OPEN ACCESS
Quick Response Code:
Website: https://wgges.us

Creative Commons (CC BY-NC-SA 4.0):
This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International Public License, which allows others to remix, tweak, and build upon the work noncommercially, as long as appropriate credit is given and the new creations ae licensed under the identical terms.

Manuscript ID:
IJWGAFES-2025-021218

DOI: 10.5281/zenodo.23409007

DOI Link:
https://doi.org/10.5281/zenodo.23409007

Volume: 2
Issue: 12
December
Year: 2025
E-ISSN: 3066-1552

Submitted: *08 Nov.2025*

Revised: *12 Nov.2025*

Accepted: *05 Dec 2025*

Published: *31 Dec. 2025*

[1]Department of Geography, Dr. Annasaheb G.D. Bendale Mahila Mahavidyalaya, Jalgaon (MH)

[2]Department of Geography, Iqra H. J. Thim College of Arts & Science, Mehrun, Jalgaon (MH)
Email:
gaware14@gmail.com

Address for correspondence:
Raju S. Gaware
Department of Geography, Iqra H. J. Thim College of Arts & Science, Mehrun, Jalgaon (MH)
Email: gaware14@gmail.com

How to cite this article:
Jadhav, H. R., & Gaware, R. S. (2025). Spatio-Temporal Changes in Land Use Pattern and Agricultural Land Use Efficiency in Buldhana District, Maharashtra. International Journal of World Geology, Geography, Agriculture, Forestry and Environment Sciences, 2(12), 98–104.
https://doi.org/10.5281/zenodo.23409007

Spatio-Temporal Changes in Land Use Pattern and Agricultural Land Use Efficiency in Buldhana District, Maharashtra

Hemraj R. Jadhav[1], Raju S. Gaware[2]

Abstract

Land use patterns and efficiency are critical factors for evaluating agricultural progress and sustainable land resource management. The current study investigates the spatial and temporal changes in the main land use categories, as well as agricultural land use efficiency, in the Buldhana District, Maharashtra, between 1995 and 2000 and 2010 and 2015. The analysis is based on secondary data obtained from the Maharashtra Government's Directorate of Economics and Statistics, District Socio-Economic Abstracts, and the Department of Agriculture, Maharashtra. Regional discrepancies in land use were assessed using percentage change analysis, the Land Use Efficiency Index, descriptive statistics, and Pearson's correlation analysis. The findings show that the forest area decreased from 115,800 ha (11.97%) to 68,500 ha (7.08%), whereas the net sown area decreased from 702,100 ha (72.60%) to 679,800 ha (70.29%). Conversely, uncultivable and fallow land increased significantly, indicating greater pressure on agricultural resources. Chikhli (127.80%), Buldhana (125.94%), Nandura (124.29%), and Mehkar (122.48%) had the highest land use efficiency from 2010 to 2015. Pearson correlation analysis demonstrated a substantial positive link between the Net Sown Area and Gross Cropped Area ($r = 0.897$, $p < 0.01$), underscoring the importance of cultivated land in increasing agricultural productivity. The study suggests that sustainable land management, irrigation extension, reclamation of degraded lands, and implementation of scientific farming practices are critical for enhancing land-use efficiency and guaranteeing balanced agricultural development in the Buldhana District.

Keywords: *Agricultural Land Use, Land Use Efficiency, Cropping Pattern, Spatial Variation, Pearson Correlation*

