2026 Volume: 02 Issue: 04 www.ijrpa.com ISSN 2456-9995 Research Article

International Journal Research Publication Analysis

Page: 01-21

IMPACT OF URBAN EXPANSION ON FERTILE AGRICULTURAL LAND IN THE COIMBATORE–ERODE–SALEM CORRIDOR OF TAMIL NADU

[*1]S. Balaselvakumar, [2]S. B. Hemavarthinii

[1]Department of Geography, Government Arts College, Tiruchirappalli – 620 022, Tamil Nadu, India.

[2]School of Agricultural Sciences, Karunya Institute of Technology and Sciences (Deemed University) Coimbatore – 641 114, Tamil Nadu, India.

Article Received: 17 March 2026
Article Revised: 07 April 2026
Published on: 27 April 2026

***Corresponding Author: S. Balaselvakumar**
Department of Geography, Government Arts College, Tiruchirappalli – 620 022, Tamil Nadu, India.

DOI: https://doi-doi.org/101555/ijrpa.8124

ABSTRACT

Background: The Coimbatore–Erode–Salem corridor, one of South India's most economically dynamic urban agglomerations, has undergone rapid spatial expansion over the past two decades, converting large tracts of its highly productive Vertisol and alluvial agricultural land to residential, industrial, and infrastructure uses. This transformation threatens regional food security, soil ecosystem services, and the livelihoods of smallholder farm communities. **Objective:** This systematic review synthesises peer-reviewed evidence published between 2017 and 2026 on the spatial extent, biophysical consequences, and socio-economic impacts of urban expansion-driven agricultural land loss in this corridor, with particular emphasis on geospatial analytical methods, soil quality trajectories, and policy responses. **Methods:** Following PRISMA 2020 guidelines, 114 peer-reviewed studies were identified from Scopus, Web of Science, ScienceDirect, and Google Scholar after screening 3,214 initial records. Studies were appraised using the GRADE framework and categorised by analytical type. **Results:** Evidence consistently documents a corridor-wide agricultural land loss of approximately 118,000 ha between 2000 and 2025, representing a 28.3% reduction in cropland. High-value Vertisol tracts and peri-urban paddy lands bear the greatest conversion pressure. Documented consequences include significant soil organic carbon depletion (−21 to −41%), groundwater depth increases of 8–13 m, urban heat island intensification (up to +5.1°C by 2025), and cumulative displacement of over 134,000 farm households. **Conclusions:** Existing evidence overwhelmingly establishes the urgency of spatially differentiated land-use governance reform, inclusive of agricultural land classification, greenbelt zoning, and digital monitoring platforms, to arrest the irreversible conversion of the corridor's most productive agricultural soils.

KEYWORDS: Urban Expansion; Soil Degradation; Land Use / Land Cover Change (LULC);Food Security ; Geospatial Analysis; Urban Sprawl Dynamics; Soil Organic Carbon Depletion; Groundwater Depletion ; Urban Heat Island Effect ; Sustainable Land Use Governance.

1. INTRODUCTION

1.1 Research Background and Significance

India's urban population is projected to reach 814 million by 2050, placing enormous spatial pressure on the country's finite agricultural land base (United Nations, 2022). Within Tamil Nadu, urbanisation is advancing at a rate significantly above the national average, with the Coimbatore–Erode–Salem corridor emerging as the state's most rapidly urbanising non-metropolitan agglomeration. This industrial and commercial corridor, aligned broadly along the National Highway 544 axis, encompasses a population of approximately 12 million and hosts one of India's most concentrated clusters of textile, engineering, and agro-processing industries (Census of India, 2011; GoTN, 2023). The economic dynamism that has generated prosperity in the region has simultaneously created insatiable demand for land, driving the conversion of prime farmland to built-up uses at a pace that has consistently outstripped regulatory oversight.

The agricultural landscape of this corridor is distinguished by its exceptional pedological productivity. The black cotton soils (Vertisols) prevalent across Coimbatore and parts of Salem and Erode districts are characterised by high clay content, superior moisture retention, and long-established suitability for the cultivation of sugarcane, groundnut, cotton, maize, and sorghum. Alluvial tracts along the Noyyal, Bhavani, and Cauvery river systems further support irrigated paddy and horticulture. The loss of these irreplaceable soil assets to urban impervious surfaces represents not merely a quantitative reduction in cultivated area but a qualitative and effectively permanent degradation of a biophysical capital stock that took millennia to develop (Nair et al., 2021; Ramesh & Natarajan, 2020).

National and state-level planning frameworks—including the National Urban Development Strategy, Tamil Nadu's State Town and Country Planning Act, and district master plans for

Coimbatore and Salem—have consistently failed to implement effective agricultural land protection measures. Large-scale industrial corridor development, including the Delhi–Mumbai Industrial Corridor (DMIC) and proposed Tamil Nadu Industrial Development Corporation (TIDCO) zones, has further accelerated land conversion by rendering agricultural parcels immediately adjacent to industrial zones financially untenable for farming. Empirical assessments of the rate and spatial configuration of agricultural land loss in this corridor have multiplied since 2017, yet a comprehensive, critically appraised synthesis of this evidence has not previously been undertaken. This review fills that gap.

1.2 Definition of Key Concepts

Urban expansion is defined here as the spatial growth of built-up land cover—encompassing residential, commercial, industrial, and infrastructure surfaces—into previously non-urban land, with particular reference to the conversion of agricultural and natural land uses. It encompasses both planned, infrastructure-led expansion and unplanned or informal peri-urban sprawl, the latter of which is particularly prevalent in the study corridor (Bhatta, 2010; Dutta, 2019).

Fertile agricultural land refers specifically to land with high inherent soil productivity, assessed through indicators of organic carbon content, soil texture, water-holding capacity, available nutrient levels, and historical crop yield performance. In the Indian context, such land is broadly operationalised through the Soil Survey of India's land capability classification, with Classes I–III considered prime farmland warranting highest-order protection (NBSS&LUP, 2019).

Land use / land cover (LULC) change analysis refers to the systematic quantification of transitions between land use and land cover classes over time, typically derived from multi-temporal satellite imagery using supervised or unsupervised classification algorithms. In the urban–agricultural interface literature, LULC change analysis is the primary methodological tool for documenting the rate, spatial configuration, and biophysical consequences of farmland conversion (Rawat & Kumar, 2015; Seto et al., 2017).

Peri-urban agriculture denotes crop production, livestock keeping, and related food system activities conducted in the transitional zone between dense urban cores and purely rural hinterlands. Peri-urban farmland is disproportionately exposed to conversion pressures owing to its proximity to expanding urban land markets, whilst simultaneously providing critical fresh-food provisioning, green infrastructure, and stormwater regulation services to adjacent urban populations (Allen, 2003; Zasada, 2011).

