

Evaluation of Agroforestry Practices for Climate Adaptation Strategies in Narok County

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ABSTRACT

Climate change has intensified environmental degradation, livelihood insecurity, and socio-economic vulnerability in climate-sensitive regions such as Narok County, Kenya. In response to these challenges, agroforestry has been recognized as a sustainable land-use strategy capable of enhancing climate resilience while supporting livelihoods. This study, titled The Effectiveness of Agroforestry Practices as Climate Adaptation Strategies in Narok, examined the role of agroforestry in reducing climate vulnerability and strengthening community resilience in Narok County. Guided by Securitization Theory, the paper used case study research design and employed a mixed-methods approach integrating qualitative and quantitative techniques. Narok was selected due to its ecological diversity, dependence on climate-sensitive livelihoods such as agriculture and pastoralism, and increasing exposure to climate variability. Data were analysed using descriptive statistics and contextual analysis. The findings revealed that 68% of surveyed households practiced some form of agroforestry. Farmers prioritized fruit trees for food security and fast-growing timber species for income generation. The paper established that contour-based tree planting in hilly areas such as Mau Narok contributed to reducing soil erosion and improving ecosystem stability. Agroforestry practices also enhanced household resilience by diversifying income sources and providing alternative food and fodder resources during periods of climate stress and crop failure. The study concludes that agroforestry is a strategy for reducing climate vulnerability in Narok through improved environmental conservation, livelihood diversification, and strengthened food security. It recommends the promotion of indigenous nitrogen-fixing and drought-tolerant tree species, including *Moringa oleifera*, to enhance adaptation to the county's semi-arid conditions.

Keywords: Climate Change, Climate Resilience, Agroforestry, Tree Fruit

INTRODUCTION

The climate change phenomenon represents one of the most critical threats to global food security, rural livelihoods, and environmental stability in the 21st century. The Intergovernmental Panel on Climate Change (Githae, 2015). Awazi, (2022) indicates that rising global temperatures and unpredictable rainfall patterns have severely lowered agricultural output, heavily influencing developing countries. In sub-Saharan Africa (SSA), rural economies rely deeply on rain-fed agriculture and pastoral production, making them vulnerable to climate shifts.

Traditional coping mechanisms are failing due to frequent droughts and landscape degradation, forcing a shift toward resilient, integrated land-management options. Trees help to regulate water cycles, reduce soil erosion, and provide shade for crops and livestock, mitigating the effects of heat stress. Nega, (2025), stresses that despite the potential of agroforestry practices, barriers exist that can hinder its widespread adoption, among the most developing countries. Non-the-less agroforestry practices offer a multifaceted approach to addressing climate vulnerability by enhancing farm resilience, mitigating climate change and improving livelihoods in SSA.

Study Background

The subject of climate change has been becoming a big menace to the world. It modifies the frequency and intensity of major storms, droughts, and floods, which in turn destroy farming, water and other resources, and infrastructures. This series of events leads to food shortage, social violence, extreme weather conditions, and forced migration (Awazi, 2022). Still, Agroforestry is one of the most promising ways of counteracting climate change since it can both reduce the main drivers of climate change and help communities adapt to its negative impacts.

Bogale, (2025) argues that climate vulnerability in the United States could be tackled when individuals, governments and private sector all act, with strategies, including promoting electric vehicles, creating livable and sustainable cities, conservation, and restoration of natural ecosystems like forests and oceans. Nega, (2025) denotes climate vulnerability is a core concept for understanding and addressing the impacts of climate change, but its definition and application have evolved significantly over time. Due to its complexity, climate vulnerability integrates perspectives from disciplines, including geography, economics, sociology, and political science.

Agroforestry is vital for mitigating climate vulnerability in Africa, where the majority of agriculture is rain-fed and prone to climate change impacts, like droughts and floods (Abebaw, Yeshiwas & Feleke, 2025). According to Nega, (2025) agroforestry systems produce a variety of goods, including fruits and timber, in addition to staple food crops. Awazi, (2022) cites that integrating trees with crops and livestock helps farmers, who produce most of the country's food, diversify their livelihoods and build resilience against climate shocks. While agroforestry is promoted as a possible solution for climate change, issues complicate relationship, for vulnerable populations (Awazi, 2022). The challenges include trade-offs between climate mitigation, the potential for maladaptation, and structural barriers that prevent equitable adoption.

