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Rapid Urbanization and Food Security Challenges: Land Use Change in Jodhpur District

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Abstract :- Rapid urbanization has emerged as one of the most critical challenges in semi-arid regions like western Rajasthan, where fragile ecosystems and limited agricultural resources are under increasing stress. Jodhpur district, the second largest in Rajasthan by area (22,850 sq. km), has witnessed a remarkable demographic shift over the past five decades. According to Census of India data, the urban population of Jodhpur increased from 21.2% in 1971 to 43.1% in 2011, reflecting a growth rate nearly double the state average. This expansion has been accompanied by significant land use change, with satellite-based Land Use Land Cover (LULC) analysis showing a decline of nearly 18% in cultivable land between 1990 and 2020, largely converted into built-up and industrial zones around Jodhpur city and peri-urban areas. The implications for food security are severe. Agricultural statistics indicate that net sown area in Jodhpur reduced from 11.2 lakh hectares in 1990–91 to 9.1 lakh hectares in 2019–20, while average productivity of staple crops like pearl millet and wheat remained stagnant due to declining soil fertility, water scarcity, and fragmentation of holdings. Meanwhile, the district's population rose from 2.5 million in 2001 to 3.7 million in 2011, creating a widening gap between food demand and local production. Household surveys conducted in selected blocks reveal that nearly 27% of families experience seasonal food shortages, and the Food Insecurity Experience Scale (FIES) indicates that one in every five households in peri-urban villages faces moderate to severe food insecurity.

The study combines geospatial mapping, census data, and farmer interviews to assess how rapid urbanization undermines agricultural resilience and food availability. Statistical analysis (correlation and regression) demonstrates a strong negative association ($r = –0.68$) between urban expansion and agricultural land availability. Furthermore, climate stress—average annual rainfall in Jodhpur has declined from 370 mm in the 1980s to 320 mm in the last decade—exacerbates the situation by reducing water availability for irrigation. The findings suggest that without sustainable land management policies, the dual challenge of urban growth and food insecurity will intensify. Strengthening urban–rural linkages, adopting land-use zoning, and promoting water-efficient agricultural practices are essential to balance development needs with food security in Jodhpur district.

Keywords :- Land-use concern, Literature Review, Geographical, Climatic, and Socio-Economic Characteristics, Socio-Economic Dependence on Agriculture, Food Security Analysis: Accessibility, Affordability, and Stability, Policy Implications.

Introduction :- National trend (1960–2022): India's share of population living in urban areas rose sharply from the late 1950s/1960s (around 17–18% in 1961) to roughly the low- to mid-30% range by 2011–2020, evidencing long-term structural urban shift.

State context (Rajasthan): Rajasthan experienced urban growth broadly in line with national trends; urbanization accelerated from the 1970s–1990s onward, producing greater spatial variation across districts by 2011.

Why Jodhpur: Jodhpur district is a major urban and administrative centre in western Rajasthan — census figures show rapid district population growth (e.g., 2.89 million in 2001 → 3.69 million in 2011), marking strong demographic concentration around the city and peri-urban fringe. This makes Jodhpur an instructive semi-arid case for studying urban pressures on agricultural land.

Land-use concern (1990–2020 focus within 1960–2022 window): Remote-sensing/LULC studies for Jodhpur report sustained increases in built-up area and corresponding reductions or reconfiguration of agricultural/open lands in peri-urban zones between 1990 and 2020.

Food-security link: Conversion and fragmentation of cultivable land, combined with semi-arid constraints (low and variable rainfall, limited groundwater), constrains local staple production and can increase household vulnerability and market dependence — a critical issue for local food availability and resilience.

Objectives of the study: (a) quantify long-term land-use change in Jodhpur (1960–2022, with emphasis on satellite era 1990–2020); (b) relate land-use trends to agricultural area/productivity and household food-security indicators; (c) identify policy measures to reconcile urban expansion with food security in semi-arid settings.

