Nyandarua County Baseline Assessment Report:

Mapping and Diagnosing the Decision Context

Regreening for the Future: Integrating Climate Change Adaptation Pathways Into Community-led Regreening in East Africa



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Suggested citation: UNU-EHS, KEFRI, WVK, CIFOR-ICRAF, UoN, WVA. (2026). *Baseline assessment report: Mapping and diagnosing the decision context: Regreening for the future: Integrating climate change adaptation pathways into community-led regreening in East Africa*. Australia.

Colophon

The Regreening for the Future project aims to explore how adaptation pathways, a planning approach for managing climate change uncertainty, can be embedded within community-led regreening models to enhance the capacity of communities in Kenya, and the broader East Africa region, to adapt to climate change long into the future. The project builds World Visions Regreening Communities, and on the understanding that the Government of Kenya is committed to restoring 10.6 million hectares of degraded land and to increase tree cover to at least 32% by 2032.

Specifically, this project focuses on three core areas:

- Integrating climate adaptation research into community-led land restoration to improve tree cover, enhance resilience to climate change, and diversify livelihood options in selected landscapes.
- Utilising evidence-based stakeholder engagement approaches to inform policy development, decision-making, and scaling.
- Developing and applying a Monitoring, Evaluation, and Learning (MEL) framework for adaptation pathways within regreening initiatives that support landscape and ecosystem restoration in targeted sites.

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Acknowledgements
This project is supported by the Australian Government through the Australian Centre for International Agricultural Research (ACIAR) and is implemented by World Vision Australia (WVA), World Vision Kenya (WVK), the University of Nairobi (UoN), the United Nations University Institute for Environment and Human Security (UNU-EHS), the Centre for International Forestry Research–World Agroforestry Centre (CIFOR-ICRAF), and the Kenya Forestry Research Institute (KEFRI), across selected sites in Makueni, Nyandarua, Nyamira, and Homa Bay counties. The views expressed in this publication are the authors' alone and are not necessarily the views of the Australian Government. We thank all interviewees, survey, focus group and workshop participants for sharing their experiences on regreening and climate change in Kenya. This research would not have been possible without you.

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List of Acronyms and Abbreviations

ACIAR – Australian Centre for International Agricultural Research
ASALs – Arid and Semi-Arid Lands
ATs – Assistive Technologies
CBOs – Community-based Organizations
CCAP – Climate Change Action Plan
CFA – Community Forest Association
CIDP – County Integrated Development Plan
CIFOR–ICRAF – Centre for International Forestry Research–World Agroforestry Centre
COPiCAD – Community Organization for Positive Impact, Care & Development
CR-RGC – Climate-Ready Regreening Communities
FGDs – Focus Group Discussions
FMNR – Farmer Managed Natural Regeneration
GCM – Global Climate Model
GDP – Gross Domestic Product
GEDSI – Gender, Equality, Disability and Social Inclusion
GVC – Green Value Chain
IGAs – Income-Generating Activities
IPM – Integrated Pest Management
ITCZ – Intertropical Convergence Zone
IVI – Importance Value Index
KALRO – Kenya Agricultural and Livestock Research Organization
KEFRI – Kenya Forest Research Institute
KFS – Kenya Forest Service
KSAA – Knowledge, Skills, Awareness, Aspirations
Ksh – Kenyan shillings
LOCCOG – Lake Ol'Bolossat Community Conservation Group
MAM – March–April–May
MEL – Monitoring, Evaluation and Learning
MESPT – Micro Enterprises Support Programme Trust
NAP – National Adaptation Plan
NDC – Nationally Determined Contribution
NEMA – National Environment Management Authority
NGOs – Non-governmental Organizations
PAR – Participatory Action Research
PCRAs – Participatory Climate Risk Assessments
PELIS – Plantation Establishment and Livelihood Improvement Scheme
PNV – Potential Natural Vegetation
PWDs – Persons with Disabilities
RCP – Representative Concentration Pathways
SACDEP – Sustainable Agriculture Community Development Programme
SHGs – Self-Help Groups
SLM – Sustainable Land Management
SOC – Soil Organic Carbon
SOM – Soil Organic Matter
TIST – International Small Group and Tree Planting Program
UNU–EHS – United Nations University Institute for Environment and Human Security
UoN – University of Nairobi
WRI – World Resources Institute
WRUA – Water Resource User Association
WVA – World Vision Australia
WVK – World Vision Kenya

1. Introduction

The Regreening for the Future project seeks to understand how integrating climate change adaptation pathways into World Vision's community-led regreening model can strengthen the long-term adaptive capacity of communities in Kenya and, ultimately, across East Africa. The project responds to the dual challenges of land degradation and accelerating climate change, both of which undermine agricultural productivity, ecosystem services, and rural livelihoods. Kenya's national commitment to restore 10.6 million hectares of degraded land by 2032, coupled with new county-level Participatory Climate Risk Assessments (PCRAs), provides an unprecedented opportunity to embed future-focused, evidence-based, and community-led adaptation planning within regreening initiatives.

The project's theory of change emphasises that communities, when equipped with climate information, facilitated decision-making processes, and strong institutional support, can actively navigate climate uncertainty by selecting regreening options that remain viable under changing conditions. Adaptation pathways—structured sequences of decisions taken over time as conditions evolve—offer a promising approach for integrating scientific evidence, local knowledge, and stakeholder engagement into long-term planning. The project will work through four counties (Makueni, Nyandarua, Nyamira, and Homa Bay) as shown in Figure 1.1.1 to develop, test, refine, and validate a Climate-Ready Regreening Communities (CR-RGC) model, bringing together practitioner experience, scientific evidence, and community aspirations.

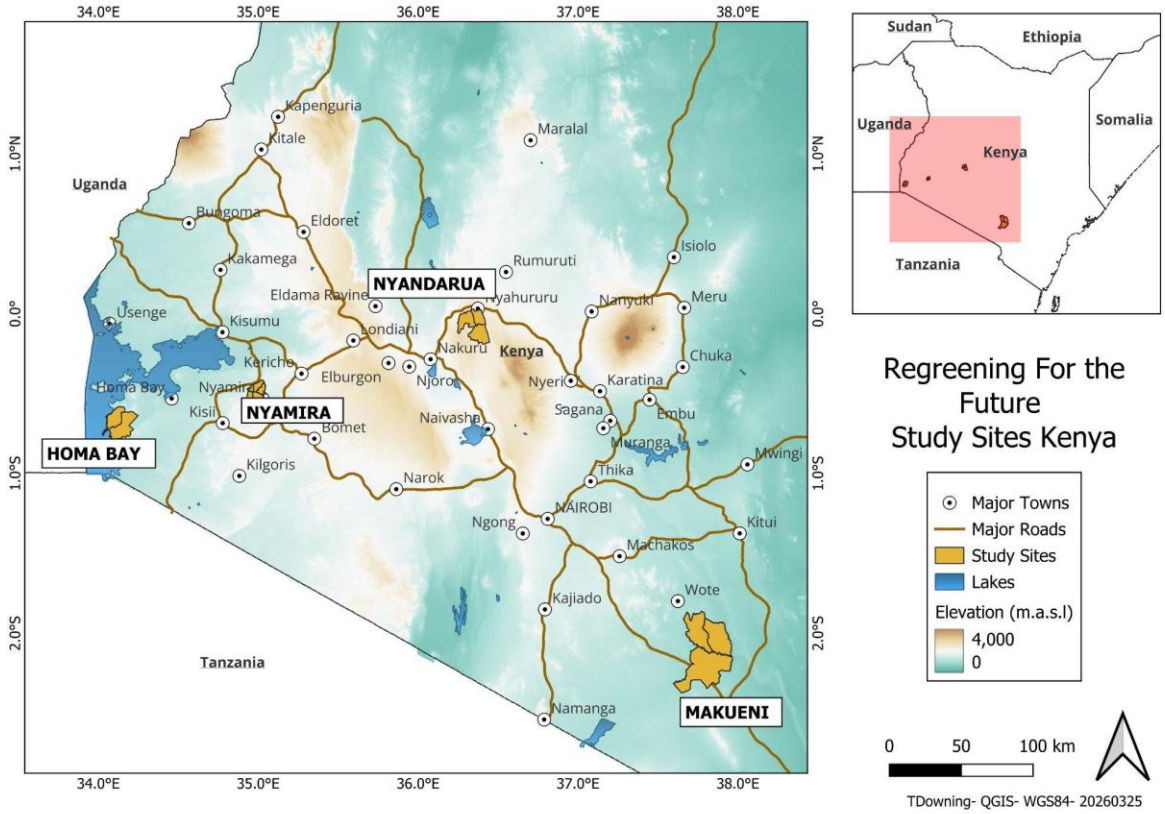


Figure 1.1.1. Map of the study sites and their locations across southern and western Kenya

This baseline assessment forms the starting point for the project's Participatory Action Research process. It provides a comprehensive understanding of the communities, ecosystems, institutions, and markets in which adaptation pathways for regreening will be co-developed. It also supports the development of the project's MEL framework, which will track changes in capacities, decisions, and outcomes over time.

1.1. Objectives of the baseline assessment

The baseline assessment is designed to establish the conditions necessary for understanding how communities, ecosystems, institutions, and markets currently support or constrain climate-ready regreening, and what can be done to strengthen this through the co-development of adaptation pathways with key stakeholders. Its objectives are to:

1. **Establish a comprehensive understanding of the decision context for adaptation pathways planning**: This includes mapping climate risks, vulnerabilities, stakeholder roles, governance arrangements, livelihood systems, existing regreening practices, and the enabling or constraining factors within each county.

2. **Document existing adaptation actions and regreening practices:** By assessing what communities, households, and institutions are already doing, the baseline identifies both entry points and gaps for future adaptation planning and regreening interventions.

3. **Provide an evidence base for designing the Participatory Action Research (PAR) process**: The baseline helps tailor the forthcoming co-creation processes by highlighting community priorities, knowledge systems, stakeholder relationships, green value chain opportunities, and gender, equality, disability and social inclusion considerations.

4. **Inform the development of the project's MEL framework:** Baseline data on Knowledge, Skills, Awareness, Aspirations (KSAA), land health indicators, stakeholder dynamics, and policy environments will anchor later assessments of change and guide learning cycles within the adaptation pathways approach.

5. **Identify key knowledge, capacity, data, and system gaps:** Understanding these gaps at the outset helps ensure that the project's action research activities target the most critical barriers to developing and implementing effective climate-ready regreening pathways.

Together, these objectives ensure that the baseline assessment not only documents initial conditions but also directly supports the design, implementation, monitoring, and scaling of a climate-ready regreening model across diverse landscapes.

1.2 Methodology

1.2.1 Study design

Eight assessment tools were employed in this baseline assessment, including stakeholder mapping and analysis, desk review of climate-related risks, adaptation pathways focus group discussions, household-level socio-economic assessment, biophysical assessment, and green value chain assessment. Additional thematic assessments include MEL and Gender, Equality, Disability and Social inclusion (GEDSI). These tools combine qualitative and quantitative methodologies to understand the biophysical and socio-economic context in which community-led regreening activities can occur. This serves to 'pin the corners' of the decision space, highlighting the breadth of adaptation options that are possible in each study area, and creating a baseline from which to monitor and evaluate proposed regreening activities.

1.2.2 Baseline assessment coverage

The Nyandarua county baseline assessment focused on Ol' Joro Orok Sub-County, covering Gathanji, Gatimu and Weru wards.

1.2.3 Baseline sample and data collection tools

The baseline used a mixed-method, site-focused sampling approach. The project counties and study locations were purposively selected because they are the project implementation and learning sites. Stakeholder mapping began with key individuals and organisations per county and then snowball sampling was used to include missing stakeholder groups and commonly mentioned actors. Focus

Groups Discussions (FGDs) and validation sessions were purposive/targeted sampling organised with community members and relevant local actors to explore climate risks, aspirations, adaptation options, enabling conditions and the logic of adaptation pathways. The household socio-economic survey used a site-focused random sampling approach within the selected project locations. In each county, the project team first obtained a list of farmers from the relevant project sites and target wards. This list served as the sampling frame from which households were randomly selected for interview. The survey therefore captured a cross-section of farming households within the project implementation areas, rather than a county-wide representative sample green value chain respondents were purposively drawn from relevant actor categories, including producers, processors, distributors and service providers.

1.2.3.1 Stakeholder mapping & analysis

The purpose of this tool is to document who are the major actors, how they are connected, and what their role is in community-led regreening to inform an engagement strategy, identifying critical actors as well as connectivity gaps. Project staff identified approximately 20 key individuals and organisations per county involved in regreening, including: Lead farmers (Farmer Managed Natural Regeneration [FMNR] or Community Forest Association (CFA) members), chiefs, Non-governmental Organizations (NGOs), private sector actors and county government representatives. The total number of stakeholder interviews conducted were 21 in Nyandarua county.

1.2.3.2 Desk review

This tool outlines the policy and planning frameworks in place for each county, to show what are the levers available for affecting change and highlight the legal-regulatory boundaries to community adaptation and provide a broader contextual framing for the baseline. A semi-systematic literature review was conducted using Scopus and Google Scholar to identify peer-reviewed and grey literature on climate-related risks, impacts, drivers, adaptation strategies, and enabling conditions at national and county levels.

1.2.3.3 Adaptation pathways focus group discussions

The Focus Groups Discussions (FGDs) were undertaken with community members using participatory tools, including impact webs and pathways mapping. These processes supported the identification of climate risks, adaptation options, and potential pathways over time. Validation sessions were conducted in selected sites to refine and prioritise options. It identified current risks, impacts and challenges; engage with aspirations; explore the opportunity space; identify enabling conditions; and expose stakeholders to the logic of climate adaptation pathways. The impact webs and pathways maps were used in validation sessions. FGDs were held in Gatimu Ward in Ol' Joro Orok Sub-County, involving 45 participants.

1.2.3.4 Socio-economic assessment at the household level

This tool provides a quantitative look at the socio-economic context that drive the behaviours and attitudes. This was a household-level socio-economic assessment. It captured data on livelihoods, regreening practices, climate perceptions, and adaptation responses, as well as access to resources, training, and information. Respondent categories included men, women, youth, persons with disabilities, elderly people, and standard demographic variables such as age, marital status, education, occupation and income. Data were analysed using descriptive statistics and cross-tabulations to identify patterns across sites and socio-demographic groups.

1.2.3.5 Biophysical assessment

The tool describes the biophysical context that underpins the decision context, highlighting the hard and soft limits to adaptation in each study area. It characterised land health, vegetation, and soil conditions, including soil organic carbon, erosion prevalence, species composition, Importance Value Index (IVI), and tree species suitability analysis under various future climate scenarios. These data provided insight into the ecological context of regreening and landscape restoration potential.

1.2.3.6 Green value chain assessment

The green value chain assessment examined production, processing, and marketing of tree- and forest-based products. The tool explored the economic opportunities that are possible with community-led regreening activities and the major obstacles. Specifically, it focused on identifying green value chain enterprises, livelihood improvement and resilience, policy-based incentives, effects of climate change on green value chains, and barriers affecting uptake. Respondent categories included producers, processors, distributors and service providers. Participatory ranking and scoring methods were used to identify priority value chains, constraints, and opportunities for strengthening livelihoods linked to regreening. Descriptive analysis of actor categories, demographics, preferred products, constraints and climate impacts were conducted.

