The Influence of Household Dynamics on Ruminant Livestock Production Systems and the Kakamega Forest Ecosystem, Kenya

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ABSTRACT

The dynamics of households significantly influence the management of ruminant livestock within the Kakamega forest ecosystem, particularly in response to the challenges posed by climate change. This, in turn, has both direct and indirect effects on the Kakamega forest ecosystem. This study sought to determine the influence of the household dynamics on ruminant livestock production systems and the Kakamega forest ecosystem, Kenya. The study was grounded in the Ecological Systems Theory. The study employed a correlational research methodology. The study used a structured questionnaire to obtain data from 298 household heads selected using simple random sampling from a population of 26,079 households by administering a structured questionnaire to capture the household's demographics and ruminant livestock production strategies within the Kakamega forest ecosystem covering the three Counties of Vihiga, Kakamega and Nandi. The researchers used the purposive sample technique to carefully select key informants from a preset list of stakeholders.The analysis of the data was conducted using both descriptive and inferential statistical methods. The findings revealed that, Majority (75%) of the households totally depended on the forest for communal grazing. Out this 60% graze their livestock in the forest for the whole year, while 40% grazed for about 8 months. The 25% of the households who did not enter their livestock into the forest still harvested forage to feed their livestock at home. Inadequate feed throughout the year was identified as a key limitation influencing cattle raising in all catchment regions (Makuchi 60%, Cheboite 58%, and Shamiloli 56%). Forage shortage was especially severe during the dry season (January to March) and the lengthy rain season (April to August), when crops were planted on farms.The primary factors influencing the Kakamega Forest Ecosystem are agricultural expansion and grazing, as seen by changes in land size before and after livestock farming. This research concluded that degradation of forest vegetation is notably extensive in Vihiga and Kakamega County, as well as the surrounding areas, where nearly all accessible land is utilized for cultivation or pasture. Based on the findings, the research suggests that feed conservation technology be promoted, and that a ruminant livestock management plan based on the Tropical Livestock Unit (TLU) be implemented, backed by suitable livestock regulations. The principal restoration and conservation technique proposed was to grow fodder crops and agroforestry trees on farms, use a participatory community approach to regulate grazing, and store agricultural leftovers to lessen strain on the forest, particularly during the dry season.

Keywords: Forage, Fodder Crops, Household Dynamics, Kakamega Forest, Livestock Management, Ruminant Livestock

I. INTRODUCTION

The intricate dynamics within a household play a crucial role in shaping the management of ruminant livestock species, including cattle, sheep, goats, and rabbits. These livestock are largely dependent on the surrounding environment for fodder, feed resources, and essential production and reproduction processes. While households serve as the fundamental units of social organization and economic sustenance, our understanding of their defining characteristics across different countries remains relatively underexplored compared to other areas of demographic research (Esteve et al., 2024).

At any level—national, regional, or global—households are typically guided by a head responsible for making critical decisions on resource allocation and utilization, regardless of gender. However, household dynamics—shaped by factors such as the education level of the household head, household size, land use patterns, land tenure systems, and landholding sizes—directly influence livestock management strategies. A stark gender disparity persists in resource control, where men often face challenges related to land fragmentation, while women encounter systemic barriers to

ownership and access. This disparity entrenches men as primary resource owners, relegating women to a subordinate role that limits their ability to access and adopt livestock-related technologies (Njiru et al., 2023).

Yet, the increasing prominence of joint decision-making underscores the need for inclusive interventions that reflect the priorities and needs of both men and women. Effective design and marketing of such interventions should actively consider gender dynamics to ensure equitable participation and benefit distribution (Voss et al., 2023). Addressing these structural inequalities is not only critical for enhancing livestock management but also for fostering broader economic empowerment within households.

Voss et al. (2023) argue that household headship and decision-making dynamics significantly shape nutritional outcomes. Their findings suggest that male-headed households generally exhibit superior nutrition compared to female-headed ones. However, households where women hold a dominant voice in decision-making tend to achieve better nutritional outcomes than those where men dominate. Interestingly, even in male-headed households, the presence of a female-dominant voice contributes to improved nutrition. These insights underscore the complexity of gendered decision-making within households and its implications for food security.

Zingwe et al. (2023) build upon these findings by highlighting persistent gender inequalities in household decision-making. They emphasize that agricultural development efforts centered on gender and social inclusion must promote equitable adoption of agricultural technologies. A key challenge in this field is the assumption that men and women make farm management decisions independently. In reality, decision-making in dual-adult households is often a negotiated process, influenced by multiple household members (Voss et al., 2023).

