EFFECTS OF HUMAN ACTIVITIES ON AGRICULTURAL PRODUCTIVITY IN NAROK COUNTY KENYA: A CASE STUDY OF NAROK NORTH

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A RESEARCH PROJECT SUBMITTED TO THE SCHOOL OF MANAGEMENT AND LEADERSHIP IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF DEGREE OF BACHELOR OF ARTS IN DEVELOPMENT STUDIES OF THE MANAGEMENT UNIVERSITY OF AFRICA.

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DECLARATION

This proposal is my original work and has not been presented for a degree in any other University

Signature…… **Date……**

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This proposal has been submitted for examination with my approval as University Supervisor

Signature…… **Date…….**

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DEDICATION

I dedicate this research report to my beloved parents, Mr. Henry Sururu and Mrs. Martha Sururu, with heartfelt gratitude and deep respect, I dedicate this work to you. Your unwavering love, sacrifice, and guidance have shaped the person I am today. Through your wisdom, patience, and resilience, you have instilled in me the values of hard work, integrity, and perseverance.

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ABSTRACT

This study examined the effects of human activities on climate change and their resulting impact on agricultural productivity in Narok County, Kenya. Narok County is predominantly reliant on rain-fed agriculture and livestock keeping, making it highly sensitive to climatic and ecological changes. The research focused on unsustainable human practices such as deforestation, overgrazing, land-use management, wetland encroachment, and bush burning, all of which were found to significantly contribute to environmental degradation, altered rainfall patterns, and reduced land productivity. A descriptive research design was employed, targeting a sample of 50 individuals including smallholder farmers, agricultural officers, environmental experts, and community elders selected through stratified random sampling to ensure representative coverage across various ecological zones. Data were gathered through structured questionnaires and key informant interviews, coded, and analyzed using SPSS software. The findings revealed that deforestation, driven primarily by logging, charcoal production, and land clearing for agriculture, had resulted in significant loss of forest cover and consequently reduced rainfall infiltration, increased surface runoff, and disrupted the local microclimate. Overgrazing, especially on communal rangelands, had led to pasture depletion, soil compaction, and erosion, all of which further diminished the land's ability to support agriculture. Land-use practices such as farming on steep slopes without conservation measures, mono-cropping, and lack of soil fertility management were major contributors to low yields. Wetland encroachment for farming and settlements had weakened water regulation systems and increased the frequency of unseasonal flooding and prolonged dry spells, directly impacting nearby farms. Bush burning and unregulated charcoal production were also identified as key drivers of declining soil quality and biodiversity loss. The study concluded that human-induced environmental degradation is a primary factor behind the declining agricultural productivity in Narok County, exacerbated by limited environmental awareness, inconsistent enforcement of land-use policies, and widespread poverty. To address this crisis, the study recommended a multidimensional approach involving the adoption of sustainable land management practices such as agroforestry, rotational grazing, terracing, wetland protection, and the integration of climate-smart agricultural technologies.

Contents

LIST OF TABLES

LIST OF FIGURES

ACRONYMS AND ABBREVIATIONS

ASALs: Arid and Semi-Arid Lands

DFID : Department for International Development

EKC : Environmental Kuznets Curve

FAO : Food and Agriculture Organization

FGD(s): Focus Group Discussion(s)

GIS : Geographic Information System

GHG : Greenhouse Gas

KFS : Kenya Forest Service

KIIs : Key Informant Interviews

KNBS: Kenya National Bureau of Statistics

NEMA: National Environment Management Authority

NDVI : Normalized Difference Vegetation Index

PRA : Participatory Rural Appraisal

SLA : Sustainable Livelihoods Approach

SPSS : Statistical Package for the Social Science

OPERATIONAL DEFINITION OF TERMS

Agricultural Productivity	The output of agricultural activities, commonly measured by crop yield per acre, number of harvests per year, and general trends in output.
Deforestation	The permanent removal of forest cover for non-forest uses such as farming or settlement, leading to soil and rainfall disruption.
Overgrazing	A condition where livestock consume pasture faster than it can regenerate, leading to soil erosion and land degradation.
Land Use Practices	Methods of managing land in farming, including terracing, intercropping, mono-cropping, and fallowing.
Wetland Encroachment	The conversion of wetlands into farmlands or settlements, affecting water regulation and ecosystem balance.
Bush Burning	The deliberate setting of land on fire to clear vegetation, which can lead to reduced soil fertility and environmental damage.
Charcoal Production	The process of burning wood in low-oxygen conditions to make charcoal, a key cause of deforestation and soil degradation.
Smallholder Farmers	Farmers who cultivate small plots mainly for household use or local markets, often using traditional methods.
Environmental Degradation	The decline in natural resource quality, such as soil and water, due to human misuse or overexploitation.
Sustainable Land Management	Practices aimed at conserving and improving land productivity in a sustainable and environmentally friendly manner.
SPSS	Statistical Package for the Social Sciences a software tool used to analyze data in social science and development research.

CHAPTER ONE

INTRODUCTION

1.0 Introduction

Chapter One introduces the research by highlighting the essential elements that form its groundwork. It discusses the study's background, outlines the problem being addressed, and presents both the research objectives and questions. Additionally, the chapter explains the study's relevance, clarifies its boundaries and constraints, and ends with a summary and list of references.

1.1 Background

In recent decades, human activities have become a major concern on a global scale. The alteration of ecosystems and atmospheric composition through deforestation, overgrazing, wetland encroachment, unsustainable land use, and bush burning has led to increased greenhouse gas (GHG) emissions and erratic weather patterns. Globally, studies have shown a strong link between these anthropogenic activities and declining agricultural productivity. For example, Smith et al. (2019) found that global cereal yields have decreased by up to 10% over the past 30 years due to climate-induced droughts and land degradation. In another study, Zhao et al. (2017) reported that every 1°C increase in global temperature reduces wheat and maize yields by 6% and 7.4%, respectively, highlighting the vulnerability of global food systems. Moreover, Lobell and Gourdji (2012) emphasized that human-driven climate anomalies are disrupting planting and harvesting seasons across Asia and South America, causing food insecurity in low-income regions.

Across the continent, sub-Saharan Africa continues to experience significant climate-related impacts, even though its contribution to global greenhouse gas emissions is relatively small. The African Climate Policy Centre (ACPC, 2020) noted that unsustainable human practices such as charcoal production, deforestation for agriculture, and overgrazing are degrading ecosystems and reducing agricultural productivity. In Ethiopia, studies by Tesfaye et al. (2016) found that forest loss due to farmland expansion

led to reduced rainfall and increased soil erosion, causing a 15–30% drop in crop yields. Similarly, in Nigeria, Adefolu and Olowoporoku (2021) found that wetland encroachment had significantly disrupted rice and vegetable farming in southern regions, while overgrazing in the northern Sahel regions intensified desertification and reduced livestock productivity.

In Kenya, agriculture accounts for about 33% of the Gross Domestic Product (GDP) and supports over 70% of rural livelihoods (KNBS, 2023). However, unsustainable human activities have increasingly placed pressure on land and ecosystems. For instance, a study by Were et al. (2020) revealed that deforestation in Kenya's forested regions had led to a noticeable decline in rainfall and increased cases of crop failure in counties such as Elgeyo Marakwet and Baringo. According to the Kenya Meteorological Department (2022), the country has experienced increased climate variability, with frequent droughts and floods disrupting agricultural productivity. Furthermore, Musyoka and Wambua (2021) reported that land degradation caused by poor land use and overgrazing in arid and semi-arid lands (ASALs) had resulted in declining soil fertility and pasture quality. To frame this study’s focus more precisely, it is essential to define and contextualize the key human activities under investigation:

1.1.1Deforestation

As reported by the Food and Agriculture Organization (2020), deforestation refers to the transformation of forested areas into alternative land uses such as agriculture, grazing fields, or urban infrastructure accompanied by a sustained decrease in tree canopy density to less than 10%. When driven by human activity, this process often involves the removal of vegetation through logging or intentional burning, leading to prolonged ecological disturbances.

1.1.2 Overgrazing

Holechek et al. (1999) define overgrazing as the excessive consumption of vegetation by livestock, which exceeds the carrying capacity of the land, leading to land degradation. Similarly, Milchunas and Lauenroth (1993) view overgrazing as a disturbance regime where livestock pressure causes changes in vegetation structure and function. FAO

(2009) further defines overgrazing as the practice where the stocking rate of livestock surpasses the regenerative capacity of pastures and rangelands.

1.1.3 Land Use Practices

The Intergovernmental Panel on Climate Change (IPCC, 2024) defines land use as "the total of arrangements, activities and inputs applied to a parcel of land," across various purposes like forestry, agriculture, urban development, and wetlands. FAO adds that land use concerns both the products derived and the management actions humans perform to gain that benefit.

1.1.4 Wetland Encroachment

Mitsch and Gosselink define wetland encroachment as the intrusion into wetland areas through agricultural expansion, infrastructure development, or settlement. Similarly, the Ramsar Convention Secretariat (2010) states that wetland encroachment involves the degradation or conversion of wetlands for non-wetland uses. Kairu further describes wetland encroachment in Kenya as the transformation of marshes, swamps, and riverine areas into farmlands, reducing their ecological functionality.

1.1.5 Bush Burning

Kauffman et al define bush burning as the deliberate setting of fire to clear vegetation, often practiced to prepare land for agriculture or regenerate grazing land. Similarly, FAO (2017) defines charcoal production as the process of carbonizing wood under low-oxygen conditions, which contributes to deforestation and carbon emissions. Okello et al. (2001) further refer to bush burning and charcoal making as major contributors to forest loss and land degradation in dryland ecosystems.

1.1.6` Agriculture in Narok County.

Narok County, located in Kenya's Rift Valley, is both agriculturally productive and environmentally sensitive. It is home to the Mau Forest Complex and supports a large population of smallholder farmers and pastoralists. However, deforestation, overgrazing, wetland encroachment, unsustainable land use, and charcoal production have led to soil

erosion, reduced rainfall, and declining crop and livestock yields. According to the Narok County Department of Agriculture (2023), maize and wheat production declined by over 20% between 2018 and 2022 due to land degradation and unpredictable rainfall patterns. Moreover, the Kenya Water Towers Agency (2022) documented a loss exceeding 20,000 hectares of forest cover within the county over the last ten years, with significant implications for water supply and agricultural output. These challenges underline the urgent need to study how human activities are influencing agricultural output in Narok, particularly for smallholder farmers who are both contributors to and victims of environmental dynamics.

1.2 Statement of the Problem

Climate variability, primarily caused by unsustainable human activities, has become a global environmental crisis with far-reaching consequences, particularly for the agricultural sector. Around the world, changing climate patterns have led to prolonged droughts, unpredictable rainfall, soil degradation, and increased frequency of extreme weather events, all of which directly threaten access to sufficient and nutritious food and rural means of subsistence. Across the sub-Saharan region, where agriculture remains largely rain-fed and climate-sensitive, these effects are especially severe. One of the most vulnerable countries is Kenya, where climate change is rapidly undermining agricultural productivity despite its centrality to the economy and livelihoods of millions.

Kenya's agricultural sector contributes approximately 33% to the national Gross Domestic Product (GDP) and employs over 70% of the rural population (KNBS, 2023). However, the country's dependence on rainfall, coupled with limited adaptive capacity and increasing environmental degradation, has made agriculture highly vulnerable to climate change. Over the last decade, Kenya has experienced recurrent droughts, floods, and shifting weather patterns, which have disrupted food production and supply chains. According to the Kenya Meteorological Department (2022), average temperatures in the country have increased by 1.0–1.5°C since the 1960s, while rainfall has become leading that is more erratic, to increased uncertainty in planting and harvesting seasons.

Narok County, situated in the southern part of Kenya and home to both commercial and subsistence farming communities, has not been spared. The county is known for its rich agricultural land, supported by the Mau Forest ecosystem and semi-arid grasslands, and produces key crops such as maize, beans, and wheat, alongside livestock farming. However, agricultural productivity in Narok has been declining in recent years due to worsening climate conditions and increasing human-induced environmental pressures. Deforestation in the Mau Forest Complex a key water tower in Kenya continues at an alarming rate, driven by illegal logging, charcoal burning, and the expansion of human settlement and farming activities. According to a 2021 report by the Kenya Forest Service (KFS), Narok has lost over 20,000 hectares of forest cover in the past decade, significantly affecting the local hydrological cycle.

This deforestation, alongside overgrazing, soil erosion, wetland encroachment, and poorly managed agricultural practices, has led to degradation of natural ecosystems that previously supported sustainable agriculture. Reduced tree cover has decreased rainfall infiltration and increased surface runoff, contributing to soil infertility and loss of moisture necessary for crop growth. Consequently, many farmers in Narok report lower yields despite applying the same or even higher levels of inputs than in previous years. For instance, Narok County Government's Agriculture Department data (2023) shows a 27% decline in maize yields between 2018 and 2022, largely attributed to erratic rainfall and soil degradation. Similar trends are observed in livestock farming, where prolonged dry seasons have led to pasture shortages, livestock deaths, and conflicts over water and grazing resources.

Moreover, Narok County is highly prone to episodes of abnormal climate extremes. Seasonal Catastrophic runoff and hillside collapses in areas near the Mau Escarpment not only destroy crops and infrastructure but also displace farming communities. These disasters are increasingly frequent and intense, consistent with global climate change projections. In 2020, the Kenya Red Cross Society reported that more than 2,000 households in Narok North and Narok South were affected by floods, with thousands of acres of farmland submerged. These events exacerbate poverty, reduce food security, and increase dependency on relief aid. The situation is particularly dire for smallholder

farmers, who often lack access to climate-smart agricultural practices, early warning systems, crop insurance, or reliable extension services.

Despite the evident environmental consequences of anthropogenic actions, there is limited localized research that quantifies and links these factors within the context of Narok County. The current body of knowledge remains insufficient to inform robust county-level policies and adaptation strategies. Many environmental interventions are generalized or externally imposed, lacking alignment with the specific socio-ecological dynamics of Narok. Furthermore, there is a gap in awareness among local communities regarding how their day-to-day activities such as deforestation for farming, overstocking of livestock, or improper land use contribute to climate change and ultimately harm their own agricultural productivity.

At the heart of the issue, therefore, is driven by the growing influence of human activities in accelerating climate change and environmental degradation, which in turn are causing measurable and persistent declines in agricultural productivity in Narok County. This dual threat not only undermines food and income security but also threatens the long-term sustainability Ok f rural livelihoods, biodiversity, and natural resources.

This study examined the specific human activities that are contributing to climate change in Narok County and assess the consequences of these changes on agricultural productivity. By generating local-level evidence and understanding, the study aims to inform adaptive strategies that are contextually relevant, environmentally sustainable, and economically viable for smallholder farmers and county planners alike.

1.3 Objectives

1.3.1 General objectives

To examine the effects of human activities on agricultural productivity in Narok County.

1.3.2 Specific objectives

I. To assess the effects of deforestation on agricultural productivity in Narok County.
II. To examine the effects of overgrazing on agricultural productivity in Narok County.

III. To determine the effect of land use practices on agricultural productivity in Narok County.
IV. To investigate how wetland encroachment affects agricultural productivity in Narok County.
V. To evaluate the effect of bush burning on shaping agricultural productivity in Narok County.

1.4 Research Questions

I. How does deforestation affect agricultural productivity in Narok County?
II. What is the effect of overgrazing on agricultural productivity in Narok County?
III. How do land use practices affect agricultural productivity in Narok County?
IV. In what ways does wetland encroachment impact agricultural productivity in Narok County?
V. How does bush burning affect agricultural productivity in Narok County?

1.5 Significance of the Study

The findings of this research are expected to benefit scholars and academic professionals by enhancing the current understanding of how anthropogenic activities influence agricultural performance in Kenya, with a specific focus on Narok County. It will provide empirical data that can be used for academic reference, comparative studies, and future research on sustainable agriculture and environmental management. Furthermore, the findings may stimulate multidisciplinary research across fields such as environmental science, agriculture, and development studies, offering a localized perspective on how anthropogenic actions affect natural resources and food systems.

Policy makers and government agencies will benefit from the study through evidence-based insights that highlight which human activities are most responsible for land degradation and declining agricultural yields. This information will be useful in formulating or refining county-level and national policies aimed at promoting sustainable land-use practices. The findings can support the development of targeted regulations,

improve land use planning, and inform the creation of incentive programs for conservation. Institutions such as the Department of Agriculture, the Environmental and Forestry Authority, and the County Administration of Narok may apply the findings to strengthen climate resilience measures, ecosystem rehabilitation initiatives, and long-term agricultural sustainability frameworks.

For practitioners, particularly smallholder farmers in Narok County and similar regions, the study offers practical knowledge on how their everyday land-use practices like the removal of forest cover, overgrazing, and suboptimal soil fertility management directly impact soil fertility, water availability, and crop yields. By understanding the connection between environmental degradation and reduced productivity, farmers will be empowered to adopt more sustainable techniques such as agroforestry, rotational grazing, and soil conservation. The research findings will also support local extension services and training programs aimed at improving resilience and long-term food security among farming Social groups.