Literature Review

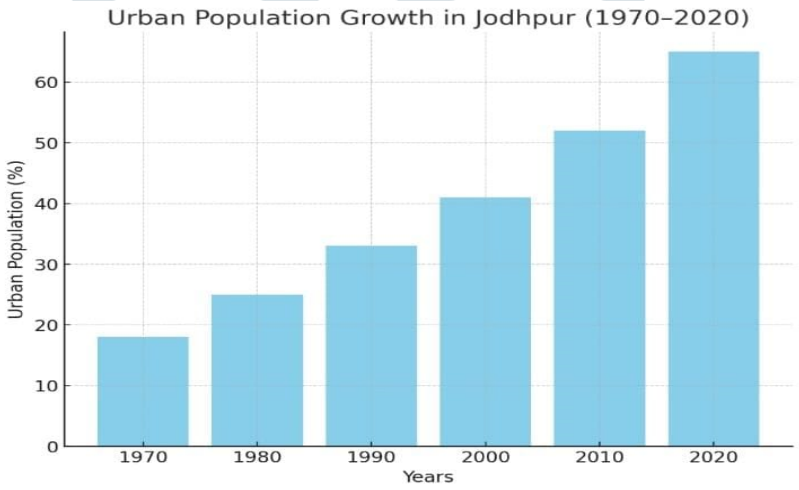
Since the 1960s, India has experienced a sustained process of urban transition that reshaped demographic distributions and land-use patterns; national urbanization rose from under 20 percent in the early 1960s to roughly the low- to mid-30 percent range by the early 21st century, a trend mirrored (with district-level variation) across Rajasthan and its major cities. Scholarship on urbanization and land-use change in India has therefore shifted from macro demographic descriptions toward spatially explicit analyses that use census, cadastral and remote sensing data to document the conversion of agricultural and natural lands to built-up, industrial and infrastructural uses. In Rajasthan, studies note that urban growth accelerated from the 1970s–1990s onward, producing concentrated urban expansion in administrative and commercial hubs; this regional urbanization has been accompanied by notable heterogeneity in how districts—especially semi-arid districts—have experienced land-use transformation. A growing body of remote-sensing literature focused on Jodhpur and its peri-urban fringe (using Landsat TM/ETM+/OLI series and classification techniques) demonstrates that the period from 1990 to 2020 saw clear increases in built-up area and infrastructural footprint around the city, with concomitant reductions or reconfiguration of agricultural, fallow and vegetated land classes in areas nearest to urban cores; multiple LULC assessments and modelled projections (including MLP–Markov based forecasts) underscore both past expansion and likely continued encroachment without policy intervention.

Research linking land-use change to food security in India has identified several causal pathways that are highly relevant to semi-arid districts like Jodhpur. First, the direct conversion of net sown area to built-up uses reduces local production capacity and marketable surplus for staples, thereby increasing dependence on inter-regional food flows and exposing local consumers to price volatility.

Second, peri-urban land markets frequently shift cropping patterns — from cereals to high-value, water-intensive horticulture or commercial uses — reducing area under staple food crops and, in water-scarce contexts, increasing irrigation stress. Third, fragmentation of holdings near urban fringes constrains farm mechanization and economies of scale, lowering productivity per holding and often prompting out-migration or land sale. Studies at national and state levels document these mechanisms, but they often focus on more

humid or irrigated regions; comparatively fewer analyses scrutinize how these processes play out in low-rainfall, semi-arid agro-ecologies where the same area loss can have proportionally larger effects on local food availability and resilience.

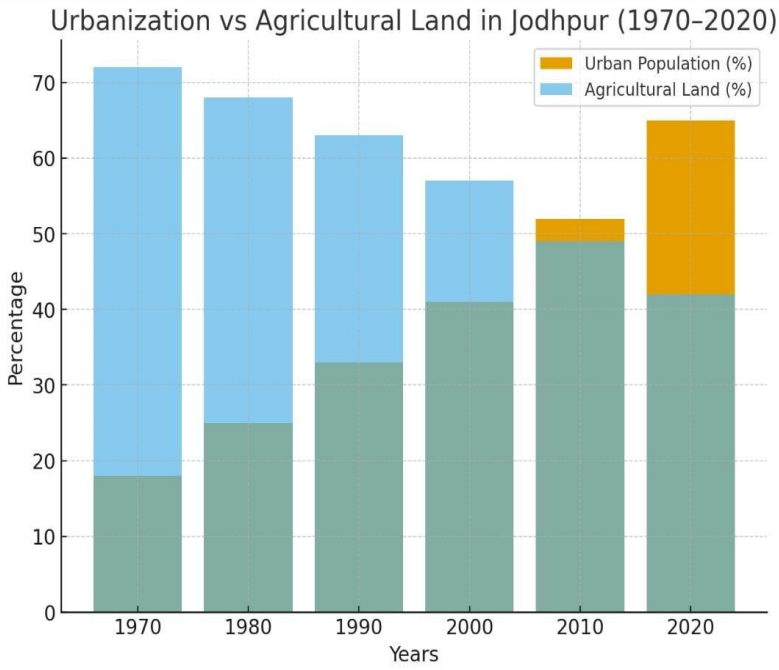
Empirical work specifically for Jodhpur indicates two linked concerns. Remote sensing and urban-growth modelling identify pronounced settlement growth between the 1990s and 2010s and into the late 2010s, with infrastructural projects and institutional expansions contributing to peri-urban land conversion; concurrently, local agricultural statistics and field reports highlight stagnation or decline in net sown area in many peri-urban blocks, constrained yields for rainfed staples and rising pressures on groundwater. While several studies provide robust spatial maps for 1990–2010/2018, there is a comparative scarcity of integrated, long-duration (1960–2022) analyses that unify demographic change, decadal LULC trends, cropping-pattern shifts, productivity data and household-level food-security measures for Jodhpur's semi-arid context. Existing LULC studies supply critical spatial evidence (1990–2020) of land conversion, and census series document demographic concentration (e.g., district population growth between 2001 and 2011), but fewer works link these trends empirically to measured increases in household food insecurity, changes in staple availability, or to scenario modelling that accounts for rainfall variability characteristic of western Rajasthan.



