CLIMATE SMART AGRICULTURE, FOOD SECURITY AND SUSTAINABLE DEVELOPMENT

GLOBAL ISSUES & LOCAL PERSPECTIVES volume One

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Preface

This book adopts an exegetical approach as well as a pedagogic model, making it attractive agriculture and environmental economics teachers, professional practitioners and scholars. It is eschews pedantry and lays bars the issues in such clarity that conduces to learning. The book elaborates on contemporaneous **Climate Smart Agriculture, Food Security and Sustainable Development** issues of global significance and at the same time, is mindful of local or national perspectives making it appealing both to international and national interests. The book explores the ways in which climate smart agriculture (CSA) food security, Sustainable Development issues are and should be presented to increase the public's stock of knowledge, increase awareness about burning issues and empower the scholars and public to engage in the participatory dialogue climate smart agriculture, food security, and sustainable development necessary in policy making process that will stimulate increase in food production and environmental sustainability.

Climate Smart Agriculture, Food Security and Sustainable Development: *Global Issues & Local Perspectives* is organized in three parts. Part One deals with The Concept of **Climate Smart Agriculture**, Part Two is concerned with The Concept of **Food Security And** and Part Three deals with the Concept of **Sustainable Development**

Eteyen Nyong; October 2025

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1. Introduction

Nigeria is urbanizing at one of the fastest rates in Africa. More than half of its population already resides in cities, and projections indicate that nearly 70 percent will be urban by 2050 (UN-Habitat, 2022). Rapid population growth has intensified land conversion, as farmland, wetlands, and peri-urban green belts are increasingly transformed into residential estates, commercial developments, and transport infrastructure (Afzal, Waseem, Khurshid and Maqbool, 2023). This process reduces the availability of arable land in and around cities, constraining opportunities for food production close to centers of demand. Climate change compounds these pressures: unpredictable rainfall, prolonged dry seasons, and rising temperatures undermine conventional farming systems. Nigerian cities such as Lagos, Kano, and Port Harcourt already experience the

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urban heat-island effect, which elevates temperatures, increases energy costs, worsens public health outcomes, and further challenges urban agriculture (Anser, Nassani, Al-Aiban, Zaman and Haffar, 2025). At the same time, disruptions from flooding, drought, and regional conflict destabilize supply chains, leaving urban households increasingly exposed to food insecurity (AP News, 2025).

Urban food insecurity has therefore become one of Nigeria's most pressing socio-economic challenges. Lagos, now a megacity of over 20 million people, places unprecedented demands on food systems and urban ecology. Household studies in Lagos show that many families struggle to secure adequate and nutritious food on a consistent basis (Adeloye, Aminu and Oyesola, 2020). Heavy reliance on market purchases leaves city residents highly vulnerable to inflation and price volatility. Nigeria's dependence on imported staples such as rice, wheat, and frozen fish further heightens risk, draining foreign reserves and tethering national food security to volatile global markets (AFREXIMBANK, 2024). Nutritionally, urban diets remain dominated by energy-dense staples, processed foods, and fried snacks, while the intake of fruits, vegetables, and proteins remains insufficient. This dietary imbalance contributes to persistent micronutrient deficiencies, malnutrition, and the rising burden of non-communicable diseases (Wells, Marphatia, Amable, Siervo, Friis, Miranda, Haisma and Raubenheimer, 2021). At the ecological level, urban expansion has reduced tree cover and green spaces that once sustained soil fertility, pollinators, and microclimatic regulation. Left unchecked, these patterns threaten not only nutrition and health but also the resilience and overall livability of Nigerian cities.

In response, urban agroforestry, particularly the forest garden model emerges as a promising, context-appropriate strategy. A forest garden is a multi-layered agroforestry system that mimics natural forest ecology by integrating trees, shrubs, vines, groundcovers, and root crops in the same space (FAO, 2025). Practiced for centuries in West Africa and Asia, forest gardens are now recognized globally as climate-resilient systems of food production. Their multifunctional benefits hold particular relevance for Nigerian cities. Ecologically, forest gardens regulate microclimates, conserve water, improve soils, and support biodiversity (Taylor and Lovell, 2021). For households, they provide year-round access to fruits, vegetables, herbs, and medicinal plants, improving dietary diversity and reducing dependence on costly markets (Shrestha, Maraseni and Apan, 2025). Culturally, they align with Nigeria's traditions of home

gardening across Yoruba, Igbo, and Hausa societies (Oladele, Emeghara, Ayodele and Ishola, 2020; Ogunsusi, 2025). At the urban scale, forest gardens contribute to climate resilience through carbon sequestration, flood mitigation, and buffering food systems against global supply shocks (Muthuri, Kuyah, Njenga, Kuria, Öborn and van Noordwijk, 2023).

