

THE IMPACT OF URBAN EXPANSION ON AGRICULTURAL ACTIVITIES IN GIDAN KWANO COMMUNITY MINNA NIGER STATE

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Abstract

This study examines the impact of urban expansion on agricultural activities in the Gidan Kwano community, Minna, Niger State, Nigeria. As urbanization increasingly encroaches upon rural areas, understanding its effects on agricultural livelihoods becomes critical for sustainable development planning. Agriculture remains the primary economic activity for most rural communities in Nigeria, yet rapid urban growth threatens this vital sector. This research evaluates how infrastructural development and residential construction have transformed land use patterns and affected the agricultural economy in this peri-urban community.

The study employed a mixed-methods approach combining spatial analysis and field surveys. Geographic Information Systems (GIS) and remote sensing techniques were utilized to map land use changes over a 12-year period (2012-2024), while structured questionnaires and interviews captured primary data from 126 farmers and residents regarding their experiences and perceptions of urbanization impacts.

Results indicate substantial agricultural land conversion, with 91% of respondents reporting farmland loss to non-agricultural development. This transformation has significantly reduced agricultural productivity, with 92% of participants experiencing moderate to severe output declines. Spatial analysis confirmed a marked decrease in cultivated areas, with agricultural land shrinking by approximately 35% during the study period. The socio-economic consequences include farmer displacement, increased poverty levels, and rising unemployment within the agricultural sector. While infrastructural improvements have enhanced market accessibility and connectivity, these benefits are overshadowed by threats to food security and rural livelihood sustainability.

The findings underscore the urgent need for integrated land use planning that balances urban growth with agricultural land preservation. Policymakers must develop comprehensive strategies to mitigate the adverse effects of urbanization on rural communities while ensuring sustainable food production systems and protecting farmer livelihoods.

KEYWORDS: Urban expansion, agricultural land conversion, land use change, GIS and remote sensing, rural livelihoods, food security.

1. INTRODUCTION

1.1 Background to the study

Agriculture remains a cornerstone of many economies, particularly in rural areas where it is often the primary source of livelihood. In Nigeria, agriculture significantly contributes to the gross domestic product (GDP) and employs a large percentage of the population (NBS, 2020). Gidan Kwano, a community in Niger State, exemplifies many rural Nigerian communities where agriculture is integral to economic and social life.

Urban expansion refers to the outward growth of urban areas as they extend beyond their initial boundaries, transforming previously non-urban land into built environments. This process is driven primarily by population growth and economic development (Seto et al., 2011). The spatial enlargement of cities through the conversion of rural and natural landscapes into urban built environments represents one of the most significant land-use transitions globally (Balk et al., 2018).

However, the relationship between urban expansion and agricultural production is complex and multifaceted. While improved infrastructure can increase productivity and improve farmers' incomes, physical development can also lead to the displacement of agricultural land, alter traditional farming practices, and have adverse effects on productivity (FAO, 2017).

In Gidan Kwano, recent physical development projects aimed at improving agricultural outputs and quality of life have been met with mixed reactions from the community. The surge in physical development projects, including infrastructure, housing, educational institutions, and commercial ventures, presents both opportunities and challenges for the agricultural sector. This research aims to examine the specific impacts of physical development on agricultural production in Gidan Kwano communities, bridging the knowledge gap by investigating land-use changes, analyzing agricultural practices, and assessing environmental implications.

2. METHODOLOGY

2.1 Study Area

The study area is Gidan Kwano Community, located in Minna, Niger State, Nigeria. This community has experienced significant physical development due to the establishment of the Federal University of Technology, Minna, and serves as an exemplar of peri-urban communities facing rapid urbanization pressures.

2.2 Research Design

This study adopted a mixed-methods approach, combining both qualitative and quantitative research methods to provide a comprehensive analysis of the research problem. The integration of spatial analysis techniques with field surveys enabled triangulation of data sources and validation of findings.

2.3 Sample Size and Sampling Technique

The population for this study included farmers, local residents, and traders in Gidan Kwano Community. A sample size of 126 respondents was calculated using Cochran's formula for simple random sampling with a 95% confidence level, 8% margin of error, and estimated proportion of 0.3. Stratified random sampling was employed to ensure representation across different farming categories: subsistence farming, commercial farming, intensive farming, and extensive farming.

2.4 Data Collection

Primary data were collected through structured questionnaires administered to the selected sample, focusing on land use changes, agricultural productivity, and socio-economic impacts. Likert scale questions were predominantly used to facilitate quantitative analysis. Secondary data were obtained from document analysis, including land use plans, development reports, and academic studies.

Spatial analysis was conducted using Geographic Information Systems (GIS) and remote sensing techniques. Satellite imagery for the years 2012, 2018, and 2024 was acquired from Google Earth. Field surveys were conducted to collect geographic coordinates for ground-truthing. The satellite images were georeferenced using ArcGIS Pro 4.1, and land cover classifications were digitized into categories including developed areas, agricultural land, drainage systems, and vegetation.

