AN ASSESSMENT OF SOCIOECONOMIC FACTORS INFLUENCING THE ADOPTION OF *Cenchrus ciliaris* FOR ENVIRONMENTAL CONSERVATION AMONG AGRO-PASTORALIST COMMUNITIES IN SOUTH BARINGO, KENYA

DAVIS NYAMBARI MATHEW

A Thesis Submitted to the Graduate School in Partial Fulfilment of the Requirements for the Degree of Master of Science in Environmental Science of Egerton University

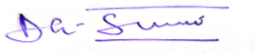
EGERTON UNIVERSITY

APRIL, 2025

DECLARATION AND RECOMMENDATION

Declaration

This thesis is my original work and has not been presented in this university or any other for the award of a degree.

Signature :  Date : 06/04/2025

Davis Nyambari Mathew

NM12/19031/18

Recommendation

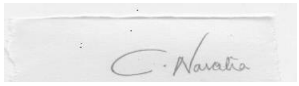
This thesis has been submitted for examination with our approval as university supervisors.

Signature:  Date: 07/04/2025

Prof. George M. Ogendi

Department of Environmental Science

Egerton University

Signature:  Date: 07/04/2025

Dr. Caren Navalia Atalitsa

Department of Environmental Science

Egerton University

COPYRIGHT

DEDICATION

This work is dedicated to my family, whose unwavering love and support have been the cornerstone of my journey. I extend my heartfelt gratitude to my parents Geofrey Mathew Nyambari and Jane Karani Mathew, who have been my biggest supporters, providing me with the strength and inspiration to persevere through challenges. Their unconditional support, constant prayers, and encouraging words have been invaluable during my studies, reminding me of the importance of dedication and hard work.

ACKNOWLEDGEMENTS

I would like to thank Egerton University for offering me the chance to pursue my studies. My special gratitude also goes to the Egerton University Senate, Faculty of Environment and Resource Development, and the Department of Environmental Science. I express my deep and sincere gratitude to my university supervisors Prof. George Morara Ogendi and Dr. Caren Navalia Atalitsa for their unending support towards my entire study including proposal development, data collection and publication and thesis writing. Their belief in my abilities and constructive feedback have empowered me to push my boundaries and strive for excellence. Lastly, I am grateful to Mr. Aaron Juma and Mrs. Belinda Chepsiang who helped me greatly during my data collection. I also register my gratitude to Mr. Davis Chiedo and Mrs. Rhoda Ondieki, staff at the Egerton University Dryland Research Training and Ecotourism Centre, Chemeron for their moral support during my studies. Lastly, but not the least, I deeply appreciate the moral and financial support that I received from my family that constantly and persistently stood by my side in the course of this academic journey. May God bless each one of you!

ABSTRACT

Land degradation is a major issue of environmental concern not only affecting food but also environmental security in many countries across the globe. Livestock production is important for communities in the arid and semi-arid lands (ASALS), but overstocking and overgrazing has over the years led to a decline in pasture production, and by extension food security. In response to soil erosion, deforestation, and *Prosopis juliflora* invasion in the Lake Baringo Landscape, the Global Environment Facility through the Small Grants Program supported communities in establishment of *Cenchrus ciliaris* (buffel grass), a grass species that has been adopted by some local communities led by local Community Based Organizations. Its establishment and adoption in relation to socioeconomic characteristics of the communities in ASALs has so far not been documented. Thus, this study was undertaken to assess its ecology, and socioeconomic factors influencing its adoption for environmental conservation three wards (*Ilchamus, Mochongoi and Marigat*) of Baringo South Sub- County. A cross-sectional survey was employed in this study and data was collected from 103 randomly selected households using a semi-structured questionnaire. Key informant interviews (KIIs) and Focus Group Discussions (FGDs) were also conducted to collect qualitative data to get more insights into the socioeconomic factors influencing the adoption of *Cenchrus ciliaris*. Both descriptive and inferential statistics were employed to analyze this data. Key findings reveal a strong relation between socioeconomic factors, specifically gender and education; and the adoption of *Cenchrus ciliaris*, with male respondents being predominant (54.40%). Higher education level was associated with improved awareness and pasture production and environmental conservation ($\chi 2 = 16.9344$, $p < 0.05$), while there was a strong association between the type of pasture grass species planted and the stakeholders involved in providing training ($\chi 2 = 153.65$; $p<0.05$). A section of the respondents (29%) stated that integrating *Cenchrus ciliaris* into pasture management systems provides dual benefits of enhancing environmental sustainability and boosting economic productivity. The findings of this study show that despite several challenges, there are multifaceted benefits of integrating *Cenchrus ciliaris* into pasture management systems which goes beyond enhancing livestock nutrition and productivity to include environmental conservation and economic stability.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS AND ACRONYMS

ASALs	Arid and Semi-Arid Lands
CBO	Community Based Organization
COR	Conservation of Resources
FAO	Food and Agricultural Organization
FDG	Focused Group Discussions
GEF	Global Environment Facility
GEMS	Global Environment Monitoring System
GPS	Global Positioning System
IBA	Important Bird Area
KALRO	Kenya Agricultural and Livestock Research Organization
KEFRI	Kenya Forest Research Institute
KES	Kenyan Shillings
KII	Key Informant Interview
KWS	Kenya Wildlife Service
LBL	Lake Bogoria Landscape
LBPL	Lake Bogoria Production Landscape
NACOSTI	National Commission of Science and Technology Innovations
NGO	Non-Governmental Organizations
SDG	Sustainable Development Goal
SGP	Small Grants Programme
SPSS	Statistical Package for Social Sciences
UNDP	United Nations Development Programme
UNESCO	United Nations Education Scientific and Cultural Organization
USD	United States Dollar
WUE	Water Use Efficiency
WWF	Worldwide Fund

CHAPTER ONE
INTRODUCTION

1.1. Background Information

Arid and semi-arid or sub-humid zones are characterized by low erratic rainfall of up to 700mm per annum, periodic droughts and different associations of vegetative cover and soils. Inter-annual rainfall varies from 50-100% in the world's arid zones, with averages of up to 350 mm. In the semi-arid zones, inter-annual rainfall varies from 20-50%, with averages of up to 700 mm (Kiage, 2013). In both arid and semi-arid lands, the households' main livelihood source is dependent on pastoralism and rain-fed agriculture and this provides limited agricultural outputs whose quantity and harvest are mostly unpredictable. Due to unpredicted rainfall in the semi-arid areas, agricultural production is uncertain, and thus livestock production is a more reliable livelihood option (Vermeulen et al., 2012).

Intermittent drought, despoiled rangelands and condensed access to traditional grazing lands have left many pastoral communities and individuals throughout the world and, more specifically, Africa's the arid and semi-arid lands (ASALs) more susceptible and thus facing severe livestock feed shortages (Ngetich et al., 2023). Most of the communities living in ASALs are low-income earners (Elhadi et al., 2012). Due to this factor, pastoral communities suffer from food and nutrition insecurity during the dry seasons. Their income sources are also reduced as a result of livestock losses and reduced livestock production especially during periods of extended droughts with climate change adding an extra layer of vulnerability to this already fragile ecosystem, exacerbating the underlying causes of poverty and food insecurity (Mwirigi et al., 2021; Napogbong et al., 2021). Over the last ten years, the Horn of Africa has faced seven major drought events, which have killed more than half of the cattle population in the most heavily affected areas, and decimated the livelihoods of millions of pastoralists each year (Measho et al., 2021).

In Kenya, the ASALs occupy 89% of the country and are home to about 14 million people and approximately 70% of the national livestock herd (Omolo & Mafongoya, 2019). The economy of arid areas is dominated by pastoralism characterized by extensive livestock production, whereas agropastoral, rain-fed and irrigated agriculture, bio-enterprise, and conservation or tourism-related activities exist in better-watered and serviced semi-arid areas (Nyariki & Amwata, 2019).

Arid and semi-arid lands are important for the country’s tourism industry, which contributes nearly 10.4 percent of Kenya’s Gross Domestic Product (GDP) (Gatwiri & Kimaiyo, 2023). In the view of these contributions, the potential of the arid lands and

livestock sub-sector are recognized by the Government of Kenya under the Vision 2030 as important drivers for economic growth for the country, (County Government of Kenya, 2013), hence the need for pastures production.

The depletion of natural resources is the world's major issue of environmental concern, for instance, the World Resource Institute of the United Nations Environment Program estimated that millions of hectares of land are degraded and completely disappeared from their original biotic functions, and 1.2 billion hectares (10%) of the earth's vegetative surface are moderately degraded, of which about one-fourth is found in Africa (Diet, 2015). Undoubtedly, environmental degradation (soil erosion and climate change) has direct effects on agricultural productivity and food security (Gabreselassiea et al., 2016). On the other hand, degradation, which can be physical, chemical and/or biological, is claiming six million hectares of the global agricultural land per annum. About 16% of the world's agricultural land is affected by soil degradation. Of all the processes leading to land degradation, erosion by water is the most threatening and accounts for 56% of the total degraded land surface of the world. In Africa alone, it is estimated that five to six million hectares of productive land are affected by land degradation each year (Gabreselassiea et al., 2016).

Poor farming practices in rural areas of the developing countries have resulted in soil loss and nutrient depletion, which finally leads to land degradation. Soil erosion causes a chronic environmental and economic burden (Eswaran et al., 2019), and results in soil degradation in most parts of the world. This, in turn, results in low agricultural productivity, food insecurity and poverty (Alemu, 2015). The major causes for desertification are overgrazing or excessive livestock farming, an ever-increasing population, cutting trees for firewood and construction, and climate change. Moreover, according to Boles et al. (2019) and Eswaran et al. (2019), enormous amounts of fertile land are being degraded, causing arable land to become desolate.

Though the magnitude varies with ecological zones, soil erosion, and loss of biodiversity persist on agricultural lands in Lake Bogoria Landscape and continue to be a formidable threat to both national food security and environmental quality. The Lake Bogoria Production Landscape (LBPL) is experiencing massive environmental challenges manifested by insecurity, resource use conflict, human-wildlife conflict and unsustainable land-use practices, which negatively influence LBPL and its ability to provide ecosystem services (Kenya Wildlife Service, 2018; GRAIN and Seed Savers Network, 2018). Due to its geological history, the landscape has unique physiographic features and geothermal

manifestations (Kenya Wildlife Service, 2018). The combination of landforms, biodiversity content, and availability of water and forage makes this site important at community, national and global levels (Ringler, 2013).

Despite Lake Bogoria Production Landscape being a dryland of international importance, it is currently at risk of environmental degradation arising from unsustainable resource exploitation and ecologically negative catchment-wide processes (Kenya Wildlife Service, 2018). The root causes of these problems are poverty, poor land-use practices, overstocking, weak traditional management approach and unsustainable farming systems witnessed within its catchment (WWF, 2018) and, above all, the unprecedented rates of agricultural expansion.

The few arable lands are overgrazed due to limited arable land and scarcity of feed resources in these semi-arid lands (Ngetich et al., 2023). To increase productivity, most farmers in the study area use conventional approaches to food production with extensive use of synthetic fertilizers that have made the soils acidic, and overuse of pest and disease control chemicals resulting in pest and disease resistance. Many individuals rearing livestock still practice pastoral systems, with a few individuals adopting pasture production (Lugusa et al., 2016; Wasonga et al., 2003).

Although pasture establishment technologies in Kenya are slowly gaining acceptance amongst the pastoral communities, their adoption has been slow. Most of these technologies are based on *Cenchrus ciliaris* (Buffel grass) and *Eragrostis Superba* (Maasai love grass), which are the most popular pasture species in the ASALs, where livestock rearing is the main economic activity. These grasses respond quickly to low rainfall, are drought-tolerant, are adapted to heavy grazing, and have fewer growth and establishment requirements.

In spite of the aforementioned advantages of *Cenchrus ciliaris*, its adoption in the rehabilitation of the degraded lands of Baringo remains under-researched (Mansoor et al., 2019). The reasons for the poor response to its adoption are still unclear. Without a good understanding of factors (including socioeconomic) affecting its adoption, even further introduction of more species may not be useful in solving the land degradation and food security challenges experienced in the region.

It is against this background that this study was conceptualized to assess socioeconomic factors that influence the adoption of *Cenchrus ciliaris* grass species among the pastoralist communities, thus informing the relevant bodies on interventions that can increase its uptake that will ultimately improve livestock production and enhance environmental conservation practices.

1.2. Statement of the problem

The Lake Bogoria Production Landscape is at risk of degradation arising from unsustainable exploitation and poor management of resources, mainly due to persistent droughts, overstocking and unsustainable farming systems. Livelihoods especially livestock production have been negatively impacted due to inadequacy of pastures in the region. In other instances, interethnic conflicts over pastures and water have been witnessed in the study area. Sustainable livestock farming is still a challenge as a majority of the population keeping livestock still practice a nomadic-pastoralism. Recognizing land degradation as a major environmental and socioeconomic problem, the government of Kenya and other development partners have intervened to alleviate the problem by introducing *Cenchrus ciliaris* to enhance livestock production and environmental conservation, which has seen large tracts of land being terraced and seedlings of this grass planted on degraded lands (Abera et al., 2020). However, factors influencing its adoption among households in the study area are little known. It is against this background that this study was conceived to assess the influence of socioeconomic factors on the adoption of *Cenchrus ciliaris* in the study area.

1.3.Objectives

1.3.1. Broad Objective

To assess the influence of socioeconomic factors on the adoption of *Cenchrus ciliaris* among the pastoralist communities in the LBL in order to improve livelihoods and enhance environmental conservation.

1.3.2. Specific Objectives

i. To assess the socioeconomic characteristics of households that utilizes *Cenchrus ciliaris* in the study area
ii. To establish the relationship between socioeconomic determinants and the adoption of *Cenchrus ciliaris* in the study area
iii. To analyze the role of other stakeholders involved in *Cenchrus ciliaris* production in the study area
iv. To evaluate the impact of stakeholders on the adoption of *Cenchrus ciliaris* in the study area

1.4. Research Questions

i. What are the socioeconomic characteristics of households that utilize *Cenchrus ciliaris* in the study area?

ii. How do socioeconomic determinants influence the adoption of *Cenchrus ciliaris* in the study area?
iii. What is the role of various stakeholders involved in *Cenchrus ciliaris* production in the study area?
iv. What impact do stakeholders have on the adoption of *Cenchrus ciliaris* in the study area?

1.5. Justification of the Study

The Lake Bogoria Landscape (LBL) is a vital economic contributor to Baringo County, recognized internationally as an Important Bird Area (IBA), a Ramsar site, and a UNESCO World Heritage site. It supports a rich diversity of wildlife, including notable species such as the lesser flamingo and the endemic Greater Kudu. The area's unique landforms and abundant natural resources, including freshwater and forage, make it essential for both biodiversity and the livelihoods of the local population, which primarily inhabits arid and semi-arid zones.

Within this landscape, dominant grass species such as *Sporobolus ioclados, Dactyolectenium aegyptium, Chloris virgata*, and *Digitaria velutina* provide essential grazing resources. However, *Cenchrus ciliaris* stands out due to its resilience in dry conditions and its capacity for high seed production, making it a key species for rehabilitation efforts in these degraded environments. Given its potential to enhance both environmental sustainability and socioeconomic development, promoting the adoption of *Cenchrus ciliaris* is crucial for the community.

This study assessed the socioeconomic factors influencing the uptake of *Cenchrus ciliaris* among the pastoralists in Baringo County. The findings will serve as a guide for stakeholders, policymakers, and community members striving to improve land rehabilitation and sustainable practices in the region. Furthermore, the research highlights the current state of these rehabilitation efforts within the LBL and identifies challenges faced by its residents. By addressing these issues, the study was intended to inform targeted interventions that enhance pasture sustainability and resource management.

Additionally, this research aligns with Bottom up Economic Transformation Agenda (BETA), particularly in advancing food security and healthcare, while contributing to Sustainable Development Goals (SDGs) 1 (No Poverty), 2 (Zero Hunger), 3 (Good Health and Well-Being), 8 (Decent Work and Economic Growth), 11 (Sustainable Cities and Communities), and 13 (Climate Action) (County Government of Kenya, 2013). These

efforts collectively support Kenya's Vision 2030 by fostering economic growth and environmental resilience in Baringo County and beyond.

1.6. Scope, Limitations and Assumptions of the Study

1.6.1. Scope of the Study

This study was carried out within Lake Bogoria Landscape, Baringo South Sub-County, Kenya. It assessed some of the socioeconomic activities and how they can influence the adoption of *Cenchrus Ciliaris* grass species. The study was carried out in six months, whereby across-sectional survey, key informant interviews and Focused Group Discussions were conducted to collect the relevant data for this study.

1.6.2. Limitations of the Study

Some of the anticipated factors that were likely to limit the successful collection of data and consequently hinder the achievement of the desired results included the unresolved community conflicts (over natural resources) and general security. Additionally, there are generally strong gender stereotypes, especially in pastoralist communities and the changing land systems from nomadism to sedentary and the limited inter-institutional coordination and harmony. Here, women and girls have limited rights or decisions on land and land use issues and has been taken as men's' role. However, the study employed strategies such as cultivating community and political goodwill by involving all community members as well as opinion and political leaders in all stages of the study. During data collection, the offices of the Coordinator of the Ministry of Interior and National Government and the Ward Administrator were the entry points to facilitate acceptability to the entire community. Separate FGDs were held for men and women to enable the latter express themselves freely. This strategy enabled us to collect data from women easily given that they were much more comfortable expressing themselves without undue influence from the men.

