MULTIDISCIPLINARY JOURNAL OF MANAGEMENT AND SOCIAL SCIENCES (MJMSS) VOL 3 NO. 1, 2026 (ISSN: 3043-6427; E-ISSN: 3043-6419),
Indexed in Google Scholar (Email: mjmss242@gmail.com) Nnamdi Azikiwe University, Awka, Nigeria

SPATIOTEMPORAL ANALYSIS OF RURAL DEPOPULATION AND AGRICULTURAL LAND-USE DYNAMICS IN ONDO WEST LOCAL GOVERNMENT AREA, NIGERIA

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Abstract
This study employs an integrative geospatial assessment to examine the spatial and temporal implications of rural depopulation on agricultural productivity in Igunshin, Ondo West Local Government Area, Ondo State, Nigeria. Land-use and land-cover (LULC) transitions were classified and analysed using multi-temporal Landsat datasets spanning 2000–2025, with advanced remote sensing and GIS techniques applied in ENVI 5.6 and ArcGIS Pro 3.0 environments. Supervised classification using the Maximum Likelihood Algorithm, supported by accuracy assessments exceeding 85%, enabled precise delineation of agricultural land, built-up areas, vegetation, and open spaces. The results reveal a significant decline in agricultural land, which decreased from 14.76 km² (13.01%) in 2000 to 7.27 km² (6.41%) in 2025, while vegetative cover increased from 52.78% to 79.80%. Built-up areas expanded modestly up to 2010 but declined sharply thereafter, indicating the spatial manifestation of rural depopulation. These dynamics highlight an inverse relationship between population decline and agricultural productivity, lending empirical support to the migration–productivity theoretical framework. The findings further indicate that sustained outmigration, an ageing rural population, and inadequate infrastructure development contribute to agrarian contraction and ecological reversion. The study concludes that agricultural productivity will continue to decline unless strategic rural revitalisation measures—such as youth agripreneurship promotion, infrastructure investment, and integrated land-use planning—are implemented. Overall, the study contributes to the broader discourse on rural spatial transformation in Sub-Saharan Africa by demonstrating the effectiveness of geospatial analytics in explaining the demographic determinants of agricultural sustainability.

Keywords: Geospatial analysis, rural depopulation, agricultural productivity, land-use dynamics, Ondo West, Nigeria.

Introduction

Rural areas are generally characterized by distinct physical, economic, and social features. Examples of these features are **low population density (usually below 400 persons per square kilometer), agricultural dominance (including farming, livestock rearing and fishing) (Ofuaku, 2012),** inadequate infrastructure, including poor roads, unreliable electricity, and limited access to healthcare and educational facilities (World Bank 2022), maintenance of traditional lifestyles and cultural practices with a strong sense of community and kinship, dependence on natural resources (including land, water, and forests, for subsistence and income generation) (FAO, 2021; Fasakin, 2018), reliance on manual labour and traditional methods for production, poor access to basic services like education, health care, higher poverty levels due to limited economic opportunities and low productivity. Rural depopulation in Nigeria has significant implications for agricultural productivity, food security, and sustainable development. The continuous decline in rural population due to urban migration has led to labor shortages, reduced crop yields, and decreased agricultural output (Adepoju, 2018; Olaleye, Ogunboye & Olanusi 2014; Olaniyan & Okunmadewa 2019).

People migrate from rural areas in search of greener pastures and better living condition majorly because of the existence of several opportunities and facilities (Awumbila, Owusu and Teye, 2014; Onyebueke and Geyer, 2011) which may not be present in rural areas. Migration is induced by both economic and non-economic reasons. People move sometimes to make a living or improve their economic status, sometimes the force exerted on the 'weaker" groups by the more "powerful" groups in search of better living makes it necessary for the weaker groups to migrate.

A migrant's decision to move may boil down to a desire to escape from economic hardships and discrimination, desire to secure freedom from political or religious oppression, a desire for freedom from personal maladjustments to family and community life and military or national considerations (Olaleye, 2023). Sometimes migration may not be triggered by gain but by a need for self-preservation in the face of persecution. The causes of migration

may be summarized as absolute poverty, the destruction of the established economic equilibrium, repulsive/attractive causes and psychological motives.