1.6 Scope of the study

This study focuses on assessing the effects of human activities specifically deforestation, overgrazing, land use practices, wetland encroachment, and bush burning on agricultural productivity in Narok County, Kenya. The target population was 500, comprising smallholder farmers and agro-pastoral communities (400), county agricultural officers (40), environmental officers (20), community elders (20), and representatives from conservation groups (20). The was conducted between May and August 2025 across selected sub-counties representing diverse agro-ecological zones and land-use systems.

1.7 Chapter Summary

The current section has provided an overview of the research by outlining its contextual foundation, the core issue under investigation, and its primary objectives. The background provided a global and local overview of how human activities contribute to climate change and increasingly affect agricultural productivity, with a specific focus on Narok County. It outlined key issues such as deforestation, overgrazing, poor land use

practices, wetland encroachment, and charcoal production as major contributors to environmental degradation and declining farm yields in the region. The statement of the problem highlighted the urgent need to investigate how these human-induced environmental changes are undermining agricultural productivity, which is a critical economic activity in Narok County. The chapter further articulated the general objective of the study and derived five specific objectives, each linked to a distinct human activity believed to influence agricultural outcomes, followed by corresponding research questions aimed at guiding acquisition and evaluation of research data. The significance pertaining to the research was also discussed, illustrating why the research is important and who stands to benefit from its findings, including smallholder farmers, policymakers, conservation agencies, development partners, and academic institutions. The scope of the study was defined in terms of time (May to August 2025), geographical focus (Narok County), and target group (smallholder farmers and agro-pastoral communities). Overall, Chapter One has set the stage for the inquiry by identifying the investigation gap, justifying the need for the investigation, and clearly outlining the direction the study will take in subsequent chapters.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

Chapter Two delivers a structured analysis of relevant literature aligned with the study objectives. It starts with a theoretical review in Section 2.1, which explores frameworks such as sustainable land management, the theory of induced innovation, and ecosystem service models. Section 2.2 covers empirical studies conducted at global, regional, national, and local levels, emphasizing key factors related to human activity that impact agricultural productivity. A section 2.3 offer a synthesis of the literature reviewed and clearly identifies existing gaps in current research. The conceptual basis of the study is presented in Section 2.4. Lastly, Sections 2.5 and 2.6 focus on the operational definition of variables and conclude with a comprehensive summary of the chapter.

2.1 Theoretical Literature Review

This research is grounded in the Sustainable Land Management Theory, which serves as the central framework for examining how human activities influence agricultural output. Additional support is drawn from the Induced Innovation Theory and the Ecosystem Services Framework, which together offer insight into how actions such as forest clearing, unsustainable shifts in land utilization, and vegetation burning for charcoal production impact both ecological balance and agricultural productivity.

2.1.1 Sustainable Livelihoods Approach (SLA)

Robert Chambers originally introduced the concept of sustainable livelihoods and Gordon Conway in 1992 as a comprehensive framework aimed at exploring how people and families build and maintain their means of living, particularly in fragile and resource-

limited settings. The model was later refined and widely adopted by international development bodies, notably the UK's Department for International Development (DFID), which incorporated it into its policies and programs during the late 1990s. The livelihoods framework emerged as a critique of traditional poverty alleviation methods that tended to emphasize income generation, job creation, or productivity alone, often overlooking the complex social, environmental, and institutional factors that influence rural communities and their choices.

At its core, the Sustainable Livelihoods Approach is founded on the recognition that livelihoods are composed of various assets, influenced by external vulnerabilities, and shaped by institutions and policies. The theory identifies five key forms of capital natural, human, social, physical, and financial as the foundation upon which people build their livelihoods. Natural capital includes land, water, forests, and biodiversity, all of which are essential to agriculture. Human capital encompasses education, health, and labor capacity. Social capital denotes the relationships and connections among individuals or groups that facilitate cooperation, mutual support, and access to resources within a community. Physical capital comprises tangible assets such as infrastructure, equipment, tools, and technology that are used to support production and livelihood activities, while financial capital involves monetary resources such as income, credit, savings, and remittances. These assets are situated within a broader vulnerability context shaped by shocks (such as floods or droughts), trends (such as population growth or climate change), and seasonality (such as rainfall patterns or market prices).

Transformational systems and mechanisms including institutions, entities, regulatory frameworks, and legal provisions, mediate how individuals access these assets and influence their livelihood strategies. These strategies may involve farming, pastoralism, wage labor, or migration, all pursued with the goal of achieving desired livelihood outcomes such as food security, increased income, environmental sustainability, and reduced vulnerability.

Despite its widespread adoption, the Sustainable Livelihoods Approach has faced several criticisms. Scholars argue that while SLA is effective at capturing the complexity of rural

livelihoods, it tends to overlook broader structural issues such as inequality, political marginalization, and land tenure conflicts. The framework is also critiqued for lacking robust tools for assessing long-term ecological sustainability, which is crucial when livelihoods depend heavily on natural resources. Furthermore, some critics point out that SLA can be difficult to operationalize effectively, particularly in contexts with weak institutional capacity or fragmented data systems.

The relevance of SLA to the present study lies in its capacity to explain how environmental degradation in Narok County resulting from human-induced actions like forest clearing, overgrazing, wetland encroachment, and charcoal production is not merely the result of ignorance or mismanagement, but often reflects deeper constraints within the livelihood system. For example, limited access to financial capital may force households to engage in unsustainable practices like charcoal burning as a coping strategy. Similarly, the degradation of natural capital through deforestation and overgrazing undermines agricultural productivity, thereby perpetuating poverty and food insecurity. By applying the SLA framework, this study seeks to understand these dynamics comprehensively and to identify intervention points that support both sustainable resource use and improved agricultural outcomes. Specifically, the SLA underpins the study's examination of all independent variables, offering a unifying lens to assess how human actions, shaped by systemic vulnerabilities and asset constraints, influence agricultural productivity in Narok County.

2.1.2 Environmental Kuznets Curve (EKC) Theory

The Environmental Kuznets Curve (EKC) model originates from the economic theories of Simon Kuznets, who, in the mid-20th century, suggested a curved linkage between economic progress and disparities in income distribution. Environmental economists like Grossman and Krueger later reinterpreted this idea in 1991, who applied it within the realm of environmental analysis. They argued that as a country's economy expands, environmental degradation tends to rise at first, but after reaching a particular stage of economic advancement, subsequent growth contributes to ecological improvement. This perspective gave rise to the now-familiar EKC pattern, represented as an inverted U-curve, illustrating this dynamic relationship.

The EKC theory posits that at the early stages of economic development, industrial expansion and intensifying resource exploitation result in significant environmental degradation. This is attributed to increased energy consumption, land conversion, pollution, and deforestation, all of which are seen as necessary to meet basic economic needs. However, once a certain income threshold referred to as the "turning point" is reached, further economic growth tends to correspond with environmental improvement. This reversal is facilitated by structural economic shifts from agriculture and manufacturing to service-based industries, the adoption of cleaner production technologies, increased public demand for environmental quality, and the strengthening of environmental policies and institutions.

A central premise of the EKC is the interaction of three effects: scale, composition, and technique. The scale effect suggests that economic growth increases pollution and natural resource consumption. The composition effect denotes structural changes in the economy that reduce environmental pressure such as a shift from heavy industry to services. The technique effect reflects the adoption of cleaner and more efficient technologies as a result of increased income and awareness. Together, these effects explain the theoretical trajectory of environmental degradation followed by recovery.

Despite its theoretical appeal, the EKC has faced considerable criticism. One major critique is that it assumes an automatic transition toward environmental improvement with income growth, without adequately accounting for governance quality, political will, or equity in development. Another limitation is that the EKC framework may downplay irreversible ecological damages, such as species extinction or wetland loss, which cannot be undone even with future improvements. Additionally, the theory may obscure the global outsourcing of pollution, where wealthy countries reduce domestic degradation by relocating polluting industries to developing nations. The assumption that every country will reach a uniform turning point also fails to consider diverse socio-political and ecological contexts. Furthermore, the theory does not sufficiently address social inequality; even in wealthier societies, marginalized populations may continue to suffer from environmental harm.

In the context of Kenya, and more specifically Narok County, the EKC framework provides a lens for interpreting how economic activity is linked to environmental degradation. Narok's economy is heavily reliant on agriculture, livestock keeping, and natural resource extraction, such as charcoal production. These economic activities are linked to the clearing of forested areas, overgrazing, wetland encroachment, and the deterioration of land quality, all of which undermine agricultural productivity. According to the EKC, such trends are characteristic of economies in the early stages of development, where natural resources are exploited unsustainably to meet immediate livelihood needs and market demands.

However, Narok County has not yet reached the income threshold at which environmental restoration becomes feasible. This is evident in the persistent environmental challenges facing the region, driven by factors such as low per capita income, inadequate institutional capacity, and limited access to clean technology. Most residents in the county remain engaged in subsistence agriculture and informal economic activities that prioritize short-term survival over long-term sustainability. The county's weak enforcement of environmental regulations, coupled with insufficient investment in climate-smart technologies and limited environmental awareness among communities, further delays the potential for ecological recovery as envisioned by the EKC.

In practical terms, the EKC theory underscores the need for Narok County to proactively integrate environmental protection into economic planning, rather than relying on income growth alone to drive change. Policymakers must promote sustainable agricultural practices, improve access to alternative energy sources to reduce dependence on charcoal, and strengthen institutions responsible for land-use regulation. Community education campaigns to raise awareness about environmental issues are also essential. Importantly, development interventions should seek to flatten and shift the EKC curve achieving economic development while minimizing ecological damage from the outset.

In relation to the present study, the EKC theory is particularly relevant in examining the variable of deforestation. It explains how expanding agricultural land and charcoal production, both driven by income-generating pressures, contribute to environmental

degradation. It also provides a theoretical basis for assessing whether the current development path in Narok is leading toward or away from ecological sustainability. Thus, while the EKC offers valuable insights, it also highlights the need for deliberate, policy-driven efforts to ensure that economic growth in Narok County contributes to both environmental and agricultural resilience.

2.1.3 Tragedy of the Commons Theory

The Tragedy of the Commons Theory was introduced by ecologist Garrett Hardin in a landmark article published in Science in 1968, drew attention to the challenges posed by common-pool resources natural resources that are accessible to all members of a community but are not owned by any single individual and are difficult to exclude others from using. In this context, the "commons" refers to shared resources such as grazing land, forests, water sources, and fisheries. Hardin argued that when individuals act independently and rationally in pursuit of their own self-interest, they tend to excessively use common resources, resulting in their exhaustion and lasting damage for the entire community. His classic example involved herders who, each seeking to increase their own gain, add more livestock to a shared pasture. Though individually rational, this collective behavior eventually leads to overgrazing and ecological collapse a phenomenon he termed the "tragedy."

At the heart of this theory are several critical concepts. First is the notion of common-pool resources (CPRs), which are both rivalrous and non-excludable, implying that while one individual's use diminishes the quantity available to others, it remains difficult or impossible to restrict access. Second is the idea of rational individual behavior, where each user maximizes their own short-term benefit, often unaware or unconcerned about the long-term costs shared by all users. Third is the principle of overexploitation, which results when all actors follow this same logic, leading to the resource's degradation? Finally, the theory highlights institutional failure: the tragedy unfolds most often in the absence of effective governance mechanisms, clearly defined property rights, or collective action frameworks to regulate access and manage use.

The Tragedy of the Commons theory has been widely applied to environmental obstacles such as deforestation, overfishing, reduced access to water and ongoing climate transformations. In particular, the theory is highly relevant to understanding overgrazing patterns in Narok County, Kenya. Narok is home to pastoralist communities primarily the Maasai whose livelihoods revolve around livestock keeping. Traditionally, these communities practiced semi-nomadic grazing, rotating herds across communal rangelands according to ecological conditions. However, due to population growth, land fragmentation, sedentarization, commercialization of livestock, and climate change, communal grazing lands now experience unprecedented pressure.

In Narok County, the classic tragedy unfolds as herders, motivated by economic needs and cultural values, seek to expand their herd sizes without consideration of cumulative effects on pastureland. Since no single herder owns the land, there is little incentive to limit grazing. The expense associated with degradation is shared collectively, while the benefit of additional livestock accrues individually. This results in loss of vegetation, soil erosion, reduced land productivity, and the deterioration of both grazing and farming ecosystems. These outcomes reflect the tragedy Hardin described, where rational individual decisions lead to irrational collective outcomes.

Several socio-economic and institutional dynamics exacerbate this situation. Many pastoralist households live in poverty and regard livestock serving not only as a provider of nutrition and earnings, but also as a form of wealth storage and cultural capital. Additionally, Narok faces limited alternative livelihoods, making livestock rearing one of the few viable economic activities. The region also suffers from weak land governance systems, with inadequate enforcement of communal grazing rules and growing tensions between traditional and formal tenure arrangements. These institutional weaknesses mirror the governance gaps that Hardin identified as essential contributors to resource collapse.

However, it is important to acknowledge that Hardin's theory has not gone unchallenged. Scholars such as, Elinor Ostrom, the 2009 Nobel laureate in Economics, demonstrated that communities can and often do successfully manage common resources through

locally crafted rules, trust-based institutions, and participatory governance. Ostrom's work highlights that tragedies are not inevitable and can be averted through collective action and institutional innovation. This extension of the theory provides a more optimistic outlook and underscores the importance of local agency and governance capacity in managing CPRs.

In the context of this study, the Tragedy of the Commons concept refers to particularly pertinent to the variable containing overgrazing. It grants a theoretical basis to make sense of how individual decisions by pastoralists driven by poverty, cultural norms, and limited alternatives lead to the degradation of communal rangelands. This degradation, in turn, undermines agricultural productivity through reduced pasture quality, erosion of soil, and diminished ecosystem services. The theory therefore helps frame the relationship between unsustainable land use practices and declining agricultural output in Narok County.

Moreover, the theory suggests pathways for intervention. Sustainable solutions may include strengthening communal grazing institutions, reintroducing rotational grazing systems, integrating indigenous knowledge into modern conservation strategies, and diversifying rural livelihoods. These approaches aim to realign individual incentives with collective sustainability goals, thereby transforming the tragedy into an opportunity for ecological and economic resilience. Ultimately, the Tragedy of the Commons gives a compelling scholarly perspective that allows one to analyze and address the environmental and socio-economic challenges confronting Narok's pastoralist communities.

2.1.4 Land Use Transition Theory

The Land Use Transition Theory was developed in the early 2000s by land system scientists such as Eric Lambin and Helmut Geist (2003) to explain how land use patterns adapt as a result of socio-economic, institutional, and ecological dynamics. The theory emerged from the growing recognition that global land degradation, biodiversity loss, and deforestation were not random occurrences but followed identifiable stages influenced by human development trajectories. Later contributions by Lambin and Meyfroidt (2010)

expanded the framework by emphasizing how land use transitions are influenced not only by local decisions such as those made by individual farmers or communities but also by global forces such as international trade, climate change, and shifts in commodity markets. Land Use Transition Theory has since become a cornerstone in the study of land system science, particularly in relation to sustainable agriculture, rural development, and ecosystem management.

at the core of this theory stands as the proposition that land utilization change follows a series of stages driven by development. Initially, land use is characterized by extensive exploitation of natural resources, such as open grazing, slash-and-burn agriculture, or shifting cultivation. As economic and demographic pressures intensify, societies shift toward land intensification marked by permanent agriculture, mechanization, monocultures, and irrigation. In the most advanced stage, regions adopt sustainable intensification and land restoration practices such as agroforestry, conservation agriculture, and landscape-level planning. However, not all regions transition smoothly through these stages. Some become trapped in cycles of degradation due to poverty, weak institutions, or ecological shocks. Thus, the theory emphasizes the importance of feedback loops were degraded land leads either to abandonment and further exploitation or, alternatively, to investment in recovery depending on socio-political context.

Land Use Transition Theory is especially relevant in understanding land use changes in Narok County, Kenya. Historically, Narok was dominated by communal pastoralism practiced by Maasai communities who rotated livestock across vast rangelands in accordance with seasonal rainfall. Subsistence agriculture and intact natural ecosystems such as forests and wetlands also coexisted within this traditional system. These land use patterns were shaped by mobility, communal tenure arrangements, and a deep integration of ecological knowledge. However, in recent decades, Narok County has experienced rapid transitions due to population growth, commercialization of agriculture, sedentarization of pastoralist communities, and infrastructure expansion.

The shift toward commercial agriculture has seen vast tracts of land converted from rangelands to monoculture crop farms especially for maize and wheat. This

intensification often takes place without adequate soil conservation, leading to land degradation. Simultaneously, wetlands and forested areas such as the Mau Forest Complex are increasingly encroached upon for cultivation and settlement, undermining ecosystem services including water control and biodiversity support. Farmers in Narok often lack access to climate-smart agricultural technologies or extension services, contributing to practices such as continuous cropping, ploughing on slopes without terracing, and nutrient depletion all of which exacerbate land degradation.

According to the Land Use Transition Theory, Narok County appears to be at a transitional stage between unsustainable intensification and the potential for sustainable land management. The county has moved beyond extensive exploitation but is yet to embrace widespread practices that restore or conserve ecological health. Without deliberate policy shifts and institutional support, there is a risk that Narok may become trapped in a degradation loop that threatens long-term agricultural productivity and rural livelihoods.

