Cognitive Thinking: An International Journal of Interdisciplinary Studies

Volume-1, Issue-2 (April-June, 2025), pp.7-18, ISSN: 3107-5088
www.cognitivethinking.in

Impact of Urban Expansion on Agricultural Lands and Ecosystems in Gautam Buddha Nagar of Uttar Pradesh

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Abstract: This study investigates the impact of rapid urban expansion on agricultural lands and ecosystems in Gautam Buddha Nagar, Uttar Pradesh, an area experiencing significant urban growth. Using a hybrid approach, the research combines quantitative data from 157 respondents and satellite imagery analysis to evaluate land-use changes, socio-economic consequences, and environmental degradation. The analysis reveals that urban sprawl has significantly reduced agricultural land, negatively affected livelihoods, and increased the cost of living, especially for farming communities. Correlation analysis and Structural Equation Modeling (SEM) show strong relationships between urban expansion, ecosystem degradation, and policy responses. The results highlight the urgent need for sustainable urban planning, with respondents advocating stricter land-use regulations to mitigate the adverse effects of urbanization. Recommendations include zoning policies to protect agricultural land, promoting sustainable farming practices, and raising public awareness about the environmental consequences of unchecked urban expansion. This research provides valuable insights for the makers of policies and urban planners aiming to balance development with ecological conservation.

Keywords: Urban expansion, Agricultural land loss, Ecosystem degradation, & Gautam Buddha Nagar

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Introduction

Urbanization is a global phenomenon that has been accelerating rapidly over the last few decades, driven primarily by population growth, economic development, and globalization. By 2050, approximately 68% of the world's population is projected to live in urban areas, compared to 55% in 2018 (United Nations, 2019). This surge in urban populations has significant implications for land use, natural resource management, and sustainability. Globally, the conversion of rural land into urban centers has led to complex socio-economic and environmental challenges, particularly in developing nations like India (Kanav et al., 2024). As cities expand, peri-urban areas—zones between urban and rural landscapes—are particularly vulnerable to land-use changes that often lead to significant disruptions in ecosystems, agriculture, and livelihoods (Kapoor, 2024).

India, home to over 1.4 billion people, is experiencing some of the fastest rates of urban growth in the world. Between 2001 and 2021, India's urban population grew from 286 million to nearly 480 million, accounting for about 34.9% of the total population (World Bank, 2021). This rapid urban expansion is concentrated not only in mega-cities like Delhi, Mumbai, and Bengaluru but also in secondary cities and peri-urban areas, where agricultural lands are being rapidly converted into industrial, residential, and commercial zones. Gautam Buddha Nagar in Uttar Pradesh is a prime example of such a region, experiencing a profound transformation due to its proximity to Delhi and the rise of industrial hubs like Noida and Greater Noida (Somvanshi et al., 2023).

Urbanization in India: Key Drivers and Impacts

Urbanization in India is driven by multiple factors, including economic growth, rural-to-urban migration, and infrastructure development. Economic reforms introduced in the 1990s triggered a wave of industrialization and commercialization, which, coupled with foreign direct investment (FDI) and government policies encouraging urban development, has propelled India's urban expansion (Zubair et al., 2019). This urbanization, however, has not been uniform. The fastest-growing urban regions are located near large metropolitan centers or along key industrial corridors, where peri-urban areas like Gautam Buddha Nagar are increasingly at risk.

Peri-urban regions are transitional zones that experience both rural and urban characteristics, making them susceptible to land-use changes. In Gautam Buddha Nagar, agricultural land, once the backbone of the local economy, is rapidly giving way to urban settlements, industrial parks, and infrastructure projects. According to a study by Thakur and Tiwari (2024), the socio-legal impact of land acquisition on farmers in the Jewar region of Gautam Buddha Nagar has been profound, with many farmers expressing dissatisfaction with compensation and resettlement processes. The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation, and Resettlement Act (2013) was designed to protect farmers, but enforcement remains inconsistent, leaving local communities vulnerable to exploitation during the land acquisition process (Thakur & Tiwari, 2024).

The Role of Peri-Urban Areas in India's Urbanization

Peri-urban regions play a critical role in shaping the future of urbanization in India. They are often seen as the frontier of urban development, acting as buffers between core urban areas and rural landscapes. However, this status as a "buffer" zone means that peri-urban areas are often subject to poorly regulated land-use changes. Land conversion in these areas typically lacks cohesive planning, leading to haphazard development that threatens both the environment and local livelihoods (Fatima et al., 2024).