1.6.3. Assumptions of the Study

Assumptions during the study included the stability of socioeconomic variables throughout the research period. It was also assumed that there would be no drastic changes in political or local intercommunal factors. Additionally, the study operated under the assumption that there would be no major catastrophic events, such as droughts, impacting livelihoods in the area. The researchers also assumed that stakeholders would provide reliable information, and that there would be a peaceful environment for data collection.

1.7. Definition of Terms

Adoption This refers to the degree of use of a relatively new technology after the farmer has heard its importance and has all the necessary conditions to embrace it.

ASALs Arid and Semi-arid lands are areas that are characterized by low erratic rainfall of up to 700mm per annum, periodic droughts and different associations of vegetative cover and soils.

Development Development is a multidimensional process involving major changes in social structures, popular attitudes and national institutions, as well as the acceleration of economic growth, the reduction of inequality and the eradication of poverty. For the purpose of this research, development is defined as the positive qualitative change from a bad to a better state in the quality of life and the enjoyment of basic needs of life.

Livelihood Outcomes This refers to the range and combination of activities and choices people choose to undertake to achieve their livelihood goals. They include productive activities, investment strategies and reproductive choices.

Poverty This refers to the inability to satisfy one's basic human needs for a minimum standard of wellbeing and life as a result of a persistent lack of income or access to basic services. It is the inadequacy of income, deprivation of basic needs and rights, and lack of access to productive assets as well as to social infrastructure and markets.

Resource-based conflict Conflicts arising from the scarcity of natural resources that can be openly accessed by community members.

Social Protection All initiatives that transfer income or assets to the poor protect the vulnerable against livelihood risks and enhance the social status and rights of the marginalized; with the overall objectives of extending the benefits of economic growth and reducing the economic or social vulnerability of poor, vulnerable and marginalized people.

Sustainability Refers to the ability of donor-aided programs to create systems that continue to connect and influence the beneficiaries even after programs wound up

CHAPTER TWO
LITERATURE REVIEW

2.1. Pasture Types and the Suitability of *Cenchrus ciliaris* in Arid and Semi-Arid Lands

Arid and semi-arid or sub-humid zones are characterized by low erratic rainfall of up to 700mm per annum, periodic droughts and different associations of vegetative cover and soils. Inter-annual rainfall varies from 50-100% in the arid zones of the world with averages of up to 350 mm (Lugusa, 2015), while in the semi-arid zones, inter-annual rainfall varies from 20-50% with averages of up to 700 mm. Regarding livelihoods systems, in general, light pastoral use is possible in arid areas, but rain-fed agriculture is usually not possible. In the semi-arid areas, agricultural harvests are likely to be irregular, although livestock productivity is satisfactory (Lugusa, 2015).

However, one of the major challenges faced by livestock farmers in the study area is the shortage of pastures. Due to the arid and semi-arid conditions in the ASALs, the availability of natural pastures is limited. This has led to overgrazing of the existing pastures, resulting in degradation of the land and a decrease in livestock productivity. The lack of sufficient pastures not only affects the quality of meat and milk produced by the livestock but also poses a threat to the sustainability of the livestock industry in the region. In order to address this issue and ensure the continued growth of the livestock sector in the ASALs, there is a need for interventions such as the adoption of buffel grass.

Cenchrus ciliaris is a grass native to southern Asia and much of Africa; it has been planted as fodder and for erosion control in most warm arid and semi-arid regions of the world. It commonly escapes from plantings, especially into disturbed habitats, where it promotes a grassfire cycle. Increased fire frequency and intensity, combined with a dense growth of *Cenchrus ciliaris*, can transform invaded ecosystems, altering ecosystems and threatening native plants and animals.

Research done in other countries shows that *Cenchrus ciliaris* can withstand infrequent germination opportunities, in part due to the extreme longevity of its seed bank, estimates of which range from 2 to 30 years (Mansoor et al., 2019). Seeds may lay dormant in the ground for up to 8 months while retaining the original seed viability. Beyond 12 months, germination rates drop to less than 12% and remain at 10% for two years after that. *Cenchrus ciliaris* appears to perform particularly well at elevated carbon (iv) oxide levels, and it demonstrates increased biomass, plant height, leaf length, leaf width and improved overall growth performance, as is usual for tropical C4 grasses (Mansoor et al., 2019). The species is drought resistant and does not tolerate extended periods of flooding or subfreezing

temperatures. *Cenchrus ciliaris* can tolerate soils with low levels of nutrients. However, it shows increased water use efficiency (WUE), crude protein, and dry forage yields with increased nitrogen, as well as a widened shoot/root ratio with increased phosphorus (Franks, 2002; Marshall et al., 2012).

Once the species has been introduced, roadsides and seasonal water drainages provide conduits for rapid spread to new sites. Open and semi-open habitats are especially vulnerable to invasion, even without human disturbance. Major *Cenchrus ciliaris* invasions have occurred in Australia, the south-western United States, Mexico, and Hawaii (Mansoor et al., 2019). Although the limited spread of *Cenchrus ciliaris* may be observed at arid sites in dry years, unusually wet years can promote sudden and expansive seedling establishment across large areas (Burgess et al., 2021). Once established, the plants are long-lived and highly tolerant of drought. *Cenchrus ciliaris* can potentially flower in its first year of growth, but established plants may live for more than a decade. Seeds can remain viable in the soil for at least four years. Fresh seeds have low germination rates due to dormancy, which is typically lost over 4-16 weeks. Seeds may germinate throughout the year in response to rain.

The study area of Baringo, Kenya, is an arid and semi-arid landscapes typical of much of the country, where average annual rainfall is limited to about 700 mm (Wasonga et al., 2003). This erratic rainfall pattern is a critical factor contributing to the challenges faced by livestock farmers, including the significant shortage of pastures necessary for sustaining livestock productivity. The cyclical nature of rainfall variability in both arid and semi-arid zones compounds these difficulties—while arid regions experience interannual rainfall variability of 50–100%, semi-arid areas exhibit a somewhat less severe variation of 20–50% (Petek, 2015;Wasonga et al., 2003). As livestock farming predominates as a livelihood in the region, the limitations posed by dry conditions significantly impact agricultural viability. The arid areas do not support rain-fed agriculture, leading livestock farmers to rely heavily on the natural pastures available. In semi-arid regions like Baringo, while agricultural activities may yield some harvests, these returns are often unpredictable, forcing many communities to depend primarily on livestock. Unfortunately, the overreliance on existing pastures—compounded by limited availability—has resulted in overgrazing, significantly degrading land quality and further reducing pasture availability (Lugusa et al., 2016).

The decline in pasture quality presents a dual threat: it directly affects livestock health and productivity, which in turn impacts the quality and quantity of meat and milk produced. As a result, the sustainability of the livestock industry—a cornerstone of the local economy—is at risk. The pressing need for effective interventions to enhance pasture

availability is thus not only an issue of immediate concern for food security but also a broader economic imperative for the region.

Cenchrus ciliaris grass species are highly valued as pastoral species and, more recently, for mine rehabilitation and erosion control. It is uniquely suited to the purposes because it has high nutritional value for livestock, high tolerance to drought and the ability to withstand heavy grazing. It also has a deep establishing root system and responds quickly to rainfall (Mansoor et al., 2019; Marshall et al., 2012).

In arid ecosystems, C_4 grasses, such as *Cenchrus ciliaris*, typically dominate tropical savannas, a biome characterized by a summer growing season (when high temperatures coincide with high rainfall), open canopies, and dense grassy under-storeys that fuel frequent fires. *Cenchrus ciliaris* demonstrates several qualities that make it uniquely suited to survive harsh arid conditions (Mansoor et al., 2019). These include the accumulation of carbohydrates at the base of its stems for slow release when needed, a deep root system (up to 2.5 m in deep soils) that enables it to access water supplies faster and for longer than most native herbs and forbs, as well as extended seed longevity and opportunistic germination (Mansoor et al., 2019). Additionally, arid environments may present *Cenchrus ciliaris* with less competition, disease and predation. For example, in most cases, anecdotal evidence indicates that *Cenchrus ciliaris*, by virtue of its presence, outcompetes native plants for water, light and nutrients. However, it can struggle for dominance against other exotic grasses of similar provenance (USDA, 2022).

Furthermore, in arid climates, Buffel grass may be less affected by tropical diseases, including Buffel Blight, Ergot, Smut, Rust, and Blast and the Paralic moth, which help to suppress the species in the tropics (Na et al., 2015). A recent study identified effective rainfall and rainfall seasonality as the most significant factors influencing the distribution of savannas on a global scale (Lehmann et al., 2012). At a regional scale, scientists have studied how topography, soils and disturbance interact with rainfall to impact woody vegetation growth and fire frequency, which reduce and promote the growth of C4 grasses, respectively. They conclude that woody vegetation growth should be considered as a potential surrogate for identifying the potential limits of the savanna biome (Lehmann et al., 2012).

One notable phenomenon in the establishment of *Cenchrus ciliaris* is its ability to quickly take over previously barren areas. Following periods of extended drought or fire, these areas can suddenly become dominated by *Cenchrus ciliaris* after rains. This dominance can persist for decades, leading to significant effects on the functioning of arid

ecosystems. However, the specific gaps in knowledge regarding the long-term impacts of *Cenchrus ciliaris* on ecosystem dynamics and stability remain a key area for future research (Mansoor et al., 2019).

2.2. Household Socioeconomic Characteristics and Pasture Production Activities in Baringo

In Kenya, the ASALs are inhabited by about 70% of the national livestock herd and about 14million of the human population. Pasture scarcity is a challenge due to the erratic rainfall experienced (Measho et al., 2021; Mwirigi et al., 2021; Oscar, 2021; Wasonga et al., 2003). In addition, the rangelands in Kenya have a history of land degradation caused by overgrazing and soil erosion. The deterioration of range condition due to these negative impacts is responsible for reduced livestock productivity, in part contributing to food and environmental insecurity experienced in the ASALs of Baringo.

Access to pasture in Kenya influences household socio-spatial livelihood. The rural citizens depend mostly on pasture for agro-pastoralism. Due to unreliable rainfall patterns, the herdsmen migrate with their livestock to territories owned by other communities. Competition for scarce pasture and the high economic and symbolic value given to domesticated animals gives the prevalence of pasture resource use conflicts amongst communities in the study area.

Limited land to perform agricultural activities, which is a livelihood source for most communities living in the ASALs, has been documented to cause major conflicts and, sometimes, displacement (Mairomi & Kimengsi, 2021). For Instance, according to Mwangi (2015), the nomadic pastoralists, the agriculturalists and fishermen of Tana River County have had resource use conflicts dating back to the 17th century. In Baringo, the area is inhabited by the Tugen, Pokot and Njemps communities who practice Pastoralism. There are no clear boundaries among these ethnic groupings who for a long time had much of their land under communal tenure system, and thus the likelihood of the degradation of the common resources.

The poverty level of Baringo County is estimated at 58.5% and is reported to be more in the rural areas where income-earning activities are not diversified (Lugusa et al., 2016). Most of the labor force in the County is unskilled and semi-skilled, with the income being derived from sales of livestock and agricultural products. Being home to more than two million livestock, a lot of emphasis is laid on this sector as a springboard toward economic empowerment (Wasonga et al., 2003).

To improve the socioeconomic wellbeing of the households, the county government has put resources in support of irrigated agriculture as opposed to reliance on rain-fed crop production. This is characterized by the establishment of over 3000 acres of irrigated land in 13 irrigation schemes where farmers grow cereals, fruits and vegetables in Ng'enyin, Emining, Ketiptergek, Rebeko, Mukuyuni, Kapkelewa and other schemes (Elhadi et al., 2012; Wasonga et al., 2003;). There is however little documentation on the adoption of the grass technologies by local communities as spearheaded by both the national and county governments.

The study area is mostly inhabited by farmers whose income mainly comes from agropastoralism. Encouraging and supporting this group of people to adopt pasture production and practice conservation during the rainy season may improve their livelihoods, and enhance environmental conservation. In addition, although the economic costs of *Cenchrus ciliaris* have not been directly quantified (Network, 2018), it has been reported as a host for the sugarcane whitefly, an important economic pest of sugarcane (Mansoor et al., 2019). It can also serve as a host for the rusty plum aphid, which is a vector of several viruses that impact economic crops (Na et al., 2015). Thus, efforts to assess some of these socioeconomic factors that may influence the adoption of pasture production technologies such as *Cenchrus ciliaris* may shed light on new interventions on how governments and the organizations working in ASALs will tackle pasture production.

2.3. Socioeconomic Factors and the Adoption of Pasture Technologies

Pasture establishment technologies in Kenya are slowly gaining acceptance amongst the pastoral communities though their adoption has been slow. Most of these technologies are based on *Cenchrus ciliaris* (Buffel grass) and *Eragrostis Superba* (Maasai love grass), which are the most popular pasture species in Arid and Semi-arid lands (ASALs), where livestock rearing is the main economic activity. The economic potential of reseeding technology using these grasses is important as it is adapted to a wide range of soil types in different agroecological zones, from semi-arid to sub-humid climatic zones (Mganga et al., 2015). Under good management, *Cenchrus ciliaris* can produce up to 200 bales of hay from one hectare of land, which is quite advantageous. Pastoral communities, therefore, would really benefit if they adopt it. Despite its economic benefits, a study by Lugusa (2015) noted that pasture availability throughout the year tends to lessen conflicts over grazing that were previously rampant in most pastoral communities.

In the Lake Bogoria Landscape, Baringo County, pasture production is carried out by individual farmers as well as by groups where the planted grass is mainly the Buffel grass

(*Cenchrus ciliaris*). It is mainly done in enclosures meant to keep off the grazing animals. The enclosures provide fodder banks for the owner's heads during the dry periods, feedlots for fattening livestock or for sale for income (Wairore et al., 2015). This has greatly rehabilitated some of the degraded natural pasture areas. Despite this initiative, a number of farmers have not yet adopted the technology, and thus the need to investigate the factors affecting its adoption.

The cost effectiveness of the pasture has been shown to influence its adoption (Twinamatsiko et al., 2020). Farmers are more likely to adopt new pasture technologies if they are cost-effective and offer a good return on investment. This includes considering the initial investment cost, ongoing maintenance costs, and potential savings or profits that can be generated from the technology.

Another factor is the pasture's potential benefits (Johnson et al., 2023; Twinamatsiko et al., 2020). Farmers are more likely to adopt new pasture technologies if they offer clear benefits such as increased productivity, improved pasture quality, and reduced labor requirements. Technologies that can help farmers address specific challenges or problems they are facing are more likely to be adopted.

Lastly, the availability of support and resources is likely to influence farmers to adopt new pasture technologies (Shelburne et al., 2017; Twinamatsiko et al., 2020). For instance, farmers are more likely to adopt new technologies if they have access to support and resources such as training, technical assistance, and financial incentives. Providing farmers with the necessary resources to adopt and use new technologies can help increase adoption rates (Siebrecht, 2020).

Available evidence in Kenya shows that there are widespread soil and water conservation problems. The problem of soil erosion was licensed when the colonial government introduced a land-use policy after many European settlers came and took up farming in Kenya (Republic of Kenya, 2020). This policy resulted in the resettlement of large numbers of African farmers and pastoralists, assigning them restricted zones or native reserves of limited agricultural potential (Mganga et al., 2015). The growth of the human and livestock population in the native reserve areas led to land degradation. Other policies encouraged contour farming, tree planting on hillsides, terracing, strip cropping and destocking of herds in certain areas.

Conservation measures such as grass strips, trash lines and rotational grazing were promoted to supplement terraces. These measures were implemented by coercion under local chiefs, headmen, and technical assistants (Abera et al., 2020). Because of this, farmers

were reluctant to maintain the structures, and as a consequence, the policy failed in the long term (Abera et al., 2020). As the population continued to increase and the shortage of good arable land became acute, the Kenyan government resolved to address the problem of increasing soil erosion as a step toward improving food production.

Grass species play a crucial role in the rehabilitation of degraded rangelands around the world. Different grass species are chosen based on their ability to tolerate various environmental conditions, their resilience to disturbances, and their capacity to improve soil fertility and biodiversity (Rognli et al., 2021).

Some of the most commonly used grass species for rangeland rehabilitation include the tall fescue (*Festuca arundinacea*), a cool-season perennial grass that is known for its deep root system and ability to withstand drought and heavy grazing pressure. It is commonly used for rangeland rehabilitation in temperate regions, such as parts of Europe and North America (Guretzky et al., 2005; Rognli et al., 2021). The blue grama grass (*Bouteloua gracilis*) is another warm-season perennial grass native to North America. It is valued for its drought tolerance, low-growing habit, and ability to regenerate quickly after disturbances. It is commonly used in the rehabilitation of degraded rangelands in the Great Plains of the United States (Jackson, 2004). The Rhodes grass (*Chloris gayana*) is also a warm-season perennial grass that is native to Africa but has been widely introduced around the world. It is known for its high productivity, drought tolerance, and adaptability to a wide range of soil types. It is commonly used for rangeland rehabilitation in tropical and subtropical regions (Twinamatsiko et al., 2020; Wasonga et al., 2003). Lastly, the Buffel grass (*Cenchrus ciliaris*) is a warm-season perennial grass that is highly drought-tolerant and resilient to overgrazing. It is widely used in degraded rangelands in arid and semi-arid regions, particularly in Australia and the southwestern United States (Miller et al., 2010).