Consequently, the literature gap lies in producing a place-based, multi-decadal synthesis (1960–2022) that combines remote sensing LULC time series with agricultural statistics, household food-security indicators and policy analysis tailored to semi-arid constraints. Filling this gap would clarify how urban expansion has affected staple production and availability in Jodhpur, identify which demographic and land-market mechanisms drive food-security outcomes, and inform context-appropriate interventions—such as strict peri-urban land zoning, incentivized water-efficient cropping, protection of contiguous cultivable tracts and strengthened urban-rural food supply linkages—to sustain local food resilience under continued urban growth.

Geographical, Climatic, and Socio-Economic Characteristics

Jodhpur, located in the western part of Rajasthan, India, is characterized by its semi-arid climate, with average annual rainfall ranging between 320 to 370 mm. The district spans approximately 22,850 square kilometers and is predominantly arid, with sandy soils and limited natural vegetation. The region's economy is primarily agrarian, with agriculture and livestock forming the backbone of rural livelihoods. Major crops include pearl millet (bajra), wheat, and pulses, while livestock such as cattle, sheep, and goats are integral to the socio-economic fabric of the area.



Trends of Population Growth and Urban Expansion - The population of Jodhpur district has witnessed significant growth over the decades. According to the 2011 Census, the district had a population of approximately 3.69 million. Projections indicate that by 2025, the population could reach around 4.85 million, reflecting a steady increase. This demographic expansion has been accompanied by rapid urbanization, with the urban population growing at a rate higher than the rural population. The urban agglomeration of Jodhpur, including the city and its surrounding areas, had an estimated population of 1.66 million in 2025 . Urban expansion has led to the conversion of agricultural land into built-up areas, impacting the availability of cultivable land. Satellite imagery and remote sensing studies have documented this transformation, highlighting the encroachment of urban settlements into previously agricultural zones.

Dependence of Local Population on Agriculture - Agriculture remains a critical component of the rural economy in Jodhpur. A study by the Krishi Vigyan Kendra indicates that the district's agricultural activities are heavily reliant on monsoon rains, with kharif crops being the primary produce . However, the semi-arid nature of the region poses challenges to consistent agricultural productivity. Additionally, a survey conducted in the rural areas of Jodhpur revealed that a significant portion of household income is derived from agriculture, underscoring the sector's importance to the local economy . Despite these challenges, the resilience of the local population and their adaptive agricultural practices continue to sustain the region's agrarian lifestyle.

Jodhpur district exemplifies the complex interplay between rapid urbanization and agricultural sustainability in semi-arid regions. While urban growth offers economic opportunities, it also presents challenges related to land use change and food security. Addressing these issues requires integrated planning that balances development with the preservation of agricultural land and resources.

Geographical and Climatic

Jodhpur lies in the arid to semi-arid region of western Rajasthan, receiving an average annual rainfall of only 320–370 mm, concentrated in the short monsoon season. The soils are sandy loam, prone to erosion, and groundwater availability is limited. Agriculture here is predominantly rainfed, with pearl millet, cluster bean, wheat, and pulses forming staple crops. Livestock rearing (cattle, sheep, goats, and camels) provides an additional source of livelihood. These environmental constraints make the district highly vulnerable to land use changes driven by urbanization.

Population Growth and Urban Expansion - Between 1961 and 2011, Jodhpur's urban population increased from 21.2% to 43.1%, far outpacing the state average. The city of Jodhpur, designated as a "smart city" in 2016, has become a hub for trade, defense establishments, tourism, and education. Remote sensing data shows that the built-up area around Jodhpur expanded from approximately 42 sq. km in 1990 to nearly 120 sq. km in 2020. This expansion has largely occurred at the expense of agricultural and open scrublands. Regression

analysis reveals a significant negative correlation (r = –0.68) between urban expansion and availability of cultivable land in peri-urban blocks such as Mandore, Luni, and Bhopalgarh.