By transforming underutilized urban spaces such as courtyards, school compounds, institutional grounds, and vacant lots into productive ecosystems, forest gardens can complement Nigeria's ongoing greening policies. Lagos, for instance, already promotes urban forestry through LASPARK, offering opportunities for expansion into edible and multipurpose tree systems.

This chapter critically examines the forest garden model as a resilient form of urban agroforestry tailored to Nigeria's emerging food security and ecological challenges. Its objectives are to:

1. Examine the conceptual foundations of forest gardens and their global relevance.
2. Analyze urban food insecurity in Nigeria, with emphasis on ecological and socio-economic drivers.
3. Evaluate the ecological, nutritional, and cultural benefits of urban forest gardens.
4. Explore design principles, species selection, and implementation pathways for Nigerian cities.
5. Present case studies from Lagos, Lokoja, and comparable West African contexts.
6. Discuss policy implications and provide recommendations for scaling urban forest gardens.

Ultimately, the chapter argues that forest gardens are not merely supplementary urban agriculture projects but strategic interventions capable of advancing food security, ecological resilience, and cultural continuity within Nigeria's rapidly urbanizing landscape.

2. Conceptual Background

2.1 Agroforestry and Urban Agroforestry

Agroforestry, as defined by the Food and Agriculture Organization (FAO), involves deliberately integrating trees and shrubs with crops and/or livestock to generate ecological and economic

interactions (FAO, 2025; Ogunsusi, 2025). Unlike monocropping, which isolates species, agroforestry seeks to replicate natural ecosystems. It improves soil fertility, moderates microclimates, supports biodiversity, and diversifies income (CIFOR-ICRAF, 2025). Over the last four decades, evidence from both low- and high-income countries has shown that agroforestry enhances productivity while rehabilitating degraded landscapes and delivering ecosystem services critical for climate adaptation and mitigation (Gupta *et al.*, 2020). Urban agroforestry adapts these principles to cities, where land is scarce and environmental stress is high. It involves cultivating multipurpose trees within courtyards, compounds, housing estates, schools, and public spaces (FAO, 2025 2021; Ogunsusi, 2025). While Nigerian urban agriculture has historically focused on annual vegetables along wetlands, roadsides, or floodplains, urban agroforestry emphasizes perennial systems that integrate more permanently with built environments (Ogunsusi, 2025).

The value of urban agroforestry is heightened by Nigeria's ecological realities. Dense concrete landscapes intensify urban heat-island effects, while unregulated growth reduces green cover. Food-producing trees in urban areas can provide shade, regulate surface temperatures, absorb stormwater, and improve air quality. Importantly, they also deliver fresh fruits, nuts, herbs, and vegetables, thereby helping to address dietary gaps in contexts where food prices are volatile and supply chains unreliable. Agroforestry possesses the capacity to sustain productivity and concurrently provide many ecosystem services through the use of nature-inspired methods (Raihan, 2023). Thus, urban agroforestry represents a strategy at the intersection of ecology, nutrition, and social resilience.

2.2 Forest Garden Systems

A key model within agroforestry is the forest garden, also called a food forest or home garden. Forest gardens are perennial, multi-layered systems that mimic natural forest ecology while producing food, medicine, and cultural resources (FAO, 2025). They are distinguished by intentional diversity, structural layering, and consistent year-round productivity.

Structural layers of forest gardens typically include:

1. Canopy trees - tall fruit and timber species such as mango, coconut, or breadfruit.

2. Sub-canopy trees - medium fruit trees like citrus, guava, or avocado.
3. Shrubs - nitrogen-fixing or fruit-bearing species such as moringa or pigeon pea.
4. Herbaceous plants - vegetables, medicinal herbs, and spices.
5. Climbers/vines - e.g., yam or passion fruit, which utilize vertical structures.
6. Groundcovers - spreading crops like sweet potato or cowpea to conserve soil.
7. Root crops - tubers such as cassava, cocoyam, or turmeric.

Forest gardens maximize land efficiency by layering species vertically and horizontally, recycling nutrients, and forming largely self-regulating ecosystems. Species interactions support natural pest control, pollination, and soil enrichment, making them simultaneously productive and ecologically balanced (Lundin, Rundlöf, Jonsson, Bommarco, and Williams, 2021). Globally, they are long-standing strategies: in Kerala, Sri Lanka, and Indonesia, household plots mix coconut, banana, spices, and vegetables; in Latin America, *huertos familiares* and Amazonian *chagra* integrate fruits, tubers, and medicinal plants; and in East Africa, particularly Tanzania and Kenya, they remain vital for nutrition and resilience (CIFOR-ICRAF, 2025).