The Livestock Sector represents a significant socio-economic enterprise, offering livelihoods to approximately 1.3 billion individuals worldwide and playing a crucial role in achieving Sustainable Development Goals (SDGs). In sub-Saharan Africa (SSA), it is often indicated that around 70–80% of agricultural land is necessary for the production of both pasture and feeds. The livestock sector in Africa accounts for approximately 30–80% of the Agricultural Gross Domestic Products. Approximately 85% of livestock keepers globally are located in Sub-Saharan Africa. The livestock sector in Kenya plays a crucial role in the economy, contributing approximately 3.8 percent to the National Gross Domestic Product (Kenya National Bureau of Statistics [KNBS], 2019). The national livestock resource base is estimated the presence of 2.2 million dairy cattle, 559,000 dairy goats, 13 million indigenous cattle, 19.3 million sheep, 28 million goats, 4.6 million camels, 1.2 million donkeys, and 561,000 rabbits classified as ruminant livestock. Livestock farming represents the largest utilization of land, with numerous developing countries participating in subsistence farming and utilizing various forest ecosystems, thereby becoming a significant contributor to deforestation. (KNBS, 2019)

Similarly, research in Ghana reinforces the critical role of household structures in food security. Mohammed et al. (2023) demonstrate that socio-economic and agricultural factors—including household size, marital arrangements, wealth status, and post-harvest loss—directly shape food security outcomes. Their study reveals that decision-making structures influence how household members negotiate and reconcile resource allocation preferences, ultimately affecting food security. These findings call for policies that account for the intricate household power dynamics when addressing food insecurity and related socio-economic challenges.

Research findings in Kenya indicate that aspects of small ruminant production, such as decision-making, ownership, labour allocation, and access to and control over assets, are influenced by gender. Ogolla et al. (2022) highlights that for agroforestry to enhance its role in conserving biodiversity within human-dominated landscapes, especially in regions with high subsistence farmer populations, it is essential to acknowledge farmers' perceptions regarding the value of trees and their choices in tree planting or maintenance (Espira et al., 2023). This study, therefore, examines the impact of household dynamics on livestock production systems and the Kakamega forest ecosystem.

1.1 Statement of the Problem

Human activities including illegal logging, charcoal manufacture, and unsustainable cattle grazing continue to cause major degradation of the Kakamega Forest ecosystem despite continuous conservation efforts by the Kenyan government and many environmental organizations (Obiri et al., 2012; Were et al., 2013). An understudied element causing this environmental problem is still the connection between household dynamics and ruminant cattle production methods.

For an extended period, Forest Adjacent Communities (FACs) have relied on indigenous knowledge to sustain livestock production and manage forest resources (Guthiga & Newsham, 2011). But changes in land-use practices, socioeconomic level, and household structures have changed conventional grazing patterns, therefore affecting the availability of forage and the sustainability of the ecosystems (Mbuvi et al., 2015). Studies show that household decision-making, herd composition, and resource access affect the intensity of cattle grazing in forested regions; their particular impact on Kakamega Forest is yet not well known (Mwangi & Dohrn, 2008). Most of the existing literature on livestock-forest interactions concentrates on economic incentives for community participation and large-scale conservation initiatives (Matiku et al., 2013; Koech et al., 2019). Limited empirical studies, however, investigate how family-level

variables—such as household size, income, and cattle management techniques directly affect forest degradation and ruminant livestock output within Kakamega Forest. Developing sustainable management strategies that balance needs for cattle production with goals for forest preservation depends on filling in this knowledge gap.

Thus, the purpose of this study is to investigate the impact of household dynamics on ruminant livestock production systems and their subsequent impact on the Kakamega Forest ecosystem. Understanding these links will help Kenya develop evidence-based plans for long-term forest management and livestock productivity.

1.2 Research Objective

To determine the influence the household dynamics had on the ruminant livestock production systems and the Kakamega Forest Ecosystem in Kenya.

II. LITERATURE REVIEW

2.1 Theoretical Framework

The study was anchored on Ecological Systems Theory. Developed by Urie Bronfenbrenner (1979), Ecological systems Theory offers a helpful perspective for analyzing the intricate relationships among homes, livestock production methods, and the Kakamega Forest ecology. The idea stresses how different environmental layers—from immediate settings (microsystem) to more general society impacts (macrosystem)—have effect on human behavior and ecological results. Within the framework of this study, the ecological systems method facilitates the analysis of interactions between ruminant cattle production systems and forest preservation initiatives with regard to household dynamics including resource consumption, decision-making, and socioeconomic level. This model emphasizes how household-level actions, community practices, and policy interventions impact environmental preservation in addition to governmental obligations (Bronfenbrenner, 1979). At the microsystem level, household choices about livestock grazing, fodder gathering, and forest resource usage directly influence the Kakamega Forest ecology. To keep their cattle, forest-adjacent villages rely on indigenous knowledge and traditional grazing techniques; overgrazing and deforestation have caused environmental damage (Opiyo et al., 2024). This paper investigates how instantaneous household activities contribute to ecological problems and how sustainable management techniques could be implemented locally using Ecological Systems Theory.