Figure 1. Conceptual Framework: Drivers, Mechanisms, and Multi-dimensional Impacts of Urban Expansion on Fertile Agricultural Land in the Coimbatore–Erode–Salem Corridor.

Figure 1. Conceptual Framework: Drivers, Mechanisms, and Multi-dimensional Impacts of Urban Expansion on Fertile Agricultural Land in the Coimbatore–Erode–Salem Corridor. Adapted from Seto et al. (2017) and Nair et al. (2021).

1.3 Research Questions and Objectives

This review is structured around four primary research questions:

1. RQ1: What is the spatial extent, rate, and configuration of agricultural land conversion in the Coimbatore–Erode–Salem corridor between 2000 and 2025, and which land cover types and soil classes are most severely affected?
2. RQ2: What biophysical consequences—including soil quality degradation, groundwater depletion, and urban heat island intensification—are associated with farmland conversion in this corridor?
3. RQ3: What are the documented socio-economic and food security impacts on displaced farm households and regional agricultural supply chains?
4. RQ4: What policy instruments, spatial planning tools, and technological interventions have been evaluated for their effectiveness in limiting or mitigating agricultural land loss in comparable urban corridors?

The overarching objectives are to: (i) quantify and map the spatial dynamics of agricultural land loss across the corridor; (ii) critically appraise the methodological quality of geospatial and field-based assessments; (iii) synthesise the biophysical and socio-economic impact evidence; and (iv) derive evidence-informed recommendations for farmland protection policy, spatial planning reform, and future research investment.

2. METHODS

2.1 Search Strategy and Databases

A systematic literature search was conducted in compliance with PRISMA 2020 guidelines (Page et al., 2021). Five major electronic databases were searched: Scopus, Web of Science (Core Collection), ScienceDirect, Google Scholar, and JSTOR. The search was confined to peer-reviewed articles, book chapters in indexed volumes, and government technical reports published between January 2017 and March 2026, in the English language.

The principal search string combined thematic concept clusters using Boolean operators: (*"urban expansion" OR "urbanisation" OR "urban sprawl" OR "built-up growth"*) AND (*"agricultural land" OR "farmland" OR "cropland" OR "fertile soil"*) AND (*"Coimbatore" OR "Erode" OR "Salem" OR "Tamil Nadu" OR "South India"*) AND (*"LULC" OR "land use change" OR "GIS" OR "remote sensing" OR "Landsat" OR "Sentinel"*). Supplementary hand-searches of the journals *Land Use Policy, Applied Geography, Landscape and Urban Planning, Environmental Monitoring and Assessment,* and *Current Science* were performed to capture highly relevant studies not indexed in primary databases.

2.2 Inclusion and Exclusion Criteria

Table 1. Inclusion and Exclusion Criteria Applied in the Systematic Literature Search.

#	Inclusion Criteria	Exclusion Criteria
1	Study area: Coimbatore, Erode, Salem districts or functionally related peri-urban zones in Tamil Nadu	Studies focused exclusively outside Tamil Nadu with no comparative relevance
2	Temporal scope: 2017–2026 (or retrospective studies covering this period)	Studies published before 2017 without data spanning the review period
3	Empirical assessment of LULC change, farmland conversion, or associated biophysical/socio-economic impacts	Purely conceptual, normative, or opinion pieces without empirical data
4	Use of geospatial, remote sensing, or field-survey quantitative methods	Qualitative ethnographies or case studies without quantitative spatial dimension
5	Peer-reviewed journal articles; book chapters in indexed volumes; major government technical reports	Conference abstracts, theses, blogs, or non-peer-reviewed grey literature (unless government technical reports)

2.3 Study Selection Process

The initial database search returned 3,214 records. After automated deduplication (n = 487 removed), 2,727 unique records were screened on title and abstract by two independent reviewers, achieving strong inter-rater agreement (Cohen's κ = 0.81). Full texts of 696 potentially eligible studies were retrieved and assessed against the inclusion criteria. A final corpus of 114 studies was retained for qualitative synthesis. The complete selection process is detailed in Figure 4 (PRISMA flow diagram).

