bazar	17036	0.06	0.08	2.83	0.97	0.86	10.52	0.04	1.54	83.10
2. Baitalpur	16778	0.10	0.13	1.79	0.77	0.86	8.75	0.04	1.30	86.27
3. Desai Deoria	12442	0.04	0.03	1.32	0.44	1.51	12.87	0.06	1.53	82.21
4. Pathar Dewa	17384	0.15	0.17	4.68	1.35	0.74	13.03	0.04	1.40	78.45
5. Rampur Karkhana	14630	0.40	0.10	2.97	1.14	0.96	12.47	0.03	1.67	80.26
6. Deoria Sadar	16974	0.07	0.25	1.43	1.63	1.14	10.56	0.04	1.56	83.32
7. Rudrapur	20295	0.05	0.27	4.70	1.22	0.66	16.63	0.02	0.83	75.62
8. Bhaluani	16182	0.07	0.30	5.08	0.96	0.46	13.16	0.03	0.84	79.09
9. Barhaj	13845	0.13	2.13	6.44	1.00	0.69	22.46	0.04	0.85	66.25
10. Bhatni	12758	0.20	0.44	5.57	0.57	0.82	14.28	0.05	0.85	77.21
11. Bhatpar Rani	10876	0.07	0.38	2.32	0.87	0.42	15.01	0.06	1.88	78.99
12. Bankata	11646	0.18	0.33	3.68	0.70	0.75	14.13	0.05	1.45	78.74
13. Salempur	15702	0.04	0.42	4.22	0.55	0.45	13.52	0.04	0.73	80.03
14. Bhagalpur	14131	0.04	0.39	2.14	1.12	0.17	14.95	0.04	1.37	79.78
15. Lar	16175	0.06	6.10	6.87	0.58	0.35	14.21	0.02	1.73	70.08
16. Tarkulwa	9599	0.20	0.23	4.42	1.02	0.29	7.42	0.03	1.08	85.31
Total Rural	236453	0.11	0.76	3.80	0.95	0.70	13.41	0.04	1.28	78.95
Total Urban	12923	0.00	0.33	1.35	0.37	0.67	12.64	0.00	0.04	84.61
Total District	249376	0.10	0.73	3.68	0.92	0.70	13.37	0.03	1.21	79.24

Source: Calculated by Authors from District Statistical Handbook, Deoria, 2014

Note: X1- Total Reporting Area (ha), X2- Forest Area (%), X3- Cultivable Wasteland (%), X4-Current Fallow (%), X5-Other Fallow (%), X6- Barren and Uncultivable Land (%), X7- Land for use other than Agriculture (%), X8- Pasture (%), X9- Area of Gardens, Trees and Bushes (%), X10- Net Sown Area (%).

Land under non-agricultural uses is relatively higher in blocks like Barhaj and Rudrapur, mainly because of urbanization, infrastructure development, and market centres. Variations in current fallow and cultivable wasteland, particularly in blocks such as Lar and Barhaj, may be attributed to seasonal flooding, waterlogging, soil degradation, and limited irrigation in certain pockets. Overall, the pattern indicates maximum land utilization under agriculture with increasing pressure from demographic growth and urban expansion.
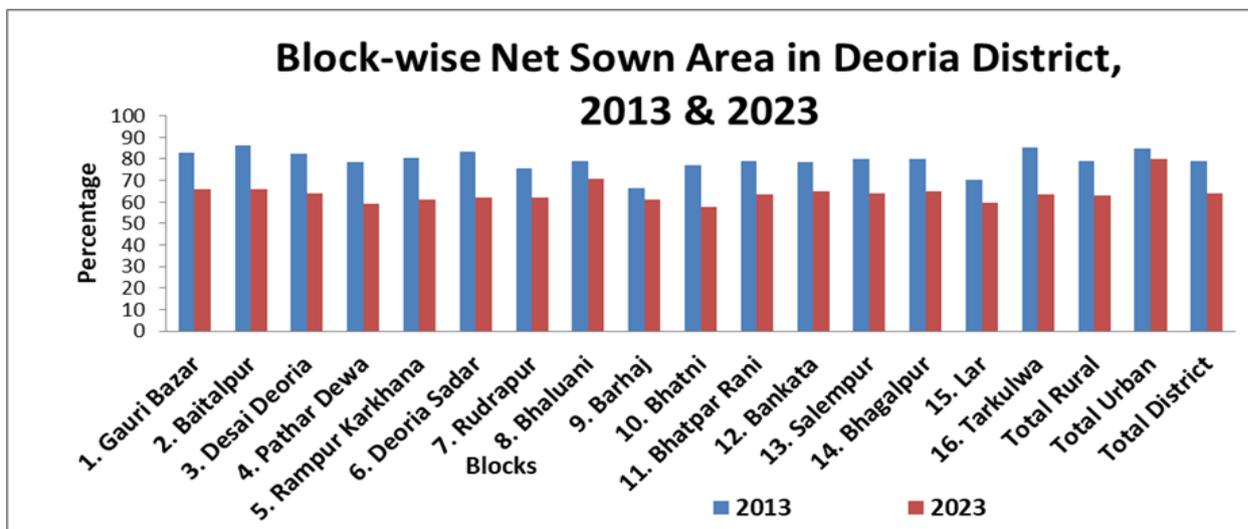