Cenchrus ciliaris is being tried in many other places in Kenya, but not much information is available concerning the progress of its growth. To add to this, there is no coordination and proper channels of communicating information on *Cenchrus ciliaris* use in Kenya for soil and water conservation. *Cenchrus ciliaris*, which has not been in existence in the tropics, has recently become the subject of intense study and experimentation as an alternative measure for soil and water conservation apart from pasture production (GRAIN and Seed Savers Network, 2022). Whereas the *Cenchrus ciliaris* has been shown to have enormous potential for environmental and economic advantages in various parts of the world, in some places, the technology has met with resistance from communities. The establishment and adoption of *Cenchrus ciliaris* in Kenya have been quite slow, and very

little has been done towards its promotion in the country for soil conservation purposes. It has been tried in various parts of the country with limited success, especially in the high-altitude areas, where some of the reasons given for its poor rate of adoption by farmers (Oscar, 2021). One of the main constraints to soil and water conservation practices in Kenya is the labor required to construct and maintain the structural measures. The lack of information on *Cenchrus ciliaris* has also hampered its development in Kenya (Oscar, 2021; USDA, 2022).

2.4. The Role of Stakeholders in Pasture Establishment

Stakeholders play a pivotal role in the establishment and management of pastures, particularly in arid and semi-arid regions like Baringo County, Kenya. The involvement and collaboration of various stakeholders—including government agencies, non-governmental organizations (NGOs), local communities, and researchers—are essential for sustainable pasture management and the adoption of effective land-use practices that address the challenges associated with environmental degradation.

Governments often serve as primary stakeholders, providing policies and regulatory frameworks that can either facilitate or hinder pasture establishment. In Kenya, the Ministry of Agriculture and the Kenya Forestry Research Institute have initiated various programs since the early 2000s aimed at bolstering pasture production and rangeland rehabilitation(Republic of Kenya, 2020). This includes introducing promising species like *Cenchrus ciliaris* and *Eragrostis superba*, which have shown resilience in adverse conditions typical of the region (Tesfaye, 2024)**.**

Non-Governmental Organizations have also significantly contributed to the processes of pasture establishment in Baringo County by offering technical support, financial assistance, and capacity building within local communities. Organizations such as the World Wildlife Fund (WWF) have implemented programs aimed at establishing sustainable pasture management systems that involve local pastoralists in decision-making processes. By promoting stakeholder participation and knowledge-sharing, these initiatives have helped foster community ownership and commitment towards the successful introduction of improved pasture species (GoK, 2018).

Community involvement is crucial for the success of pasture establishment projects. Local pastoralists often have traditional knowledge about the landscapes they inhabit, and understanding their needs and practices can enhance the effectiveness of introduced technologies (Mansoor et al., 2019). However, a significant challenge remains, as many pastoralists may exhibit resistance to adopting novel practices due to socioeconomic

constraints or a lack of awareness of the benefits, particularly given that their livelihoods are heavily dependent on traditional nomadic herding practices (Byambaa & de Vries, 2021).

Enhancing the adoption of improved pasture species, such as *Cenchrus ciliaris*, requires a concerted effort by all stakeholders to address the barriers to adoption. Research indicates that successful pasture establishment is often contingent upon fostering strong networks among stakeholders and ensuring that scientific insights resonate with local practices (Mairomi & Kimengsi, 2021). In the context of Baringo County, initiatives that incorporate the voices of local communities alongside the expertise of researchers and NGOs can lead to sustainable pasture management practices capable of improving agroecological conditions and food security.

2.5 Research Gaps

Despite the established advantages of *Cenchrus ciliaris* for mitigating pasture scarcity and enhancing soil conservation in arid regions, such as the Lake Bogoria Landscape in Baringo County, significant gaps remain in our understanding of the factors influencing its adoption among local farmers. Existing literature underscores the roles of cost-effectiveness, perceived benefits, and availability of support in the adoption of new pasture technologies. However, there is insufficient data on how these elements specifically relate to the uptake of *Cenchrus ciliaris* in this particular study area.

Additionally, the socio-spatial dynamics, resource use conflicts, and poverty levels within Baringo County are critical in shaping household decisions regarding pasture utilization. Yet, the specific nexus between socioeconomic characteristics and the adoption of *Cenchrus ciliaris* remains largely unexplored. Consequently, this study seeks to address these research gaps by examining the socioeconomic and ecological attributes of households involved in *Cenchrus ciliaris* production while elucidating the relationships between these factors and the grass's adoption within the Lake Bogoria Landscape. By filling these gaps, this research aims to yield valuable insights for policymakers and stakeholders seeking to facilitate the sustainable adoption of *Cenchrus ciliaris* in ASAL regions, thereby contributing to the long-term viability of both livestock production and environmental conservation.

The identification of these research gaps directly informed the specific objectives outlined in this study. The need to assess the socioeconomic characteristics of households using *Cenchrus ciliaris* (Objective i) originated from the recognition that local socioeconomic contexts and dynamics significantly influence adoption rates. Understanding these characteristics helped to contextualize the challenges and opportunities faced by farmers in the region. Objective (ii), aimed at analyzing the role of stakeholders in *Cenchrus*

ciliaris production, and is rooted in the acknowledgment of various actors including; government agencies, NGOs, and local communities, who can impact the grass's adoption through their support and resources. Objective (iii), which focused on establishing the relationship between socioeconomic determinants and the adoption of *Cenchrus ciliaris*, is essential for understanding how specific factors, such as income, education, and resource availability, converge to affect adoption decisions. This addresses the identified gap concerning the socio-spatial dynamics of resource use conflicts and poverty in influencing these decisions. Lastly, Objective (iv) aimed to evaluate the impact of stakeholders on the adoption process, reflecting the realization that effective collaboration and support could significantly enhance the likelihood of success for *Cenchrus ciliaris* adoption, thus bridging the gap between technical potential and on-the-ground practice.

2.6. Theoretical Framework

This study was led and guided by the Conservation of Resources (COR) Theory authored by Dr. Stevan E. Hobfall in 1989 (Holmgreen et al., 2017). This is a stress theory that describes the motivation that drives humans to both maintain their current resources and pursue new resources. The theory postulates that psychological stress occurs in three instances; when there is a threat of a loss of resources, an actual net loss of resources, and a lack of gained resources following the spending of resources. From this perspective, resources are defined as things that one values, specifically objects, states, and conditions. COR states that the loss of these resources will drive individuals into certain stress levels. COR covers two basic principles involving the protection of resources from being lost. The first principle is called the *Primacy of Resource Loss*. This principle states that it is more harmful to individuals to lose resources compared to when there is a gain of resources.

The second principle is known as *Resource Investment*. This principle of COR states that people tend to invest resources to protect against resource loss, recover from losses, and gain resources. Within the context of coping, people will invest resources to prevent future resource losses. From these two principles, COR has suggested a number of corollaries that can be applied to resource changes. They are as follows: Individuals with higher resources will be set up for gains in resources (Holmgreen et al., 2017). Similarly, individuals with fewer resources are more likely to experience resource losses. Initial resource loss will lead to resource loss in the future. Initial resource gains will lead to resource gains in the future. And lastly, a lack of resources will invariably lead to defensive attempts to conserve the remaining resources.

2.7 Conceptual Framework

Socioeconomic characteristics such as income, education level, and land ownership are vital independent variables influencing the decision-making process. These factors can dictate the resources available to a household, including their capacity to invest in new agricultural practices. For instance, households with higher income and better education may be more inclined to adopt innovative agricultural practices, including the cultivation of *Cenchrus ciliaris*, due to greater access to information, financial resources, and support services. Conversely, households with limited financial resources or lower educational attainment may lack the means or knowledge to introduce such innovations into their farming systems.

The intervening variable of availability of extension services and presence of stakeholders involved in the production of *Cenchrus ciliaris* plays a crucial role in bridging the gap between socioeconomic factors and actual adoption behavior. Even if a household possesses favorable socioeconomic characteristics, a lack of information about the benefits, cultivation methods, and maintenance of Cenchrus ciliaris can hinder its adoption. Therefore, enhancing knowledge dissemination through agricultural extension services, community workshops, and peer learning could significantly influence the adoption rates among pastoralist communities. Stakeholders involved in *Cenchrus ciliaris* production, such as government agencies and NGOs, can act as catalysts in this regard, promoting awareness and demonstrating the advantages of its cultivation for both livelihood improvement and environmental sustainability.

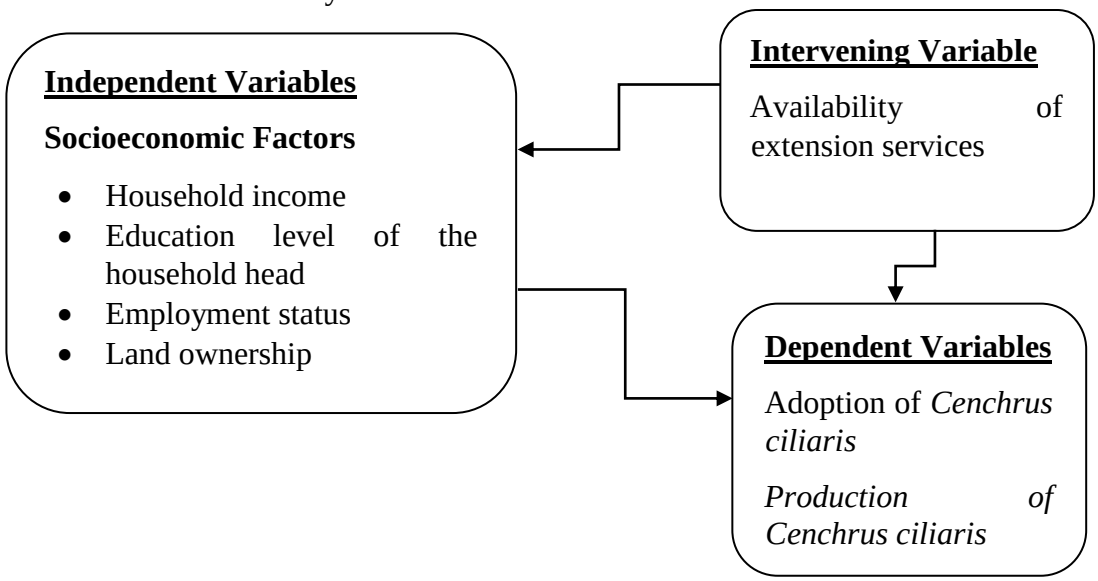


Figure 2.1:Conceptual Framework showing the relationship between dependent and independent variables

CHAPTER THREE
RESEARCH METHODOLOGY

3.1. Description of the Study Area

The Study area is located in the Eastern (Gregory) Rift Valley in Kenya. It is an open savannah bushland/woodland environment with an elevation varying from 970 m at the lake surface to over 2200m above sea level (Kiage & Liu, 2009). A variety of dryland woody species characterize the vegetation including *Commiphora* (Myrrh), *Acacia xanthophloea* (Fever tree), *Balanites aegyptiaca* (Desert date) although two introduced species, *Prosopis juliflora* (Mesquite) and *Opuntia ficus indica* (Pricky pear cactus), have become invasive and now occupy vast tracts of land in the lowlands. Grass species includes red oat grass (*Themeda triandra*), Maasai lovegrass (*Eragrostis superba*) while herbaceous plants include the African wild basil (*Ocimum gratissimum*). Many of the lowlands are now used for irrigation, farming and grazing.

The topsoil was formed in the early Holocene as a lakebed, during a period when Lake Baringo and Lake Bogoria (just to the south) formed a single lake (Kiage & Liu, 2009).

The soils are an unconsolidated silty loam, with varying contents of silt and clay but almost no sand. These soils and the surrounding highlands are now subject to high rates of sheet, wind, and gully erosion due to a mixture of soil properties, lack of undergrowth, persistent winds and high-intensity downpour (Petek, 2015). Because of this erosion, the region has been subject to many different land rehabilitation projects, which have all failed, and it attracted a lot of research from various disciplines concerned with the degradation and the paleoecology of the environment (Kiage, 2013).

The study was conducted in the semi-arid reaches of Baringo South Sub-County of Kenya, within three wards (Ilchamus, Mochongoi and Marigat) (Figure 2). The area covers the rangelands inhabited by these communities. It falls within agroclimatic zones IV and V, at an average altitude of 900-1200m above sea level (Petek, 2015). Climate is generally hot and dry (22º-24ºC). Rainfall is low, erratic, unreliable in both space and time 300-700 mm, and bimodal in distribution.

It borders Laikipia County. The dominant ethnic groups in Baringo South Sub-County are the Pokot, Tugen, Ilchamus and Endorois. It has two distinct weather patterns, with temperatures in the southern part ranging between 25°C during the cold month (June and July) and 30°C during the hot months (January and February). It receives rainfall amounts of between 1000m-1500 and m annually in the highlands and 600m in the lowlands. It lies

between longitude 35.602°-36.277°E and latitude 0.541-0.723°N at an altitude ranging between 870 and 2499m above sea level (Kiage & Liu, 2009).

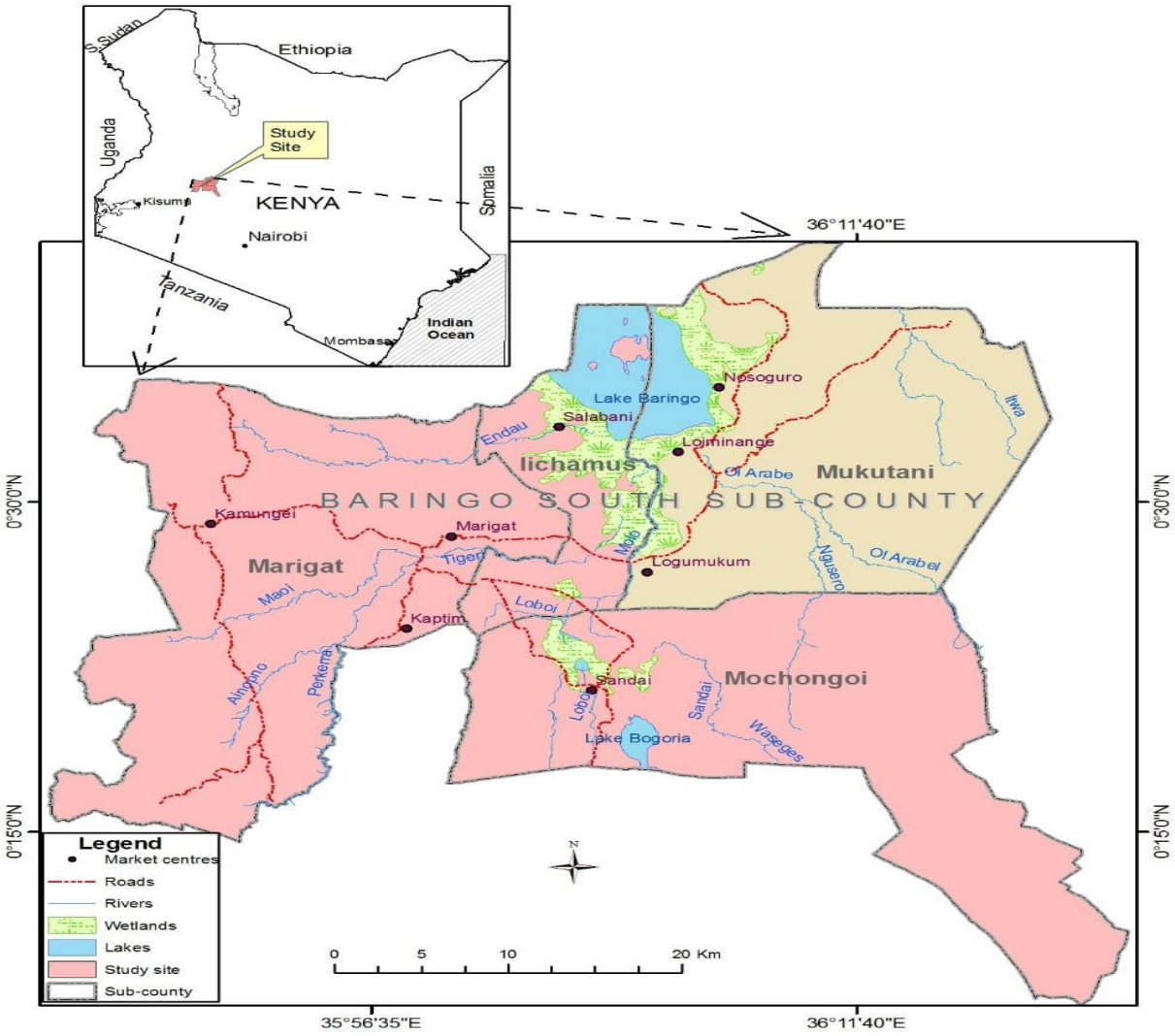


Figure 2:Map of Baringo County Showing the Study Areas

3.2. The Population of the Study

The target population for the study included the household heads in Ilchamus, Mochongoi and Marigat wards of Baringo South Sub- County, Baringo County. Additionally, local administrative leaders, opinion leaders and local informants included the chiefs from the region, leaders representing various women groups, officials from non-governmental organizations operating in the region, religious leaders, youth groups and members of the council of elders from the communities form the key informants (Table 1).

Table 1: Population of the Study Area

Location / **Parameter**	Headcount Index: % of people below the Poverty line	Poverty Gap as % of Poverty Line	The severity of Poverty as % of Poverty Line	Wealth Gap index as % of Poverty Line	Mean Expenditure	Ginni Co-efficient	Contribution to national Poverty	Total Population
Kimalel	38.5	7.5	1.9	61.1	2,400	0.290	0.009	4,072
Marigat	45.2	10.1	3.0	64.7	3,530	0.383	0.034	12,753
Salabani	83.8	28.2	11.9	10.4	1,280	0.255	0.023	4,725
Ngambo	68.7	14.6	4.1	21.9	1,680	0.244	0.022	5,324
Ilchamus	59.2	12.1	3.2	30.4	1,850	0.263	0.011	3,298
Sandai	54.6	11.2	3.0	34.9	1,930	0.271	0.008	2,564
Kapkuikui	52.2	9.8	2.6	39.8	2,030	0.269	0.003	1,080
Loboi	51.4	11.8	3.5	51.5	2,180	0.326	0.006	2,126
Kimondis	44.8	9.5	2.7	53.5	2,250	0.296	0.004	1,357
Ilngarua	54.1	10.2	2.6	34.7	1,950	0.258	0.008	2,555
Ewalel Soi	56.8	11.8	3.3	39.5	2,000	0.286	0.005	1,364

3.3. Research Design

A descriptive cross-sectional design was used to collected data among households to assess socioeconomic factors influencing the adoption of *Cenchrus ciliaris* pasture grass species in the study area.