Introduction

Land is one of the most valuable and limited natural resources that sustains human life, economic activity, and environmental health. It provides a physical foundation for agriculture, settlements, industries, transportation, forestry, and biodiversity preservation. Agriculture is the most common land use in developing countries, such as India, where a large majority of the population relies directly or indirectly on agriculture for a living. Consequently, the pattern and efficiency of land use have become critical indices for assessing agricultural development, food security, and sustainable resource management (Mather, 2006; Singh & Dhillon, 2004). Land use refers to how humans use land to meet their social, economic, and cultural demands, whereas land cover denotes the natural or physical characteristics of the Earth's surface. The current land use pattern of a region is the result of interactions between physical factors such as climate, soil, relief, water availability, and drainage, as well as socioeconomic factors such as population growth, technological advancement, market accessibility, government policies, and agricultural infrastructure. Land use patterns alter significantly both temporally and spatially as these elements evolve over time (Stamp, 1960; FAO, 1976). Agricultural land use is one of the most dynamic drivers of regional development. Crop intensity, cropping pattern, irrigation facilities, and land use efficiency all have direct impacts on agricultural productivity and farmer livelihoods. Land-use efficiency, commonly defined as the ratio of the gross cropped area to the net sown area, represents the intensity with which the available agricultural land is used. Higher land-use efficiency indicates that land resources are being used effectively through multiple cropping and improved agricultural practices, whereas lower efficiency suggests that available resources are being underutilized owing to environmental constraints, inadequate irrigation, or socioeconomic limitations (Singh & Dhillon 2004). This study fills this research gap by investigating the spatiotemporal variations in major land use categories, such as forest area, land not suitable for cultivation, uncultivable land, fallow land, and net sown area in Buldhana District between 1995-2000 and 2010-15. The study also assessed tahsil-specific land use efficiency using the gross cropped area to net sown area ratio, as well as variations in per capita net sown area as a measure of population pressure on agricultural land.

Regional differences in agricultural land utilization were identified using percentage change analysis, the land use efficiency index, descriptive statistics, and comparative spatial analysis. The study's findings are designed to help researchers better understand agricultural land-use trends in Maharashtra's semi-arid regions. The findings will help planners, policymakers, agricultural scientists, and resource managers design sustainable land-use policies, increase agricultural production, promote efficient land resource use, and achieve balanced regional development. Furthermore, this study provides a scientific framework for evaluating land-use transformation and agricultural efficiency, which may be applied to other agriculturally dominated regions with comparable environmental and socioeconomic conditions.

Study Area

The Buldhana District is situated between latitudes 19°51′ and 21°17′ North and longitudes 75°57′ and 76°59′ East in the western portion of the Vidarbha region of Maharashtra, India. The region is formed of 13 tahsils and has a total area of approximately 9,661 km² (966,100 hectares). Its borders are Jalna district to the south, Jalgaon district to the west, Akola and Washim districts to the east, and Madhya Pradesh to the north.