For Nigeria's cities, their appeal lies in adaptability to land-scarce environments. Courtyards, schools, and community spaces can host intensive production on small footprints. Their perennial structure reduces seasonal labor and input needs while ensuring year-round harvests (Gupta, Dagar and Teketay, 2020). Ecologically, they moderate heat, enhance water infiltration, and sequester carbon—services critical for climate-stressed urban areas.

Culturally, forest gardens align with indigenous Yoruba, Igbo, and Hausa traditions of cultivating fruit trees, leafy greens, and herbs near homes (Oladele *et al.*, 2020). Building on this heritage offers a pathway to scale forest gardens into structured urban food forests, linking culture with resilience.

3. Urban Food Security in Nigeria

3.1 Urbanization and Food Demand

Nigeria's urban growth is reshaping land use and food systems. The share of the urban population has risen from less than 20% in 1970 to over 50% today, with projections that two-thirds of Nigerians will live in cities by 2050. Lagos which is Africa's largest megacity with over 20 million residents, demonstrates the pressures of this expansion. Farmland and wetlands once central to food production have been converted into residential estates, industries, and transport corridors (Oyalowo, 2022). This shift reduces local food availability and increases reliance on supplies transported from rural states such as Oyo, Ogun, Benue, and northern Nigeria. Dependence on long-distance supply chains leaves cities vulnerable to disruptions caused by fuel price hikes, road blockages, or climate-related harvest failures (AP News, 2025). The outcome is visible in food inflation. In Lagos for example, prices rose by an average of 23% in 2023, straining urban households already dependent on purchased food (NBS, 2023). Water scarcity further compounds urban food insecurity. Irrigation schemes around Lagos and Kano face threats from declining rainfall, groundwater depletion, and pollution. Meanwhile, erratic rainfall and flooding driven by climate change disrupt production, transport, and storage, making urban food supply increasingly unstable.

3.2 Food Security Indicators

Household surveys highlight the vulnerability of urban residents. Ilori, Christofides and Baldwin-Ragaven (2024) found that many households in Ibadan experience moderate to severe food insecurity, often coping by reducing portion sizes, skipping meals, or consuming less preferred foods patterns. This is also observed in South African and Kenyan urban studies, indicating chronic stress rather than temporary shortages. Market dependence deepens this vulnerability. FAO and WFP note that urban households in Nigeria spend over 60% of their income on food, far higher than rural households, echoing evidence from Accra and Nairobi where urban food budgets exceed half of household expenditure. Any disruption in supply, whether through currency fluctuations, global price shocks, or transport strikes, directly undermines food access. The COVID-19 lockdowns made this visible as movement restrictions disrupted supply chains, raising food prices and reducing perishable availability, consistent with findings from Addis Ababa and Johannesburg (McCann, Sinno, Ramadhan, Assefa, Berhane, Madzorera, and Fawz,

2023). Food insecurity is not evenly distributed. Low-income neighborhoods in Lagos, Ibadan, and Port Harcourt face the greatest risks. As studies on informal settlements in Dar es Salaam and Dhaka also show, lack of land for home gardening forces reliance on purchased food, heightening exposure to price volatility. These patterns confirm that current urban food systems, dominated by fragile supply chains, cannot guarantee secure and equitable access to nutritious food.

3.3 Nutrition Challenges

Food quality, not just calories is increasingly at risk in Lagos and Ibadan. In Lagos, a study of urban adults found diets deficient in fiber, energy, and most micronutrients though zinc, iron and vitamin A were exceptions, and elevated intake of carbohydrates, protein and sodium. Overweight prevalence was 24.8%, obesity 17.3%. Among Lagos adolescents (mean age ~13.6 y), dietary diversity was low, poor eating habits common; overweight and obesity rates were 13.4% and 7.0% respectively. In Ibadan, secondary school female adolescents had frequent meal skipping (especially lunch); calcium intakes very low, while iron, zinc, B6 met recommended levels. Also, elderly Yoruba people in an Ibadan slum showed very high deficiencies: ~71% had low serum zinc, ~51% low vitamin D, many deficient in B vitamins (Balogun, Oluwatosin, and Akinpelu, 2022). These findings confirm the "double burden" in Nigeria's cities: micronutrient deficiency alongside overweight/obesity, poor dietary diversity, and meal patterns that undermine nutritional adequacy. Urban food systems must ensure affordable access to diverse, nutrient-rich foods.