2.5 Data Analysis

Quantitative data were analyzed using descriptive statistics (mean, median, standard deviation) and inferential statistics (t-tests and chi-square tests) to identify significant differences and relationships between variables. Qualitative data from documents were analyzed thematically to identify key patterns related to land use and development policies. Spatial data were analyzed to track land use and land cover (LULC) changes over the 12-year period, with particular attention to the conversion of agricultural land to developed areas.

3. RESULTS

3.1 Spatial Analysis of Land Use Changes

The spatial analysis revealed significant transformations in land use patterns between 2012 and 2024. In 2012, agricultural land covered 8.57 km² (59% of total area), while developed areas occupied only 1.09 km² (5%). By 2018, agricultural land had decreased to 12.38 km² (48%), while developed areas expanded to 1.21 km² (17%). The trend continued through 2024, with agricultural land further declining to 10.62 km² (40%) and developed areas increasing to 2.32 km² (22%).

Overall, the 12-year period witnessed a total increase in developed areas of 1.23 km² (more than 100% expansion) and a corresponding decrease in agricultural land of 2.03 km² (representing a 19% loss). This represents a significant shift from an agriculturally-dominated landscape to an increasingly urbanized environment.

Sattelite Imaery**Years**



2012



2018

Sattelite Imaery

Years



2024

Source: google map

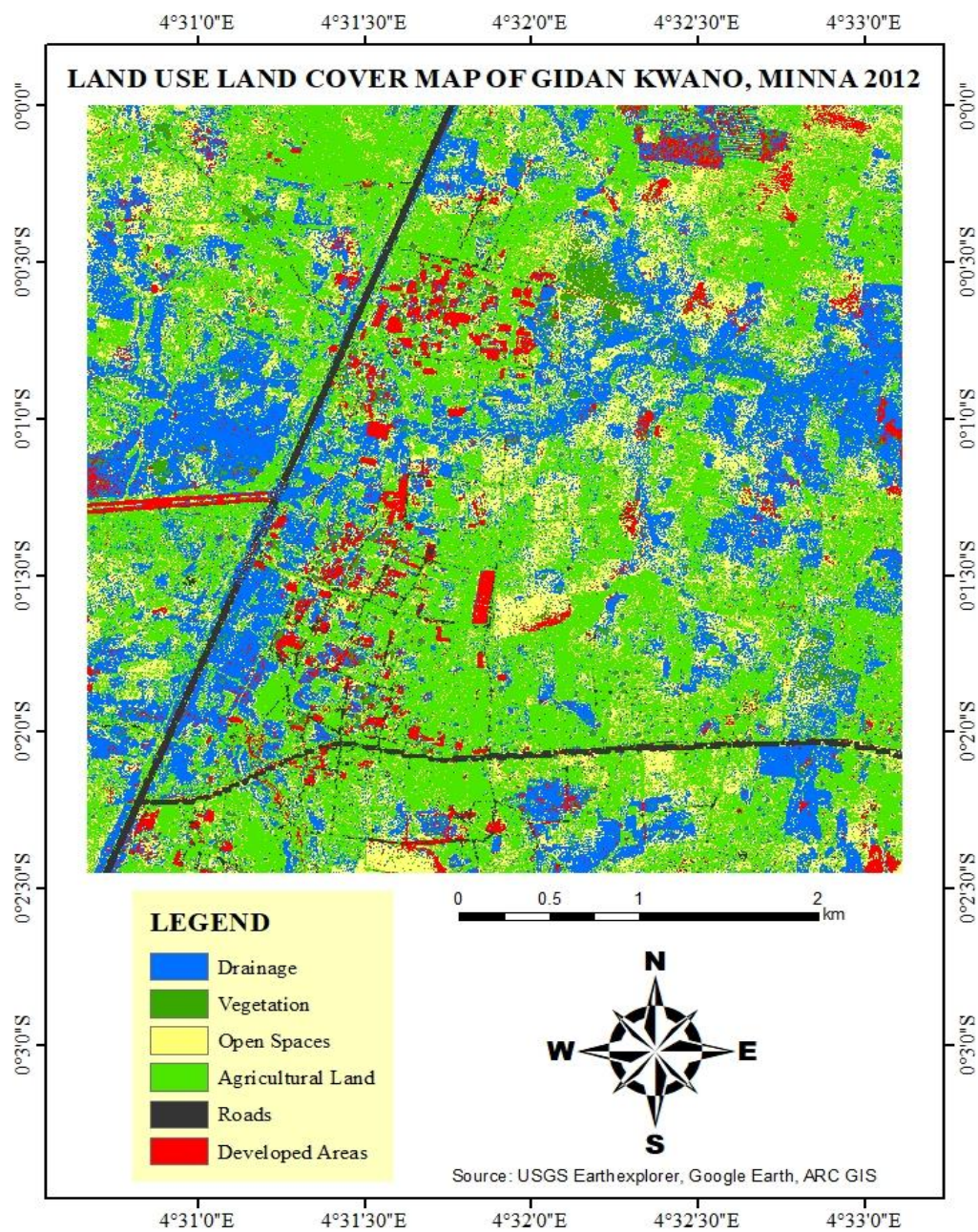


Figure 4.0 LULC Map of Gidan Kwano, Minna 2012.