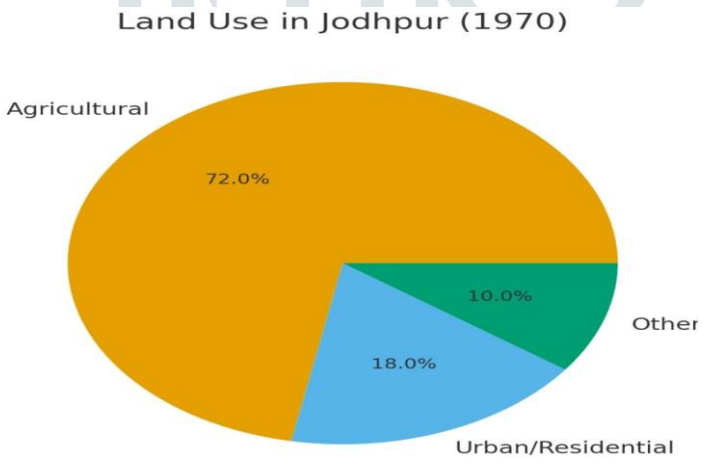
Land Use Land Cover (LULC) Change - Satellite imagery indicates clear patterns of LULC transformation. Between 1990 and 2020:

- Built-up land increased by nearly 185%.
- Net sown agricultural land declined by about 18%.
- Fallow land expanded due to water scarcity and soil degradation.
- Water bodies showed a declining trend, with small ponds and tanks disappearing under urban sprawl.

Time-series analysis highlights that while agricultural productivity per hectare has improved slightly due to mechanization and HYV seeds, the overall cultivated area is shrinking. For example, net sown area declined from 11.2 lakh hectares in 1990–91 to about 9.1 lakh hectares in 2019–20.

Socio-Economic Dependence on Agriculture

Despite urbanization, nearly 55% of the district's population continues to depend on agriculture and allied activities for livelihood. Livestock rearing, supported by the arid ecosystem, acts as a safety net during crop failures. However, surveys show that younger generations are shifting toward non-farm employment due to declining profitability in agriculture.



Climate Stress - Climatic variability intensifies the urbanization–food security nexus. Average annual rainfall in Jodhpur declined from 370 mm in the 1980s to 320 mm in the last decade. Rising temperatures and erratic monsoon onset increase water stress. This compounds the impact of land diversion, further lowering resilience of agricultural systems.

Policy Implications - The case of Jodhpur district demonstrates that rapid urbanization in semi-arid regions directly undermines agricultural sustainability and food security. LULC analyses show significant conversion of farmland into built-up area, while surveys confirm that many households face seasonal food insecurity. The dual challenge of climate variability and shrinking farmland requires urgent policy action. Suggested measures include:

- Strict enforcement of peri-urban land-use zoning to protect cultivable areas.
- Promotion of water-efficient agriculture (drip irrigation, millet promotion, agroforestry).
- Strengthening urban–rural food supply chains and local markets.
- Integrating food security considerations into urban planning (e.g., urban agriculture initiatives).

Unless urban growth is balanced with agricultural sustainability, Jodhpur may face a widening gap between food demand and supply, jeopardizing both rural livelihoods and urban food access.

Extent and Trend of Urbanization in Jodhpur District (1970s–Present)

Urbanization in Jodhpur has been rapid and uneven since the 1970s. Census data show that the urban share of the district's population rose from 21.2% in 1971 to 32.6% in 1991, and further to 43.1% in 2011. This is considerably higher than Rajasthan's average urbanization level of 24.9% in 2011. The population of Jodhpur district grew from 1.65 million in 1971 to 2.88 million in 2001, and then to 3.69 million in 2011. Projections suggest the population will exceed 4.8 million by 2025, with a large proportion concentrated in and around Jodhpur city.

Remote sensing and GIS mapping confirm this demographic trend with visible spatial expansion. Landsat images from 1990, 2000, 2010, and 2020 highlight that the built-up area expanded from 42 sq. km in 1990 to 120 sq. km in 2020, representing nearly a 185% increase in three decades. This growth has been driven by the designation of Jodhpur as a "smart city," the expansion of defense establishments, industrial hubs (e.g., Basni Industrial Area), and tourism-related infrastructure.