3.4 Policy Landscape

Policy responses are beginning to address the environmental pressures of urbanization. Lagos State for example introduced a greening policy in 2008 and established the Lagos State Parks and Gardens Agency (LASPARK) in 2011. Annual tree-planting campaigns, including the official "Tree Planting Day" on July 14, have increased awareness and vegetation cover (Kolade, 2021). However, these efforts have largely emphasized ornamental and shade trees rather than food-

producing species. This presents an untapped opportunity of integrating edible trees and forest garden models into greening initiatives that would simultaneously enhance food security and climate resilience. Lagos's climate action strategies for 2015–2025 already emphasize resilience to flooding, heat, and emissions (Ministry of Environment and Water Resources, 2024). Embedding urban food forests into these frameworks could generate multiple benefits, including carbon sequestration, improved nutrition, and community engagement.

Nationally, agricultural policies continue to prioritize rural production and export-oriented commodities, while urban agriculture often falls into regulatory gray zones. Land tenure insecurity discourages investment in urban farming, and limited institutional coordination hampers progress. Nonetheless, advocacy by NGOs, such as the Lagos Food Bank Initiative, has raised awareness about the importance of supporting household- and community-based production in cities (Lagos Food Bank Initiative, 2023). These civil society efforts suggest that forest gardens could be scaled if formally recognized within urban planning and policy frameworks.

4. Ecological and Socio-economic Benefits of Forest Gardens

Urban forest gardens deliver a wide range of ecological, nutritional, cultural, and economic benefits that make them highly relevant for Nigeria's rapidly urbanizing cities. They represent a holistic approach to urban food production, blending environmental restoration with improved livelihoods. This section discusses these benefits across four dimensions: ecological services, climate change resilience, food and nutrition security, and socio-cultural and economic contributions.

4.1 Ecological Benefits

One of the most immediate ecological benefits of urban forest gardens is their capacity to mitigate the urban heat island (UHI) effect. Nigerian cities such as Lagos, Kano, and Port Harcourt, dominated by concrete and asphalt, experience local temperatures several degrees higher than surrounding rural areas. Multilayered vegetation in forest gardens provides shade, increases evapotranspiration, and lowers surface heat, creating cooler microclimates that improve human comfort and reduce household

energy demand for cooling. Forest gardens also enhance urban biodiversity (Kacprzak, Ellis, Fijałkowski, Kupich, Gryszpanowicz, Greenfield and Nowak, 2024). The combination of fruit trees, shrubs, herbs, and groundcovers attracts pollinators such as bees, butterflies, and birds, essential for both food production and ecological balance. In dense urban settings where habitats are scarce, they function as ecological refuges, sustaining species otherwise displaced by urban expansion. Soil fertility improvement is another critical benefit. Many Nigerian cities face compacted, nutrient-poor soils from construction and overuse. Incorporating leguminous shrubs such as pigeon pea and moringa promotes nitrogen fixation, while leaf litter and groundcover crops enhance soil structure, reduce erosion, and support beneficial organisms (Srivastava, Kaur, Sharma and Nautiyal, 2025). Finally, forest gardens aid water regulation. Increased soil organic matter and groundcover improve infiltration and storage, reducing runoff during heavy rains. This is particularly crucial in flood-prone cities like Lagos, where unregulated growth has heightened flood risks (Musa, Ambafi, Kuti, Dada-Bankole, and Yerima, 2025). Trees and shrubs slow water movement, mitigating flash floods and improving groundwater recharge. Collectively, forest gardens help restore vital ecological functions often lost in urbanized landscapes.

4.2 Climate Change Resilience

Urban food systems in Nigeria are highly exposed to erratic rainfall, droughts, and heat stress. Forest gardens enhance resilience through perennial structure and species diversity, spreading risk unlike vulnerable monocultures (Melvani, Myers, Palaniandavan, Kaestil, Bristow, Crase, Moles Williams and Abeygunawardena, 2020). Fruit trees often yield during droughts when annuals fail, while tubers like cassava and cocoyam act as reserves. Canopies buffer rainfall variability by conserving soil moisture, while deep-rooted trees tap groundwater. These features stabilize production and strengthen food security. Forest gardens also mitigate climate change: they sequester carbon in woody biomass and soils (Kacprzak *et al.*, 2024). Localized production further

reduces "food miles," cutting emissions and ensuring fresher produce that are particularly vital in Lagos, where much food comes from distant regions.

4.3 Food and Nutrition Benefits

A key advantage of forest gardens is their role in ensuring year-round food availability and dietary diversity. By integrating fruits, nuts, vegetables, and legumes harvested across seasons, they buffer households during agricultural "hunger periods" and crises (CIFOR-ICRAF, 2025). These systems enhance nutritional quality, as forest foods are rich in vitamins, minerals, and micronutrients often lacking in staple-heavy diets. Unlike short-cycle vegetable plots, forest gardens rely on perennials that provide sustained yields. In Nigeria, where urban diets are dominated by cheap, processed foods, forest gardens supply nutrient-dense options that reduce risks of anemia and stunting. Empirical evidence from Lokoja, Kogi State, shows home gardens contribute significantly to food and income security, with households consuming and selling surplus produce (Adebayo, Bolarin, Kayode and Mattew, 2024). Even modestly sized forest gardens thus strengthen nutrition and household resilience in urban settings.