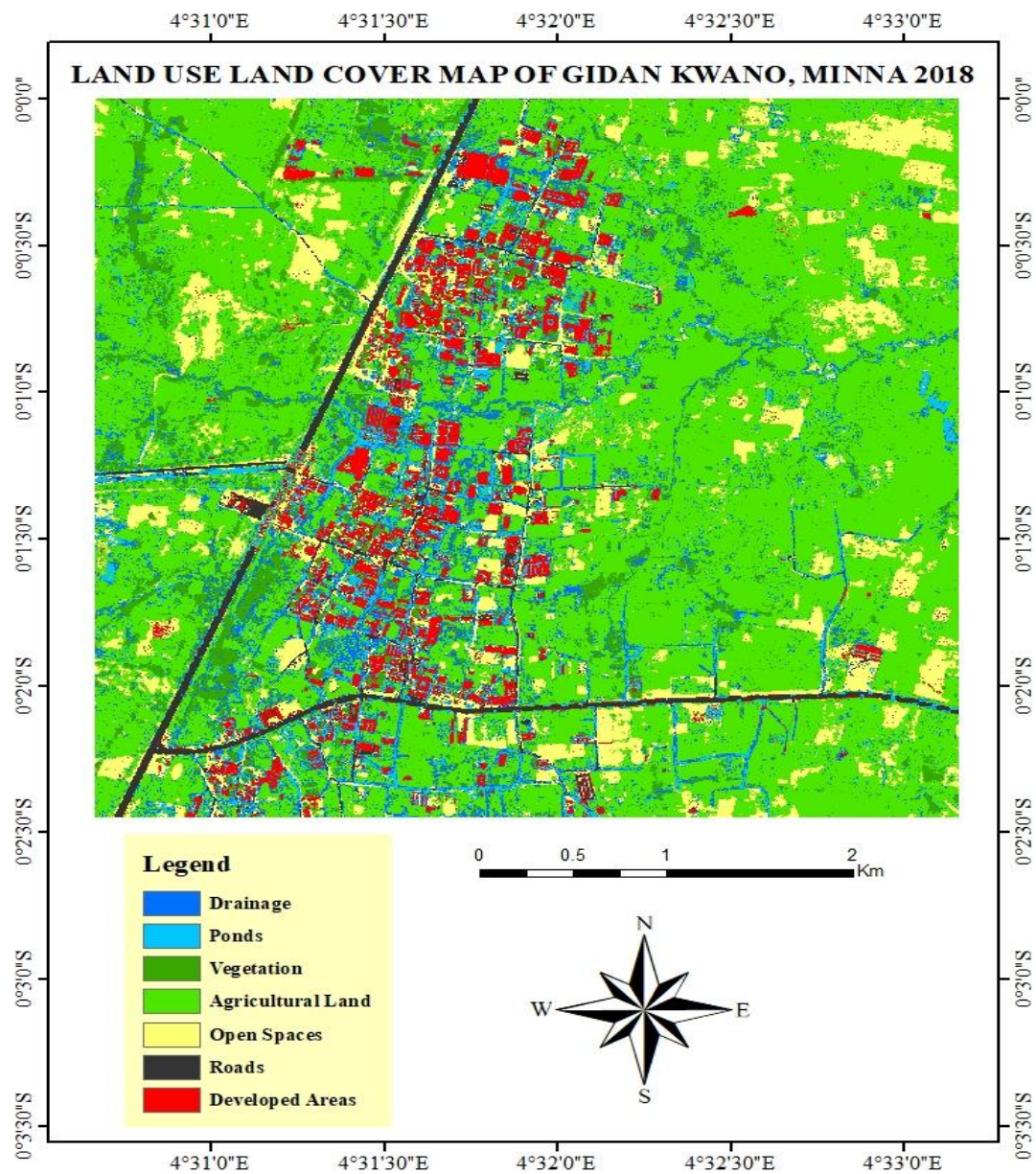


Figure 4.1 Showing the LULC Map of Gidan Kwano, Minna 2018.

