

## ACHIEVING SUSTAINABLE AGRICULTURE IN THE CONTEXT OF RAPID URBANIZATION: AN OVERVIEW

Ashwini BC\*, Nandana Kumar HV<sup>1</sup>

ICAR-Indian Institute of Soil and Water Conservation, Dehradun.

<sup>1</sup>Forest Survey of India, MoEF&CC, Dehradun.

\*Corresponding author: [ashwinibc3@gmail.com](mailto:ashwinibc3@gmail.com)

Received: May 01, 2026; Accepted: May 20, 2026

### Introduction

Interaction between agriculture and urbanization is grounded in the concepts of sustainable intensification, land-use change, ecosystem services, and climate-smart agriculture (CSA). Sustainable intensification focuses on enhancing agricultural productivity from the same land area while minimizing environmental degradation and conserving essential natural resources such as soil, water, and biodiversity. With the rapid pace of urban growth, significant land-use changes occur, especially in peri-urban areas where productive agricultural lands are increasingly converted to residential, industrial, or infrastructural purposes. This peri-urban interface serves as both a zone of opportunity - offering proximity to markets and diversified livelihoods and a site of tension due to competition for land and natural resources. Furthermore, agriculture provides critical ecosystem services, including soil fertility maintenance, pollination, and water regulation, which are often undermined by unplanned urbanization. Within this context, climate-smart agriculture offers an integrated framework that seeks to enhance productivity, build resilience to climate variability, and reduce greenhouse gas emissions, thereby aligning agricultural growth with sustainable urban development goals.

The table presents an overview of India's agricultural and urbanization trends from 2000 to 2023, highlighting the dynamic interaction between economic growth, demographic shifts, and sustainability challenges. The data reveal a steady decline in arable and net sown area, indicating the gradual conversion of cultivable land to non-agricultural uses driven by rapid urban expansion.

**Table 1:** Trends in Agricultural Land Use, Urbanization, and Sustainability Indicators in India (2000–2023)

Year	Arable Land (million ha)	Net Sown Area (million ha)	Urban Population (%)	Agricultural Land Lost to Urbanization (cumulative, million ha)	Pesticide Use (000 tonnes)	Land Degraded (million ha)	Vegetables Market Value (US\$ bn)
2000	160.9	142.8	27.8	0.00	55	94.5	38.4
2005	158.2	142.0	29.9	0.20	58	95.3	52.7
2010	156.4	141.0	31.9	0.45	61	96.1	63.9
2015	155.1	141.4	33.9	0.60	64	97.2	80.4
2018	154.5	141.2	34.9	0.65	62	97.7	90.5
2020	154.4	140.9	35.9	0.70	61	97.8	99.3
2023	154.1	140.7	36.6	0.73	60	97.85	108.6

**Source:** Pooled from Multiple sources (World Bank (2024); FAOStat (2023); ISRO-SAC (2021); Ministry of Agriculture & Farmers' Welfare (2024); Statista (2024)).

Urban population increased from 27.8% in 2000 to 36.6% in 2023, contributing to a cumulative loss of about 0.73 million hectares of agricultural land. Despite this contraction, the agricultural sector has shown signs of commercialization, with the vegetable market value nearly tripling over the period, driven by growing urban demand and improved logistics. Meanwhile, land degradation remains persistent, affecting nearly 30% of the country's geographical area, posing a critical threat to long-term productivity. Pesticide use initially rose but later stabilized due to the adoption of Integrated Pest Management (IPM) and sustainable farming initiatives. Overall, the table underscores the dual challenge of achieving sustainable agricultural growth while accommodating rapid urbanization pressures in India.

### Strategies for Sustainability

Achieving sustainable agriculture in rapidly urbanizing regions requires an integrated approach that aligns policy, technology, institutions, and on-ground practices. The literature underscores the need for multi-level coordination to safeguard agricultural productivity, environmental integrity, and food security amid urban pressures.

1. Land Use Policy and Planning: Effective zoning laws, peri-urban boundary controls, and farmland preservation incentives are essential to curb the conversion of fertile land into built-up areas. Evidence from India highlights the importance of integrated urban planning and efficient land management to prevent unregulated sprawl and farmland loss (Yasir, Kour, & Sehgal,

2025). The Maharashtra case further demonstrates that weak land-use regulation leads to haphazard land conversion and declining agricultural resilience (Marawar, 2016).

2. Promoting Urban and Peri-Urban Agriculture: Expanding rooftop and community gardens, hydroponic and vertical farming systems, and ensuring secure land tenure can enhance food security and social inclusion. Studies note that while urban agriculture contributes to sustainable city food systems, scaling requires addressing economic and regulatory barriers (Mathew et al., 2025; STM Journals, 2024).