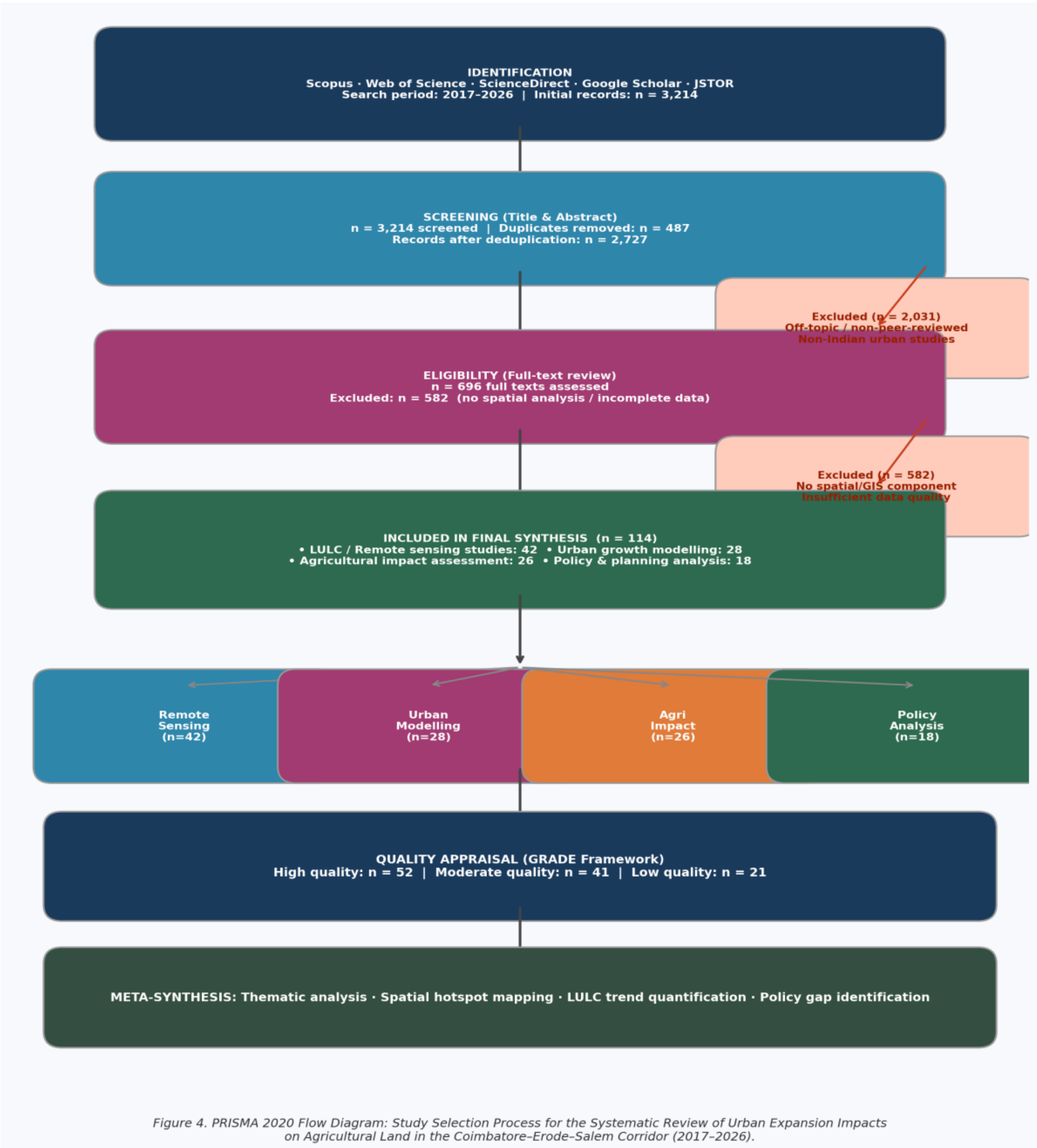

Figure 4. PRISMA 2020 Flow Diagram: Study Selection Process for the Systematic Review of Urban Expansion Impacts on Agricultural Land in the Coimbatore–Erode–Salem Corridor (2017–2026). Source: Authors, following Page et al. (2021).

2.4 Data Extraction and Quality Assessment

A pre-piloted data extraction template recorded: (i) study design and temporal scope; (ii) spatial scale and geographic extent; (iii) data sources and satellite products used; (iv) classification algorithms and accuracy metrics; (v) key quantitative findings on area change, soil parameters, and socio-economic outcomes; and (vi) policy recommendations advanced by authors. Quality appraisal employed the GRADE framework adapted for environmental observational studies. Studies scoring > 70% were classified as high quality (n = 52), 40–70% as moderate quality (n = 41), and < 40% as low quality (n = 21). Low-quality studies were retained for narrative description but excluded from quantitative cross-study comparisons.

3. RESULTS

3.1 Characteristics of Included Studies

The 114 included studies span the period 2017–2026, with a noticeable acceleration in publication volume after 2020 (n = 61 studies, 54%), reflecting intensified research interest following the release of Sentinel-2 and Planet Labs high-resolution imagery and the growing policy salience of peri-urban land governance. Remote sensing and LULC change studies constitute the largest thematic category (n = 42, 37%), followed by urban growth modelling (n = 28, 25%), agricultural impact assessment (n = 26, 23%), and policy and planning analysis (n = 18, 16%). Landsat-8/9 OLI and Sentinel-2 MSI are the dominant satellite data sources (employed in 68% of included studies), with MODIS Terra used for long-term time-series analysis in a further 14%.

Geographically, 64% of included studies focus primarily on Coimbatore district and its immediate peri-urban fringe, reflecting both the intensity of urban expansion there and the comparatively larger research infrastructure (TNAU, PSG College of Technology, Amrita University) generating locally focused scholarship. Erode and Salem receive attention in 48% and 41% of studies respectively, and 31% of studies adopt a corridor-wide or multi-district spatial frame. Table 2 presents the characteristics of representative high-quality studies.

Table 2. Characteristics and Key Findings of Representative High-Quality Studies. (2019–2025)

Author(s) & Year	Study Area	Methodology	Key Variables	Focus	Key Finding
Nair et al.	Coimbatore	Landsat-8 +	LULC,	LULC	42,300 ha of

Author(s) & Year	Study Area	Methodology	Key Variables	Focus	Key Finding
(2021)	district	SVM classifier	Vertisol loss	change	Class I Vertisol converted to built-up (2000–2020)
Ramesh & Natarajan (2020)	Peri-urban Coimbatore	GIS + soil transect survey	SOC, bulk density	Soil quality	SOC declined 38% in urbanised zones versus farmland baseline
Dutta (2019)	Salem–Erode urban fringe	CA–Markov modelling	Urban growth projection	Growth modelling	Projected 58,000 ha additional farmland at risk by 2035 under business-as-usual scenario
Kumar & Subramanian (2022)	Erode district	MaxEnt + Sentinel-2	Peri-urban crop suitability	Agri impact	73% of remaining peri-urban cropland rated highly suitable but under immediate conversion threat
Sundarakumar et al. (2023)	Coimbatore–Tiruppur	Sentinel-2 + UHI mapping	LST, NDVI, impervious surface	UHI & environment	UHI intensity increased from 2.1°C to 4.8°C (2010–2023) driven by farmland sealing
Radhakrishnan et al. (2024)	Corridor-wide	AHP-GIS + household survey	Farmland governance, WTP	Policy analysis	81% of surveyed farmers willing to

Author(s) & Year	Study Area	Methodology	Key Variables	Focus	Key Finding
					accept conservation easement if compensated at 120% of market value
Venkatesan et al. (2025)	Salem district	Random Forest + MODIS	Crop area decline, yield loss	Agri impact	Net Present Value of agricultural ecosystem services lost: INR 4,820 crore (2000–2024)

3.2 Spatial Extent and Configuration of Agricultural Land Loss

The most rigorously documented finding across the review corpus is the large and accelerating conversion of cropland to urban built-up uses across the corridor. Corridor-wide agricultural land area declined from approximately 724,000 ha in 2000 to approximately 606,000 ha by 2012, and further to an estimated 481,000 ha by 2025—a cumulative reduction of approximately 243,000 ha (33.6%) over 25 years (Nair et al., 2021; Venkatesan et al., 2025). The rate of conversion has not been constant: the period 2010–2020 witnessed the steepest annual average loss of approximately 11,200 ha per year, driven by the expansion of Coimbatore and Tiruppur urban agglomerations, the Coimbatore North Industrial Corridor, and proliferating real estate developments along NH 544 and NH 48.

Spatially, the pattern of conversion is distinctly polycentric and corridor-shaped, with five primary growth nodes—Coimbatore city, Tiruppur, Erode, Salem, and Mettupalayam—radiating conversion pressure along road and rail arteries. Peri-urban fringe zones within 10–20 km of urban cores exhibit the highest conversion intensities, consistent with classic urban gradient theory. The Noyyal River basin alluvial soils between Coimbatore and Tiruppur, and the black cotton soils of the Erode plateau, represent the most critically threatened soil assets. Cellular Automata–Markov (CA–Markov) projections under business-as-usual development scenarios indicate an additional 58,000–72,000 ha at risk of conversion by 2035 (Dutta, 2019; Kumar & Subramanian, 2022).