Rural depopulation refers to the decline in population within rural areas, primarily due to out-migration. This phenomenon has been observed in various regions worldwide and is influenced by multiple factors. Advancements in agricultural technology have reduced the need for labour in rural areas, leading to fewer employment opportunities (Ikwuyatum, 2006). Consequently, individuals migrate to urban centers in search of better job prospects. Urban areas often offer improved access to education, healthcare, and other essential services, attracting rural inhabitants seeking a higher quality of life. The migration of younger populations to urban areas results in an aging rural demographic. This shift leads to higher mortality rates and lower birth rates, further accelerating depopulation.

Agricultural productivity in Nigeria is influenced by various factors including climate change/variability (Adejuwon, 2004; Enete & Amusa, 2010); soil degradation (erosion, nutrient depletion, and poor land management practices (Lal, 2007; Ogundele., 2018); inadequate access to improved seeds, fertilizers, and irrigation facilities (Akinwumi, 2011), inadequate rural infrastructure (roads, storage facilities, and markets (Adepoju, 2018; Oluwasegun & Ojo, 2018) and rural-urban migration and ageing farming population (Olaniyan & Okunmadewa, 2019; Afolabi et al., 2022).

Recent studies (2020-2025) on rural depopulation in Nigeria highlight a critical, ongoing shift of the population toward urban centers, driven by infrastructure deficits, insecurity, and agricultural decline. This trend is characterized by a "youth flight" that leaves behind an aging population, causing agricultural labor shortages and weakening rural economies (Obilor, N. M., Amadi, F. U., & Ahamefula, G. C. (2024); Adam O.B, Enemi A.G , Zakari M. (2024).

Rural depopulation has been a persistent issue in Nigeria, with significant implications for agricultural productivity. Studies have shown that rural-urban migration leads to a decline in agricultural labour, resulting in reduced productivity and food insecurity (Afolabi, 2022; NBS, 2020). Some of the causes of rural depopulation include lack of employment opportunities, poor infrastructure, and limited access to credit (Oluwasegun & Ojo, 2018), desire for better education, healthcare, and living standards, climate change, land degradation, and natural disasters. A decline in the number of people who live and are actively involved in economic activities in rural areas may lead to reduced agricultural productivity due to lack of labour (Afolabi, 2022), aging population (decline in working population) and limited youth involvement in agriculture (NBS, 2020); unused arable land and reduced agricultural output.

Statement of the problem

The rural population in Nigeria has been declining, with a growth rate of 1.11% in 2010 and 0.94% in 2020. This trend is linked to increased urbanization and migration of young adults to cities, leaving agriculture in the hands of the elderly and resulting in labor shortages, reduced crop yields, and decreased food production. The persistent nature of rural-urban migration in Ondo West LGA, Nigeria, has led to a significant decline in rural population, resulting in a shortage of labour and decreased agricultural productivity. This trend threatens food security, livelihoods, and sustainable development in the region. Rural depopulation has been a persistent issue in Nigeria, with significant implications for agricultural productivity (Adepoju, 2018; Olaniyan & Okunmadewa, 2019). Ondo West LGA, a predominantly rural area, has experienced substantial out-migration of young people, leading to a decline in agricultural labour and productivity (Ondo State Government, 2020). Despite efforts to boost agricultural production, the impact of rural depopulation on agricultural productivity remains understudied, making it challenging to develop effective strategies to address this issue. This study aims to investigate the spatiotemporal effects of rural depopulation on agricultural productivity in Ondo West LGA, Nigeria. This study is necessary as there exist limited studies on spatiotemporal analysis of rural depopulation effects on agricultural productivity in Nigeria, there is also the need for location-specific studies to inform policy interventions

Significance of the Study

Understanding the spatio-temporal dynamics of rural depopulation and its effects on agricultural productivity is crucial for developing effective policies and strategies to promote rural development, improve agricultural productivity, and ensure food security in Nigeria. This study has significant implications for policy, practice, and future research. Findings will inform government policies on rural development, agriculture, and migration management and an understanding of depopulation's impact on productivity can guide interventions to boost agricultural output and food security. The outcome of the study can shape strategies to improve rural livelihoods and infrastructure and the findings of the research will add to existing literature on migration, rural depopulation and agricultural productivity in Nigeria.

Aim and Objectives

The aim of this study is to analyze the spatiotemporal effects of rural depopulation on agricultural productivity in Nigeria. The specific objectives are:

1. To analyze the spatiotemporal dynamics of rural depopulation in Ondo West Local Government between 2000 and 2025.
2. To assess the effects of rural depopulation on agricultural productivity, land-use pattern and rural livelihoods.