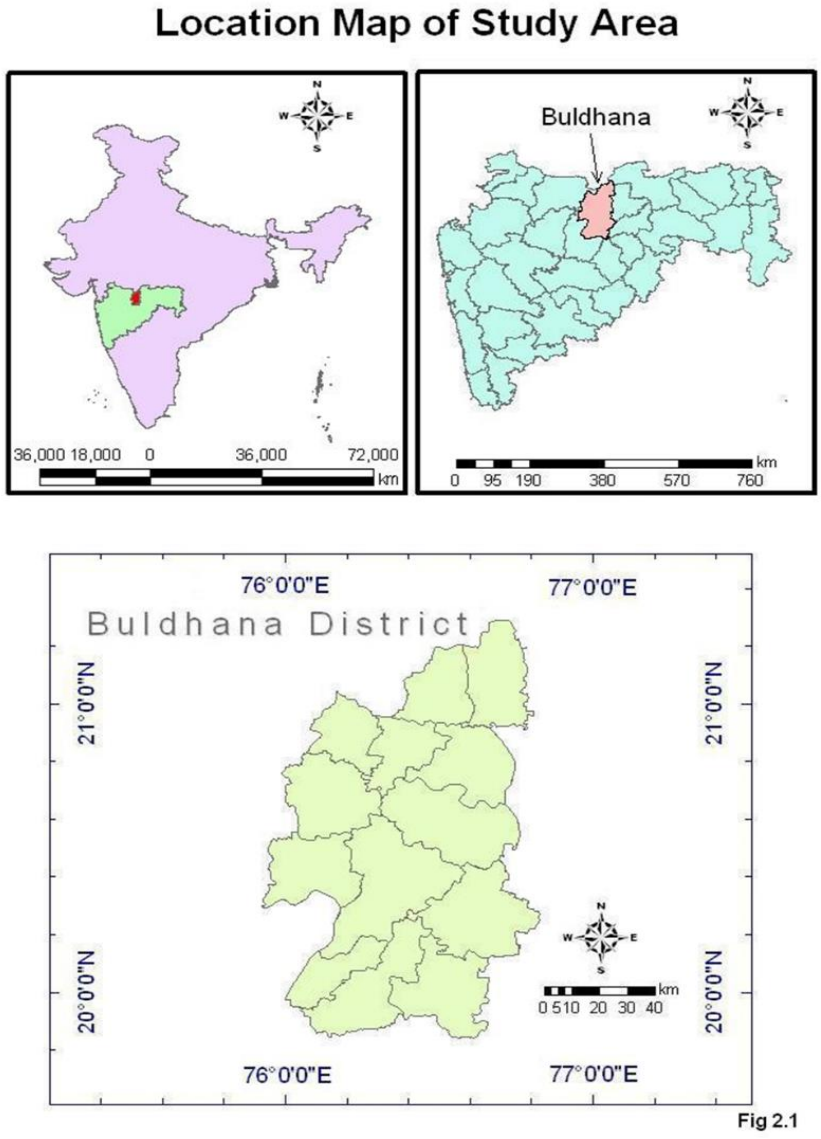

Image
Fig. 1:

Materials and Methodology

The present study is based on both secondary and primary data to analyze the land use pattern and agricultural land use efficiency in Buldhana District, Maharashtra. Secondary data on land use categories, gross cropped area, net sown area, and other agricultural statistics for the periods 1995–2000 and 2010–15 were collected from the District Socio-Economic Abstracts, District Gazetteers, Directorate of Economics and Statistics, Government of Maharashtra, and the Department of Agriculture, Government of Maharashtra. Administrative boundary maps were obtained from the Survey of India (SOI) and Maharashtra Remote Sensing Applications Center (MRSAC). Relevant literature, research articles, books, and government reports were consulted to support the analysis. The collected data were compiled, classified, tabulated, and analyzed using Microsoft Excel and ArcGIS/QGIS software packages. Percentage change analysis was employed to examine the temporal

variations in different land use categories across the thirteen tahsils. Agricultural land use efficiency was measured using the Land Use Efficiency Index, which was calculated as the ratio of Gross Cropped Area (GCA) to Net Sown Area (NSA) multiplied by 100. Land use efficiency = Descriptive statistical techniques, including percentage analysis, mean, standard deviation (SD), and coefficient of variation (CV), were used to assess the regional disparities in land use. Tahsils were classified into low, moderate, and high land-use efficiency regions based on the calculated index values. A comparative analysis was conducted to identify changes in land utilization between the two study periods. The analyzed results were presented through statistical tables and thematic maps to facilitate a comprehensive understanding of the spatial and temporal dynamics of land use and agricultural land use efficiency in the Buldhana District.

Results and Discussion

Spatial Pattern of General Land Use Pattern in Buldhana District

Land is the most important natural resource for agricultural production and regional development. Land use patterns reflect the interaction of physical elements such as climate, relief, soil, and drainage, as well as socioeconomic influences such as population pressure, irrigation, technology, and government policy. The current study examines the key land use categories in Buldhana District between 1995-2000 and 2010-15 to better understand the spatial and temporal trends in land utilization.

Area under Forest

Forests are essential natural resources that help maintain a stable and diverse environment. Table 4.1 shows that the total forest area in Buldhana District decreased from 115,800 ha (11.97%) in 1995-2000 to 68,500 ha (7.08%) in 2010-15, representing an overall 4.89% decrease. The largest proportion of forest area was observed in Jalgaon Jamod (27.02%) between 1995 and 2000, followed by Khamgaon (22.23%), Sangrampur (20.28%), and Chikhli (19.75%). During 2010-15, Sangrampur had the highest forest cover (14.04%), whereas Shegaon had the lowest (0.72%). Most tahsils saw a decrease in forest area because of the increase in agriculture, settlement development, and anthropogenic activities. However, Malkapur showed a positive increase of 3.49%, indicating an improvement in forest cover through plantation or conservation programs.

Area Not Available for Cultivation

Settlements, highways, industries, bodies of water, and other non-agricultural uses occupy land that is not suitable for farming. During the research period, the district's area decreased by 0.61%, from 82,100 hectares (8.48%) to 76,200 hectares (7.87%). Sindkhed Raja (27.16%) had the largest proportion between 1995 and 2000, while Malkapur (3.03%) had the lowest figure from 2010 to 2015. Positive changes were recorded in Lonar (8.62%), Motala (5.67%), and Buldhana (4.27%), indicating increased urban and infrastructure development in these talukas. In contrast, Sindkhed Raja (-20.75%) experienced the highest reduction, indicating that non-cultivable land was converted into productive agricultural land.

