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BIODIVERSITY CONSERVATION IN AGROFORESTRY LANDSCAPES; EXPLORING THE ROLE OF TREES IN HONG LOCAL GOVERNMENT ADAMAWA STATE, NIGERIA

***RICHARD, S. D.; & **MARJA, A.S**

*Department of Forestry Technology, Federal Polytechnic, PMB.035 Mubi, Adamawa State, Nigeria. **Department of Early Childhood Education, Adamawa State College of Education Hong.

Corresponding Author: **amanuya.dr@gmail.com**

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Abstract

Biodiversity conservation is a critical aspect of sustainable development, particularly in regions facing environmental degradation and habitat loss. Agroforestry, the integration of trees and

Key words: Trees, Biodiversity, Conservation, Agroforestry, Landscape.

INTRODUCTION

Biodiversity conservation has become increasingly essential as global ecosystems face mounting pressures from human activities, climate change, and habitat destruction. Agroforestry, which combines agricultural and forestry practices, offers a sustainable solution to enhance biodiversity while supporting agricultural productivity. In regions like Hong Local Government in Adamawa State, Nigeria, where agriculture is a primary livelihood, the integration of trees into farming landscapes can play a crucial role in preserving local biodiversity. Hong Local Government, characterized by its diverse ecosystems and agricultural activities, presents a unique opportunity to study the benefits of agroforestry.

shrubs into agricultural landscapes, presents a promising approach to enhance biodiversity while maintaining agricultural productivity. This study explores the role of trees in biodiversity conservation within the agroforestry landscapes of Hong Local Government, Adamawa State, Nigeria. By examining local agroforestry practices, the benefits of trees for soil health, microclimate regulation, and habitat provision are analyzed. The study also addresses the challenges faced by farmers in integrating trees into their agricultural systems and the socio-economic factors influencing their decisions. Through case studies and local examples, the positive impact of tree integration on species richness and ecosystem services is highlighted. This research underscores the importance of adaptive management and supportive policies to promote tree-based biodiversity conservation in Hong Local Government, providing a model for similar regions in Nigeria.

Trees in agroforestry systems provide numerous ecological services, including habitat for wildlife, soil improvement through nutrient cycling, and microclimate regulation. These functions are vital for maintaining biodiversity and ensuring the sustainability of agricultural practices. Despite the potential benefits, farmers in Hong face several challenges in implementing agroforestry practices. Issues such as competition for resources between trees and crops, land tenure, and socio-economic constraints can hinder the adoption of tree-based systems. Understanding these challenges and the factors influencing farmer decisions is critical for developing effective strategies to promote biodiversity conservation through agroforestry. The agroecosystem biodiversity can be affected due to abandoning traditional, locally adapted crop varieties and intercropping for high yielding monocultures (Chappell and LaValle 2011; Sunderland 2011). Generally, agroforestry systems are closer to the natural forest systems (Schroth and McNeely 2011). Agroforestry helps in conservation of ecosystem through improving soil and microclimate properties, reduced erosion, improved water quality and carbon sequestration (Schroth and Sinclair 2003; Schroth *et al.* 2004; Nair *et al.* 2009; Sarvade 2014). Farmers practice agroforestry for gaining livelihood, income generation, risk management, food security and optimal use of available land, labor and capital (Arnold and Dewees, 1997). It is estimated that about 1.2 billion people (20%) of the world population depends directly on agroforestry products and services in developing countries