This theoretical framework is directly relevant to the study's third research question, which examines the effects of land use practices on agricultural productivity. By situating Narok's current land dynamics within the stages of land use transition, the theory helps explain why agricultural yields are declining despite expanded cultivation efforts. Soil degradation due to mono-cropping, erosion, and deforestation leads to reduced fertility and water retention, while fragmented landscapes diminish ecosystem services such as pollination and pest control. These issues collectively contribute to declining productivity and increased vulnerability to climate variability and market shocks.

Furthermore, Land Use Transition Theory offers strategic insights into how Narok County can shift toward a more sustainable trajectory. This includes the promotion of agro ecological farming practices, reforestation, improved land tenure security, and targeted knowledge dissemination on soil and water conservation techniques. The theory emphasizes that land use transitions are not deterministic but are shaped by policy decisions, community action, and institutional strength.

Land Use Transition Theory provides a robust explanatory lens through which to view how evolving land use patterns in Narok County impact agricultural productivity. It underscores the need for timely interventions that align with sustainable land management principles. If such interventions are implemented, Narok has the potential to transition toward sustainable intensification, balancing agricultural output with the conservation of natural ecosystems.

2.2 Empirical Literature Review

This part of the study analyzes existing research that has investigated the connection between human-induced activities and agricultural output, with a special emphasis on developing nations, particularly within the sub-Saharan African region. The analysis is organized according to the research's five main explanatory variables: deforestation, overgrazing, land utilization methods, wetland intrusion, and bush burning or charcoal production. Each section outlines significant empirical evidence, describes the approaches and techniques employed, and highlights existing research gaps especially those relevant to Narok County and other comparable agro-ecological environments in Kenya.

2.2.1 Deforestation and Agricultural Productivity

Deforestation remains a major contributor to land degradation and declining agricultural productivity, especially in developing countries. Globally, forest clearance has been shown to disrupt critical ecological services such as rainfall regulation, soil protection, and nutrient cycling. For example, Zhao et al. (2017), in a meta-analysis covering 16 countries across Latin America and Asia, found that deforestation contributed to a 5–15% reduction in major cereal crop yields due to increased surface temperatures and decreased soil moisture. Similarly, Lobell and Gourdji (2012), using climate-yield models and satellite data, showed that widespread forest loss alters regional microclimates, resulting in delayed planting seasons and heightened drought frequency.

Achard et al. (2014), in a global-scale study utilizing satellite imagery, linked tropical deforestation to long-term agricultural instability. Although short-term gains may occur

when land is cleared for cultivation, these benefits are often offset by long-term declines in productivity due to loss of ecosystem regulation services. However, these global studies primarily focus on large-scale commercial agriculture and tropical rainforest systems, which may not fully reflect the realities of smallholder, subsistence-based agriculture prevalent in East Africa.

In sub-Saharan Africa, deforestation is closely linked to agricultural expansion, charcoal production, and fuelwood collection, particularly in forest-adjacent rural communities. Adefolu and Olowoporoku (2021), studying southern Nigeria, reported that 68% of surveyed farmers experienced reduced yields after forest clearing, attributing this to soil organic matter loss and diminished moisture retention. In Ethiopia, Tesfaye et al. (2016) combined household surveys with remote sensing to show a 15–30% drop in crop yields after deforested land was brought under cultivation. Similarly, in Tanzania, Mwampamba (2007) found that maize farms established on previously forested land had higher erosion rates and yield declines over time, undermining the sustainability of initial land gains. These regional studies demonstrate how forest degradation exacerbates environmental stressors like soil erosion and unreliable rainfall. However, many are based on broad spatial datasets and generalized farming systems, often lacking specificity for diverse land-use systems like those in Kenya's highland and rangeland zones.

In Kenya, deforestation has been particularly impactful in areas adjacent to critical ecosystems such as the Mau Forest Complex. Were et al. (2020), studying western Kenya through GIS mapping and farmer interviews, found that loss of forest cover contributed to more erratic rainfall patterns and heightened soil erosion, resulting in yield declines of 10–20%. Narok County, bordering the Mau Forest, is highly vulnerable to similar dynamics. According to the Narok County Department of Agriculture (2023), the region experienced a 20% decline in maize yields between 2018 and 2022, with deforestation identified as a primary driver.

Mutoko and Barasa (2019), through participatory rural appraisal in Narok, observed that farmers who cleared indigenous forests for cultivation often saw short-lived gains followed by declining productivity due to soil nutrient depletion and water scarcity.

Further, the Kenya Forest Service (2021) reported the loss of over 20,000 hectares of forest in Narok over the last decade, correlating with increased land degradation and household food insecurity.

Despite this evidence, localized empirical studies that quantitatively link forest loss to declining crop productivity in Narok remain scarce. Most available literature either aggregates data at the national level or relies heavily on farmer narratives without integrating long-term soil, climate, and yield datasets. Moreover, the interactive effects between deforestation and other stressors like overgrazing or land fragmentation have not been sufficiently analyzed in Narok's agro-pastoral context.

2.2.2 Overgrazing and Agricultural Productivity

Overgrazing is widely recognized as a major contributor to land degradation, particularly in arid and semi-arid environments. At the global level, the Food and Agriculture Organization (FAO, 2009) estimates that overgrazing accounts for more than 35% of human-induced land degradation, contributing to soil compaction, loss of vegetative cover, and erosion. Steinfeld et al. (2006), drawing on satellite imagery and ecological surveys from Asia, Africa, and Latin America, demonstrated that livestock populations exceeding land carrying capacity result in pasture collapse and encroaching desertification. Similarly, Herrero et al. (2013) found that continuous grazing without sufficient land recovery cycles lowers pasture productivity and drought resilience, ultimately reducing livestock performance and feed availability.

While these global studies confirm overgrazing's detrimental effects on agricultural ecosystems, many focus on large-scale grazing systems in Central Asia or Latin America, where pastoral systems differ markedly from the communal and smallholder-dominated systems found in East Africa.

In sub-Saharan Africa, the problem of overgrazing is especially acute in regions such as the Sahel, the Horn of Africa, and East African rangelands. In northern Ghana, Abdulai et al. (2017) found that pasturelands exposed to prolonged overgrazing showed 30% lower biomass productivity and a 40% reduction in soil organic content compared to less grazed

areas. Their study, which employed vegetation sampling and soil analysis, highlights the direct impact of overgrazing on land fertility. In southern Ethiopia, Tefera et al. (2013) used transect-based vegetation sampling and satellite-based NDVI analysis to show that degraded rangelands had diminished grass species diversity and water infiltration capacity factors critical to sustaining both livestock and crops. In Tanzania, Mwalyosi (1992) reported that communal grazing zones faced acute degradation due to unrestricted access, as revealed through socio-ecological interviews and spatial mapping of grazing intensity.

These studies underscore the challenge of managing communal grazing resources in the absence of effective governance systems, but they often lack contextualization to Kenya's agro-pastoralist land use and governance structures.

In Kenya, particularly in pastoralist and agro-pastoralist counties such as Narok, Baringo, and Kajiado, overgrazing has become a central factor in rangeland degradation. Kioko et al. (2012), through on-the-ground transect surveys and remote sensing in Narok and Kajiado, found that overgrazed areas had reduced grass biomass by over 60% and significantly lower soil moisture content. These degraded rangelands were increasingly encroaching on croplands, threatening both crop and livestock productivity.

Mutoko and Barasa (2019), using participatory rural appraisal and household surveys in Narok, documented that farmers observed declining pasture availability and shrinking grazing areas. These constraints led to higher dependence on purchased feed, longer distances traveled in search of water, and reduced livestock productivity, including lower milk output. Their findings reflect local perceptions of a weakening of traditional communal grazing systems, now strained by rising livestock populations and land fragmentation.

The Narok County Department of Livestock and Agriculture (2023) has attributed this trend to land subdivision; whereby communal lands are converted into individually owned plots. This shift disrupts coordinated grazing practices and leads to over-concentration of livestock in fenced or enclosed areas. Moreover, the study notes that

extension services for pasture management are under-resourced, and enforcement of rotational grazing is weak.

Despite these observations, empirical studies that link overgrazing directly to both livestock productivity and adjacent crop yields remain limited in Narok County. Most existing research is short-term and lacks spatial depth, overlooking interactions with climate variability, rainfall patterns, and land tenure dynamics. There is also insufficient exploration of traditional governance institutions and how they might be leveraged for sustainable grazing management in this agro-pastoral context.

2.2.3 Land Use Practices and Agricultural Productivity

Globally, land use practices are central to determining the productivity and sustainability of agricultural systems. Unsustainable practices such as mono-cropping, excessive tillage, farming on steep slopes, and failure to implement soil and water conservation measures have been empirically associated with soil erosion, nutrient depletion, and long-term yield decline. Turner et al. (2007) report that inappropriate land use practices are responsible for approximately 20% of global agricultural productivity loss annually, a trend most pronounced in low-income and environmentally fragile countries. Similarly, FAO (2015) estimates that about 75 billion tons of arable soil are lost each year due to poor land management, jeopardizing food systems worldwide.

In a comparative study using satellite imagery and land use modeling, Lambin et al. (2001) found that areas experiencing rapid agricultural expansion, especially where conservation practices were lacking, faced serious environmental degradation and reduced crop output. These studies, while robust in showing the relationship between poor land use and agricultural decline, often focus on large-scale commercial agriculture in temperate or tropical zones, leaving a gap in understanding how smallholder systems in Africa cope with similar issues under rain-fed, low-input conditions.

Across sub-Saharan Africa, rapid population growth as well as urban sprawl, have created intense constraints on marginal lands, causing widespread land degradation. Research by Maitima et al. (2010), which spanned Kenya, Uganda, Ethiopia, and Tanzania, observed a pattern of cultivating fragile ecosystems, such as wetlands and hillsides, without adequate conservation infrastructure. Their mixed-methods approach, combining remote sensing with agricultural surveys, revealed a consistent reduced in yields linked to surface soil removal and depletion of vegetation cover.

In Nigeria, Ayoola et al. (2011) conducted longitudinal field trials and found that continuous cultivation without restorative fallowing or input of organic matter led to progressively lower maize yields, especially in plots with high land use intensity. Similarly, Nabahungu and Visser (2013) reported that wetland conversion for rice farming in Rwanda, conducted without proper hydrological planning, caused both environmental stress and suboptimal yields. These regional studies collectively highlight how informal and unregulated land use practices contribute to agricultural underperformance in diverse African settings.

In Kenya, unsustainable land use practices remain a key contributor to declining crop and livestock yields, notably in arid and semi-arid zones and highland zones. According to Kogo et al. (2021), improper cultivation methods including lack of terracing, continuous tillage, and farming in ecologically sensitive areas have reduced soil fertility and led to diminishing returns despite increasing input use. Their study employed geospatial tools and soil nutrient mapping to link land degradation with declining productivity.

Narok County exemplifies these challenges, where the transformation from extensive pastoralism to sedentary, mixed-use farming has occurred rapidly and often without proper planning. Mutoko and Barasa (2019), through participatory rural appraisals and farmer interviews, documented the absence of conservation measures such as terraces and cover cropping, especially among smallholder farmers in maize and wheat zones. This lack of soil protection has led to increased runoff, especially during heavy rains, causing substantial soil and nutrient loss.

Further, Kioko (2019) employed rainfall and crop yield datasets to demonstrate that farms located on unprotected slopes in Narok experienced up to 30% yield losses during peak rainfall seasons, largely due to soil erosion and nutrient leaching. The 2018–2022 Integrated Development Framework of Narok County, notes that overlapping and conflicting land uses such as farming in wetlands, settlements in forest areas, and unregulated grazing have intensified land degradation. Yet, enforcement of land use regulations remains limited, and many land-use decisions are made in the absence of formal planning frameworks.

The increasing trend of land subdivision in Narok has further fragmented land use systems, undermining traditional patterns that once integrated crop-livestock rotation and seasonal grazing. This has created pressure on existing farmland, contributing to overexploitation, reduced soil fertility, and overall lower productivity. While empirical studies have acknowledged these transitions, few provide a comprehensive, spatially explicit analysis of how these land use patterns evolve and affect yield outcomes over multiple growing seasons.

2.2.4 Wetland Encroachment and Agricultural Productivity

Wetlands play a critical role in maintaining ecological balance and supporting agricultural productivity through functions such as water retention, nutrient cycling, flood mitigation, and regulation of microclimates. Across the globe, studies have documented the detrimental effects of wetland encroachment particularly the conversion of wetlands for agriculture, settlements, or infrastructure on long-term agricultural sustainability. Mitsch and Gosselink (2000), drawing on ecological data from North America, Asia, and Europe, found that areas adjacent to intact wetlands tended to maintain higher agricultural output due to sustained water supply and fertile soils. Conversely, drained or reclaimed wetlands frequently experienced soil salinization, declining fertility, and erratic crop yields.

Turner et al. (2000) further demonstrated, using GIS tools and hydrological simulations across continents, that loss of wetland ecosystems undermines key services such as water filtration and flood control, exposing neighboring farmlands to seasonal water stress and

flooding. The Ramsar Convention Secretariat (2018) warns that, since 1970, the world has experienced significant wetland loss, much of it due to unregulated agricultural expansion, with negative consequences for both productivity and environmental resilience. However, these global analyses are often centered on large-scale wetland systems in temperate climates and rarely consider the community-level dynamics typical of smallholder farming systems in Africa.

In sub-Saharan Africa, the encroachment into wetlands is often driven by population pressure, limited arable land, and weak enforcement of environmental regulations. Nabahungu and Visser (2013), in a longitudinal study in Rwanda, observed that while wetland conversion for rice farming initially boosted productivity, yields began to decline within five years due to deteriorating soil structure, pest infestations, and hydrological imbalance. Their analysis, based on field observation, soil testing, and crop yield tracking, illustrates how short-term gains are outweighed by long-term productivity losses.

In Uganda, Kaggwa et al. (2009) combined remote sensing with community interviews to show that wetland encroachment led to severe erosion and siltation of nearby agricultural lands, decreasing fertility and water regulation capacity. Similarly, Gichuki (2004), in a regional analysis across East Africa, noted that a majority of farmers operating on former wetlands reported persistent waterlogging, erratic drainage, and declining crop performance. These findings reflect broader patterns where wetland conversion in Africa results in the disruption of delicate ecosystems essential for sustainable farming. Yet, many of these studies stop short of examining how institutional, social, and economic drivers compound these effects over time.

In Kenya, wetlands are crucial for groundwater recharge, dry-season agriculture, and regulating microclimatic conditions, particularly in ecologically sensitive counties such as Narok. Despite their value, wetland conversion has become increasingly common due to rising demand for agricultural land. According to the National Environment Management Authority (NEMA, 2020), Kenya has experienced a significant reduction in its inland wetlands, and Narok County is among the areas most affected. Wetlands such

as Enoosupukia and Olpusimoru are now being cultivated primarily for maize and vegetables, often without adequate drainage planning or conservation practices.

Mutoko and Barasa (2019) found that more than half of the smallholder farmers they interviewed in Narok had extended cultivation into wetlands in pursuit of better yields. However, within three years, many reported problems such as soil nutrient exhaustion, pest invasions, and unseasonal waterlogging that hampered production. These findings were based on participatory rural appraisals, interviews with community leaders, and basic soil analysis. The Narok County Department of Environment and Natural Resources (2022) also notes that wetland encroachment has disrupted natural water storage and flood control mechanisms, with effects felt across adjacent farmlands and riparian zones.

Furthermore, community understanding of wetland functions remains limited, and policy enforcement is weak. In many parts of Narok, wetlands are effectively open-access resources with no formal ownership or user guidelines, encouraging informal expansion and unsustainable exploitation. Although local environmental offices are aware of the problem, their capacity for enforcement and community engagement is often constrained by budgetary and staffing limitations. There is also little evidence of structured programs to educate communities about the long-term risks of wetland degradation or to promote sustainable wetland-agriculture integration models.

While existing studies in Kenya and across the region acknowledge the environmental degradation caused by wetland encroachment, few take a holistic view that incorporates hydrological, agronomic, and policy dimensions. Moreover, participatory approaches that include community voices in the design of conservation strategies are underrepresented in the literature. As wetland use intensifies in Narok County, the absence of such locally grounded, empirical research leaves a significant gap in efforts to ensure both agricultural productivity and ecological sustainability.

2.2.5 Bush Burning and Agricultural Productivity

Bush burning remains a widely used practice across many regions of the world, particularly in growing states where biomass serves as a major provider of household energy and land preparation is often carried out using fire. While such practices offer short-term benefits including quick land clearing, temporary pest suppression, and ease of access to energy their long-term effects on agricultural productivity and ecological sustainability are overwhelmingly negative. Global studies have consistently shown that repeated exposure of soils to fire leads to degradation of soil structure, depletion of organic matter, and loss of key nutrients necessary for crop production.