Uncultivable Land

Permanent wastelands, rocky terrain, gullied soil, and other areas unfit for cultivation are examples of uncultivable land. The district's total area grew by 1.58%, from 52,900 ha (5.47%) to 68,200 ha (7.05%). Between 1995 and 2000, Lonar had the largest percentage of uncultivable land (17.41%), whereas Shegaon had the largest percentage between 2010 and 2015 (14.25%). Buldhana (9.90%), Mehkar (4.59%), and Jalgaon Jamod (4.82%) showed notable increases, whereas Lonar (-11.34%) and Chikhli (-2.34%) had discernible decreases, suggesting the reclamation of wasteland for agricultural uses.

Table 1: General Land Use Pattern of Buldhana District (1995-2000 & 2010-15)

Sr.	Category	Year	Jalgaon Jamod	Sangrampur	Shegaon	Nandura	Malkapur	Motala	Khamgaon	Mehkar	Chikhli	Buldhana	Deulgaon Raja	SindkhedRaja	Lonar	District Total
1	**Area under Forest**	1995 – 2000	15700 (27.02)	13100 (20.28)	600 (0.78)	2300 (4.97)	600 (1.27)	10700 (14.62)	23300(22.23)	14600 (15.89)	17400 (19.75)	5300 (7.46)	3600 (4.41)	5000 (6.09)	3600 (4.44)	115800 (11.97)
		2010 –15	2300(3.95)	9000(14.04)	600 (0.72)	1100 (2.44)	2200(4.76)	5700 (7.62)	11900(10.94)	12100 (12.74)	10200(11.32)	4100(5.79)	3500 (4.17)	3500 (4.39)	2300 (3.40)	68500 (7.08)
		VOC (%)	-23.07	-6.24	-0.06	-2.53	3.49	-7.00	-11.29	-3.15	-8.43	-1.67	-0.24	-1.70	-1.04	-4.89
2	**Area not Available for Cultivation**	1995 – 2000	2100 (3.61)	4500(6.97)	13800 (17.95)	1600 (3.46)	2400(5.06)	2700 (3.69)	7700 (7.35)	2800 (3.05)	5100(5.79)	6500 (9.15)	7400(9.06)	22300 (27.16)	3200 (3.95)	82100 (8.48)
		2010 –15	3500 (6.02)	2800(4.37)	11000 (13.29)	2000 (4.43)	1400(3.03)	7000 (9.36)	10800 (9.93)	3800 (4.00)	4100 (4.55)	9500 (13.42)	6700(7.98)	5100(6.40)	8500 (12.57)	76200 (7.87)
		VOC (%)	2.41	-2.60	-4.66	0.97	-2.03	5.67	2.58	0.95	-1.24	4.27	-1.08	-20.75	8.62	-0.61
3	**Uncultivable Land**	1995 – 2000	300 (0.52)	1800(2.79)	8700 (11.31)	600 (1.30)	300(0.63)	5500 (7.51)	5900 (5.63)	1100 (1.20)	4800 (5.4	2600 (3.66)	3500(4.28)	3700 (4.51)	14100 (17.41)	52900 (5.47)