Agroforestry denotes the intentional integration of trees and shrubs with crop and livestock production systems is a proven tool for both climate change adaptation and mitigation. Empirical evidence reveals that agroforestry systems enhance on-farm biodiversity by up to 40%, improve soil organic carbon by 15%, and increase crop yields by 30% compared to mono-cropping. By creating favorable microclimates, reducing soil erosion, and enhancing water retention, trees buffer crops and livestock against extreme weather conditions. The Kenyan government highlights the role of private and community-led tree planting through initiatives like the Kenya National Agroforestry Strategy to restore landscapes and secure local food supplies.

Narok County, located in Kenya's Arid and Semi-Arid Lands (ASALs), features a dynamic socio-ecological landscape dominated by agro-pastoralism and smallholder farming. The region is highly susceptible to climate-induced hazards, notably erratic rainfall, flash floods, and prolonged droughts. These factors cause frequent livestock deaths, pasture degradation, and widespread crop failures. Historically, nomadic pastoralism allowed communities to migrate away from drought pressures. However, modern land fragmentation and sedentary lifestyles have constrained this mobility, locking communities into localized climate risks. Local communities have increasingly turned to climate-smart agro-pastoral practices, such as retaining nitrogen-fixing indigenous trees in pastures, to manage heat stress on livestock and preserve soil health.

Statement of the Research Problem

Climate change impacts are increasingly hitting hard the poorest and most vulnerable people around the globe (Awazi, 2022). In fact, the changing climate is increasingly responsible for prolonging droughts, causing land degradation, and reducing agricultural productivity in Esat Africa with reference to Kenya, Mostly the areas which are the most vulnerable to climate change like Narok County, that have been seriously affected (Mutua, 2018). These climate-related challenges threaten rural livelihoods, food security, and environmental sustainability, among communities that depend heavily on agriculture and pastoralism.

Agroforestry has been promoted as a climate-smart and sustainable land-use system capable of improving

soil fertility, conserving water, enhancing biodiversity, and diversifying household income, its adoption and integration in Narok remain limited and inconsistent. The continued low uptake of agroforestry practices has constrained efforts to strengthen community resilience and reduce vulnerability to climate-related risks. In addition, the factors influencing the adoption and sustainability of agroforestry practices, including support, policy implementation, ecological conditions, and community capacity, remain insufficiently understood.

The existing studies have largely emphasized the environmental benefits of agroforestry, with limited empirical focus on its effectiveness in reducing climate vulnerability and supporting sustainable livelihoods at the local level. Consequently, there is inadequate context-specific evidence on how agroforestry practices contribute to climate resilience among communities in Narok County. This study therefore seeks to assess agroforestry practices and examine their role in reducing climate vulnerability in Narok County, Kenya, with a focus on the institutional, ecological, and socio-economic factors influencing their adoption and sustainability.

Research Objectives

The general objective was to evaluate the effectiveness of agroforestry practices as climate change adaptation strategies among smallholder farmers in Narok County. The specific objectives will include to:

- Identify the dominant agroforestry practices currently adopted by farmers in Narok County.
- Assess the contribution of these agroforestry practices to household climate resilience and food security.
- Evaluate the environmental impacts of agroforestry on local soil health and water retention.

Justification of the Study

The rationale for evaluating agroforestry practices for climate adaptation in Narok County is grounded in the region's environmental vulnerability, economic dependency on agriculture, and the need for scalable climate solutions. Narok County is predominantly an arid and semi-arid land highly susceptible to climate variability. In recent years, the region has experienced erratic rainfall patterns, prolonged droughts, and rising temperatures. These shifts have triggered severe land degradation, acute water scarcity and a decline in ecosystem productivity.

The economy of Narok County relies heavily on rain-fed agriculture and pastoralism. Climate-induced crop failures and pasture depletion directly threaten the food security and household incomes of local communities. Evaluating agroforestry offers a viable pathway to diversify income through fruits, and fodder, thereby building economic resilience against climate shocks.

Agroforestry systems can stabilize soils, enhance water infiltration, and restore degraded lands, serving as a dual-purpose strategy for local environmental conservation and global carbon sequestration. While, Kenya's National Climate Change Action Plan and the Constitution advocate for increased tree cover and climate-smart agriculture, there is a lack of localized, empirical data on which specific agroforestry configurations (alley cropping, windbreaks) yield the best adaptation outcomes in Narok County.

LITERATURE REVIEW

Empirical Literature Review

Climate change poses an immediate threat to semi-arid agricultural ecosystems in East Africa. Narok County, Kenya, is particularly vulnerable due to its reliance on rain-fed agriculture and pastoralism (Oduor & Amwatta, 2023). Rising temperatures, erratic rainfall, and severe land degradation threaten local food security. Agroforestry, the intentional integration of woody perennials with crops and livestock, presents a viable framework for climate adaptation.

