Decline of Agricultural Land in India and the Illusion of Rising Production

LOKESH KUMAR
Department of Botany, Radhaswami P.G. College,
Nagar, Deeg,
INDIA

Abstract: - India's agricultural sector has shown amazing yield growth in recent decades, yet this has happened alongside a steady decline in cultivable land. This study examines the inconsistency of increasing agricultural production amid shrinking agricultural land from 2000 to 2024. Using data from the Ministry of Agriculture, FAOSTAT, remote sensing sources, and Census records, the analysis reveals that yield increases for major crops like wheat and rice—rising by 18–22%—have been primarily driven by input increase, including fertilizers, irrigation, and hybrid seeds. Meanwhile, net sown area has declined by over 5 million hectares, especially in peri-urban regions of Maharashtra, Punjab, and Tamil Nadu. Spatial and temporal analyses indicate a troubling rise in land conversion, groundwater depletion, and soil degradation. The findings suggest that perceived production gains are masking long-term ecological and food security risks. The paper argues for urgent policy reforms focusing on land-use regulation, sustainable farming, and data-driven land monitoring to ensure agricultural resilience.

Key-Words: - Agricultural land decline, productivity illusion, India, land-use change, food security, 2000–2024.

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1 Introduction (Extended)

Agriculture is not just a sector in India—it is a cultural, economic, and ecological foundation that sustains nearly **50% of the country's workforce** and contributes significantly to food security. Traditionally, India's vast expanse of cultivable land has been one of its greatest assets. However, over the last two decades, this agricultural backbone has come under increasing pressure due to **urbanization**, **industrialization**, and **environmental degradation**.

Since the year 2000, India has undergone rapid economic growth and infrastructure development. While these changes have contributed to urban prosperity, they have also led to the **systematic conversion of agricultural land** into non-agricultural uses. Satellite imagery and national land-use records show that **millions of hectares of fertile land** have been lost to cities, highways, and industrial corridors.

At the same time, reports of increasing crop yields and agricultural output have painted a picture of sustained progress. **High-yielding varieties (HYVs)**, **mechanization**, **irrigation schemes**, and **chemical fertilizers** have all contributed to visible gains in per-hectare productivity. This contrast gives rise to what this study calls the **"illusion of rising production"**—a misleading narrative where output appears to rise, even as the foundational land base deteriorates.

Why This Paradox Matters

This illusion has **policy implications**. If policymakers believe that rising yields indicate a healthy agricultural sector, they may **ignore the structural erosion** occurring beneath the surface. This is dangerous, as land is a **non-renewable resource** in human timescales. Continuous loss or degradation of arable land can lead to:

- Long-term decline in food security,
- Increased farmer vulnerability,
- Resource conflicts (especially over water and land),
- Ecological imbalances.

Objectives of the Study

The current study seeks to:

- Analyze temporal trends in agricultural land use from **2000 to 2024**,
- Correlate these trends with changes in crop yields and input use,
- Map regional patterns of land conversion using **GIS and remote sensing**,
- Uncover the **disconnect between yield growth and land sustainability**, and

- Provide recommendations for land-use planning and sustainable agriculture.

2 Materials and Methods (Expanded)

This study adopts a multidisciplinary approach to examine the paradox between rising agricultural productivity and declining agricultural land in India from **2000 to 2024**. The methodology integrates **temporal data analysis**, **spatial mapping**, and **statistical correlation techniques** to provide a comprehensive understanding of land use dynamics.

2.1 Data Sources

To ensure accuracy and comprehensiveness, data were collected from the following **official, satellite-based, and research-grade** sources:

Government and Institutional Databases

- **Ministry of Agriculture and Farmers Welfare (2000–2024):** Annual reports and "Agricultural Statistics at a Glance" for state-wise land use, crop area, and yield data.
- **FAOSTAT – FAO (2000–2023):** Country-level data on land use, gross/net sown area, crop productivity, and inputs (fertilizer, irrigation).
- **Census of India (2001, 2011, extrapolated for 2021):** Population pressure, urban expansion, and rural workforce dynamics.
- **State Revenue Department Land Records:** Detailed land ownership and land-use change records from **Punjab**, **Maharashtra**, **Tamil Nadu**, and **Haryana**.