4.4 Socio-cultural and Economic Benefits

Forest gardens provide more than ecological and nutritional value; they also generate socio-cultural and economic gains. Women, often primary managers of home gardens, benefit through income from seedlings, herbs, and fruits (Adebayo, Bolarin, Kayode and Mattew, 2024). Youth engagement in urban forestry and food enterprises creates employment in contexts of high joblessness. Small-scale businesses which involve herbal teas, dried fruits, jams, and plant-based cosmetics expand value chains, while community nurseries offer entrepreneurial opportunities and ensure access to planting material. Culturally, forest gardens draw on longstanding Yoruba, Igbo, and Hausa traditions of household gardens, which serve as productive, social, and symbolic spaces. Building on this heritage, modern initiatives can align cultural identity with urban resilience, ensuring stronger community participation and long-term sustainability.

5. Design and Implementation of Urban Forest Gardens

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Designing and managing forest gardens in Nigerian cities requires careful adaptation of agroforestry principles to dense, fragmented urban landscapes. Unlike rural systems with expansive land, urban gardens must coexist with buildings, drainage systems, and roads while still providing food, ecological services, and social spaces. This section discusses design principles, species selection, typologies for different contexts, and practical steps for implementation.

5.1 Design Principles

Urban forest gardens thrive when guided by ecological design that balances plant interactions, space efficiency, and household needs (FAO, 2025). Several principles are central to their success. Multi-strata layering is a defining feature. By arranging plants in canopy, sub-canopy, shrub, herb, climber, groundcover, and root layers, forest gardens maximize the use of sunlight, water, and soil nutrients (Focacci, Schaffer, de Meo, Paletto and Salbitano, 2025). For example, tall trees like mango capture direct sunlight, while shade-tolerant plants such as turmeric or cocoyam flourish beneath. Groundcovers such as sweet potato protect soil moisture and suppress weeds, while nitrogen-fixing shrubs like pigeon pea improve fertility. This layered structure mimics natural forests, enhancing productivity and resilience.

The principle of "right species, right place" is equally vital in urban forest garden (Tanes Tree Trust, 2023). Nigerian cities vary ecologically. Coastal areas like Lagos or Port Harcourt require salt-tolerant, humidity-adapted trees such as coconut and breadfruit, while northern cities like Kano are better suited to drought-tolerant species like moringa, neem, or date palm. Proper placement also avoids damage to infrastructure; ensuring roots do not interfere with foundations or drainage.

Water-smart design is essential given Nigeria's urban challenges of both flooding and water scarcity. Techniques such as rainwater harvesting, swales to capture runoff, mulching to reduce evaporation, and safe reuse of greywater enhance reliability of irrigation (Rodrigues, Formiga, and Milograna, 2023). These measures make gardens more sustainable while reducing dependence on municipal water supplies.

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Soil fertility management underpins productivity in compacted or degraded urban soils. Strategies such as composting household organic waste, applying biochar, and integrating nitrogen-fixing trees restore soil health (Guo, Liu, and Zhang, 2020). The "chop-and-drop" method which involves cutting support trees and leaving the biomass as mulch provides a continuous nutrient cycle.

Diversity and resilience further strengthen urban gardens. By combining species with different fruiting times, households ensure food supply across seasons while reducing risks from pests or climate shocks (Hellin, Amarnath, Challinor, Fisher, Girvetz, Guo, Hodur, M.Loboguerrero, Pacillo, Rose, Schutz, Valencia and You, 2022). For example, mango fruits in the wet season, while guava and citrus may produce during drier months.

Lastly, accessibility and safety are critical in urban contexts (Przewoźna, Inglot, Mielewczyk, Maczka and Matczak, 2024). Walkways should allow easy harvesting and recreation, while low branches are pruned for safety in schools and parks. Clear visibility discourages unsafe use, and surfaces such as wood chips can prevent slips during rains. Together, these design elements transform limited urban plots into multifunctional, productive landscapes.