The mesosystem links homes to nearby institutions like community-based groups, agricultural extension agencies, and conservation projects. These interactions affect the decisions on cattle production and the acceptance of environmentally friendly methods. Studies on restricted cooperation between households and forest preservation organizations have revealed that inadequate management techniques follow from this (Mutiso & Mugambi, 2021). By means of an ecological perspective, one can better integrate local communities into conservation activities and guarantee that policies reflect the socioeconomic reality of homes near forests. External influences on household livestock production and forest preservation at the exosystem level include government policies, land ownership systems, and market factors. Policies meant to lower deforestation and support sustainable agriculture impact household decisions indirectly since availability to alternative grazing grounds or feed sources helps to lower reliance on forest resources (Kariuki et al., 2023). This paper evaluates how outside policies and interventions affect household actions and their environmental effects using Ecological Systems Theory.

The macrosystem takes into account more general society and cultural standards influencing opinions on forest preservation and cattle raising. Many rural Kenyan villages have cattle as a cultural emblem of wealth and prestige in addition to an economic benefit. Often resulting in environmental strain, this conventional viewpoint affects household decisions on herd sizes and grazing patterns (Mwangi et al., 2021). Understanding these strongly ingrained ideas helps one to plan conservation projects in line with cultural values and encourage environmentally friendly behavior. At last, the chronosystem addresses temporal variations in land use patterns, population increase, and climate variability that influence household dynamics as well as ecological sustainability. Rising demand for agricultural land combined with climate change has over time aggravated deforestation and biodiversity loss in the Kakamega Forest (Opiyo et al., 2023). This paper investigates how historical trends and future forecasts affect the interaction among households, livestock production, and forest preservation using Ecological Systems Theory.

Using Ecological Systems Theory, this study offers a comprehensive knowledge of the several elements influencing ruminant cattle output and forest preservation in the Kakamega Forest environment. It emphasizes the importance of multi-level interventions aiming at durable results considering home practices, institutional support, legislative frameworks, cultural values, and environmental changes.

2.2 Empirical Review

The inadequate feed quality in developing nations, particularly in Sub-Saharan Africa, remains a pressing challenge, as livestock primarily rely on nutrient-deficient grasses. This deficiency forces livestock in resource-limited

countries to consume up to ten times the amount of feed compared to their counterparts in developed nations to produce an equivalent quantity of protein. Consequently, a larger land area is required for livestock production in developing countries, exacerbating land use pressure. This interconnected relationship between livestock feed demands, land use, and forest ecosystems varies by region and necessitates critical examination. A notable consequence is the increased deforestation driven by the need for additional grazing land, further straining fragile ecosystems. While Oladunni et al. (2022) acknowledge this issue, their analysis lacks an in-depth exploration of sustainable alternatives that could mitigate the environmental footprint of livestock production in these regions.

Furthermore, research highlights how smallholder livestock husbandry in South-East Asia poses challenges to sustainable forest management, as farmers supplement inadequate on-farm forage with forest resources (Nugroho et al., 2024). Historically, reliance on locally available plant resources, including agricultural field residues and native forages from communal lands, has shaped livestock feeding strategies. However, while existing literature underscores the importance of forest forage, it inadequately addresses the competing land-use interests at the farm level. This oversight is significant, as balancing livestock production with conservation efforts requires a nuanced understanding of land allocation priorities. Nugroho et al. (2024) emphasize the need for sustainable fodder management but do not offer concrete policy interventions or scalable solutions to mitigate land conflicts.

Additionally, the persistence of traditional grazing practices across various regions further complicates forest management strategies. Socio-economic disparities, geographical remoteness, and alternative livelihood opportunities influence the extent of dependence on forests, shaping degradation patterns (Igu & Marchant, 2017). While these factors are well-documented, the existing research often falls short in proposing adaptive management strategies that account for local economic realities and ecological sustainability. It is imperative to move beyond descriptive analyses and toward prescriptive solutions that integrate both conservation and agricultural productivity, ensuring a more sustainable coexistence between livestock farming and forest ecosystems.

According to Voss et al. (2024), livestock grazing plays a crucial role in the household income of various groups living in the forest ecosystems of developing countries. While this assertion holds true, it overlooks the broader socio-economic and environmental implications of livestock grazing, particularly in the context of deforestation and land degradation. In a similar manner, the communities living near the Kakamega Forest Ecosystem depend on both livestock and timber for their livelihoods. However, this dual dependence raises concerns about sustainability, as unchecked exploitation of forest resources may threaten the long-term viability of these livelihoods.