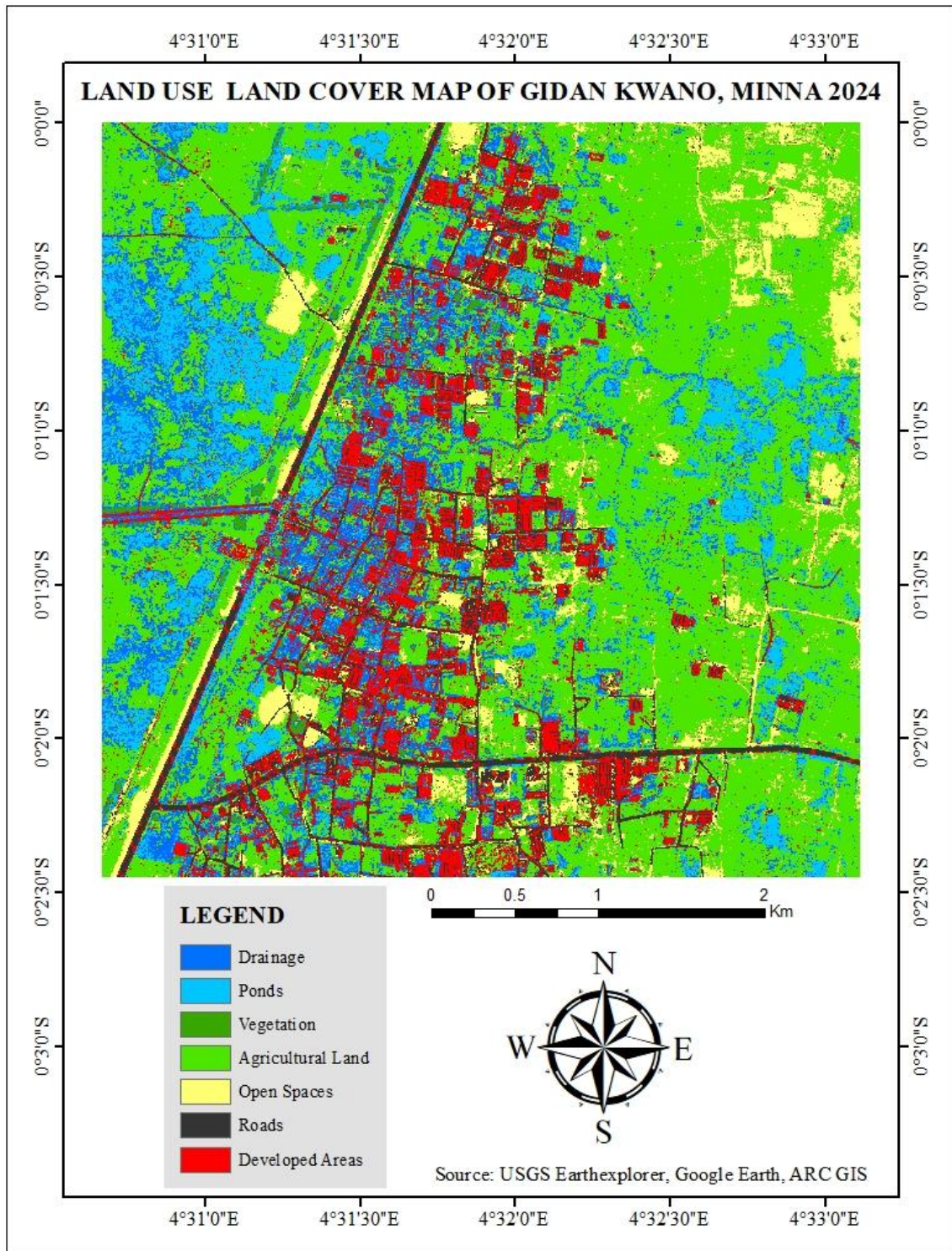


Figure 4.2 Showing the LULC Map of Gidan Kwano, Minna 2024.

Table 1: Land Use and Land Cover Changes (2012-2024)

Year	Developed Areas	Agricultural Land
2012	1.09 km ² (5%)	8.57 km ² (59%)
2018	1.21 km ² (17%)	12.38 km ² (48%)
2024	2.32 km ² (22%)	10.62 km ² (40%)

3.2 Factors Driving Urban Expansion

Survey results identified residential housing as the predominant type of development replacing agricultural lands, with 100% of respondents indicating this as a primary driver. Commercial buildings were identified by 42% of respondents as another significant factor. Additionally, 78% of respondents perceived that the pace of physical development was proceeding too rapidly, suggesting widespread concern about the rate of urbanization.

3.3 Impact on Agricultural Land Availability

The impact on farmland availability was substantial, with 96% of respondents reporting significant reductions in available farmland over the past five years, while 4% noticed slight reductions. No respondents reported an absence of change. Furthermore, 91% of respondents indicated that their personal farmlands had been converted to non-agricultural uses within the past decade, demonstrating that the majority of farmers in the community have been directly affected by land use changes.