1.2.3.7 Gender, equality, disability & social inclusion

This final toolset provides an appreciation of some of the ethical considerations that overlay the entire project. An understanding of the decision context is not complete without an understanding of differential benefits and harms that are possible and means of alleviating these disparities. Therefore, GEDSI considerations were integrated across all baseline components and further examined through a dedicated assessment. This included analysis of participation, access to resources, decision-making, and structural barriers affecting women, youth, persons with disabilities, and other vulnerable groups. These insights inform inclusive adaptation pathways design and implementation.

Table 1.1.1 summarises the respondent/participant summary table and a short description of the mixed-method and site-focused sampling approach.

Table 1.1.1. Respondent/participant summary table

Baseline component	Number of respondents/participants
Stakeholder mapping	21interviews
Household socio-economic survey	299 respondents
Preliminary FGDs	45 participants
Validation sessions	Not available
Green value chain assessment	26 respondents

1.3. Guide for the reader

- Chapter 2: Introduces the current status of regreening in the World Vision sites
- Chapter 3: Includes results of different baseline assessments
- Chapter 4: Presents the projects gender, equality, disability and social inclusion considerations
- Chapter 5: Synthesizes the key results of chapters 3, 4 and 5 with a focus on relevance for pathways planning
- Chapter 6: Includes recommended next steps for pathways planning

This report is structured to lead the reader from the detailed findings of each baseline tool through to an integrated understanding of the decision context for adaptation pathways, and finally towards implications for the next phase of the project.

Chapter 3: Results of the Baseline Assessments: This chapter presents the findings from all six baseline components, including:

- Stakeholder mapping and social network analysis.
- National and county-level desk review of climate-related risks.
- Rapid adaptation pathways focus group discussion.
- Household-level socio-economic assessments.
- Biophysical and land health assessments.
- Green value chain diagnostics.

Each subsection provides county-specific insights relevant to adaptation and regreening.

Chapter 4: Gender, equality, disability & social inclusion assessment: This chapter provides the evidence base to understand the gender, disability, and social inclusion dynamics that influence

regreening outcomes across the counties. Specifically, the assessment examines roles and responsibilities, access to and control of assets, participation and leadership, decision-making power, and structural barriers (institutional, physical, attitudinal, and communication), and uses these insights to inform practical recommendations and a GEDSI Action Plan for implementation.

Chapter 5: Synthesis of key results towards adaptation pathways planning: This chapter integrates results across all tools to describe the overall decision landscape for adaptation pathways planning. It identifies cross-cutting risks, vulnerabilities, existing adaptation options, stakeholder roles, and enabling or constraining conditions for climate-ready regreening.

Chapter 6: Recommendations and Next Steps: The final chapter outlines how baseline results will guide forthcoming Participatory Action Research activities, MEL framework development, engagement processes, and refinement of the climate-ready regreening approach.

2. Current status of regreening

Nyandarua County is a highland agricultural county in central Kenya, located in the Aberdare Range foothills at elevations between 1,800 and 3,300 metres above sea level. The project sites are in Ol' Joro Orok Sub-County, covering Gathanji, Gatimu and Weru wards (see Figure 2.1.1). The landscape is characterised by rolling hills, fertile volcanic soils and a bimodal rainfall pattern historically supporting smallholder farming systems based on Irish potato, dairy cattle, peas and vegetables. The biophysical assessment (see Chapter 3.5) finds the county has high potential for regreening, with favourable ecological conditions. The county's adjacency to the Aberdare Forest Complex makes catchment health and forest conservation central concerns for both livelihoods and downstream water security.

Regreening activities in Nyandarua are predominantly farmer-driven, with limited external institutional support to date. The socio-economic baseline survey found that 74.2% of respondents undertake regreening practices, with boundary planting (63%), homestead tree planting (50%) and agroforestry (47%) being the most widely practiced activities. Respondents reported an average of 15.5 years of engagement, and 55% practice regreening year-round. The vast majority is self-financed from personal savings or farm produce, with less than 2% accessing NGO, government or microfinance support. Agroforestry systems commonly integrate timber species such as *Grevillea robusta* and *Eucalyptus* spp. alongside fruit trees including avocado, tree tomato and orange. Soil and water conservation practices commonly practiced including terracing, gabion construction and rainwater harvesting complement tree-based regreening at the farm level. County policy is broadly supportive, with the Climate Change Action Plan setting a target of restoring 200,000 hectares of degraded forest and recognising agroforestry as a primary adaptation strategy.

Green value chain development is in its early stages, with fruit and timber seedlings and timber products as the primary green products in circulation. Around 62% of households link regreening products to value chain enterprises, primarily through fruits, beekeeping and timber products, though processing and value addition remain underdeveloped. Key barriers to scaling regreening include limited access to quality seedlings, lack of knowledge and awareness, financial constraints and weak farmer group structures. 75% of respondents reported no active group promoting regreening in their community. Youth engagement is particularly low, with only 11% of 18-24 year olds practicing regreening, reflecting barriers around land access and limited institutional support.

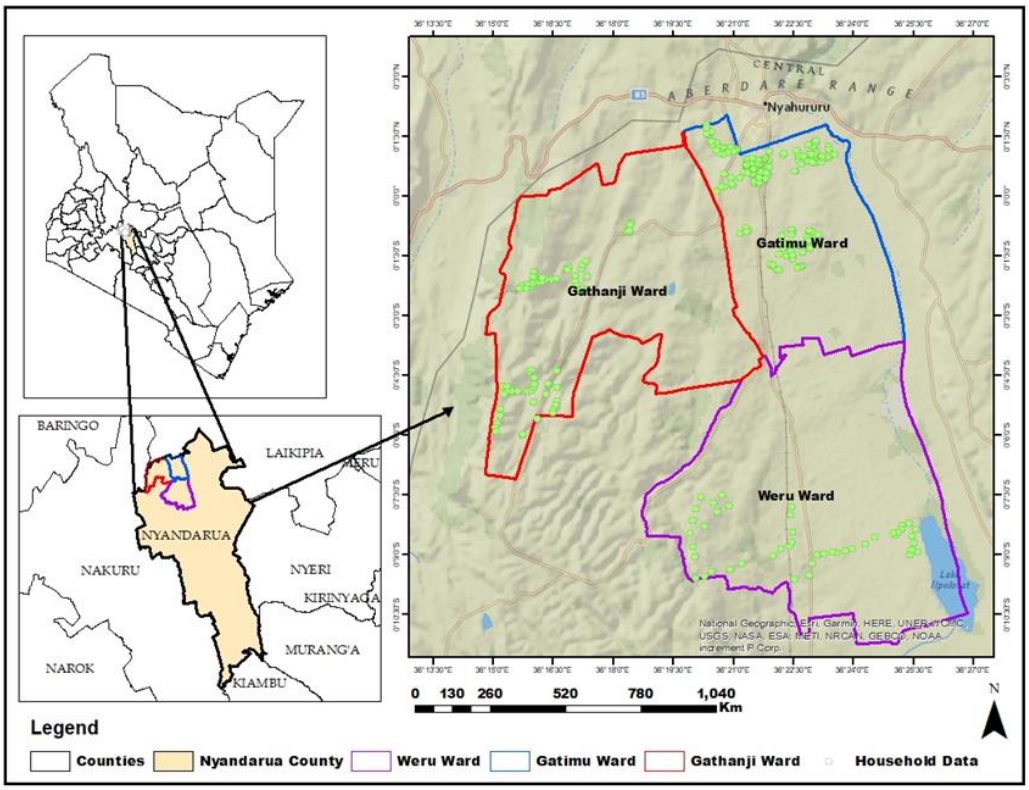


Figure 2.1.1. Map of the Nyandarua study site and Gathanji, Gatimu and Weru wards where survey data was collected for this baseline report

3. Results of baseline assessments

3.1 Stakeholder mapping and analysis

Stakeholder mapping and analysis was undertaken to understand the individuals and organisations that are present in the locations in relation to regreening as well as their relationships. Through this process it is possible to determine the stakeholders that are interested and influential to promote regreening as well as those that are absent and may be necessary for climate adaptation pathways actions, building on regreening.

Project staff identified approximately key individuals and organisations linked to regreening in their project area. These included lead farmers for FMNR or CFA members, chiefs, NGOs, private sector and county government. Surveys were undertaken with the listed stakeholders and individuals using Kobo Toolbox. Surveys captured information from the respondent- or their organisation- including the type of organisation, level of interest and power in relation to regreening and up to ten stakeholders they are connected to for regreening in relation to information, investment, value chains, inputs or policy. Connections were further characterized in terms of the frequency of connection, value of the connection to each stakeholder, and the directionality of the connection. Value refers to the value of the connection to the stakeholder being interviewed. Initial results were reviewed and missing stakeholder groups and commonly mentioned stakeholders were interviewed (snowball sampling). In total, there were 21 interviews in Nyandarua county. Data was cleaned and then visualised using Gephi software. Results were presented to community members and county level stakeholders for validation, discussion and additional input, which is included in this report.

Results are presented to include the types of stakeholders, their connections and their levels of interest and influence (power). The sociogram reveals a highly clustered and fragmented network (Figure 3.1.1). Seventeen (17) distinct communities are present in the network. NGOs, national government actors, most Community-based Organizations (CBOs) and county government departments are the most well-connected actors. The least connected actors are individual farmers, county agricultural extension staff, and self help groups.

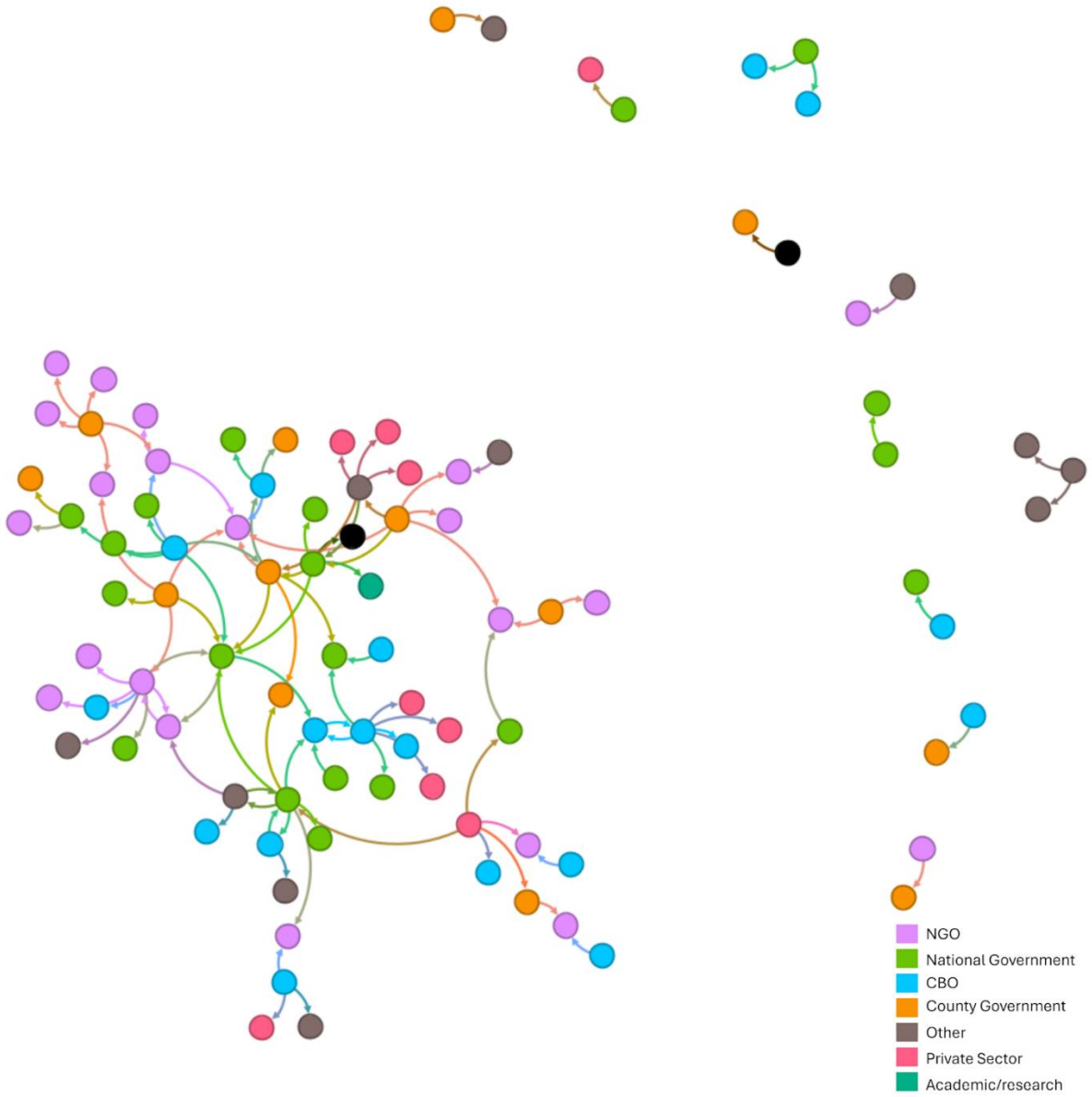


Figure 3.1.1. Sociogram showing connections (ties) between nodes (individuals and organisations), depicted as circles, coloured by organisation type for Nyandarua County, with a focus on Gathanji and Weru Wards in Ol'Joro Orok Sub-County.

Of the 103 connections captured, the majority (87) were considered very valuable, most (76) of the interactions for which information on frequency was provided took place often (weekly to monthly), and the majority of the connections (91) shared information both ways. In terms of the regreening topic of interaction, information/education and awareness on regreening practices was mentioned 82 times, regreening investment 25 times, green value chain processes and products 27 times, policy and governance 28 times, and inputs such as seeds or seedlings 58 times across the 103 reported connections.

With respect to interest (of individuals and organisations) and power (for organisations only) interviewed, Community Organization for Positive Impact, Care & Development (COPiCAD), Kenya Forest Service (KFS), National Environment Management Authority (NEMA), County Directorates of Climate Change, Agriculture and Livestock; Ministry of Interior Weru, and Lake Ol'Bolossat Community Conservation Group (LOCCOG) ranked highly and are very well connected. County Directorate of Natural Resources, Micro Enterprises Support Programme Trust (MESPT), World Resources Institute (WRI), Kenya Agricultural and Livestock Research Organization (KALRO), Equator Water Resource User Association (WRUA), Sustainable Agriculture Community Development Programme (SACDEP) Kenya, KIVIGO CBO, Weru Farmers Cooperative Society, and the Nature Conservancy are well

connected but ranked low in power and interest. County government extension, CFA, Teacher, Civil Servant and Stephen Njagi are not well connected but ranked high in power and interest. Field validation workshops added depth to the sociogram, and provide details on the roles of different organizations, notable organisations missing from the diagram, and recommendations to enhance engagement between local and regional actors.

3.1.1 Stakeholder engagement planning

Results from the stakeholder mapping and analysis as well as discussions with community and other actors at the county level have informed the engagement plans for Regreening for the Future in Nyandarua county. Identification of stakeholders present in each study site and across the county are provided information on what types of regreening adaptation options were already supported as well as the type of support that could be accessed in the future. Feedback from community and County level stakeholders on the initial mapping in combination with regreening adaptation options revealed stakeholders that may need to be included when looking at future climate. Information on existing and possible institutional structures for planning and capacity development emerged from dialogue only and not through the mapping activity. Individual plans have been prepared (focused on the study sites) but four main goals have emerged that are important.