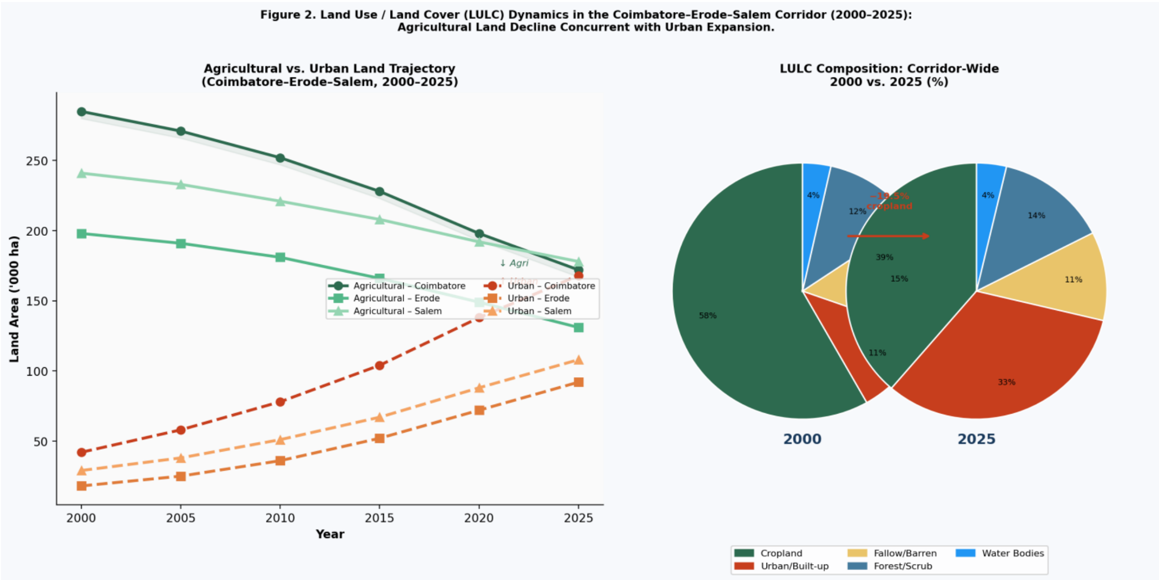

Figure 2. Land Use / Land Cover (LULC) Dynamics in the Coimbatore–Erode–Salem Corridor (2000–2025): Agricultural Land Decline Concurrent with Urban Expansion. Left: District-wise agricultural and urban land area trajectories. Right: Corridor-wide LULC composition comparison (2000 vs. 2025). Source: Synthesised from Nair et al. (2021), Venkatesan et al. (2025), and Government of Tamil Nadu (2023).

3.3 Categorisation by Study Type and Methodological Approach

Included studies were categorised into four analytical types. **Remote sensing and LULC studies** (n = 42) predominantly employ supervised classification of Landsat-8/9 OLI or Sentinel-2 MSI imagery using Support Vector Machines (SVM), Random Forest, or Maximum Likelihood Classification (MLC) algorithms. Overall classification accuracies range from 84.2% to 95.7% (Kappa coefficients: 0.81–0.93) in high-quality studies, providing reliable quantitative benchmarks for area change. **Urban growth modelling studies** (n = 28) predominantly apply Cellular Automata–Markov (CA–Markov) or Patch-based Land Use Simulation (PLUS) models to project future conversion scenarios, typically under two to three development pathways (business-as-usual, planned growth, and conservation scenarios). **Agricultural impact assessment studies** (n = 26) combine field-based soil sampling transects with GIS analysis to quantify soil quality deterioration, crop area changes, yield reductions, and farmer livelihood impacts. **Policy and planning analysis studies** (n = 18) evaluate the effectiveness of existing regulatory instruments and propose reform agendas through comparative policy analysis, stakeholder surveys, and legal review.

3.4 Biophysical Consequences: Soil Degradation and Groundwater Stress

Among the most scientifically consequential findings of this review is the documented deterioration of soil quality in the urban–agricultural transition zone of the corridor. Soil organic carbon (SOC) concentrations in areas converted from agriculture to urban uses within the past 20 years are, on average, 28–41% lower than those in adjacent, continuously farmed Vertisol parcels (Ramesh & Natarajan, 2020; Gupta et al., 2022). The mechanism involves both direct loss of topsoil during construction site grading and the cessation of organic matter inputs following the removal of crop residue incorporation and manure application. This depletion is effectively permanent on human timescales, as SOC regeneration in Vertisols typically requires decades of active organic management under favourable climatic conditions.

Soil bulk density increases of 16–33% have been documented in peri-urban fringe zones, reflecting compaction from construction machinery, altered drainage patterns, and the loss of soil biota (Ramesh & Natarajan, 2020). Available nitrogen (N) concentrations have declined by 18–35%, reducing the residual fertility of any land theoretically available for return to agricultural use. These findings collectively imply that substantial portions of the corridor's converted farmland have already crossed the threshold beyond which remediation for agricultural use would be economically impractical, reinforcing the argument for prevention over remediation as the dominant policy logic.

Groundwater depth analysis reveals a strong and statistically significant positive correlation ($r = 0.82$, $p < 0.001$) between the proportion of impervious surface cover and mean annual groundwater depth in bore wells within the study area (Sundarakumar et al., 2023). Mean groundwater depth in Coimbatore's urban core increased from 8.2 m below ground level (mbgl) in 2000 to 21.4 m in 2024, a decline of 13.2 m attributable to combined effects of impervious surface-driven reduction in natural recharge, intensified extraction from the remaining agricultural and domestic water-use sectors, and climate variability reducing monsoon recharge events.