3.4 Agricultural Productivity Impacts

The conversion of agricultural land had severe consequences for agricultural output. Survey data revealed that 50% of respondents reported significantly reduced agricultural output, while 42% experienced moderate reductions. Only 6% reported no significant impact, and 2% found the question not applicable to their situation. Cumulatively, 92% of respondents experienced either moderate or significant declines in agricultural productivity, indicating a widespread and substantial negative impact on the agricultural sector.

3.5 Socio-Economic Impacts

The socio-economic consequences of agricultural land loss were pronounced. Regarding income sources, 54% of respondents continued to rely primarily on farming, while 36% had transitioned to the service sector, and 10% had found work in construction or labor. This diversification reflects both necessity and opportunity in the face of declining agricultural prospects.

The impact on household income was predominantly negative, with 60% of respondents reporting decreased household income, while 40% experienced no significant change. Notably, 100% of respondents reported experiencing changes in the cost of living, particularly increased food prices, due to reduced agricultural activities. This unanimous response underscores the community-wide economic impact of agricultural land conversion.

Concerning long-term consequences, respondents identified several critical issues: decline in food production (78%), increased poverty and unemployment (55%), and loss of cultural heritage (71%). These concerns highlight the interconnected nature of agricultural, economic, and cultural dimensions of community life.

4. DISCUSSION

4.1 Interpretation of Spatial Changes

The spatial analysis reveals a clear pattern of urban expansion encroaching upon agricultural lands in Gidan Kwano. The transformation from 59% agricultural coverage in 2012 to 40% in 2024 represents a fundamental shift in the community's landscape and economic structure. This pattern is consistent with urban expansion trends observed in other Nigerian cities, including Lagos, Abuja, and Ibadan, where similar conversions of peri-urban agricultural lands have been documented (Adelekan, 2016; Fanan et al., 2011).

The establishment of the Federal University of Technology, Minna, appears to have served as a growth pole, as conceptualized in Perroux's (1950) Growth Pole Theory. While this has stimulated economic development and infrastructure improvement, it has simultaneously created pressures that have displaced traditional agricultural activities. The concentration of development activity in the initial period (2012-2018) suggests a rapid response to institutional establishment, followed by continued but somewhat slower expansion in the subsequent period (2018-2024).

4.2 Agricultural Productivity Decline

92% of respondents reflects not merely the quantitative loss of farmland but also qualitative changes in farming conditions. As farmers are displaced to marginal lands or forced to cultivate smaller plots, economies of scale are lost, traditional farming systems are disrupted, and access to resources becomes more limited. This finding aligns with research by Lambin and Meyfroidt (2011), who documented that land use changes lead to fragmentation of agricultural landscapes and reduced productivity.

The permanence of agricultural land conversion presents a critical challenge. Unlike temporary disruptions, the transformation to urban uses is effectively irreversible, as agricultural lands once paved over cannot easily be restored to productive farming. This irreversibility underscores the need for proactive land use planning rather than reactive measures.

4.3 Socio-Economic Transformations

The diversification of income sources observed in the community represents both adaptation and necessity. While 54% of respondents continue to rely on farming, the fact that 46% have sought alternative livelihoods indicates significant economic restructuring. This transition, however, has not been uniformly beneficial. The 60% reporting decreased household income suggests that alternative employment has not adequately compensated for lost agricultural income for many households.

The universal experience of increased cost of living, particularly food prices, creates a paradox: as the community becomes less agricultural, it becomes more dependent on external food sources, leading to increased vulnerability and reduced food security. This finding resonates with concerns raised by Satterthwaite et al. (2010) regarding the food security implications of peri-urban agricultural land loss.

4.4 Positive Aspects of Development

Despite the predominantly negative impacts on agriculture, the study acknowledges positive developments. Improved infrastructure has enhanced market access, educational facilities have increased, and healthcare services have become more accessible. These improvements represent genuine gains in quality of life and development. However, the critical question is whether these benefits justify the costs, particularly given the threats to food security and agricultural livelihoods.

The challenge lies in achieving a more balanced development approach that preserves agricultural viability while accommodating necessary growth. As demonstrated by case studies from Nairobi and other rapidly urbanizing areas, infrastructure development need not come at the complete expense of agriculture if proper planning mechanisms are in place (UN-Habitat, 2014).

4.5 Policy Implications

The findings suggest several critical policy needs. First, the implementation of comprehensive land use planning that designates and protects agricultural zones is essential. Second, development policies should incorporate agricultural impact assessments to evaluate the full costs of land conversion. Third, mechanisms to support displaced farmers, including compensation, retraining, and access to alternative livelihoods, should be established. Finally, policies should promote intensive agricultural practices and urban agriculture to maximize food production within limited spaces.