Figure 2:Block-wise Net Sown Area in Deoria District, 2013 &2023

Table 2: Block-wise Land Use in Deoria District, 2023

Block	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10
1. Gauri Bazar	19875	0.05	0.09	14.70	3.97	2.29	12.40	0.02	0.78	65.70
2. Baitalpur	18187	0.09	0.14	14.57	3.30	2.39	12.71	0.03	0.67	66.11
3. Desai Deoria	16054	0.04	0.10	16.58	2.33	1.99	14.17	0.04	0.74	64.02
4. Pathar Dewa	17624	0.15	0.19	17.83	3.51	1.80	16.69	0.04	0.81	58.98
5. Rampur Karkhana	16574	0.36	0.11	17.67	2.32	1.99	15.53	0.04	0.70	61.29
6. Deoria Sadar	16185	0.08	0.29	15.93	3.52	2.51	14.72	0.04	0.95	61.96
7. Rudrapur	19487	0.05	0.30	15.65	1.81	1.87	17.15	0.03	0.87	62.27
8. Bhaluani	20082	0.05	0.26	13.67	2.09	1.56	11.04	0.03	0.41	70.87
9. Barhaj	18078	0.09	1.42	16.07	3.65	1.84	15.22	0.03	0.48	61.18
10. Bhatni	18485	0.14	0.33	16.58	4.06	1.43	19.01	0.04	0.60	57.81
11.Bhatpar Rani	16955	0.05	0.27	16.87	3.59	1.66	13.55	0.04	0.70	63.27
12. Bankata	16408	0.13	0.26	16.74	1.35	2.54	13.49	0.04	0.63	64.82
13. Salempur	17179	0.03	0.42	16.46	1.45	2.18	14.87	0.03	0.42	64.12
14. Bhagalpur	16097	0.03	0.37	14.59	1.61	2.32	15.47	0.04	0.73	64.84
15. Lar	17571	0.05	5.11	17.48	1.57	1.44	14.09	0.03	0.76	59.47
16. Tarkulwa	15204	0.13	0.18	16.73	1.57	1.72	15.77	0.01	0.62	63.28
Total Rural	280045	0.09	0.62	16.08	2.63	1.96	14.71	0.03	0.68	63.18
Total Urban	11734	0.00	0.59	1.16	0.42	0.69	16.16	0.00	1.22	79.77
Total District	291779	0.09	0.62	15.48	2.54	1.91	14.77	0.03	0.70	63.85

Source: Calculated by Authors from District Statistical Handbook, Deoria, 2024

Note: X1- Total Reporting Area (ha), X2- Forest Area (%), X3- Cultivable Wasteland (%), X4-Current Fallow (%), X5-Other Fallow (%), X6- Barren and Uncultivable Land (%), X7- Land for use other than Agriculture (%), X8- Pasture (%), X9- Area of Gardens, Trees and Bushes (%), X10- Net Sown Area (%).

Table 2 indicates a noticeable shift in the land use pattern of Deoria district in 2023 compared to 2013, marked by a decline in net sown area (63.85% for the district) and a substantial rise in current fallow land (15.48%). Many blocks such as Pathar Deva, Rampur Karkhana, and Lar show particularly high proportions of fallow land, which may be attributed to soil degradation, erratic rainfall, rising input costs, fragmentation of holdings, and temporary withdrawal of land from cultivation. Land under non-agricultural uses (14.77%) has increased across most blocks, especially in Rudrapur and Bhatni, reflecting urban expansion, infrastructure development, and growth of market centres (Figure 2). Forest area remains negligible, while cultivable wasteland shows slight variation in a few blocks like Lar, possibly due to localized environmental stress such as flooding or waterlogging. The 2023 pattern suggests increasing pressure from urbanization and agrarian stress, leading to a reduction in the effective cultivated area in the district.