The engagement plans have four main goals:

1. Keep the county government and key actors informed and engaged through regular meetings of a county level working group. Stakeholder mapping and dialogue at community and county level highlighted the existing level of connection between the community and county levels and the types of structures that exist. The modalities are still under discussion.
2. Identify and engage organisations that can support adaptation pathway actions at local level. Once communities have identified actions they can implement to adapt to climate change, identifying organisations that can support or enable this implementation will be important. Through the county level working group and dialogue with different stakeholders, the project aims to align needs with actors providing support. Overall, NGOs and administration were connected locally with national government parastatals present in the larger county. Links to county departments were limited. Finance institutions, organisations working on water and crops and diseases were generally underrepresented and mentioned as necessary stakeholders to engage for adaptation pathways planning and support.
3. Introduce adaptation pathways into ward and county level planning. Through capacity development and engagement with multiple stakeholders the project hopes to raise awareness and capacity for climate adaptation pathways work and integrate this approach in the county climate change planning processes. Ward level climate change committees were not identified in the mapping nor in community level discussions. They were identified at county level as important for decisions on climate investments along with the climate change units and therefore should be included in the adaptation pathways capacity development.
4. Local level socialisation of the project and progress and support for regreening actions including through local administration, faith leaders, education, and media. By strengthening communication and linkages at the local level, the project aims to both increase awareness of the activities and project results but also to increase support for regreening and pathways implementation.

An important question for adaptation pathways is the community/institutional structure to engage in planning activities. While the entry point is FMNR committees/groups, additions to these committees or other mechanisms may be needed where these organisations are not sufficiently formed or functional.

The major actor categories are largely the same in each study site, but with different importance, connection, and roles. These differences will be critical in tailoring individual engagement plans for each study site. One element that emerged clearly from the stakeholder analysis is the disconnect between local and county actors, and the need to bridge that gap for effective policy and implementation planning. Most sites have fairly strong, frequent, and bi-directional connections but the topics vary from site to site. While information continues to be the most important use for the connections, there is heavier reliance on these connections for a wide variety of activities including setting policy, investment, and enhancing green value chains. This points to the important and perhaps underutilised nature of some of these social networks with relevance to the nature of the engagement in each site.

3.2 Desk review of climate related risks

A semi-systematic literature review was conducted on Scopus and Google Scholar. It aimed at identifying key peer-reviewed research papers and grey literature (i.e., policy and planning documents, project reports) discussing additional negative climate-related risks and impacts and their drivers, as well as adaptation strategies carried out and their related enabling conditions in Homa Bay county and the Kenyan context more broadly.

3.2.1 National level

At the national level, Kenya's National Adaptation Plan (NAP) 2015–2030 (Government of Kenya, 2016) and its Second Nationally Determined Contribution (NDC) 2031–2035 (Republic of Kenya, 2025) are two key sources of information. They list the key climate risks, impacts, drivers of risks and vulnerabilities and set short- to long-term priorities, guiding climate policy and action at national and county levels. They also provide an overview of country-level climate projections. Additionally, peer-reviewed literature and project reports provide a more nuanced understanding of risks, impacts and measures being implemented in different parts of the country.

Climate projections

According to the NDC, Kenya's mean annual temperature has risen by approximately 1.2°C since the 1960s, increasing at an average rate of 0.21°C per decade. Changes in rainfall patterns and temperature increase are already resulting in cycles of longer dry seasons and intense short rains, with shorter periods between extreme weather events (Republic of Kenya, 2025). Projections by the UK Met Office's Global Climate Model (GCM) indicate further temperature increases of between 0.8 to 1.5°C by the 2030s and up to 3°C by 2100. The same model projects an average rise in precipitation during heavy rainfall events of 2–11 per cent by 2060 (Government of Kenya, 2016). However, March–April–May (MAM) precipitation levels are expected to decline by more than 100 mm by 2035 across many regions (Republic of Kenya, 2025). Northern Kenya is projected to experience both higher temperatures and more pronounced rainfall deficits compared to the southern regions. Further modelling under Representative Concentration Pathways (RCP) 4.5 and 8.5 scenarios suggest shifts in agroecological zones, with implications for agricultural productivity and land use (Ndungu et al., 2022).

Key Climate Risks and Observed/Potential Impacts

The reviewed literature identifies flood and drought events as the primary climate risks facing Kenya, mainly driven by the country's climate variability due to El Niño Southern Oscillation. Drought and flood-related disasters cause yearly losses that amount to 3 to 5% of the country's Gross Domestic Product (GDP) and adversely impacting lives and livelihoods. They exacerbate existing vulnerabilities and inequalities, increasing food insecurity, poverty, conflicts, displacements, infectious diseases, gender-based violence and disruptions in healthcare and education (Government of Kenya, 2016; Republic of Kenya, 2025). The 2024 floods, for instance, affected over 306, 520 people in 43 counties, displacing more than 290,000 people, causing more than 315 deaths and interrupting school for over 350,000 children (UN OCHA, 2024). When it comes to drought, Kenya's Arid and Semi-Arid Lands (ASAL) are at higher risk. As of 2023, 6.4 million people, 35% more than in 2022, needed humanitarian assistance due to the most prolonged and severe drought in the country's recent history (UN OCHA, 2023). Although Arid and Semi-Arid Lands (ASALs) counties have reported normal drought levels since June 2025, the impacts on their household livelihoods and food security are still ongoing (UN OCHA, 2025). Sea level rise and heat stress are other key climate risks already impacting communities in Kenya.

Drivers of risks and vulnerabilities

Climate change is identified as a key driver of risk in Kenya, exacerbating floods and droughts and compounding unsustainable land use practices, insecure and unequal land tenure, and insufficient access to climate information (Government of Kenya, 2016). These factors accelerate land degradation and productivity loss, particularly for smallholder farmers. Kenya's economy remains heavily reliant on climate-sensitive sectors, with rain-fed agriculture accounting for nearly one-third of GDP and providing livelihoods for about 70 per cent of the rural population, most of whom are smallholder farmers (Ndungu et al., 2022; Republic of Kenya, 2025). In 2023, the compounding effects of prolonged drought, the

COVID-19 pandemic and a locust invasion, the highest level recorded in two decades, drove approximately 4.4 million Kenyans to acute food insecurity (Muia et al., 2025; Ndungu et al., 2022), highlighting the severity of these interconnected drivers.

Adaptation and Risk Management Options

Kenya's increased climate variability, its reliance on rain-fed agriculture and the high vulnerability of its smallholder farmers make climate change adaptation a priority in the country, together with addressing the multiple drivers of land degradation and food insecurity. According to Ouma (2023), adaptation options and policy solutions in Kenya, particularly those linked to agriculture, are influenced by four dominant discourses: 1) technological solutions and technocratic narratives, 2) adaptive capacity narratives, 3) climate justice narratives and 4) gender and feminist narratives. While the first two focus on technical solutions and individual behavioural changes, the latter represent more and transformational approaches, emphasising the need to address the drivers and root causes of risk and vulnerability, including structural inequalities and historical injustices.

The dominance of the two former narratives in policymaking and the overlap between the different discourses (Ouma, 2023) is reflected in the adaptation and risk management options identified through this literature review. Kenya's NAP and NDC articulate a vision of climate action anchored in achieving low-carbon, climate-resilient development as articulated in its NAP and NDC (Government of Kenya, 2016; Republic of Kenya, 2025). Their roadmap includes short-term measures such as enhancing climate-smart agriculture, rehabilitating and conserving degraded land, promoting afforestation and reforestation, and strengthening community and institutional governance structures for resource management. Long-term measures focus on building the adaptive capacity of smallholder farmers, developing a forestry adaptation strategy and promoting climate-resilient tree species (Government of Kenya, 2016; Republic of Kenya, 2025). In particular, the NAP (Government of Kenya, 2016) aims to develop climate resilient spatial planning, enhancing scenario planning with communities, which can represent an entry point for adopting an adaptation pathways approach.

The rest of the reviewed literature highlights diverse ongoing community-driven approaches specifically relevant for regreening. The Regreening Communities Handbook (World Vision, 2023), for instance, presents the community-led environmental restoration model -the base of this project- implemented by World Vision Kenya and CIFOR-ICRAF in different parts of the country. Additionally, at least 14 peer-reviewed papers were identified focusing on themes such as sustainable farming practices (Andati et al., 2022, 2023; Capitani et al., 2019; Kioko et al., 2024; Matere et al., 2024; Wakaba et al., 2025), regreening and ecosystem restoration (Fuchs et al., 2024), gender dynamics among smallholder farmers (Crossland et al., 2021; Kariuki & Birner, 2021; Langill et al., 2023), and landscape and ecological management (Gibbon et al., 2024; Jansen & Kalas, 2024; Magaju et al., 2020; Wakaba et al., 2025) in Kenya. These works collectively underline the potential of community-based measures for restoring degraded land, enhancing ecosystem services, and improving livelihoods, while incorporating more justice- and gender-based narratives. However, none of them integrate future adaptation planning under different scenarios, highlighting the current gap in integrating adaptation pathways in climate adaptation research in Kenya.

Despite this gap, three papers were identified which touch upon this approach in Kenya. Akwany et al. (2025), for example, present a project in which a community climate change adaptation assessment guided the development of community-based adaptation plans to identify and prioritise adaptation strategies and planning in the Yala Wetlands. Ndungu et al., (2022) assessed opportunities to improve agriculture adaptation and resilience based on future expected climate change, exploring changes in agroecological zones. Finally, Ouma (2023) recognises the challenges to developing inclusive adaptation pathways that encompass diverse knowledge, experiences and understandings. The author highlights that being aware of the historical contexts into which adaptation responses are entering is crucial when considering adaptation pathways for agriculture in Kenya.

3.2.2. Nyandarua County

Just like the NAP and NDC at the national level, county-level policy documents are key sources of information about the main climate risks and impacts, drivers and adaptation strategies in Nyandarua county. The Climate Action Plans (Nyandarua County Government, 2023a), serve as the guiding

framework for the county government's climate strategy. The PCRA reports (Nyandarua County Government, 2023b), resulted from a participatory process with diverse local stakeholders, present a detailed assessment of the main climate risks and impacts at the guard level, highlighting differentiated impacts and drivers of risk for key vulnerable groups. Finally, the Climate Risk Profiles (MoALF, 2016c, 2016b, 2016a; MoALFC, 2021) provide an overview of the agricultural context in each county, highlighting their reliance on this economic sector. They provide an overview of their major agricultural value chain commodities in each county, underscoring the main climate risks and impacts facing each stage of the value chains. They also provide insights into the current and potential adaptation strategies being implemented by farmers, as well as key recommendations to enable adaptation.

The findings drawn from these policy documents were supplemented with peer-reviewed literature and relevant reports from ongoing and recent projects in each county to make a deeper assessment. It is worth mentioning that no existing projects or research on adaptation pathways were identified for any of the four counties through the literature review. This presents an opportunity for the Regreening for the Future project to explore how to address the gap in integrating adaptive planning into existing farming adaptation measures at the county and local levels in Kenya.

Nyandarua County's Climate Change Action Plan (Nyandarua County Government, 2023a), Climate Risk Profile (MoALF, 2016b) and Participatory Climate Risk and Vulnerability Assessment (PCRVA) Report (Nyandarua County Government, 2023b) are key sources of literature regarding the county's outlook on climate change, risks and impacts and adaptation. Additional grey literature and peer-reviewed papers complement these government reports, focusing on the adaptation strategies of smallholder farmers (Andati et al., 2022, 2023; Changara, 2018; Mandere Mandere et al., 2011; Murithi, 2023; Mwongeram et al., 2019) and the effect of climate variability on crops (Mwangi, 2014; Ndegwa et al., 2020).

Climate trends and projections

According to Nyandarua's Climate Change Action Plan (Nyandarua County Government, 2023a), the county's climate has experienced significant changes since the early 1980s, with steady temperature increases and increasingly erratic rainfall patterns. Records show an average temperature increase of 1°C during the first half of the year, and of 0.5 °C during the second half, as well as a significant increase in the mean annual minimum temperature is also rising. Thus, although frost and extreme cold events remain major hazards, their occurrence is decreasing and is expected to become increasingly rare by 2050 (Nyandarua County Government, 2023b, 2023a).

Rainfall in Nyandarua county shows a slight tendency to increase, but its distribution is increasingly unpredictable. While the long rainy season is shortening and becoming drier, the short one is becoming longer and with heavier rainfall. The combination of higher temperatures and less rain is leading to more dry spells, especially during the first half of the year, with an average of 30 to 45 consecutive days of moisture stress (Nyandarua County Government, 2023a).

Projections shown in the county's Climate Risk Profile (MoALF, 2016b) suggest that temperatures will continue to increase over the upcoming decades. Mean annual temperatures are projected to increase 0.3° C by 2040 and between 1° and 2.8°C by 2060, reaching higher temperatures during the first half of the year. In contrast, precipitation is projected to decrease, reducing by up to 6% in the second rainy season by 2040. Similarly, moisture stress is projected to double across both rainy seasons, reaching up to 70 consecutive days (MoALF, 2016b).

Key Climate Risks and Observed/Potential Impacts

Nyandarua's Climate Change Action Plan (Nyandarua County Government, 2023a) reports an increase in the occurrence and intensity of extreme weather events since the 1950s. It highlights that flood occurrences rose from ~3 events per year in the 1980s to 10 events per year between 2000 and 2006. For instance, in 2020, heavy rains affected over 54,000 hectares of maize and potatoes, leading to major flood events (MoALF, 2016b; Nyandarua County Government, 2023a). According to Nyandarua's PCRA Report, flash flood risk is projected to increase in vulnerable wards due to the cascading impacts of deforestation, strong winds and soil erosion (Nyandarua County Government, 2023b). The rise of flood risk in the county is also raising health concerns linked to the emergence of waterborne diseases, such as cholera (MoALF, 2016b), particularly for poor households (Nyandarua County Government, 2023b).

The county's PCRA Report (Nyandarua County Government, 2023b) and the Climate Risk Profile (MoALF, 2016b) also underscore drought as a historically major hazard across the county, underlining that it leads to increased water scarcity, deforestation, biodiversity loss and crop failure in all 25 wards (Nyandarua County Government, 2023b). Coupled with more frequent heatwaves and stronger winds, drought is also leading to more frequent fires, with impacts on biodiversity and health and affecting the county's main value chains: dairy, poultry, irish potato and pea. This directly impacts over 80% of Nyandarua's residents, who depend on these value chains for food security and livelihoods (MoALF, 2016b; Nyandarua County Government, 2023b).

Nyandarua presents extreme cold events, particularly in January and September (Nyandarua County Government, 2023a). During these months, frost is a major hazard, leading to crop failure (especially Irish potatoes and peas) and destruction of pastures for livestock, increasing production costs, affecting food security and damaging livelihoods (MoALF, 2016b). Extreme cold events and their impacts are projected to decrease in the coming decades due to rising temperatures in Nyandarua (Nyandarua County Government, 2023b).

Unlike the case of Makueni and Homabay, no literature was found discussing specifically gender-specific impacts of climate change. The county's Climate Risk Profile (MoALF, 2016b) reports a lack of data on the percentage of women landowners and those employed by agriculture production. Nonetheless, some of the reviewed literature discusses some of these impacts. The PCRA Report (Nyandarua County Government, 2023b) discusses the increased labour burden for women and girls after floods and mudslides contaminate water sources. Changara (2018) and (Murithi, 2023) underline that women are at the forefront of climate risk, due to their traditional caregiving role, but face systemic resource barriers to adaptation, i.e., limited ownership and control of livestock and land. Similarly, the Climate Risk Profile highlights that female-headed households have limited access to information on dairy technologies and improved crop varieties (MoALF, 2016b).