3.4. Research Instruments

Data was collected using semi-structured questionnaires that were administered to household heads. Focused Group Discussions (FGD) and key informant interviews (KII) were conducted to collect qualitative data. Observations were also used to gather information on the establishment and management of *Cenchrus ciliaris* among the selected households.

3.5. Target Population and Sampling

A social survey was used for data collection through the administration of the questionnaire, oral interviews and focus group discussions (FGD). Data was collected from

103 households. For this data, simple random sampling was used to select household. Simple random sampling technique was preferred for this study as it ensured equal chances for every household in the study area being included in the sample (Mugenda & Mugenda, 2009).

n = NC 2 /C 2 + (N-1) e 2

n= 100 households

Where;

n is the size of the sample; N is the size of the population;

C which is the coefficient of variation (30%) and;

e is the standard error 0.05%.

The formula was useful in obtaining samples from population where probability distribution is unknown. It utilizes the coefficient of variation and error margin, which are a measure of reliability of the sample size to be obtained. The lower the coefficient of variation and the error margin, the more reliable the sample will be.

3.5.1. Key Informant Interviews and Focused Group Discussion Data

For qualitative data, KII and FGD participants were selected purposely based on their willingness to participate in the study. The strategy was used because it enabled the researcher to get people who were in a better position to provide relevant information. KII respondents included those groups and individuals that had adopted *Cenchrus ciliaris* pasture production. Owing to ethnic and gender stereotypes, the focus group discussants were drawn and segregated along ethnic and gender considerations to encourage and ensure free, fair and active participation in the discussions.

A total of 20 key informants were selected at random based on their level of knowledge about the community and knowledge about production of *Cenchrus ciliaris* grass species. In addition, Focus Group Discussions for 6 to 8 participants per FGD group were selected purposively based on their willingness to participate in the study. The two tools Key informant interviews (KIIs) constituted opinion leaders, Ministry of Agriculture, Livestock and Fisheries personnel, Staff in the Ministry of Wildlife and Tourism, Kenya Wildlife Service, Kenya Forestry and Research Institute and representatives of development partners working in the study area, and local county administrators. By the end of the study, a total of four Focused Group Discussions had been conducted.

3.6. Validity and Reliability of the Data Collection Instruments

This study used questionnaires, KIIs, and FGDs for data collection; therefore, checking their validity before the real data collection was paramount. There were a number of

proposed activities that were carried out in order to validate these data collection tools. For instance, randomization, the use of a research design, and statistical analysis appropriate to the types of data to be collected were implemented. After the establishment of face validity, a pilot test was carried out in Emining, an area with similar agroclimatic and socioeconomic conditions, where *Cenchrus ciliaris* had been adopted for pasture production. The sample size for the pilot test was 5% of the total target sample for the whole study.

Fifteen questionnaires were distributed to assess validity and reliability using Cronbach's Alpha. A reliability coefficient, specifically Cronbach's Alpha, was calculated to evaluate the internal consistency of the questionnaire items. A higher coefficient, generally above 0.7, indicates that the items measure the same underlying concept and can be considered reliable. Respondents were randomly selected at least a week before the main study to ensure a diverse sample. Participants were observed as they answered the questions to determine if the questionnaire measured what it intended to measure. Other factors, such as the time taken to interview each respondent, appropriateness of response choices, and the effectiveness of collecting necessary information, were also considered. Any necessary adjustments to the tool were made based on the findings from the pilot study, ensuring that the final data collection instruments were both valid and reliable for the main study.

3.7. Ethical Considerations

Before carrying out the data collection, permit approvals were obtained from the National Commission of Science, Technology and Innovation (NACOSTI). Further permission to conduct research within the community was sought from the Sub-County Commissioner and the leadership of the Coordinator of the National Government activities within the local level. For confidentiality, no personal data regarding names or contacts were captured. Furthermore, all the data captured was used within the confines of the research objectives. Participants in this study were asked to participate in the study by signing a confidentiality form and provide their informed consent.

3.8. Data Processing and Analysis

Data from the questionnaire were coded and analyzed using Statistical Package for Social Sciences (SPSS) software (version 22). Descriptive statistics (frequencies and percentages) were used to present the results in graphs and tables, whereas inferential statistics by use of Person Chi-Square method were done to determine the relationship between socioeconomic factors and adoption of pastures production. For the FGDs and the KII, the audiotapes of the discussions and the interviews were carefully transcribed. After the data was transcribed and translated, it was coded following keywords, key concepts, or

reflections using respondents' exact words and analyzed manually for common themes (Theme/content analysis). The codes were finalized, written and illustrated with some quotations from the original text to communicate its meaning better. Table 2 presents a summary of the statistical tools used in this study.

Table 2: Summary of Variables and Data Analysis Tools

Objectives	**Variables**	**Statistical test**
To assess the socioeconomic characteristics of households that utilizes *Cenchrus ciliaris* in the study area	Socioeconomic characteristics	Descriptive statistics (Frequencies and percentages)
To establish the relationship between socioeconomic determinants and the adoption if *Cenchrus ciliaris* in the study area	Socioeconomic characteristics Adoption of *Cenchrus ciliaris*	Inferential statistics (Chi Square) Qualitative data (thematic analysis)
To analyze the role of other stakeholders involved in *Cenchrus ciliaris* production in the study area	Stakeholders' roles	Descriptive statistics (Frequencies and percentages)
To evaluate the impact of stakeholders on the adoption of *Cenchrus ciliaris* in the study area	Stakeholders impact	Descriptive statistics (Frequencies and percentages) Inferential statistics (Chi Square)

CHAPTER FOUR
RESULTS AND DISCUSSIONS

4.1. Results

4.1.1. Socioeconomic Characteristics of Study Participants

One hundred and three respondents participated in this household survey within the selected wards (Ilchamus, Mochongoi and Marigat). In terms of gender, 54.4% of the respondents were males (Table 3). Eighty-eight percent of the respondents were farmers whereas only 7.8% had formal employment (Table 3). Additionally, 36% of the respondents had attained primary level of education while 7.8% had obtained a university level education (Table 3). Approximately 52% of the respondents had a household size ranging between 6 and 10 members.

Table 3: Socioeconomic characteristics of respondents that participated in the study

Characteristics	**n**	**%age**	**Characteristics**	**n**	**% age**
Respondents' age			**Education level**		
18-25	21	20.40	None	2	1.90
26-35	40	38.80	Primary	38	36.90
36-45	27	26.20	Secondary	36	35.00
46-55	12	11.70	College	19	18.50
Above 56	3	2.90	University	8	7.80
Occupation level			**Household size**		
Farmer	91	88.30	1-5	35	34.00
Pastor	2	1.90	6-10	53	51.50
Formally Employed	8	7.80	11-15	14	13.60
Casually Employed	2	1.90	Above 16	1	1.00
Respondents' Gender					
Male	56	54.40			
Female	47	45.60			

Eighty-six percent of the respondents owned a grazing land with 68% of the grazing fields being privately owned while 24% were communally owned (Table 4). The majority of respondent (69%), reported owning between 1-10 cows. Additionally, nine percent owned between 21-30 cattle and 18% did not own any cattle (Table 4).

In terms of the size of grazing land, most respondents (47%) had access to between two and five acres of land. Twelve percent of them had more than 11 acres. Thirty nine percent reported that the distance to the grazing fields was between two and five kilometers from their households. Nearly 9% had to travel a distance of more than 5 kilometers to the grazing lands. A section of the respondents (82.5%) further noted that they were buying pastures for their livestock during the dry periods of the year when grazing lands were bare and could not support their animals.

During times of crisis, farmers opt for alternative types of pastures for their livestock. The majority (41%) use maize stalks/pods, followed by tree leaves/pods (26%) and hay (21%). *Prosopis juliflora* (locally known as 'Mathenge') seeds and open grazing were the least cited as types of livestock feed (Table 4).

Eighty-six of the respondents had knowledge of the contribution of pasture production to environmental conservation (Table 4). The types of pasture establishments varied, with 13% practicing furrow farming, 8% practicing round-basin farming, while the rest practiced terracing and afforestation for soil and water conservation. Despite their knowledge of the contribution of pasture establishments to environmental conservation, 70% of the respondents reported not practicing any pasture production establishments and depends on free grazing fields (Table 4).

Table 4: Pasture Adoption and Establishments in the Study Area

Characteristics	**n**	**%**	**Characteristics**	**n**	**%**
Grazing land ownership			**Main sources of pasture**		
Yes	89	86.40	Communal land	10	9.70
No	14	13.60	Hay	4	3.90
Type of ownership			Maize stalks	12	11.60
Communal	25	24.30	Open grazing fields	67	65.10
Lease	4	3.90	*Prosopis juliflora*	2	1.90
Owner	69	67.90	Silage	1	1.00
Not specified	5	4.00	Other tree leaves/pods	7	6.80
Size of grazing land			**Alternative pasture during crisis**		
0-1	22	21.40	Tree leaves/pods	27	26.20
2-5	49	47.60	Hay	22	21.40
6-10	20	19.40	Maize stalks/pods	42	40.80

More than 11	12	11.70	Open grazing	1	1.00
Does household buy pasture			Pastoralism	4	3.90
Yes	85	82.50	Prosopis seeds	1	1.00
No	18	17.50	Silage	3	2.90
Cost of pasture per bale			None	3	2.90
0-50 Kshs	1	1.00	**Distance to primary source of pasture**		
51-100 Kshs	6	5.80	0-1 Km	26	25.20
101-150 Kshs	3	2.90	1-2 Km	29	28.20
151-200 Kshs	43	41.80	2-5 Km	39	37.90
More than 200 Kshs	50	48.50	More than 5Km	9	8.70
Pasture production establishments			**Number of cattle owned**		
Afforestation	1	1.00	0	18	17.50
Furrow farming	13	12.60	1-10	71	68.90
Round basin farming	8	7.80	11-20	3	2.90
Terracing	2	1.90	21-30	9	8.70
Natural grass	2	1.90	61-70	2	1.90
Gulley	2	1.90			
None	72	69.90			
Others	3	2.90			

The main pasture grasses in the study area were Maasai love grass (*Eragrostis superba*), buffelgrass (*Cenchrus Ciliaris)* and star grass (*Cynodon aethiopicus)*(Figure3.

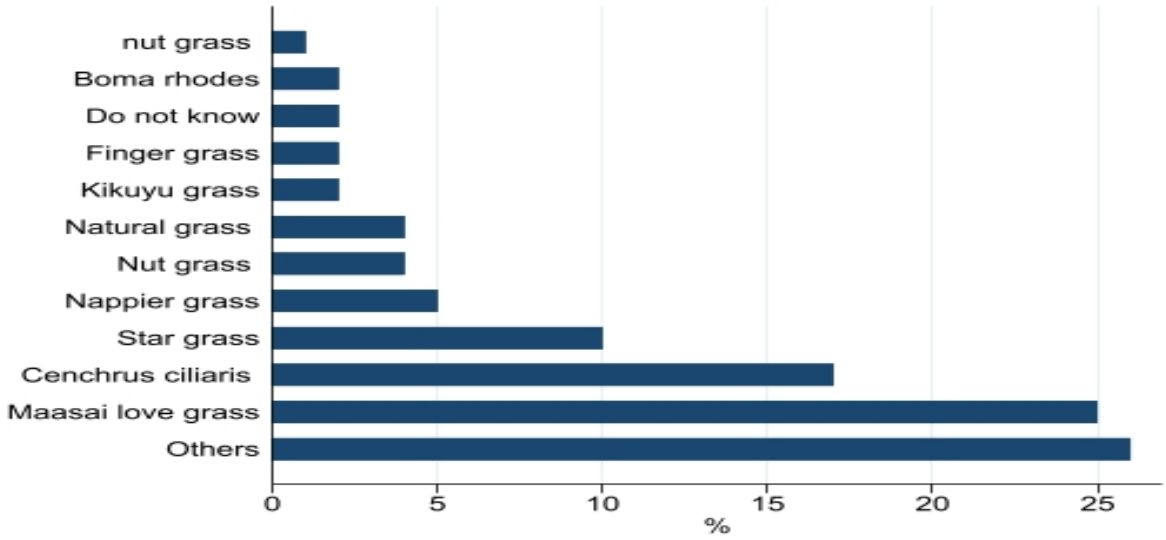


Figure 3: Types of pasture grass species in the study area

At least 30 participants (29% of the total) identified the benefits of pasture production in preventing soil erosion. Similarly, 25% of the participants recognized improved animal production as a result of pasture utilization. Additionally, 17% of them acknowledged the income generated from pasture production, while only 7% recognized its potential for improving soil fertility. Only one percent of them identified the reduction of conflicts as a benefit of pasture production (Table 5).

Regarding soil conservation activities in the study area, 34% of them mentioned the importance of providing training to farmers on establishing pastures for environmental benefits. A section (19.42%) highlighted the significance of afforestation, while 13% believed that educating farmers would be beneficial. Nine percent of the participants suggested providing farmers with capital or seeds to support their efforts in soil conservation. The least common suggestions were building gabions, mentioned by 1%, and fencing of farms, mentioned by 2%. Thirteen percent did not propose any specific activity to aid farmers in conserving soil.

Table 5: Environmental Conservation measures through pasture within the study area

Activities done for soil conservation	**Freq.**	**Percent**	**Benefits of pasture production**	**Freq.**	**Percent**
Afforestation	20	19.42	Environmental aesthetic value	4	3.88
Building gabions	1	0.97	Improved animal production	26	25.24
Animal Production	4	3.88	Improvement of soil fertility	7	6.80
Constructing boreholes	3	2.91	N/A	6	5.83
Educating the community on pasture establishment	13	12.62	Prevention of soil erosion	30	29.13
Help in fencing of farms	2	1.94	Provides thatching grass	11	10.68
None	13	12.62	Reduced conflicts	1	0.97
Providing capital/seeds to the famers	11	8.74	Source of income	18	17.48
Training farmers	35	33.98	**Total**	**103**	**100**
Total	**102**	**100**			

4.1.2. Relationship between the *Socio-economic Factors and Adoption of Pastures*

Pearson's Chi-square tests were conducted to assess if there was a relationship between specific socioeconomic factors and the establishment of pastures. The study results indicate that there was a significant association observed between the respondent's gender and establishment of pasture lands (χ^2= of 3.80; p= 0.05, Table 6).

Table 6: Influence of gender on adoption of pasture establishments

Respondents' gender/Pasture land	No	Yes	Chi Square
Female	3	44	3.80, p=0.05
Male	11	56	

The level of education of the respondents had a significant association with the participants' knowledge regarding the advantages of pasture production for environmental conservation (χ^2 = **16.93** , $p < 0.05$); Table 7.

Table 7: Education level/knowledge on pasture establishment for environmental conservation.

	Education level					
Familiarity with pasture production for environmental protection	**College**	**None**	**Primary**	**Secondary**	**University**	**Total**
No	4	2	2	4	2	**14**
Yes	15	0	36	32	6	**89**
Total	19	2	38	36	8	**103**
	Pearson chi2(4) = 16.93 P = 0.00					

There was no association between the educational level of the participants and their preference for specific type of stakeholders involved in training on pasture establishments in the study area (χ^2 =18.29; $p > 0.05$; Table 8).

Table 8: Relationship between education level and preferred training institutions sought.

Education level	training on pasture							
	Administrative	[illegible] CBOs	Government	KVDA	NGOs	Research	None	Chi Square
College	0	4	1	0	1	4	9	18.29, p=0.79
Primary	0	3	9	1	0	8	17	
Secondary	1	3	6	1	0	12	13	
University	0	2	1	0	0	1	4	
None	0	0	0	0	0	0	2	

A strong association was observed between the amount of pasture land owned by the participants and the daily pasture harvest ($\chi 2$ = **32.84** ; $p<0.05$; Table 9).

Table 9: Relationship between pasture harvest and the size of land owned

Pasture harvest per day	Land size in acres					
	0	0-1	2-5	6-10	≥11	Total
1-200 bales	1	6	14	8	0	29
201- 400 bales	0	0	7	0	0	7
401-600 bales	0	0	4	0	0	4
601-800 bales	0	1	1	1	3	6
801-1000 bales	0	1	2	3	0	6
None	3	10	21	8	9	51
Total	4	18	49	20	12	103
Pearson chi2(20) = 32.84 Pr = 0.04						

Similarly, there was a strong association between the size of the grazing land and the number of (goats) (χ^2 = **77.71** ; $p<0.05$; Table 10).

Table 10: Relationship between grazing land size and number of goats owned

	Size of the grazing land (in Acres)					
No of goats owned	**0**	**0-1**	**2-5**	**6-10**	**More than 11**	**Total**
0-10	1	2	5	1	0	9
11-20	0	6	22	7	7	42
21-30	0	6	9	9	0	24
31-40	1	0	0	0	0	1
41-50	0	0	2	0	0	2
51-60	0	0	2	0	0	2
61-70	1	2	6	0	2	11
71-80	0	0	1	0	0	1
81-90	1	2	1	3	0	7
91-100	0	0	0	0	3	3
Total	4	18	48	20	12	102
Pearson chi2 (36) = 77.71 P = 0.00						

4.1.3. The Role of Stakeholders and their Impact in Pasture Establishments

Different stakeholders were involved in sourcing and provision of pastures for adoption to the farmers in the study area. For instance, thirty-eight percent of the respondents indicated that they purchased their pastures from market stores in the adjacent towns and trading centers (Figure 3). Only 1% of the respondents indicated KEFRI as their main source for their pasture seeds (Figure4.