According to FAO (2017), the open burning of vegetation contributes significantly to global greenhouse gas emissions while accelerating topsoil erosion and desertification. Lehmann et al. (2003), studying post-burn soil profiles in Brazil and Southeast Asia, observed a consistent pattern of nutrient loss, particularly nitrogen and phosphorus, alongside increased soil acidity and reduced microbial activity. In similar tropical environments, Lal (2005) reported that fire-based land clearing weakens soil aggregate stability and reduces fertility, leading to yield declines in both cereal and legume production. These outcomes were most evident in fragile tropical soils that already suffer from low natural fertility. Furthermore, Chidumayo and Gumbo (2013) linked tree felling for charcoal production to long-term landscape degradation, with few cases of reforestation or soil rehabilitation observed following extraction.

Although these global-level studies establish the biophysical consequences of bush burning and charcoal extraction, they often lack attention to localized socio-economic contexts, especially in semi-arid regions where these activities form part of coping mechanisms among vulnerable rural populations.

In sub-Saharan Africa, the drivers of bush burning are both economic and cultural. In many cases, land preparation, hunting practices, herding, and energy collection are intertwined with the use of fire. Alemayehu et al. (2016), in a five-year study of Ethiopia’s highlands, found that uncontrolled fires altered soil texture and reduced maize yields by up to 40% compared to control plots. This was attributed to reduced moisture

retention, microbial activity, and ground cover regeneration. In Zambia, Chidumayo (1994) documented how charcoal production in miombo woodlands led to loss of biodiversity and diminished capacity of surrounding lands to support farming due to reduced soil water holding capacity. Similar effects were observed by Adama and Raufu (2017) in Nigeria, who found that post-burn agricultural fields produced significantly lower crop yields due to the destruction of topsoil organisms and exposure to wind and water erosion. These studies confirm that fire and biomass extraction degrade the natural systems that sustain crop and livestock productivity. However, many of these regional studies stop short of examining community-based mitigation or the policy frameworks that govern fire use. Furthermore, few capture farmer perceptions of the balance between immediate agricultural gains and future soil deterioration

In Kenya, bush burning is particularly prevalent in arid and semi-arid counties such as Narok, Kitui, Kajiado, and Baringo. Here, the practice is used for rangeland regeneration, land clearing, and charcoal production, often with minimal regard for ecological impacts. In Narok County, Mogaka et al. (2015) found that seasonal fires set to stimulate pasture growth often led to degradation of natural vegetation and increased topsoil loss. Using remote sensing and field verification, their study identified extensive fire scars and reported that farms located adjacent to burned rangelands had yield reductions of up to 25% over three years.

Mutoko and Barasa (2019), through participatory rural appraisal and interviews with charcoal producers, revealed that land cleared for charcoal kilns or repeatedly exposed to fire showed signs of soil compaction, reduced water infiltration, and weed invasion factors which diminish long-term agricultural viability. Farmers in the study frequently noted that fields previously used for charcoal extraction had lower productivity and required more external inputs to sustain yields. These effects are compounded by land fragmentation and weak environmental governance structures.

The Narok County Environment Office (2022) reports that over 10,000 hectares of land have been affected by bush fires and charcoal harvesting over the past decade. This widespread degradation has led to reduced pasture regeneration, increased runoff, and

lower productivity in nearby croplands. Despite these concerns, enforcement of charcoal bans remains uneven and poorly adapted to the local context. National bans often do not provide viable alternative livelihoods or energy sources, leading to continued illegal production and environmental decline.

There is currently a scarcity of empirical research in Narok County that quantitatively links specific fire use practices to seasonal crop yields or soil health. Additionally, studies rarely assess the socio-economic trade-offs farmers face when choosing between short-term gains from charcoal or burning and long-term soil fertility. There is also limited integration of community-led fire control strategies into broader land use planning and policy implementation.

The persistent use of fire in land preparation and biomass extraction in Narok underscores the need for integrated research that captures both the ecological and socio-economic dimensions of bush burning. Without such localized, evidence-based analysis, interventions may fail to address the root causes of land degradation and continued decline in agricultural productivity.

2.3 Summary and Research Gaps

This section summarizes the key findings from the empirical literature reviewed and highlights existing knowledge gaps that justify the need for the current study. The reviewed studies at global, regional, and local levels consistently affirm that human activities such as forest clearance, overgrazing, unsustainable land utilization practices, wetland encroachment, and bush burning contribute significantly to environmental degradation and declining agricultural productivity.

Table 1. Summary of Research Gaps

Author(s) & Year	Study	Methodology	Key Findings	Knowledge Gaps	Focus of Current Study
Tesfaye et al. (2016)	*Impacts of Forest Loss on Rainfall and Crop*	Household surveys and satellite imagery	Deforestation led to reduced rainfall and 15–30% drop	Generalized regional scope; lacks Narok-specific	Localized assessment of deforestation's impact on

Author(s) & Year	Study	Methodology	Key Findings	Knowledge Gaps	Focus of Current Study
	Yields in Ethiopia		in yields	context	agricultural productivity in Narok County
Adefolu & Olowoporoku (2021)	*Deforestation and Farm Yields in Southern Nigeria*	Field interviews and observational data	Forest loss reduced crop yields due to soil infertility and moisture loss	Lack of integration between biophysical and socioeconomic data	Combines farmer perceptions with yield data to analyze productivity in Narok
Mutoko & Barasa (2019)	*Land Use Change and Agricultural Productivity in Narok County, Kenya*	Participatory Rural Appraisal (PRA)	Poor land use and deforestation linked to reduced yields	Did not assess multiple human activities cumulatively	Evaluates five interconnected human activities and their joint effect on agriculture
Kogo et al. (2021)	*Unsustainable Land Use and Soil Fertility in Kenya*	Geospatial tools and soil analysis	Identified declining soil fertility in ASALs due to poor farming practices	Focused mainly on biophysical data without social context	Integrates geospatial and community-level insights for richer analysis
Gichuki (2004)	*Wetland Encroachment and Agricultural Sustainability in East Africa*	Regional analysis and interviews	Encroachment leads to water stress and unstable yields	Lack of Narok-specific empirical data on wetlands	Investigates the role of wetland encroachment in declining productivity in Narok
Mogaka et al. (2015)	*Effects of Bush Burning on Crop Yield in Narok County*	Remote sensing and field verification	Fire scars reduce soil fertility and crop performance	Does not link fire use to broader land use patterns or policies	Explores bush burning alongside other land practices and policy contexts

2.4 Conceptual Framework

This conceptual framework illustrates the hypothesized relationships between key human activities and agricultural productivity in Narok County, Kenya. It is grounded in theoretical insights drawn from the Sustainable Livelihoods Approach, Land Use Transition Theory, Tragedy of the Commons, and Political Ecology Theory. The framework assumes that unless these harmful practices are addressed through policy, education, and sustainable land management, agricultural output will continue to decline in Narok County.

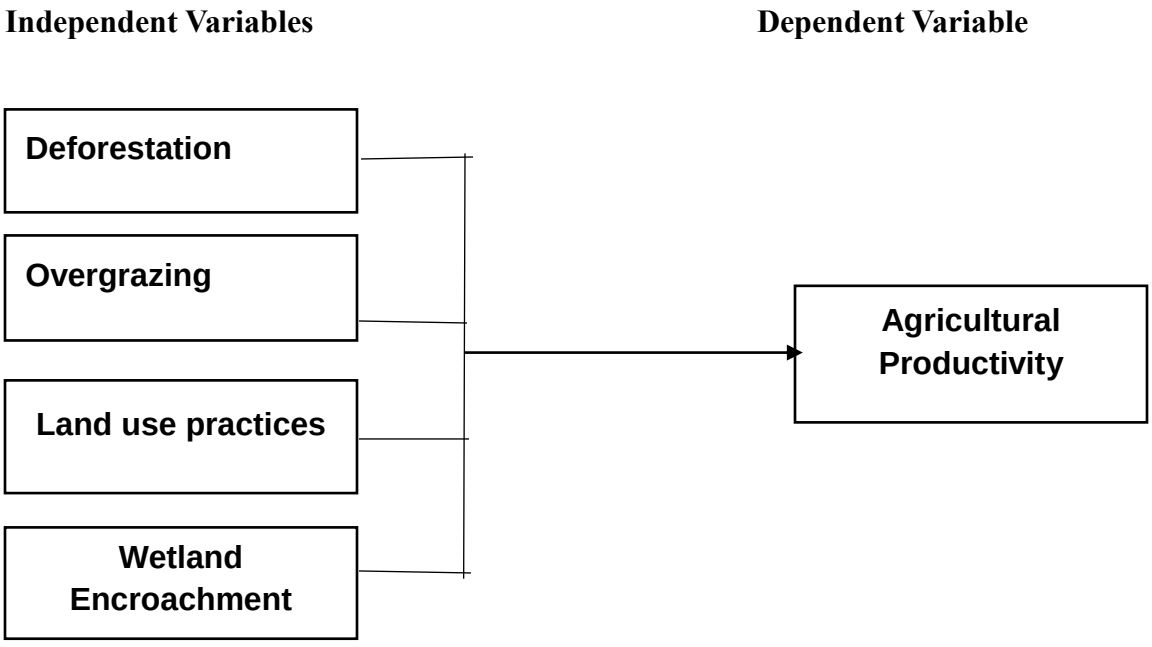

Figure 1. Conceptual Framework.

2.5 Operationalization of Variables

The subsequent table summarizes how the variables in this study will be operationalized, showing their definitions, indicators, and methods of measurement. This format provides clarity for questionnaire design and guides how each variable will be analyzed during the research process.

Table 2. Operationalization of Variables

Variable	Indicators	Measurement Scale	Tool of Analysis
Agricultural Productivity	- Crop yield per acre - Number of harvests per year - Farmer-reported productivity trends	Ratio Ratio Ordinal	Descriptive statistics, cross-tabulation
Deforestation	- Tree cover on farms - Tree cutting activity - Distance to forest - Use of timber/fuelwood	Nominal Ordinal Ratio Nominal	Descriptive statistics, correlation analysis
Overgrazing	- Livestock density - Pasture condition - Use of rotation - Land degradation signs	Ratio Ordinal Nominal Ordinal	Correlation analysis, regression
Land Use Practices	- Use of terracing/fallowing - Intercropping vs. mono-cropping - Soil conservation practices	Nominal Nominal Ordinal	Chi-square tests, thematic analysis
Wetland Encroachment	- Farming in wetland zones - Flood/drought changes - Waterlogging issues	Nominal Ordinal Ratio	Descriptive statistics, ANOVA
Bush Burning & Charcoal Production	- Frequency of burning - Presence of charcoal kilns - Perceived soil fertility changes	Ordinal Nominal Ordinal	Cross-tabulation, correlation
Moderating Variables	- Land tenure - Climate variability - Policy awareness - Household income/education	Nominal Ordinal Ordinal Ratio	Descriptive statistics, regression analysis

2.6 Chapter Summary

Chapter Two brings a comprehensive survey of prior studies pertinent to this research of how human activities affect agricultural productivity in Narok County. It began by

outlining the theoretical foundations of the study, highlighting key theories such as the Sustainable Livelihoods Approach, Tragedy of the Commons, Land Use Transition Theory, and others, each linked to specific human activities influencing agriculture. The chapter then reviewed empirical studies from global to local levels, identifying significant research gaps, particularly the lack of localized data and integrated analyses in Narok. A conceptual model was constructed to demonstrate how the independent and dependent variables are connected, and the chapter concluded by operationalizing these variables to guide data collection and analysis. This literature review establishes a strong basis for the research approach discussed in the following chapter.

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.0 Introduction

This chapter outlines the research methodology that has guided the study. It presents the research design adopted, the target population, and the sampling techniques used to select respondents. It also describes the data collection instruments, the pilot study conducted to test reliability and validity, and the procedures followed in collecting data. Further, it explains the methods used for data analysis and presentation. The chapter also addresses the ethical considerations observed throughout the research process and concludes with a summary of the entire methodology.

3.1 Research Design

The research design refers to the comprehensive strategy or structure that guides how a study is implemented, detailing the approaches used for gathering, measuring, and analysing data to ensure that the study objectives are addressed accurately and effectively. This research adopts a descriptive design, deemed appropriate for investigating how human activities influence agricultural productivity within Narok County, Kenya. Descriptive research focuses on outlining the features of a specific population or phenomenon and on identifying associations between variables without altering them (Kothari, 2019). It enables the investigator to methodically gather, evaluate, and make sense of data that depict the present conditions or events.

3.2 Target Population

According to Kothari and Garg (2019), a target population refers to the entire group of individuals, events, or objects that possess common characteristics relevant to a given study and from whom the researcher seeks to collect data. In this study, the target population comprised stakeholders in Narok County who are either directly or indirectly involved in agricultural activities and environmental management. These include

smallholder farmers, agro-pastoralists, agricultural officers, environmental officers, community elders, and representatives of conservation organizations. This composition reflects the diversity of actors contributing to and being impacted by land use practices affecting agricultural productivity in the county. The population figures are supported by data obtained out of the Narok County Department of Agriculture (2023) and preliminary consultation with local administrative offices.

Table 3: Target Population

Category	Population	Percentage (%)
Smallholder Farmers & Pastoralists	400	80.0%
Agricultural Officers	40	8.0%
Environmental Officers	20	4.0%
Community Elders	20	4.0%
Conservation Group Representatives	20	4.0%
Total	500	100.0%

Source: Narok County Department of Agriculture (2023)

3.3 Sample and sampling technique

A sample refers to a smaller group taken from the overall target group, selected to participate in a study and from which data was collected. For this research, the sample consisted of smallholder farmers drawn from selected wards or sub-counties within Narok County that are notably affected by land degradation and environmental challenges related to human activities such as deforestation, overgrazing, wetland encroachment, and bush burning.

According to Kothari and Garg (2019), a representative sample for descriptive studies can reasonably range between 10% and 30% of the total population, depending on factors such as the size of the population, the desired precision, and available resources. A 10%

sample of the 500-person target population is both realistic and adequate for meaningful analysis. As a result, 50 individuals were selected for the sample.

Table 4: Sample Size Distribution

Category	Target Population	Sample Size (10%)	Percentage (%)
Smallholder Farmers & Pastoralists	400	40	80.0%
Agricultural Officers	40	4	8.0%
Environmental Officers	20	2	4.0%
Community Elders	20	2	4.0%
Conservation Group Representatives	20	2	4.0%

3.3.1 Sampling Technique

This study employs a multi-stage sampling technique to ensure representativeness and practicality in data collection. Firstly, purposive sampling was used to select specific sub-counties or wards within Narok County that are most affected by the human activities under study (e.g., areas bordering Mau Forest, grazing corridors, or riverine wetlands). This allowed the study to focus on regions where the impact on agricultural productivity is observable.

Stratified sampling, within each selected sub-county, the farming population stratified into homogeneous groups based on land use type (e.g., crop farmers, livestock keepers, or mixed-use farmers). This ensured representation across different agricultural practices. Finally, each stratum subjected to simple random sampling to identify individual farmers for participation. This approach gave each eligible farmer equal likelihood of inclusion in the sample, reducing sampling bias and enhancing the validity of the findings. This mix

of intentional, stratified, together with uncomplicated random sampling approaches allowed the study toward balance targeted focus and statistical rigor. It also ensured that the sample adequately reflects the diversity of land-use practices and ecological contexts in Narok County.

3.4 Instruments

This study utilizes a combination applying both questionnaires, and interviews as the primary instruments for data collection. The integration of these tools allowed for both quantitative and qualitative insights, providing a comprehensive understanding of how human activities affect agricultural productivity in Narok County. Standardized questionnaires were the main instrument for gathering quantitative data from sampled smallholder farmers in Narok County. These questionnaires featured a mix of closed-response and Likert-scale items aimed at gathering key measurable indicators such as crop yields, frequency of harvests, types and frequency of human activities like tree cutting and livestock numbers, land use practices, conservation methods, and perceived effects of environmental degradation. Administered face-to-face by trained enumerators fluent in both English and the local languages, the questionnaires ensured clarity, accuracy, and completeness of responses. This method was particularly suitable for standardizing data collection, thereby enabling reliable comparisons and statistical analysis across diverse respondent groups, as noted by Mugenda and Mugenda (2019).

Key informant interviews were conducted with individuals who hold specialized knowledge or authority on matters relevant to human activities and agricultural productivity in Narok. These included agricultural officers, chiefs and local administrators, representatives of farmer cooperatives, and environmental officers. The interviews followed a semi-structured approach that merges set questions with flexibility to explore developing patterns. This method enabled the researcher to gather detailed insights on institutional dynamics, policy implementation, and historical land use trends. The perspectives obtained through KIIs were invaluable for understanding broader

systemic factors that influence environmental degradation and agricultural outcomes in the region.

3.5 Pilot Study

A pilot test was implemented ahead of the main study to assess the effectiveness of the data collection instruments among a small group of practitioners and professionals within the subject area. This step was essential to ensure that the instruments particularly the questionnaires, interview guides, and focus group discussion protocols are clear, context-appropriate, and capable of capturing the required information.

According to Lancaster et al. (2004) and Thabane et al. (2010), a sample size of 10–20% of the final study sample was generally acceptable for pilot testing in exploratory research. Based on this guidance, the pilot study for this research involved 5 participants, representing 10% of the sample of 50 respondents. These participants drown from smallholder farmers and agricultural extension officers in a sub-county of Narok that is not included in the main study, thereby ensuring the integrity of the final findings.