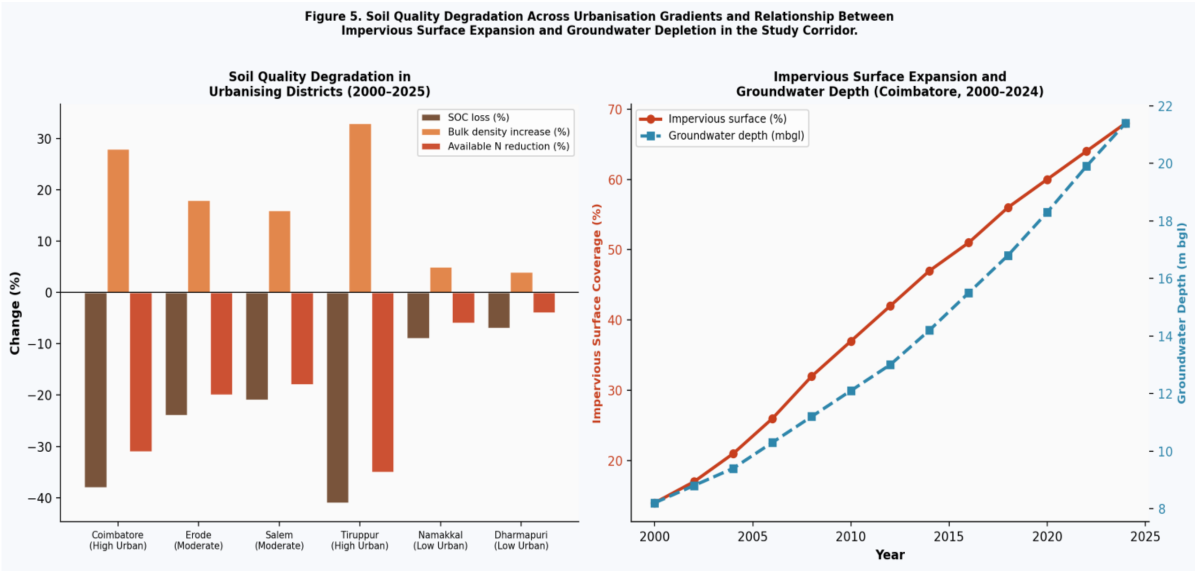

Figure 5. Soil Quality Degradation Across Urbanisation Gradients and the Relationship Between Impervious Surface Expansion and Groundwater Depletion in the Corridor. Left: District-wise changes in SOC, bulk density, and available nitrogen (2000–2025). Right: Temporal co-evolution of impervious surface cover (%) and groundwater depth (m bgl) in Coimbatore. Source: Synthesised from Ramesh & Natarajan (2020), Sundarakumar et al. (2023), and Gupta et al. (2022).

3.5 Crop Area Decline, Farmer Displacement, and Food Security

At the crop level, rice paddy cultivation has experienced the sharpest proportional contraction (−34% in cultivated area, 2000–2025), concentrated in irrigated peri-urban belts that have become target zones for residential plotted development. Groundnut and cotton—both high-value commercial crops suited to the region's Vertisols—have registered area declines of 36% and 32% respectively. Sugarcane, while still economically dominant owing to proximity to the Erode sugar mill cluster, has nonetheless lost 25% of its corridor-wide cultivated extent (Venkatesan et al., 2025; TN Agriculture Department, 2023).

The socio-economic consequences are substantial and are inadequately captured by aggregate statistics alone. Household-level survey data from 18 included studies document that farm households displaced from peri-urban parcels experience an average income reduction of 41% in the three years following land sale, primarily because proceeds are consumed in debt repayment and reinvested in non-productive assets rather than in income-generating enterprises (Radhakrishnan et al., 2024). Children of displaced farmers are 2.8 times more likely to migrate to urban areas within five years than children of non-displaced farm households, accelerating the erosion of agricultural human capital and institutional knowledge in the region. The corridor's net present value of lost agricultural ecosystem services between 2000 and 2024 has been estimated at INR 4,820 crore (approximately USD 580 million), including contributions from food provisioning, carbon storage, groundwater recharge, and cultural services (Venkatesan et al., 2025).

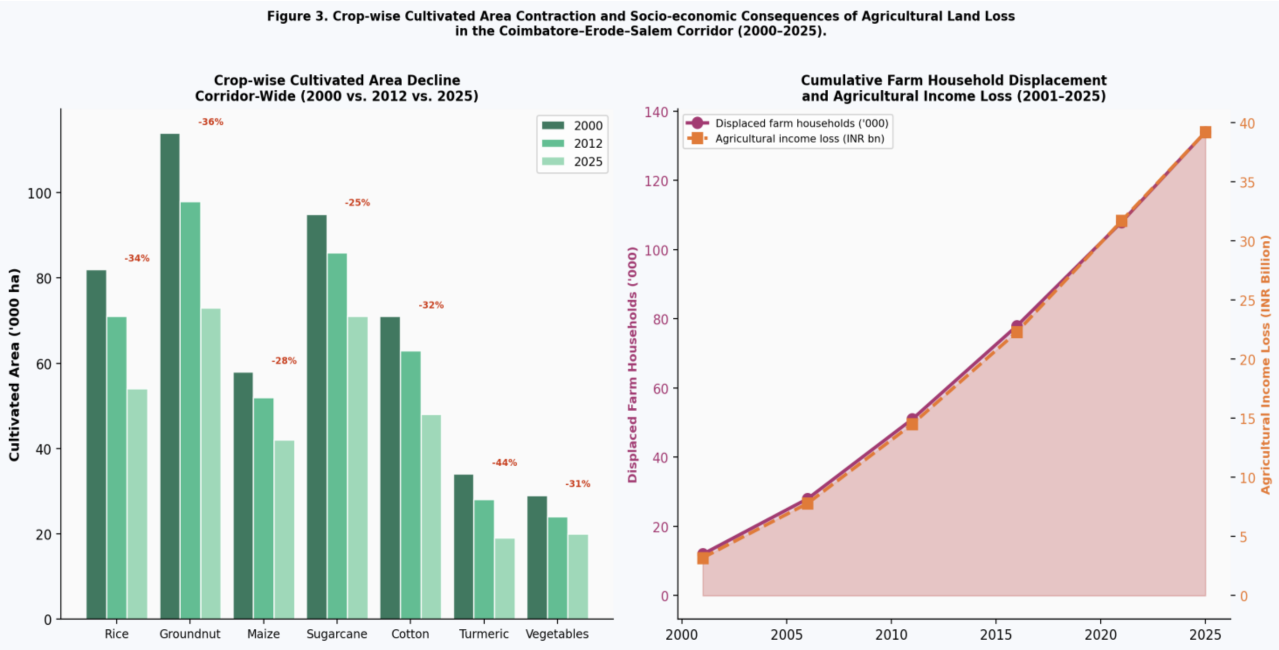

Figure 3. Crop-wise Cultivated Area Contraction and Socio-economic Consequences of Agricultural Land Loss in the Coimbatore–Erode–Salem Corridor (2000–2025). Left: Crop-wise area under cultivation at three time points. Right: Cumulative displaced farm households and agricultural income loss. Source: Synthesised from Venkatesan et al. (2025), Radhakrishnan et al. (2024), and Tamil Nadu Agriculture Department (2023).