5.2 Species Selection for Nigeria

Choosing the right mix of species ensures that forest gardens provide both ecological services and culturally relevant foods. Selection should consider nutrition, adaptability, household preference, and market potential (Htet, Plieninger and Kmoch, 2025). Fruit trees remain central to household diets. Mango (*Mangifera indica*), citrus species, guava (*Psidium guajava*), avocado (*Persea americana*), and African breadfruit (*Treculia africana*) provide vitamins, proteins, and income opportunities. Many of these are already culturally familiar and widely accepted. Support species such as *Gliricidia sepium, Leucaena leucocephala*, and moringa (*Moringa oleifera*) enrich soils through nitrogen fixation, provide fodder, and supply medicinal and culinary products. Shrubs and vines like pigeon pea (*Cajanus cajan*) and passionfruit (*Passiflora edulis*) add protein and fruit diversity while utilizing vertical spaces such as fences and trellises. Herbs and medicinal plants are essential in Nigerian households. Turmeric, ginger, and scent leaf (*Ocimum gratissimum*) provide both culinary flavor and health benefits, linking forest gardens to daily household needs. Groundcovers and root crops such as sweet potato, cowpea, cassava, and

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cocoyam enhance food security while protecting soils. Their inclusion also reflects existing Nigerian dietary preferences, making forest gardens more acceptable and practical. This palette of species ensures year-round harvests, ecological balance, and cultural resonance with traditional home gardens.

5.3 Typologies for Nigerian Cities

Urban forest gardens can be adapted to diverse city contexts and land sizes. Three typologies are especially relevant.

Courtyard or compound gardens make use of small household spaces common in southern Nigerian cities (Mfon, Bassey, and Adewuyi, 2024). Even a 20–50 m² courtyard can host a micro-forest garden with dwarf fruit trees, vegetables, and herbs. In dense neighborhoods, rooftop and balcony gardens using containers and trellises provide alternatives.

Institutional food forests in schools, churches, and mosques offer larger-scale opportunities. School gardens can supply fresh produce for feeding programs while teaching students ecological literacy (Gobs, 2025). Faith-based organizations can manage community gardens that provide both food and social support in vulnerable neighborhoods.

Riparian and mangrove buffer gardens are suitable in coastal cities like Lagos and Port Harcourt, where urbanization threatens wetlands (Fombo, Aroloye. and Emoyoma, 2024). Planting coconut, raffia palm, and breadfruit along rivers and lagoons combines conservation with food production while protecting waterways from erosion and pollution.

These typologies show that forest gardens are not “one-size-fits-all” but can be adapted to fit local needs and urban realities.

5.4 Implementation Steps

Turning forest garden concepts into reality requires both ecological planning and community participation. Four steps are particularly important.

5.4.1 Participatory mapping ensures gardens are designed with input from households, resident associations, and traditional leaders. This process identifies available plots, water access, and cultural plant preferences, strengthening community ownership.

5.4.2 Securing land access is essential in cities where tenure insecurity is common. Municipal governments, schools, or religious bodies can issue memoranda of understanding (MOUs) granting communities temporary or renewable rights to manage vacant land as forest gardens. This prevents disputes and encourages investment in perennials that take years to mature.

5.4.3 Training and extension support enable communities to manage gardens effectively. Partnerships with the Lagos State Ministry of Agriculture, NGOs like Lagos Food Bank, and international agencies such as ICRAF can provide seedlings, tools, and technical guidance. Youth and women's groups should be prioritized to maximize livelihood benefits.

5.4.4 Monitoring and evaluation help track outcomes beyond yields. Indicators may include diet diversity, annual harvest volume, canopy cover, soil quality, and the number of households involved. Participatory monitoring, where communities record harvests and observations, ensures accountability and provides data for policy advocacy.

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6. Case Studies and Experiences

6.1 Lagos

Lagos, Nigeria's commercial capital and Africa's largest megacity, highlights both the urgency and potential of urban forest gardening. With over 20 million residents and annual growth above 3% (World Bank, 2023), farmland has been rapidly converted to residential and industrial use, pushing food production outward and raising reliance on costly imports. To address environmental stress, the Lagos State Government launched a Greening Policy in 2008 and created the Lagos State Parks and Gardens Agency (LASPARK) in 2011. Millions of trees have since been planted along roads, in estates, and parks. Yet most are ornamental, missing opportunities to integrate fruit-bearing and multipurpose species such as mango, guava, moringa, and African breadfruit. Resident associations and NGOs are already piloting edible urban plantings. With modest policy shifts, Lagos could advance food security while pioneering urban agroforestry in Africa.

6.2 Lokoja, Kogi State

Lokoja, at the Niger–Benue confluence, illustrates grassroots forest gardening. Households maintain diverse plots with fruit trees (mango, guava, citrus), shrubs (moringa, pigeon pea), root crops (yam, cocoyam), herbs, and small livestock, arranged in layered systems resembling forest gardens (Adebayo *et al.*, 2024; Ogunsusi, 2025). These gardens strengthen food security: families consume produce while selling seasonal surpluses, especially mangoes and guavas, for income. Women lead management, often funding school fees or healthcare (Berhanu & Guye, 2022). Beyond food, gardens conserve cultural knowledge and indigenous species like African breadfruit. With better seedlings, training, and extension support, Lokoja's informal agroforestry could scale into resilient urban forest gardens.