Research Questions

1. What are the spatiotemporal trends of rural depopulation in Ondo West LGA between 2000 and 2025?
2. How has rural depopulation affected agricultural productivity in Ondo West LGA?
3. How does the spatial distribution of agricultural productivity relate to population decline in rural areas?

Study Area

Ondo West LGA is located in Ondo State, southwestern Nigeria, within the tropical rainforest zone (Ondo State Government, 2020). The area lies between latitudes 7°5'N and 7°15'N, and longitudes 4°30'E and 4°45'E, covering approximately 1,500 km² (Ogundele et al., 2018). It enjoys the tropical climate with high temperatures (24°C-32°C) and rainfall (1,500-2,000 mm annually) (Ondo State Government, 2020). It is situated within the Tropical rainforest with dense forest cover and high biodiversity. Situated on a gently undulating terrain with elevations ranging from 50-200 meters above sea level; the population, according to the 2006 Census, is 283, 672. There are 141, 759 males and 147, 109 females. The population density of the area under study is 481.4/ km^2. (Olaleye, 2023; NBS, 2022).

Ondo West LGA is a significant agricultural hub, with major crops including cocoa, palm oil, and cassava. Farming is the most prevalent livelihood activity of the people of Ondo West Local Government Area, and it offers income and job possibilities for a considerable proportion of its population. Palm fruit, cocoa, and lumber are among the major commercial crops grown in the state. Other livelihood activities available to female migrants in rural areas include cultivation, trading, garri processing, palm oil production, fruit gathering, food gathering, lumbering, hawking, basket weaving, wood fetching, cloth weaving among many others. Ondo State is the largest cocoa producer in Nigeria, accounting for over 40% of the country's cocoa export.

Theoretical Framework: Push-Pull Theory (Lee, 1966)

This provides a suitable framework for studying rural depopulation and its effects on agricultural productivity. This theory explains migration as a result of push factors (e.g., lack of opportunities, poverty) and pulls factors (e.g., better living standards, employment opportunities). The theory is relevant to the study as rural areas in the study area may be experiencing push factors such as: limited access to credit and markets, poor infrastructure (e.g., roads, healthcare), climate change and environmental degradation. The residents in rural areas hear and see pull factors in urban areas which may serve as attractions to migrants. Such pull factors include better employment/ livelihood opportunities, improved living standards, access to education and healthcare. The interplay between push and pull factors results in shortage of labour in rural/agricultural areas, reduction in population and agricultural productivity, food insecurity and so on. The theory serves as a framework in analyzing:

(a) how push and pull factors contribute to rural depopulation in Ondo West LGA
(b) the impact of migration on agricultural productivity and food security
(c) strategies to mitigate the effects of depopulation on agriculture

Research Methodology

This study adopts a spatio-temporal research design, combining geospatial analysis, remote sensing, and statistical correlation methods to evaluate the effect of rural depopulation on agricultural productivity in Ondo West Local Government Area (LGA). The design enables both temporal tracking (2000–2025) and spatial distribution mapping of land-use and land-cover (LULC) changes in Igunshin, a representative rural community. Data for this study were derived from primary and secondary sources. Multi-temporal Landsat datasets were utilized to map LULC changes at five-year intervals between 2000 and 2025. The imagery sources include: Landsat 7 ETM+ (2000, 2005, and 2010), Landsat 8 OLI/TIRS (2015, 2020), Landsat 9 OLI-2 (2025 projection). Each image was selected based on minimal cloud cover (<10%) and similar seasonal periods to ensure comparability.

Pre-processing was performed using ENVI 5.6 and ArcGIS Pro 3.0, including radiometric calibration, geometric correction, and atmospheric correction using the Dark Object Subtraction (DOS) method. All images were co-registered to UTM Zone 31N, WGS84 datum, to ensure spatial uniformity. A supervised classification approach using the Maximum Likelihood Algorithm (MLA) was employed to categorize each image into four primary LULC classes: Agricultural Land, Built-Up Area, Open Space, and Vegetation.

Accuracy assessment was conducted using confusion matrices and kappa statistics, achieving classification accuracies above 85% for all years. Change detection analysis was then carried out using the Post-Classification Comparison technique to compute area and percentage changes between temporal layers (2000–2005, 2005–2010, etc.). Temporal dynamics of LULC were examined using cross-tabulation matrices and annual rate of change formulas. The Land Use Transition Matrix (LUTM) was generated to quantify conversions among categories.