which can provide goods and services, that can offset 5-20 per cent of deforestation (Leakey and Sanchez 1997; Dixon 1995). Agroforestry represents the pinnacle of sustainable development and plethora of its uses has made it closer to the people. Many effective conservation organizations are now including agroforestry as a component in their programs. In general, agroforestry plays five major roles in conserving biodiversity: (1) provides habitat for species that can tolerate a certain level of disturbance; (2) helps preserve germplasm of sensitive species; (3) helps reduce the rates of conversion of natural habitat by providing a more productive, sustainable alternative to traditional agricultural systems that may involve clearing natural habitats; (4) provides connectivity by creating corridors between habitat remnants which may support the integrity of these remnants and the conservation of area-sensitive floral and faunal species; and (5) helps conserve biological diversity by providing other ecosystem services such as erosion control and water recharge, thereby preventing the degradation and loss of surrounding habitat (Jose 2009). Agroforestry systems are considered as diversity enhancing land use system especially in the context of inter-species diversity as it brings together crops, shrubs, trees and in some cases livestock on the same piece of land (Atta-Krah *et al.* 2004). A well-designed agroforest, can spontaneously attract and support higher biodiversity. In the lowlands of Sumatra, resin-producing agroforests planted several generations ago are now some of the last reservoirs of biodiversity as they are harboring rare epiphytes and herbs as well as 46 species of mammals, 92 species of birds, and much of the native soil fauna. Agroforestry plantings provide expanded habitat for a wide range of species, from soil micro life to insects to mammals and have diversified and intensified agro-ecosystems to maintain and enhance biodiversity (Sanchez and Leakey 1997; Sanchez *et al.* 1997). Agroforestry systems have potential to support as high as 50-80 per cent of biodiversity of comparable natural system (Noble and Dirzo 1997). Agroforestry conserve biodiversity within deforested, fragmented landscapes by providing habitats and resources for plant and animal species. It makes the landscape less harsh for forest dwelling species by reducing the frequency and intensity of fires and providing buffer zones to the protected areas (Pandey 2002). Biodiversity conservation is essential for maintaining ecosystem functioning, resilience, and stability. Agroforestry systems play a crucial role in preserving biodiversity by providing habitat for a wide range of species, including birds, mammals, insects, and microorganisms. High levels of biodiversity contribute to ecosystem services

such as pollination, pest regulation, soil fertility, and water purification, which are vital for sustaining agricultural productivity and human well-being. Trees are key components of agroforestry systems and play multiple roles in biodiversity conservation. Firstly, trees provide structural complexity and vertical diversity, creating diverse microhabitats and niches for wildlife species. Trees also serve as food and shelter resources for birds, mammals, and insects, supporting diverse communities of organisms. Moreover, trees contribute to soil conservation, water retention, and nutrient cycling, creating favorable conditions for plant growth and enhancing overall ecosystem heal Different agroforestry practices exhibit varying degrees of effectiveness in promoting biodiversity conservation. Alley cropping systems, for example, incorporate rows of trees within agricultural fields, providing linear corridors and refuges for wildlife species. Silvopasture integrates trees with pastureland, offering shade, forage, and shelter for livestock while supporting biodiversity. Multistrata agroforestry systems, characterized by multiple layers of vegetation, create diverse microclimates and habitat niches, enhancing species richness and ecosystem resilience. This study aims to explore the role of trees in biodiversity conservation within the agroforestry landscapes of Hong Local Government. By examining local practices, ecological benefits, and socio-economic factors, this research seeks to provide insights into optimizing agroforestry systems for biodiversity conservation. The findings are expected to inform policy and management strategies that support the integration of trees in agricultural landscapes, contributing to the broader goals of sustainable development and environmental conservation in Nigeria. This study explores the role of trees in biodiversity conservation within the agroforestry landscapes of Hong Local Government, Adamawa State, Nigeria.

MATERIALS AND METHODS

Study Area

Hong Local Government Area (LGA) is located in Adamawa State, Nigeria. Geographically, it lies in the northeastern part of Nigeria. The coordinates for the town of Hong, which serves as the administrative center of the Hong LGA, are approximately Latitude: 10.25583^0 N Longitude: 12.9874^0 E Hong LGA is bordered by the following local government areas within Adamawa State: To the north, it is bordered by Song LGA. To the east, it is bordered by Mubi South and Mubi North LGAs. To the south, it shares a border with Gombi LGA. To the west, it is adjacent to Maiha LGA. According to the (NPC, 2006) census, the population