Some of the literature also highlights specific climate risks and impacts on vulnerable groups in Nyandarua. The county's Climate Risk Profile (MoALF, 2016b) and Climate Change Action Plan (Nyandarua County Government, 2023a) discuss specific impacts on children. These include stunting and malnutrition due to climate-induced food scarcity (MoALF, 2016b), increased respiratory diseases and higher school dropout rates due to floods, droughts and air pollution (Nyandarua County Government, 2023a). The PCRVA Report (Nyandarua County Government, 2023b) also underscores impacts and risk drivers (e.g., reduced mobility, exclusion from decision-making, livelihood loss) facing older people and persons with disabilities.

Adaptation and Risk Management Options

Although no specific mention was found of FMNR or regreening, the literature reviewed identified diverse adaptation measures linked to land management, restoration and farming. Nyandarua's Climate Risk Profile (MoALF, 2016b) reports that 98% of farmers in the county have adopted at least one on-farm measure to adapt to droughts, floods and frost. These include crop diversification, using improved or early maturing crops, changing planting dates to align with shifting rain patterns, switching to manure for pest control (MoALF, 2016b; Murithi, 2023) and adopting small-scale irrigation and greenhouse technology (Murithi, 2023). Murithi (2023) also reports an increase in farmers' interest in crop insurance, but highlights its adoption is low due to financial constraints.

According to the county's Climate Risk Profile and PCRVA report, agroforestry is a primary adaptation strategy in Nyandarua. Farmers purposefully integrate trees, particularly fruit trees, and shrubs with crops and livestock sectors to create microclimates to reduce frost damage and soil erosion (Nyandarua County Government, 2023b). The Climate Risk Profile (MoALF, 2016b) highlights that male- and youth-headed households tend to get more engaged in tree planting, encouraged by initiatives like "Tree is Life" and the government's Plantation Establishment and Livelihood Improvement Scheme (PELIS). According to this report, 51% of households in Nyandarua employ water and soil conservation measures. Female-headed households adopt these practices more than male- and youth-headed households. Water conservation strategies include building gabions, terraces and infiltration ditches to manage run-off and prevent soil erosion. Soil management includes composing, green manure and crop rotation. (MoALF, 2016b).

Given the importance of Irish potato and dairy to food security and livelihoods (MoALF, 2016b; Mwongeram et al., 2019), some of the reviewed literature focuses specifically on farmers' adaptation strategies linked to these value chains. Andati et al. (2022) discuss the factors that determine the adoption of climate-smart agricultural technologies among potato farmers and Andati et al. (2023) assess the effect of these technologies on potato crop yields. Regarding livestock, the literature underscores that dairy farmers have adopted hay and silage storage and fodder diversification, rainwater harvesting, early milking and cattle shades to avoid high heat and the use of local herbal remedies against livestock pests and diseases (Changara, 2018; MoALF, 2016b; Mwongeram et al., 2019).

Finally, Mwongeram et al. (2019) reflect on the development of Nyandarua's Climate Risk Profile, arguing for the inclusion of value chain perspectives into the design and scaling of climate-smart agriculture. While the authors do not explicitly discuss adaptation pathways, they underline the relevance of integrating adaptation strategies into agriculture planning and highlight the need to include smallholder farmers in the process (Mwongeram et al., 2019).

Visions, aspirations and targets

According to Nyandarua's Climate Change Action Plan 2023-2027 (Nyandarua County Government, 2023a), the county aims to promote community adaptive capacity to climate impacts through specific adaptation measures to enhance climate resilience and sustainable development. To achieve this, the county established sectoral objectives and measurable targets, based on the priorities identified during the participatory climate risk and vulnerability assessment – specifically aimed at reducing the impacts of floods and droughts (Nyandarua County Government, 2023a).

The county's sectoral objectives and targets specifically relevant to regreening include restoring 200,000 ha of degraded forest and planting of trees for carbon sequestration; increasing crop productivity through climate-smart agriculture, the introduction of drought tolerant crops and training small-holder farmers on smart irrigation technologies; enhancing the resilience of the water sector by promoting water-use efficiency and restoring riparian ecosystems; reducing environmental degradation, and establishing a county-level early warning system and developing flood-management infrastructure (Nyandarua County Government, 2023a). The Climate Change Action Plan (Nyandarua County Government, 2023a) also highlights key enabling actions to achieve its set targets, including the mainstreaming of climate change across all sectors, allocating 2% of the county's development budget to climate action, engaging local communities in adaptation projects and developing a climate information management system at the county level.

3.3 Adaptation pathways focus group discussions

3.3.1 Overview

The adaptation pathways FGDs provide a way to identify and validate key baseline information with stakeholders who the regreening for the future research team will engage and work within the project to make adaptation pathways. This includes farmers, county government staff, development organisations, NGOs, National Government staff, community-based organisations, faith-based organisations and private sector businesses involved in regreening activities in the sites (see Section 3.1 of the baseline assessment report for more information on stakeholder analysis). The approach is participatory. All the results presented here have been given to us by farmers, facilitated through guiding questions in the FGD exercise. The results gained from the FGDs are not a finalised output or outcome but rather helps to identify further areas that need to be investigated in the project. The objective of the FGDs is to:

- Identify current risks, impacts and challenges that communities and other stakeholders (e.g. county government) face in the four sites, including understanding what's driving these challenges (called drivers and root causes of risks)
- Engage with stakeholders' aspirations in how they want the area they live and farm in to be in the future

- Look into the 'opportunity space', by asking how to get from the current risks, impacts and challenges towards the future aspiration, thereby identifying adaptation and development actions that can be taken by communities and other stakeholders
- Identifying what are important enabling conditions for those actions to be taken
- Expose stakeholders we will engage and work within the project to the overarching idea and logic behind the climate adaptation pathways

For the full results, including the methodology and full tables of collected data see the Baseline Assessment Results Annex Report: Adaptation Pathways Focus Group Discussions.

3.3.2 Results

Table 3.3.1. Number of farmers engaged in FGDs in Gatimu ward, Ol Joro Orok subcounty

	No. engagements	Men	Women	Youth	Persons with disabilities	Total
FGDs	24	18	16	11	Not known	45

Table 3.3.2. Summary of data collected in FGDs in Gatimu ward, Ol Joro Orok subcounty

Category	Total Identified	Consolidated FGD items	Number of thematic clusters
Negative impacts	105	43	10
Drivers of impacts	32	12	3
Actions (community)	61	21	4
Actions (other actors)	22	17	4
Enabling conditions	42	33	8
Aspirations	38	27	7

Climate Risk Narrative

Communities in Nyandarua describe climate risks and impacts shaped by increasingly variable and unreliable rainfall, colder temperatures, and more frequent climate-related crop failures, interacting with land use fragmentation, land degradation, and socio-economic/ development pressures. Reduced and erratic rainfall, prolonged dry spells and droughts, and cold snaps during critical growing periods are disrupting planting calendars and undermining the viability of rain-fed agriculture, which remains the key income generating activity of households. These climate drivers compound with deforestation, forest degradation driven by charcoal burning, cultivation of riparian areas, and soil erosion on steep slopes, contributing to declining soil fertility, reduced water retention in landscapes, and increasing water scarcity.

These interacting climate and environmental drivers create cascading impacts across multiple interconnected systems within the county. Farmers reported declining crop yields, repeated crop losses, and reduced livestock productivity due to water shortages, disease, and pasture scarcity. Fragmented landholdings and reduced access to productive land further constrain agricultural viability, while inappropriate use of chemicals and poor access to quality germplasm exacerbate declining productivity. With reduced agricultural production, households experience growing food insecurity, rising hunger, and declining incomes. These livelihood stresses contribute to broader social and wellbeing impacts, including rising poverty, unemployment, family separation, increased insecurity and theft, and deteriorating physical and mental health. Limited access to education and medical services across much of the county further compounds vulnerability, particularly for children, women, the elderly, and persons with disabilities.

A number of underlying drivers intensify these risks. High poverty levels and limited access to financial resources constrain farmers' ability to invest in improved seeds, soil and water conservation, irrigation, or livelihood diversification. Weak agricultural extension services and limited access to bodies or institutions that can support equipment provision, skills and technical knowledge restrict the uptake of climate-resilient practices. Poor road and crop storage infrastructure and limited market access raise the costs of inputs and reduce returns from farm produce, while low and volatile market prices undermine incentives to invest in farming. Governance challenges noted during discussions include corruption, weak leadership, and high taxation, which were said to further constrain adaptive capacity and erode trust in institutions. Population growth and land fragmentation place increasing pressure on

already degraded land and water resources, reinforcing cycles of environmental degradation and livelihood vulnerability.

Together, these interacting hazards, drivers and impacts illustrate complex climate change risks in Nyandarua, characterised by cascading and compounding effects across agriculture, water, ecosystems, livelihoods, health and social wellbeing. Climate hazards interact with degraded landscapes, limited financial and institutional capacity, and socio-economic inequities, producing feedback loops that lock-in households to low-productivity, high-vulnerability livelihood pathways.

Pathways Narrative

In response to the complex and interacting risks identified in focus group discussions in Nyandarua, communities articulated a wide range of actions that together form the basis of locally led adaptation pathways. At the farm and household level, farmers are already adopting incremental practices such as crop diversification, kitchen gardening, poultry keeping, small livestock rearing, soil testing, and improved soil management. Agroforestry, fruit tree planting, woodlots and boundary tree planting are increasingly viewed as key strategies to restore soil fertility, regulate microclimates, reduce erosion, and provide diversified sources of food, fuel and income. These regreening actions represent early steps to buffer livelihoods against rainfall variability and land degradation.

As with Homa Bay and Makueni, water security emerges as a central leverage point for pathways in Nyandarua. Communities emphasise the importance of rainwater harvesting, small scale irrigation, and improved water access for both crops and livestock as foundational for sustaining agricultural production under increasingly unreliable rainfall. However, in contrast to the more arid counties of Homa Bay and Makueni, Nyandarua's pathways are shaped by cold-related crop stress and water scarcity driven by catchment degradation rather than absolute aridity. Catchment protection, riparian restoration, and tree planting in upper watershed areas are therefore seen as important medium-term restoration strategies to improve water regulation and landscape function.

Livelihood diversification is a major focus for climate-resilient development. Communities aspire to expand beyond reliance on rain-fed food crops through engagement in fruit production, beekeeping, dairy production and small businesses to expand value chain agricultural enterprises. Strengthening farmer groups, cooperatives and marketing arrangements is viewed as essential to improve bargaining power, reduce transaction costs, and stabilise incomes. These diversification pathways aim to reduce exposure to climate shocks by spreading risk across multiple income sources and strengthening local value chains.

The realisation of more ambitious and transformative pathways in Nyandarua depends on a set of enabling conditions that communities consistently highlighted. These include improved access to certified seeds and quality germplasm, reliable extension services and technical training, access to affordable finance and credit, improved access to markets. Institutional coordination between county government, national agencies, NGOs and research organisations is seen as necessary to align regreening efforts, value-chain development and service provision. Without these enabling conditions, community-led adaptation actions and choices will remain fragmented and reach limits, becoming insufficient to counteract the structural drivers of vulnerability.

Towards the long term, community aspirations converge on a vision of a regreened, food-secure and economically viable landscape, characterised by restored forests and watersheds, productive and climate-resilient farming systems, diversified livelihoods, and improved access to markets, finance, education and health services. These shared visions reflect a desire to move beyond short term coping towards transformative change in land management, livelihood structures and institutional support systems. Subsequent engagement should prioritise trust-building, awareness raising, clarification of roles, and validation of pathway options with communities and county-level actors.

3.3.3 Key lessons

Drivers and risk dynamics to factor into pathways planning

Across Nyandarua, climate change is amplifying existing vulnerabilities through increasingly unreliable rainfall, prolonged droughts, and climate-related crop failures, intersecting with land degradation, fragmented landholdings, and structural socio-economic pressures. The county relies heavily on rain-

fed agriculture as the primary livelihood base and face cascading impacts across food security, incomes, ecosystem health and social wellbeing as these systems come under stress. Governance weaknesses, including corruption, inadequate extension services, limited access to quality inputs and poor enforcement of land and environmental regulations, represent shared institutional drivers of vulnerability across both sites.

In Nyandarua, the primary climate stressor is the interaction of increasingly erratic rainfall with cold-related crop stress and catchment degradation from riparian cultivation and deforestation, reducing water retention and driving water scarcity. The risk is strongly shaped by structural challenges around declining productivity, high input costs, weak markets and governance failures. Therefore, the county requires pathways addressing climate variability, land degradation and livelihood fragility. Nyandarua pathways should prioritise catchment rehabilitation, cold-resilient cropping systems and dairy-based diversification.

Opportunity space for actions

Distinct opportunities

- Dairy-based livelihood pathways as both adaptation and income-generating strategies, particularly through improved breeds and dairy processing
- Regreening and catchment protection in upper watershed areas to stabilise water availability
- Climate information services targeted to cold spells, rainfall variability and dry spell management for crops such as potatoes and vegetables

Enabling conditions

Given the challenges around financial access, limited inputs, weak services and governance constraints in both counties, adaptation pathways will require sequenced enabling conditions alongside community actions.

Enabling conditions for Nyandarua include:

- Water infrastructure investments and catchment protection as foundational conditions for sustained agricultural productivity
- Tax relief on farm inputs to reduce barriers to adoption of improved practices
- Extension service strengthening given the identified gap in technical support

Future aspirations as goals and long-term targets for pathways

- Restored forest cover and functioning upper catchment watersheds stabilising water and soil systems
- Expanded dairy value chains and fruit farming as sustainable livelihood pathways
- Improved access to finance, microfinance and savings mechanisms for investment in farming and livelihood activities

3.4 Socio-economic assessment at the household level

3.4.1 Overview

The socio-economic baseline assessment sought to provide reference data in addressing some elements of the following research questions.

a) (RQ3) *What are the changes in the adaptive capacity of target communities, stakeholders and the enabling environment as a result of integrating climate adaptation pathways into the regreening process?*

b) *(RQ4) To what extent are the climate adaptation practices and expected outcomes resulting from integrating adaptation pathways into the regreening process equitable and inclusive, considering trade-offs and synergies among actors and livelihood practices?*

Specifically, in RQ3, this socio-economic baseline survey addressed some aspects of how the adaptive capacity (skills, knowledge, resources, partners, social and human assets) of diverse individuals and participating communities is likely to change because of the climate-ready regreening process. In RQ4, the baseline data provides information on the current and what to consider in future climate scenarios based on the available regreening practices, livelihood options and planned pathways, at different scales. The following key characteristics were considered as reference data from households whose findings are provided in this report for the selected study sites in Homabay county.

i. Demographic characteristics of the respondents and regreening practices.
ii. Regreening practices undertaken at farm level and their contribution to livelihoods.
iii. Sustainable land management practices.
iv. Climate change adaptation and its nexus to regreening practices.
v. Capacity building and skills development in regreening practices.
vi. Gender roles, people with disabilities and youth engagement in regreening practices.
vii. Challenges/barriers in re-greening practices.