Research concerning households indicates that management decisions, particularly those pertaining to purchased inputs, were somewhat more frequently overseen by men. In contrast, decisions regarding labor hiring and the utilization of maize were more commonly made by women. While these findings shed light on gendered decision-making in agricultural households, they fail to critically analyze the power dynamics at play. The assumption that joint decision-making inherently ensures gender equity may be overly simplistic, as power imbalances within households could still influence decision outcomes. Furthermore, interventions aimed at supporting maize production, such as improvements in seed systems, farmer capacity building, and input delivery, may not adequately address the structural barriers that limit women's access to resources and decision-making power.

Additional studies concerning household dynamics demonstrated that the implementation of enhanced forages, cultivated near homesteads, decreased the time men and boys dedicated to grazing livestock while simultaneously increasing the time women and girls allocated to harvesting fodder. This shift, though seemingly beneficial, inadvertently reinforces traditional gender roles by increasing women's workload. Njuguna et al. (2024) observe that after the implementation of gender sensitivity training in conjunction with forage introductions, Ethiopian men engaged in forage harvesting, chopping, and feeding, challenging existing norms, while Kenyan women assumed increased decision-making responsibilities. While this suggests progress toward gender equity, it is essential to question the depth and sustainability of these changes. Were these shifts in roles voluntary and transformative, or were they merely temporary responses to project interventions? The positive outcomes in gender equity indicate that the incorporation of gender and forage technology training can yield substantial benefits for both women and men within households, yet a more nuanced examination of long-term behavioral change and power redistribution is necessary.

III. METHODOLOGY

The study employed a correlational research methodology. A correlational research design is used when a researcher wants to examine the relationship between two or more variables without manipulating them. This design therefore was suitable because the major emphasis was on the influence the household dynamics had on the ruminant livestock production systems and the Kakamega Forest Ecosystem in Kenya.The data for this study was collected from a sample of 298 households, using structured questionnaires across three distinct micro-catchments: Cheboite, Makuchi, and Shamiloli, all of which are adjacent to the Kakamega Forest. The researchers used the purposive sample technique to carefully select key informants from a preset list of stakeholders. The sub-locations were chosen in the same way,

and were divided into administrative villages known as micro-catchments. The household selection approach used a multistage random sampling method. The participants in the research were either top decision-makers in the home or a resident member of the household. The researcher partitioned the study region into strata on different levels. The division was divided into four zones, each of which had one village. Random sampling was used to choose study participants from these villages. The study involved the selection of 271 household heads as a representative sample from a total of 15,755 families residing in 10 different places adjacent to the Kakamega Forest Ecosystem. These locations were situated within the three Counties of Kakamega, Vihiga, and Nandi. The sample size was arrived at using formula suggested by (Fisher, 1999). The research tool employed in this study included structured questionnaires featuring closed-ended questions, which limited respondents to providing relevant information only. This instrument was considered appropriate for the current study due to its effectiveness in efficiently collecting data from a large number of farmers within a limited timeframe.

The raw data collected from the household was subjected to a cleaning process to eliminate any outliers, and was then processed and coded into a format appropriate for analysis. The encoded data and primary data were entered into the computer for analysis purposes. The analysis of the data was conducted using descriptive. The data was processed and analyzed using SPSS version 21.0, a statistical tool frequently utilized in social sciences research.

IV. FINDINGS & DISCUSSION

4.1 Distribution of Household Heads by Age

The study sought to establish the age of the respondents that were living within the Kakamega Forest Ecosystem and the results presented as shown in Table 1.

Table 1

Distribution of Household Heads by Age

Age Group	Frequency	Percent	X^2	P
Below 35	35	16.8	129.761 (116)	0.181
36-45	58	27.2		
46-55	43	20.4		
56-65	45	21.5		
66-75	22	10.5		
Above 76	8	3.7		
Total	**211**	**100.0**		

According to Table 1 above, a majority 27.2% of the respondents were between 36-45 years of age, 21.5% of the respondents were between 56-65 years, 20.4% of the respondents were between 46 and 55 years. It was also observed that 16.8% of the respondents indicated to be below 35 years, 10.5% of the respondents indicated to be between 66 and 75 years while only 3.7% of the respondents indicated that they were above 76 years of age. Like most rural areas in Kenya, the sample in Shinyalu division mainly comprises the younger (18-25 years) and older (over 50 years) population. The younger age category mainly comprises of people searching for employment while the older category mainly comprises individuals retired from active service/employment.