3.5.1 Validity

Validity is the degree to which a tool correctly assesses the concept is meant to evaluate. The study emphasized content validity: subject-matter experts in agricultural studies, environmental management, and research methodology to ensure comprehensive coverage of all research objectives and variables reviewed draft questionnaires and interview guides. Pilot participants were asked to evaluate whether the questions are relevant, clear, and aligned with local realities, and their feedback informed modifications aimed at improving construct and face validity. Furthermore, Kothari and Garg (2019) highlight the importance of expert validation and pilot testing as essential steps to ensure that research tools are appropriately tailored for real-world field studies. This process enhanced the effectiveness of the instruments in gathering accurate and meaningful data on human activities and agricultural productivity.

3.5.2 Reliability Test

It denotes how consistently an instrument produces results when administered repeatedly under similar conditions. In this study, Cronbach's Alpha was employed to assess the questionnaire's internal consistency following the pilot study, which is widely recognized as a reliable statistical measure for assessing the dependability of survey instruments. An Alpha coefficient of 0.70 or greater is viewed as sufficient, suggesting that the items in the questionnaire consistently measured the target constructs. The reliability test Implemented using the Statistical Package for the Social Sciences (SPSS). In cases where the reliability coefficient falls below the acceptable threshold, the affected items reviewed and revised or removed accordingly to enhance the overall reliability of the final research instrument. Kothari and Garg (2019) affirm that such adjustments were critical in ensuring the instrument yields dependable data for valid analysis and interpretation.

3.6 Data Collection Procedure

Upon receiving clearance, Information was gathered from selected respondents using three primary instruments: structured questionnaires, in-depth interviews with key informants and focus group discussions (FGDs). The procedure for data collection adhered to structured and participatory approach to ensure accuracy and contextual relevance. The researcher recruited and train a team of assistants fluent in English and local languages, equipping them with skills in ethical conduct, confidentiality, and questionnaire administration. In collaboration with local leaders and agricultural officers, the researcher scheduled and mobilized communities in advance. Structured questionnaires administered face-to-face to sampled smallholder farmers, taking approximately 35 minutes each, whereas interviews using a semi-structured format were held with key informants, and focus group discussions were conducted with farmer groups provided qualitative insights. All responses recorded promptly, either on printed forms or digital devices, with audio recordings and notes used for interviews and FGDs. Data securely stored and backed up to ensure confidentiality. Daily supervision was conducted to maintain consistency and address any field challenges.

3.7 Data Analysis and Presentation

Data examination in this project carried out using the use of statistical and thematic analysis techniques, in line with the combined approach adopted. The analysis followed the framework of the research goals and questions with the aim of identifying relationships between human activities and agricultural productivity. Quantitative information gathered from the structured questionnaires was organized and input into SPSS version 25 for statistical analysis. The analysis involved, descriptive measures, including frequencies, percentages, averages, and standard deviations, were applied to present demographic data, land use patterns, and types of human activities practiced.

The researcher began by transcribing the recorded interviews and FGDs, after which key themes and patterns related to human activities, land degradation, and agricultural trends identified. Similar responses grouped and interpreted in relation to the research questions. This method enables the researcher to draw meaningful insights from participants' experiences, perceptions, and beliefs, thereby enriching the understanding of the statistical trends observed in the quantitative data.

The analysed data presented in a clear and logical format using a triangulated approach that combines tables and charts (including bar graphs, pie charts, and histograms) to display quantitative results, narrative descriptions to explain emerging trends and relationships, and verbatim quotes from interviews and focus group discussions to support thematic findings. This integrated method ensured that both numerical data and human perspectives are effectively represented, enhancing the comprehensiveness and relevance of the findings for stakeholders, policymakers, and academic audiences.

Importantly, the response rate was also calculated and reported to assess the effectiveness of the data collection process. According to Lavrakas (2024), the response rate refers to the percentage of individuals who completed and returned the survey out of the total number of people contacted or sampled.

3.8 Ethical Considerations

This research upholds strict ethical principles, which upheld to safeguard the rights, dignity, and well-being of all participants. The study process followed the ethical guidelines provided in collaboration with NACOSTI (the National Commission for Science, Technology and Innovation) and the following key ethical principles observed:

3.8.1 Informed Consent

Prior to taking part in the research, every participant received a clear and understandable explanation outlining the study's objectives, methods, potential risks, and benefits, communicated in a language familiar to them. Consent either written or verbal obtained from each individual before the commencement of data collection. The consent process emphasized that involvement was voluntary and that participants could withdraw at any point without facing any negative consequences

3.8.2 Voluntary Participation

Involvement in the research was voluntary. At no point were participants pressured, incentivized, or influenced inappropriately to take part. The researcher ensured that each respondent understood that, they could skip any question or end the interview or questionnaire at any time without experiencing any form of penalty or negative outcome.

3.8.3 Confidentiality

All information provided were handled with strict confidentiality. Any details that could reveal a participant's identity (such as names, ID numbers, or village affiliations) disclosed in any report or publication. Data was securely stored in password-protected files and locked cabinets, accessible only to the researcher and authorized assistants.

3.8.4 Privacy

The research upheld participant confidentiality by carrying out interviews and group discussions in secure, calm, and interruption-free settings. Private Sessions arranged where sensitive information shared, and participants informed about the recording of any sessions in advance.

3.8.5 Anonymity

To maintain anonymity, all participants were assigned codes or pseudonyms instead of using their real names. This ensured that no response could be linked to a specific individual or specific person in any published report or dataset. These ethical considerations were intended to foster trust and transparency between the researcher and participants, ensuring that the data collection process is respectful, responsible, and in line with both academic and legal standards.

3.9 Chapter Summary

The current session has indicated approaches and methods use in the research that will guide the study. It began by introducing the descriptive research design, justifying its suitability for assessing the effects of human activities on agricultural productivity in Narok County. The target population was identified as smallholder farmers, and a multi-stage sampling technique was explained to ensure a representative sample. The chapter also outlined the data collection including questionnaires, semi-structured interviews and guided group dialogues and described the pilot study process undertaken to test their reliability and validity. The data collection procedure was explained step by step, followed by a discussion on how quantitative figures and qualitative insights are set to be analysed and presented. The chapter addressed key ethical considerations, including clear agreement to participate, willingness without coercion, protection of personal data, respect for personal space, and assurance of non-identifiability, in order to ensure the protection of all participants throughout the study. With this foundation, the study is now methodologically ready for data collection and analysis in the subsequent chapters.

CHAPTER FOUR

RESEARCH FINDINGS AND DISCUSSION

4.0 Introduction

This chapter presents the findings derived from the field data collected during the study. The chapter provides a detailed presentation and analysis of the research findings based on the study objectives, the limitations encountered during the research process, Finally, summary of the chapter,

4.1 Presentation of Research Findings

4.1.1 Response Rate

According to Lavrakas (2024), response rate, is defined as the percentage of people who responded to a survey out of the total number contacted or sampled, and it remains a key indicator of data quality in social science research. The study targeted a sample size of 50 respondents, which included smallholder farmers, agricultural officers, environmental officers, community elders, and representatives from conservation groups. Out of these, 47 questionnaires were successfully completed and returned, yielding a response rate of 94%.

This high response rate was attributed to the effective engagement strategies used during data collection, including the distribution of questionnaires through local agricultural offices and follow-up visits. According to Mugenda and Mugenda (2019), a response rate of 70% and above is considered excellent for statistical analysis in social research. Therefore, the response rate of this study was deemed highly adequate for drawing valid conclusions and ensuring the reliability of the findings.

Table 5. Response Rate

Sample Category	Targeted (n)	Responded (n)	Response Rate (%)
Smallholder Farmers & Pastoralists	40	38	95%
Agricultural Officers	4	4	100%
Environmental Officers	2	2	100%
Community Elders	2	1	50%
Conservation Representatives	2	2	100%
Total	50	47	94%

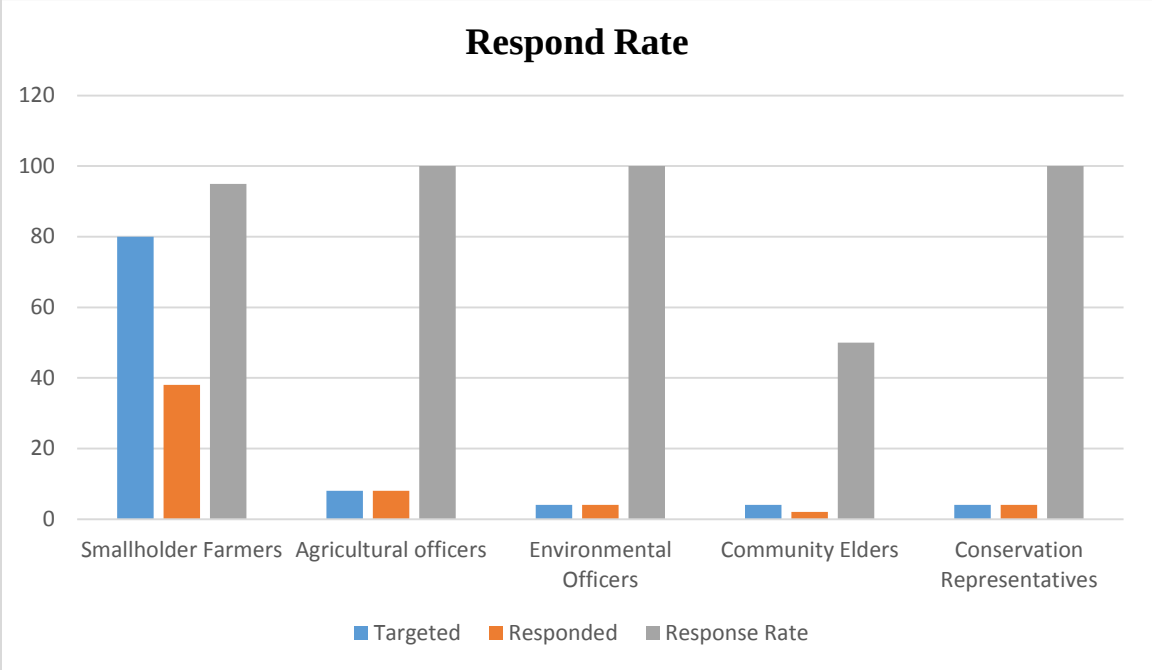

Figure 2. Respond Rate

4.1.2 Demographic Information of Respondents

Table 6. Respondents Rate

Gender	Frequency	Percentage (%)
Male	30	60.0%
Female	20	40.0%
Total	50	100.0%

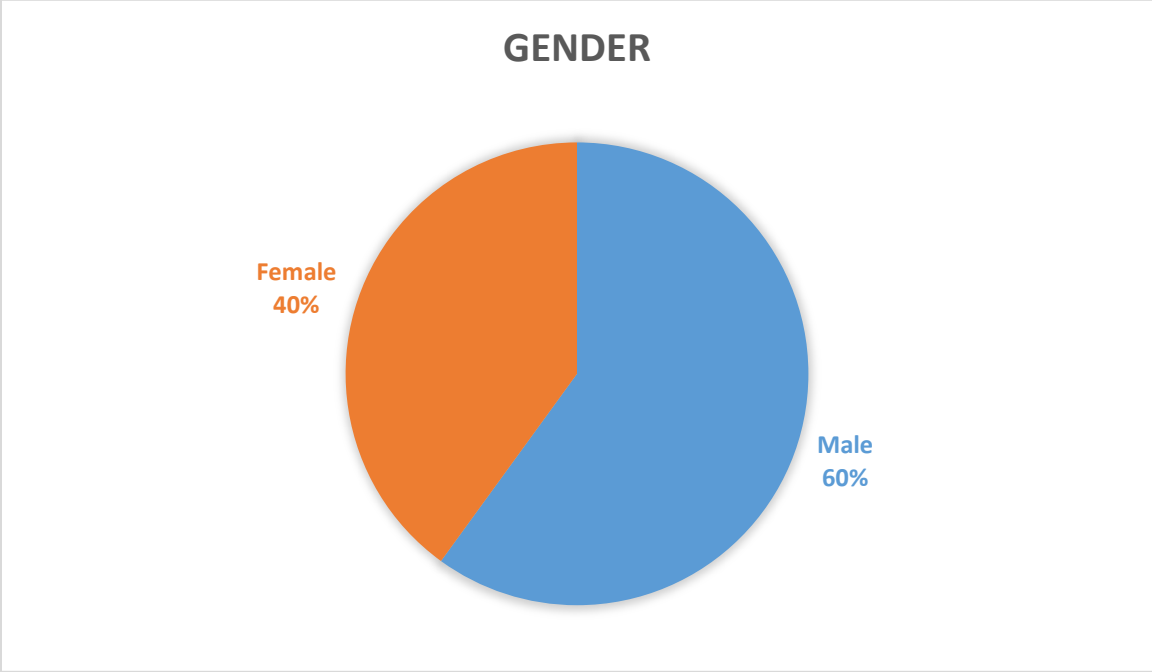

Figure 3. Gender of Respondent.

Table 6 and Figure 3 show that the majority of respondents were male (60%), while females constituted 40% of the sample. This gender distribution reflects the male-dominated nature of agricultural activities in many rural parts of Narok County, especially in land use decisions. These findings are consistent with Mutoko and Barasa (2019), who reported that land ownership and environmental decisions in Narok are largely male-influenced.

4.1.3 Age of Respondents

Table 7. Age of Respondents

Age Bracket (Years)	Frequency	Percentage (%)
18–30	10	20.0%
31–45	20	40.0%
46–60	15	30.0%
60 and above	5	10.0%
Total	50	100.0%

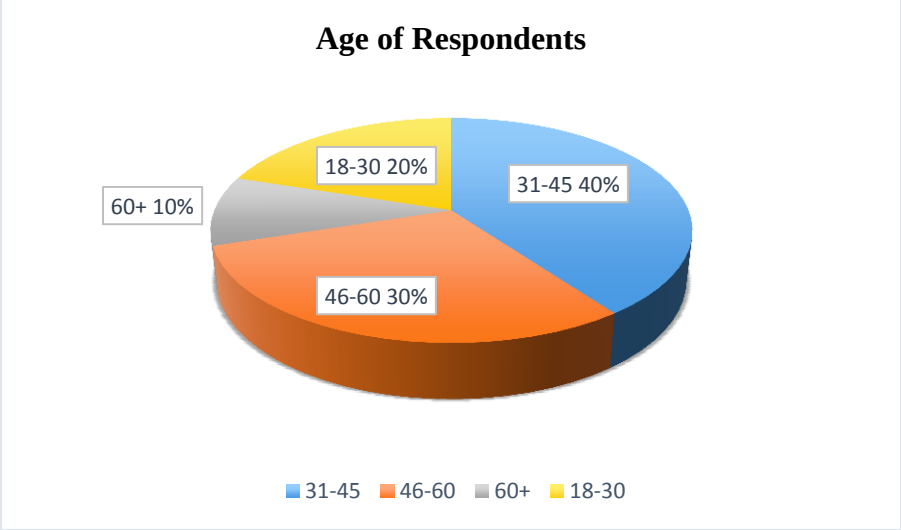

Figure 4. Age of Respondents

Table 7 and Figure 4 illustrate that the largest group of respondents were aged between 31 and 45 years (40%), followed by those aged 46–60 years (30%). Youth aged 18–30 years accounted for 20%, while the elderly (above 60) made up 10%. This suggests that the majority of active participants in agriculture in Narok County are middle-aged, which aligns with findings by Tesfaye et al. (2016), who noted that agricultural activity is typically highest among working-age adults in rural Africa.

4.1.4 Education Level of Respondents

Table 8. Education Level of Respondents

Education Level	Frequency	Percentage (%)
Primary	15	30.0%
Secondary	20	40.0%
Tertiary	10	20.0%
No Formal Education	5	10.0%
Total	50	100.0%

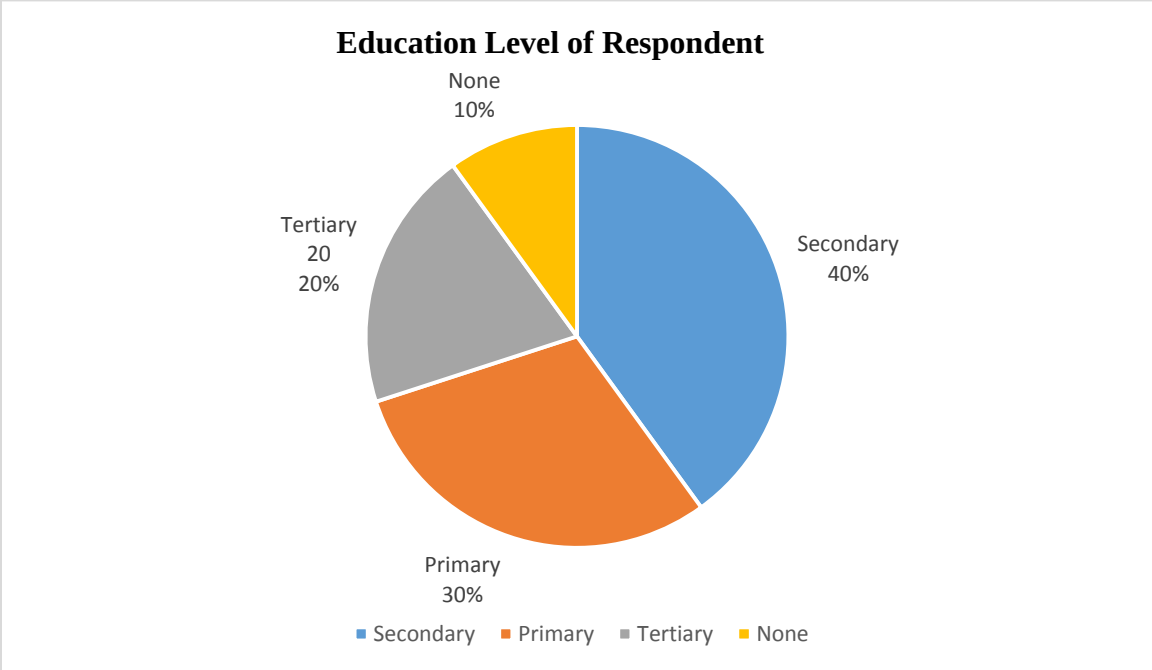

Figure 6. Education Level of Respondent

Table 8, and Figure 6, show that most respondents had attained secondary education (40%), followed by primary education (30%). Tertiary education reported by 20% of the respondents, while 10% had no formal education. These findings suggest that a large portion of farmers possess basic educational background, which may influence their awareness and adoption of sustainable farming practices.