3.4.2 Results

An overview of demographic characteristics of the respondents and regreening practices

The study revealed that most (76.5%) respondents were male headed households as compared to female headed households across the three administrative wards, Gathanji, Gatimu and Weru. Of the male headed households, 78.5% were practicing regreening activities as compared to 60% female headed households, that significantly differed (p=0.002) across the three wards (Table 3.4.1). This may imply that the power of decision making at household level in the study areas were dominantly vested in men which is more likely to influence regreening practices as they have greater authority over land use, access to resources, decisions over labour and training opportunities. This also points that the success of regreening practices may rely heavily on how men should be convinced on the benefits of regreening practices, what they prioritize on their farms in short- and long-term basis. Similarly, depending on the number of children at household level, especially in rural areas where most families use household labour to undertake various farming activities, men/sons often implement labour-intensive regreening practices such as Farmer Managed Natural Regeneration (FMNR), terracing, contour and other sustainable land management practices. This was evident in the study as male headed households had significantly higher (p=0.003) number of children than female headed ones (Table 3.4.2).

In contrast, the male dominance in many households imply that female-headed households may face some structural barriers such as land rights, access to farm inputs and other key decisions that may hinder uptake and adoption of regreening practices. This may equally exclude women's role in offering useful indigenous ecological knowledge that is key to promoting suitable and site-specific regreening activities that are crucial for biodiversity and sustainable land management. Therefore, male dominance in household leadership may lead to male-centred community decision-making limiting women's voices in regreening activities that are even gender responsive. In this baseline, the data therefore showed that considering majority of households were male headed, who can be lured to offer supportive role as gatekeepers to enable women and youth participate more actively in regreening activities that aligns to future climate.

Table 3.4.1. Summary demographic characteristics of household respondents at Ol' Joro Orok Sub County

Category	Descriptors	Frequency	Percentage (%)
Wards	Gathanji	72	24.1
	Gatimu	181	60.5
	Weru	46	15.4
Gender of respondent	Male	166	55.7
	Female	132	44.3
	Prefer not to say	0	0
Gender of household head	Male	228	76.5
	Female	70	23.5
Marital status	Married	202	67.8

Category	Descriptors	Frequency	Percentage (%)
	Single	64	21.5
	Widow	25	8.4
	Divorced	7	2.3
Highest education level	None	4	1.3
	Informal education	11	3.7
	Primary	73	24.5
	Secondary	110	36.9
	Tertiary colleges	69	23.2
	University	31	10.4
Age category of respondent (years)	18-24	9	3.0
	25-35	48	16.1
	36-44	81	27.2
	45-55	87	29.2
	Over 55 years	73	24.5
Current occupation of the respondent	None	2	0.7
	Farmer	183	61.4
	Civil servant	9	3.0
	Casual labourer	33	11.1
	Academician/teaching staff	9	3.0
	Business	58	19.5
	Others (Motorcyclist, Chef, house help, preacher)	4	1.3

Table 3.4.2. Statistical comparisons of demographic characteristics and regreening practices at Ol' Joro Orok Sub County

		Proportion (%) of the respondents practicing regreening		
Category	Descriptors	Yes	No	Total % (n)
Wards	Gathanji	81.9	18.1	100 (72)
	Gatimu	68.2	31.8	100 (173)
	Weru	83.7	16.3	100 (49)
	Statistical test: X^2=7.787, d.f=2, p=0.020			
Gender of respondent	Male	79.5	20.5	100 (166)
	Female	67.4	32.6	100 (132)
	Statistical test: X^2=5.612, d.f=1, p=0.018			
Gender of household head	Male	78.5	21.5	100 (228)
	Female	60.0	40.0	100 (70)
	Statistical test: X^2=9.575, d.f=1, p=0.002			
Marital status	Married	82.2	17.8	100 (202)
	Single	46.9	53.1	100 (64)
	Widow/wed	76	24	100 (25)
	Divorced	85.7	14.3	100 (7)
	Statistical test: X^2=32.174, d.f=3, p<0.001			
Highest education level	None	100	0	100 (4)
	Informal education	81.8	18.2	100 (11)
	Primary	78.1	21.9	100 (73)
	Secondary	76.4	23.6	100 (110)
	Tertiary colleges	71.0	29.0	100 (69)
	University	58.1	41.9	100 (31)
Age category of respondent (years)	18-24	11.1	88.9	100 (9)
	25-35	52.1	47.9	100 (48)
	36-44	67.9	32.1	100 (81)
	45-55	89.7	10.3	100 (87)
	Over 55 years	84.9	15.1	100 (73)
	Statistical test: X^2=47.855, d.f=4, p<0.001			
Current occupation of the respondent	None	0	100	100 (2)
	Farmer	88	12	100 (183)
	Civil servant	44.4	55.6	100 (9)
	Casual labourer	42.4	55.6	100(33)
	Academician/teaching staff	77.8	22.2	100 (9)

Category	Descriptors	Proportion (%) of the respondents practicing regreening		
		Yes	No	Total % (n)
	Business	55.2	44.8	100 (58)
	Others (Motorcyclist, Chef, house help, preacher)	75	25	100 (4)
	Statistical test: $X^2=56.442$, d.f=6, p<0.001			

Marital status of respondents also plays a pivotal role in promoting regreening practices. Of those interviewed, about 68% were married as compared to those who were widowed, single and divorced that was significantly associated with regreening. Specifically, of the married households, 82% practiced regreening practices as compared to 47% of the single households. This may imply that married households may have affordable labour force, joint green investments, long-term land tenure planning and are likely to pool resources towards regreening practices such as tree planning in the area, terracing, fruit tree growing and other agroforestry activities as compared to widowed/single/divorced families. They are also more likely to promote intergenerational knowledge transfer on regreening practices from parents to children and to community groups.

Married households may also engage in joint decision making for regreening activities which may accelerate uptake of the regreening practices depending on the level of agreement as compared to single/widowed/divorced who may have autonomy in decision making. Equally, married families may have better economic capacity to engage in regreening activities as compared to single/widowed/divorced who may struggle financially requiring financial support from other sources that some of them may not be affordable in repayment, thus constraining their ability to participate in regreening practices. This may force single/widowed/divorced families to engage in short term regreening activities with quick benefits that may not contribute to the overall goal of regreening in the context of future climate.

Married families remain advantageous in aligning to community social norms reflecting the traditional family structure promoting networks and social inclusion that may be beneficial to communal regreening practices. On the contrary, single/widowed/divorced families are likely to face the risk of social exclusion from community/family based regreening practices that are long term in nature. This becomes apparent especially when the majority of the community members are farmers who in most cases frame their livelihood strategies on agriculture production such as fruit tree growing, timber production/wood forest products, fodder production, integrated soil fertility management practices and other climate smart related activities.

The data also showed that the majority (81%) of the respondents were adults above 35 years old as compared to the youths between 18 to 35 years old significantly ($p<0.01$) influencing regreening practices. Specifically, 11% of the youth aged 18-24 and 52% of the youth aged 25-35 years old practiced regreening as compared to 68%, 90% and 85% of the adults aged 36-44 years, 45-55 years and over 55 years old, respectively. This may demonstrate that leadership roles and decision making in regreening practices were primarily undertaken by adults as compared to the youth considering that they own land, control finances/resources and require buy-in from them. It may also imply that they have long-term experience and knowledge in regreening activities because they are more familiar with their traditional land management practices. They are also more likely to detect variability in soil fertility of their lands that may make it easier to adopt practices that restore land productivity. On the contrary, youths may lack land, financial resources and historical land uses, limiting their capacity to actively engage in regreening activities. Age can also be disadvantageous to old farmers, especially on adoption of new innovations that are technologically oriented and user friendly to the youth. In the long run, this may be beneficial to both adults and youth by bridging the intergenerational equity, promoting innovation, energy and openness to new regreening practices that are climate responsive.

Regreening practices undertaken at farm level and their contribution to livelihoods.

Majority (74.2%) of the respondents agreed that they undertake regreening practices as compared to 25.8% who indicated that they do not due to staying in rented plot, inadequate land, lack of knowledge and resources. Of those implemented regreening practices, 82.8% funded the activities from personal savings, 32.6% from sale of farm produce and 27.1% revenue from own investments. Very limited proportions, less than two percent (<2%) obtained funding from Non-Governmental Organizations, micro financial institutions/banks, Government grants and private sector partnerships. This reflects that

regreening efforts in the area were predominantly locally funded, with limited access to institutional or external financial support. This may have implications for the scale, sustainability, and intensity of regreening interventions.

The proportion of respondents implementing regreening practices significantly (p=0.020) varied among the Wards sampled where Weru had the highest proportion (83.7%) followed by Gathanji (81.9%) of respondents practicing regreening as compared to Gatimu Ward (68.2%). Fifty five percent (55%) of the respondents indicated that they implement regreening practices throughout the year (Figure 3.4.2) where higher proportion were engaged in boundary planting (63%), homestead tree planting (50%) and agroforestry (47%) among other practices (Figure 3.4.1). They had undertaken these practices for an average of 15.48 years (std dev.=10.708) with a minimum of one-year and a maximum of 50 years. This significantly (p<0.01) differed across the selected Wards (Table 3.4.3). Similarly, there was sufficient evidence (p<0.01) to believe that the frequency of regreening practices implemented differed across the Wards.

Table 3.4.3. Mean comparison of duration in years respondents practiced regreening across selected administrative Wards in Ol'Joro Orok Sub County

					95% Confidence Interval for Mean			
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
Gathanji	59	19.24	12.143	1.581	16.073	22.402	1.0	50.0
Gatimu	118	15.00	9.568	0.881	13.256	16.744	1.0	50.0
Weru	39	11.31	6.114	0.979	9.326	13.290	3.0	30.0
Total	216	15.49	10.167	0.692	14.127	16.854	1.0	50.0
Test statistics: $F_{(2,213)} = 7.925$, p<0.001								

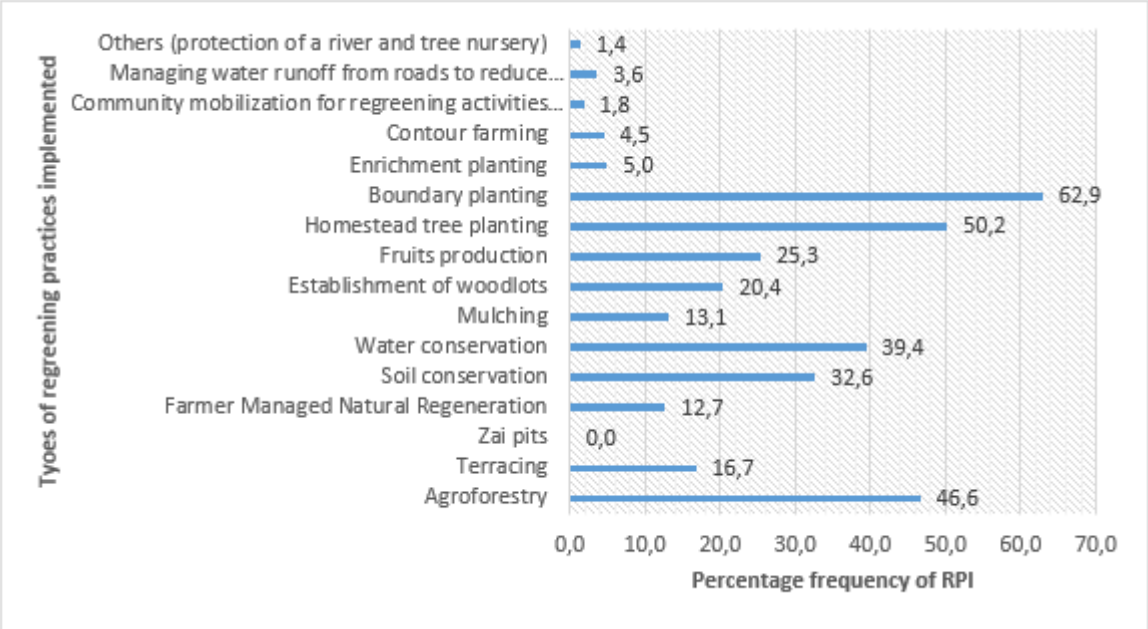


Figure 3.4.1. Type of regreening practices implemented at Ol'Joro Orok Sub County

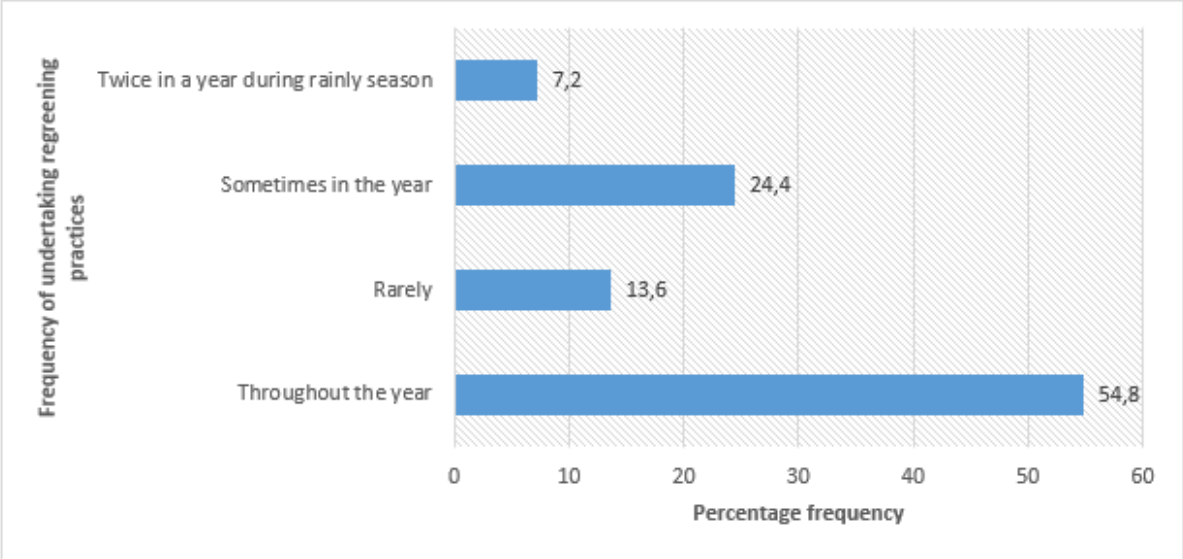


Figure 3.4.2. Frequency of implementing regreening practices in Ol'Joro Orok Sub County,

Subsequently, soil and water conservation practices in the area have the potential to improve soil fertility, water retention and erosion control, critical for adaptation to climate change. This corroborates well with the perception of respondents in the study where 71.4% attributed control of soil erosion and leaching as key benefits of regreening practices (Table 3.4.4).

Table 3.4.4. Perceived benefits derived from regreening practices in Ol'Joro Orok Sub County,

Benefits of regreening practices	Frequency	Percentage
Controls soil erosion and leaching	195	71.4
Improves water conservation and moisture retention	126	46.2
Increases biodiversity	78	28.6
Improves soil fertility and crop yields	89	32.6
Increases in income and better livelihoods	91	33.3

Similarly, production of fruits and other agroforestry practices indicate diversification of livelihoods that enhances food security and provision of income to households, making regreening economically viable and sustainable. Overall, this baseline data showed that the community is ready to upscale regreening practices based on prioritized and key interventions for validation and upscaling as a practical approach that strengthens both environmental health and household livelihoods. Further, the data provides insights on scale-up potential build on existing practices by expanding agroforestry models, promoting diverse tree species and integrating climate responsive practices. It also offers opportunities to build capacity of the community regreening techniques like soil and water conservation, propagation of high-quality germplasm, pests and diseases management in agroforestry and woodlot establishments, forest plantation and post harvesting.