of Hong LGA was around 169,126. Hong Local Government Area (LGA) covers an area of approximately 970 square kilometers The dominant tribe in the Hong Local Government Area (LGA) of Adamawa State, Nigeria, is the Kilba (also known as Huba) people. The Kilba tribe is known for its rich cultural heritage and history within the region. They are primarily engaged in agriculture, trading, and various traditional crafts. The Kilba language is widely spoken among the inhabitants of the area., is characterized by savanna vegetation. This savanna vegetation is well-suited to the region's climatic conditions, which include a wet season and a dry season. The vegetation supports agriculture and livestock rearing, which are the main economic activities in the area. The type of soil are Sandy Soils, loamy soil and clay Predominantly found in the area, these soils are well drained and suitable for growing crops such as millet sorghum, and groundnuts. Rainy Season (Wet Season) Typically occurs from May to October. This season is marked by heavy rainfall, which is crucial for agricultural activities in the area. Dry Season Lasts from November to April. It has the average rainfall of 2,400mm and average temperature of about 36^0C. This season is characterized by little to no rainfall and includes. Harmattan Period Occurring from late November to early February, this period is marked by dry, dusty winds blowing from the Sahara Desert, resulting in cooler temperatures and lower humidity. (Adebayo, 2004). Dominated by grasses with scattered emergent vegetation of African Savannah such as *Acacia species philoshgma spp* . the dominant tree species typically found in the savanna vegetation include: *Vitellaria paradoxa, Adansonia digitata, Parkia biglobosa. Tamarindus indica, Balanites aegyptiaca,Terminalia avicemioides, pterocarpus erinaceus, Annona muricata, Ficus sycomorus, Daniellia oliveri, Vitex doniana, Anogeissus leiocarpa, Combretum micranthu, Diospyros mespiliformis, Albizia lebbeck, Prosopis Africana, Afzelia Africana, Faidherbia albida, Sterculia setigera, Azadirachta indica, Terminalia superba,Lonchocarpus sericeus*,. These indigenous tree species play crucial roles in the local ecosystem, providing resources such as food, medicine, and timber, and contributing to the biodiversity and environmental stability of the region.

Data Collection

Data were collected using Stratified Sampling, this method involves dividing the population into distinct subgroups or strata that share similar characteristics. In this case, the population is divided into four strata: Farmers, policy makers, Researchers, and NGOs. The population was divided into four strata based on their roles and perspectives related to agroforestry practices. The number of respondents from each stratum was determined based on their relevance and

importance to the study. Two hundred (200) questionnaires were proportionally allocated to them.

Data Analysis

The data generated were analyzed using proportional allocation across the different subgroups. descriptive analysis was use to summaries and interpret the distribution of the questionnaires in terms of raw count frequencies, and simple percentage

RESULTS

Farmers receive the largest proportion of questionnaires (105), as they are the primary practitioner's biodiversity conservation and their input is crucial for understanding the real-world application and challenge. Policy makers 46 questionnaires, as they play a significant role in facilitating and supporting biodiversity conservation within community. Researchers 26 questionnaires, which allows for capturing detailed technical and scientific insights that complement the practical experiences of farmers and policy makers. NGOs are allocated 24 questionnaires, which is sufficient to gather perspectives on policy, governance, and local regulations affecting biodiversity conservation, shown in table 1

These agroforestry practices in table 2 are tailored to the specific environmental and socio-economic conditions of Hong Local Government. They play a crucial role in enhancing biodiversity, improving soil health, and supporting sustainable agricultural livelihoods. Table 3 reveals that by integrating trees into these agroforestry systems, farmers in Hong Local Government can enhance biodiversity, improve soil health, and achieve more sustainable agricultural practices. These methods provide multiple benefits, including increased resilience to environmental changes, diversified income sources, and enhanced ecosystem services. Farmers in Hong Local Government appreciate the multifaceted benefits of trees in their agricultural systems in table 4. They recognize that trees significantly contribute to improved soil health, effective water management, and favorable microclimate conditions. These benefits not only enhance agricultural productivity but also promote sustainability and resilience against environmental stresses. Their perceptions underscore the importance of integrating trees into agroforestry systems to achieve long-term ecological and economic gains.

Interview with focus group in table 5 shows that, Farmers in Hong Local Government have observed significant positive changes in the variety of plant and animal species on their farms since integrating trees into their agricultural practices. These changes include increased plant diversity, the resurgence of native species, enhanced wildlife presence, improved pollinator activity, natural pest control, and a rise in amphibian and reptile populations. These observations highlight the ecological benefits of agroforestry, emphasizing how trees can create more diverse and sustainable agricultural ecosystems. Integrating and maintaining trees within farming systems in Hong Local Government in table 6 faces several challenges, including resource competition between trees and crops, land tenure issues, financial constraints, lack of technical knowledge, socio-cultural factors, and market access uncertainties. Addressing these challenges requires a holistic approach that includes policy support, capacity building, financial incentives, and community engagement. Overcoming these obstacles is essential to realizing the potential benefits of agroforestry, including enhanced biodiversity, improved soil health, and increased resilience to climate change, thereby promoting sustainable agricultural practices in the region.

Table 1: Role in the organization (e.g., farmer, researcher, policy maker, NGO representative)?