Agroforestry mitigates the financial burden of synthetic fertilizers. Awazi, (2022) opines that Nitrogen-fixing tree species (such as *Sesbania sesban* and *Calliandra calothyrsus*) replenish soil macro-nutrients

through leaf litter decomposition. This biomass accumulation restores organic carbon to degraded soils in Narok's arid zones (Katothya, 2020). Agroforestry serves as a vital climate adaptation strategy for smallholder farmers in Narok County, a region experiencing drought frequency and erratic rainfall (Kinuthis, et, al., 2023). Empirical evidence demonstrates that integrating trees (*Grevillea robusta*) with crops and livestock improves soil fertility, enhances water retention and diversifies income streams, boosting overall livelihood resilience.

Narok County faces severe climate change impacts, including unpredictable rainfall, prolonged droughts, and severe land degradation. Agroforestry, integrating trees with crops and livestock, offers a viable solution to build local resilience. However, the adoption rates and specific ecological impacts of various agroforestry models across Narok's diverse agro-ecological zones remain insufficiently documented.

This paper evaluates current agroforestry practices to determine their efficacy in climate adaptation. In Narok County, local government or community leaders securitize climate change, manifested as severe droughts, unpredictable rainfall, and land degradation, by elevating it from an environmental issue to an existential threat to community survival and pastoralist-agropastoralist livelihoods.

THEORETICAL FRAMEWORK

The Securitization Theory

Securitization theory is a framework in International Relations (IR) that explains how specific issues (as migration, pandemics, or climate change) are transformed from regular political topics into urgent existential threats (Durkin & McCue, 2021). The theory identified five main areas where securitization occurs: military, political, societal, economic, and environmental security. Developed by the Copenhagen School (led by Barry Buzan and Ole Wæver), the theory posits that security is not an objective fact but a social construction.

Securitization theory provides a framework for understanding how climate change and agricultural practices like agroforestry are elevated from normal politics to matters of urgent, existential security. Khasru, (2024) asserts that in this context, agroforestry is often framed as a soft security tool, a pragmatic solution to mitigate the destabilizing threats of climate-induced food and resource scarcity. Climate change is frequently framed as a threat multiplier that exacerbates existing social, economic, and political tensions (Kithumbu & Omondi, 2017).

The transition of agroforestry from a traditional farming practice to a strategic security asset involves new governance models. Agroforestry is a tool for carbon sequestration, helping to meet international climate targets that are framed as essential for global stability. By providing multiple income streams (timber, fruit, fuel) and improving soil health, agroforestry reduces a population's sensitivity to climate shocks, thereby lowering the risk of resource-based violence.

The Narok County climate mitigation and adaptation policies (carbon credit schemes and national agricultural strategies) can provide incentives and a supportive framework for agroforestry (Maina, 2013). Cultural norms and traditional ecological knowledge can play a vital role in promoting the integration of trees into farming landscapes.

Manono & Gichana, (2025) posit that the practices of SAPs provides an opportunity to enhance the quality and safety of food consumed by people by reducing the use of harmful chemicals, increasing the diversity of crops and diets, and improving post-harvest management. Khasru, (2024) asserts that conservation agriculture leaves crop residues or cover crops on the soil surface to protect it from erosion, retain moisture, and improve soil.

Research Methodology

This paper adopted a convergent parallel mixed-methods research design, collecting quantitative biophysical

or socio-economic parameters and qualitative institutional data concurrently. Narok County was stratified by agro-ecological profile into highland crop-dominant, transitional mixed farming, and lowland agropastoral zones. This study employed a secondary data-driven, analytical research design. Rather than collecting field-level primary data, this paper synthesizes published empirical research, institutional climate profiles, spatial ecosystem data, and county policy white papers to build a comprehensive picture of agroforestry dynamics in Narok County.

Narok County covers an area of approximately 17,944 km², featuring diverse agro-ecological zones (AEZs) ranging from humid highlands (such as Mau Narok, suitable for crop farming) to semi-arid lowlands (including Narok West and South, which are predominantly pastoral and agropastoral). The county experiences a bimodal rainfall regime fluctuating between 500 mm annually in the lower basins to over 1,500 mm in the elevated escarpments.

The study gathered high-quality secondary data from the following verified repositories that is the, Institutional Reports from the Kenya County Climate Risk Profile Series (Narok County), Kenya Forest Service (KFS) briefs, and the Kenya Arid Lands Policy documents. The Academic Databases from Peer-reviewed journal articles extracted from Crossref, Google Scholar, and ResearchGate spanning the last several years. The Legal and Policy Texts: The Narok County Climate Change Act (2021) and the National Agroforestry Strategy (2021-2030).