This poses a challenge for development in rural areas as the young lack exposure, experience, financial resources and sometimes the knowledge to instigate development while the older people lack the energy and zeal to run development causes. Under the direction and guidance of Experts, the young present a human resource opportunity for development in rural areas. Other studies done by Lukuyu *et al.* (2019) indicated that the mean age of farmers was 48.12, ranging from 20 to 87 years in Western Kenya. Koyi and Siamba (2017) found out that majority of the dairy farmer respondents were between 45-54 years accounted for by 40.2% and over 54 years accounting for 26.2%. There was only one respondent in the age bracket of 18-24 years old. In Kiambu, Kigathi (2016) revealed majority of the dairy farmers were old and mature people who owned land to practice dairy farming. The studies also revealed that majority of young people were only hired to work on these dairy farms.

This findings agree with research studies done by Segnon et al. (2021) on availability of productive household members, household resource endowments, livelihood diversification and social networks were the main discriminant factors of household adaptive capacity, while challenges relating to food and water security make households more sensitive to stressors. The analysis highlighted the heterogeneity in household vulnerability patterns within and across communities. Failing to account for this heterogeneity in adaptation planning might result in a mismatch between adaptation needs and interventions, and potentially in maladaptation.

Land size and use within the Kakamega Forest Ecosystem: The researcher sought to establish the land size after livestock farming within the Kakamega Forest Ecosystem used their land and results tabulated as shown in the Figure 1.

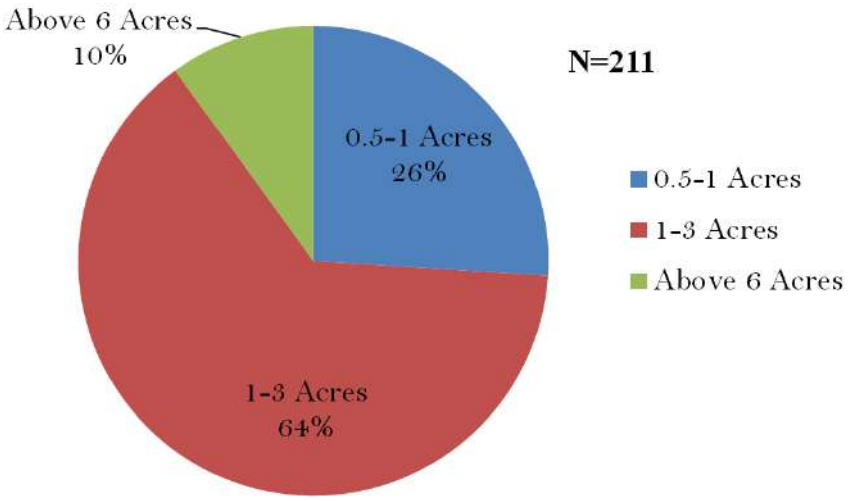

Figure 1
Land Size after Livestock Farming

According to Figure 1 majority, 64% of the respondents had between 1 and 3 acres of land after they began livestock farming, 26% of the respondents had between a half and 1 acre of land while only 10% of the respondents had above 6 acres of land after livestock farming. A chi-square test of association was also performed comparing land sizes in Kakamega-Nandi Forest Ecosystem after livestock farming.

The increase in land after livestock farming is likely to be attributed to demand for cultivated fodder and other feeds necessitating for increase land for cultivation by leasing land elsewhere. Adoption of new dairy technologies may be responsible for 26% of the respondents having 0.5 to 1 acre of land after deciding to practice dairy farming.

According to Nundu's (2021) study, the majority of farmers in Kakamega East had less than one acre of their land allocated to fodder production. Additionally, approximately 49.5% of farmers had between 1 and 2 acres of land dedicated to fodder production. The survey additionally observes that 20.5% of the participants possessed 3-4 acres of land dedicated to fodder production, but a mere 4.5% of the participants had more than 5 acres of land allocated for the same purpose. The findings agree with Nigatu et al. (2012) who indicated that experience in dairy value chain is needed in adoption of technologies such as feeding, breeding and marketing. In their study, those dairy farmers who have spent long time in dairy farming are quick to adopt various production technologies.

The researcher sought to establish how the respondents living within the Kakamega Forest Ecosystem used their land and results tabulated as shown in Table 2.

Table 2
Land Use

Land Use	Frequency	Percentage
Cultivation	147	69.6
Animal Raising	42	19.9
Agricultural support services	22	10.5
Total	**211**	**100.0**

Based on the findings shown in Table 2, it can be observed that a majority of households within the research region devote their land usage primarily towards cultivation, encompassing both cash crops and food production. Approximately 69.6% of the land holdings are designated for agricultural cultivation, with less than 20% allotted for animal husbandry, and 10.5% allocated for agricultural support services. There is variation in land ownership across different localities, as seen by the highest percentage of households expressing alternative ownership of land in Vihiga (63.4%) and the lowest percentage in Nandi (8.4%).