6.2: Cropping Intensity, Irrigated Area, and Decadal Change

Table 3 reveals a significant increase in cropping intensity in Deoria district between 2013 and 2023 (from 161.70% to 191.81%), indicating greater multiple cropping and intensified agricultural practices, particularly in blocks such as Pathar Deva, Rampur Karkhana, and Baitalpur. However, this rise contrasts with a notable decline in net irrigated area (–13.75% at the district level), suggesting growing pressure on water resources, possible groundwater depletion, irregular rainfall, and rising irrigation costs.

Table 3: Block-wise Cropping Intensity, Irrigated Area, and Decadal Change in Deoria District, 2013–2023

Block	Cropping Intensity and Irrigated area in Deoria District, 2013–2023								
	Cropping Intensity (%)		Decadal Change (%)	Net irrigated area (%)		Decadal Change (%)	Gross Irrigated Area (%)		Decadal Change (%)
	2013	2023		2013	2023		2013	2023	
1. Gauri Bazar	166.21	194.62	28.41	82.83	60.90	-21.93	126.26	112.88	-13.39
2. Baitalpur	149.62	200.09	50.47	86.17	60.68	-25.49	131.36	117.36	-13.99
3. Desai Deoria	156.77	202.79	46.03	82.13	69.81	-12.31	125.19	122.32	-2.87
4. Pathar Dewa	160.72	217.03	56.31	78.23	61.48	-16.75	119.25	121.75	2.50
5. Rampur Karkhana	119.09	196.72	77.63	79.48	62.84	-16.64	121.16	125.75	4.60
6. Deoria Sadar	171.55	212.21	40.67	80.95	78.96	-1.99	123.40	150.47	27.07
7. Rudrapur	164.30	201.37	37.07	72.20	52.29	-19.92	110.07	120.80	10.74
8. Bhaluani	196.62	162.96	-33.67	71.75	50.74	-21.01	109.37	117.22	7.86
9. Barhaj	169.68	178.24	8.56	66.07	61.80	-4.26	100.72	146.33	45.61
10. Bhatni	170.26	184.33	14.07	76.90	58.39	-18.51	117.22	118.88	1.66
11. Bhatpar Rani	180.72	192.83	12.11	76.88	56.95	-19.93	117.20	123.12	5.92
12. Bankata	162.40	184.85	22.45	78.40	63.05	-15.36	119.52	122.94	3.42
13. Salempur	143.08	187.82	44.74	79.44	72.22	-7.22	121.09	116.89	-4.19
14. Bhagalpur	164.51	197.78	33.27	78.83	71.29	-7.54	120.17	121.15	0.98
15. Lar	171.21	195.72	24.51	69.84	59.92	-9.93	106.47	118.05	11.59
16. Tarkulwa	128.47	171.83	43.37	84.17	64.26	-19.91	128.31	104.22	-24.09
Total Rural	161.23	192.06	30.84	77.59	62.45	-15.13	118.27	122.41	4.14
Total Urban	169.73	186.97	17.24	12.09	12.51	0.42	55.06	19.50	-35.56
Total District	161.70	191.81	30.11	74.19	60.45	-13.75	115.00	118.27	3.27

Source: Calculated by Authors from District Statistical Handbook, Deoria, 2023- 24

Despite this, gross irrigated area shows a marginal overall increase (3.27%), reflecting better utilization of available irrigation through repeated cropping rather than expansion of irrigated land. Some blocks like Deoria Sadar and Barhaj record substantial growth in gross irrigated area, likely due to improved irrigation infrastructure and market-oriented farming, whereas others such as Tarkulwa show decline, possibly due to water scarcity or infrastructural limitations. The pattern suggests intensification of agriculture amid constrained irrigation resources and increasing resource stress.

6.3: Seasonal cropping patterns

Table 4 shows noticeable shifts in the cropping pattern of Deoria district between 2013 and 2023. At the district level, the area under Rabi crops slightly declined (–2.84%), while Kharif crops also registered a moderate decrease (–3.14%), indicating some contraction in seasonal crop coverage. However, Zaid crops

increased marginally (0.41%), suggesting growing adoption of short-duration summer crops supported by residual moisture and irrigation facilities (Figure 3, 4 and 5).