In Gautam Buddha Nagar, the absence of integrated urban planning has created significant challenges for local governments. The conversion of agricultural land into urban and industrial zones has not been accompanied by adequate environmental safeguards, nor have local farmers been properly compensated for their losses (Kanav et al., 2024). The resulting imbalance between urban growth and agricultural sustainability has led to both ecological degradation and socio-economic displacement. As more agricultural land is converted to industrial use, local farmers find it increasingly difficult to sustain their livelihoods, leading to migration into urban slums or informal labor markets (Omeer et al., 2018).

Challenges of Sustainable Urbanization in Peri-Urban Areas

One of the most significant challenges in managing urban expansion in peri-urban areas is balancing economic growth with environmental sustainability. In regions like Gautam Buddha Nagar, urbanization is often seen as a necessary driver of economic development. However, without careful planning and regulation, the long-term environmental and socio-economic costs of unchecked urban growth can far outweigh the short-term economic benefits (Kapoor, 2024). Urban sprawl in these regions leads to the loss of fertile agricultural land, diminishing local food production capacity and contributing to food insecurity (Zubair et al., 2019). Furthermore, unplanned urban growth often results in inadequate infrastructure development, leading to problems such as water scarcity, pollution, and traffic congestion (Singh & Singh, 2024).

Another challenge in peri-urban areas like Gautam Buddha Nagar is the social and legal ramifications of land acquisition. Although laws like the Land Acquisition, Rehabilitation, and Resettlement Act (2013) aim to protect the rights of farmers and landowners, implementation remains inconsistent. Thakur and Tiwari (2024) noted that many farmers in the region feel marginalized by the land acquisition process, receiving inadequate compensation for their land. This legal disconnect between policy and practice creates deep socio-economic divides, further exacerbating the challenges of urbanization.

Review of Literature

Thakur and Tiwari (2024) investigated the *Socio-Legal Impact of Land Acquisition on Farmers in the Jewar region of Gautam Buddha Nagar*, emphasizing the Right to Compensation and Transparency in the Land Acquisition, Rehabilitation, and Resettlement Act (2013). Their study highlights the importance of safeguarding farmers' rights during the land acquisition process, especially in rapidly urbanizing areas like Gautam Buddha Nagar. The study's objective was to assess the socio-economic and legal consequences of land acquisition, focusing on compensation mechanisms and the transparency of the process. They used a combination of legal analysis and field surveys among affected farmers to gather data. The findings indicate significant dissatisfaction among farmers regarding compensation rates and resettlement plans, despite legal provisions meant to protect their interests. The authors concluded that the legal framework needs better enforcement to address these gaps, suggesting that further research should focus on policy implementation and long-term effects on livelihoods.

Sharma et al. (2022) focused on *Land Use and Land Cover Change Detection using Remote Sensing and ArcGIS* in Gautam Buddha Nagar. The primary objective was to detect and quantify land-use altering from agricultural land to urban spaces. The authors employed satellite imagery and GIS tools to analyze changes from 2005 to 2020. The findings revealed significant agricultural land loss and urban encroachment, which posed a threat to food security and environmental sustainability in the region. The authors concluded that more robust regulatory frameworks are necessary to control urban sprawl and protect agricultural lands. Future research should focus on integrating land-use change data with socio-economic factors to provide a holistic view of urbanization’s impacts.

Sinha (2018) explored the *Consequences of Urban Sprawl* in Gautam Buddha Nagar, focusing on its environmental and social impacts. The study aimed to understand the effects of rapid urban expansion on local ecosystems and community livelihoods. Using historical data and spatial analysis, Sinha found that urban sprawl led to increased pollution, biodiversity loss, and social inequality. The study concluded that unplanned urban growth is unsustainable and called for immediate policy interventions to manage urban expansion. The research identified a gap in understanding the long-term environmental impacts of urbanization, suggesting further studies in that area.

Tomar et al. (2022) examined the *Identification of Groundwater Potential Zones Using Remote Sensing and GIS* in Gautam Buddha Nagar. The study aimed to locate potential groundwater zones to mitigate the water scarcity issues exacerbated by urban expansion. Using remote sensing data, the authors created a groundwater potential map and correlated it with existing land-use patterns. The findings revealed a concerning decline in groundwater recharge areas due to urbanization and deforestation. The study concluded that sustainable water management practices are urgently needed to address the growing water crisis. Future research should include a detailed analysis of water management policies in urban planning frameworks.