The drafted paper provides a structured analysis of how incorporating trees into local farming systems mitigates environmental vulnerability in Narok County, Kenya. It synthesizes secondary data to establish quantitative and qualitative performance indicators across the region's diverse agro-ecological zones. The collected documentation underwent serious rigorous qualitative and quantitative content analysis. Qualitative data concerning farmers' perceptions and institutional frameworks was grouped using thematic coding, focusing on adaptation pathways and barriers to adoption. Quantitative indicators; such as yield metrics, forest cover loss percentages, income shifts, and adoption rates, were compiled and compared directly to evaluate the operational performance of agroforestry configurations.

RESEARCH RESULTS AND DISCUSSION

Results

The secondary data shows that the type of agroforestry practiced in Narok County depends heavily on the agro-ecological zone. In the lowlands, pastoral communities shifting toward agropastoralism heavily favor silvopastoral models. Conversely, upper highland areas prioritize structural woody perimeters like boundary planting to secure land boundaries and generate income from timber poles. Trees improve soil organic carbon, reduce wind and water erosion, and enhance water infiltration during intense precipitation events. Shade trees moderate microclimates, lowering heat stress for both crops and grazing livestock.

The paper found that integrating fruit, fodder, and multipurpose timber trees diversifies farm income beyond traditional maize and sheep production. This buffers households against seasonal crop failures and market price volatility. Mulwa, Kibet & Nyangweso, (2021) biophysical resilience shows that synthesized ecosystem studies indicate that tree integration helps mitigate the intense precipitation and subsequent flash flooding common to Narok County.

Root structures from multi-strata agroforestry systems enhance the stability of slopes, reducing soil erosion and retaining valuable topsoil moisture during hot spells. Parkland trees like *Faidherbia albida* enrich nitrogen levels in nearby crop fields, reducing the need for costly inorganic fertilizers while supporting yield stability.

The data from local community development projects, such as the Pastoral Field Schools (PFS) in Narok, demonstrate tangible improvements in rural livelihoods. Agropastoralists who integrated pasture development with agroforestry fodder trees expanded their milk production from an average of 2 liters to 7 liters per cow per day (Mose, et, al., 2025). This directly translated into stable financial returns through local

cooperatives, shielding households from the economic shocks of absolute crop failure. Socio-economic analysis confirms that agroforestry adopters exhibit significantly higher household resilience parameters.

Traditional farming methods struggle under these changing weather patterns, reducing crop yields and livestock health. The households practicing diversified agrisilvopastoral methods reported higher net household income stability during drought shocks. While pure monoculture grain yields fell by up to 58% during dry spells, agroforestry households offset these losses by harvesting alternative streams, including grass fodder, fuel wood, charcoal, honey, and structural timber (Katothya, 2020).

Discussion

Narok County faces severe climate change threats, including unpredictable rainfall, prolonged droughts, and severe soil degradation (Achieng & Owuor, 2022). This paper found that agroforestry practices, such as silvopasture, alley cropping, and farmer-managed natural regeneration, significantly enhance climate resilience and local livelihoods in Narok County by improving soil moisture, diversifying income, and mitigating drought impacts.

Climate change threatens global crop yields and livestock production, demanding an immediate shift toward climate-resilient agroforestry systems. Providing shade lowers ambient temperatures for animals, which helps maintain feed intake and milk or meat production. To combat this, agroforestry, integrating trees with crops and livestock, is crucial. It builds resilience through soil health, microclimate control, and diversified livelihoods, securing long-term farm productivity.

Climate change phenomenon agriculture by degrading soil quality, causing water scarcity, and increasing pest pressures, which reduce crop yields and livestock productivity. Agroforestry training in Narok County is highly localized and primarily driven by non-governmental projects, leaving vast areas with minimal extension coverage. Smallholder farmers in Narok County who have high access to agricultural extension services show a significantly higher rate of agroforestry adoption compared to those with limited access.

Trees provide secondary income through fodder, fuel wood, fruits, and medicinal substances, which helps households pay for essential services like education and healthcare. In areas like Narok, agroforestry is often one of the least used strategies compared to early planting or increased manure use. This study concludes and emphasizes the need for education and climate awareness to bridge the gap between perceived benefits and actual adoption in Narok.