											5)					
		2010–15	3100 (5.34)	1400(2.18)	11800 (14.25)	1500 (3.33)	1100 (2.38)	4900 (6.55)	7400 (6.80)	5500 (5.79)	2800 (3.11)	9600 (13.56)	8900 (10.60)	6100 (7.65)	4100 (6.07)	68200 (7.05)
		VOC (%)	4.82	-0.61	2.94	2.03	1.75	-0.96	1.17	4.59	-2.34	9.90	6.32	3.14	-11.34	1.58
4	**Fallow Land**	1995–2000	300 (0.52)	1400 (2.17)	600 (0.78)	1300 (2.81)	400 (0.84)	600(0.82)	3100 (2.96)	800(0.87)	1800 (2.04)	300 (0.42)	1400 (1.71)	700(0.85)	1500 (1.85)	14200 (1.47)
		2010–15	7500 (12.91)	6000 (9.36)	6600 (7.97)	1800 (3.99)	1800 (3.90)	2200 (2.94)	9900 (9.10)	8200(8.63)	700 (0.78)	2500 (3.53)	15100 (17.98)	8300(10.41)	3800(5.62)	74400 (7.69)
		VOC (%)	12.39	7.19	7.19	1.18	3.06	2.12	6.14	7.76	-1.26	3.11	16.27	9.56	3.77	6.22
5	**Net Sown Area**	1995–2000	39700 (68.33)	43800 (67.80)	53200 (69.18)	40500 (87.47)	43700 (92.19)	53700 (73.36)	64800 (61.83)	726000(79.00)	59000 (66.97)	56300 (79.30)	65800 (80.54)	50400(61.39)	58600 (72.35)	702100 (72.60)
		2010–15	41700 (71.77)	44900 (70.05)	52800 (63.77)	38700 (85.81)	39700 (85.93)	55000 (73.53)	68800 (63.24)	654000(68.84)	72300 (80.24)	45100 (63.70)	49800 (59.29)	56700(71.14)	48900 (72.34)	679800 (70.29)
		VOC (%)	3.44	2.25	-5.41	-1.66	-6.26	0.17	1.41	-10.16	13.27	-15.60	-21.25	9.75	-0.01	-2.31