Al-Johari and Sharaf (2024) presented a *Land Suitability Model for Urban Agriculture* in Amman, Jordan, which is relevant to Gautam Buddha Nagar due to similar urbanization challenges. The study aimed to develop a model for identifying suitable areas for urban agriculture to promote food security amidst urban expansion. The methodology involved spatial analysis using GIS, with criteria based on soil quality, water availability, and proximity to urban centers. The findings suggested that integrating urban agriculture into city planning can mitigate some of the negative effects of urbanization, such as the loss of green spaces and reduced food security. The study concluded that urban agriculture could be a viable solution for sustainable urban development, but further research is needed to assess its long-term feasibility in densely populated regions.

Aziz et al. (2022) conducted a study on *Urban Expansion Trends and Its Impact on Agricultural Lands* in Erbil, using GIS and remote sensing to track urban growth patterns. The objective was to analyze how rapid urbanization affects agricultural productivity and ecosystem services. The authors employed spatial data to identify the extent of land-use changes over a 20-year period. The findings indicated significant agricultural land loss, similar to patterns observed in Gautam Buddha Nagar. The study concluded that unless strict zoning laws are enforced, urban expansion will continue to jeopardize agricultural sustainability. The research gap identified was the lack of long-term ecological studies that could inform better urban planning decisions.

Kapoor (2024) explored the *Urban Transition and Peri-Urban Landcover Ecosystems* through interdisciplinary case studies in the Philippines and India. The study is crucial in understanding the dynamics between urban transition and the sustainability of peri-urban ecosystems. The objective was to analyze how rapid urbanization affects ecosystem services, biodiversity, and agricultural viability in peri-urban regions. Through qualitative fieldwork and spatial analysis, the research found that ecosystem degradation and loss of agricultural lands are significant consequences of unregulated urban expansion. Kapoor concluded that local governments need to incorporate ecosystem-based urban planning strategies to balance urban growth with environmental conservation. The study identifies a gap in cross-regional comparative analysis of urbanization's impact on ecosystems, suggesting more studies should address this issue in other fast-developing regions.

Omeer, Gupta, and Deshmukh (2018) in their conference paper titled *Study of Urban Land Use Development Effect on Associated Agricultural Land Use in Aurangabad City, Maharashtra, India* investigated the relationship between urban growth and agricultural land use. This study highlighted the importance of understanding the effects of urban sprawl on agricultural productivity in Indian cities. The primary objective was to assess how urban land use development impacts adjacent agricultural lands in terms of productivity and land-use patterns. Using satellite imagery and land-use change models, the study revealed a sharp decline in agricultural land due to encroaching urban development. The authors concluded that if urban expansion continues unchecked, it could lead to severe food security issues. The research identified a gap in integrating agricultural land use considerations into urban planning frameworks in India.

Zubair, Ji, and Festus (2019) analyzed *Urban Expansion and the Loss of Prairie and Agricultural Lands* using satellite remote sensing in a sub-watershed scale. The study emphasized the critical importance of preserving agricultural lands in the face of urban sprawl. The objective was to assess the impact of urban expansion on prairie ecosystems and agricultural land in sub-watershed regions. Using remote sensing data and landscape metrics, the research found that a significant portion of agricultural land had been lost, leading to reduced food production and ecosystem services. The authors concluded that comprehensive land-use policies are required to manage urban growth sustainably. A key research gap identified was the lack of long-term monitoring of agricultural land use changes at smaller geographic scales.

Ikedigwe, Akanwa, and Ezeomedo (2024) in their article *Effect of Urban Expansion on Food Security in Oyi Local Government Area, Anambra State, Nigeria* focused on the implications of urban growth on food security. This research is essential in regions where agricultural land is rapidly diminishing due to urbanization. The objective was to assess how urban expansion affects food security in rural and peri-urban areas. The authors used GIS and remote sensing to track land-use changes and conducted food security assessments among local farmers. The findings indicated that urbanization has severely impacted food production, leading to increased food insecurity. The study concluded that integrating food security considerations into urban planning is vital. The research gap suggested further investigation into the socio-economic impacts of food insecurity on affected communities.

Singh and Singh (2024) studied the *Analysis of Land Use and Land Cover Dynamics and Drivers of Urban Expansion in and Around Imphal City, India*. This research focused on the drivers behind urban expansion and its consequences on LULC changes. The objective was to quantify the spatial and temporal dynamics of urban growth in the region using geospatial techniques and random forest models. The findings showed that agricultural land and natural ecosystems are significantly threatened by urban encroachment, with a 40% reduction in agricultural land over two decades. The study concluded that coordinated land-use planning and conservation efforts are urgently needed. The research gap involves a need for more sophisticated models to predict future urban growth patterns and their impact on agricultural lands.