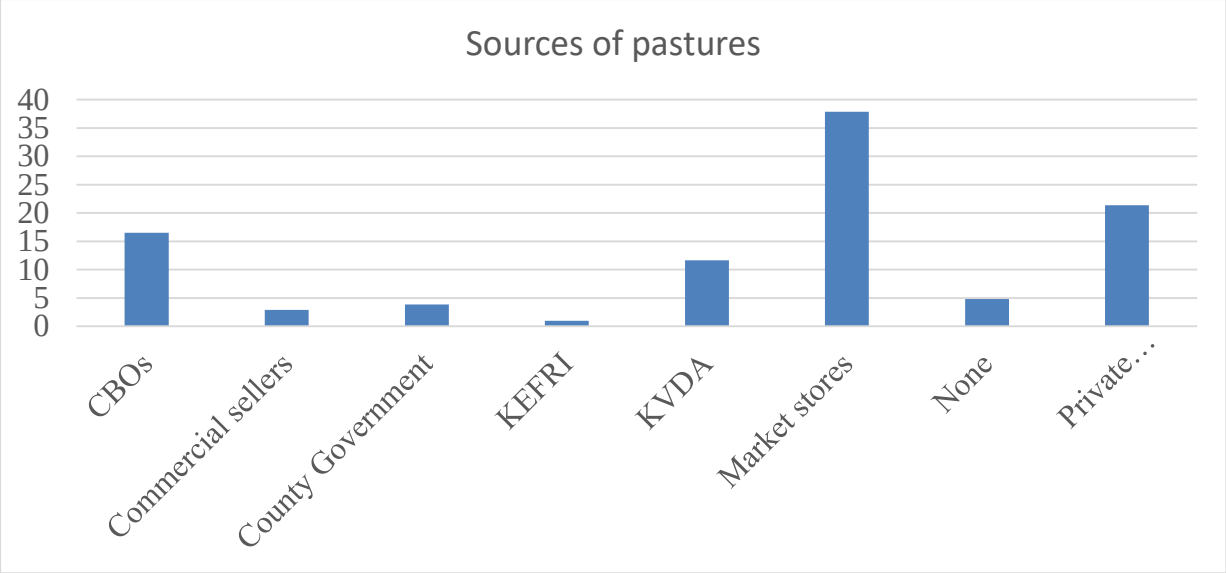


Figure 4:Stakeholders involved in provision/selling of pastures versus the number of respondents within the study area

In terms of stakeholders involved in pasture establishment, 23% of the respondents indicated that they had received training on their establishments from their fellow farmers who had adopted the grass within their community, while only 1% received it from teaching and research institutions such as Egerton University (EU) and the Kenya Forest Research Institute (KEFRI). All these stakeholders had their different roles in pasture establishment activities in the study area (Table 11).

Table 11:Stakeholders involved in pasture establishment activities

Stakeholders involved in pasture establishment activities	n	%
CBOs	17	16.50
Government/Ministries	3	2.90
Community/Neighbors	4	3.90
Egerton University (Chemeron)	1	1.00
KVDA	12	11.70
KEFRI	39	37.90
NGOs	22	21.30

Further, there was a strong association between pasture establishment and the type of stakeholders and institutions sought by the respondents to train on pasture establishments ($\chi 2 = 153.65$; $p<0.05$; Table 12).

Table 12:Relationship between pasture and types of stakeholders & institutions offering training services

	Type of establishment								
Stakeholder types/institutions offering training	Communal	Hay	Milling maize stalks	Open grazing	Paddocking	Prosopis	Silage	Tree leaves	Total
Administrative leaders	0	0	0	0	0	0	0	1	1
CBOs	3	0	0	9	0	0	0	0	12
Government ministries	0	0	10	4	0	0	1	2	17
KVDA	0	0	0	1	1	0	0	0	2
NGOs	0	1	0	0	0	0	0	0	1
None	2	2	1	35	0	1	0	4	45
Research Organization	5	1	1	18	0	0	0	0	25
Total	10	4	12	67	1	1	1	7	103
Pearson chi2 (42) = 153.65, Pr = 0.00									

It was found that the type of pasture alternatives used during periods of extended droughts did not have any association with the type of stakeholders or institutions chosen by the participants for training on pasture establishments (χ^2 = 57.5003; p> 0.05). This suggests that farmers may have a strong preference for specific stakeholders or institutions for training, regardless of the potential environmental impact of their pasture choices during droughts. Whereas in normal circumstances, efforts should focus on educating farmers on sustainable pasture management practices that prioritize environmental resilience and conservation, regardless of the pasture alternatives being used. Conversely, there was a significant association between the type of pasture grass species planted by the participants and the stakeholders/institutions sought for training on pasture establishments (χ^2 = 90.61; p> 0.05; Table 13).

Table 13: Relationship between pasture grass species and stakeholders and institutions offering training services

Training providers	**Type of grass species**												
	Boma Rhodes	*ciliaris*	Don't know	Finger grass	Kikuyu grass	Maasai grass	Nappier grass	Natural grass	Nut grass	Others	Star grass	species)	Others
Admin	0	0	1	0	0	0	0	0	0	0	0	0	1
CBOs	0	0	0	0	0	9	1	12	0	0	1	0	12
Ministries	1	1	7	0	0	2	1	1	0	2	3	0	17
KVDA	0	0	1	0	0	1	0	0	0	0	0	0	2
NGOs	0	0	0	0	0	0	1	0	0	0	0	0	1
None	1	1	3	1	2	3	2	2	4	20	4	1	45
Research Organization	0	0	6	1	0	11	0	0	0	5	2	0	25
Total	2	2	18	2	2	26	5	4	4	27	10	1	103
Pearson chi2(66) = 90.61 Pr = 0.02													

In this objective, total of twenty (20) key informant interviews (KIIs) were conducted with various individuals representing major stakeholders in the pasture and livestock production. Additionally, four focus group discussions (FGDs) were conducted involving community members; two of which involved community-based organizations. Based on these findings, the following information was obtained.

The primary occupation reported by the majority of respondents was agro-pastoralism. The commonly cultivated crops included maize, melon, green grams, and pawpaw. Land ownership in the community is communal, although each household has designated demarcations ranging from 2-5 acres. The primary pasture species utilized for livestock feeding included maize stalks, *Cenchrus ciliaris* (Buffel grass), *Leucaena leucocephala* (a legume tree), bean straws, and *Acacia seyal* barks.

The qualitative analyses revealed that *Cenchrus ciliaris* was used as a pasture due to its various benefits, as reported by the respondents. For instance, 32.4% of the participants mentioned its ability to be drought resistant, while 45.6% noted that it helps in preventing soil erosion. Additionally, 12.7% highlighted its minimal management requirements, 37.8% mentioned its role as a source of income, and 9.5% pointed out its function in moderating crude protein levels. Furthermore, 15.9% reported that *ciliaris* is easy to harvest, 50.8% noted its ability to increase livestock production, and 19% mentioned its quality as hay. Finally, 25.4% of respondents recognized *Cenchrus ciliaris* for its potential use as thatch grass, showcasing its versatility and value as a pasture option. The use of *Cenchrus ciliaris* for thatching was also reported by some male FGD respondents saying;

> '*We adopted this grass species owing to its great benefits not only in livestock and environmental protection but also for thatching our houses',* Male FGD respondent

However, the grass species was reported to be extinct due to overgrazing in the study area (Ilchamus, Mochongoi and Marigat wards) and the surrounding areas as mentioned by one female KII participant from KALRO;

> '*Cenchrus ciliaris is an indigenous grass species which was there before but due to overgrazing, it became extinct and we can only access its seeds in areas such as Kapedo'*

Similar to quantitative findings, Maasai love grass was also used as pasture by most respondents. Other types of grass pasture reported by the respondents included Boma Rhodes and Star grass which was mentioned as being excellent for water and soil conservation.

Respondents reported that they had received training on pasture establishment from a variety of community-based organizations as the main stakeholders involved in pasture production. The training sessions included topics such as pasture establishment and management, adopting paddocking methods to reduce overgrazing, harvesting quality seeds, managing *Prosopis juliflora*, and proper planting timings for *Cenchrus ciliaris* to prevent competition from unwanted grass species. These trainings were aimed at improving the community's knowledge and skills in pasture management, ultimately leading to healthier pastures and increased livestock productivity. The information provided in these sessions was valuable in ensuring sustainable and efficient pasture establishment practices within the community.

During the drought season, respondents reported alternative ways to get pasture for their livestock, with 11 of them moving their animals to graze near wetland areas around the

community. Another option was buying hay from market stores, with 9 key informant interview respondents stating that the cost ranged from Kshs 350-400. Additionally, 2 participants mentioned practicing nomadism, where they moved their animals to areas with better pastures. A small number of participants, including those from local women CBOs, mentioned receiving assistance in adopting *Cenchrus ciliaris* as the primary type of pasture in their homes. They received seeds and a milling machine from development partners within the country.

4.1.4 Challenges Hindering the Establishment of Pastures

Respondents reported to have faced a number of challenges when it came to establishing pastures on their land. One major issue was the lack of knowledge on the benefits of pasture establishments, with many respondents having a limited understanding of the advantages associated with growing pastures. Illegal grazing by livestock in certain areas also posed a problem, given the communal land ownership in the study area. The illegal grazing disrupted the growth and development of the pastures. Financial constraints were another barrier, as many respondents cited a lack of resources to purchase the necessary seeds for pasture establishments. Access to quality seeds was also a challenge, with a limited availability of high-quality seeds making it difficult to establish productive pastures.

Overgrazing was a common issue, with pastures often subjected to excessive grazing by livestock, leading to the degradation and depletion of the vegetation. The communal land ownership structure further complicated matters, creating social and logistical complexities that discouraged the establishment of pastures. Social-cultural issues, such as traditional beliefs and practices, also hindered the adoption and success of pasture establishments. Unpredictable rainfall patterns were identified as a significant factor affecting pasture establishments, as the irregular nature of rainfall impacted the availability of water for the growth and maintenance of pastures.

Government policies were reported as hindrances to pasture establishments, with the preference for tree-related research over grass-related research limiting the promotion and development of pastures. Additionally, the invasion of the invasive species *Prosopis juliflora*, locally known as '*Mathenge*', posed a significant obstacle to the successful establishment of pastures, of the observed challenges hindered their ability to establish healthy and productive pastures on their land.

The qualitative analysis of the transcripts revealed several noteworthy recommendations. Firstly, it was suggested that there should be a focused effort in creating awareness amongst farmers regarding the best practices for establishing pastures. This

would involve providing farmers with training and education on the most effective methods for pasture establishment. In addition, community mobilization efforts should be implemented to highlight the benefits of *Cenchrus ciliaris*, a specific type of grass. This would involve educating the community about the advantages of utilizing this particular grass species for pastures. Furthermore, it was suggested that access to certified seeds of *Cenchrus ciliaris* should be increased. This would involve making high-quality and genetically verified seeds more readily available to farmers. To ensure effective implementation of pasture technologies, it was recommended that organizations should actively seek to establish linkages and partnerships with other individuals or groups working towards the adoption of *Cenchrus ciliaris*. This collaboration would promote knowledge sharing and the exchange of best practices in pasture establishment.

To support farmers in this endeavor, it was deemed necessary to assist them in finding markets for their pasture seeds. By connecting farmers with potential buyers, it would enable them to sustain their activities and generate income. Finally, it was suggested that the formation of cooperatives would play a crucial role in enhancing the growth and sustainability of pasture technologies. By coming together and pooling resources, farmers can benefit from collective decision-making, shared resources, and increased bargaining power.

4.2. Discussion

4.2.1. Socioeconomic Factors of the Study Participants

The results of the household survey illuminate important socioeconomic dynamics within the pastoralist communities of the LBL concerning the adoption of *Cenchrus ciliaris*. The demographic and socioeconomic characteristics of the 103 respondents provide critical insights into the barriers and opportunities that these communities face in enhancing their livelihoods and promoting environmental conservation through the use of this grass species.

The survey reveals a slight predominance of male respondents, with 54.4% identifying as male. This finding is significant as it highlights potential gender disparities within the pastoralist communities regarding involvement in agricultural and environmental projects. Gender roles in such contexts can lead to differential access to resources, information, and decision-making processes (Gabela et al., 2022; Paudel et al., 2019). The findings also show that a substantial majority (88%) of respondents are engaged in farming activities. This not only underscores the importance of agriculture within the community's economic framework but also emphasizes the potential of *Cenchrus ciliaris* to augment agricultural productivity, soil conservation, and livestock nutrition (Mwirigi et al., 2021). A

low percentage (7.8%) of respondents with tertiary-level education in pasture establishment was noted. This reliance on subsistence farming highlights the necessity of introducing sustainable practices and species like *Cenchrus ciliaris* that can improve agricultural resilience amid environmental challenges.

The educational background of the respondents is another critical aspect of understanding socioeconomic factors influencing the adoption of *Cenchrus ciliaris.* With 36% of the respondents having attained only primary education and a mere 7.8% achieving university-level education, there appears to be a significant gap in higher educational attainment within the survey population. This disparity may present challenges in disseminating information about best practices, benefits, and management of *Cenchrus ciliaris*. Lack of formal education may lead to lower levels of awareness regarding the ecological and economic advantages of adopting this grass species, thereby impeding its widespread acceptance (Gabela et al., 2022; Mujeyi et al., 2021; Vaintrub et al., 2021). Additionally, the low education levels may indicate potential resistance to new agricultural practices due to traditional knowledge systems that dominate pastoralist communities (Vaintrub et al., 2021). Therefore, targeted educational initiatives, including workshops and demonstrations that communicate the benefits of *Cenchrus ciliaris*, will be critical for overcoming these barriers.

The study findings further suggest that livestock keeping is a common practice among the community, as indicated by 86% of respondents owning grazing land. This aligns with previous research that has shown livestock farming to be a prevalent activity in similar rural communities (Vaintrub et al., 2021). The preference for private ownership of grazing land, with 68% of fields being individually owned, further supports this observation. The majority of respondents reported owning between 1-10 cattle, indicating that livestock farming is predominantly smallholder type of farming. The availability of grazing land is another important factor for livestock farmers, and the findings suggest that a moderate amount of land is accessible to a significant proportion of respondents. About 47% reported having access to 2-5 acres of grazing land, while a few reported having more than 11 acres. This indicates a higher availability of land for a smaller proportion of farmers, which could potentially affect the overall productivity and profitability of livestock farming in the community (Mujeyi et al., 2021).

The distance to grazing fields is also a factor that can impact livestock farming, and the findings suggest that the proximity of grazing land is relatively convenient for a significant number of farmers. However, few respondents reported that the distance to

grazing fields was more than 5 kilometers, which could pose logistical challenges for livestock management (Ngetich et al., 2023). Therefore, need for the adoption and establishment of the grass pastures, this also highlights the importance of considering the accessibility and proximity of grazing land when designing support programs and interventions for livestock farmers.

The fact that the majority of respondents reported buying pastures at some point for their livestock suggests that the available grazing land might not be sufficient to meet the dietary needs of the livestock year-round. This emphasizes the need to improve pasture production and management practices by incorporating grass species such as *Cenchrus Ciliaris* in order to ensure a sustainable and reliable source of feed for livestock (Duguma & Janssens, 2021).

Open grazing fields were cited as the main source of pasture by a majority of respondents, indicating a reliance on natural pastures for livestock feeding. This finding is consistent with that of Omollo et al. (2023). Maize stalks were also mentioned as an additional feed source, suggesting the utilization of crop residues. However, silage was cited by only 1% of respondents, indicating its limited use as a pasture source which suggests that there may be opportunities to promote the use of silage as a more reliable and consistent feed source for livestock (Mwirigi et al., 2021; Oscar, 2021).

During times of crisis, when alternative pastures are needed, respondents reported using maize stalks/pods as the most commonly used alternative. This indicates that farmers adapt to different feed sources when their usual pastures are not available, highlighting their resourcefulness in finding suitable feed substitutes. Tree leaves/pods and hay were also mentioned as alternative pastures, further emphasizing the need for diverse and accessible feed sources for livestock (Napogbong et al., 2021).

The findings also highlight the cost and sources of pasture for the majority of respondents which suggests that a significant proportion of individuals had to spend a substantial amount of money to acquire pasture. On the other hand, only 1% of the respondents reported that they were able to buy pasture for a cost ranging from 1-50 Kshs. This indicates that a very small percentage of individuals managed to find cheaper alternatives or perhaps had access to their own pasture without incurring significant expenses. Incorporating sustainable pasture practices could help sort this issue and further protect the environment (FAO, 2017).

When examining the sources of pasture, it is interesting to note that a majority of respondents mentioned purchasing it from market stores in the nearby trading centers.

Market stores can be seen as convenient sources where one can easily buy the required pasture. This high percentage suggests that these stores are either widely available or preferred by the respondents due to factors such as convenience, variety, or quality. On the other hand, only a few respondents reported buying pasture from local government research institution stores. This low percentage implies that these institutions are yet to actualize their potential in influencing livestock production through pasture establishment and production, including being sources for pasture seeds (Mwirigi et al., 2021).