5. CONCLUSION

This study has demonstrated that urban expansion in Gidan Kwano, driven primarily by residential and commercial construction, has resulted in significant negative impacts on agricultural activities. Over the 12-year study period (2012-2024), agricultural land decreased by 19%, while developed areas more than doubled. The consequences extend beyond mere land conversion to encompass reduced agricultural productivity, diminished household incomes, increased food insecurity, and threats to rural livelihoods and cultural heritage.

While urban development has brought infrastructure improvements and economic diversification opportunities, these benefits have not adequately compensated for the losses experienced by the agricultural community. The near-universal perception that development is proceeding too rapidly (78% of respondents) and the comprehensive nature of negative impacts (92% experiencing productivity declines, 60% experiencing income decreases, 100% experiencing cost of living increases) indicate that current development trajectories are unsustainable.

The findings underscore the critical need for integrated land use planning that balances urban growth with agricultural preservation. Policymakers must move beyond reactive approaches to implement proactive strategies that protect agricultural lands, support farmer livelihoods, and ensure food security. This requires coordinated efforts across multiple sectors, engagement

with local communities, and recognition that sustainable development must account for both urban needs and agricultural sustainability.

Future research should investigate the long-term sustainability of current development patterns, evaluate the effectiveness of various mitigation strategies, and explore innovative approaches to reconciling urban growth with agricultural preservation. Additionally, comparative studies across multiple peri-urban communities would help identify best practices and context-specific solutions. The challenge facing Gidan Kwano and similar communities is not whether to develop, but how to develop in ways that preserve essential agricultural functions while meeting legitimate aspirations for improved living standards and economic opportunities.

Discussion

This research aimed to assess the impact of urban expansion on agricultural activities in the Gidan Kwano community. Key findings include:

- i. **Factors Influencing Urban Expansion:** The primary drivers of development in Gidan Kwano are residential and commercial construction. Over 76% of respondents felt that physical development is progressing too quickly, leading to a transformation of the community's land use from agriculture to urban uses. Housing expansion was identified as the most significant cause of farmland loss.
- ii. **Extent of Agricultural Land Conversion:** The physical development has led to a considerable reduction in agricultural land. Over 91% of the respondents reported the conversion of their farmland to non-agricultural purposes, which has significantly reduced agricultural output. The survey also revealed that most farmers experienced reduced agricultural productivity, with 50% reporting significant decreases.
- iii. **Socio-Economic Effects on the Community:** The decline in available agricultural land has disrupted the livelihoods of farmers. Many have been forced to seek alternative sources of income, mostly in low-wage sectors like construction and services.

Additionally, the community has experienced a rise in the cost of living and food prices, with 100% of respondents reporting a notable impact on household expenses.

Overall, physical development has had mixed consequences. While it brought improvements in infrastructure, better market access, and economic diversification, it has also displaced farmers, reduced agricultural productivity, and increased socio-economic challenges.

5.1 CONCLUSION

The study's conclusion highlights the intricate and often negative relationship between rapid urban expansion and agricultural activities in rural areas, with Gidan Kwano serving as a prime example. The transformation from a predominantly agricultural community to one characterized by increasing urbanization has had profound implications for both the agricultural sector and the socio-economic well-being of its residents.

The urban expansion in Gidan Kwano, driven primarily by the need for residential housing and commercial infrastructure, has significantly reduced the amount of land available for farming. As more land is converted into non-agricultural uses, agricultural productivity has declined. The study found that most farmers have experienced a reduction in crop yields and income, which has negatively impacted the community's food security. As agricultural land diminishes, the community becomes increasingly reliant on external food sources, which could lead to higher food prices and exacerbate poverty in the long run.

In addition to the economic impacts, urban expansion has led to the displacement of farmers, pushing them to less fertile areas or out of agriculture entirely. This displacement has socio-cultural consequences, as farming has been a way of life for generations in Gidan Kwano. The loss of farmland is not just an economic issue but also a cultural one, as it disrupts traditional livelihoods and alters the fabric of the community.

While there are some positive effects of urban expansion such as improved infrastructure, better market access, and job creation in non-agricultural sectors, the negative impacts on agriculture seem to outweigh these benefits. The loss of agricultural land is largely irreversible, and the long-term sustainability of the community is at risk if these trends continue unchecked.

In conclusion, the study's objectives were met in demonstrating the extent of physical development's impact on agriculture in Gidan Kwano. The findings align with previous research, which has shown that unregulated development in rural areas can lead to significant socio-economic and environmental challenges. The research underscores the need for more balanced development strategies that consider both the need for urban expansion and the preservation of agricultural livelihoods. Without such strategies, rural communities like Gidan Kwano may face long-term challenges, including food insecurity, increased poverty, and loss of cultural heritage.