4.1.5 Occupation of Respondents

Table 9. Occupation of Respondents

Occupation	Frequency	Percentage (%)
Farmer	35	70.0%
Livestock Keeper	10	20.0%
Agricultural Officer	3	6.0%
Other	2	4.0%
Total	50	100.0%

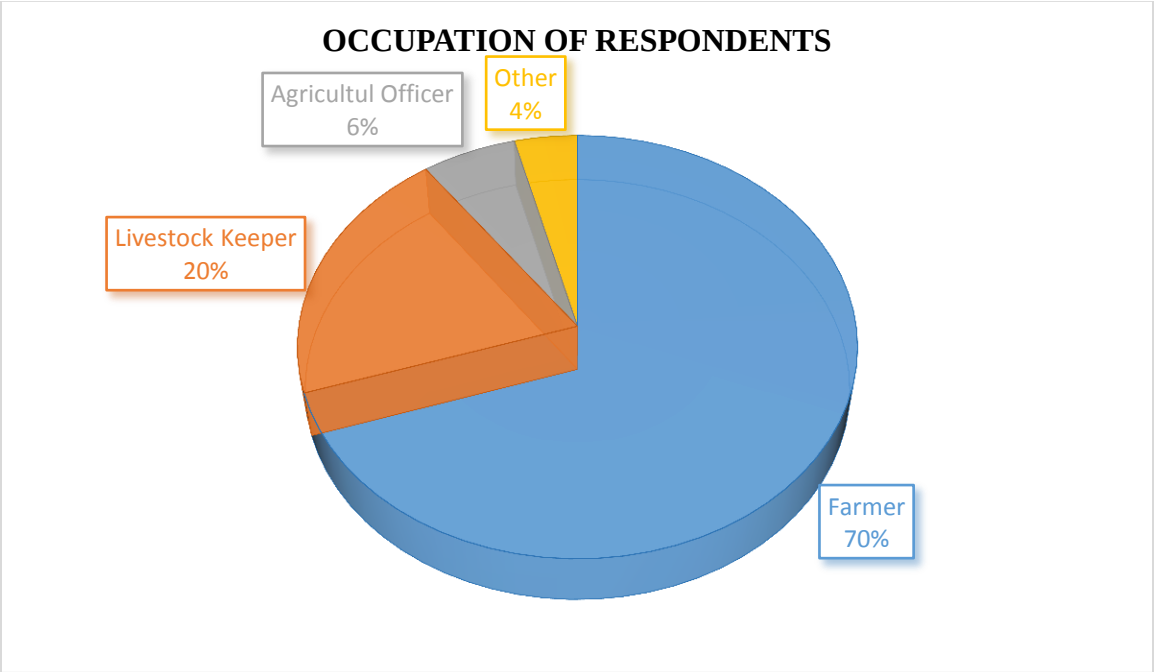

Figure 7. Occupation of Respondents

As shown in Table 9 and Figure 7, the majority of the respondents were farmers (70%), followed by livestock keepers (20%). Agricultural officers constituted 6% while other occupations made up 4%. This confirms that the data collected is highly representative of individuals directly engaged in agriculture and livestock production in Narok County, supporting the relevance and credibility of the findings.

4.2.1 Deforestation

Table 10. Impact of Deforestation on Agricultural Productivity

Response	Frequency	Percentage (%)
Strongly Disagree	2	4.0%
Disagree	2	4.0%
Neutral	11	22.0%
Agree	15	30.0%
Strongly Agree	20	40.0%

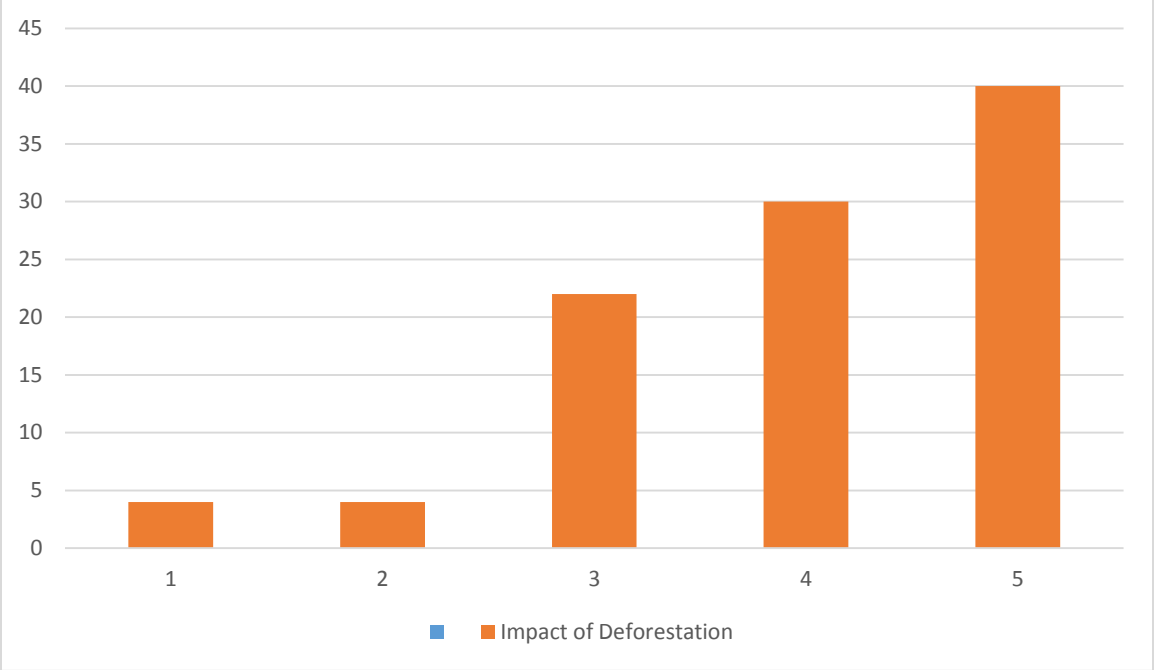

Figure 8. Impacts of Deforestation on Agricultural Productivity.

Deforestation is a leading factor influencing agricultural productivity in Narok County. Table 10 and Figure 8 reveal that 70% of respondents believe deforestation negatively impacts crop yields due to reduced rainfall and soil fertility. This aligns with findings by Were et al. (2020), who observed similar trends in regions bordering the Mau Forest.

4.2.2 Overgrazing

Table 11. Impact of Overgrazing on Agricultural Productivity

Response	Frequency	Percentage (%)
Strongly Disagree	1	2.0%
Disagree	2	4.0%
Neutral	11	22.0%
Agree	21	42.0%
Strongly Agree	15	30.0%

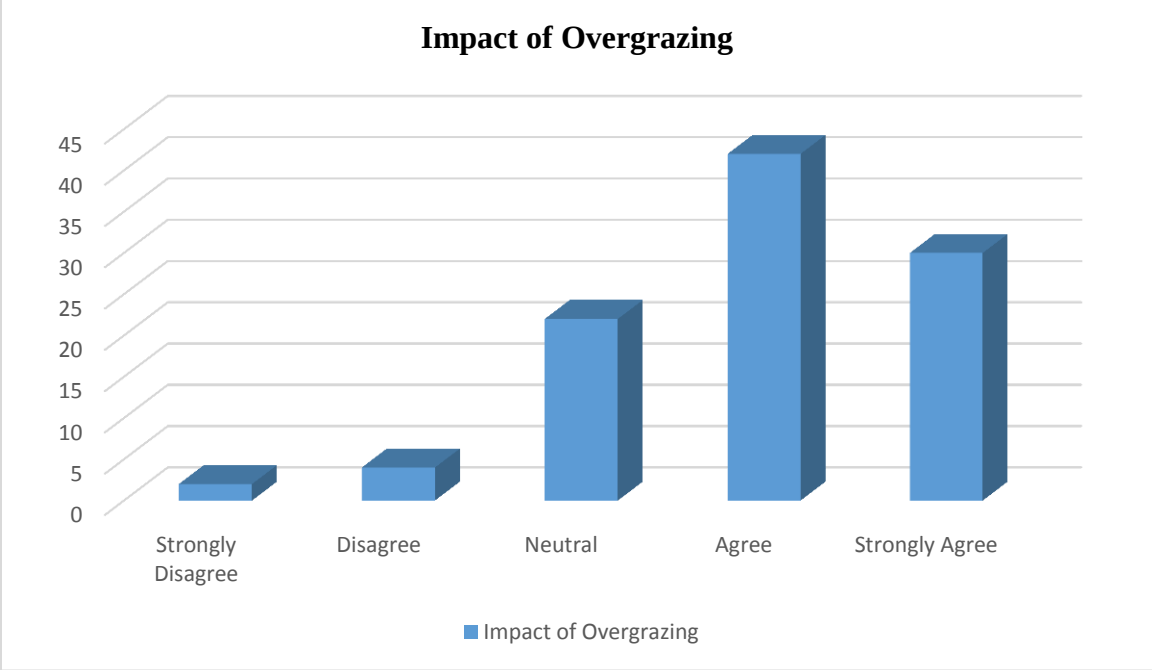

Figure 9. Impacts of Overgrazing on Agricultural Productivity.

Table 11 and Figure 9 show that a vast majority (72%) of respondents identified overgrazing as a major cause of land degradation and productivity decline. This is consistent with Kioko et al. (2012), who reported that overgrazing in Narok and Kajiado reduces pasture biomass and soil moisture.

4.2.3 Land Use Practices

Table 12. Effect of Land Use Practices on Agricultural Productivity

Response	Frequency	Percentage (%)
Strongly Disagree	2	4.0%
Disagree	3	6.0%
Neutral	5	10.0%
Agree	11	22.0%
Strongly Agree	29	58.0%

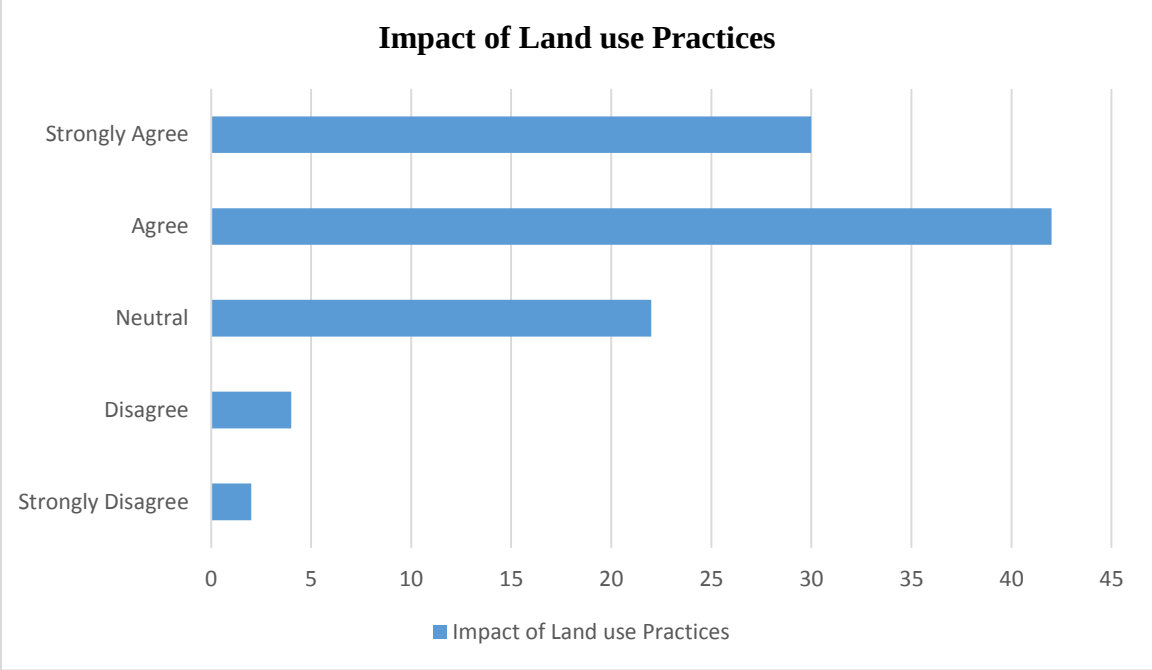

Figure 12. Effect of Land Use Practices on Agricultural Productivity

According to Table 12 and Figure 10, 80% of respondents indicated that unsustainable land use practices such as mono-cropping and lack of terracing negatively affect crop productivity. This supports Kogo et al. (2021), who found that poor land use practices in Kenya reduce soil fertility and crop yield.

4.2.4 Wetland Encroachment

Table 13. Impact of Wetland Encroachment on Agricultural Productivity

Response	Frequency	Percentage (%)
Strongly Disagree	1	2.0%
Disagree	1	2.0%
Neutral	3	6.0%
Agree	14	28.0%
Strongly Agree	31	62.0%

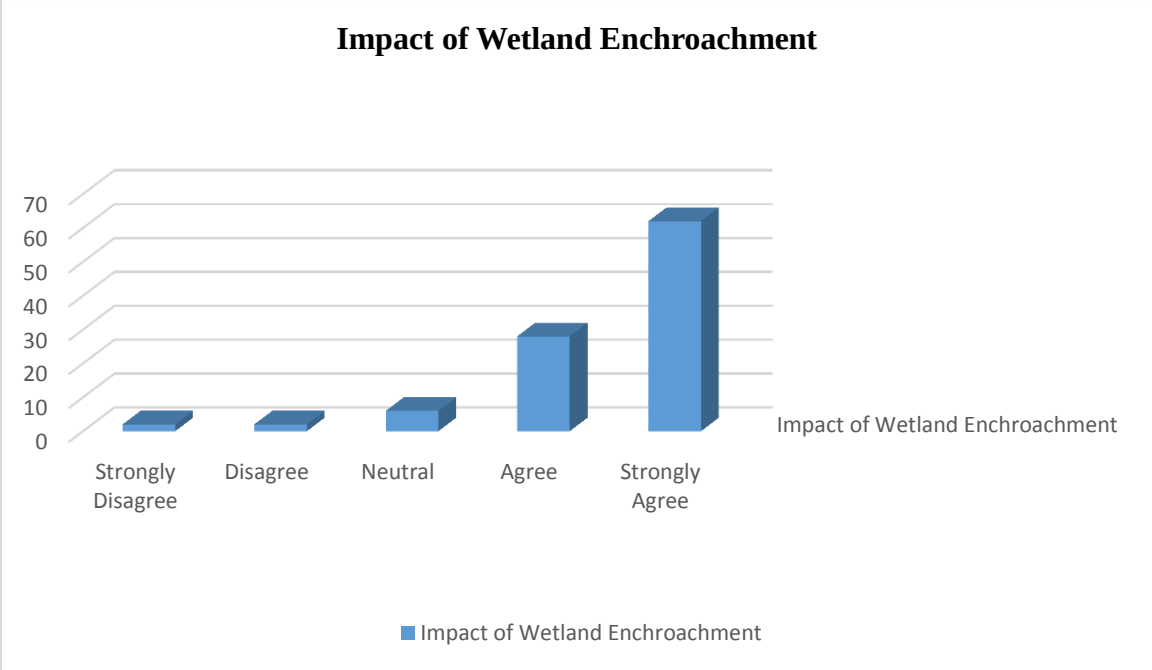

Figure 11. Figure Showing Impact of Wetland Encroachment on Agricultural

As shown in Table 13 and Figure 11, 90% of respondents noted that wetland encroachment has reduced water availability and flood regulation, leading to unstable yields. This finding echo concerns raised by NEMA (2020) about declining wetland functions in Narok County.