The average land size in Vihiga is comparatively smaller in relation to Nandi County, hence resulting in the adoption of alternate land ownership practices like as leasing. The survey findings indicate that a majority, specifically somewhat over 50%, of the land is allocated for the cultivation of food crops. The utilization of fallow land and natural pasture accounted for 20% of the total area, whereas cultivated fodders, such as Napier grass, were observed on a mere 6% of the land. The distribution pattern exhibited spatial heterogeneity throughout the region. In the region of Nandi,

approximately 40% of the land was allocated for pasture, while 35% was dedicated to the cultivation of food crops. A relatively small proportion, specifically 8%, was utilized for the cultivation of cash crops. Previous research indicates that in the region of Rachuonyo, around 60% of the land was dedicated to food crop cultivation, while approximately 20% was utilized for grazing purposes. According to Waithaka et al. (2002), Kisii had the highest percentage of land dedicated to cash crops, accounting for 17% of the total land area. Additionally, Kisii, along with Vihiga and Nyamira, had the largest proportion of land allocated for planted forages, ranging from 8% to 10%. Agevi (2016) reported that there have been observed alterations in the land use and land cover categories within the vicinity of Kakamega Forest over a period of time. The conversion of the indigenous forest to other land uses, such as agriculture, settlement, planted forest, grassland, and various others, has been observed. The decline in forest coverage has been attributed to various socio-economic issues, including population pressure, high population density, unemployment, limited access to education, poverty, and lack of awareness. In addition to alterations in indigenous forest, there have been concurrent modifications in many land use and land cover categories.

According to the study conducted by Kimenchu et al. (2014), a significant majority of dairy producers, specifically over 95%, practiced zero-grazing for their livestock. The land holdings typically averaged two acres, with a tendency towards excessive stocking and inadequate feeding of cows. The agricultural approach employed by the community involved the integration of dairy cow rearing with crop cultivation, sometimes referred to as mixed farming. Intense competition for the distribution of land resources among various farm operations was seen, driven by disparities in the prices of inputs and outputs. There are two primary factors that likely contributed to the adoption of mixed crop-livestock farming: enhanced food security and a lack of incentives for specialization among farmers.

According to Nundu (2021), a significant proportion of agricultural land owned by farmers was found to have integrated cultivation of additional staple crops. The constraint on the amount of land available for fodder crops has resulted in reduced productivity for many dairy farmers. This is due to the decreased space for cultivating forage materials, which necessitates the purchase or outsourcing of additional feed at a financial expense. The findings from the focused group discussion indicate that farmers primarily allocate their farmlands for the cultivation of food crops, with a limited portion being dedicated to the production of fodder crops. This phenomenon has resulted in a scarcity of feed, leading farmers to depend on commercially acquired fodder and by-products derived from grain crops. Additionally, these by-products are utilized as supplements in animal feed formulations. Consequently, a significant outcome of this phenomenon is that numerous farmers have opted to procure reduced quantities of feedstuffs of worse quality, so exerting a detrimental impact on the productivity of their livestock.

According to Masayi (2021), there was a notable shift in land use within the specified area over an 8-year period from 2013 to 2021. Specifically, there was a substantial 37.01% rise in the allocation of land for agricultural purposes. The study revealed a decrease of 29.22% in human settlements, a decrease of 6.40% in natural forest coverage, and a decrease of 1.39% in bare land. A significant portion of the land encompassing both natural forest areas and human settlements underwent a conversion process, resulting in its utilization for agricultural purposes. The degradation of the forest ecosystem within Kabras division may have been exacerbated by the development of a road within the Malava Forest environment and the presence of varying agro-ecological zones.

Communal forest grazing and perceived forest damage: To establish the extent of human interference with the Kakamega Forest Ecosystem, the researcher asked the respondents living within the Kakamega Forest Ecosystem whether they practiced communal forest grazing or not. Findings are as shown in Figure 2.

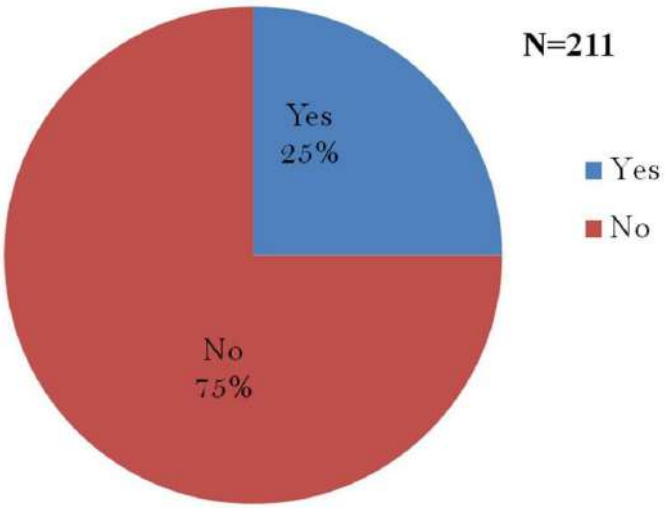

Figure 2
Communal Forest Grazing

According to Figure 2 above, a majority 75% of the respondents were practicing communal forest grazing. However, 25% of the respondents indicated that they were not practicing communal forest grazing. A chi-square test of association was performed comparing those who were practicing communal forest grazing in Kakamega-Nandi Forest Ecosystem.