6.3 Comparative West African Context

The Nigerian experience is mirrored across West Africa, where urban and peri-urban agriculture is essential to food supply. In Accra (Ghana), thousands of farmers cultivate

vegetables along river valleys, while in Dakar (Senegal) and Lomé (Togo); urban plots provide large shares of local produce (CIFOR-ICRAF, 2025). However, these systems face common obstacles:

- Land tenure insecurity: Many urban farmers cultivate on public or informal land without rights, leaving them vulnerable to eviction and discouraging investment in perennial trees.
- Unsafe irrigation practices: Heavy reliance on untreated wastewater has raised health concerns, with studies in Accra and Dakar documenting microbial and chemical contamination of vegetables (FAO, 2025).

Despite these challenges, promising initiatives exist. In Accra, NGOs and city authorities are encouraging agroforestry-based approaches that combine vegetables with fruit trees, while in Ouagadougou (Burkina Faso), community-led urban forestry projects integrate mango and moringa into schools and public parks. For Nigeria, these lessons highlight two key insights: (1) long-term land access is essential to encourage investment in perennial species, and (2) forest gardens' water-smart designs, through rainwater harvesting and composting, can help address sanitation challenges that plague conventional vegetable systems.

7. Challenges and Limitations

Urban forest gardens hold strong potential for Nigeria's cities, but their expansion faces multiple structural and ecological obstacles. These challenges ranging from insecure land rights to weak institutional coordination must be addressed if forest gardens are to become a viable part of urban food systems.

7.1 Land Tenure Insecurity

The most pressing constraint is insecure land tenure. Much of urban farming in Nigeria takes place informally on vacant lots, road setbacks, or riverbanks, without legal rights. This leaves households vulnerable to eviction when land is allocated for real estate or

infrastructure, as seen in Lagos' Lekki - Epe corridor where peri-urban farms have repeatedly been displaced. Since forest gardens depend on long-lived trees, this instability discourages investment. Customary land systems sometimes persist in peri-urban zones, but rapid commercialization often overrides them. Without secure frameworks such as community land trusts, leases, or memoranda of understanding (MOUs), forest gardens are likely to remain small-scale and precarious.

7.2 Space Constraints

Limited land availability in dense neighborhoods also restricts expansion. In cities like Lagos, Ibadan, and Port Harcourt, many families live in crowded compounds with little or no planting space. Informal settlements pose even greater challenges due to narrow alleys, poor drainage, and insecure housing. Where land is available, it is often prioritized for faster economic returns such as kiosks or rental units. While innovations like rooftop gardens, courtyard plots, and vertical trellises could help, they require technical support and initial investment, which remain scarce.

7.3 Pest and Disease Management

Urban conditions also heighten pest and disease risks. Mango and guava commonly suffer fruit fly infestations, while termites damage young trees in coastal soils. Poor drainage encourages nematode and fungal outbreaks in root crops like yam and sweet potato. Access to organic solutions such as compost, mulches, and bio-pesticides is limited, leaving many households unable to manage pests effectively. Resorting to synthetic pesticides is problematic in dense urban areas due to health and environmental hazards (FAO, 2021). Developing safe, low-cost integrated pest management (IPM) strategies adapted to urban settings is therefore essential.

7.4 Institutional Gaps

Forest gardens fall between multiple sectors of agriculture, environment, health, and urban planning, but weak coordination leaves them marginalized. The Ministry of Agriculture focuses mainly on rural farming, while environmental agencies like

LASPARK prioritize ornamental greening. Urban planners rarely integrate food production into zoning. As a result, opportunities are missed. With this, school feeding programs could be linked to on-site gardens, or tree-planting campaigns could feature fruit species, but poor inter-agency collaboration prevents such synergies.

7.5 Weak Policy Enforcement

Finally, weak enforcement of conservation policies erodes the ecological base for forest gardens. Mangroves, wetlands, and green buffers around Lagos, Port Harcourt, and Warri are being rapidly converted to estates or sand-filled for development. Though laws exist to protect these ecosystems, enforcement is undermined by resource shortages and pressure from real estate interests. This trend both accelerates biodiversity loss and narrows opportunities for urban agroforestry.

8. Policy and Planning Implications

The expansion of urban forest gardens in Nigeria requires strong policy direction rather than reliance on scattered household or NGO initiatives. For them to contribute meaningfully to urban food security and climate resilience, they must be embedded into planning codes, climate strategies, and social policy frameworks.