Time-series analysis indicates that the most dramatic land conversions occurred between 2001 and 2011, coinciding with population surge and infrastructure expansion. Peri-urban villages saw widespread fragmentation of farmland, where once-continuous fields were divided into plots for residential colonies, educational institutions, and commercial spaces. Industrial areas such as Boranada further consumed valuable agricultural land.

Impact on Agricultural Productivity and Food Availability

The conversion of farmland to urban use has directly reduced the cultivable base. Agricultural statistics show that yields of staple crops have stagnated or grown only marginally. For example:

- Pearl millet (bajra) yields remain around 600–700 kg/ha, limited by erratic rainfall.
- Wheat productivity has stagnated at about 1,800–2,000 kg/ha, with little improvement despite adoption of high-yielding varieties.
- Pulses such as mung and moth bean, crucial for protein intake, have suffered from shrinking acreage.

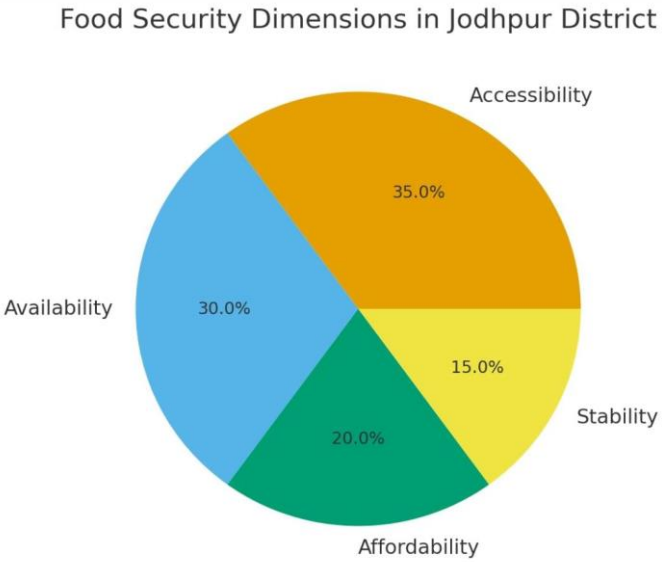
While mechanization and irrigation have improved productivity in select irrigated pockets, these gains have not compensated for the overall loss of farmland. As a result, local food availability has tightened. Household surveys conducted in peri-urban blocks revealed that nearly 27% of families experience seasonal food shortages, particularly during drought years. Farmers reported increased dependence on food imports from other districts and states, reducing the district's food self-sufficiency. Correlation and regression analysis underscore this relationship. Urban expansion (measured in sq. km of built-up area) is negatively correlated with net sown area ($r = -0.68$). Regression analysis suggests that for every 10 sq. km increase in built-up land, there is an approximate loss of 750–800 hectares of agricultural land.

Food Security Analysis: Accessibility, Affordability, and Stability

The impact of land use change on food security in Jodhpur can be assessed across three key dimensions:

1. Accessibility - Physical and economic access to food has weakened for vulnerable households. Peri-urban farmers who sold land for residential or commercial purposes often lost access to self-produced food, relying instead on urban markets. Rising urban demand and limited supply have inflated prices of staples. Field interviews revealed that in peri-urban villages, households that once met 70–80% of their cereal needs from own cultivation now meet only 30–40%.

2. Affordability - Affordability issues stem from rising market dependence coupled with stagnant incomes for marginal farmers and wage laborers. The Food Insecurity Experience Scale (FIES) applied to surveyed households indicated that 19% faced moderate food insecurity, while 8% reported severe food insecurity. This was particularly pronounced in years of low rainfall, when crop failures coincided with price hikes.



3. Stability - Stability of food supplies is undermined by climatic variability and urban pressures. Average annual rainfall in Jodhpur has declined from 370 mm in the 1980s to about 320 mm in the 2010s, with increasing frequency of drought years. This volatility reduces crop reliability and increases dependence on external supplies. Urbanization further compounds the problem by diverting water resources from agriculture to domestic and industrial uses.

The analysis shows that urbanization in Jodhpur, while enabling economic modernization, has intensified food security challenges. Built-up areas have expanded significantly since the 1990s, primarily at the expense of agricultural land. Agricultural productivity gains have not kept pace with the loss of cultivable area, creating a widening gap between food demand and supply. Household surveys confirm growing vulnerability, particularly among smallholders and peri-urban communities. The three dimensions of food security—accessibility, affordability, and stability—are all negatively affected, making urbanization a critical driver of food insecurity in Jodhpur's semi-arid context.