References

1. Adelekan IO. Urban dynamics, everyday hazards and disaster risks in Ibadan, Nigeria. *Environ Urban*. 2016;28(1):51–68.
2. Adjei-Nsiah S, Kuyper TW, Leeuwis C, Abekoe MK, Giller KE. Evaluating sustainable and profitable cropping sequences with cassava and four legume crops. *Ecol Econ*. 2010;69(4):732–740.
3. Agboola JI, Nwokoro IJ, Kareem KO. Impact of urbanization on agricultural land use in Minna Metropolis, Niger State. *J Geogr Reg Plann*. 2017;10(6):162–170.
4. Altieri MA, Nicholls CI. *Agroecology and the search for a truly sustainable agriculture*. Berkeley (CA): University of California; 2005.
5. Altieri MA, Toledo VM. The agroecological revolution in Latin America: Rescuing nature, ensuring food sovereignty and empowering peasants. *J Peasant Stud*. 2011;38(3):587–612.
6. Balk D, Montgomery MR, McGranahan G, Kim D, Mara V, Todd M, et al. Urbanization in India: Population and urban classification grids for 2011. *Data*. 2018;3(3):35.

7. Barau AS, Maconachie R, Ludin ANM, Abdulhamid A. Urban morphology dynamics and environmental change in Kano, Nigeria. *Land Use Policy*. 2015;42:307–317.
8. Batterbury S. Socio-ecological resilience and sustainable development. In: Redclift M, Springett D, editors. *Routledge international handbook of sustainable development*. London: Routledge; 2016. p. 179–193.
9. Bhattacharya S. Infrastructure development and its impact on agricultural productivity. *Econ Polit Wkly*. 2018;53(26–27):56–62.
10. Braimoh AK, Onishi T. Spatial determinants of urban land use change in Lagos, Nigeria. *Land Use Policy*. 2007;24(2):502–515.
11. Bryceson DF. Disappearing peasantries? Rural labour redundancy in the neo-liberal era and beyond. In: Araghi C, Kay C, editors. *Peasants and globalization*. London: Routledge; 2019. p. 299–326.
12. Caldwell JC. *Demographic transition theory*. Dordrecht: Springer; 2015.
13. Chamberlin J, Jayne TS. Unpacking the meaning of “market access”: Evidence from rural Kenya. *World Dev*. 2013;41:245–264.
14. Cheong PH, Edwards R, Goulbourne H, Solomos J. Immigration, social cohesion and social capital: A critical review. *Crit Soc Policy*. 2007;27(1):24–49.
15. Cotula L. *The great African land grab? Agricultural investments and the global food system*. London: Zed Books; 2013.
16. Ellis F, Biggs S. Evolving themes in rural development 1950s–2000s. *Dev Policy Rev*. 2001;19(4):437–448.
17. Escobar A. *Encountering development: The making and unmaking of the Third World*. Princeton (NJ): Princeton University Press; 2011.
18. Fanan U, Dlama KI, Oluseyi IO. Urban expansion and vegetation loss in and around Nigeria’s Federal Capital City. *J Ecol Nat Environ*. 2011;3(1):1–10.
19. Farming First. *Why farming matters to the future of our planet*. Washington (DC): International Food Policy Research Institute; 2013.
20. Food and Agriculture Organization of the United Nations (FAO). *The future of food and agriculture: Trends and challenges*. Rome: FAO; 2017.
21. FAO. *The state of the world’s biodiversity for food and agriculture*. Rome: FAO; 2019.
22. FAO. *The state of food and agriculture 2020: Overcoming water challenges in agriculture*. Rome: FAO; 2020.
23. Foley JA, DeFries R, Asner GP, Barford C, Bonan G, Carpenter SR, et al. Global consequences of land use. *Science*. 2005;309(5734):570–574.

24. Folke C. Resilience: The emergence of a perspective for social-ecological systems analyses. *Glob Environ Change*. 2006;16(3):253–267.
25. Fourchard L. Urban slums reports: The case of Ibadan, Nigeria. In: *Understanding slums: Case studies for the global report on human settlements*. Nairobi: UN-Habitat; 2003.
26. GIZ. *Sustainable land management for food security and climate change adaptation*. Bonn: Deutsche Gesellschaft für Internationale Zusammenarbeit; 2018.
27. Healey P. *Collaborative planning: Shaping places in fragmented societies*. London: Macmillan Press; 1997.
28. Lambin EF, Meyfroidt P. Global land use change, economic globalization, and the looming land scarcity. *Proc Natl Acad Sci U S A*. 2011;108(9):3465–3472.
29. Long H, Li Y, Liu Y, Woods M, Zou J. Accelerated restructuring in rural China fueled by “increasing vs. decreasing balance” land-use policy. *Land Use Policy*. 2011;29(1):11–22.
30. Maconachie R. The Kano region. In: Mortimore MJ, editor. *Adapting to climate uncertainty in African agriculture*. Dordrecht: Springer; 2012. p. 85–102.
31. McDonald RI, Kareiva P, Forman RTT. The implications of current and future urbanization for global protected areas and biodiversity conservation. *Biol Conserv*. 2008;141(6):1695–1703.
32. Mmom PC, Fred-Nwagwu WF. Analysis of land use and land cover change around the city of Port Harcourt, Nigeria. *Glob Adv Res J Geogr Reg Plann*. 2013;2(5):143–152.
33. Mwangi SW. Impact of urban expansion on agricultural land use: The case of Nairobi. *Afr J Agric Res*. 2017;12(40):2950–2958.
34. National Bureau of Statistics (NBS). *Nigerian gross domestic product report*. Abuja: NBS; 2020.
35. Njenga M, Karanja N, Karlsson H, Jamnadass R, Iiyama M, Kithinji J, et al. Additional cooking fuel supply and reduced global warming potential from recycling charcoal dust into briquettes in Kenya. *J Clean Prod*. 2019;81:81–88.
36. Nkonya E, Gerber N, Baumgartner P, von Braun J, De Pinto A, Graw V, et al. *The economics of desertification, land degradation, and drought*. Washington (DC): IFPRI; 2011.
37. Olanrewaju RM, Naeem MA, Soom AP. The impact of infrastructure on economic growth in Nigeria. *J Econ Sustain Dev*. 2017;8(16):1–12.