Table 4: Block-wise seasonal cropping patterns in Deoria District, 2013–2023

Block	Block-wise seasonal cropping patterns in Deoria Distric, 2013–2023								
	Rabi (%)		Decadal Change (%)	Kharif (%)		Decadal Change (%)	Zayad (%)		Decadal Change (%)
	2013	2023		2013	2023		2013	2023	
1. Gauri Bazar	76.94	65.69	-11.25	59.48	58.99	-0.49	1.50	2.07	0.58
2. Baitalpur	72.20	66.60	-5.60	55.33	57.80	2.47	1.34	2.21	0.87
3. Desai Deoria	73.40	74.11	0.71	53.95	61.13	7.18	1.32	2.19	0.87
4. Pathar Dewa	70.98	62.55	-8.43	53.41	56.44	3.03	1.50	2.13	0.63
5. Rampur Karkhana	49.61	59.68	10.07	43.91	59.32	15.41	1.89	2.37	0.48
6. Deoria Sadar	81.70	80.65	-1.04	59.64	60.25	0.62	1.45	1.95	0.50
7. Rudrapur	71.15	51.95	-19.20	52.05	50.47	-1.58	0.98	2.02	1.05
8. Bhaluani	89.61	50.41	-39.20	63.81	48.98	-14.83	2.00	1.88	-0.11
9. Barhaj	55.73	65.17	9.44	54.81	53.47	-1.34	1.78	1.75	-0.02
10. Bhatni	67.56	53.05	-14.51	61.94	50.53	-11.41	1.78	1.64	-0.13
11. Bhatpar Rani	73.37	63.14	-10.23	66.82	54.35	-12.47	2.34	1.94	-0.40
12. Bankata	60.66	65.09	4.43	64.49	57.50	-6.99	2.53	2.41	-0.12
13. Salempur	54.83	68.68	13.85	57.80	62.17	4.38	1.76	2.53	0.76
14. Bhagalpur	57.73	67.50	9.77	71.91	62.66	-9.26	1.51	1.94	0.43
15. Lar	63.55	58.41	-5.14	54.63	55.80	1.17	1.72	1.62	-0.10
16. Tarkulwa	47.56	64.02	16.46	59.45	47.81	-11.64	2.46	2.39	-0.06
Total Rural	67.56	63.17	-4.39	57.90	55.97	-1.92	1.68	2.06	0.38
Total District	64.28	61.45	-2.84	62.04	58.89	-3.14	1.67	2.08	0.41

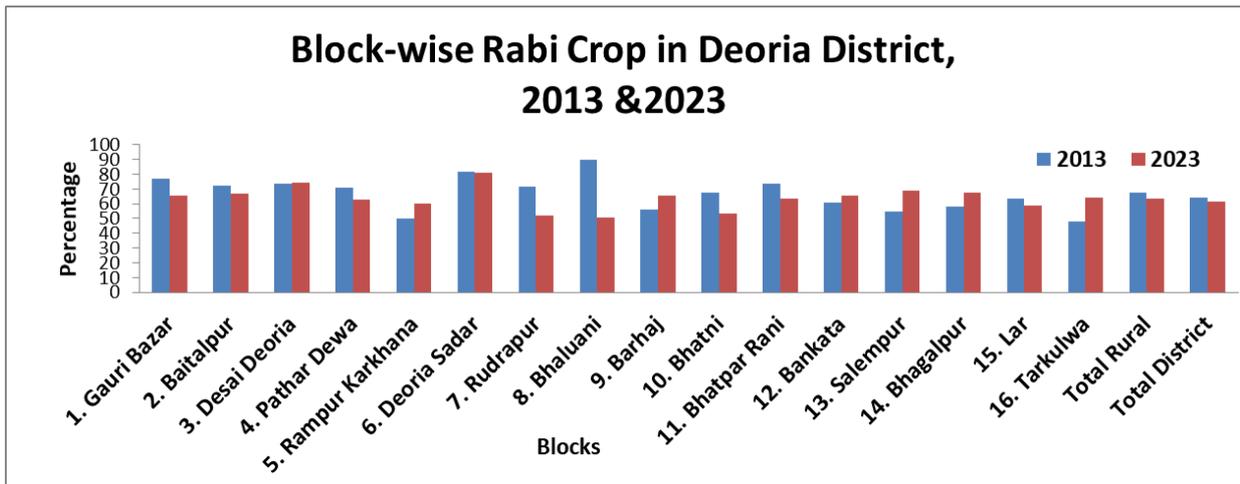*Source: Calculated by Authors from District Statistical Handbook, Deoria, 2023- 24*