The findings also indicated that *Eragorostis superba* and *Cenchrus Ciliaris* were the most commonly planted pasture grass species by farmers in the region, with Maasai grass being the most popular choice. This suggests that these grass species are well-adapted to the local conditions and are preferred by farmers for their livestock (Rognli et al., 2021). Guretzky et al. (2005) conducted a study on grass species diversity and their nutritional composition in pasture systems and found that different grass species have varying nutritional values, affecting livestock performance and health. This highlights the importance of selecting suitable grass species for livestock feeding. A different study by Zainelabdeen et al. (2020) investigated farmers' perceptions and preferences for different grass species in grazing systems. They found that farmers considered factors such as palatability, persistence, and adaptation to local conditions when choosing grass species for their livestock. It is interesting to note that a larger group of respondents cited different varieties of other local grasses as the main ones for their livestock. This highlights the diversity of grass species that farmers rely on in the region, indicating a more varied approach to pasture management. The preference of *Cenchrus Ciliaris* over other grasses may also mean that farmers are aware of its value, that includes environmental conservation (GRAIN and Seed Savers Network, 2022).

The findings also reveal that a significant number of respondents recognize the benefits of pasture production. The majority of respondents attribute the benefits to prevention of soil erosion and improved animal production. This indicates an understanding of the importance of sustainable land management practices for both environmental and economic reasons (De Klein et al., 2021). only a small percentage of respondents had no idea on the benefits of pasture production to improved soil fertility and reduced conflicts. This suggests that there may be a need for further education and awareness on the potential impacts of pasture production on soil and environmental conservation in the region. A study by Sollenberger et al. (2019) examined the ecosystem services provided by pastures, including soil erosion control, carbon sequestration, and water regulation. They emphasized

the role of well-managed pastures in delivering multiple benefits to both livestock and the environment. A different study by Sharma et al. (2021) assessed the economic benefits of pasture-based livestock systems. The study found that pasture-based systems contribute to increased income and reduced production costs for farmers, while also providing ecosystem services and improving animal welfare.

In terms of activities recommended for soil conservation, the majority of respondents suggested training on pasture establishment as a key activity. This reflects the recognition of the importance of proper pasture management in preventing soil erosion and maintaining soil health (De Klein et al., 2021). Other suggested activities include afforestation, education, provision of capital or seeds to farmers, and the building of gabions and fencing. Shinde et al. (2019) conducted a study on soil conservation strategies in agricultural landscapes and it highlighted the importance of implementing a range of practices, including afforestation, erosion control measures, and sustainable land management, to preserve soil quality and prevent erosion. The study also explored farmers' perceptions and adoption of soil conservation practices. It was found that training and education programs, along with financial support and policy incentives, are crucial for promoting farmers' engagement in soil conservation activities (Shinde et al., 2019).

These recommendations demonstrate a variety of approaches to soil conservation, indicating the need for a multifaceted approach that considers the specific needs and challenges of the local context. However, it is concerning that a significant number of respondents did not suggest any specific activity for soil conservation. This may indicate a lack of awareness or understanding of the importance of soil conservation practices or a disconnect between current practices and knowledge (GRAIN and Seed Savers Network, 2022; Oscar, 2021).

4.2.2. Relationship Between Socioeconomic and Adoption of Pastures

Pearson's Chi-square test was used to determine if there was a significant association between socioeconomic factors and adoption of pastures. While examining the association between the gender of the respondents and the ownership of pasture land, there was a significant association realized at a Chi-square value of 3.8. This implies that there is enough evidence to suggest that gender influences the likelihood of owning pasture land. Various studies have examined the association between socioeconomic factors (e.g. gender and education) and land ownership or adoption of specific pastures. For instance, a study by Paudel et al. (2019) investigated the role of gender in the adoption of agroforestry practices in Nepal. The authors reported significant associations between gender and specific

agroforestry practices. Another study by Auma (2018) examined gender differentials in agricultural productivity in Kenya, covering aspects such as land ownership and other socioeconomic factors. The study reported significant association between gender and land ownership, highlighting gender disparities in agricultural productivity.

Secondly, the findings revealed that the education level of respondents significantly influenced their knowledge about the benefits of pasture production for environmental protection. The Chi-square test statistic of 16.93 with a p-value less than 0.05 suggests that there is a statistically significant association between education level and knowledge about the topic. This finding is consistent with previous research conducted on similar topics. For example, a study by Durán Gabela et al. (2022) examined the relationship between education level and environmental knowledge in the context of sustainable farming practices. The findings indicated that individuals with a higher education level had a better understanding of the ecological benefits of sustainable farming methods compared to those with lower education levels. This suggests that education plays a crucial role in enhancing knowledge and awareness of environmental protection strategies.

Another study by Siebrecht (2020) investigated the influence of education on individuals' knowledge of sustainable land management practices. The results revealed that higher education levels were associated with a greater awareness and understanding of the benefits of sustainable land management for environmental conservation. These studies support the idea that education level plays a crucial role in shaping individuals' knowledge and awareness about environmental protection strategies, including pasture production. The more educated individuals are, the more likely they are to possess knowledge about the benefits of pasture production for environmental preservation.

The findings indicated that the size of the pasture land owned by the respondents is significantly associated with the pasture harvest per year. This indicates that respondents who own larger pasture lands tend to have higher pasture harvests on a daily basis. This finding is consistent with similar studies conducted by Xie et al. (2019) who also found a positive association between the size of pasture land and the yield of pasture harvest. They argued that larger pasture lands provide more grazing area for livestock, which in turn leads to higher pasture productivity.

In addition, the study also found a strong association between the size of the grazing land and the number of goats owned by the respondents. This suggests that respondents who have larger grazing lands tend to keep a larger number of goats. These findings are consistent with those of a study by Byambaa and de Vries (2021), which also found a

positive association between the size of grazing land and the number of livestock kept. They proposed that larger grazing lands provide more forage for the livestock, allowing for a larger herd size.

4.2.3 The Role of Stakeholders in Pasture Establishments

There was a strong association between the type of pasture grass species planted by the respondents and the stakeholders involved in providing training sessions to the farmers using different pasture species. This suggests that the respondents were more likely to seek training from specific stakeholders based on the type of pasture grass species they had chosen to plant. These findings highlight the importance of considering the specific needs and preferences of individuals when it comes to relevant stakeholders and training in pasture establishment (Shinde et al., 2019). It is evident that individuals who have chosen a particular grass species for their pastures are more inclined to seek training from reputable stakeholders like KEFRI and KALRO. This information can be valuable for different stakeholders who provide training services and policymakers in understanding the factors that influence individuals' choices in seeking training on pasture establishment.

The type of pasture establishment was also found to have a strong association with the type of institutions sought by the respondents for training. This suggests that respondents who have a specific type of pasture establishment are more likely to seek training from specific institutions. While there is limited research directly addressing this specific association, a study by Shelburne et al. (2017) examined the relationship between the type of agricultural practices and the training sought by farmers. They found that farmers who adopted specific agricultural practices were more likely to seek training from stakeholders and organizations that specialize in those practices.

Furthermore, the findings indicated that the type of pasture alternatives used during the crisis did not have any relationship the type of stakeholders or institutions sought by the respondents for training on pasture establishments. This means that regardless of the pasture alternatives chosen, the respondents were not influenced in their choice of stakeholders or other training providers (Gabela et al., 2022). The findings are similar to those of Twinamatsiko et al. (2020) that shows that lack of knowledge in adoption of new technologies or scientific advancements offered during such trains leads to limited knowledge of new advancements in agricultural fields.

On the other hand, there was a strong association between the type of pasture grass species planted by the respondents and the types of stakeholder or institutions sought for training. This suggests that the respondents were more likely to seek training from specific

stakeholders or institution based on the type of pasture grass species they had chosen to plant. These findings highlight the importance of considering the specific needs and preferences of individuals when it comes to adoption of pastures (Zainelabdeen et al., 2020). It is evident that individuals who have chosen a particular grass species for their pastures are more inclined to seek training from a specific source. It also indicates that research and community development institutions have a strong influence on the type of pastures being adopted and established. This information can be valuable for different stakeholders and policymakers in understanding the factors that influence individuals' choices in seeking training on pasture establishment.

From the data obtained, the qualitative analysis revealed that the use of *Cenchrus ciliaris* as a pasture was attributed to its benefits such as drought resistance, soil erosion prevention, minimal management requirements, and the ability to generate income through seed sales. Additionally, it has moderate crude protein levels, is easy to harvest, can increase livestock production, and has uses as hay and thatch grass.

However, the grass species was reported to be extinct in the study area due to overgrazing. Respondents also mentioned the use of Maasai love grass *(Eragrostis superba*), Boma Rhodes (*Chloris gayana*), and Star grass (*Cynodon dactylon*) as alternative pasture options. Various community-based organizations provided training to the community on pasture establishment and management, paddocking method adoption, seed harvesting methods, managing *prosopis juliflora*, and proper planting timings for *Cenchrus ciliaris*. In their study, Mganga et al. (2015) also found out that the choice of grass species to combat desertification is influenced more by its contribution as a source of forage for livestock than its contribution for rehabilitation purposes.

During drought seasons, respondents mentioned alternative ways of getting pasture for their livestock, such as moving animals to wetland areas, buying hay from market stores, and practicing nomadism. Some respondents, particularly the local women groups, received support from institutions like teaching and development to establish *Cenchrus ciliaris* as the main pasture species in their households. A similar study in Burkina Faso shows that prolonged droughts lead to forage scarcity and forces the pastoralists communities to develop multiple strategies to maintain livestock production. These strategies includes forage conservation practices like grass mowing, woody species pods collect, crop residues conservation, purchase of hay and cottonseed cakes and use of *Senna obtusifolia* as a supplementary food and feed (Ouédraogo et al., 2021).

Challenges in pasture establishment mentioned by respondents included a lack of knowledge on its benefits, illegal grazing, financial constraints, lack of access to quality seeds, overgrazing, communal land ownership, social-cultural issues, unpredictable rainfall patterns, government policies favoring trees over grasses, and the invasion of *Prosopis juliflora.* Recommendations from the qualitative transcripts included creating awareness and training farmers on best pasture establishment practices, mobilizing the community on the benefits of *Cenchrus ciliaris*, increasing access to certified seeds, creating linkages with organizations doing similar work, assisting farmers in finding markets for their pasture seeds, and forming cooperatives to enhance growth and sustainability of pasture technologies (Dörre, 2015; Vaintrub et al., 2021; Oscar, 2021).

This study's findings and recommendations align with similar work in the field of pasture establishment and management. Previous studies by Diet (2015), Shinde et al. (2019), Twinamatsiko et al. (2020) and Goba et al. (2022) have also highlighted the benefits of specific grass species, such as drought resistance, soil erosion prevention, and income generation. They also identified challenges related to seed availability, grazing practices, and government policies. Additionally, recommendations for awareness creation, training, and forming cooperatives are common in similar studies.

For instance, a research conducted by Johnson et al. (2023) and Shelburne et al. (2017 on the relationships between farmers' decision-making and their choice of training stakeholders in the field of agriculture might help shed light on the findings. This study found that farmers were more likely to seek training from stakeholders or institutions that offered specialized knowledge or expertise in the specific area they were interested in, rather than general training providers. This is consistent with the strong association found between the type of pasture grass species and the desired training provider in the present study.

Furthermore, a study by Pratiwi and Suzuki (2017) on the influence of farmers' social networks on their training choices might also be relevant. This research showed that farmers were more likely to seek training from institutions recommended by their peers or trusted individuals within their social networks. This could potentially explain the association found between the type of pasture grass species and the desired training provider. It is possible that the respondents sought training from institutions that were known to specialize in the particular grass species they were planting, based on recommendations from their network.

A study conducted by Jackson (2004) found that the use of specific grass species, including *Cenchrus ciliaris*, had similar benefits such as drought resistance and soil erosion prevention. They also identified challenges related to seed availability and grazing practices,

similar to observations made in the current study. The study recommended the promotion of these grass species through awareness creation and training programs targeting smallholder agro-pastoralists. Another study by Twinamatsiko et al. (2020) examined the challenges faced by farmers in establishing pasture. The study found that financial constraints, lack of access to quality seeds, and communal land ownership were common challenges, which are also mentioned by the respondents in the current study. The study recommended increasing access to certified seeds and forming cooperatives to enhance the sustainability of pasture technologies, consistent with the recommendations of the current study.

The impact of the Global Environment Facility/Small Grants Programme (GEF/SGP) in pasture establishment and livestock production in the study area has been significant, as it has provided funding to enhance livestock production and environmental conservation through established Community-Based Organizations (CBOs) and line ministries. Studies by Dörre (2015) and Mairomi and Kimengsi (2021) have highlighted the crucial role of CBOs in promoting sustainable pasture management, emphasizing the importance of training programs and forming partnerships with organizations with similar goals. These findings align with the recommendations of the current study, which underlines the importance of creating linkages with organizations and providing training on pasture establishment practices to improve livestock production and environmental conservation efforts in the area.

4.2.4. Implication of the Study

The study presents a comprehensive assessment of the socioeconomic factors influencing the adoption of *Cenchrus ciliaris*, a pivotal grass species within the pastoralist communities of the Lowlands of Baringo. The findings and discussions highlight important implications for understanding and improving agricultural practices, environmental conservation, and the overall socioeconomic wellbeing of these communities. Below are the implications derived from the discussion section:

The predominance of male respondents and the gender disparities reflected in resource access implicate potential obstacles to equitable participation in agricultural practices. This suggests a pressing need for gender-sensitive approaches to agricultural training and resource allocation that empower women and ensure their involvement in pasture management initiatives. Programs aimed at enhancing women's roles can contribute significantly toward greater adoption rates and the sustainable management of *Cenchrus ciliaris*. The notable gaps in educational attainment among the respondents highlight a crucial barrier to the effective dissemination of knowledge regarding sustainable agricultural practices. Targeted educational initiatives, particularly focusing on the benefits of *Cenchrus*

ciliaris, are imperative. Educational workshops, community seminars, and hands-on training can cultivate awareness, mitigate resistance to new practices, and foster broader acceptance of this potentially beneficial grass species.

The concerning statistic that 70% of respondents are not practicing pasture production despite acknowledging its importance calls for interventions addressing this knowledge-implementation gap. By identifying barriers to practice, such as resource availability, training needs, and sociocultural dynamics, tailored support strategies can be developed. Such strategies may include mentorship programs enabling experienced farmers to share their practices with those less involved in pasture production. The findings around grazing land ownership and livestock management illustrate the scope of land holding and its impact on livestock productivity. Given that a significant percentage own small land sizes for grazing areas, enhancing pasture management is vital for supporting food security. Further, community-driven land-use planning might be essential to address overuse and ensure equitable access to grazing resources.

The strong association between pasture species choice and the type of training sought from stakeholders emphasizes the importance of context-specific education and support systems. Collaborative partnerships with educational institutions, government agencies, and NGOs are critical in tailoring training modules to the specific needs of farmers engaged with *Cenchrus ciliaris*. This synergy can encourage more effective knowledge transfer and adoption rates. The role of stakeholders and community-based organizations suggests that local initiatives must be supported by larger networks that facilitate access to resources, credible information, and proper training. Enhanced communication and coordination among these entities can amplify the impact of educational efforts and resource mobilization for pasture establishment.

Recognizing *Cenchrus ciliaris* for its ecological benefits, such as soil erosion prevention and livestock nutrition, is paramount. While the community acknowledges its advantages, boosting public awareness on soil conservation and biodiversity can further promote its adoption. Future policies that highlight the dual benefits of pasture establishment for both economic and ecological sustainability could foster a culture of environmental stewardship while enhancing livestock productivity. The study provides a foundation for policymakers to develop interventions that improve pasture production practices in pastoralist communities.

CHAPTER FIVE
CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the conclusions and recommendations of the study based on the analyzed responses of the socioeconomic factors influencing the adoption of *Cenchrus ciliaris* for environmental conservation among the pastoralist communities in South Baringo, Kenya

5.2 Conclusions

This study offers significant insights into the adoption of *Cenchrus ciliaris* as a pasture species for livestock grazing, as well as the socioeconomic characteristics influencing its adoption in the pastoral communities of Baringo. The study's findings align with the defined objectives, underscoring the vital relationship between socioeconomic factors, stakeholder involvement, and pasture adoption as detailed in the following paragraphs;

I found that the socioeconomic profile of households, including gender roles and education levels, significantly influences the knowledge and adoption of *Cenchrus ciliaris*. A predominance of male respondents and a low level of formal education (with 36% having only primary education) could create barriers in accessing innovative agricultural practices, thereby impeding the full potential of *Cenchrus ciliaris* in fostering both livestock productivity and environmental conservation.

The study demonstrates a strong association between socioeconomic characteristics—particularly education level and pasture land size—and the adoption of *Cenchrus ciliaris*. Respondents with larger pasture areas and higher education levels demonstrated greater pasture yields and livestock ownership, indicating that enhancing educational outreach could leverage pasture production effectively. Financial constraints, lack of access to quality seeds, and challenges stemming from communal land ownership emerged as significant hurdles preventing wider adoption.

The research highlights the pivotal role played by various stakeholders in facilitating the adoption of *Cenchrus ciliaris*. Institutions providing training and support significantly influenced farmers' choices in pasture selection. Respondents who received institutional support for *Cenchrus ciliaris* were notably more inclined to adopt this species. This underscores the necessity for continued stakeholder engagement in delivering practical training and resources that address local challenges.

The findings emphasize that stakeholder involvement, especially through community-based organizations offering training and resources, is integral to fostering the adoption of sustainable practices like *Cenchrus ciliaris* cultivation. Further efforts to mobilize educational resources, increase access to certified seeds, promote cooperative formations, and enhance market linkages for pasture products will improve the adoption rates of *Cenchrus ciliaris* and contribute to sustainable pasture management in the region.