Livestock farmers totally depended on Kakamega Forest for their livestock feed, they used the grass and browse species inside the forest for the whole year. Significant differences ($p < 0.05$) were seen among the three research areas based on the duration of time spent in the forest. As the duration of their stay in the forest prolonged, the impact of grazing and browsing intensified. Within the designated research domain, a significant majority of the participants, specifically 75%, reported utilizing Kakamega Forest as a primary resource for feeding their cattle. Conversely, a minority of 25% indicated that they did not rely on the forest for this purpose. The cattle population, on average, utilized the Kakamega Forest as a primary source of feed for a duration of 8 months. According to the survey participants, a majority of 60% utilized Kakamega Forest as a primary source of feed for their livestock during the entire year. Conversely, a minority of 25% reported that they did not permit their animals to access the forest. A quarter of the participants refrained from releasing their cattle into the forest, opting instead to employ a cut and carry approach, whereby grass was harvested from the forest and transported to the animals.

The findings demonstrate the reliance of the participants on the forest as a source of feed for their livestock, which was corroborated by the focus group discussions conducted in all the micro-catchments. Those participants who held the belief that there was no harm caused by livestock provided the rationale that the grass and trees were able to regenerate after being browsed or grazed upon. Findings in this section clearly indicate that livestock management have an influence on the Kakamega Forest Ecosystem. The primary factors influencing the Kakamega Forest Ecosystem are agricultural expansion and grazing, as seen by changes in land size before and after livestock farming. Additionally, administrative decisions influenced by cultural considerations and rapid population increase are significant contributors to the impacts on the Kakamega Forest Ecosystem. Furthermore, the degradation and depletion of the forest resource base significantly affect other sectors of the economy, including agriculture, water resources, energy, and biodiversity conservation.

Those who believed that livestock does not cause damage argued that livestock get grass, browse species from the forest, and use the forest as shade to protect the livestock from direct sun light. On the other hand, forest plant species benefit from the manure and that grass, undergrowth plants and trees regenerate after browse or grazing. According to this respondents, reduction of plant species inside the forest only occurred when severe grazing or harvesting of forage during dry season. This result is in concurrence with Nyanje et al, (2024) findings in Kaya forest of Kwale County revealed that for sustainable conservation efforts, it was prudent to consider both the economic and social benefits of this resource as a whole. Consequently, the study recommends the need to identify and repackage such benefits and to sensitize the community on the benefits that accrue from such arrangement In our study, respondents reported that damages to the forest was caused by browsing, severe grazing and trampling by cattle.

On farm forage production: The primary goal of cultivating agricultural fodder was examined and afterwards depicted in Table 3.

Table 3

Objective of Planting Farm Forage

Objective of Planting Farm Forage	**Frequency**	**Percent**
For Sale	2	1.0
Livestock Feed supply	206	97.4
Soil conservation and fertility	3	1.6
Total	**211**	**100.0**

According to Table 3, the main objective of planting farm forage by the respondents was for livestock feed supply accounting for 97.4%, 1.6% of the respondents planted farm forage for soil conservation and fertility while only 1% of the respondents planted for sale. A chi-square test of association was performed comparing the objectives of planting farm forage in Kakamega-Nandi Forest Ecosystem.

Majority of the respondents opted to plant forage due to restriction to forest grazing and introduction to forest grazing permits. Planting of forage as a conservation measure was an initiative of the National Government through soil and water conservation project in the 1990's. Planting of fodder for sale is developing into an enterprise due to the rising demand for animal feed. The types of farm forage that were majorly planted by the respondents in the Kakamega Forest Ecosystem is as tabulated in Table 4.

Table 4
Types of Farm Forage

Type of Farm Forage	Frequency	Percent
Fallow and Natural Pasture	9	4.2
Napier Grass	202	95.8
Total	**211**	**100.0**

According to Table 4, Nappier grass was the main farm forage as indicated by 95.8% of the respondents, only 4.2% of the respondents stated that there was fallow and natural pasture. Nappier grass was grown by most of the respondents due to herbage quantity and ease of establishment. A chi-square test of association was performed comparing the types of farm forage in Kakamega-Nandi Forest Ecosystem.

Information on the duration of fodder trees that were planted in the Kakamega Forest Ecosystem was also sought from the respondents and the findings are as shown in Table 5.