3. Sustainable Pest and Input Management: Integrated Pest Management (IPM) combines biological, cultural, and chemical control methods to reduce agrochemical use and enhance yields. Evidence from Asia and Africa shows that IPM adoption can raise productivity by approximately 40 per cent while cutting pesticide use by over 30 per cent (Pretty & Bharucha, 2015). The FAO emphasizes IPM as a cornerstone of ecosystem based pest control that sustains biodiversity and soil health.

4. Technological Innovation and Precision Agriculture: Smart farming technologies such as soil moisture sensors, remote sensing, and decision support systems optimize input use, conserve resources, and improve efficiency. Research on digital agriculture and controlled environment systems in the Varanasi region underscores their potential to enhance productivity and resource-use efficiency.

5. Institutional Support and Policy Incentives: Strengthening Farmer Producer Organizations (FPOs), providing targeted subsidies and credit, and improving extension services are critical to empower smallholders in peri-urban areas. Reviews highlight that inadequate institutional frameworks and unclear policies hinder urban-agriculture expansion (Mathew et al., 2025). Enabling policies and fiscal incentives can bridge this gap and promote adoption of sustainable practices.

6. Environmental Safeguards and Ecosystem Services: Protecting green belts, buffer zones, water bodies, and pollinator habitats supports long-term ecological stability. Studies on ecosystem service valuation reveal that loss of cropland and forests directly reduces water regulation, soil retention, and biodiversity services. Integrating agroforestry, organic farming, and runoff control measures within planning frameworks can restore ecological balance and resilience in urbanizing landscapes.

Together, these interconnected strategies offer a comprehensive pathway toward sustainable and climate-resilient agriculture in rapidly urbanizing regions. By coupling evidence-based policy with technological innovation and community-driven practices, cities can balance growth with food security, ecological conservation, and equitable rural–urban linkages.

### **Policy Recommendations and Research Agenda**

1. **Integrated Spatial Planning:** Urban planners must include agricultural land preservation in city master plans, enforcing peri-urban boundaries, promoting mixed land uses that allow agriculture close to markets.
2. **Regulatory & Incentive Structures:** Policies that ensure land tenure for peri-urban farmers; financial incentives (such as grants or subsidies) for sustainable farming; penalties or tariffs for conversion of prime agricultural land without mitigation.
3. **Support for IPM and Sustainable Input Use:** Extension services and public investment to train farmers in IPM, regulation of pesticide sales, certification/labelling for produce with low chemical residues.
4. **Technology and Infrastructure Investments:** Shared infrastructure for cold storage, transport, logistics, investments in precision agriculture tools, energy efficient vertical farms, wastewater reuse for irrigation where it is safe.
5. **Socio-Economic Safeguards:** Protecting smallholders and marginalized farmers (especially those near urban fringes) through participatory planning; ensuring their access to credit, markets, land.
6. **Monitoring, Evaluation, and Research**
  - Long-term impacts of urbanization on agricultural productivity and ecosystem services,
  - Cost-benefit analyses of urban agriculture vs land preservation,
  - Health impacts of pesticide use in peri-urban agriculture,
  - Effectiveness of various models of sustainable farming (e.g. vertical farms, rooftop gardens) in different Indian contexts.

### **Conclusion**

Rapid urbanization presents both opportunities and threats to agriculture. Positive potentials include better market access, demand for high-value produce, and chances for

innovation. But without thoughtful regulation, sustainable practices, and supportive institutions, the risks of land degradation, environmental harm, and social inequity are high. The path to sustainable agriculture in urbanizing regions lies in balancing growth with ecological stewardship; promoting practices such as IPM, urban agriculture, technological innovation; maintaining ecosystem services; and ensuring policies and institutions protect agricultural land and farmers' livelihoods. Future research should fill gaps in localized empirical data and examine trade-offs in different urbanization scenarios.

### References:

- Fatima, W., Awan, H., & Khalid, A. (2023). Urban expansion and its impact on sustainable agriculture in Pakistan: A case study of fertile land conversion. *Sustainability*, 15(4), 2152. <https://doi.org/10.3390/su15042152>
- Marawar, A. (2016). Urbanization and its impact on agricultural land in a growing city (Pune). *International Journal of Research in Civil Engineering, Architecture & Design*, 4(2), 15–22.
- Mathew, R., Sreedaya, S. G., Smitha, S., & Shaji, A. T. (2025). Urban agriculture: An approach towards creating sustainable smart cities—A review. *Agricultural Reviews*, 46(1), 1–12. <https://doi.org/10.18805/ag.r>
- STM Journals. (2024). Vertical farming and urban horticulture in India: A review. *Journal of Agricultural Engineering and Technology*, 13(3), 45–59.
- Yasir, M., Kour, S., & Sehgal, S. (2025). Impact of population growth and urbanization on agricultural land use: Evidence from India. *Advances in Consumer Research*, 9(2), 54–68.