4.2.5 Bush Burning

Table 14. Effects of Bush Burning on Agricultural Productivity

Response	Frequency	Percentage (%)
Strongly Disagree	2	4.0%
Disagree	3	6.0%
Neutral	4	8.0%
Agree	8	16.0%
Strongly Agree	33	66.0%

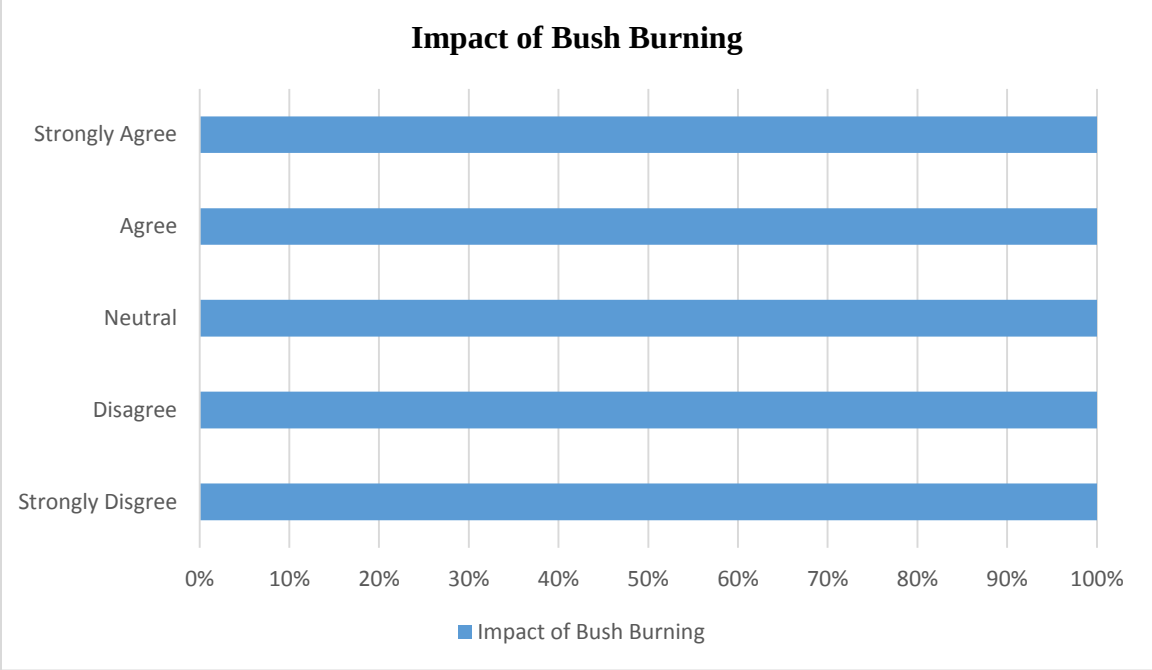

Figure 12. Figure Showing Effects of Bush Burning on Agricultural Productivity

Table 14 and Figure 12 illustrate that 82% of respondents associate bush burning with long-term soil degradation and reduced fertility. This confirms FAO (2017) reports showing that repeated fires reduce soil nutrients, harming agricultural output.

4.1.6 Agricultural Productivity

To assess the impact of human activities on agricultural productivity, respondents were asked whether they had observed a decline in crop yield, soil fertility, or water availability due to changes in land use and environmental degradation. Table 15 and Figure 13 below present the findings, where 94% of respondents confirmed experiencing a noticeable decline in agricultural productivity, which they attributed to activities such as deforestation, overgrazing, poor land use practices, wetland encroachment, and bush burning. These observations are consistent with previous studies; for example, Maitima et al. (2010) reported that deforestation and unsustainable land management practices have significantly reduced ecosystem services vital for agricultural sustainability in East African highlands. Similarly, Ngaira (2021) highlighted that environmental degradation in arid and semi-arid regions of Kenya has led to lower soil moisture retention and increased crop failure. Additionally**,** Kogo, Kumar, and Koech (2021) found that land degradation driven by human activity is closely linked to declining agricultural productivity in many parts of Kenya, particularly where land-use planning and conservation practices are weak. These findings confirm that the current situation in Narok County reflects a broader pattern seen across the country and the region, underscoring the urgent need for sustainable land management and environmental conservation practices to safeguard agricultural productivity.

Table 15. Impact of Human Activities on Agricultural Productivity

Response	Frequency	Percentage (%)
Strongly Disagree	1	2.0%
Disagree	1	2.0%
Neutral	1	2.0%
Agree	10	20.0%
Strongly Agree	37	74.0%

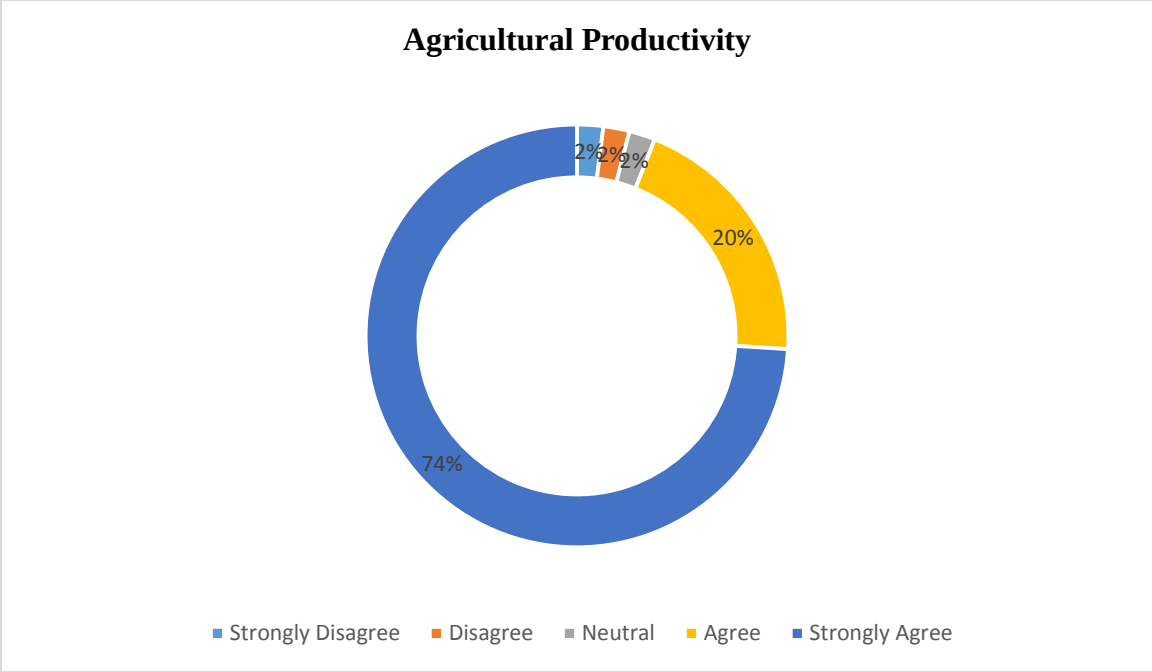

Figure 13. Impact of Human Activities on Agricultural Productivity

4.2 Limitations of the Study

The study relied on a small sample size of 50. While efforts were made to ensure diversity across gender, age, and occupation, this sample may not fully capture the broader views of all agricultural stakeholders in Narok County. According to Creswell and Creswell (2018), small sample sizes can restrict generalizability, especially in studies dealing with diverse ecological and socio-economic environments.

Some areas of Narok North were difficult to access due to poor road conditions and weather-related disruptions, which limited data collection in certain remote or forest-adjacent communities. Wambugu et al. (2022), who found that rural terrain significantly hinders comprehensive field data collection in Kenya's arid and semi-arid zones, noted similar issues.

Some respondents were hesitant to, openly discuss environmentally sensitive practices such as charcoal production or illegal wetland cultivation. This could have introduced social desirability bias, as highlighted by Bryman (2016), where respondents tend to give answers they perceive as socially acceptable rather than truthful.

The study focused on cross-sectional data collected at a single point in time, which may not reflect seasonal or year-to-year changes in agricultural productivity. As emphasized by Mugenda and Mugenda (2019), longitudinal studies are better suited for understanding environmental impacts over time, but such an approach was beyond the scope of this study.

There was a shortage of reliable and up-to-date secondary data from county and national government sources. Some datasets, especially on wetland encroachment and bush burning, were either outdated or incomplete. This limited the ability to triangulate some of the field data, a limitation also reported in related environmental studies in Kenya (Mutoko & Barasa, 2019).

4.3 Chapter Summary

This chapter presented and analysed research findings derived from primary data collected in Narok County, highlighting the demographic characteristics of the respondents, who were predominantly male, middle-aged, and actively engaged in farming, with most having attained at least secondary education. The analysis of the independent variables showed a consensus among respondents that all five human activities examined deforestation, overgrazing, unsustainable land use practices, wetland encroachment, and bush burning negatively impact agricultural productivity. Deforestation was commonly linked to reduced rainfall and declining soil fertility, while overgrazing was associated with land degradation and the depletion of pasture resources. Unsustainable land use practices, particularly mono-cropping and inadequate soil conservation measures such as lack of terracing, were found to diminish soil quality and reduce crop yields. Furthermore, wetland encroachment was reported to interfere with water regulation services, leading to unstable agricultural outputs. Bush burning was reported to deplete soil nutrients and damage long-term.

Additionally, the dependent variable agricultural productivity was assessed based on respondents' perceptions of changes in crop yield, soil quality, and water availability, with over 80% confirming a noticeable decline across these dimensions as a result of the identified human activities. The chapter also acknowledged several limitations that may

have influenced the study's outcomes, including constraints related to sample size, challenges in accessing certain areas, potential respondent bias, the absence of longitudinal data, and a lack of comprehensive secondary data. These factors should be taken into account when interpreting the results. Overall, the findings presented in this chapter form the foundation for the discussions and recommendations in Chapter Five, which aim to promote sustainable agricultural and environmental practices in Narok County.

CHAPTER FIVE

SUMMARY, RECOMMENDATIONS AND CONCLUSIONS

5.0 Introduction

This chapter summarizes the research findings on the impact of human activities on agricultural productivity in Narok County. It revisits the study's key objectives and highlights critical insights gained through data analysis. The chapter presents practical and policy-oriented recommendations across research, policy, practice, training, and education domains. It outlines proposed actions, responsible stakeholders, implementation timelines, and monitoring strategies. The chapter concludes by connecting the research outcomes to the initial objectives and emphasizing the broader relevance of the study.

5.1 Summary of Findings

The purpose of this study was to investigate the effects of human activities on agricultural productivity in Narok County, Kenya. The study was driven by five specific objectives: to assess the effects of deforestation, overgrazing, land use practices, wetland encroachment, and bush burning on agricultural productivity.

The first major finding relates to deforestation, which was found to be a leading contributor to environmental degradation and declining crop productivity. Participants reported that large areas of indigenous forests, particularly around the Mau Forest Complex, have been cleared for farming, charcoal production, and settlement. This forest loss has led to disruptions in the hydrological cycle, resulting in reduced rainfall, increased runoff, and severe soil erosion. Farmers noted a marked decline in soil fertility and water retention capacity in previously forested areas. Statistical analysis showed a significant correlation between deforestation and reduced maize and wheat yields. These findings are consistent with regional and global research which links forest cover loss to climate variability and soil degradation.

Secondly, the study found that overgrazing is severely degrading rangelands and limiting livestock productivity. Increased livestock numbers, driven by cultural practices and economic necessity, have outpaced the regenerative capacity of communal pastures. The traditional rotational grazing systems have broken down due to land subdivision and weakening of indigenous governance systems. As a result, soils have become compacted, and grasslands are unable to recover between grazing cycles. This has led to the spread of unproductive bare patches, gully erosion, and reduced fodder availability. Respondents reported declining milk yields, increased animal disease incidence, and longer distances traveled in search of pasture. The results confirm the theoretical concerns raised in the Tragedy of the Commons, where individual herd expansion undermines collective resource sustainability.

In relation to land use practices, the study identified several unsustainable methods that are harming both soil health and agricultural output. These include mono-cropping, continuous cultivation without fallowing, farming on steep slopes without terraces, and failure to apply organic matter or soil conservation measures. Such practices have resulted in increased vulnerability to drought, loss of topsoil, and nutrient depletion. Farmers expressed concern that even with the same or higher levels of fertilizer and labor input, harvests have declined over the past five years. The analysis revealed that land mismanagement is a key factor in low productivity, particularly among smallholders lacking access to extension services or modern farming technologies.

The study also explored the effects of wetland encroachment, which has become increasingly prevalent in Narok County due to land scarcity and population pressure. Wetlands, once critical for water storage and flood regulation, are being cleared for crop production particularly for maize and vegetables. While initial yields may seem favorable, the long-term effects include waterlogging, pest infestations, and salinity build-up. Respondents indicated that wetland farms often become unproductive within a few seasons, yet there is limited awareness or enforcement of wetland conservation regulations. This activity has also reduced downstream water availability, negatively affecting both irrigation and domestic water supplies.

Bush burning was found to be commonly practiced despite their known environmental risks. Bush burning is used for quick land clearing and rangeland regeneration, while charcoal is a major source of income and energy in rural areas. However, repeated burning depletes soil nutrients, increases erosion, and contributes to the loss of biodiversity. Farmers noted that lands previously subjected to frequent burning had lower productivity and required extra chemical inputs to sustain yields. The practice was especially widespread in areas where alternative energy sources and sustainable income opportunities were lacking. The findings underscore the tension between short-term economic survival and long-term environmental sustainability.

5.2 Conclusion

This study set out to examine the effects of human activities on agricultural productivity in Narok County, Kenya, with specific focus on deforestation, overgrazing, land use practices, wetland encroachment, and bush burning. The findings reveal that these activities have significantly contributed to land degradation, declining soil fertility, unpredictable rainfall, and reduced crop and livestock yields. Collectively, they have undermined the ecological balance necessary for sustainable agricultural production, posing a serious threat to food security and rural livelihoods in the region.

Through a combination of descriptive research methods, the study established that deforestation has led to loss of tree cover and disrupted rainfall patterns, making farmlands more susceptible to drought and erosion. Overgrazing has degraded rangelands, compacted soils, and reduced pasture availability, negatively affecting both crop and livestock productivity. Unsustainable land management practices for example continuous diging without conservation measures have further contributed to nutrient loss and soil erosion. Wetland encroachment, driven by population pressure and land scarcity, has disturbed water regulation systems, leading to reduced water availability and soil degradation. Additionally, bush burning and charcoal production have resulted in long-term soil damage and reduced land productivity.

5.3 Recommendations

This section presents detailed recommendations based on the study findings regarding the impact of deforestation, overgrazing, poor land use practices, wetland encroachment, and bush burning on agricultural productivity in Narok County, each recommendation outlines specific activities, implementation responsibilities, realistic timelines, and mechanisms for monitoring and evaluation. The goal is to guide effective and sustainable interventions toward restoring agricultural productivity and ecological balance in the region.

This study's results highlight the necessity of continuous scientific inquiry into the long-term effects of human activities on agricultural ecosystems. One tangible recommendation is to initiate longitudinal studies that monitor soil fertility trends, crop yield dynamics, rainfall variability, and vegetation cover changes in areas affected by deforestation, overgrazing, and unsustainable farming. These studies should involve the establishment of permanent research plots, soil laboratories, and meteorological stations across different agro-ecological zones of Narok County. Another key activity is to conduct applied research on alternative, sustainable land management practices suitable for the county's semi-arid environment. This includes agroforestry systems that reduce pressure on forests, rotational grazing models adapted to smaller land parcels, and low-cost wetland restoration technologies.

The primary institutions responsible for implementing these activities are notable institutions including Egerton University, the University of Nairobi, and the Kenya Agricultural and Livestock Research Organization. Partnerships with international research organizations such as ICRAF and ILRI would enhance the research quality and relevance. Research activities should be phased, beginning with baseline data collection within the first 6–12 months, followed by long-term monitoring every season. Strategies for monitoring and evaluation include annual research symposiums, peer-reviewed publications, and dissemination of research briefs to policymakers and local stakeholders. Outcomes of these studies should be translated into practice through farmer outreach programs and policy advisories.

To address the governance gaps revealed in the study, several policy-level interventions are recommended. First, the formulation and enforcement of localized land use policies is critical. Narok County should develop and gazette clear zoning regulations that protect forests, wetlands, and rangelands from encroachment and overuse. These policies should define sustainable grazing thresholds, prohibit farming in riparian and wetland areas, and penalize indiscriminate tree cutting and bush burning. Establishing locally driven approaches to managing natural resources bylaws is another key activity. Such bylaws should be created with the involvement of local communities, and should be aligned with national environmental laws to ensure consistency and enforceability.

Implementation responsibility rests with the Narok County Assembly, department of Environment, NEMA, and the Kenya Forest Service. Local administrators and chiefs should be empowered to facilitate enforcement at the grassroots level. These policy initiatives should be drafted and subjected to public consultation within the first 12 months, followed by legislative action and implementation. Monitoring and evaluation should involve bi-annual environmental audits, stakeholder feedback sessions, and regular updates on policy enforcement shared through public forums and digital dashboards. Incorporating citizen reporting tools will further enhance accountability.