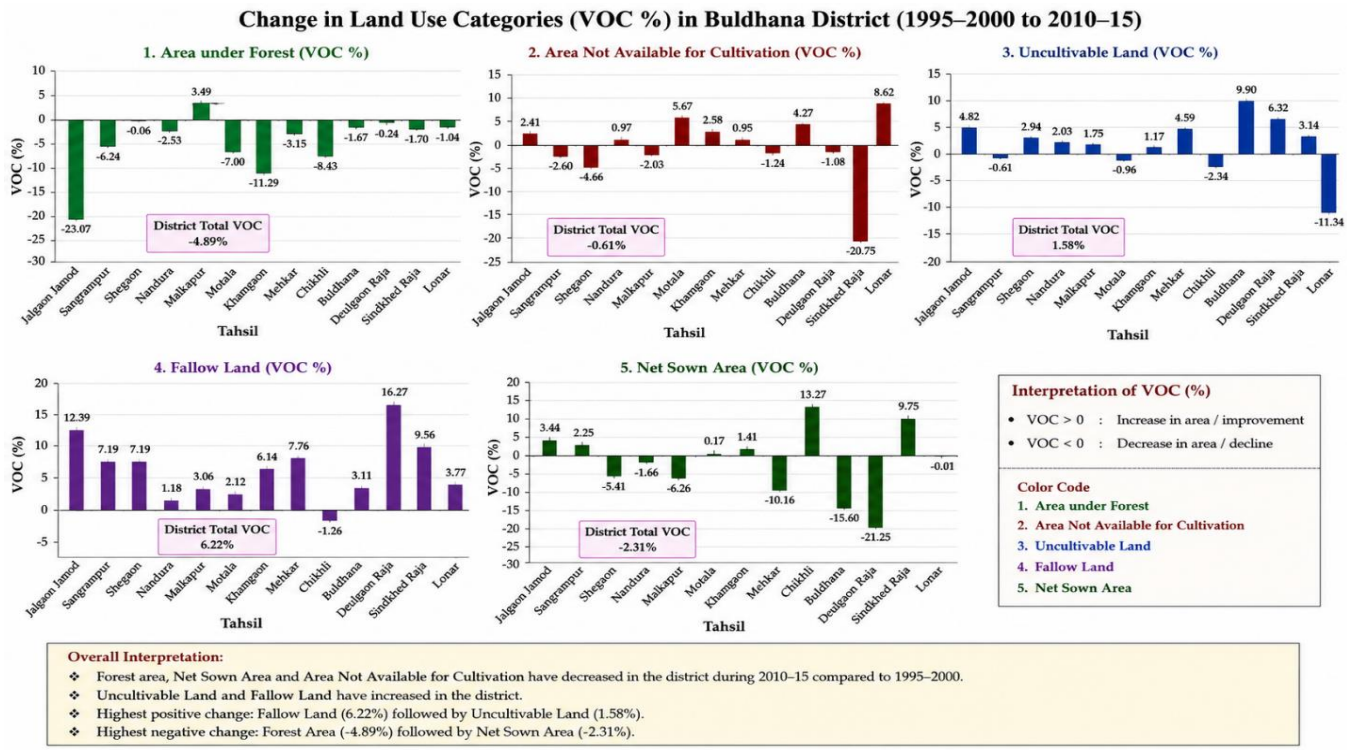

Image
Fig. 1

Fallow Land

Fallow land represents cultivable land left uncropped for one or more seasons owing to inadequate rainfall, labor shortages, poor soil fertility, or economic reasons. The total fallow land increased substantially from 14,200 ha (1.47%) during 1995–2000 to 74,400 ha (7.69%) during 2010–15, reflecting an overall increase of 6.22%. The highest percentage during 2010–15 was recorded in Deulgaon Raja (17.98%), followed by Jalgaon Jamod (12.91%) and Sindkhed Raja (10.41%). Only Chikhli (-1.26%) recorded a slight decline in fallow land, suggesting improved agricultural use. The increase in fallow land in many tahsils indicates the influence of rainfall variability, groundwater depletion, and changes in agricultural practices.

Net Sown Area

The net sown area is the principal indicator of agricultural land utilization. The district recorded a decline from 702,100 ha (72.60%) during 1995–2000 to 679,800 ha (70.29%) during 2010–15, representing an overall decrease of 2.31%. During 1995–2000, Malkapur (92.19%) recorded the highest proportion of net sown area, followed by Nandura (87.47%) and Deulgaon Raja (80.54%). From 2010 to 15, Malkapur (85.93%) and Nandura (85.81%) continued to dominate agricultural land use, whereas Deulgaon Raja (59.29%) recorded the lowest proportion. Chikhli (13.27%) and Sindkhed Raja (9.75%) registered the highest positive changes, whereas Deulgaon Raja (-21.25%) and Buldhana (-15.60%) experienced considerable reductions in cultivated land.

Land Use Efficiency Analysis

The ratio of gross cropped area to net sown area is known as land-use efficiency, and it represents the intensity of agricultural land utilization. The intensity of crops and the use of available agricultural land increased with the index. According to Table 2, Nandura had the best land use efficiency during 1995 - 2000 (119.51%), followed by Khamgaon (118.67%) and Mehkar (115.56%), while Motala (102.05%) and Malkapur (102.06%) had the lowest values. In a number of tahsils, land use efficiency significantly increased during 2010–2015. Buldhana (125.94%), Nandura (124.29%), Mehkar (122.48%), and Chikhli (127.80%) had the highest efficiency. Conversely, because of the decrease in gross cultivated area and the increase in fallow land, Deulgaon Raja (76.31%) had the lowest land use efficiency.

Significant spatial variation in cropping intensity was observed in the volume of change. Chikhli had the largest positive change (19.83%), followed by Buldhana (12.80%) and Mehkar (6.92%), respectively. This is due to the adoption of modern agricultural practices, mechanization, and better irrigation facilities. In contrast, a decrease in land use efficiency was observed in Deulgaon Raja (-30.98%), Khamgaon (-9.66%), Sindkhed Raja (-8.11%), Lonar (-4.18%), and Sangrampur (-4.14%), primarily as a result of fluctuating rainfall, an increase in fallow land, and modifications to cropping techniques.

Table 2: Land use Efficiency in Buldhana District (Area in '000 hectares)

Sr. No.	Name of the Tahsil	1995-2000			2010-15			VOC (%)
		Gross Cropped Area	Net Sown Area	Index of Land Use Efficiency	Gross Cropped Area	Net Sown Area	Index of Land use Efficiency	
1	Jalgaon Jamod	421	397	106.05	460	417	110.31	4.26
2	Sangrampur	463	438	105.7	456	449	101.56	-4.14
3	Shegaon	557	532	104.7	556	528	105.3	0.6
4	Nandura	484	405	119.51	481	387	124.29	4.78
5	Malkapur	446	437	102.06	423	397	106.55	4.49
6	Motala	548	537	102.05	583	550	106	3.95
7	Khamgaon	769	648	118.67	750	688	109.01	-9.66
8	Mehkar	839	726	115.56	801	654	122.48	6.92
9	Chikhli	637	590	107.97	924	723	127.8	19.83
10	Buldhana	637	563	113.14	568	451	125.94	12.8
11	Deulgaon Raja	706	658	107.29	380	498	76.31	-30.98
12	Sindkhed Raja	552	504	109.52	575	567	101.41	-8.11
13	Lonar	662	586	112.97	532	489	108.79	-4.18

Source: Compiled by the author.