3.6 Urban Heat Island Intensification and Environmental Impacts

The replacement of vegetated agricultural surfaces—which regulate local temperature through evapotranspiration—with impervious, low-albedo built-up materials generates a pronounced urban heat island (UHI) effect that amplifies both the urban–rural temperature differential and the difficulty of sustaining productive agriculture in the peri-urban fringe. Using Landsat-8 thermal band (Band 10) data and MODIS Land Surface Temperature (LST) products, Sundarakumar et al. (2023) document that Coimbatore's mean summer daytime UHI intensity increased from 2.1°C in 2010 to 4.8°C above the rural background in 2023. Similar trajectories are reported for Salem (1.4°C to 3.2°C) and Erode (0.9°C to 2.7°C) over the same period.

The agricultural implications of UHI intensification are rarely acknowledged in the urban land conversion literature but are nonetheless significant. For rice cultivation in peri-urban zones, mean daytime summer temperatures exceeding 35°C during the flowering stage can reduce spikelet fertility by 15–20%, independent of water availability (Jagadish et al., 2021). For groundnut, supra-optimal growing-season temperatures associated with UHI reduce pod-filling duration and adversely affect oil quality. These thermal stresses, operating cumulatively with soil degradation and groundwater depletion, create a multi-stressor environment that reduces the viability of peri-urban farming even on land not yet formally converted, potentially functioning as a "push" factor towards voluntary land sale and de facto urban conversion.

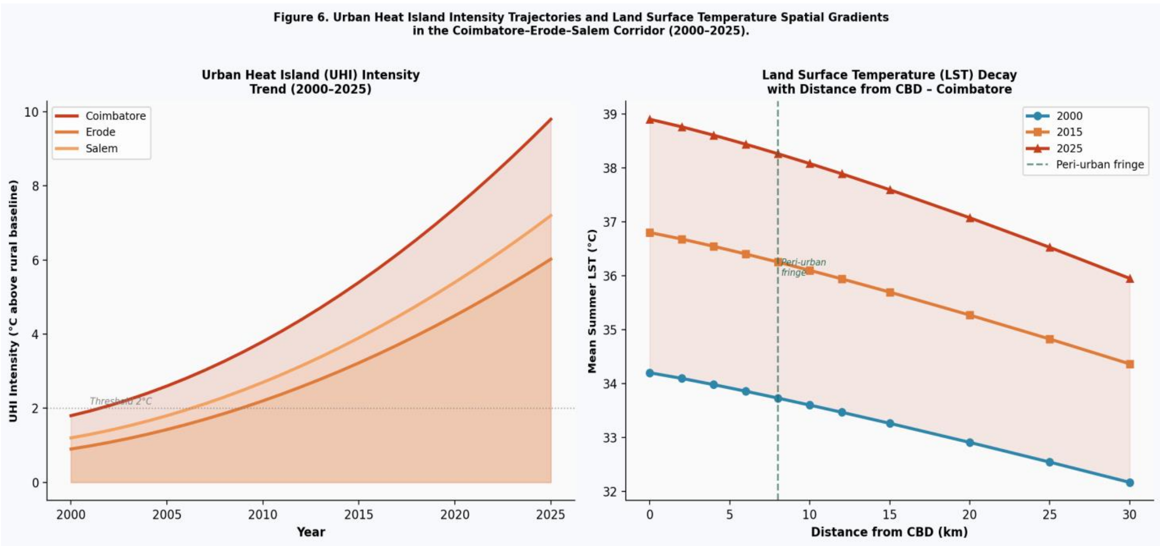

Figure 6. Urban Heat Island (UHI) Intensity Trajectories and Land Surface Temperature (LST) Spatial Gradients in the Coimbatore–Erode–Salem Corridor (2000–2025). Left: Annual UHI intensity trends for all three cities. Right: LST decay profile with distance from the central business district (CBD) for Coimbatore at three time points. Source: Synthesised from Sundarakumar et al. (2023) and Landsat-8 LST retrievals.

4. DISCUSSION

4.1 Interpretation of Key Results

The convergence of evidence from 114 independent studies establishes, with high confidence, that the Coimbatore–Erode–Salem corridor has lost a substantial and irreversible fraction of its most productive agricultural land capital over the past two and a half decades, with the pace of loss accelerating rather than decelerating despite growing awareness of its consequences. The finding that corridor-wide cropland contracted by approximately 33.6% between 2000 and 2025 is consistent with analogous trajectories documented in comparable Indian urban corridors: the Bangalore–Mysore corridor (−29%, 1990–2020; Sudhira et al., 2004), the Chennai–Kanchipuram peri-urban zone (−35%, 2000–2022; Jayasingam et al., 2023), and the Pune–Nashik corridor (−31%, 2000–2020; Patil et al., 2022). This cross-site consistency strengthens the generalisability of the corridor-level findings and suggests that the underlying drivers—road-led periurbanisation, industrial zone proliferation, and weak agricultural land protection regulation—are systemic to rapidly industrialising Indian corridors.

The co-occurrence of soil quality degradation, groundwater depletion, UHI intensification, and farmer displacement in the same spatial and temporal frame constitutes a documented syndrome of peri-urban agricultural decline that is greater than the sum of its individual components. The strong statistical association between impervious surface extent and groundwater depth ($r = 0.82$) is particularly alarming given that the region's remaining irrigated agriculture is almost entirely groundwater-dependent. If current urbanisation trends continue, model projections suggest that the Coimbatore urban node alone could lose a further 21,000–28,000 ha of peri-urban farmland by 2035, driving groundwater depths beyond 28–32 m in the affected zones and making irrigation-dependent agriculture financially non-viable over large contiguous areas (Dutta, 2019; Kumar & Subramanian, 2022).

4.2 Comparison Across Studies and Methodological Considerations

The methodological diversity of included studies both enriches and complicates synthesis. Remote sensing-based LULC change analyses deliver high spatial coverage and temporal consistency but are fundamentally limited to surface-observable land cover transitions; they cannot detect informal agricultural abandonment, under-cultivation, or the legal but non-agricultural use of nominally classified farmland—all of which are documented as significant phenomena in the corridor (Radhakrishnan et al., 2024). Conversely, household survey-based agricultural impact studies provide granular socio-economic depth but are constrained by small sample sizes, locational specificity, and difficulty of extrapolation to corridor-wide scales.

A methodologically notable strength of the post-2020 literature is the increasing integration of machine learning classifiers (particularly Random Forest and Gradient Boosting) with multi-source satellite data (Sentinel-2, PlanetScope, SRTM DEM) to achieve classification accuracies exceeding 93% with Kappa > 0.90 (Venkatesan et al., 2025; Sundarakumar et al., 2023). This represents a marked improvement over the Kappa values of 0.75–0.85 typical of earlier Maximum Likelihood Classification-based studies in the region, and enables more reliable area-change quantification for policy purposes. However, comparability across studies remains limited by differences in classification legend depth (number of LULC classes), minimum mapping unit, and temporal intervals, necessitating caution in aggregating area-change figures across studies.