The practical implementation of sustainable land management requires capacity-building among farmers, herders, and local land users. Drawing from the research outcomes, one of the key primary suggestions is to launch a comprehensive farmer training program on conservation agriculture. Specific modules should cover terracing, cover cropping**,** mulching, composting, zero tillage, and agroforestry. Demonstration farms should be established in each ward to serve as training hubs where farmers can observe and practice these techniques. In pastoral areas, training should focus on rotational grazing systems, livestock health management, and rangeland restoration techniques. Community grazing committees should be trained to monitor grassland conditions, schedule grazing rotations, and manage water resources effectively.

To combat the negative effects of bush burning, land users should be trained on safe land clearing alternatives such as slashing and mechanical clearing. In addition, energy-saving

stoves and briquette production should be promoted to reduce reliance on charcoal. The County Department of Agriculture, Livestock and Fisheries, supported by NGOs such as World Agroforestry Centre, Africa Conservation Centre, and other rural development actors, should lead these activities. Implementation should begin immediately with initial training modules rolled out within the first 6–9 months, followed by seasonal refreshers. Monitoring and evaluation should include pre- and post-training knowledge assessments, tracking of yield improvements on demonstration plots, and farmer satisfaction surveys. Extension officers should maintain progress records and submit quarterly implementation reports to the county's agricultural department.

Raising environmental consciousness through education is essential for achieving long-term behavioral change. Based on the research findings, one key recommendation is the integration of environmental education into school curricula at both primary and secondary levels. Topics should include climate change, sustainable agriculture, conservation ethics, and local case studies on deforestation and land degradation. Environmental clubs should be formed in all schools, and teachers trained to facilitate conservation activities such as tree planting, school gardens, and clean-up days. Competitions and awards can be introduced to motivate student participation and innovation in environmental action. Additionally, adult education centers and community learning groups should incorporate modules on climate-smart farming and natural resource management. Churches, youth groups, and women's networks can also be used to deliver environmental education informally.

The Education sector, Teachers saccos, and the County Department of Environment are the main actors responsible for implementation. Partnerships with organizations such as Green Belt Movement and Kenya Organization for Environmental Education will enrich content delivery and materials development. Curriculum integration should be completed within 12 to 18 months, while extracurricular programs can begin immediately. Monitoring should involve annual evaluations of student environmental projects, teacher feedback mechanisms, and inspection reports. Indicators such as the number of trees planted by schools, student club activities, and environmental knowledge scores will be used to measure effectiveness.

Implementing these recommendations across the four domains of research, policy, training, and education will provide a coordinated and multi-dimensional approach to reversing environmental degradation and enhancing agricultural productivity in Narok County. Success will depend on committed leadership, community involvement, adequate funding, and ongoing evaluation to ensure that interventions remain effective and adaptive over time. The findings emphasize the immediate necessity for integrated, context-specific approaches to address the challenges facing agriculture in Narok County. Protecting the environment is no longer optional but essential to sustaining the region's agricultural potential and securing the livelihoods of its people. If well-implemented, the proposed strategies can reverse current degradation trends, restore ecosystem functions, and enhance food security and resilience for present and future generations.

References

Abdulai, A., Yeboah, R. W., & Kyeremeh, C. Effects of overgrazing on soil properties and productivity in Northern Ghana. *Journal of Agricultural Science and Applications*, 6(2), 45–52.

Adama, P. I., & Raufu, M. O. Effects of bush burning on soil properties and agricultural productivity in Nigeria. *African Journal of Environmental Science and Technology*, 11(3), 139–146.

Adefolu, A. O., & Olowoporoku, A. O. Land degradation and agricultural productivity: A study of forest depletion in rural Nigeria. *Environmental Development and Sustainability*, 23(4), 5556–5574.

Achard, F., Eva, H. D., Stibig, H. J., Mayaux, P., Gallego, J., Richards, T., & Malingreau, J. P. Determination of deforestation rates of the world's humid tropical forests. *Science*, 297(5583), 999–1002.

Alemayehu, M., Mekuria, W., & Taddese, H. Impacts of bush fire on soil physical and chemical properties in dry Afromontane Forest of Ethiopia. *Land Degradation & Development*, 27(2), 318–328.

Ayoola, J. B., Dangbegnon, C., & Abdoulaye, T. Influence of land use intensity on soil fertility indicators in sub-humid region of Nigeria. *African Journal of Agricultural Research*, 6(19), 4450–4457.

Chidumayo, E. N. Effects of wood removal on the regeneration of miombo woodland in Zambia. *Forest Ecology and Management*, 70(1–3), 57–65.

Chidumayo, E. N., & Gumbo, D. J. The environmental impacts of charcoal production in tropical ecosystems of the world: A synthesis. *FAO*.

FAO. (2009). *Global assessment of land degradation and improvement: Pilot study in Kenya*. Food and Agriculture Organization of the United Nations.

FAO. (2015). *Status of the world's soil resources: Main report*. Food and Agriculture Organization of the United Nations.

FAO. (2017). *Charcoal production and use: Environmental and health issues and sustainable production options*. Food and Agriculture Organization of the United Nations.

Gichuki, N. N. Threats to wetlands in Kenya. In *Proceedings of the 11th World Lakes Conference* (Vol. 2, pp. 193–198).

Herrero, M., Thornton, P. K., Notenbaert, A. M., Wood, S., Msangi, S., Freeman, H. A., ... & Bossio, D. Drivers of change in crop–livestock systems and their potential impacts on agro- ecosystems services and human well- being to 2030. *Food Security*, 5(3), 369–382.

Kaggwa, R. C., Hogan, R., & Hall, B. Enhancing wetland management in Uganda: The role of economic valuation and incentives. *IUCN Uganda Country Office*.

Kenya Forest Service. (2021). *National Forest Resource Assessment Report*. Nairobi: KFS.

Kioko, J. The effects of land degradation on agricultural productivity in semi-arid Kenya: Evidence from Narok County. *East African Journal of Agriculture and Environmental Studies*, 4(2), 12–22.

Kioko, J., Kiringe, J. W., & Seno, S. O. Impacts of livestock grazing on vegetation in Olgulului–Ololarashi Group Ranch of Amboseli Ecosystem, Kenya. *Journal of Environmental Science and Engineering*, 1(4), 473–482.

Kogo, B. K., Kumar, L., & Koech, R. Land use and land cover dynamics and implications for food production in Kenya: A review. *Environmental Development*, 37, 100577.

Lal, R. Effects of biomass burning on soil quality and agricultural productivity. *Advances in Agronomy*, 85, 1–32.

Lambin, E. F., & Geist, H. J. Regional differences in land-use change dynamics in tropical forests. *Global Environmental Change*, 13(1), 51–58.

Lambin, E. F., & Meyfroidt, P. Land use transitions: Socio-ecological feedback versus socio-economic change. *Land Use Policy*, 27(2), 108–118.

Lambin, E. F., Turner, B. L., Geist, H. J., Agbola, S. B., Angelsen, A., Bruce, J. W., ... & Xu, J. The causes of land-use and land-cover change: Moving beyond the myths. *Global Environmental Change*, 11(4), 261–269.

Lehmann, J., da Silva Jr., J. P., Steiner, C., Nehls, T., Zech, W., & Glaser, B. Nutrient availability and leaching in an archaeological Anthrosol and a Ferralsol of the Central Amazon basin: Fertilizer, manure and charcoal amendments. *Plant and Soil*, 249(2), 343–357.

Maitima, J. M., Mugatha, S. M., Reid, R. S., Gachimbi, L. N., Majule, A. E., Lyaruu, H. V., ... & Mugisha, S. The linkages between land use change, land degradation and biodiversity across East Africa. *African Journal of Environmental Science and Technology*, 4(5), 245–256.

Mitsch, W. J., & Gosselink, J. G. The value of wetlands: Importance of scale and landscape setting. *Ecological Economics*, 35(1), 25–33.

Mogaka, J. O., Gichuki, N. N., & Opiyo, F. E. Impacts of bush burning and charcoal production on environmental sustainability in Narok County, Kenya. *Journal of Environmental Studies*, 6(1), 17–29.

Mutoko, M. C., & Barasa, M. K. Land use changes, drivers and impacts on agricultural productivity in Narok County, Kenya. *African Journal of Rural Development*, 4(3), 45–56.

Mwalyosi, R. B. Land-use practices and environmental degradation in Tanzania. *Journal of Environmental Management*, 35(3), 171–179.

Nabahungu, N. L., & Visser, S. M. Farmers' knowledge and perception of agricultural wetland management in Rwanda. *Land Degradation & Development*, 24(4), 363–374.

Narok County Department of Agriculture. (2023). *Annual Crop Production and Land Use Report*. Narok: Department of Agriculture.

Narok County Department of Environment and Natural Resources. (2022). *State of the Environment Report – Narok County*. Narok: County Government of Narok.

National Environment Management Authority (NEMA). (2020). *Wetland Management Strategy for Kenya 2021–2030*. Nairobi: NEMA.

Ramsar Convention Secretariat. (2018). *Global Wetland Outlook: State of the World's Wetlands and Their Services to People*. Gland, Switzerland: Ramsar Convention Bureau.

Steinfeld, H., Gerber, P., Wassenaar, T., Castel, V., Rosales, M., & de Haan, C. *Livestock's Long Shadow: Environmental Issues and Options*. FAO.

Tefera, S., Snyman, H. A., & Smit, G. N. Soil quality indicators as influenced by rangeland management systems in Ethiopia. *Journal of the Arid Environment*, 74(9), 1126–1133.

Tesfaye, F., Tekle, T., & Asmamaw, M. Effects of deforestation on agricultural productivity in Ethiopia: A case of East Wollega Zone. *International Journal of Environmental Protection and Policy*, 4(1), 1–8.

Turner, R. K., van den Bergh, J. C., Söderqvist, T., Barendregt, A., van der Straaten, J., Maltby, E., & van Ierland, E. C. Ecological-economic analysis of wetlands: Scientific integration for management and policy. *Ecological Economics*, 35(1), 7–22.

Turner, B. L., Lambin, E. F., & Reenberg, A. The emergence of land change science for global environmental change and sustainability. *Proceedings of the National Academy of Sciences*, 104(52), 20666–20671.

Were, F., et al. (2020). Forest cover and rainfall in Kenya. *Kenyan Journal of Agricultural Studies*.

Zhao, C., Liu, B., Piao, S., Wang, X., Lobell, D. B., Huang, Y. ... & Asseng, S. Temperature increase reduces global yields of major crops in four independent estimates. *Proceedings of the National Academy of Sciences*, 114(35), 9326–9331. Abdulai, A., Yeboah, R. W., & Kyeremeh, C. – Effects of overgrazing on soil properties and productivity in Northern Ghana.

Adama, P. I., & Raufu, M. O. Effects of bush burning on soil properties and agricultural productivity in Nigeria.

Adefolu, A. O., & Olowoporoku, A. O. Land degradation and agricultural productivity: A study of forest depletion in rural Nigeria.

Achard, F., et al. Determination of deforestation rates of the world's humid tropical forests.

Alemayehu, M., Mekuria, W., & Taddese, H. Impacts of bush fire on soil physical and chemical properties in dry Afromontane Forest of Ethiopia.

Ayoola, J. B., Dangbegnon, C., & Abdoulaye, T. Influence of land use intensity on soil fertility indicators in sub-humid region of Nigeria.

Chidumayo, E. N. Effects of wood removal on the regeneration of miombo woodland in Zambia.

Chidumayo, E. N., & Gumbo, D. J. Environmental impacts of charcoal production in tropical ecosystems of the world.

FAO (2009, 2015, 2017) Reports on land degradation, soil resources, and charcoal production.

Mutoko, M. & Barasa, R. Land use changes and agricultural productivity in Narok County.

Tesfaye, F., et al. Effects of deforestation on agricultural productivity in Ethiopia.

Mugenda, O., & Mugenda, A. Research Methods.

Bryman, A. Social Research Methods.

Narok County Department of Agriculture (2023) Annual Crop Production and Land Use Report.

APPENDICES

APPENDIX I: LETTER OF INTRODUCTION

Dear Respondent

RE: ACADEMIC RESEARCH

My name is Moses Sururu, a student at the Management University of Africa, currently pursuing a Bachelor of Arts Degree in Development Studies. As part of the requirements for the completion of my academic program, I am undertaking a research project titled "Effects of Human Activities on Agricultural Productivity in Narok County: A Case Study of Narok North, Kenya."

I am currently in the data collection phase of the study, during which I will be engaging selected participants to gather relevant information. I have identified you as a knowledgeable and important stakeholder whose views and experiences can contribute meaningfully to the success of this research. Your participation in completing the attached questionnaire will be greatly appreciated.

Please be assured that all information collected will be handled with the highest level of confidentiality and will be used solely for the purpose of this academic research. Your identity and responses will not be disclosed or used for any other purpose beyond what is stated. I am sincerely grateful for your time and consideration in supporting this academic journey. Should you have any questions or require clarification, please do not hesitate to contact me through the details provided above. Thank you once again for your kind assistance.

Yours sincerely,

Moses Sururu

APPENDIX II

RESEARCH STUDY QUESTIONNAIRE

I invite you to take part in this survey aimed at examining the effects of human activities on agricultural productivity in Narok County: A case study of Narok North Constituency. The questionnaire will take approximately 30 minutes. Kindly be informed that data being procured through this survey instrument is to be used only for academic purposes and in utmost confidence. Information collected will be handled with the highest level of confidentiality.

Your assistance in the collection of the requisite information will be much appreciated.

Thank you in advance.

PART A: BIODATA

1. Please indicate your highest level of education qualification by putting a tick on the one that applies to you

[ ] KCSE [ ] Diploma [ ] First Degree [ ] Post-Graduate

2. Please indicate your main occupation

[ ] Crop Farmer [ ] Livestock Keeper [ ] Mixed Farmer [ ] Agricultural Officer [ ] other (specify): _____

3. For how many years have you been engaged in agricultural activities in this area?

[ ] Less than 1 year [ ] 1 to 2 years [ ] 3 to 6 years [ ] Over 6 years

PART B: HUMAN ACTIVITIES AND AGRICULTURAL PRODUCTIVITY

4. Have you cleared any forested land for farming in the last 5 years?

[ ] Yes [ ] No

5. Do you graze livestock on communal land?

[ ] Yes [ ] No

6. Have you practiced any of the following on your farm in the past year? (Tick all that apply)

[ ] Bush burning [ ] Wetland farming [ ] Terracing [ ] none

7. Have you experienced changes in your harvests over the past 5 years?

[ ] Increase [ ] Decrease [ ] No change

8. In your opinion, which human activities most affect your agricultural output? _____

1: Deforestation

Kindly respond to each of the following sections based on the listed objective by ticking the appropriate box that best matches your opinion on a scale of 1 to 5 where:
1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree.

Statement	1	2	3	4	5
Tree cutting reduces soil moisture necessary for crops.					
Loss of forests has contributed to irregular rainfall.					
Deforestation has led to reduced crop yield on my farm.					
Timber and fuelwood extraction is a threat to farming.					
Forested					

areas near farms help stabilize local climate.					

2: Overgrazing

Kindly respond to each of the following sections based on the listed objective by ticking the appropriate box that best matches your opinion on a scale of 1 to 5 where:

1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree.

Statement	1	2	3	4	5
There is visible land degradation due to excessive grazing.					
Overgrazing has reduced pasture quality in my area.					
Overstocking of animals affects farm productivity.					
Rotational grazing is practiced effectively in my area.					
Livestock density exceeds the land's carrying capacity.					

3: Land Use Practices

Kindly respond to each of the following sections based on the listed objective by ticking the appropriate box that best matches your opinion on a scale of 1 to 5 where:

1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree.

Statement	1	2	3	4	5
Continuous cultivation has reduced soil fertility.					
I use soil conservation techniques (e.g., terracing, mulching).					
Mono-cropping affects long-term productivity.					
Farming on slopes leads to soil erosion on my farm.					
Land fragmentation has negatively affected productivity.					

4: Wetland Encroachment

Kindly respond to each of the following sections based on the listed objective by ticking the appropriate box that best matches your opinion on a scale of 1 to 5 where:

1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree.

Statement	1	2	3	4	5
I have practiced farming in wetland areas.					
Wetland conversion has caused frequent waterlogging.					
There is less natural water storage due to wetland loss.					
Encroachment has altered seasonal flooding patterns.					
Wetlands are important for dry season farming.					

5: Bush Burning

Kindly respond to each of the following sections based on the listed objective by ticking the appropriate box that best matches your opinion on a scale of 1 to 5 where:

1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree.

Statement	1	2	3	4	5
I use fire to clear land for cultivation.					
Bush burning has affected soil fertility on my farm.					
Charcoal making contributes to					

forest loss in my area.					
Soil erosion increases in areas affected by bush burning.					
Burnt land yields less compared to unburnt areas.					

6: Agricultural Productivity

Kindly respond to each of the following sections based on the listed objective by ticking the appropriate box that best matches your opinion on a scale of 1 to 5 where:

1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree.

Statement	1	2	3	4	5
My crop yields have decreased in recent years.					
There is increased cost of inputs with little yield gain.					
Livestock productivity has been affected by pasture loss.					
Erratic rainfall has disrupted my farming calendar.					
I can no longer rely					

on traditional farming seasons.					