Based on the land-use efficiency index, the tahsils can be classified into three categories:

1. High Land Use Efficiency (>115%): Chikhli, Buldhana, Nandura, and Mehkar.
2. Moderate Land Use Efficiency (106–115%): Jalgaon Jamod, Nandura (1995–2000), Khamgaon, Lonar, and Malkapur.
3. Low Land Use Efficiency (<106%): Sangrampur, Shegaon, Motala, Deulgaon Raja, and Sindkhed Raja.

Corelation Matrix

Pearson's correlation analysis was used to investigate the link between the selected land use variables, namely Forest Area, Net Sown Area, Gross Cropped Area, and Land Use Efficiency in Buldhana District. The analysis was conducted using tahsil-level data from 2010–2015. The correlation coefficient (r) measures the strength and direction of a linear relationship between variables, ranging from -1 to +1. Positive numbers imply a direct association, whereas negative numbers suggest an inverse relationship. Table 3 presents the findings of the correlation analysis.

Table 3: Pearson Correlation Matrix among Forest Area, Net Sown Area, Gross Cropped Area and Land Use Efficiency (2010–15)

Variables	Forest Area (ha)	Net Sown Area (ha)	Gross Cropped Area (ha)	Land Use Efficiency (%)
Forest Area	1	0.757 **	0.734 **	0.244
Net Sown Area	0.757 **	1	0.897 **	0.184
Gross Cropped Area	0.734 **	0.897 **	1	*0.595*
Land Use Efficiency	0.244	0.184	*0.595*	1

Source: Compiled by the author.
Significance levels (n = 13):
$p < 0.01$ = **
$p < 0.05$ = *

Table 4: Corresponding p-values

Variable Pair	r	p-value	Significance
Forest Area – Net Sown Area	0.757	0.0027	Significance**
Forest Area – Gross Cropped Area	0.734	0.0043	Significance**
Forest Area – Land Use Efficiency	0.244	0.4226	NS
Net Sown Area – Gross Cropped Area	0.897	<0.001	Significance**
Net Sown Area – Land Use Efficiency	0.184	0.5465	NS
Gross Cropped Area – Land Use Efficiency	0.595	0.0319	Significance*

Source: Compiled by the author.

The Pearson correlation study showed a strong positive and statistically significant association between Net Sown Area and Gross Cropped Area ($r = 0.897$, $p < 0.01$). This suggests that tahsils with larger cultivated areas have larger gross cropped areas. Forest Area has a significant positive association with Net Sown Area ($r = 0.757$, $p < 0.01$) and Gross Cropped Area ($r = 0.734$, $p < 0.01$), indicating that tahsils with more forest resources also have more agricultural areas. The gross cropped area had a moderate positive correlation with land use efficiency ($r = 0.595$, $p < 0.05$), suggesting that an increase in the cropping area leads to an increase in the cropping intensity. However, the relationships between Land Use Efficiency and forest area ($r = 0.244$) and Net Sown Area ($r = 0.184$) were not statistically significant ($p > 0.05$), indicating that cropping intensity and agricultural practices have a greater influence on land use efficiency than the extent of forest or net sown area alone.

Conclusion

The present analysis investigated the spatial and temporal changes in land use patterns and agricultural land use efficiency in Buldhana District from 1995-2000 to 2010-15. The data show significant differences in the use of land resources throughout the 13 tahsils, suggesting the combined influence of physical, socioeconomic, and technological variables. The forest and net sown areas declined overall, whereas uncultivable and fallow land increased during the research period, indicating a greater demand for agricultural land and natural resources. The results also reveal significant regional differences in agricultural land utilization. Malkapur and Nandura retained a higher proportion of net sown area, whereas Deulgaon Raja and Buldhana experienced a significant reduction in cultivated land. Similarly, Chikhli, Buldhana, Nandura, and Mehkar have excellent land-use efficiency owing to increased cultivation intensity, irrigation facilities, and the use of better agricultural methods. In contrast, Deulgaon Raja, Sangrampur, Sindkhed Raja, and Khamgaon displayed comparatively decreased land use efficiency, mostly due to increased fallow land, rainfall unpredictability, and decreasing cropping intensity. Pearson's correlation analysis indicated a strong and statistically significant positive link between Net Sown Area and Gross Cropped Area ($r = 0.897$, $p < 0.01$). This suggests that expanding the cultivated area directly helps increase agricultural productivity. Gross Cropped Area also had a substantial positive relationship with Land Use Efficiency, underscoring the importance of multiple cropping and efficient use of agricultural land. These findings show that land-use efficiency is determined not only by the area of cultivated land but also by irrigation development, cropping intensity, and current farming practices.