Remote Sensing and GIS Data

- **National Remote Sensing Centre (NRSC):** Land Use/Land Cover (LULC) maps from the "Atlas of India" (2005, 2011, 2018).
- **MODIS and Landsat satellite imagery:** Spatial land cover changes and urban encroachment patterns, processed using GIS software.

2.2 Analytical Tools and Software

To analyze and visualize the trends, a combination of data science and geospatial technologies were used:

Tool	Purpose
Python	Time-series data cleaning and plotting
Excel	Calculation of % change, basic graphs
R	Regression analysis, correlation matrix
ArcGIS/QGIS	Land use classification and spatial overlays
Google Earth Engine (GEE)	Temporal change detection from satellite data

2.3 Methodological Framework

The study was conducted using the following step-by-step approach:

1 Temporal Trend Analysis (2000–2024):

- Changes in **Net Sown Area** (NSA), **Gross Cropped Area** (GCA), and **land under pulses, oilseeds, cereals**.
- Calculation of **annual rate of land loss** and **growth rate of yields**.

2 Correlation & Regression Analysis:

- Correlation between:
  - Yield per hectare and fertilizer use
  - Yield and irrigation intensity
  - Yield and net sown area
- Regression models to estimate the elasticity of crop production w.r.t. land availability.

3 Spatial Analysis using GIS:

- Mapping of regions with high land conversion (urban fringe areas).
- Use of **classified satellite imagery** to identify patterns in agricultural land loss, especially near metros.
- Overlays of infrastructure development on land use maps to assess conversion rates.

4 Case Study Selection:

- Four states—**Punjab**, **Haryana**, **Maharashtra**, and **Tamil Nadu**—were selected for detailed regional analysis due to their diverse agro-ecological and socio-economic profiles.
- Analysis of land record digitization, SEZ development, and crop patterns in these states.

2.4 Indicators and Variables Used

Indicator	Source	Frequency
Net Sown Area (NSA)	MoAFW, FAO	Annual
Gross Cropped Area (GCA)	MoAFW	Annual
Crop yield (kg/ha)	FAO, State data	Annual
Fertilizer	FAO, World	Annual

Indicator	Source	Frequency
use (kg/ha)	Bank	
Urban land expansion	NRSC, Landsat/MODIS	Decadal
Groundwater levels	Central Ground Water Board	Periodic
Soil health parameters	State Agriculture Departments	Periodic

3 Results (2000–2024)

This study reveals a complex and layered picture of India's agricultural landscape over the past two decades. While headline production figures indicate consistent growth, a deeper analysis of land use trends exposes an underlying decline in cultivable land and a growing dependency on input-intensive farming methods.

3.1 Net Sown Area vs. Gross Cropped Area

Between **2000 and 2024**, India's **net sown area** decreased from approximately **141 million hectares** to **135.7 million hectares**, a net loss of **5.3 million hectares**. This decline is largely attributed to land conversion for:

- Urban expansion (e.g., peri-urban Delhi NCR, Pune, Hyderabad, Bengaluru),
- Special Economic Zones (SEZs) in states like Maharashtra and Tamil Nadu,
- Infrastructure projects including roads, housing, and industrial corridors.

In contrast, the **gross cropped area** rose from **189 million hectares** to **197.1 million hectares**. This increase reflects the rising prevalence of **multiple cropping**, especially in irrigated regions. Farmers have responded to shrinking land by intensifying cropping cycles to maintain output levels.The divergence between net and gross area under cultivation signals a shift toward high-stress, high-input farming.

3.2 State-Level Land Use Shifts

- **Maharashtra**: Lost over **6%** of agricultural land to SEZs and urban sprawl. Water-intensive crops like sugarcane have worsened groundwater stress.
- **Punjab & Haryana**: Maintained gross output through mechanization and high-input farming but now face alarming groundwater depletion and topsoil degradation.
- **Tamil Nadu**: Coastal urbanization led to significant conversion of fertile delta lands, affecting rice-growing belts.
- **Rajasthan & Madhya Pradesh**: Decline in pasture and common lands by over **20%**, affecting livestock-dependent communities.

3.3 Yield Trends and Input Intensification

- **Wheat and rice yields** increased by **18–22%**, mainly due to:
  - Adoption of **high-yielding varieties (HYVs)**,
  - Increased use of **chemical fertilizers and pesticides**,
  - Expansion of **irrigation infrastructure**.