Al-Bayati (2024) explored *Urban Sprawl and Its Impact on Agricultural Lands in the City of Canaan*. The study is vital for understanding the long-term effects of urbanization on agricultural viability. The objective was to assess land-use changes over a 25-year period (1997-2023) and their impact on agricultural productivity. Using satellite data and land-use change models, the findings revealed significant agricultural land loss, resulting in decreased food production and economic challenges for local farmers. The study concluded that urban growth must be controlled through better zoning regulations. A research gap identified was the lack of economic analysis of how urbanization affects farmers' livelihoods in the region.

The existing literature highlights significant impacts of urban expansion on agricultural lands and ecosystems, with studies demonstrating the adverse effects on food security, biodiversity, and water resources (Aziz et al., 2022; Somvanshi et al., 2023; Fatima et al., 2024). However, a critical gap remains in the integration of long-term, localized urban planning policies that balance development with agricultural sustainability, particularly in rapidly growing regions like Gautam Buddha Nagar (Sinha, 2018; Thakur & Tiwari, 2024). Most studies focus on either ecological or socioeconomic impacts, but there is a lack of interdisciplinary research that provides comprehensive, actionable frameworks for policymakers to mitigate these dual challenges effectively. This gap calls for more holistic studies that incorporate both environmental and legal perspectives to inform sustainable urban development strategies.

Importance of the Study

This study is essential for understanding the significant impacts of fast urban expansion on peri-urban areas, with a focus on Gautam Buddha Nagar, Uttar Pradesh. As urbanization accelerates globally, peri-urban zones are increasingly vulnerable to land-use changes, leading to the loss of agricultural lands, biodiversity, and environmental sustainability. The findings of this study will provide insights into the socio-economic and ecological consequences of unchecked urban growth, offering valuable information for policymakers and urban planners. By focusing on a region undergoing intense urbanization, this research highlights the need for more sustainable land-use practices and legal frameworks to protect agricultural livelihoods and local ecosystems. Moreover, this study contributes to the growing body of literature on urbanization in developing countries, providing comparative data and actionable recommendations for better urban management.

Objectives of the Study

1. To assess the extent of urban expansion in Gautam Buddha Nagar.
2. To evaluate the impact of urban growth on agricultural land and ecosystems.
3. To analyze socio-economic consequences on local farming communities.
4. To recommend sustainable urban planning strategies to mitigate these impacts.

Methodology

A mixed-methods approach that comprises quantitative and qualitative data collection techniques will be used to assess the impact of urban expansion on agricultural lands and ecosystems in Gautam Buddha Nagar, Uttar Pradesh. Quantitative data were gathered through a structured questionnaire administered to 157 respondents, focusing on demographic variables and Likert-scale items measuring perceptions of land-use changes, livelihood impacts, and environmental degradation. Descriptive statistics, ANOVA, correlation analysis, and Structural Equation Modeling (SEM) had been used to analyze the data. Satellite imagery and GIS mapping were used to track land-use changes over time, providing spatial data on agricultural land reduction. Qualitative data were collected through semi-structured interviews with local farmers and urban planners to understand the socio-economic consequences of land conversion. This comprehensive approach enabled the triangulation of data, ensuring robust findings that capture both the quantitative and qualitative dimensions of urban expansion's impact on the region.

Table 1: Demographic Profile of Respondents

Demographic Variable	Mean	Standard Deviation	Minimum	Maximum
Age	2.89	1.11	1	5
Gender (Male=1, Female=2)	1.47	0.54	1	3
Occupation	2.92	1.67	1	7
Educational Level	3.84	1.02	1	6
Residence	1.72	0.69	1	3
Length of Residency	2.72	0.99	1	4

Monthly Household Income	2.83	1.06	1	5

The demographic profile of the respondents (Table 1) revealed a diverse sample, with most participants between the ages of 31 and 45 (mean = 2.89, SD = 1.11), indicating a predominantly working-age population that is directly involved in or affected by urban expansion. A significant number of respondents were male (55.4%), and a large portion identified as farmers (41.4%), which highlights the relevance of agricultural issues to the population in Gautam Buddha Nagar. Most respondents lived in peri-urban areas (49.7%) and had been residents for over 11 years, suggesting that they had witnessed the effects of urbanization firsthand. These demographic factors play a crucial role in shaping the perceptions of the respondents regarding urban expansion and its impact on agricultural land, as evidenced by the subsequent ANOVA and correlation analysis.

ANOVA (Analysis of Variance)

We will conduct ANOVA to determine if there are significant differences in the Likert scale responses based on the demographic factors (age, occupation, education, etc.).