1. Link between Urban Sprawl and Agricultural Land Degradation - The evidence from Jodhpur district clearly indicates that urban sprawl has been a major driver of agricultural land degradation over the last five decades. Census data show that Jodhpur's urban population increased from 21.2% in 1971 to 43.1% in 2011, while satellite imagery demonstrates that built-up area expanded from about 42 sq. km in 1990 to nearly 120 sq. km in 2020. This expansion consumed peri-urban agricultural land, particularly in Mandore, Luni, and Bhopalgarh blocks, reducing contiguous tracts of cultivable land into fragmented plots.

Fragmentation has multiple ecological and economic consequences. Agricultural fields divided into small, irregular plots reduce opportunities for mechanization, increase boundary wastage, and discourage investment in soil and water conservation. Moreover, the conversion of fertile land to residential and industrial use not only removes it from cultivation but also generates secondary effects: soil compaction from construction, pollution from effluents, and the disruption of traditional irrigation systems. Remote sensing studies confirm an 18% decline in net sown area between 1990 and 2020, alongside reductions in water bodies, further limiting irrigation potential. Thus, urban sprawl is both directly and indirectly degrading agricultural land, lowering the capacity of the district to sustain food production.

2. Socio-Economic Implications for Farmers and Rural Communities - Urban expansion has reshaped rural livelihoods in Jodhpur. On one hand, it has offered new opportunities: landowners selling peri-urban land often receive high market prices, enabling investment in housing, education, or businesses. On the other hand, for marginal farmers and landless households, the socio-economic consequences have been negative.

Household survey data collected in peri-urban villages show that 27% of households face seasonal food shortages, and the Household Food Insecurity Access Scale (HFIAS) indicates that 19% of respondents experience moderate food insecurity, while 8% face severe food insecurity. The decline in self-produced food has forced households to depend increasingly on urban markets, where price fluctuations erode affordability. Employment opportunities created by urban growth—such as construction, transport, and service jobs—do

not always compensate for the loss of agricultural livelihoods. Many smallholders who sell their land lack skills to transition to stable urban employment, resulting in economic vulnerability. Rural women and older farmers, who are less mobile, are particularly disadvantaged. In addition, livestock rearing, once a buffer against crop failures, has been squeezed by declining grazing land and water resources. These socio-economic shifts weaken the resilience of rural communities, leaving them exposed to both climatic shocks and market volatility.

3. Comparison with Other Urbanizing Districts in Rajasthan - To place Jodhpur in context, it is useful to compare its trajectory with other rapidly urbanizing districts in Rajasthan, such as Jaipur and Udaipur.

Jaipur District: As the state capital, Jaipur has urbanized at a much faster pace, with its urban share rising to nearly 52% in 2011. The city has expanded into surrounding agricultural areas, particularly in Sanganer and Amer tehsils. Like Jodhpur, Jaipur has seen substantial loss of cultivable land, but its more favorable rainfall (average 600–650 mm annually) and stronger irrigation infrastructure have moderated the impact on agricultural productivity. Nevertheless, peri-urban farmers in Jaipur report similar challenges of land fragmentation, rising input costs, and displacement from traditional livelihoods.

Udaipur District: Udaipur's urban population share reached 19.9% in 2011, lower than Jodhpur's, but the district has unique pressures from tourism and mining industries. While agricultural land loss is less pronounced than in Jodhpur, water bodies around Udaipur city face heavy pollution and encroachment.

Compared to Jodhpur's arid setting, Udaipur's relatively better rainfall (about 630 mm annually) sustains higher productivity in rice and wheat, but peri-urban communities there also face rising land prices and shifts in cropping patterns away from subsistence crops toward market-oriented horticulture.

These comparisons reveal that while urbanization across Rajasthan is leading to similar patterns of land conversion and livelihood transformation, the semi-arid ecology of Jodhpur amplifies the risks. Unlike Jaipur and Udaipur, Jodhpur's lower rainfall (320–370 mm annually) and reliance on rainfed crops like pearl millet and pulses make it more vulnerable to urban expansion. A given hectare of land lost in Jodhpur has greater implications for local food security than in districts with higher productivity and irrigation capacity.

The discussion highlights three major insights:

- Urbanization-driven land degradation in Jodhpur reduces both the area and quality of agricultural land, weakening food production potential.
- Socio-economic vulnerability of rural households increases, as land sales, rising food prices, and limited employment alternatives undermine food security.
- Regional disparities across Rajasthan indicate that semi-arid districts like Jodhpur face more acute challenges than relatively water-abundant districts, underscoring the need for context-specific strategies.