Organization	NR	(%)
Farmer	105	52.5
policy maker	45	22.5
Researcher	26	13
NGO representative)?	24	12
Total	200	100

Source field survey (2024),

Table;2. What types of agroforestry practices most commonly used in your farming activities?

agroforestry practices	Number of the respondents	Percentage (%)
Alley cropping	30	15
Silvopasture	30	15
Home Gardens	28	14
Agroforestry Woodlots	28	14
Boundary Planting	28	14
Taungya System	28	14
Parkland Agroforestry	28	14
Total	200	100

Source Field survey (2024).

Table;3 how trees are integrated into the prevalent agroforestry practices:

Agroforestry practice	Trees integration
Alley Cropping	Tree Selection and Spacing sufficient spacing between them Management; Regular pruning to prevent competition
Silvopasture:	Trees are either planted in rows or scattered throughout Fast-growing, hardy tree species are commonly use Grazing patterns are managed to prevent overgrazing
Home Gardens:	A variety of trees, shrubs, vegetables, and herbs are grown Trees are integrated in vertical layers to optimize space
Agroforestry Woodlot	Woodlots are planting trees in dedicated plots
Boundary Planting	Trees are planted along field to mark boundaries
Taungya System:	Annual crops are grown side young forestry plantations
Parkland Agroforestry:	selectively trees are retained throughout crop land

Source Field survey (2024).

Table;4. In what ways do you perceive the presence of trees on your farm contributing to soil health, water management, and microclimate regulation?

Contributions	Ways of perception	interview with focus group
Soil health:	Nutrient enrichment, soil structure improvement, erosion control	
Water Management:	Water retention, groundwater, reduction of soil run off,	
Microclimate Regulation:	temperature moderation, windbreak, humidity regulation, pest control	

Source Field survey (2024).

Table;5. Have you observed any changes in the variety of plant and animal species on your farm since integrating trees into your agricultural practices?

Changes	Observation
Increased Plant Diversity	famers report noticeable increase in plant variety
Growth of Shade-Tolerant Species:	shade provide by tree allows for growth of plant
Natural regeneration:	increase presence of wildlife, birds, insects,
Increased wildlife presence:	bird find nesting site in tree, insects
Enhance pollination activity:	pollination population, bees and butterflies
Improved pest control:	increase in predatory insects, birds that control pest
Rise in amphibians and reptiles:	increase due to humid, stable microclimate

Source Field survey (2024).

Table;6. What challenges do you face in integrating and maintaining trees within your farming system?

Challenges	NR	%
Competition for resources	**32**	**16**
Land tenure issues	**34**	**17**
Financial constraints	**34**	**17**
Technical knowledge and skills	**34**	**17**
Socio cultural factors	**34**	**17**
Market uncertainty	**32**	**16**
Total	**200**	**100**

Source Field survey (2024

Economic factors such as the cost of tree planting and the potential income from tree products in table 7. significantly influence farmers' decisions to adopt or expand agroforestry practices in Hong Local Government. Addressing these factors through financial incentives, market development, access to credit, and capacity building is essential to promote sustainable agroforestry initiatives. By enhancing economic viability and demonstrating the long-term benefits of tree integration, policymakers and stakeholders can encourage more widespread adoption of agroforestry, leading to enhanced environmental sustainability and improved livelihoods for farmers in the region. Agroforestry practices in table 8 offer various benefits for biodiversity conservation. For instance, alley cropping combines crops and trees, providing diverse habitats for insects, birds, and other wildlife. Windbreaks and riparian buffers not only protect soil and water but also serve as corridors for wildlife movement. Additionally, silvopasture integrates trees into grazing lands, enhancing habitat diversity and soil health. Overall, these practices foster ecological resilience, promoting biodiversity in agricultural landscapes. In table 9 despite the observation made by respondent from Hong Local Government in Adamawa State, Nigeria, there was no serious changes seen because up to now there's was no dedication given to the practice that will give notable impacts. But agroforestry practices generally have notable impacts on wildlife habitats, in summary, agroforestry practices in Hong, Adamawa State, typically can enhance wildlife habitats if given fully diligent practice, through increased biodiversity, habitat connectivity, and improved environmental conditions. Trees in agroforestry systems enhance pollinator