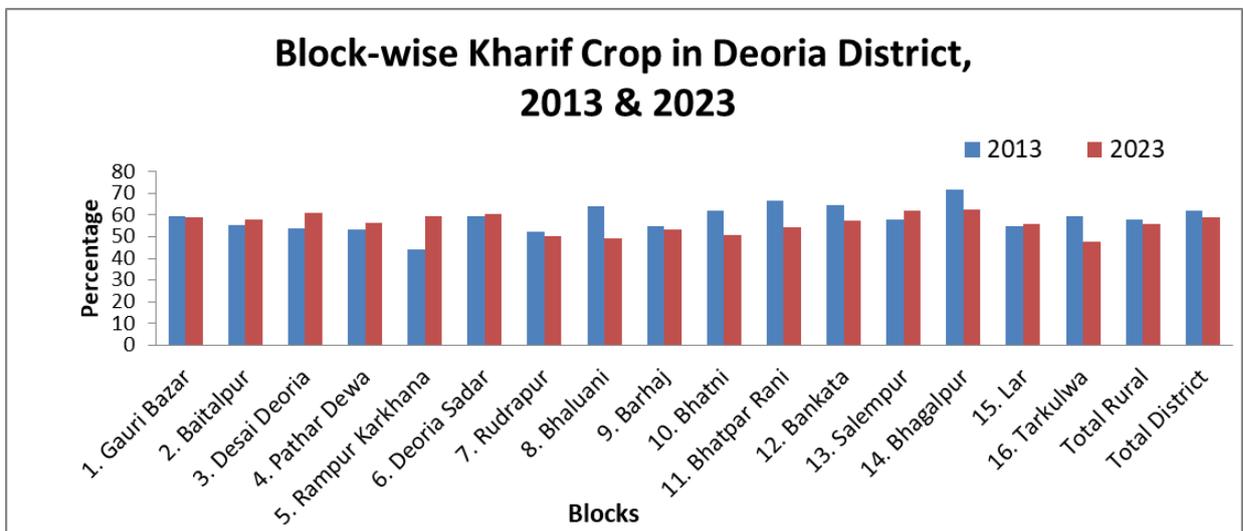*Figure 3:Block-wise Rabi Crop in Deoria District, 2013 &2023*

Figure 4:Block-wise Kharif Crop in Deoria District, 2013 &2023

Block-level variations are significant: Rampur Karkhana, Salempur, and Tarkulwa recorded substantial increases in Rabi area, possibly due to better irrigation and input use, whereas Bhaluani and Rudrapur experienced sharp declines, likely due to land diversion, water stress, or shifting crop preferences. The decline in Kharif area in several blocks may be linked to erratic monsoon rainfall and flood vulnerability, while the modest rise in Zaid cultivation reflects intensification strategies and market-oriented vegetable production. Overall, the pattern indicates diversification and seasonal adjustment in response to irrigation changes, climatic variability, and economic considerations.
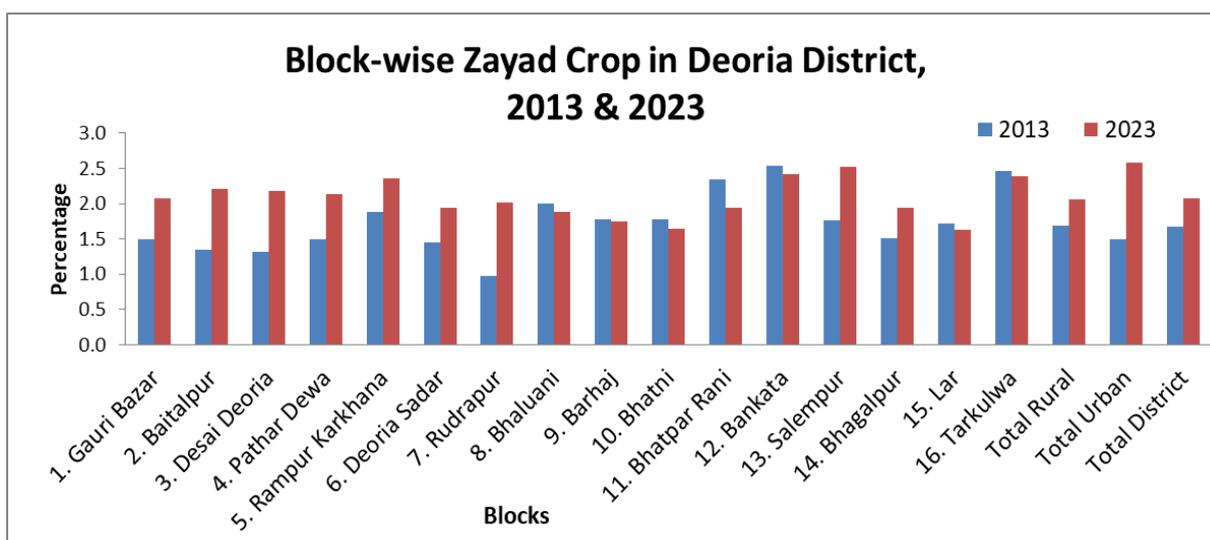
Figure 5:Block-wise Zayad Crop in Deoria District, 2013 &2023