Results and Discussion

The spatio-temporal assessment of land use and land cover (LULC) dynamics in the study area between 2000 and 2025 as shown in Figure 1 provides significant insights into the changing rural landscape and its implications for agricultural productivity. The longitudinal data reveal a marked decline in agricultural land from 14.76 km² (13.01%) in 2000 to 7.27 km² (6.41%) in 2025, a reduction of nearly 50% over 25 years. This trend coincides with a concurrent increase in vegetative cover from 52.78% in 2000 to 79.80% in 2025, and a fluctuating built-up area that peaked at 7.95 km² in 2010 before contracting to 2.23 km² by 2025. These spatial transformations point to the intertwined processes of rural depopulation, land abandonment, and agricultural regression, reflecting broader demographic and socio-economic changes in rural Nigeria (Adewumi & Fasona, 2022; Nwankwo *et al.*, 2021).
The observed decline in agricultural land use corresponds with the theory of rural outmigration and land transition, where population movements from rural to urban centers lead to the abandonment of farmland and a subsequent natural re-vegetation process (Müller et al., 2020). In the study area, the return of vegetation over former croplands signifies a reversal of anthropogenic land pressure, consistent with findings from similar studies in southwestern Nigeria and sub-Saharan Africa (Oluwatayo & Adebayo, 2023; Adepoju *et al.*, 2020). These changes are not merely ecological but are emblematic of rural depopulation's demographic signature, where declining rural population density diminishes the human labor base necessary to sustain agricultural productivity.

The decline of agricultural land from 13.01% in 2000 to 6.41% in 2025 as revealed in Table 1 to Table to Table 6 underscores a fundamental restructuring of rural livelihoods in the study area. This contraction aligns with the increasing pace of rural depopulation driven by youth migration, aging rural populations, and urban attraction (FAO, 2021; Okafor & Eze, 2022). As young people migrate to urban centers like Akure and Lagos in search of employment and education, the agricultural workforce diminishes, leading to a fall in the intensity of cultivation and abandonment of marginal lands.

This dynamic has been widely observed across rural Africa, where outmigration often results in decreased labor availability, fallowing, and reduced agricultural output (World Bank, 2022). In the case of the study area, the sharp decline between 2000 and 2010 where agricultural land decreased from 13.01% to 4.92% correlates strongly with Nigeria's early 2000s rural–urban migration boom. The process corresponds with push–pull migration theory, which attributes depopulation to push factors such as rural poverty, low infrastructure, and declining farm profitability, juxtaposed with pull factors such as urban wage opportunities and social amenities (Todaro & Smith, 2015).

Moreover, the temporal pattern of agricultural decline reveals that the depopulation effect is non-linear. The slight recovery in agricultural land between 2015 and 2020 (from 5.82% to 6.78%) could reflect temporary policy interventions or remittance-driven agricultural reinvestments (Oyinbo & Rekwot, 2022). However, the subsequent drop to 6.41% in 2025 confirms that these recoveries are unsustainable without structural reinvigoration of the rural economy.

The expansion of vegetative cover from 52.78% in 2000 to 79.80% in 2025 represents a paradox in land use transition: environmental regeneration amid socio-economic decline. While vegetation recovery can signal ecological resilience, in this context, it reflects agricultural land abandonment due to depopulation. This trend aligns with findings by Lasisi and Oduro (2021), who observed that rural population decline often facilitates secondary forest growth as agricultural plots revert to natural vegetation.

In the study area, the temporal shifts in vegetation are particularly telling. Between 2010 and 2015, vegetation decreased from 75.47% to 66.77%, likely due to short-term reoccupation of land for cultivation or infrastructural expansion. However, by 2025, vegetation rebounded dramatically to 79.80%, suggesting sustained depopulation and permanent withdrawal from farming activities. Similar dynamics have been documented in Eastern Europe and East Asia, where post-agricultural landscapes are dominated by natural reforestation following rural exodus (Liu *et al.*, 2020; Estel *et al.*, 2015).