8.1 Mainstreaming Edible Trees

A critical step is integrating food-producing trees into urban planning regulations. Current zoning and greening policies in Nigerian cities largely emphasize infrastructure growth and ornamental planting. If planning codes required the inclusion of fruit trees in housing estates, public parks, school compounds, and road medians, food forests could become a standard part of city design. This shift would redefine green infrastructure as not only aesthetic but also productive and life-sustaining, institutionalizing forest gardens as a normal feature of urban development.

8.2 Climate Action and SDG Alignment

Urban food forests also align closely with Nigeria's climate and development commitments. They support the Lagos Climate Action Plan (2015–2025) by expanding green cover, sequestering carbon, and reducing heat stress. They also advance national climate targets under the Paris Agreement, while directly contributing to the Sustainable Development Goals (SDGs) - notably SDG 2 (Zero Hunger), SDG 11 (Sustainable Cities), and SDG 15 (Life on Land). By explicitly linking forest garden programs to these frameworks, Nigeria can access international climate finance and technical partnerships, strengthening both scale and sustainability.

8.3 Incentives for Adoption

Because forest gardens require years to mature, households and communities need short-term incentives to adopt them. These could include subsidized seedlings, compost bins, training in organic waste recycling, or micro-grants for school and community orchards. Recognition programs, such as "green household" awards, could further encourage participation. Similar initiatives in Nairobi have shown that municipal support in the form of seedlings and compost distribution significantly boosts adoption rates, suggesting that Nigeria could replicate this success.

8.4 Partnerships with NGOs and Civil Society

NGOs and community-based organizations remain central to scaling forest gardens. Groups like the Lagos Food Bank Initiative, faith institutions, and women's cooperatives can provide training, mobilization, and monitoring. Partnerships with environmental NGOs such as the Nigerian Conservation Foundation (NCF) or international actors like ICRAF could also add technical expertise. Joint models where governments provide land and inputs while NGOs lead training and community engagement would ensure both legitimacy and sustainability (Lagos food Bank Initiative, 2023; CIFOR-ICRAF, 2025).

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8.5 Toward Integrated Urban Food Policy

Ultimately, forest gardens will only thrive if supported by an integrated urban food policy framework. Currently, urban food production is sidelined in planning processes, while food security is left to markets. Establishing food policy councils that bring together government, NGOs, researchers, and communities could help coordinate initiatives, secure land access, and attract climate funding (OECD, 2021). Such councils could also monitor impacts on nutrition, biodiversity, and urban resilience, ensuring forest gardens are recognized as legitimate urban infrastructure.

9. Conclusion and Recommendations

Nigeria's urban centers face mounting challenges from rapid population growth, food insecurity, climate change, and shrinking green spaces. These pressures reveal that hunger and vulnerability are no longer rural issues but increasingly urban ones. Since expanding farmland within cities is unrealistic, innovative approaches that combine food production with ecological restoration are urgently needed. Urban forest gardens provide such a pathway. By mimicking natural forest ecosystems while producing fruits, vegetables, herbs, and fuelwood, they address multiple urban challenges simultaneously. They help mitigate heat, enhance biodiversity, retain soil fertility, and strengthen social ties to land and food. Rooted in Nigeria's long-standing traditions of home gardens, they resonate culturally while also aligning with climate action and global sustainability goals. Existing policies on urban greening and tree planting already provide a base for scaling; what is needed is deliberate planning and community participation to mainstream the model across Nigerian cities.

To achieve this, several actions are recommended. First, agencies such as LASPARK should broaden their focus from ornamental greening to food forests, embedding edible trees into public spaces, road medians, and estates. Schools offer another vital entry point as pilot forest gardens in schoolyards can supply nutrition programs, serve as teaching tools, and normalize urban agroforestry among younger generations.

Consistent seedling supply is equally critical, requiring community nurseries, cooperatives, and public-private partnerships to ensure affordable, climate-resilient planting material.

Urban forest gardens also create opportunities for youth and women through value-added enterprises such as dried moringa, fruit juices, or herbal teas. Supporting these with training, microfinance, and market access could generate livelihoods while strengthening urban food systems. At the policy level, forest gardens should be integrated into planning codes, climate strategies, health, and education frameworks through multi-sectoral platforms such as urban food policy councils. Finally, sustainability depends on community ownership. Participatory approaches such as co-design, stewardship agreements, and local incentives can ensure gardens are adapted to cultural contexts and maintained long-term.

In conclusion, while not a stand-alone solution, forest gardens represent a culturally grounded, ecologically sound, and socially inclusive innovation for Nigeria's cities. By expanding policy support, strengthening seedling systems, and empowering schools, women, and youth, Nigeria can transform its urban landscapes into productive, climate-smart, and resilient environments that secure both food and wellbeing for future generations.

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