38. Owusu G, Agyei-Mensah S, Lund R. Slums of hope and slums of despair: Mobility and livelihoods in Nima, Accra. *Norsk Geogr Tidsskr.* 2015;62(3):180–190.
39. Oyeniyi BA. Internal migration in Nigeria. In: Ness I, editor. *The encyclopedia of global human migration*. Oxford: Wiley-Blackwell; 2013.
40. Perroux F. Economic space: Theory and applications. *Q J Econ.* 1950;64(1):89–104.
41. Peters DH, Garg A, Bloom G, Walker DG, Brieger WR, Rahman MH. Poverty and access to health care in developing countries. *Ann N Y Acad Sci.* 2008;1136(1):161–171.
42. Pinto-Correia T, Kristensen L. Linking research to practice: The landscape as the basis for integrating social and ecological perspectives of the rural. *Landscape Urban Plann.* 2013;120:248–256.
43. Portes A. Social capital: Its origins and applications in modern sociology. *Annu Rev Sociol.* 1998;24(1):1–24.
44. Pretty J, Noble AD, Bossio D, Dixon J, Hine RE, Penning de Vries FWT, et al. Resource-conserving agriculture increases yields in developing countries. *Environ Sci Technol.* 2005;40(4):1114–1119.
45. Pretty J, Sutherland WJ, Ashby J, Auburn J, Baulcombe D, Bell M, et al. The top 100 questions of importance to the future of global agriculture. *Int J Agric Sustain.* 2010;8(4):219–236.
46. Pretty J, Toulmin C, Williams S. Sustainable intensification in African agriculture. *Int J Agric Sustain.* 2018;9(1):5–24.
47. Putnam RD. *Bowling alone: The collapse and revival of American community*. New York: Simon & Schuster; 2000.
48. Rockström J, Steffen W, Noone K, Persson Å, Chapin FS III, Lambin EF, et al. A safe operating space for humanity. *Nature.* 2009;461(7263):472–475.
49. Satterthwaite D, McGranahan G, Tacoli C. Urbanization and its implications for food and farming. *Philos Trans R Soc Lond B Biol Sci.* 2010;365(1554):2809–2820.
50. Seto KC, Fragkias M, Güneralp B, Reilly MK. A meta-analysis of global urban land expansion. *PLoS One.* 2011;6(8):e23777.
51. Tacoli C. The links between rural and urban development. *Environ Urban.* 2003;15(1):3–12.
52. Tayyebi A, Pijanowski BC, Pekin B. Two rule-based urban growth boundary models applied to the Tehran Metropolitan Area, Iran. *Appl Geogr.* 2016;35(1–2):32–42.

53. Thrupp LA. Linking agricultural biodiversity and food security. *Int Aff*. 2000;76(2):283–297.
54. UN-Habitat. *The state of African cities 2014: Re-imagining sustainable urban transitions*. Nairobi: UN-Habitat; 2014.
55. UN-Habitat. *World cities report 2020: The value of sustainable urbanization*. Nairobi: UN-Habitat; 2020.
56. United Nations Development Programme (UNDP). *Human development report 2020: The next frontier – Human development and the Anthropocene*. New York: UNDP; 2020.
57. Waiyaki N. Assessment of the effects of urban expansion on agricultural land: A case study of Ruiru Municipality, Kenya. *Int J Sci Res Innov Technol*. 2016;3(8):1–19.
58. World Commission on Environment and Development (WCED). *Our common future*. Oxford: Oxford University Press; 1987.
59. World Bank. *Agriculture and rural development*. Washington (DC): World Bank Group; 2018.
60. World Bank. *Infrastructure for development*. Washington (DC): World Bank Group; 2021.