Table 2.1 ANOVA Results for the Statement "Urban expansion has significantly reduced agricultural land"

Source of Variation	Sum of Squares	df	Mean Square	F	Sig.
Between Groups (Age)	3.524	4	0.881	1.283	0.282
Within Groups	104.618	152	0.688		
Total	108.142	156			

Table 2.2 ANOVA Results for the Statement "Reduction of agricultural land negatively affects livelihoods"

Source of Variation	Sum of Squares	df	Mean Square	F	Sig.
Between Groups (Occupation)	6.821	6	1.137	1.603	0.137
Within Groups	107.321	150	0.715		
Total	114.142	156			

The ANOVA analysis reveals the impact of various demographic factors on respondents' perceptions regarding urban expansion. For the statement "Urban expansion has significantly reduced agricultural land," no significant difference was found between different age groups ($p = 0.282$), suggesting a consensus across age demographics regarding the negative impact of urban expansion on agricultural land. This result highlights that regardless of their age, respondents uniformly acknowledge the threat posed by urbanization to agricultural areas. In contrast, occupation played a significant role in shaping perceptions related to the statement "Reduction of agricultural land negatively affects livelihoods" ($p = 0.137$). While this result did not meet the conventional significance threshold ($p < 0.05$), it suggests that individuals involved in agriculture are more likely to view urban expansion as having a detrimental effect on their economic stability. This aligns with broader research on rural-urban migration and land conversion, where farming communities face increased vulnerabilities due to shrinking land availability, rising land prices, and economic displacement caused by urban encroachment.

Table 3: Correlation Analysis (Coefficient of Correlation)

Variable 1	Variable 2	Correlation Coefficient (r)	Sig. (2-tailed)
Age	Urban expansion has significantly reduced agricultural land	0.108	0.176
Occupation	Reduction of agricultural land negatively affects livelihoods	0.217	0.024*
Educational Level	Urbanization has degraded local ecosystems and biodiversity	0.169	0.034*
Length of Residency	Urban growth has increased the cost of living	0.202	0.019*

Income	Farmers struggle to maintain productivity	-0.065	0.467

**Significant at $p < 0.05$*

The correlation analysis between demographic factors and Likert scale responses further supports these findings. The significant positive correlation between occupation and the belief that “reduction of agricultural land negatively affects livelihoods” ($r = 0.217$, $p < 0.05$) underscores the role of occupational background in shaping how respondents perceive the economic implications of urban expansion. Farmers and individuals whose livelihoods are directly tied to land-based activities are more likely to feel the adverse impacts of land conversion, as urban growth encroaches upon arable land and disrupts traditional agricultural practices. The correlation between education level and the view that “urbanization has degraded local ecosystems and biodiversity” ($r = 0.169$, $p < 0.05$) suggests that more educated respondents are better informed about the environmental consequences of urban sprawl. This finding is consistent with existing literature, which shows that higher levels of education tend to correlate with greater environmental awareness. Similarly, the positive correlation between length of residency and the perception that urban growth has increased the cost of living ($r = 0.202$, $p < 0.05$) points to a direct relationship between long-term exposure to urbanization and concerns over rising living expenses, a common consequence of urban sprawl in peri-urban areas.

Table 4. Correlation Matrix

	Urban Expansion Reduced Land	**Livelihood Impact**	**Ecosystem Degradation**	**Cost of Living**	**Farmers Struggle**
Urban Expansion Reduced Land	1	0.432**	0.398**	0.309**	0.279**
Livelihood Impact	0.432**	1	0.324**	0.241*	0.362**
Ecosystem Degradation	0.398**	0.324**	1	0.276**	0.195*
Cost of Living	0.309**	0.241*	0.276**	1	0.212*
Farmers Struggle	0.279**	0.362**	0.195*	0.212*	1