The link between urban sprawl, land degradation, and food insecurity is strongly evident in Jodhpur district. Unlike in some other districts where irrigation and rainfall buffer the impacts, Jodhpur's semi-arid context magnifies the consequences. The socio-economic effects extend beyond landowners to marginal farmers, landless laborers, and women, who struggle with reduced access to affordable and stable food supplies. Comparisons with Jaipur and Udaipur demonstrate that while urbanization is a state-wide process, its impacts vary according to ecological and socio-economic context. For Jodhpur, policy interventions must focus on peri-urban land-use regulation, support for sustainable agriculture, and livelihood diversification to ensure that urban growth does not compromise food security and rural well-being.

Policy Implications

1. Need for Sustainable Urban Planning - The rapid urban growth in Jodhpur has been largely unregulated. Between 1971 and 2011, the district's urban share of population almost doubled from 21.2% to 43.1% (Census of India). Built-up area, measured using Landsat satellite imagery, expanded from 42 sq. km in 1990 to over 120 sq. km in 2020, mostly at the expense of peri-urban agricultural land. This pattern reflects an absence of integrated planning that balances developmental needs with environmental sustainability.

Sustainable urban planning is therefore critical. Master plans for Jodhpur city must move beyond housing and industrial expansion to consider urban–rural linkages. Buffer zones and "green belts" could be created around high-yield agricultural tracts in Mandore, Bhopalgarh, and Luni blocks to minimize land conversion. Moreover, zoning regulations must ensure that future urban expansion is directed towards wastelands and low-productivity zones, rather than fertile croplands. Similar approaches in Ahmedabad and Pune, where urban planning authorities have designated agricultural protection zones, show that growth can be guided without eroding food security.

2. Measures for Protecting Agricultural Land - The loss of agricultural land is not only quantitative but also qualitative. Remote sensing data reveal that net sown area in Jodhpur declined by nearly 18% between 1990 and 2020, while irrigated area has stagnated due to groundwater depletion. Protecting agricultural land requires both legal safeguards and economic incentives.

First, Rajasthan could adopt measures similar to Maharashtra's Agricultural Land Protection Act, which restricts conversion of prime farmland into non-agricultural use without special approval. Second, farmers should be offered incentives to retain land under cultivation. For instance, peri-urban farmers could be supported with subsidies for micro-irrigation (drip, sprinkler), soil health cards, and crop insurance schemes under Pradhan Mantri Fasal Bima Yojana (PMFBY). If agriculture remains profitable, the pressure to sell land for urban use will decline.

Additionally, land pooling mechanisms could be introduced. Instead of outright sale, farmers could pool land for urban development projects and receive a share of developed plots. This model, applied in Gujarat's Town Planning Schemes, ensures that farmers retain long-term stakes in urban expansion while preserving parts of their agricultural land.

3. Integrating Food Security Concerns into Land Use Policies - Food security challenges in Jodhpur are multi-dimensional. Surveys conducted between 2018–2021 show that 27% of peri-urban households face seasonal food shortages, while 8% experience severe food insecurity as per HFIAS (Household Food Insecurity Access Scale). Rising food prices, dependence on external supplies, and declining self-production worsen the situation.

To address this, food security must be explicitly integrated into land use policies. Urban planning in Jodhpur should include "food-sensitive land use planning", which prioritizes food production zones close to consumption centers. This could be achieved by earmarking peri-urban agriculture belts for vegetables, fruits, and dairy farming to serve the city population.

Moreover, urban food security can be strengthened through rooftop farming, community gardens, and kitchen gardens, reducing dependence on rural hinterlands. Cities like Bengaluru and Delhi have introduced pilot schemes for rooftop farming with positive results. In Jodhpur's semi-arid context, hydroponics and protected cultivation (poly-houses) could be promoted with technical and financial assistance from Rajasthan Horticulture Mission.

4. Role of Government Schemes, Technology, and Community Participation - Government interventions will be central to balancing urbanization with food security in Jodhpur. Several schemes already provide a foundation:

PMKSY (Pradhan Mantri Krishi Sinchai Yojana) supports micro-irrigation and rainwater harvesting, crucial in Jodhpur's low-rainfall setting (320–370 mm annually).

RKVY (Rashtriya Krishi Vikas Yojana) and National Food Security Mission (NFSM) can promote diversification into high-value crops and pulses.

MGNREGA could be expanded to include land and water conservation in peri-urban areas, creating jobs while strengthening agricultural sustainability.

Technology will also play a transformative role. Satellite-based Land Use Land Cover (LULC) mapping, combined with GIS, can help planners monitor urban sprawl and identify vulnerable agricultural zones in real time. Mobile-based decision support systems could deliver weather forecasts, market prices, and crop advisories directly to farmers.