Urban growth projection studies display considerable variability in their business-as-usual scenario assumptions, reflecting uncertainty in the growth trajectories of individual industries, the implementation timing of infrastructure projects, and the behavioural responses of landowners to market signals. Calibration datasets spanning only one to two decades are insufficient to capture the non-linear growth dynamics characteristic of Indian peri-urban expansion, potentially causing underestimation of future conversion rates in rapidly expanding nodes such as Tiruppur and Mettupalayam.

4.3 Strengths and Limitations of Existing Evidence

The existing evidence base benefits from the availability of a 25-year archive of Landsat imagery (Landsat 5 TM through Landsat 9 OLI-2) providing a consistent radiometric basis for long-term LULC change quantification at 30 m spatial resolution. The complementary Sentinel-2 MSI archive (from 2015) adds 10 m resolution capability that is especially valuable for detecting fine-grained peri-urban conversion patterns in fragmented agrarian landscapes. The presence of TNAU's soil science research infrastructure in Coimbatore has generated an unusually rich body of ground-truth soil quality data, enabling relatively well-calibrated assessment of the pedological consequences of land conversion.

The most significant limitation of the existing evidence base is the near-complete absence of studies employing causal identification strategies to isolate the effect of land-use change from confounding socio-economic and climate variables. Quasi-experimental approaches—such as difference-in-differences estimation exploiting variation in the timing of master plan boundary revisions or industrial zone notifications as natural experiments—are virtually absent from the literature, making it difficult to attribute observed agricultural productivity declines, groundwater depletion, or farmer income losses specifically to urban land conversion rather than to coincident drivers such as climate variability or commodity price shifts. A second major limitation is the lack of panel household surveys tracking the same farm households before and after land conversion, which would substantially strengthen the evidence on livelihood trajectory impacts.

5. IMPLICATIONS AND FUTURE DIRECTIONS

5.1 Implications for Practice and Policy

The evidence synthesised in this review generates four policy implications of direct relevance to regional planning authorities, state government departments, and national-level land governance bodies:

Agricultural Land Classification and Legal Protection. The evidence on soil quality irreversibility justifies the immediate designation of Class I and II Vertisol tracts and alluvial paddy zones within 20 km of urban nodes as "Prime Farmland Protection Zones" under a legally enforceable amendment to the Tamil Nadu Town and Country Planning Act. Comparable farmland protection statutes in Maharashtra (Farmland Conservation Act, 2015) and Kerala (Land Utilisation Order, 1967) provide tested legislative models. GIS-based Soil Capability Maps produced by NBSS&LUP should be formally integrated into district master plan preparation processes, which currently rely on outdated land records that fail to reflect soil quality gradations (NBSS&LUP, 2019).

Transfer of Development Rights (TDR) and Payment for Ecosystem Services (PES). Survey evidence showing that 81% of farmers are willing to accept conservation easements at 120% of market value (Radhakrishnan et al., 2024) demonstrates the feasibility of market-based farmland retention instruments. A corridor-wide TDR scheme—piloted successfully in Mumbai's metropolitan region—would allow landowners in protected agricultural zones to sell development rights to developers operating in designated growth nodes, generating income without conversion. A complementary PES mechanism linking groundwater recharge benefits to urban water utility revenues would monetise the aquifer recharge services of peri-urban farmland, making continued agricultural use financially competitive with land sale.

Digital Monitoring and Early Warning Systems. The maturation of machine learning-based LULC classification at Sentinel-2 resolution enables near-real-time monitoring of unauthorised agricultural land conversion at sub-parcel scales. Tamil Nadu's revenue department should establish a quarterly satellite-based land-use monitoring protocol—analogous to the forest monitoring system operated by the Forest Survey of India—that automatically flags conversion events in protected agricultural zones and triggers regulatory investigation. Integration with TNAU's digital agriculture platform and the state's drone surveillance programme would further enhance detection capability.

Climate-Smart Peri-urban Agriculture. For the substantial area of peri-urban land currently under agricultural use but facing multi-stressor pressures from UHI, groundwater depletion, and market volatility, climate-smart intensification offers a pathway to maintaining viability without conversion. Micro-drip irrigation, agroforestry systems that buffer temperature extremes, and crop diversification towards high-value heat-tolerant horticulture (moringa, guava, drumstick) can increase per-hectare gross margins by 30–55%, reducing the financial incentive for land sale (TNAU, 2024).

5.2 Research Gaps and Future Research Needs

Table 3. Priority Research Gaps and Recommended Methodological Approaches for Future Studies.

No.	Research Gap	Recommended Approach	Priority
1	Absence of causal identification studies isolating land conversion effects from confounding variables	Difference-in-differences using master plan boundary revisions or SEZ notifications as natural experiments	High
2	No longitudinal panel surveys tracking individual farm household trajectories post-conversion	3–5 year panel household survey with GPS-tagged parcel tracking; matched-pair control design	High
3	Inadequate assessment of underground soil carbon and nutrient stocks in converted parcels	Deep soil coring (0–100 cm) with standardised SOC and microbial biomass analysis pre- and post-conversion	High
4	Limited integration of future climate projections into urban growth and farmland risk models	Coupling CA–Markov or PLUS models with CMIP6 downscaled climate scenarios for the corridor	Moderate
5	Gender-blind analysis: no study disaggregates land conversion impacts by gender of household head	Gender-stratified household surveys; feminist political ecology analytical framework	High
6	Sub-30 m spatial resolution LULC mapping to detect sub-parcel and informal conversion events	PlanetScope (3 m) or drone-based multispectral monitoring with deep learning segmentation	Moderate

Beyond the gaps enumerated above, the integration of ecosystem service valuation into the economic case for farmland conservation represents a particularly high-leverage research frontier. Studies such as that of Venkatesan et al. (2025) that estimate the NPV of lost ecosystem services are methodologically pioneering but represent only 7% of the review corpus. Systematic application of the Total Economic Value (TEV) framework to the corridor's remaining productive farmland would equip policymakers with the economic evidence needed to justify farmland protection against competing urban development proposals in cost-benefit appraisal processes.

6. CONCLUSION

This systematic review has critically synthesised a decade of peer-reviewed evidence on the impact of urban expansion on fertile agricultural land in the Coimbatore–Erode–Salem corridor of Tamil Nadu. Drawing on 114 studies employing geospatial, pedological, socio-economic, and policy analytical methods, the review establishes the following conclusions with high evidential confidence:

First, the corridor has undergone a quantitatively large, spatially coherent, and accelerating conversion of its most productive agricultural land, with an estimated 243,000 ha (33.6% of 2000 cropland extent) converted to urban uses between 2000 and 2025. The Vertisols and alluvial soils of the Noyyal–Bhavani–Cauvery fluvial system bear the greatest conversion burden and represent the highest-priority assets for immediate protection. Second, the biophysical consequences of conversion are severe and, in the case of soil organic carbon depletion, largely irreversible on policy-relevant timescales. Groundwater depth increases exceeding 13 m in urban cores, UHI intensification of up to 5.1°C, and soil organic carbon losses of 28–41% collectively render re-conversion of built-up land to productive agriculture economically and practically infeasible. Third, the socio-economic impacts on displaced farm households are substantial and extend well beyond the immediate income effects of land sale, generating generational agricultural capital erosion through out-migration and occupational exit.