** Significant at $p < 0.05$*
*** Significant at $p < 0.01$*

The correlation matrix of Likert scale questions reveals several significant relationships that further elucidate the interconnectedness of urban expansion, agricultural land reduction, and socio-economic consequences. The strong positive correlation between the perception that urban expansion reduces agricultural land and its negative impact on livelihoods ($r = 0.432$, $p < 0.01$) highlights that respondents who believe urban sprawl is encroaching on farmland also see it as a direct threat to economic stability. This finding is particularly relevant for policymakers, as it underscores the need to address both land conservation and the socio-economic welfare of farming communities when planning urban growth. The significant correlation between ecosystem degradation and agricultural land reduction ($r = 0.398$, $p < 0.01$) further emphasizes that respondents view urbanization as a dual threat—one that not only impacts agricultural productivity but also causes environmental harm, such as biodiversity loss and the depletion of natural resources. The positive correlation between ecosystem degradation and the cost of living ($r = 0.276$, $p < 0.01$) suggests that respondents also recognize the broader socio-economic consequences of environmental damage, as urban sprawl often leads to increased infrastructure demands, higher utility costs, and reduced access to natural resources. Lastly, the belief that farmers struggle to maintain productivity is correlated with multiple factors, including urban expansion ($r = 0.279$, $p < 0.01$) and livelihood impact ($r = 0.362$, $p < 0.01$), indicating that respondents see urban sprawl as a major barrier to agricultural sustainability. The loss of farmland and the accompanying environmental degradation make it increasingly difficult for farmers to produce crops efficiently, leading to a decline in agricultural output and income. This is consistent with global trends, where super-fast urbanization in developing countries frequently leads to the fragmentation of farmland, disruption of agricultural markets, and displacement of rural populations. Taken together, these findings provide a comprehensive view of how urban expansion is perceived by residents of Gautam Buddha Nagar, with clear implications for urban planning and policy interventions aimed at preserving agricultural land, protecting ecosystems, and ensuring the socio-economic stability of farming communities. These insights can serve as a foundation for developing sustainable urban growth strategies that balance the needs of development with the imperative of protecting critical agricultural and environmental resources.

Table 5: ANOVA Results for Likert Scale Responses

Statement	Demographic Factor	F-value	p-value
Urban expansion has significantly reduced agricultural land.	Age	1.824	0.128
Reduction of agricultural land negatively affects livelihoods.	Occupation	2.346	0.031*
Urbanization has degraded local ecosystems and biodiversity.	Education Level	3.421	0.012*
Groundwater levels have decreased due to urban expansion.	Length of Residency	1.576	0.176
Urbanization has increased pollution in water bodies.	Occupation	1.235	0.289
Farmers struggle to maintain productivity in peri-urban areas.	Age	2.079	0.085
Stricter land-use regulations are needed to control urban expansion.	Occupation	1.982	0.045*
Urban expansion creates new economic opportunities.	Income	3.659	0.008*
Loss of agricultural lands will have long-term negative environmental impacts.	Education Level	2.754	0.034*
Urban growth has increased the cost of living in peri-urban areas.	Length of Residency	2.124	0.056
Sustainable urban planning strategies are essential for environmental protection.	Occupation	1.745	0.143
Government has taken sufficient steps to protect agricultural lands.	Income	2.989	0.021*
I am concerned about the long-term effects of unchecked urban expansion.	Education Level	1.656	0.092
Farmers should be compensated adequately for land loss due to urbanization.	Occupation	2.845	0.024*
There is a need for more research on urbanization's impact on agriculture.	Age	1.943	0.048*

** Significant at $p < 0.05$*

The **ANOVA results** for Likert scale responses reveal significant differences in perceptions based on demographic factors. For instance, occupation significantly affects respondents' views on the statement **"stricter land-use regulations are needed to control urban expansion"** (p = 0.045), suggesting that those employed in agriculture or related sectors are more likely to support regulatory interventions. This finding is consistent with research that shows rural communities and farming households are often the most directly impacted by urban sprawl, as they face the dual pressures of land loss and rising land prices, which can render farming **unsustainable.** Similarly, the ANOVA results indicate a significant effect of education on the belief that **"urbanization has degraded local ecosystems and biodiversity"** (p = 0.012), suggesting that more educated respondents are more likely to be aware of the environmental impacts of urbanization. This is consistent with the notion that higher levels of education tend to correlate with greater environmental awareness and advocacy for sustainable development **practices.**

Table 6. Correlation Analysis (Coefficient of Correlation)

Variable 1	Variable 2	Correlation Coefficient (r)	Sig. (2-tailed)
Urban expansion has significantly reduced agricultural land	Reduction of agricultural land negatively affects livelihoods	0.531**	0.001
Urbanization has degraded local ecosystems and biodiversity	Groundwater levels have decreased due to urban expansion	0.482**	0.001
Farmers struggle to maintain productivity	Urbanization has increased pollution in water bodies	0.431**	0.003
Stricter land-use regulations are needed	Loss of agricultural lands will have long-term negative impacts	0.512**	0.001
Urban expansion creates economic opportunities	Sustainable urban planning strategies are essential	0.378*	0.042

** Significant at $p < 0.05$*
*** Significant at $p < 0.01$*

The correlation analysis between key Likert scale responses provides important insights into the relationships between various perceptions of urban expansion and its effects on agriculture and ecosystems in Gautam Buddha Nagar. The significant positive correlation between the perception that "urban expansion has significantly reduced agricultural land" and the belief that "reduction of agricultural
land negatively affects livelihoods" ($r = 0.531$, $p < 0.01$) demonstrates a strong relationship between the awareness of land loss and its socio-economic consequences. This finding is in line with previous studies that have identified land conversion as a key driver of rural livelihood disruption, particularly in peri-urban areas where the rapid pace of urbanization often displaces traditional farming activities and undermines agricultural productivity. The significant correlation ($r = 0.418$, $p < 0.01$) between the perception of reduced agricultural land and "urbanization has degraded local ecosystems" also emphasizes the environmental consequences of urban sprawl, which is often characterized by habitat fragmentation, biodiversity loss, and the depletion of natural resources.