This re-vegetation process also signifies a decline in agricultural productivity, as active farmland contracts while idle land expands. Agricultural productivity, traditionally measured in yield per hectare, becomes constrained not only by land area but also by labor scarcity and reduced capital investment (Adeyemi & Ologunde, 2024). Thus,

vegetation expansion in this context is not a marker of environmental sustainability, but a symptom of socioeconomic withdrawal and demographic hollowing.

The fluctuations in built-up land rising from 5.75% in 2000 to a peak of 7.00% in 2010 before declining to 1.97% in 2025 offer critical insight into the spatial signature of rural depopulation. Initially, the increase in built-up areas reflects rural modernization and population concentration, possibly linked to localize development or housing expansion. However, the subsequent decline indicates population outflow and structural decay of rural settlements.

This pattern aligns with the rural contraction model proposed by Li *et al.* (2019), which describes the gradual physical shrinking of rural spaces as populations migrate and local economies disintegrate. In the rural settlements of Ondo West LGA, the decrease in built-up land post-2010 likely reflects abandonment of housing units and reabsorption of built environments by vegetation, confirming a spatial manifestation of depopulation.
Furthermore, this trend resonates with the theory of rural spatial transformation (Long *et al*., 2021), where depopulation leads to the reconfiguration of rural land use hierarchy from active agricultural and residential functions toward passive ecological states. The diminishing built-up footprint in the study area thus represents the material consequence of demographic transition, corroborated by both spatial data and migration trends within Ondo West LGA.

The changing pattern of open space, which fluctuated between 28.45% in 2000 and 11.82% in 2025, mirrors the oscillating phases of agricultural land contraction and vegetative expansion. Open spaces in rural LULC contexts often serve as buffers between agricultural and residential zones, and their reduction indicates the compression of multifunctional rural landscapes (Akinyemi *et al*., 2023).

The most notable contraction occurred between 2010 and 2025, where open space declined by over 10 percentage points. This suggests encroachment by vegetation and reduced communal land utilization, often associated with the disappearance of local social functions such as grazing, markets, and communal farming (Edeh & Nwachukwu, 2021). In the context of rural depopulation, this transition signals a loss of social capital and collective land management practices, both of which are critical to maintaining agricultural productivity.

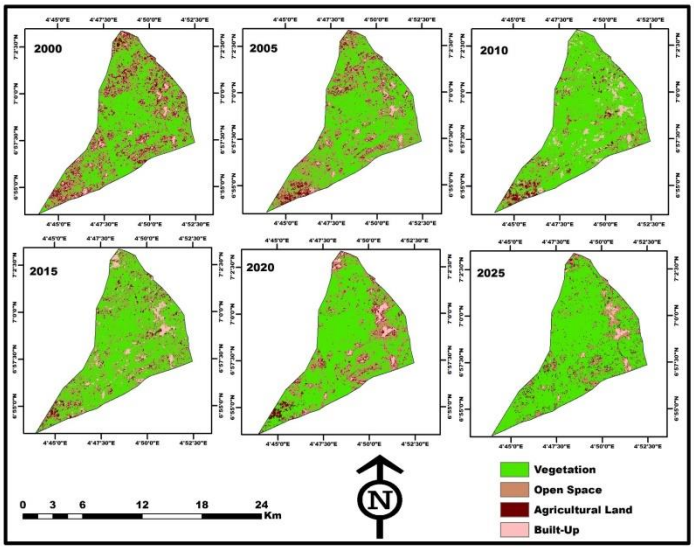

Figure 1: Land Use Land Cover Change from 2000 to 2025
Source: Author's Analysis, 2026

Table 1: Igunshin Land Use Land Cover for 2000

Class Name	Area (sq. km)	%
Agricultural Land	14.76	13.01
Built-Up	6.52	5.75
Open Space	32.27	28.45
Vegetation	59.87	52.78
Total	**113.42**	**100**

Source: Author's Analysis, 2026

Table 2: **Igunshin Land Use Land Cover for 2005**

Class Name	Area (sq. km)	%
Agricultural Land	9.41	8.29
Built-Up	4.99	4.40
Open Space	31.62	27.88
Vegetation	67.41	59.43
Total	**113.42**	**100**

Source: Author's Analysis, 2026

Table 3: **Igunshin Land Use Land Cover for 2010**

Class Name	Area (sq. km)	%
Agricultural Land	5.58	4.92
Built-Up	7.95	7.00
Open Space	14.29	12.60
Vegetation	85.59	75.47
Total	**113.42**	**100**