Table 5
Fodder Trees Duration

Fodder Trees Duration	Frequency	Percent
Never Planted	102	48.2
Less than 5 years	15	7.3
Between 5 and 10 years	44	20.9
Over 10 years	50	23.6
Total	**211**	**100.0**

According to Table 5, 48.2% of the respondents have never planted fodder trees, for those who planted 20.9% indicated that they took between 5 and 10 years while 7.3% of the respondents indicated that they took less than 5 years. These fodder trees are legumes and mostly introduced through Governments projects like the National Dairy Project in the 1990's and Non-Governmental Organizations (NGO's). A chi-square test of association was performed comparing the fodder trees duration in Kakamega-Nandi Forest Ecosystem.

Having established that a good percentage of the respondents have never planted fodder trees, the researcher sought to establish whether the respondents had any information about fodder trees, this finding is as shown in Table 6.

Table 6
Information on Fodder Trees

Fodder Trees Duration	Frequency	Percent
Never had about fodder Trees	97	46.1
Extension Service agents/KFS	12	5.8
Projects	98	46.6
NGO	3	1.6
Total	**211**	**100.0**

According to Table 6, 46.1% of the respondents stated that they have never had about fodder trees, 5.8% of the respondents indicated that they had information on fodder trees from extension service agents/KFS. 6.6% of the respondents indicated that they had heard about fodder trees from projects while only 1.6% had heard from NGOs. The findings from this study show that for a farmer to fully adopt a practice, time and more resources are required, the extension service providers both Government and private require more time with the farmers in the field. A chi-square test of association was performed comparing the information on fodder trees in Kakamega-Nandi Forest Ecosystem.

According to Figure 3, 81% of the respondents did not plant forage legume while only 19% of the respondents planted forage legume. The findings show that most respondents didn't plant forage legumes due to lack of information of its importance to livestock feeding**.** A chi-square test of association was performed comparing those who planted forage and those who did not plant forage in Kakamega-Nandi Forest Ecosystem.

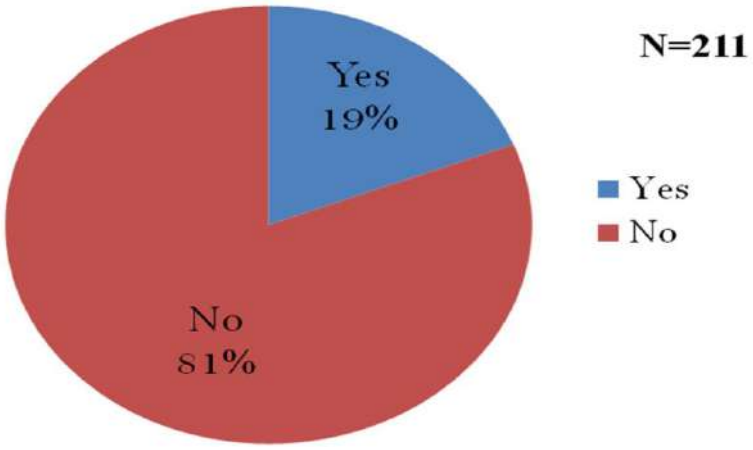

Figure 3
Plant Forage Legume

4.2 Forage Legume Planted

In the same regard, the researcher sought to establish whether the respondents in the Kakamega Forest Ecosystem planted and fed their livestock using legumes, the findings are as shown in Table 7.

Table 7: Forage Legume Planted

Forage Legume Planted	Frequency	Percent
Doesn't Plant any Forage Legume	173	82.2
Desmodium	9	4.2
Lucern	3	1.6
Vetch	2	1.0
Potato Vines	23	11.0
Total	**211**	**100.0**

According to Table 7, 82.2% did not cultivate any forage legume, for those who planted 11% indicated that they planted potato vines and 4.2% indicated that they planted desmodium. Only 1.6% and 1% indicated that they planted lucerne and vetch respectively. Majority of the farmers didn't plant any forage legume most likely because they had alternative from the forest grazing.

V. CONCLUSION & RECOMMENDATIONS

5.1 Conclusions

This study helped to understand the household dynamics influencing ruminant livestock production systems and Kakamega forest ecosystem. The majority of the households dependent on the forest as a source of feed through grazing or harvesting for stall feeding. Grazing within the forest affect the sustainable forest management. Livestock keepers suggested grazing schemes for small land holders and large scale land holders to ensure the ecosystem preservation and conservation.

5.2 Recommendations

The study recommends Gender transformative policy approaches that are inclusive of both women and men in a comprehensive dialog on collective household decision-making and control of productive resources should be employed. It's also important for the Government to do away with policy resist and review existing forest policies to allow indigenous traditional knowledge to complement it with modern knowledge for sustainability of the forest ecosystem

Conflicts of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper

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