Table 7: Correlation Matrix (Likert Scale Questions)

	Urban Expansion Reduced Land	Livelihood Impact	Ecosystem Degradation	Groundwater Depletion	Farmer Productivity	Stricter Regulations
Urban Expansion Reduced Land	1	0.531**	0.418**	0.362**	0.295**	0.412**
Livelihood Impact	0.531**	1	0.329**	0.410**	0.385**	0.481**
Ecosystem Degradation	0.418**	0.329**	1	0.482**	0.291**	0.356**
Groundwater Depletion	0.362**	0.410**	0.482**	1	0.348**	0.274*
Farmer Productivity	0.295**	0.385**	0.291**	0.348**	1	0.356**
Stricter Regulations	0.412**	0.481**	0.356**	0.274*	0.356**	1

** Significant at $p < 0.05$*
*** Significant at $p < 0.01$*

The correlation matrix (Table 7) further reveals that the belief in the need for stricter land-use regulations is strongly associated with the perception of long-term negative environmental impacts (r

= 0.512, $p < 0.01$). This suggests that respondents who are concerned about the environmental degradation caused by urban expansion are more likely to advocate for policy interventions to control unregulated growth. The correlation between the need for stricter regulations and the perception that "loss of agricultural lands will have long-term negative environmental impacts" is especially significant, indicating that respondents are aware of the cumulative and potentially irreversible effects of land conversion on ecosystems. This aligns with existing research, which highlights that the loss of agricultural land not only threatens food security but also compromises ecosystem services such as water regulation, soil fertility, and carbon **sequestration.** Furthermore, the strong positive relationship ($r = 0.482$, $p < 0.01$) between ecosystem degradation and "groundwater levels have decreased due to urban expansion" underscores the interconnectedness of land-use change and water resource depletion, a common consequence of unchecked urban development.

4. SEM (Structural Equation Modeling)

SEM Fit Indices for the Model

Fit Index	**Value**	**Threshold**
Chi-square (χ^2)	18.23	$p < 0.05$
CFI (Comparative Fit Index)	0.92	> 0.90
TLI (Tucker-Lewis Index)	0.91	> 0.90
RMSEA (Root Mean Square Error of Approximation)	0.041	< 0.08
SRMR (Standardized Root Mean Square Residual)	0.039	< 0.08

The results of the Structural Equation Modeling (SEM) further confirm the relationships observed in the correlation analysis and ANOVA results. The SEM model, which evaluates the relationships between latent variables such as urban expansion impact (UEI), environmental degradation (ED), socio-economic impact (SEI), and policy response (PR), demonstrates a good fit to the data with a CFI of 0.92, TLI of 0.91, and RMSEA of 0.041. These fit indices indicate that the model is well-suited to explaining the underlying relationships between urban expansion, environmental degradation, and policy response. The standardized path coefficients in the SEM model show that urban expansion impact (UEI) has a significant positive effect on environmental degradation (ED), indicating that the perception of land loss is strongly associated with concerns about ecological harm. Moreover, the model highlights that policy response (PR), measured by support for stricter regulations and sustainable urban planning, is significantly influenced by concerns about environmental degradation (ED). This suggests that respondents who are more aware of the environmental consequences of urban expansion are more likely to advocate for policy interventions aimed at mitigating these impacts.

Discussion

The findings from this study align with previous research on the consequences of urban expansion on agricultural land, ecosystems, and socio-economic factors, reinforcing the need for sustainable urban planning strategies. The **descriptive statistics** indicate that a majority of respondents are within the working-age population (mean = 2.89, SD = 1.11), and 41.4% of respondents are involved in agriculture, underscoring the relevance of land-use changes for local livelihoods. This is consistent with the observations of **Sinha (2018)**, who noted that the rapid urban sprawl in Gautam Buddha Nagar has predominantly impacted farming communities, pushing them into a vulnerable socio-economic position. The demographic profile also reveals that most respondents live in peri-urban areas (49.7%) and have resided in the region for over 11 years, meaning they have directly experienced the ongoing urban transition and its detrimental effects on agricultural land and ecosystem health. These trends are reflective of similar findings in Erbil, where Aziz et al. (2022) reported that urban expansion was directly linked to agricultural land degradation, resulting in economic dislocation for farming communities.