In summary, the study concludes that sustainable agricultural development in the Buldhana District necessitates the preservation of forest resources, reclamation of degraded and fallow lands, expansion of irrigation infrastructure, promotion of scientific farming techniques, and implementation of effective land management strategies. Such initiatives will boost agricultural output, improve land-use efficiency, and promote balanced regional development while ensuring that land resources are used sustainably for future generations.

Acknowledgment

The authors express their sincere gratitude to the institutions and individuals whose support contributed to the successful completion of this study on the spatio-temporal changes in land use patterns and agricultural land use efficiency in Buldhana District, Maharashtra. The authors are grateful to the Directorate of Economics and Statistics, Government of Maharashtra, the Department of Agriculture, Government of Maharashtra, and the concerned District Socio-Economic Abstracts and District Gazetteers for providing the statistical information and secondary data required for the analysis.

Financial support and sponsorship

Nil.

Conflicts of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

References

1. Coppock, J. T. (1968). Changing land use in Great Britain. Land Use and Resources: Studies in Applied Geography. Institute of British Geographers.
2. Food and Agriculture Organization (FAO). (1976). A framework for land evaluation (FAO Soils Bulletin No. 32). Food and Agriculture Organization of the United Nations (FAO).
3. Government of Maharashtra, India. (2000). District socioeconomic abstract: Buldhana district. Directorate of Economics and Statistics, Government of Maharashtra, India.

4. Government of Maharashtra. (2015). District socioeconomic abstract: Buldhana district. Directorate of Economics and Statistics, Government of Maharashtra, India.
5. Government of Maharashtra. (2015). Agricultural statistics of Maharashtra, India. Department of Agriculture, Government of Maharashtra, India.
6. Lambin, E. F., Turner, B. L., Geist, H. J., Agbola, S. B., Angelsen, A., Bruce, J. W., Coomes, O. T., Dirzo, R., Fischer, G., Folke, C., George, P. S., Homewood, K., Imbernon, J., Leemans, R., Li, X., Moran, E. F., Mortimore, M., Ramakrishnan, P. S., Richards, J. F., … Xu, J. (2001). The causes of land use and land cover change: Moving beyond the myths. Global Environmental Change, 11(4), 261–269. https://doi.org/10.1016/S0959-3780(01)00007-3
7. Mather, A. S. (2006). Land use. Routledge.
8. Maharashtra Remote Sensing Applications Center. (2015). District resource atlas: Buldhana District. MRSAC.
9. Shafi, M. (1968). Techniques of rural land use planning with special reference to India. The Geographer, 13, 15–24.
10. Singh, J., & Dhillon, S. S. (2004). Agricultural geography (3rd ed.). Tata McGraw-Hill Education.
11. Singh, V. R. (1979). Dynamics of agricultural development in the region. Concept Publishing Company.
12. Stamp L. D. (1960). Our developing world. Faber and Faber.
13. Survey of India. (2011). Administrative map of the Buldhana district. Survey of India.
14. United States Geological Survey (USGS). (2023). Landsat missions. https://landsat.gsfc.nasa.gov
15. Field, A. (2018). Discovering Statistics Using IBM SPSS Statistics (5th ed.). Sage Publications.
16. Gomez, K. A., & Gomez, A. A. (1984). Statistical Procedures for Agricultural Research (2nd ed.). John Wiley & Sons.
17. Montgomery, D. C., Peck, E. A., & Vining, G. G. (2021). Introduction to Linear Regression Analysis (6th ed.). John Wiley & Sons.