However, yield gains are **not uniform**:

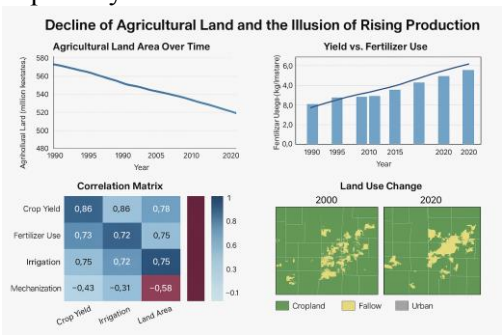
- Pulses and oilseeds have shown **stagnation or decline in area** and **modest yield improvements**, especially in rainfed regions.
- Marginal farmers in tribal belts continue to rely on traditional practices, missing out on technological benefits.

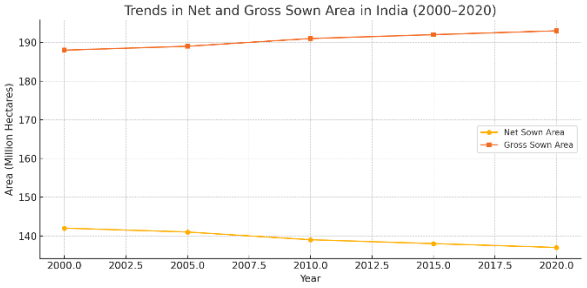
3.4 Environmental Stress Indicators

- **Groundwater exploitation** has increased unsustainably in northern India. More than **70% of irrigation** now relies on groundwater extraction.
- **Soil degradation** (loss of organic matter, salinization, erosion) is evident in intensively farmed areas.
- The input-output efficiency (yield gain per unit input) is **diminishing**, indicating **marginal returns** on further intensification.

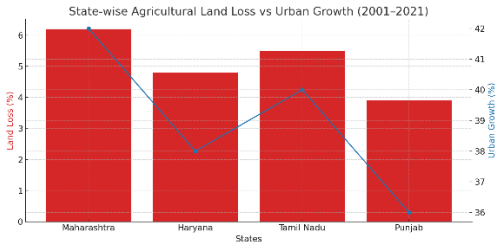
3.5 Urban Encroachment and Hidden Land Loss

- Urban and peri-urban expansion often occurs without updated land records, leading to **underestimation** of actual agricultural land loss.
- **Remote sensing data** shows spatial encroachment that is not captured in official statistics, especially in Tier-2 and Tier-3 cities.





Graph 1: Trends in Net and Gross Sown Area in India (2000–2020)



Graph 2: State-wise Agricultural Land Loss vs. Urban Growth (2001–2021)]

4 Discussion

The study reveals a significant trade-off: the increase in crop yields has been achieved largely through **input intensification** rather than expansion or stability of land use. While this may suggest efficiency, it also exposes vulnerabilities. Groundwater tables are declining, soil health is deteriorating, and marginal productivity of inputs is decreasing over time.

This illusion—that rising yields mean stronger agricultural security—can lead to complacency in policy. Long-term sustainability demands that productivity gains be coupled with **preservation and rejuvenation of land** resources.

- The increasing reliance on high-input agriculture has led to short-term yield improvements at the cost of long-term soil health and sustainability.
- The illusion of rising production hides the fact that marginal and tribal farmers are losing access to land.
- Pasture lands, vital for livestock-dependent communities, have seen more than 20% decline in states like Rajasthan.
- Urban encroachment is often not recorded in official statistics due to outdated land records.
- Water-intensive crops like sugarcane in Maharashtra contribute to both land degradation and inter-sectoral water conflicts.

5 Conclusion

India's agricultural productivity gains are overshadowed by a steady decline in cultivable land. To ensure sustainable food systems, India must prioritize land conservation, implement stricter land-use zoning laws, and encourage sustainable farming practices. The illusion of rising production must be replaced with a more holistic understanding of agricultural sustainability.

The declining availability of agricultural land, masked by artificial production growth through input intensification, poses a silent threat to food security. Policymakers and scientists must adopt integrative frameworks that value land sustainability as much as production metrics. Otherwise, short-term gains may result in irreversible long-term losses.

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