7. Conclusion

The study reveals significant structural changes in land use and agricultural patterns in Deoria district between 2013 and 2023. Net sown area declined from nearly 79 percent in 2013 to about 63.85 percent in 2023, while current fallow land increased substantially (15.48% at the district level). Simultaneously, land under non-agricultural uses expanded, reflecting urbanization and infrastructure development. Despite declining net irrigated area (–13.75%), cropping intensity increased markedly from 161.70 percent to 191.81 percent, indicating intensified multiple cropping and greater pressure on existing irrigation resources. Seasonal cropping patterns show moderate decline in Rabi and Kharif areas but marginal growth in Zaid crops, suggesting diversification and adaptive strategies. Block-level variations highlight spatial disparities influenced by irrigation availability, flooding, groundwater stress, soil degradation, and market accessibility. The overall pattern suggests agricultural intensification under conditions of constrained land and water resources. The study emphasizes the urgent need for sustainable land and water management, improved irrigation efficiency, flood control measures, and climate-resilient agricultural practices to ensure long-term agrarian stability and balanced regional development in Deoria district.

References

[1] Bhalla, G. S. and Singh, G., *Growth of Indian Agriculture: A District Level Study*, Planning Commission, Government of India, 2010.

[2] Census of India, *District Census Handbook: Deoria*, Office of the Registrar General & Census Commissioner, India, 2011.

[3] Government of India, *Agricultural Statistics at a Glance 2020*, Ministry of Agriculture & Farmers Welfare, 2020.

[4] Government of Uttar Pradesh, *District Statistical Handbook: Deoria*, Directorate of Economics and Statistics, 2013.

[5] Government of Uttar Pradesh, *District Statistical Handbook: Deoria*, Directorate of Economics and Statistics, 2023.

[6] Indian Council of Agricultural Research (ICAR), *Climate Change and Indian Agriculture: Impact and Adaptation Strategies*, ICAR Publications, 2020.

[7] Kumar, A., "Cropping pattern diversification and irrigation dynamics in eastern Uttar Pradesh," *Indian Journal of Agricultural Economics*, vol. 74, no. 3, pp. 345–358, 2019.

[8] Pandey, R., "Flood hazards and agricultural land use change in the Ghaghara basin," *Annals of the National Association of Geographers, India*, vol. 36, no. 2, pp. 145–158, 2016.

[9] Planning Commission, *State Development Report: Uttar Pradesh*, Government of India, 2013.

[10] Sharma, V. P., "Urbanization and agricultural land conversion in India: Trends and implications," *Land Use Policy*, vol. 72, pp. 107–115, 2018.

[11] Singh, G., *Agricultural Geography of India*, Tata McGraw-Hill, 1976.

[12] Singh, J. N., "Agricultural regionalization in the Indo-Gangetic Plain," *National Geographical Journal of India*, vol. 20, no. 1, pp. 1–15, 1974.

[13] Singh, R. B., "Environmental consequences of agricultural intensification in the Indo-Gangetic Plain," *Geographical Review of India*, vol. 71, no. 2, pp. 123–140, 2009.

[14] Singh, R. L., *India: A Regional Geography*, National Geographical Society of India, 1971.

[15] Singh, S. and Yadav, S., "Irrigation expansion and cropping intensity in eastern Uttar Pradesh," *Transactions of the Institute of Indian Geographers*, vol. 36, no. 1, pp. 59–72, 2014.

[16] Swaminathan, M. S., *Sustainable Agriculture: Towards an Evergreen Revolution*, Konark Publishers, 1991.

[17] Von Thünen, J. H., *Isolated State*, C. M. Wartenberg, Trans., Pergamon Press, 1966 (original work published 1826).