In conclusion, the research underscores the multifaceted benefits of integrating *Cenchrus ciliaris* into pasture management systems. These benefits extend beyond enhancing livestock nutrition and productivity to include environmental conservation and economic stability. Therefore, addressing the outlined socioeconomic challenges through targeted education and stakeholder collaboration will be crucial in optimizing the adoption of *Cenchrus ciliaris*, ultimately promoting sustainable agriculture in the lowlands of Baringo. Future initiatives should focus on improving access to resources, enhancing education related to pasture management, and leveraging community involvement to create a resilient agricultural framework that benefits both farmers and the environment.

5.3 Recommendations

i. To address the identified barriers in adopting *Cenchrus ciliaris*, it is recommended to implement targeted educational programs aimed at improving farmers' knowledge and skills in innovative agricultural practices, particularly for those with limited formal education. These initiatives should prioritize inclusivity by actively engaging both men and women, ensuring that gender roles do not limit participation. Extension services and community-based workshops tailored to local contexts can effectively bridge the knowledge gap, fostering greater adoption of *Cenchrus ciliaris* and enhancing its potential to improve livestock productivity and contribute to environmental conservation.

ii. To overcome the barriers to adopting *Cenchrus ciliaris* and maximize its benefits, it is recommended to prioritize educational outreach programs that emphasize the economic and environmental advantages of improved pasture management. Additionally, strategies should be developed to address financial constraints and improve access to quality seeds, such as providing subsidies or establishing community seed banks. Tailored support for farmers with smaller pasture areas and those operating under communal land ownership structures is essential to ensure equitable adoption. These combined efforts will enhance pasture yields, livestock ownership, and overall agricultural productivity.

iii. To enhance the adoption of *Cenchrus ciliaris*, it is recommended to strengthen stakeholder engagement through collaborative efforts involving institutions, government agencies, and community organizations. These stakeholders should focus on delivering practical, locally tailored training programs and providing essential resources to farmers. Establishing consistent support systems, such as extension services and on-site demonstrations, can address specific challenges faced by farmers and foster informed decision-making regarding pasture selection. Sustained partnerships and resource allocation will be critical to promoting widespread and effective adoption of *Cenchrus ciliaris*.

iv. To improve the adoption of *Cenchrus ciliaris* and promote sustainable pasture management, efforts should be focused on mobilizing educational resources to build farmer capacity, increasing access to certified seeds, and encouraging the formation of cooperatives to strengthen collective action. Additionally, fostering robust market linkages for pasture products will incentivize adoption by ensuring economic returns. Such integrated approaches will support sustainable agricultural practices and improve livelihoods in the region.

5.4. Suggestions for Further Research

Given the importance of *Cenchrus ciliaris* in enhancing livestock productivity and contributing to environmental conservation, future research could investigate how its adoption may influence the resilience of pastoral communities to climate variability. Studies could explore adaptive management strategies that incorporate *Cenchrus ciliaris*, evaluating its effectiveness in reducing vulnerability to droughts or changing weather patterns. Further research will also focus on the socio-environmental benefits of integrating climate-smart agricultural practices alongside *Cenchrus ciliaris* cultivation to promote both food security and ecological sustainability in the region. This would contribute valuable insights into the role of *Cenchrus ciliaris* in supporting environmental conservation alongside its socio-economic benefits.

REFERENCES

Abera, W., Tamene, L., Tibebe, D., Adimassu, Z., Kassa, H., Hailu, H., Mekonnen, K., Gessesse, G. D., Sommer, R., & Verchot, L. V. (2020). Characterizing and evaluating the impacts of national land restoration initiatives on ecosystem services in Ethiopia. *Land Degradation & Development, 31*(1), 37–52. https://doi.org/10.1002/ldr.3424

Alemu, B. (2015). The effect of land use land cover change on land degradation in the highlands of Ethiopia. *Journal of Environment and Earth Science, 5*(1), 1–15. https://www.researchgate.net/publication/324845329

Auma, J. (2018). Gender differentials in agricultural production and productivity in smallholder marginal farms: Rachuonyo and Homa-Bay District, Kenya. *Journal of Agriculture and Rural Development, 7*(1), 13–22.

Boles, O., Shoemaker, A., Courtney Mustaphi, C. J., Petek, N., Ekblom, A., & Lane, P. J. (2019). Historical ecologies of pastoralist overgrazing in Kenya: Long-term perspectives on cause and effect. *Human Ecology, 47*(3), 419–434. https://doi.org/10.1007/s10745-019-0070-1

Burgess, T. L., Bowers, J. E., & Turner, R. M. (1991). Exotic plants at the Desert Laboratory, Tucson, Arizona. *Madroño, 38*(2), 96–114.

Byambaa, B., & de Vries, W. T. (2021). The production of pastoral space: Modeling spatial occupation of grazing land for environmental impact assessment using structural equation modeling. *Land, 10*(2), 1–19. https://doi.org/10.3390/land10020211

County Government of Baringo. (2013). *County integrated development plan (2013–2017).*

De Klein, C., Monaghan, R., Donovan, M., Wall, A., Schipper, L., & Pinxterhuis, I. (2021). Attributes of resilient pasture for achieving environmental outcomes at farm scale. *NZGA: Research and Practice Series, 17*, 15–24. https://doi.org/10.33584/rps.17.2021.3487

Diet, C. P. (2015). Existing soil and water conservation practices and their constraints: A case of Hiruy Abargay Kebele, South Gonder Zone, Ethiopia. *ISAR Journal of Multidisciplinary Research and Studies, 1*(1), 28–31.

Dörre, A. (2015). Promises and realities of community-based pasture management approaches: Observations from Kyrgyzstan. *Pastoralism, 5*(1), 15. https://doi.org/10.1186/s13570-015-0035-8

Duguma, B., & Janssens, G. P. J. (2021). Assessment of livestock feed resources and coping strategies with dry season feed scarcity in mixed crop–livestock farming systems around the Gilgel Gibe catchment, southwest Ethiopia. *Sustainability*, *13*(19), 10713. https://doi.org/10.3390/su131910713

Durán Gabela, C., Trejos, B., Lamiño Jaramillo, P., & Boren-Alpízar, A. (2022). Sustainable agriculture: Relationship between knowledge and attitude among university students. *Sustainability*, *14*(23), 15523. https://doi.org/10.3390/su142315523

Elhadi, Y. A. M., Nyariki, D. M., Wasonga, V. O., & Ekaya, W. N. (2012). Factors influencing transient poverty among agro-pastoralists in semi-arid areas of Kenya. *African Crop Science Journal*, *20*(1), 113–122.

Eswaran, H., Lal, R., & Reich, P. F. (2001). Land degradation: An overview. In E. M. Bridges, I. D. Hannam, L. R. Oldeman, F. W. T. Pening de Vries, S. J. Scherr, & S. Sompatpanit (Eds.), *Response to land degradation* (pp. 20–35). Science Publishers.

Food and Agriculture Organization of the United Nations. (2017). *The future of food and agriculture: Trends and challenges.* FAO. http://www.fao.org/3/a-i6583e.pdf

Franks, A. J. (2002). The ecological consequences of buffel grass (*Cenchrus ciliaris*) establishment within remnant vegetation of Queensland. *Pacific Conservation Biology*, *8*(2), 99–107. https://doi.org/10.1071/PC020099

Gatwiri, W., & Kimaiyo, F. (2023). *Unlocking tourism potential in arid and semi-arid counties of Kenya* (KIPPRA Discussion Paper No. 308). Kenya Institute for Public Policy Research and Analysis. https://repository.kippra.or.ke/handle/123456789/4618

Gebreselassie, S., Kirui, O. K., & Mirzabaev, A. (2016). Economics of land degradation and improvement in Ethiopia. In E. Nkonya, A. Mirzabaev, & J. von Braun (Eds.), *Economics of land degradation and improvement: A global assessment for sustainable development* (pp. 401–430). Springer. https://doi.org/10.1007/978-3-319-19168-3_14

Goba, W. B., Muluneh, A., & Wolka, K. (2022). Evaluating farmers' perception on soil erosion and management of physical soil and water conservation measures in southwest Ethiopia. *Journal of Forestry and Natural Resources*, *1*(2), 39–53.

Government of Kenya. (2018). *National Wildlife Strategy 2030.* https://www.tourism.go.ke/wp-content/uploads/2018/06/WILDLIFE-STRATEGY2030-Final-V1-Online.pdf

GRAIN & Seed Savers Network. (2022). Hands off our buffel grass! Kenyan herders resist the privatisation of their biodiversity. https://grain.org/en/article/6886-hands-off-our-buffel-grass-kenyan-herders-resist-the-privatisation-of-their-biodiversity

Guretzky, J. A., Moore, K. J., Brummer, E. C., & Burras, C. L. (2005). Species diversity and functional composition of pastures that vary in landscape position and grazing management. *Crop Science*, *45*(1), 282–289. https://doi.org/10.2135/cropsci2005.0282a

Holmgreen, L., Tirone, V., Gerhart, J., & Hobfoll, S. E. (2017). Conservation of resources theory. In G. Fink (Ed.), *Stress: Concepts, cognition, emotion, and behavior* (pp. 65–68). Academic Press. https://doi.org/10.1016/B978-0-12-800951-2.00007-8

Jackson, J. (2004). *Impacts and management of Cenchrus ciliaris (buffel grass) as an invasive species in northern Queensland* (Doctoral dissertation). James Cook University, Townsville, Australia. https://researchonline.jcu.edu.au/1114/

Johnson, D., Almaraz, M., Rudnick, J., Parker, L. E., Ostoja, S. M., & Khalsa, S. D. S. (2023). Farmer adoption of climate-smart practices is driven by farm characteristics, information sources, and practice benefits and challenges. *Sustainability*, *15*(10), 8083. https://doi.org/10.3390/su15108083

Kenya Organic Agriculture Network (KOAN). (2018). *Lake Bogoria production landscape adaptive strategy; SGP country; Kenya*.

Kenya Wildlife Service. (2007). *Lake Bogoria National Reserve Management Plan 2007–2012*. Kenya Wildlife Service. Retrieved from http://www.kws.go.ke

Kiage, L. M. (2013). Perspectives on the assumed causes of land degradation in the rangelands of sub-Saharan Africa. *Progress in Physical Geography*, 35(5), 664–684. https://doi.org/10.1177/0309133313492543

Kiage, L. M., & Liu, K. (2009). Palynological evidence of climate change and land degradation in the Lake Baringo area, Kenya, East Africa, since AD 1650. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 279(1–2), 60–72. https://doi.org/10.1016/j.palaeo.2009.05.002

Lehmann, C. E. R., Archibald, S., Hoffmann, W. A., & Bond, W. J. (2011). Deciphering the distribution of the savanna biome. *New Phytologist*, 191(1), 197–209. https://doi.org/10.1111/j.1469-8137.2011.03689.x

Lugusa, K. O. (2015). *Fodder production as an adaptation strategy in the drylands: A case study of producer groups in Baringo County, Kenya* (Master's thesis). University of

Nairobi, Nairobi, Kenya. Retrieved from http://erepository.uonbi.ac.ke/handle/11295/94363

Lugusa, K. O., Wasonga, O. V., Elhadi, Y. A., & Crane, T. A. (2016). Value chain analysis of grass seeds in the drylands of Baringo County, Kenya: A producers' perspective. *Pastoralism*, 6(1), 6. https://doi.org/10.1186/s13570-016-0053-1

Mairomi, H. W., & Kimengsi, J. N. (2021). Community-based actors and participation in rangeland management: Lessons from the Western Highlands of Cameroon. *Sustainability*, *13*(4), 1700. https://doi.org/10.3390/su13041700

Mansoor, U., Fatima, S., Hameed, M., Naseer, M., Ahmad, M. S. A., Ashraf, M., Ahmad, F., & Waseem, M. (2019). Structural modifications for drought tolerance in stem and leaves of *Cenchrus ciliaris* L. ecotypes from the Cholistan Desert. *Flora*, *261*, 151485. https://doi.org/10.1016/j.flora.2019.151485

Marshall, N. A., Friedel, M., Van Klinken, R. D., & Grice, A. C. (2011). Considering the social dimension of invasive species: The case of buffel grass. *Environmental Science & Policy*, *14*(3), 327–338. https://doi.org/10.1016/j.envsci.2010.10.005

Marshall, V. M., Lewis, M. M., & Ostendorf, B. (2012). *Buffel grass (Cenchrus ciliaris) as an invader and threat to biodiversity in arid environments: A review*. *Journal of Arid Environments*, 78, 1–12. https://doi.org/10.1016/j.jaridenv.2011.11.005

Measho, S., Chen, B., Pellikka, P., Guo, L., Zhang, H., Cai, D., Sun, S., Kayiranga, A., Sun, X., & Ge, M. (2021). *Assessment of vegetation dynamics and ecosystem resilience in the context of climate change and drought in the Horn of Africa*. *Remote Sensing*, 13(9), 1668. https://doi.org/10.3390/rs13091668

Mganga, K. Z., Musimba, N. K. R., Nyariki, D. M., Nyangito, M. M., & Mwang'ombe, A. W. (2015). *The choice of grass species to combat desertification in semi-arid Kenyan rangelands is greatly influenced by their forage value for livestock. Grass and Forage Science*, 70(1), 161–167. https://doi.org/10.1111/gfs.12102

Miller, G., Friedel, M., Adam, P., & Chewings, V. (2010). Ecological impacts of buffel grass (*Cenchrus ciliaris* L.) invasion in central Australia—Does field evidence support fire-invasion feedback? *The Rangeland Journal*, *32*(4), 353–365. https://doi.org/10.1071/RJ09076

Mugenda, O. M., & Mugenda, A. G. (2003). *Research methods: Quantitative and qualitative approaches*. African Centre for Technology Studies.

Mujeyi, A., Mudhara, M., & Mutenje, M. (2021). The impact of climate-smart agriculture on household welfare in smallholder integrated crop–livestock farming systems:

Evidence from Zimbabwe. *Agriculture & Food Security, 10*(1), 1–15. https://doi.org/10.1186/s40066-020-00277-3

Mwangi, L. N. (2015). *The role of women in conflict management: A case study of the Tana River region of Kenya* (Master's thesis). University of Nairobi.

Mwirigi, P., Owino, J., Eco-region, R. V., & Kemboi, J. (2021). The potential of nature-based enterprises in the arid and semi-arid lands of Kenya: Case studies in Loima and Turkana West sub-counties, Turkana County. *International Journal of Research in Business and Social Science, 8*(2), 1–11. https://doi.org/10.20525/ijrbs.v8i2.371

Napogbong, L. A., Ahmed, A., & Derbile, E. K. (2021). Fulani herders and indigenous strategies of climate change adaptation in Kpongu community, North-Western Ghana: Implications for adaptation planning. *Climate and Development, 13*(3), 201–214. https://doi.org/10.1080/17565529.2020.1746231

Ngetich, W., Gitau, K. G., Abuom, O. T., & Aboge, G. O. (2023). Description of cattle production systems in different agro-ecological zones of Narok County, Kenya. *East African Journal of Science, Technology and Innovation, 4*(4), 1–20. https://doi.org/10.37425/eajsti.v4i4.765

Nyariki, D. M., & Amwata, D. A. (2019). The value of pastoralism in Kenya: Application of total economic value approach. *Pastoralism, 9*(1). https://doi.org/10.1186/s13570-019-0144-x

Odintsov Vaintrub, M., Levit, H., Chincarini, M., Fusaro, I., Giammarco, M., & Vignola, G. (2021). Review: Precision livestock farming, automats, and new technologies: Possible applications in extensive dairy sheep farming. *Animal, 15*(3), 100143. https://doi.org/10.1016/j.animal.2020.100143

Omollo, E. O., Wasonga, O. V., & Chimoita, E. L. (2023). Use value of indigenous range grass species in pastoral northern Kenya. *Ethnobotany Research and Applications, 25*, 1–16. https://doi.org/10.32859/era.25.16.1-16

Omolo, N., & Mafongoya, P. L. (2019). Gender, social capital and adaptive capacity to climate variability: A case of pastoralists in arid and semi-arid regions in Kenya. *International Journal of Climate Change Strategies and Management, 11*(5), 744–758. https://doi.org/10.1108/ijccsm-01-2018-0009

Oscar, K. (2021). *Pasture production and conservation training manual* (pp. 1–42). Publisher.

Ouédraogo, K., Zaré, A., Korbéogo, G., Ouédraogo, O., & Linstädter, A. (2021). Resilience strategies of West African pastoralists in response to scarce forage resources. *Pastoralism, 11*(1). https://doi.org/10.1186/s13570-021-00210-8

Palmer, C. (2016). Buffel grass (*Cenchrus ciliaris* L.) is a host for the sugarcane whitefly *Neomaskellia bergii* (Signoret) (Hemiptera: Aleyrodidae) in central Australia. *Australian Entomologist, 36*(2), 88–95.

Paudel, D., Tiwari, K. R., Raut, N., Sitaula, B. K., & Paudel, P. (2019). Agroforestry practices in midhills of Nepal from gender perspective. *Open Journal of Forestry, 9*(4), 323–340. https://doi.org/10.4236/ojf.2019.94018

Petek, N. (2015). An archaeological survey of the Lake Baringo lowlands 2014: Preliminary results. *Nyame Akuma, 83*, 100–111.

Pratiwi, A., & Suzuki, A. (2017). Effects of farmers' social networks on knowledge acquisition: Lessons from agricultural training in rural Indonesia. *Journal of Economic Structures, 6*(1). https://doi.org/10.1186/s40008-017-0069-8

Republic of Kenya, Ministry of Agriculture, Livestock, Fisheries and Cooperatives. (2020). *National agricultural soil management policy*. Ministry of Agriculture, Livestock, Fisheries and Cooperatives.