Consequently, the predominantly mentioned regreening practices offer impetus for market linkages of green value chains and resource mobilization as an incentive to make them economically viable and sustainable as evident from the findings (Table 3.4.5). This also provides a room to mobilize communities to anchor them as collective regreening champions that is likely to position their households as agents of climate resilience. It also offers ground to validate, monitor and evaluate promising regreening practices for upscaling, strengthening and making them sustainable by ensuring inclusivity and linkage to broader climate resilience strategies at the County and national levels.

Table 3.4.5. Incentives to accelerate uptake of regreening practices in Ol'Joro Orok Sub County

Incentives to be in place	**Frequency**	**Percentage**
Financial support	247	85.2
Market access to tree-based products	121	41.7
Training and capacity building	170	58.6
Tax waiver on inputs for regreening practices	53	18.3
Better or higher prices for products from regreening practices	67	23.1
Certification	28	9.7

Sustainable land management practices

The assessment on land management practices addressed the issues of land ownership, observed land cover changes and their causes over the last 10 years, water conservation practices implemented in the study area, soil fertility changes and benefits of sustainable land management practices. The study revealed that most of the respondents (54%) purchased land followed by those inherited from their parents (Table 3.4.6) where they were implementing regreening activities. This implies that majority of the respondents have private land ownership which guarantees secure land tenure for long-term investment such as tree growing, soil and water conservation, fruit tree growing and other agroforestry practices for sustainable land management. This may also influence adoption of long-term regreening practices that align with strategies for building resilience to climate change now and the future. Notably, 61% of the respondents observed changes in land cover over the 10 years that they noted has been declining due to different causes such as deforestation, clearing of vegetation for settlement and infrastructure, changes of land use such as wetlands, grassland and woodlands to agricultural activities among others (Table 3.4.7). Of those observed increase in land cover changes attributed tree planting and other agroforestry practices as well as establishment of wood lots/plantations for supply of timber products.

Table 3.4.6. Type of land ownership occupied by respondents in Ol'Joro Orok Sub County

Type of landownership for regreening practices	Frequency	Percentage frequency
Purchased	120	54.5
Communal	2	0.9
Rented	16	7.3
Public land	5	2.3
Ancestral land	28	12.7
Inherited	58	26.4

Table 3.4.7. Causes of land cover changes over the last 10 years in Ol'Joro Orok Sub County

Causes of land cover change in the last 10 years	Frequency (n)	Percentage (%)
Clearing of hilltops and planting of agricultural crops	16	8.8
Deforestation	76	42.0
Clearing of vegetation cover for settlement and infrastructure	75	41.4
Clearing of woodlands for agricultural activities	29	16.0
Clearing of bushlands for grazing	13	7.2
Changes of grassland to agricultural land	18	9.9
Changes of wetlands to agricultural land	21	11.6
Introduction of FMNR	10	5.5
Tree planting	56	30.9
Policy implementation on environmental conservation	6	3.3
Climate change	57	31.5
Increased in human population	66	36.5
Increased demand for biomass energy leading to increased charcoal production/cutting trees for fuelwood	5	2.8
Increased demand for crops	19	10.5

Further, 35% of the respondents affirmed that they have observed decline of soil fertility in their farms as compared to 65% who did not. Of those observed soil fertility changes attributed mainly to overcultivation and increasing of soil degradation resulting from unsustainable farming practices (Table 3.4.8). Soil erosion and changing climate conditions were also reported as growing threats to soil health. Issues like poor soil structure and overgrazing were less common but were still present in some areas. Overall, the perceptions of the causes of declining soil fertility point to a combination of human and climate-related factors driving soil degradation. This has direct implications for agricultural productivity and land sustainability, highlighting the need to validate and scale up regreening and Sustainable Land Management (SLM) practices that address soil degradation while supporting farm-based livelihoods in the sub-county (Table 3.4.9).

Table 3.4.8. Perceived reasons for decline in soil fertility in Ol'Joro Orok Sub County

Perceived reasons for decline in soil fertility on farmlands	Frequency	Percentage
Increased soil degradation due to unsustainable farming practices	49	47.6
Rising soil erosion	22	21.4
Over cultivation	54	52.4
Climate change effects like prolonged droughts and erratic rainfall	33	32.0
Poor soi structure	11	10.7

Overgrazing	14	13.6

Table 3.4.9. Perceived benefits of sustainable land management practices in Ol'Joro Orok Sub County

Benefits of SLM being practiced farmlands	Frequency	Percentage
Increased agricultural productivity	184	68.1
Enhanced soil health and water retention	116	43.0
Biodiversity conservation	72	26.7
Reduced land degradation	59	21.9
Introduction of eco-tourism	4	1.5
Improved plant health	57	21.1

The perceived benefits of SLM, especially on soil health and water retention, can be amplified with other water conservation practices such as rainwater harvesting that was dominantly (83%) practiced in the area followed by efficient water use (Table 3.4.10). This showed that the community recognizes SLM as a multifaceted approach that integrates agricultural productivity with ecological sustainability, making it a key strategy for climate resilience and land restoration.

Table 3.4.10. Water conservation practices implemented in Ol'Joro Orok Sub County

Water conservation implemented at study sites	Frequency	Percentage
Rainwater harvesting	244	83.0
Construction of water pans	16	5.4
Riverbank protection	13	4.4
Riparian restoration	3	1.0
Drip irrigation	11	3.7
Efficient water uses	120	40.8
Construction of soil water conservation structures like tie and tie, half-moons etc	1	0.3
Use of hydrogels	1	0.3

Studies in Kenya and the rest of the world have shown that SLM remains key to realisation of regreening outcomes. It contributes to the restoration of soil health, water regulation, and ecological biodiversity resulting in enhancement of livelihoods in various landscapes. FAO (2017a) identified SLM as measures designed to biophysical and socio-economic realities that protect, conserve, and restore soil, water and biodiversity-foundational outcomes for regreening at farm and landscape scales. It forms part of the integrated land resource planning that helps land users to select combinations of biological, agronomic and structural options, increasing the effectiveness of and persistence of restoration.

Climate change adaptation and its nexus to regreening practices

The benefits of regreening practices directly contribute to building climate resilience of social and biophysical systems in any landscape. This part of the baseline assessment obtained data on changes in climate patterns of the locality, adaptation measures and their level of perceived effectiveness, and emergence of pests and diseases. It was evident from the study that majority (67%) of the respondents observed changes in climate patterns, which included prolonged droughts, erratic rainfall, temperature rise, delays in rainfall and some extreme weather patterns among others (Table 3.4.11) for varied periods exceeding five years (Table 3.4.12). 20% of respondents said they did not see observed climate changes, and 12% were unsure.

Table 3.4.11. Changes observed by respondents about climate patterns over time in in Ol'Joro Orok Sub County

Changes observed	Frequency	Percentage
Prolonged droughts	64	32
Temperature rise	85	42.5
More hotter seasons	48	24
Delays in rainfall	116	58
Erratic rainfall	97	48.5
Periodic occurrence of floods	9	4.5
Increased flooding	23	11.5
Extreme weather patterns	115	57.5

Table 3.4.12. Period when observed changes about climate patterns over time in Ol'Joro Orok Sub County

Period started observing the changes in climate	Frequency	Percentage
For the last 5 years	63	21.1

For the last 5-10 years	69	23.2
For the last 10-20 years	47	15.8
Over 20 years	21	7.0

These findings demonstrate a high level of awareness of climate change and climate variability within the community. This that is critical, as it often drives adoption of adaptation measures, such as adjusting farming practices or diversifying livelihoods. A smaller segment of the population remains uncertain or unaware, highlighting gaps in climate knowledge and information access. These differences in perception suggest potential variation in vulnerability and readiness to implement adaptive strategies. For example, the observed changes on climate patterns point to increasing seasonal unpredictability and heat stress rather than only one-off events. These perceptions may typically drive farmers to alter planting dates, choose different crops or varieties, and seek climate information to adapt to drought risks reduce increasing exposure to drought risk and crop failures. This is because, the study revealed that the community perceived varied impacts of changes in climate patterns to their regreening practices. These included altered planting seasons (73%), reduced land productivity, increased soil erosion and water scarcity among others (Table 3.4.13).

Table 3.4.13. Effect of changes in climate patterns on regreening practices undertaken at Ol'Joro Orok Sub County

Effect of changes observed on regreening practices	Frequency	Percentage
Increased soil erosion	47	24.5
Altered planting seasons	140	72.9
Reduced productivity	92	47.9
Reduced tree survival	34	17.7
Water scarcity	35	18.2
Emergence of pests and diseases affecting trees, fruit trees and crops	25	13.0

These effects are more likely to undermine regreening efforts by disrupting seasonal timing thus lowering crop/tree productivity and survival, increasing water stress, and accelerating soil loss and exposure to pests and diseases. These combined effects reduce the success rate of tree planting and make farmers more likely to change planting calendars or favour short-term crops over long-term restoration interventions. This implies that regreening interventions must be designed around climate-smart species selection, timing and water-management. A significant minority has not taken any adaptation action, highlighting the need for improved extension services, capacity building, and targeted investments to strengthen community resilience (Table 3.4.14).

Table 3.4.14. Adaptation measures employed by communities in addressing climate change in Ol'Joro Orok Sub County

Adaptation measures in addressing shifts to climate patterns	Frequency	Percentage
Integrating crops and trees (practicing agroforestry)	69	35.4
Selection of drought tolerant tree species	7	3.6
Undertaking climate smart agriculture	49	25.1
Water harvesting	99	50.8
Irrigation systems in farming	11	5.6
Land restoration practices	27	13.8
Soil conservation strategies	55	28.2
Climate resilience investment mechanisms	4	2.1
Engagement in diversity of green-value chain enterprises	6	3.1
Use of climate forecasting tools or early warning systems	1	0.5
None	43	22.1

These adaptation measures were rated differently in addressing the impacts of climate change, varying from not effective at all to being effective. For example, water harvesting was highly rated as effective with a score of 3.741 out of five (5) as compared to agroforestry, climate smart agriculture, soil conservation strategies, integrated soil, water and fertility practices and integrated pest management that were rated somewhat effective whereas use of climate forecasting tools or early warning systems was rated not effective at all (Table 3.4.15). This demonstrated that communities were increasingly being aware of climate changes and their impacts, adopting low-cost, nature-based strategies perceived as most effective, while technical or expensive measures are less used. Some households have not adapted, that may be attributable to limited knowledge, resources, and support among other factors.

Table 3.4.15. Rating the effectiveness of adaptation measures in addressing impacts of climate change in Ol'Joro Orok Sub County

Adaptation measures in addressing shifts to climate patterns	Percentage rating on effectiveness of adaptation measures					Overall score and rating	
	Not effective at all	Slightly effective	Somewhat effective	Effective	Very effective	Mean score	Overall rating
Integrating crops and trees (practicing agroforestry)	19.6	5.4	7.6	58	8.7	3.315	Somewhat effective
Selection of drought tolerant tree species	52.9	20.6	17.6	8.8	0	1.823	Slightly effective
Undertaking climate smart agriculture	23.0	12.2	9.5	43.2	12.2	3.095	Somewhat effective
Water harvesting	6.0	7.8	14.7	49.1	22.4	3.741	Effective
Irrigation systems in farming	39.4	21.2	3.0	18.2	18.2	2.545	Slightly effective
Land restoration practices	30.6	16.3	10.2	36.7	6.1	2.714	Somewhat effective
Soil conservation strategies	18.7	13.3	16.0	44.0	8.0	3.093	Somewhat effective
Climate resilience investment mechanisms	53.6	32.1	3.6	10.7	0	2.036	Slightly effective
Engagement in diversity of green-value chain enterprises	0.6	0.2	0	0.1	0.0	1.814	Slightly effective
Use of climate forecasting tools or early warning systems	64.0	28.0	4.0	4.0	0	1.48	Not effective at all
Integrated soil, water and fertility practices	30.8	3.8	0	61.5	3.8	3.038	Somewhat effective
Integrated pest management	19.2	0	0	80.8	0	3.423	Somewhat effective

Integrated Pest Management (IPM) has been found to reduce crop losses from climate-induced pest outbreaks, stabilizes yields, and lowers reliance on chemical pesticides, supporting sustainable adaptation (Kansiime and Mastenbroek, 2016). This merges with the baseline findings where IPM and traditional knowledge measures were found to be effective in controlling pests and diseases in the farmland (Table 3.4.16). This was in response to the emergence of pests and diseases that were reported in the area and found that were problematic (Table 3.4.17).

Table 3.4.16. Type of pests and diseases that found to be problematic on farm in Ol'Joro Orok Sub County

Pest and diseases problematic on farm	Frequency	Percentage
Insect infestation such as aphids, termites, ants	84	47.5
Fungal diseases e.g. wilting, powdery mildew, root rot	0	0.0
Viral and bacterial infections	0	0.0
Ticks and mites on animals	35	19.8

This showed that insect pests including aphids, termites, and ants were the most problematic to farmers, affecting nearly half of respondents. Animal health issues such as ticks and mites were also significant but less widespread. Interestingly, respondents did not report fungal, viral, or bacterial crop diseases, which may suggest limited occurrence, underreporting, or lack of diagnostic awareness. Overall, pest pressure particularly from insects emerges as a key constraint to both crop and livestock productivity, highlighting the need for integrated pest and animal health management strategies. The methods used for controlling emerged pests and diseases varied and were rated differently with IPM and biological control being the most common, reflecting adoption of environmentally friendly and sustainable

practices. Traditional knowledge measures, such as local botanical remedies or cultural practices were also widely applied, while the use of resistant or indigenous tree species was comparatively less common. Overall, these approaches indicated a blend of modern and traditional strategies aimed at reducing crop and tree losses, enhancing productivity, and supporting sustainable regreening efforts.

Table 3.4.17. Methods used by farmers in controlling emerging pests and diseases in Ol'Joro Orok Sub County

Methods of pests and disease control	Frequency	Percentage
Use of resistant tree species such as indigenous ones	25	9.0
Biological control	110	39.6
Integrated pest management	121	43.5
Traditional knowledge measures	70	25.2

The perceived effectiveness of pest and disease control methods varied among farmers. Traditional knowledge remained a valuable and effective tool for pest management, especially in low-resource settings. IPM and biological control were somewhat effective that should be encouraged alongside farmer training to enhance their effectiveness. Wider access to resistant or indigenous species, coupled with guidance on matching species to local conditions, could increase long-term resilience (Table 3.4.18). It was evident that farmers prefer locally adaptable and knowledge-based interventions, while modern or technical solutions require better support, training, and resource access to improve effectiveness.

Table 3.4.18. Rating the effectiveness of methods of pests and diseases control in Ol'Joro Orok Sub County

Methods of pests and disease control	Rating effectiveness of methods of pests and diseases control						
	Not effective at all	Slightly effective	Somewhat effective	Effective	Very effective	Mean score	Overall rating
Use of resistant tree species such as indigenous ones	39.6	18.8	6.3	22.9	12.5	2.5	Slightly effective
Biological control	13.9	18.1	25.0	37.5	5.6	3.028	Somewhat effective
Integrated pest management	8.1	11.7	15.3	53.2	11.7	3.486	Somewhat effective
Traditional knowledge measures	2.1	8.5	21.3	61.7	6.4	3.617	Effective

Capacity building and skills development in regreening practices

Capacity building and skills development are essential for effective regreening because they empower communities to restore degraded landscapes more sustainably, creating long-term environmental, social, and economic benefits. This baseline assessment examines the support communities have received on regreening initiatives, including training programs, organizational structures (such as groups and associations), community roles in regreening efforts, and access to information about regreening practices. The study revealed significant capacity gaps in regreening knowledge and skills among community members. Only 4% of respondents had received support for regreening practices, 9% had received training, and 30% had accessed information about regreening practices. Among those who received training, the majority (67%) had been trained multiple times, while smaller proportions had been trained once (15%), twice (4%), or three times (15%). These findings indicate that most community stakeholders have been implementing regreening activities with minimal external support. This presents a significant opportunity: targeted capacity building could validate existing efforts and scale up regreening interventions more effectively. Research has shown that training equips farmers, youth, and community groups with practical techniques such as FMNR, agroforestry, and soil conservation, enabling them to take ownership of restoration efforts (WRI, 2015). The training areas proposed by respondents during the baseline survey align well with this approach.