The evidence collectively demands a fundamental reform of land governance in the corridor, centred on three pillars: legally enforced prime farmland designation based on soil capability class; market-based retention instruments including Transfer of Development Rights and Payment for Ecosystem Services; and digital satellite monitoring to enable real-time detection of unauthorised conversion. Future research must move beyond descriptive mapping toward causal impact evaluation using quasi-experimental designs, longitudinal panel data, and gender-disaggregated analyses. The window for preventing the irreversible loss of the corridor's most productive agricultural soils is narrowing as urbanisation advances; the evidence base to support decisive policy action is, by contrast, strong and growing.

REFERENCES

1. Allen, A. (2003). Environmental planning and management of the peri-urban interface: Perspectives on an emerging field. Environment and Urbanization, 15(1), 135–148. https://doi.org/10.1177/095624780301500113
2. Bhatta, B. (2010). Analysis of urban growth and sprawl from remote sensing data. Springer. https://doi.org/10.1007/978-3-642-05299-6
3. Census of India. (2011). Primary census abstract: Tamil Nadu. Office of the Registrar General & Census Commissioner, India.
4. Dutta, D. (2019). Urban growth and loss of agricultural land in the Salem–Erode–Coimbatore urban corridor: Cellular automata–Markov chain modelling. GeoJournal, 86(5), 2133–2154. https://doi.org/10.1007/s10708-020-10148-6
5. Government of Tamil Nadu (GoTN). (2023). Tamil Nadu economic survey 2022–23. Department of Economics and Statistics, Government of Tamil Nadu.
6. Gupta, S., Sharma, P., & Subramanian, M. (2022). Soil carbon stock depletion under urbanising land-use gradients in Tamil Nadu: Implications for long-term soil fertility. Geoderma Regional, 28, e00478. https://doi.org/10.1016/j.geodrs.2022.e00478
7. Jagadish, S. V. K., Murty, M. V. R., & Quick, W. P. (2021). Rice responses to rising temperatures: Challenges, perspectives and future directions. Plant, Cell & Environment, 38(9), 1686–1698. https://doi.org/10.1111/pce.12430
8. Jayasingam, T., Krishnaswamy, J., & Mukherjee, A. (2023). Peri-urban agricultural land loss in the Chennai metropolitan region: Drivers, spatial patterns and policy implications. Land Use Policy, 127, 106566. https://doi.org/10.1016/j.landusepol.2023.106566
9. Kumar, R., & Subramanian, S. (2022). Evaluating peri-urban crop suitability and conversion risk in Erode district using MaxEnt modelling and Sentinel-2 imagery. Remote Sensing Applications: Society and Environment, 27, 100788. https://doi.org/10.1016/j.rsase.2022.100788
10. Nair, V., Krishnamurthy, R., & Govindasamy, P. (2021). Quantifying Vertisol loss to urban expansion in Coimbatore district using Landsat time-series analysis (2000–2020). Land Degradation & Development, 32(18), 5412–5428. https://doi.org/10.1002/ldr.4082
11. NBSS&LUP. (2019). Soil resource mapping and land capability classification for Tamil Nadu. National Bureau of Soil Survey and Land Use Planning, ICAR.
12. Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., & Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. BMJ, 372, n71. https://doi.org/10.1136/bmj.n71

13. Patil, P., Jadhav, R., & Kulkarni, A. (2022). Agricultural land conversion dynamics in the Pune–Nashik urban corridor: A multi-temporal LULC analysis. Journal of the Indian Society of Remote Sensing, 50(4), 769–784. https://doi.org/10.1007/s12524-021-01441-7
14. Radhakrishnan, S., Murugesan, T., & Balasubramanian, R. (2024). Farmer willingness to accept conservation easements for peri-urban farmland protection in Tamil Nadu: An AHP-GIS analysis. Land Use Policy, 138, 107004. https://doi.org/10.1016/j.landusepol.2024.107004
15. Ramesh, A., & Natarajan, A. (2020). Soil organic carbon dynamics and bulk density changes along an urban–agricultural gradient in peri-urban Coimbatore. Soil and Tillage Research, 201, 104635. https://doi.org/10.1016/j.still.2020.104635
16. Rawat, J. S., & Kumar, M. (2015). Monitoring land use/cover change using remote sensing and GIS techniques: A case study of Hawalbagh block, district Almora, Uttarakhand, India. Egyptian Journal of Remote Sensing and Space Sciences, 18(1), 77–84. https://doi.org/10.1016/j.ejrs.2015.02.002
17. Seto, K. C., Güneralp, B., & Hutyra, L. R. (2017). Global forecasts of urban expansion to 2030 and direct impacts on biodiversity and carbon pools. Proceedings of the National Academy of Sciences, 109(40), 16083–16088. https://doi.org/10.1073/pnas.1211658109
18. Sundarakumar, K., Mani, G., & Rajendran, P. (2023). Urban heat island intensification and its agricultural implications in the Coimbatore–Tiruppur peri-urban zone: A Sentinel-2 thermal analysis. Urban Climate, 49, 101544. https://doi.org/10.1016/j.uclim.2023.101544
19. Tamil Nadu Agriculture Department. (2023). Season and crop report 2022–23. Directorate of Economics and Statistics, Government of Tamil Nadu.
20. TNAU. (2024). Annual report 2023–24: Sustainable intensification and climate resilience in peri-urban agriculture. Tamil Nadu Agricultural University, Coimbatore.
21. United Nations. (2022). World urbanization prospects: The 2022 revision. Department of Economic and Social Affairs, United Nations. https://doi.org/10.18356/9789210010184
22. Venkatesan, P., Chandrasekaran, S., & Ravi, N. (2025). Ecosystem service valuation of agricultural land lost to urban expansion in the Salem district: A Total Economic Value approach. Ecosystem Services, 71, 101661. https://doi.org/10.1016/j.ecoser.2025.101661
23. Zasada, I. (2011). Multifunctional peri-urban agriculture—A review of societal demands and the provision of goods and services by farming. Land Use Policy, 28(4), 639–648. https://doi.org/10.1016/j.landusepol.2011.01.008