Ringler, C. (2013, September 2). What's really causing water scarcity in Africa south of Sahara? *International Food Policy Research Institute*. https://www.ifpri.org/blog/whats-really-causing-water-scarcity-africa-south-sahara/

Rognli, O. A., Pecetti, L., Kovi, M. R., & Annicchiarico, P. (2021). Grass and legume breeding matching the future needs of European grassland farming. *Grass and Forage Science, 76*(2), 175–185. https://doi.org/10.1111/gfs.12535

Sharma, M., Kaushal, R., Kaushik, P., & Ramakrishna, S. (2021). Carbon farming: Prospects and challenges. *Sustainability (Switzerland), 13*(19), 1–15. https://doi.org/10.3390/su131911122

Shelburne, I., Lawver, D. E., Fraze, S., Ulmer, J., Stephenson, C., & Magogo, J. (2017). Adoptive behaviors of farmers after training and their subsequent diffusive behaviors in Uasin Gishu County, Kenya. *Journal of International Agricultural and Extension Education, 24*(1), 74–89. https://doi.org/10.5191/jiaee.2016.24108

Shinde, R., Sarkar, P., Thombare, N., & Naik, S. (2019). Soil conservation: Today's need for sustainable development. *Agriculture & Food: E-Newsletter, 1*(5), 175–183. Retrieved from https://www.researchgate.net/publication/332780118

Siebrecht, N. (2020). Sustainable agriculture and its implementation gap - Overcoming obstacles to implementation. *Sustainability (Switzerland), 12*(9), Article 3853. https://doi.org/10.3390/su12093853

Sollenberger, L. E., Kohmann, M. M., Dubeux, J. C. B., & Silveira, M. L. (2019). Grassland management affects delivery of regulating and supporting ecosystem services. *Crop Science, 59*(2), 441–459. https://doi.org/10.2135/cropsci2018.09.0594

Tesfaye, A. (2024). The effect of deficit irrigation on water productivity and yield of common bean in semiarid areas in Ethiopia. *International Journal of Agricultural Research, 2*, 1–11.

Twinamatsiko, R., Nalule, A. S., & Okello, S. (2020). Drivers and restrictions of range pasture improvement by agro-pastoralists in Kiruhura District, Uganda. *African Journal of Agricultural Research, 16*(11), 1514–1530. https://doi.org/10.5897/ajar2020.14959

U.S. Department of Agriculture (USDA). (2022). Distribution and plant communities, botanical and ecological characteristics, fire ecology and management, management. *Fire Effects Information System*, 1–45. Retrieved from https://www.feis-crs.org/feis/

Vermeulen, S. J., Campbell, B. M., & Ingram, J. S. I. (2012). Climate change and food systems. *Annual Review of Environment and Resources, 37*(1), 195–222. https://doi.org/10.1146/annurev-environ-020411-130608

Wairore, J. N., Mureithi, S. M., Wasonga, O. V., & Nyberg, G. (2015). Enclosing the commons: Reasons for the adoption and adaptation of enclosures in the arid and semi-arid rangelands of Chepareria, Kenya. *SpringerPlus, 4*(1), 595. https://doi.org/10.1186/s40064-015-1392-3

Wasonga, V. O., Ngugi, R. K., & Kitalyi, A. (2003). Traditional range condition and trend assessment: Lessons from Pokot and Il Chamus pastoralists of Kenya. *The Anthropologist, 5*(2), 79–87. https://doi.org/10.1080/09720073.2003.11890783

World Wildlife Fund (WWF). (2018). *Water and security*. Retrieved February 5, 2025, from https://www.worldwildlife.org/initiatives/water-and-security

Xie, H., Huang, Y., Chen, Q., Zhang, Y., & Wu, Q. (2019). Prospects for agricultural sustainable intensification: A review of research. *Land, 8*(11), 157. https://doi.org/10.3390/land8110157

Zainelabdeen, Y. M., Yan, R., Xin, X., Yan, Y., Ahmed, A. I., Hou, L., & Zhang, Y. (2020). The impact of grazing on the grass composition in temperate grassland. *Agronomy, 10*(9), 1230. https://doi.org/10.3390/agronomy10091230

APPENDICES

Appendix I: Household Questionnaire

Introduction

My name is Davis Mathew Nyambari. I am pursuing a Masters" Degree in Environmental Science. In order to fulfil the requirement for the award of the Degree, I am required to carry out research **to assess socioeconomic factors influencing the adoption of *Cenchrus ciliaris* for environmental conservation among the pastoralist communities in south Baringo, Kenya.** Subsequently, I shall present a report on the assessment.

The report entails conducting a survey to get stakeholders' views within the Lake Bogoria Landscape and its environs. The information collected will be used for the sole purpose of this survey and to inform the government and development partners on issues relating to the adoption of pasture production activities. The purpose of this questionnaire is to collect data in the stated area of study. You have been chosen randomly. The information from this interview will be kept confidential and anonymous.

Are you willing to continue? [1] Yes [2] No

(Interviewer, please make sure you are talking to the household head, the spouse of the household head or some other informed adult member of the household that is 18 years and above.)

Name of Enumerator					Serial No.
Date		Start		End Time	

Grid Reference of place the meeting is taking place where GPS (set to Decimal using Degrees, WGS84 Datum)

Northing (Latitude)	**Easting (Longitude)**	**Altitude**	**Time**

Section A: Respondent/household Demographic Information

1) Name of Respondent …….……
2) Age Bracket
    a. 18-25
    b. 26-35
    c. 36-45
    d. 46-55
    e. Above 56
3) Gender of respondent
    a. Male
    b. Female
4) Education level of respondent
    a. University
    b. College
    c. Secondary
    d. Primary
    e. None
5) Position in Household of respondent
    a. Husband
    b. Wife
    c. Child
    d. House help
    e. Others (specify)…….…….
6) What is the household size (i.e., Persons who have lived here for the last year, including you?)
    a. 1-5
    b. 6-10
    c. 11-15
    d. Above 16
7) How many members of the household are:
    a. Under 18 years? b. Over 18 years?

Section B: Household Pasture Production Activities

8) What is the main occupation of the household head? (Maybe more than one occupation)

a. Farmer
b. Employed
c. Business
d. Others (specify, e.g. casual worker)

9) Do you own land for grazing?
   a. Yes
   b. No

10) If (Yes), name the type of ownership
   a. Owner
   b. Lease
   c. Communal

11) What is the size of your household grazing land in acres?
   a. 0 – 1
   b. 2 – 5
   c. 6 – 10
   d. >11

12) List the numbers of livestock owned by your household.

Type	Cattle	Goats	Sheep	Chicken	Donkeys	Camels	Others (Specify)
Quantity							

Section C: Determinants of *Cenchrus Ciliaris* Pasture Establishments in Baringo county

13) Have you ever attended training on pasture establishment?
   a. ……..……..……..
   b. ……..……
   c. ……..……
   d. ……..……

14) List the main sources of pasture for your livestock.
   a. ……..……..……..
   b. ……..……
   .
   c. ……..……

d. ……..……

15) Which are the main grass species that are good for livestock production in your area?

a. ……..……

b. ……..

c. ……

d. ……

16) Distance to the primary source of pasture?

a. 0 – 1 Km
b. 1 – 2 Km
c. 2 – 5 Km
d. >5 Km

17) Does your household buy pastures?

a. Yes
b. No

18) What is the cost of a bale of grass?

a. 0-50 Kshs
b. 51-100 Kshs
c. 101-150 Kshs
d. 151-200 Kshs
e. More than 201 Kshs

19) Where do you buy pasture from at the time of need?

a. ……...……..…
…

b. ……...……
……

c. ……...……
……

20) Which alternative pastures does your household use at times of crisis?

a. ……..……..…
…

b. ……..……
…

c. ……..……
…

21) Are you familiar with the establishment and adoption of pasture production for environmental conservation activities?
    a. Yes
    b. No
22) If yes, from whom?
    .....……
23) How many pastures does your household harvest per area per year?
    ……

Section 5.0: Factors that Influence Adoption of *Cenchrus Ciliaris*.

24) What benefits do you derive from the establishment and adoption of pasture production for environmental conservation as a household?
    a. ……
    b. ……
    c. ……
25) What are the factors that affect the establishment and productivity of pasture?
    a. ……
    b. ……
    c. ……
26) What challenges do you personally encounter during the establishment and adoption of pasture production for environmental conservation?
    a. ……
    b. ……
    c. ……
27) Are there any farmers who do pasture production within your area?
    a. Yes
    b. No
28) What are pasture production's main establishment and adoption for environmental conservation activities within your area?
    a. ……..…
    b. ……
    ….……
29) Which activities do you think can be done to assist in the establishment and adoption of pasture production for environmental conservation?
    a. ……

b. ……

c. ……

30) Are there any other issues that I may know of which we have not captured here for the establishment and adoption of pasture production for environmental conservation?.....

Appendix II: Key Informant Schedule

Introduction

My name is Davis Mathew Nyambari. I am pursuing a Masters" Degree in Environmental Science. In order to fulfil the requirement for the award of the Degree, I am required to carry out research **to assess socioeconomic factors influencing the adoption of *Cenchrus ciliaris* for environmental conservation among the pastoralist communities in south Baringo, Kenya.** Subsequently, I shall present a report on the assessment.

The report entails conducting a survey to get stakeholders' views within the Lake Bogoria Landscape and its environs. The information collected will be used for the sole purpose of this survey and to inform the government and development partners on issues relating to the adoption of pasture production activities. The purpose of this questionnaire is to collect data in the stated area of study. Your organization was purposely targeted because of its engagement in Pasture production and Environmental Conservation. The information from this interview will be kept confidential and anonymous.

Are you willing to continue? [1] Yes [2] No

Name of Enumerator					Serial No.
Date		Start		End Time	

Section A: Household Demographic Information

1) Name of Respondent ……..……
2) Name of organization…….
3) Age Bracket…….
4) Gender of respondent…….
5) Education level of respondent…….
6) Position in Organization …….

Section B: Pasture Production Activities of Households

7) What is the MAIN occupation of most residents of Lake Bogoria Landscape?
8) Do households own individual land for grazing?
9) If (yes), name the type of ownership
10) What is the **Average size** of household grazing land in ACRES?
11) Do you think the household socioeconomic characteristics influence the adoption of new pasture technologies in the area? If yes, please tell me more (Also probe for *Cenchrus ciliaris)*

Section C: Determinants of Adoption of *Cenchrus Ciliaris* Pasture Establishments

12) Do farmers attend training on pasture in the area?

……..……..……

13) What are some of the main sources of pasture for their livestock in this region?

a. ……..……..……..

b. ……..……

.

c. ……..……

14) Which are the main grass species that are good for livestock production in the area?

a. ……..……

b. …….

c. ……

15) Do households buy pastures?

a. Yes

b. No

16) If yes, what is the cost of a bale of grass? ……..,……

17) Where do they buy pasture from at the time of need?

a. ……...……..……

b. ……...……

c. ……...……

18) Which alternative pastures do the household use at times of crisis?

a. ……..……..……

b. ……..……

c. ……..……

Section D: Factors that influence the adoption of *Cenchrus ciliaris* Grass Pasture

19) What benefits do households derive from establishing and adopting pasture production for environmental conservation as a household?

a. ……

b. ……

c. ……

20) What are the factors that affect the establishment and productivity of pasture in the area?

a. ……..……

b. ……..……

c. ……..……

21) What challenges does your organization encounter during the establishment and adoption of pasture production for environmental conservation?

a. ……..……

b. ……..……

c. ……..……

22) What are pasture production's main establishment and adoption for environmental conservation activities within your area?

a. ……..…

b. ……..

c. ……

23) Which activities do you think can be done to assist in the establishment and adoption of pasture production for environmental conservation?

a. ……..……..

b. ……

c. ……

24) Are there any other issues that I may know of which we have not captured here on some of the factors that influence the adoption of pasture production for environmental conservation in Baringo? ……

Appendix III: Focus Group Discussion Guide

Introduction

My name is Davis Mathew Nyambari. I am pursuing a Masters" Degree in Environmental Science. In order to fulfil the requirement for the award of the Degree, I am required to carry out research **to assess socioeconomic factors influencing the adoption of *Cenchrus ciliaris* for environmental conservation among the pastoralist communities in south Baringo, Kenya.** Subsequently, I shall present a report on the assessment.

The report entails conducting a survey to get stakeholders' views within the Lake Bogoria Landscape and its environs. The information collected will be used for the sole purpose of this survey and to inform the government and development partners on issues relating to the adoption of pasture production activities. This questionnaire aims to collect data in the stated area of study. You were purposely selected because you are members of this community and can provide better information on some of the factors that influence the adoption of *Cenchrus ciliaris* grass species among the pastoralist communities in your region. The information from this interview will be kept confidential and anonymous.

Are you willing to continue? [1] Yes [2] No

Name of Enumerator					Serial No.
Date		Start		End Time	

<u>Factors influencing the adoption of *Cenchrus ciliaris* among the community members</u>

1) What do you think is the MAIN occupation of most residents of Lake Bogoria Landscape?.....
2) Do households own individual land for grazing? Explain……
3) What is the average size of household grazing land in ACRES?.....
4) What are the main sources of pasture for their livestock?…….
5) In your own opinion, which are the main grass species that are good for livestock production in the area?.....
6) In your own opinion, have farmers adopted new pasture establishment technologies?.....

7) What do you think are some of the factors influencing the adoption of new pasture technologies in the area? ……
8) Have you heard about *Cenchrus ciliaris* grass species? Have you adopted this technology in your community?.....
9) Do you think ecological characteristics or household socioeconomic status influences the adoption of *Cenchrus ciliaris* grass species in your community? If so, tell me more……..…
10) Which activities do you think can be done to assist in the establishment and adoption of pasture production for environmental conservation?.....
11) Are there any other issues that I may know we have not captured here on some of the factors influencing the adoption of pasture production in your area? If yes, please tell me more……

Appendix IV: Nacosti Research Permit

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: **489539**

Date of Issue: **03/May/2024**

RESEARCH LICENSE

This is to Certify that Mr.. Davis Nyambari Nyambari of Egerton University, has been licensed to conduct research as per the provision of the Science, Technology and Innovation Act, 2013 (Rev.2014) in Baringo on the topic: SOCIOECONOMIC AND ECOLOGICAL FACTORS THAT INFLUENCE ADOPTION OF Cenchrus ciliaris AMONG THE PASTORALISTS COMMUNITIES IN SOUTH BARINGO, KENYA for the period ending : 03/May/2025.

License No: **NACOSTI/P/24/34696**

489539

Applicant Identification Number

Director General
NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Verification QR Code

NOTE: This is a computer generated License. To verify the authenticity of this document, Scan the QR Code using QR scanner application.

See overleaf for conditions

Appendix V: Journal Article Published in Refereed Journal

Scientific Research Publishing

Open Journal of Ecology, 2024, 14, 629-650
https://www.scirp.org/journal/oje
ISSN Online: 2162-1993
ISSN Print: 2162-1985

Socioeconomic Factors Influencing the Adoption of *Cenchrus ciliaris* among the Pastoralist Communities in South Baringo, Kenya

Nyambari Davis Mathew[1], Ogendi George Morara[2,3], Atalitsa Caren Navalia[3]

[1]Dryland Research Training & Ecotourism Centre, Egerton University, Kenya
[2]Directorate of Post-Graduate Studies, Egerton University, Kenya
[3]Department of Environmental Science, Egerton University, Kenya
Email: davemathews@gmail.com

How to cite this paper: Mathew, N.D., Morara, O.G. and Navalia, A.C. (2024) Socioeconomic Factors Influencing the Adoption of *Cenchrus ciliaris* among the Pastoralist Communities in South Baringo, Kenya. *Open Journal of Ecology*, **14**, 629-650.
https://doi.org/10.4236/oje.2024.148036

Received: July 4, 2024
Accepted: August 27, 2024
Published: August 30, 2024

Abstract

Land degradation poses significant threats to food and environmental security globally. In arid and semi-arid lands (ASALs), livestock production is an important and significant livelihood. Unfortunately, overstocking and overgrazing have diminished pasture availability, and thus adversely impacting on the sector's contribution to food security for many ASAL communities. The Global Environment Facility's Small Grants Program in its quest to combat soil erosion, deforestation, and *Prosopis juliflora* invasion in the Lake Bogoria Landscape, Baringo County, Kenya has supported the establishment of *Cenchrus ciliaris* (buffel grass) since 2018. Despite its introduction and establishment, the socioeconomic factors influencing its adoption remain undocumented. This study evaluated these factors in three administrative wards, namely: Ilchamus, Mochongoi, and Marigat of Baringo South Sub-County. Data was collected from 103 households using a semi-structured questionnaire, key informant interviews (KIIs), and Focus Group Discussions (FGDs). Our results revealed that *Cenchrus ciliaris* adoption has partially reduced soil erosion and deforestation, improved livelihoods and environmental conservation. Nearly 50% of the respondents have established 2 to 5 acres of buffel grass pasturelands on their farms. The level of education of the respondents for had a significant association with the participants' knowledge regarding the advantages of pasture production for environmental conservation (χ^2 = 16.93; $p < 0.05$). Nearly 90% of the respondents linked buffel grass to improved livestock production in the study area ($\chi^2 = 77.71$; $p < 0.05$). Adoption of the grass was also correlated with the level of education ($\chi^2 = 18.3$; $p < 0.05$) as was Gender ($\chi^2 = 3.8$; $p < 0.05$). Tertiary teaching and research insti-