- Agroforestry development and management
- Climate change -mitigation and adaptation measures

- Sustainable farming practices
- Fruit farming and market linkages
- Apiary practices
- Soil and water conservation practices
- Tree growing
- Nursery establishment and management
- Green value chain development
- Pests and diseases management
- FMNR practices
- Leadership and group management

These identified areas of training are critical in regreening as the beneficiaries will gain skills that will help communities to maintain regreening beyond external funding embedding them into daily livelihoods. These will also build resilience, promote innovation and strengthen collaboration where skills in leadership, negotiation and collective action enable communities to organize, advocate for resources and scale regreening across landscapes. Notably, 75% of the respondents affirmed that they do not have farmer groups/associations promoting regreening practices in their communities as compared to 12% who indicated they have and 13% didn't know. This is an imminent gap that requires communities to be organized and form farmers groups that will be supported into associations graduating to cooperatives on specific green products to enable uptake and adoption of regreening practices. For those that have farmer groups/associations, need to be identified and capacitated to aid upscaling of regreening practices as they were undertaking different roles (Table 3.4.19). Therefore, strengthening and expanding group structures may significantly increase promotion and adoption of regreening interventions.

Table 3.4.19. Roles of farmer groups/associations in regreening at Ol'Joro Orok Sub County

Roles do your group/association in regard to regreening	Frequency	Percentage
Advocacy and policy engagement in regreening	12	15.6
Capacity building	11	14.3
Knowledge sharing	9	11.7
Market linkages for green products	10	13.0
Resource mobilization	11	14.3
Seedling supply	7	9.1
Tree planting	17	22.1

Gender roles, people with disabilities and youth engagement in regreening practices

Gender inclusion, disability empowerment and youth engagement remain crucial in building the success of regreening practices as they ensure equity, sustainability and community ownership of landscape restoration efforts. This assessment therefore sought to address the roles of women, men, youth and persons with disabilities in regreening practices and decision-making process as shown in Table 3.4.20. Both men (69%) and women (67%) were dominantly engaged in tree planting and land restoration activities, showing gender balance in these regreening activities. Leadership in community-based conservation efforts was dominantly led by men (67%) compared to women (35%) while 52% of men and 48% of women overall are engaging in sustainable farming practices. This variance and similarity on gender roles demonstrated the uniqueness men and women have in implementing regreening practices. For instance, women's engagement in sustainable farming practices aligns with key roles women play in household food security and natural resources. Equally the fact that both played critical roles in land restoration and farming, showed synergy and complementarity at household level in advancing regreening practices. This implies that designing programs for empowering both men and women is more likely to result achieving better results such as higher tree survival, increase soil fertility, better soil and water conservation practices and stronger community cohesion during regreening.

Table 3.4.20. Roles of men and women in regreening practices at Ol'Joro Orok Sub County

Roles of men and women in regreening practices	**Men**		**Women**	
	(n)	**%**	**n**	**%**
Advocacy & policy influence	64	21.5	49	16.4
Business enterprises in green value chains	54	18.1	41	13.8
Leadership in community-based conservation efforts	202	67.8	106	35.6
Marketing products	1	0.3	0	0.0
Providing Security	1	0.3	0	0.0

Provision of quality tree/fruit seeds	38	12.8	30	10.1
Smart agriculture	1	0.3	0	0.0
Sustainable farming practices	157	52.7	143	48.0
Transportation to planting venue	1	0.3	0	0.0
Tree nursery production	85	28.5	79	26.5
Tree planting & land restoration activities	207	69.5	200	67.1

Studies have underscored the importance of gender inclusivity when addressing regreening issues, where results have shown that some regreening practices are gender sensitive and responsive while others are gender blind. The youths were mainly engaged in community awareness and advocacy (44%), regreening innovation and technology (35%), tree planting (32%) and raising seedlings for regreening activities (Table 3.4.21) showing some gaps in regreening practices and areas of synergy such as technology to leverage on men's and women's roles in landscape restoration. The variance of regreening activities by youth demonstrated a mix of hands-on and intellectual/organizational roles. Their involvement is crucial for sustainability, modern approaches, and future leadership in regreening. Limited participation in agroforestry and other farm-based activities may indicate a need for targeted training, mentorship, and incentives.

Table 3.4.21. Role of youths in regreening activities at Ol'Joro Orok Sub County

Role of youths in regreening activities	n	%
Agroforestry practices	3	1.0
Chicken farming	1	0.3
Community awareness and advocacy	130	43.6
Establishing Green Enterprises and Startups	54	18.1
Forest scouts	3	1.0
Participating in Environmental Clubs & Initiatives	55	18.5
Preparing land for plantation	1	0.3
Raising seedling for regreening	67	22.5
Regreening Innovation & Technology (e.g. Smart Agriculture)	105	35.2
Seed collection for regreening	50	16.8
Tree planting	94	31.5

Persons with Disability (PWDs) have specific needs while being also disproportionately affected by climate change. In view of this, 67% of the respondents were not sure the extent to which Persons with Disability were involved in regreening initiatives as compared to 17% who affirmed so and 16% reported that they are not involved in regreening practices. This implies that there are information gaps about the role of PWDs in regreening activities, demanding a clear need for inclusive and accessible approaches to restoration and green value chain participation. For instance, amongst those that were engaged in regreening practices, the majority undertook tree nursery management and participation in environmental clubs against many of the existing regreening activities in the area (Figure 3.4.3). Further their involvement in decision making for regreening initiatives was low as compared to the overall share of men, women and youth in the study area (Table 3.4.22). This provides further evidence on the need for disability inclusive approaches in regreening.

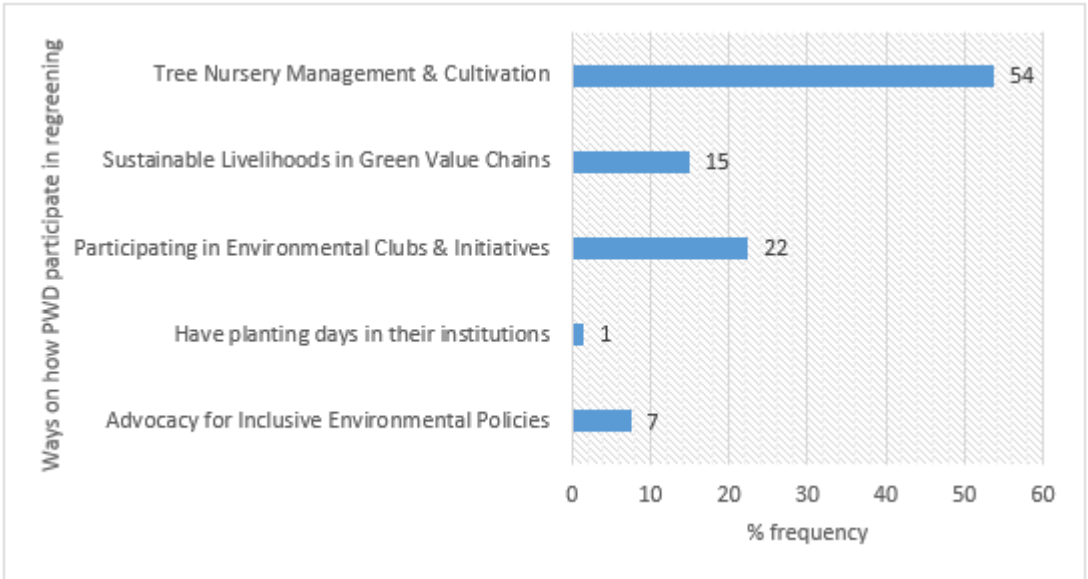


Figure 3.4.3. Ways on how persons with disability participate in regreening initiatives at Ol'Joro Orok Sub County

Table 3.4.22. Level of involvement of men, women, youth and persons with disability in decision making for regreening initiatives at Ol'Joro Orok Sub County

Extent of involvement	Proportion (%) of involvement by men, women, youth and persons with disability in decision making for regreening initiatives			
	Women	Men	Youth	Persons with disabilities
Not at all	3.1	0.7	4.1	12.3
Rarely	18.7	5.8	25.9	50
Sometimes	42.9	31.9	43.9	27.3
Frequently	26.9	38.6	18.7	8.1
Very involved	8.5	23.1	7.5	2.3

Overall involvement in decision making for regreening practices showed that men had the highest level of engagement, with over 60% participating frequently or being very involved. Women were moderately engaged, with most reporting they were sometimes involved (42.9%), reflecting their participation in daily regreening tasks but limited decision-making power. Youth involvement appears mixed: 43.9% reported being sometimes involved, while 25.9% reported rare involvement. This suggests moderate but irregular participation, with a substantial share of youth engaging infrequently. Persons with disabilities were the least involved, with more than 60% reporting rarely *or* no involvement, indicating strong barriers related to accessibility, exclusion from training, and lack of targeted support. Some of the reasons stated why persons with disabilities, men, women and youth were not often involved in decision making for regreening initiatives included the following (Table 3.4.23).

Table 3.4.23. Reasons for not involving men, women, youth and Persons with disabilities in decision making for regreening initiatives at Ol'Joro Orok Sub County

Women	Men	Youth	Persons with disabilities
Cultural norms	Drug and substance use	A belief that youth should not offer advice to people	Differences in communication
Economic class	Fear of home conflicts	Drug and substance abuse	Few people with disabilities hence no entity formed to help them
Home indifferences with husbands	Inaccessibility of information gadgets	Engagement in other businesses	Lack of physical capacity
Household responsibilities	Lack of entities teaching people on environmental conservation	Ignorance	Low accessibility of PWDs

Inadequate capital	Lack of environmental awareness	Lack land	Most of them are mentally incapacitated
Lack of environmental sensitization	Lack of interest in regreening practices	Lack of Capital	Stigmatization
Lack of interest in regreening practices	Lack of knowledge on regreening practices	Lack of interest	They do not have masculine power to handle serious matters
Lack of knowledge on regreening	Lack of prioritization in regreening practices	Lazy youths	They rarely attended to public meetings
Low understanding of species that fit in this climatic condition	Lack of public participation meeting	Not aware of how they can benefit from regreening activities	Weak policy implementation
Male chauvinism	Men who live away from their homes	Relocation to towns	
Many women do not have basic education	Men with mental disorders		
Women do not inherit land	Pests and diseases		
Women do not think of investing through long-term projects such as regreening			

These reasons were further coupled with limited access to information by PWDs on regreening initiatives (Figure 3.4.4)

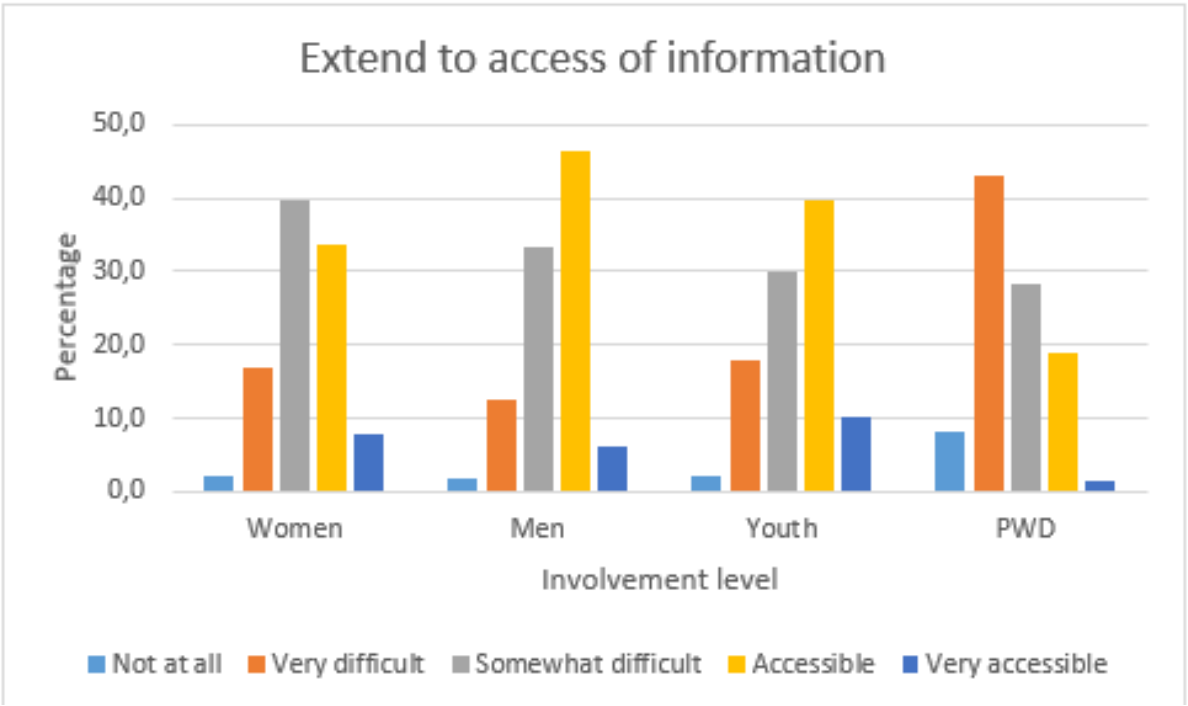


Figure 3.4.4. Extent of access to information by men, women, youth and PWDs on regreening initiatives at Ol'Joro Orok Sub County

In general, persons with disability were least (51%) in accessing as only 20.4% found information accessible or very accessible. Men had fair access (46.4%) to information while women and youth were mostly moderate in accessing regreening information. Overall, the study revealed a clear digital/information divide that disproportionately disadvantages persons with disability and, to a lesser extent, women. These findings add to existing knowledge on the need to include persons with disability in all aspects of regreening for landscape restoration and improvement of livelihood.

Challenges/barriers in re-greening practices

Regreening practices are also prone to challenges hindering their uptake of promising interventions across various landscapes. This study addressed gender responsive challenges including the elderly, youth and persons with disability, land-based barriers and market-based hindrances. The study revealed that gender-related challenges in regreening efforts were nearly evenly split, with 48.8% of

respondents reporting such challenges and 51.2% saying there were none. Although the majority slightly leans toward "No," the high proportion indicating challenges suggests that gender dynamics still play a meaningful role in some areas of regreening. This highlights the need to remain attentive to potential gender barriers when planning and implementing regreening initiatives. For example, the baseline data showed that women were mainly constrained with limited land ownership, lack of financial support for women-led regreening initiatives and cultural and social norms as well as technical skills in regreening practices (Table 3.4.24). These structural barriers, especially land rights, financing, and entrenched gender norms affect their decision-making power in regreening and limit long-term investment in trees and restoration. Equally, technical skill gaps also reflect inequalities in training access and exposure to updated innovative regreening practices in different landscapes.