Source: Author's Analysis, 2026

Table 4: **Igunshin Land Use Land Cover Change for 2015**

Class Name	Area (sq. km)	%
Agricultural Land	6.60	5.82
Built-Up	7.33	6.46
Open Space	23.75	20.94
Vegetation	75.74	66.77
Total	**113.42**	**100**

Source: Author's Analysis, 2026

Table 5: **Igunshin Land Use Land Cover Change for 2020**

Class Name	Area (sq. km)	%
Agricultural Land	7.69	6.78
Built-Up	4.65	4.10
Open Space	23.94	21.11
Vegetation	77.14	68.01
Total	**113.42**	**100**

Source: Author's Analysis, 2026

Table 6: **Igunshin Land Use Land Cover Change for 2025**

Class Name	Area (sq. km)	%
Agricultural Land	7.27	6.41
Built-Up	2.23	1.97
Open Space	13.41	11.82
Vegetation	90.51	79.80
Total	**113.42**	**100**

Source: Author's Analysis, 2026

Conclusion

Implications for Agricultural Productivity

The empirical evidence from the study area underscores a direct and negative relationship between rural depopulation and agricultural productivity. As the rural population diminishes, agricultural land use shrinks, labor availability declines, and productivity per unit of land falters. This relationship aligns with the agricultural labor theory of productivity, which posits that sustained productivity depends on the balance between land availability and effective labor utilization (Hayami & Ruttan, 1985; Olayide *et al.*, 2018).

In the case of the study area, the near-halving of agricultural land correlates with national data showing declining smallholder productivity and increasing food import dependency (NBS, 2022). Moreover, depopulation not only reduces the physical input of labor but also undermines the social structures that sustain agricultural innovation and cooperative production, such as farmer associations and knowledge exchange networks (Adesina & Ojo, 2020).

The consequences are multifaceted. First, the contraction of cultivated land results in declining output and farm incomes, exacerbating poverty traps and reinforcing the migration cycle. Second, the abandonment of marginal land fosters land degradation and biodiversity shifts, as natural succession processes alter soil nutrient cycles. Third, declining rural population densities weaken local markets, making it less viable for remaining farmers to commercialize production. Collectively, these processes create a negative feedback loop, where depopulation fuels low productivity, which in turn drives further outmigration; a pattern consistent with findings by Barrios *et al.* (2006) and Tacoli (2019).

The spatio-temporal dynamics observed in the study area reflect a broader regional phenomenon across southwestern Nigeria, where rural communities are experiencing demographic contraction, agricultural de-intensification, and ecological reversion (Fasona & Omojola, 2022). Studies in Ekiti, Osun, and Oyo States have documented similar land-use transitions, with agricultural areas declining by 30–60% over the past two decades (Akinbile *et al*., 2023). This regional pattern suggests that the area's trajectory is not isolated but part of a systemic shift in rural spatial organization influenced by national economic restructuring and urban bias in policy (Egbetokun & Fashola, 2021).

The expansion of vegetation and decline of built-up land mirror the African "green return" phenomenon, where rural outmigration indirectly leads to reforestation (Van Vliet *et al.*, 2020). While this trend offers ecological benefits such as carbon sequestration and habitat restoration, it simultaneously reveals a collapse in rural production systems and the disintegration of agrarian livelihoods.

Policy and Theoretical Implications

The findings from the study area's LULC data bear significant theoretical and policy implications. Theoretically, they reinforce the land-use transition framework (Lambin & Meyfroidt, 2010), which posits that economic and demographic transitions drive shifts from agricultural expansion to land abandonment and ecological recovery. The observed trends also extend the rural depopulation and productivity nexus, highlighting how demographic decline not only reduces agricultural output but also reshapes spatial structures and ecological balances.

From a policy perspective, the evidence points to an urgent need for rural revitalization strategies that can counteract depopulation and sustain agricultural productivity. These include:

- Youth re-engagement in agriculture through agripreneurship programs and mechanization incentives.
- Rural infrastructure investment—particularly roads, power, and digital connectivity to make farming more viable.

- Land-use planning frameworks that balance ecological conservation with agricultural reclamation.
- Population retention policies that improve rural living standards and discourage outmigration (Olaniyan & Ajibade, 2022).
- The restoration of agricultural productivity in depopulated areas like Igunshin requires not merely technical interventions but socio-demographic reinvestment, ensuring that human capital returns to the land.

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