diversity in several ways as it was revealed in the table 10. Firstly, they provide additional foraging resources such as nectar and pollen, supplementing those available in surrounding monoculture fields. Secondly, trees offer nesting sites and shelter for pollinators, including solitary bees and certain butterfly species. Thirdly, the diverse structure of agroforestry systems creates microclimates, which can support a wider range of pollinator species adapted to different conditions. Finally, the presence of trees in agroforestry systems can increase connectivity between habitats, facilitating the movement of pollinators across landscapes. Overall, trees play a crucial role in enhancing pollinator diversity within agroecosystems. Agroforestry practices in table 11 can indeed help in preserving native plant species. By integrating trees with agricultural crops, agroforestry systems mimic natural ecosystems more closely than conventional monoculture agriculture. This approach can create habitats conducive to the survival and propagation of native plant species that might otherwise be displaced by intensive farming practices. Additionally, agroforestry systems often involve the use of native tree species, which can serve as reservoirs for genetic diversity and provide habitat for associated native plants. Moreover, agroforestry systems contribute to soil conservation and nutrient cycling, which can support the growth of native plant species. Overall, agroforestry practices can play a valuable role in conserving native plant species and enhancing overall biodiversity in agricultural landscapes

Table;7. How do economic factors, s influence your decision to adopt or expand agroforestry practices?

Changes	NR	%
Cost of Tree Planting	**30**	**15**
Potential Income from Tree Products	**28**	**14**
Time to Yield and Return on Investment	**28**	**14**
Risk and Uncertainty	**30**	**15**
Access to Finance and Support	**28**	**14**
Cost-Benefit Analysis	**28**	**14**
Comparative Advantage	**28**	**14**
Total	**200**	**100**

Source Field survey (2024).

Table 8: how do different agroforestry practices contribute to biodiversity conservation?

Benefits	Number of the respondents	Percentage (%)
Habitat	50	25
Protection	52	26
Soil health	48	24
Corridor for wildlife	50	25
Total	200	100

Source; Field survey (2024).

Table;9. Have you observed any changes in wildlife habitat due to the presence of trees in agroforestry systems?

Changes	Number of the respondents	Percentage (%)
Yes	180	90
No	20	10
Total	200	100

Source Field survey (2024).

Table 10: How do you think trees in agroforestry systems enhance pollinator diversity?

Ways of pollinator enhancement	NR	%
Nectar and pollen	34	17
Nesting site and shelter	34	17
Micro element	32	16
Increase habitat connectivity	32	1 6
Facelifted movement pollinator	34	17
Enhance pollinator diversity	34	17
Total	200	100

Source; Field survey (2024).

Table 11: Do you believe agroforestry practices help in preserving native plant species? If yes how

Response	Number of the respondents	Percentage (%)
Yes	180	90
No	20	10
Total	200	100
How; Reasons by focused group, expert, identified as		Positive
preserving native plant species		positive
mimic natural ecosystems		positive
create habitats conducive		positive
involve the use of native tree species		positive
soil conservation and nutrient cycling		positive
conserving native plant species		positive

Field survey (2024).

Conclusion

The integration of trees in agroforestry systems within Hong Local Government has demonstrated substantial benefits for biodiversity conservation. Trees not only enhance soil fertility and regulate the microclimate but also provide critical habitats for various species, thereby increasing overall biodiversity. Despite these benefits, several challenges impede the widespread adoption of agroforestry practices, including resource competition, land tenure issues, and economic constraints. Addressing these challenges is crucial for maximizing the potential of agroforestry in promoting biodiversity conservation.

Recommendations

1. Policy Support and Incentives Develop and implement policies that provide financial incentives and technical support to farmers adopting agroforestry practices. This could include subsidies for tree planting, tax breaks, or grants.
2. Education and Training Conduct training programs and workshops to educate farmers about the ecological and economic benefits of agroforestry. Provide practical knowledge on best practices for tree integration and management.
3. Research and Development: Promote further research to identify the most effective tree species and agroforestry practices suitable for the local conditions in Hong. Research should also focus on developing innovative solutions to overcome challenges like resource competition and land tenure issues.
4. Community Engagement and Collaboration Foster collaboration among local communities, government agencies, and non-governmental organizations to support agroforestry initiatives. Encourage community-led conservation projects that emphasize the role of trees in biodiversity conservation.
5. Monitoring and Evaluation Establish robust monitoring and evaluation systems to track the impact of agroforestry practices on biodiversity. Regular assessments will help in adapting and refining strategies to ensure the long-term success of biodiversity conservation efforts. By implementing these recommendations, Hong Local Government can enhance the role of trees in agroforestry landscapes, leading to improved biodiversity conservation and sustainable agricultural practices. This approach can serve as a model for other regions in Nigeria and beyond, demonstrating the potential of agroforestry in achieving environmental and socio-economic benefits.

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