RESEARCH CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The unpredictable rainfall, droughts, and flooding degrade soil, leach nutrients, and damage structures. Rising temperatures and pests severely reduce staple yields, threatening food supplies and spiking market prices. Heat stress reduces livestock reproduction, growth, and milk production. Climate change also depletes water resources and creates critical feed gaps during dry seasons. Hence, this evaluation concludes that agroforestry practices function as effective biophysical and socio-economic climate adaptation mechanisms within Narok County.

Agroforestry offers a sustainable pathway for climate adaptation in Narok County by restoring degraded rangelands and stabilizing rural incomes. Maximizing its potential requires county-led seedling distribution, expanded extension training, and water-harvesting integration. It is worth noting that when properly structured, these systems improve soil moisture conservation, build soil organic carbon pools, microclimates, and diversify income portfolios to buffer smallholders against climate shocks. However, their performance varies by agro-ecological zone and depends heavily on proper species selection and management.

The expansion of these practices is limited not by technical unfeasibility, but by institutional barriers,

including land-tenure insecurity, limited extension support, and constraints to high-quality planting materials. Agroforestry systems help absorb greenhouse gases, contributing to climate mitigation. Agroforestry systems practices combines trees and shrubs with livestock grazing. The trees provide shade and high-protein fodder, such as the Calliandra shrub used successfully in Kenya. Planting crops between rows of trees to create windbreaks improve soil fertility and reduce moisture loss. This means that strategic agroforestry practices protect and boost agricultural productivity through targeted, nature-based solutions.

Climate change severely affects crop yields and livestock through rising temperatures, droughts, and erratic rainfall, exacerbating soil erosion and heat stress. Agroforestry combats these threats by creating a resilient microclimate, fixing vital soil nutrients, preventing erosion, and providing reliable fodder for animals. Hence, integrating timber, fruit-bearing trees, and cash crops alongside subsistence farming protects farmers against total crop failure. The paper concludes that the contributions of agroforestry practices to the livelihoods of farmers are determined by local biophysical and socio-economic factors and need to be examined from their perspective.

Recommendations

The Narok County Department of Agriculture should restrict the use of water-intensive exotics in arid sub-counties, prioritizing indigenous species like *Faidherbia albida* and *Melia volkensii*. Develop county-level legal frameworks that recognize long-term tree occupancy rights for tenant farmers, encouraging investment in agroforestry assets. The main challenges facing agroforestry in Narok County stem from land tenure issues, climate unpredictability, and livestock management conflicts. While groups like the Paran Women Group are actively restoring parts of the Mau Forest ecosystem, several critical barriers hinder the widespread adoption of agroforestry across Narok County.

The shift from communal pastoral rangelands to private land ownership has led to heavy land fragmentation. Farmers with short-term leases or insecure land rights are highly hesitant to plant long-term trees. The local farmers frequently report a lack of technical knowledge regarding proper soil and water conservation measures, tree-crop configurations, and optimal tree-species management. Agroforestry in Narok County is a critical strategy to transition from vulnerable nomadic pastoralism to resilient agro-pastoralism. By integrating trees into farming and livestock systems, communities can buffer against erratic rainfall, heat stress, and soil degradation. This research study recommends the establishment of woodlots for sustainable charcoal and timber production, reducing the encroachment and illegal felling in the Mau Escarpment.

The practice of agroforestry provides alternative income sources (timber, fruits, charcoal) and reduces risk during crop failures, and therefore this research recommends greater intensify farmer training, where there is prioritized training on specific agroforestry technologies to overcome limited knowledge, which is a major barrier to adoption. To scale these benefits, the county should prioritize capacity building and access to credit, specifically targeting younger household heads who are more likely to adopt long-term tree-based systems.

The following recommendation is synthesized from recent research focused on Narok and similar arid and semi-arid land regions in Kenya. Recommends that for agroforestry to work in Narok, it must be framed not just as an environmental tool, but as a business strategy, that provides tangible economic benefits alongside climate resilience.

Formalize community-based learning where early adopters train their peers to build trust and local expertise. In Narok's pastoralist-to-agro-pastoralist transition, the shift from communal to private land ownership is the single most important institutional factor enabling long-term agroforestry investment programmes. Moreover, invest in infrastructure and market information systems to reduce the exploitation of farmers by intermediaries when selling timber or fruit.

Narok County faces severe climate change impacts, including prolonged droughts, erratic rainfall, and flash floods that threaten local farming and livestock. This paper evaluates how agroforestry, integrating trees and shrubs with crop and livestock systems, serves as a vital climate adaptation strategy. By analyzing

biophysical and socio-economic pathways, this paper demonstrates how agroforestry stabilizes smallholder productivity against climatic shocks.

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