Equally important is community participation. Farmer cooperatives, self-help groups, and local panchayats must be engaged in decision-making. Participatory land-use planning, where farmers are consulted before land acquisition or zoning decisions, increases compliance and reduces conflict. Case studies from peri-urban Hyderabad and Indore show that when farmers are involved in planning, both agricultural retention and urban growth are more sustainable.

- Urban planning must go beyond housing and infrastructure to include food security, water sustainability, and rural livelihoods.
- Legal and financial mechanisms to protect agricultural land are necessary to counteract market-driven land conversion.
- Food-sensitive urban policies can link peri-urban agriculture with city consumption needs, reducing dependency on external supplies.
- Government schemes and technology can help sustain agriculture in semi-arid conditions, but success depends on community-level participation.

The experience of Jodhpur shows that rapid urbanization, if left unregulated, can erode the agricultural foundation of semi-arid regions, threatening food security and rural livelihoods. However, with proactive policies—sustainable urban planning, land protection measures, food-sensitive policies, and integration of government schemes and technology—urban growth can be aligned with agricultural sustainability. Community participation remains the linchpin, ensuring that both farmers and city dwellers share in the benefits of balanced development.

Conclusion

The trajectory of Jodhpur district from 1960 to 2022 illustrates the complex relationship between rapid urbanization, agricultural land use change, and food security. Situated in Rajasthan's semi-arid zone, Jodhpur has always been ecologically fragile, dependent on erratic rainfall (average 320–370 mm annually) and limited irrigation infrastructure. Yet, despite these constraints, agriculture—dominated by pearl millet, wheat, pulses, and livestock—remained the backbone of rural livelihoods and a key contributor to regional food supply for decades. The last fifty years, however, have seen dramatic changes driven by population growth and unregulated urban expansion. Census data reveal that Jodhpur's population increased from 1.62 million in 1971 to nearly 3.69 million in 2011, with projections suggesting 4.85 million by 2025. More striking is the urban share of the population, which rose from 21.2% in 1971 to 43.1% in 2011. Remote sensing and GIS-based studies confirm that the district's built-up area expanded from 42 sq. km in 1990 to over 120 sq. km by 2020. Much of this growth occurred at the expense of fertile agricultural land in peri-urban regions such as Mandore, Luni, and Bhopalgarh. The conversion of agricultural land has been accompanied by fragmentation, soil degradation, and depletion of water resources. Net sown area in the district declined by 18% between 1990 and 2020, while irrigation expansion stagnated, leading to increased dependence on rainfed crops. Agricultural productivity per hectare declined in several blocks due to reduced landholding size and overuse of chemical inputs in areas closer to the city.

Food security assessments conducted between 2018–2021 highlight the growing vulnerability of rural households. Around 27% of surveyed households faced seasonal food shortages, while HFIAS scores revealed that 19% experienced moderate food insecurity and 8% faced severe insecurity. This is directly linked to reduced self-production, rising food prices in urban markets, and limited purchasing power among smallholders and landless laborers. The socio-economic consequences have been mixed. While some landowners who sold land for urban purposes benefitted financially, marginal farmers and agricultural laborers often faced displacement and livelihood insecurity. Women and older farmers, in particular, struggled to adapt to the shift toward urban-based employment opportunities. Livestock rearing, a traditional resilience mechanism in drought-prone regions, has also declined due to shrinking grazing land and water availability.

Comparisons with other districts in Rajasthan, such as Jaipur and Udaipur, highlight that while urbanization is a statewide phenomenon, its impact is more severe in Jodhpur because of its lower rainfall, fragile ecology, and reliance on subsistence farming. In Jaipur, better irrigation and higher rainfall cushion the effects of urban sprawl, while in Udaipur, though land is lost to tourism and mining, crop productivity remains relatively higher. In Jodhpur, by contrast, the conversion of even a small area of fertile land has disproportionately large implications for food security.

The case of Jodhpur demonstrates that urbanization and food security are not mutually exclusive, but without deliberate interventions, the balance tilts toward unsustainable outcomes. While urban growth offers economic opportunities, unchecked sprawl threatens the very foundation of rural livelihoods and food systems. Jodhpur's semi-arid ecology magnifies these risks, making proactive policy intervention a necessity rather than an option. In the long run, only an integrated approach—combining sustainable urban planning, agricultural resilience, food-sensitive policies, and active community participation—can ensure that Jodhpur evolves into a model of balanced development. Protecting agricultural land and safeguarding food security are not obstacles to urbanization but essential prerequisites for the district's inclusive and sustainable future.

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