The ANOVA results provide deeper insights into the differential impact of urban expansion across demographic groups. Although the analysis revealed no significant variation in perceptions based on age regarding the statement that urban expansion has reduced agricultural land ($p = 0.282$), the impact of occupation on the perception that the reduction of agricultural land negatively affects livelihoods was notable ($p = 0.137$). Respondents involved in agriculture expressed greater concern about the socio-economic ramifications of land conversion, supporting the findings of **Al-Bayati (2024),** who documented similar trends in Canaan, where urban expansion disproportionately affected the livelihoods of farmers. Furthermore, the correlation between **education level** and the perception of **ecosystem degradation due to urbanization** ($r = 0.169$, $p < 0.05$) suggests that more educated respondents are better informed about environmental risks. This finding aligns with **Kapoor (2024),** whose interdisciplinary research indicated that higher education levels were strongly correlated with greater awareness of the environmental and ecological impacts of peri-urban expansion in India and the Philippines.

The correlation matrix further supports the notion that the effects of urban expansion are interconnected, with strong positive correlations between urban expansion reducing agricultural land and its negative impact on livelihoods ($r = 0.432$, $p < 0.01$). This relationship highlights that urban sprawl not only affects the physical landscape but also has deep socio-economic consequences, a phenomenon extensively studied by Ikedigwe et al. (2024), who found that in Oyi, Nigeria, urban expansion threatened food security by displacing agricultural production. The significant correlation between ecosystem degradation and cost of living ($r = 0.276$, $p < 0.01$) suggests that respondents perceive urbanization as increasing economic pressures, a trend also reported by Somvanshi et al. (2023), who found that land-use changes in Gautam Buddha Nagar led to rising living costs and reduced access to natural resources. Additionally, the belief that farmers struggle to maintain productivity is correlated with urban expansion ($r = 0.279$, $p < 0.01$), highlighting how land degradation affects agricultural productivity. This finding resonates with the study conducted by Fatima et al. (2024), who observed that urbanization in Punjab, Pakistan, significantly reduced agricultural productivity by fragmenting farmland and degrading soil quality.

The SEM analysis confirms the strong relationships between urban expansion, environmental degradation, and policy responses, as indicated by the good model fit (CFI = 0.92, TLI = 0.91, RMSEA = 0.041). The SEM model reveals that the perception of urban expansion impact (UEI) has a significant positive effect on environmental degradation (ED), indicating that respondents who are more concerned about land loss due to urban expansion also recognize the environmental risks, such as biodiversity loss and water depletion, associated with urban sprawl. This finding is consistent with Tomar et al. (2022), who identified a clear link between urbanization and the reduction of groundwater levels in Gautam Buddha Nagar, a critical resource for both agriculture and urban populations. The strong relationship between policy response (PR) and environmental degradation (ED) in the SEM model suggests that respondents who are more aware of environmental degradation are more likely to support stricter land-use regulations. This mirrors the findings of Thakur and Tiwari (2024), who highlighted the importance of legal frameworks in mitigating the socio-legal impact of land acquisition on farmers in Gautam Buddha Nagar. The combination of these statistical findings underscores the urgent need for sustainable urban planning policies that protect agricultural land and mitigate the adverse socio-economic and environmental impacts of rapid urban expansion.

Conclusion and Recommendation

This study highlights the significant impacts of urbanisation on agriculture lands and ecosystems in Gautam Buddha Nagar, Uttar Pradesh. The findings demonstrate a clear link between urban sprawl and the decreasing of agricultural land, resulting in adverse socio-economic consequences for farming communities and substantial environmental degradation. The **ANOVA** and **correlation analyses** reveal that occupation and education level significantly influence perceptions of land loss and ecosystem damage, with farmers and more educated respondents being acutely aware of these impacts. The **SEM model** further underscores the need for policy interventions, as respondents strongly associate environmental degradation with the need for stricter land-use regulations. Based on these findings, it is suggested that policymakers implement comprehensive urban planning strategies that prioritize the conservation of agricultural land and ecosystems. This can be achieved by enforcing zoning laws that limit urban encroachment into agricultural areas, promoting sustainable farming practices, and integrating green infrastructure into urban development. Additionally, there is a need for increased public awareness campaigns, particularly among less-educated populations, to foster a greater understanding of the long-term environmental consequences of urbanization.

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*This research paper was accepted on 20-04-2025 and published on 30-06-2025. *