Table 3.4.24. Challenges/barriers limiting women participation in regreening practices at Ol'Joro Orok Sub County

Challenges women face in regreening practices	Frequency	Percentage
Cultural and Social Norms Limiting Participation	90	30.2
Exclusion from policy implementation	1	0.3
Lack of Financial Support for Women-Led Initiatives	103	34.6
Limited Access to Land Ownership	113	37.9
Technical capacity to fundraise for regreening	28	9.4
Technical skills in regreening practices	62	20.8

The youth was mainly confronted with economic and institutional barriers, which hinders their ability to innovate, adopt green technologies, or participate meaningfully in regreening initiatives/activities. Their exclusion from policy platforms suggests they lack influence in shaping natural resource decisions (Table 3.4.25).

Table 3.4.25. Challenges youth face in implementation of regreening activities at Ol'Joro Orok Sub County

Challenges youth face	Frequency	Percentage
Lack of financial support for green start-ups	125	41.9
Limited access to green-based technology	39	13.1
Limited access to land and decision making	1	0.3
Limited access to training and skill development	75	25.2
Limited policy engagement and representation	87	29.2
Unemployment	1	0.3

PWDs experience socio-cultural exclusion more than any other group, especially stigmatization (70%). Their barriers were embedded in community attitudes, lack of disability-friendly programs, and insufficient financial inclusion. Structural support systems were weak, limiting the ability of Persons with disabilities to join regreening activities (Table 3.4.26).

Table 3.4.26. Challenges Persons with disabilities face in regreening practices at Ol'Joro Orok Sub County

People with disability challenges	Frequency	Percentage
Exclusion from policy and decision making	97	32.6
Lack of community support	158	53.0
Limited access to financial resources	138	46.3
Limited access to regreening inputs	1	0.3
Limited access to training	99	33.2
Low understanding of regreening practices	1	0.3
Physical incapacity to participate in regreening activities	2	0.7
Social stigma	208	69.8

As shown in Table 3.4.27, elderly people were reported to encounter economic and knowledge-related barriers rather than physical limitations. They lack access to modern technologies and participation platforms, reducing their ability to engage in new regreening methods despite having traditional ecological knowledge. Their low engagement on policy matters and representation deprives them an opportunity to fill the expected intergenerational equity in policy formulation on regreening that is ground with local indigenous technical knowledge and experience.

Table 3.4.27. Challenges elderly people face in undertaking regreening practices at at Ol'Joro Orok Sub County

Challenges old people face in undertaking regreening practices	Frequency	Percentage
Excluded from regreening practices	1	0.3
Infection by diseases which hinder them from working	2	0.7
Lack of financial support for green start-ups	211	70.8
Limited access to green-based technology	114	38.3
Limited access to training and skill development	211	70.8
Limited policy engagement and representation	175	58.7
Old age	10	3.4
Shortage of land	1	0.3

There were other multi-dimensional barriers to regreening practices that can broadly be reflected as technical, environmental and socio-economic, pointing to the need for integrated approaches combining input provision, capacity building, policy support, and market facilitation to increase regreening adoption as shown in Table 3.4.28.

Table 3.4.28. Major challenges community face in implementing regreening practices at Ol'Joro Orok Sub County

Major challenges hindering implementation of regreening practices	Frequency	Percentage
Climate extremes such as floods and drought	30	10.1
High cost of technological equipment	19	6.4
Lack of access to digital infrastructure	12	4.0
Lack of financial resources	124	41.6
Lack of knowledge and awareness on regreening benefits	140	47.0
Lack of seedlings	155	52.0
Land tenure issues	79	26.5
Limited access to markets for green products	39	13.1
Poor soils	42	14.1
Resistance from local communities	6	2.0
Water access	78	26.2
Weak policy implementation	19	6.4

The market-based barriers were also identified as significant bottlenecks in the green value chain as shown in Table 3.4.29. These covered structural constraints (poor roads, lack of value addition), financial barriers (limited access to capital, pricing challenges), and knowledge gaps (market intelligence, certification requirements) limiting profitability and sustainability in engaging regreening activities. The proposed solutions such as improved market linkages, youth engagement, digital platforms, government support, and resource provision if implemented are more likely to create new impetus in regreening practices across green value chains.

- Better Market Access for Green Products
- Engaging youth in tree planting exercises
- Enhanced Community Engagement & Awareness
- Expanding digital and e-commerce platforms
- Government support for green business development
- Incentive for sustainable product certification
- Increased Access to Financial Resources
- Provision of fruit tree species
- Provision of pruning equipment
- Strengthening of community groups which will enable easy market access
- Stronger market linkages and partnership
- Stronger Policy Support
- Subsidies, access to technology/Innovation
- The community should be educated on the benefits and effects of different tree species

Table 3.4.29. Challenges community face in accessing market for the green value chain products and services at Ol'Joro Orok Sub County

Challenges in accessing the market for their green value chain products and services	Frequency	Percentage
Lack of certification or standardization	67	22.5
Lack of cooperative groups taking part in regreening practices	1	0.3

Lack of market information and intelligence	57	19.1
Limited finance	122	40.9
Limited Infrastructure for Value Addition	59	19.8
Limited market access	214	71.8
Poor roads/infrastructural network	74	24.8
Pricing & competition challenges	122	40.9
Seasonality in production and low uneconomical volumes	38	12.8

3.5 Biophysical assessment

3.5.1 Overview

Adaptation pathways are largely socially constructed, depending to a large degree on local views of current challenges, visions of the future, and adaptation capacity. Nevertheless, the corners of the opportunity space to develop pathways are pinned by fixed biophysical limits. Each pathway must pass through a fixed biophysical prism to be viable, and this prism also is subject to change with climate change. Biophysical constraints can be determined as a function of the physiognomic characteristics of each site. This can provide a good estimate of the current decision space, and then future decision spaces can be built in a probabilistic manner based on what is currently known and assumptions about the future.

3.5.2 Biophysical Overview of Kenya

Biophysical drivers

In Kenya, elevation and topography are the principal drivers of biophysical conditions. As Kenya is located on the equator, altitude is more important than latitude in determining climate. Solar radiation at the equator drives tropical wind patterns known as the Intertropical Convergence Zone (ITCZ) which creates a bimodal pattern of rainfall. These patterns are modified in a somewhat predictable fashion by the two monsoon systems affecting Kenya- the El Nino Southern Oscillation and Indian Ocean Dipole. The moisture bearing clouds come into Kenya largely from the Indian Ocean and then spatial patterns in rainfall are largely a function of orographic effects (Konecky et al., 2014). This differential rainfall in the country leads to high rainfall in the west and dry conditions in much of the north and east. Temperature also is then determined by elevation, as the atmosphere thins with elevation leading to a cooling effect of roughly -0.6° C per 100 m elevation gain (Coe, 1967).

Soils also vary as a function of elevation, as the parent geology varies with topography and weathering rates vary based on temperature and precipitation. Most of the nutrient-rich deep volcanic soils are concentrated around the mountains, whereas well weathered poor soils are generally found in the low-lying regions (ISIRC, 2004). Hydrology too is a function of elevation as the highland areas receive the majority of rain and then that rain drains to the lowland areas according to topography and soil conditions. These drainage conditions, rainfall, temperature, and soils then determine vegetation and primary productivity. The highest productivity naturally is in the highland areas, with high potential areas also following water courses (van Breugel et al., 2015).

Coarse-scale climate projections

Homa Bay county is in the western portion of the country near Lake Victoria. The county is overall warmer and drier. In the global climate models, southern Kenya falls in the geographic region known as Southeastern Africa which covers much of Tanzania and Kenya and some of Uganda. The general future trends for this area include an increase in temperature (average and extreme events), sea level rise, and flooding. There is more uncertainty however about wind patterns and average rainfall. Under a middle of the road scenario (SSP2), temperature is predicted to increase by 2° C over the next 75 years with more warming in the cooler months (https://interactive-atlas.ipcc.ch).

3.5.3 Biophysical situation of Nyandarua County

Table 3.5.1. Biophysical Characterizations

Biophysical characterizations	Description
Agro-climate Zone	Sub/Semi Humid Lower and Upper Highlands
Elevation	2300-2600m
Rainfall	800-1200mm/yr
Mean Temperature	10-15° C
Soils	Rhodric Nitisols; Ferric Luvisols, Eutric Vertisols
Potential Natural Vegetation	Afromontane undifferentiated forest

The Nyandarua study site is located in the northern part of Nyandarua county in the Ol Jorok sub-county, and the Ol' Joro Orok, Gathanji, Gatimu, Weru and Charagita wards. This is a high elevation (2300-2600 m.a.s.l) area on the north slopes of the Aberdare mountains that contains the headwaters to several river systems feeding the north and east of the country. The area straddles Kenya's topographic divide, whereby water falling in the eastern portion of the site drains into the Ewaso Ng'iro river and from there to the Indian Ocean, whereas water falling in the western portion drains south into the Rift Valley lakes. Consistent with its topographical situation, Nyandarua has a relatively high precipitation (800-1200mm/year, reaching up to 1600mm in the highest elevations), and a cool mean annual temperature of 10-15° C (annual mean maximum of 23°C, annual mean minimum of 6°C). This corresponds to an agro-ecological zone that is characterized by the Farm Handbook as 'Sub/Semi Humid Lower and Upper Highlands (LH2 and UH2/3), optimally suited for growing wheat, pyrethrum, barley, and maize. The geology is largely tertiary volcanics giving rise to deep, nutrient rich soils such as Rhodric Nitisols and Ferric Luvisols, as well as Eutric Vertisols in the poorly-drained valley-bottom areas. These conditions create high potential primary productivity: the Potential Natural Vegetation (PNV) state for the area is characterized as 'Afromontane undifferentiated forest' reflecting biodiverse natural forest state for the area.

The Nyandarua site is currently far removed from it's PNV, as most of the area is currently under dense, small-holder agriculture. This drastic reshaping of the landscape has profound effects on the overall ecology and hydrology of the region. As Nyandarua is located at the headwaters of the Ewaso Narak and Ewaso Ng'iro rivers system, it serves a vital function in protecting these headwaters and regulating the flow of water. Currently only a small portion is left in its natural state- the Ol-bolossat forest reserve and surrounding wetland areas. This forest also serves as a biodiversity reserve for the once large Afromontane forest ecosystem. The large area under constant cultivation on the steep slopes of the Aberdares is also vulnerable to erosion and loss of valuable rich top-soil.

Despite these challenges, the high productivity of the site makes for a broad opportunity space for climate change adaptation. The climate and rich soil can support any number of different agricultural and re-greening pathways, and this makes for interesting possibilities when considering how to address current challenges and move to desired futures. The high altitude will somewhat buffer the area from the largest impacts of climate change, and it's even possible that the warmer conditions, coupled with the CO_2 fertilizer effect, will increase vegetative productivity at least in the near to mid term (IPCC, 2019). This makes Nyandarua the ideal site to experiment with the full range of adaptation options-experimenting with multi-purpose forest corridors, managed wetlands, high value niche crops, and much more.

An overview of vegetation structure and soil health in Ol' Joro Orok Sub County Nyandarua County

Tree species composition and diversity

Cropland, forestland and grasslands were the main vegetation structure in the study area (Table 3.5.2). The species assessment in these vegetation types from 18 plots revealed a total of 20 tree species of 385 trees that were dominated by *Cupressus lusitanica* (37.1%), *Juniperus procera* (13.8%), *Eucalyptus grandis* (13.5%), *Olea europea* (10.6%), and *Pinus patula* (10.1%), indicating a skewed abundance distribution (Figure 3.5.1) and variances in Importance Value Index (IVI)-Table 3.5.3 and Figure 3.5.2. These species characterised forest plantations and agroforestry systems in the humid ecosystem, indicating their ecological adaptation and significance in regreening initiatives. They had an overall

Shannon diversity index of 2.01 implying a moderate level of species diversity that varied across vegetation structures (Table 3.5.1). Cropland sites recorded species richness of 14 and a Shannon index of 1.74, with an evenness value of 0.66. This suggested that although croplands supported a relatively high number of species, dominance by a few species slightly reduced overall diversity. Forest sites exhibited lower species richness (11 species) compared to croplands but showed a higher Shannon diversity index of 1.80 and the highest evenness (0.75), indicating a more equitable distribution of individuals among species and a structurally stable plant community. Grassland plots recorded no tree species, resulting in zero species richness and Shannon diversity, reflecting land-use intensity and limited woody regeneration. These findings demonstrated that tree species diversity was strongly influenced by vegetation structure and land management practices.

Table 3.5.2. Species richness and diversity by vegetation structure in Ol' Joro Orok Sub County

Vegetation structure	Richness	Shannon	Evenness
Cropland	14	1.7411	0.6597
Forest	11	1.8023	0.7516
Grassland	0	0.0000	
Overall	20	2.0070	0.6700

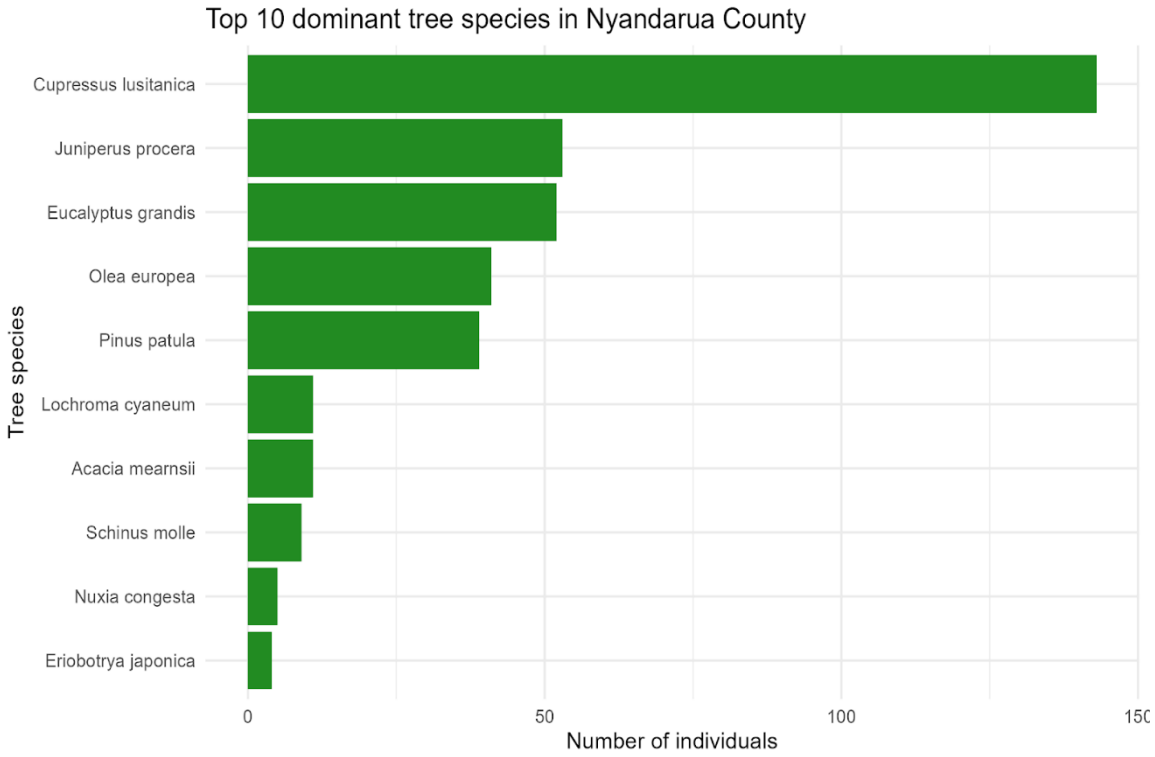


Figure 3.5.1. Top 10 dominant tree species in Ol' Joro Orok Sub County

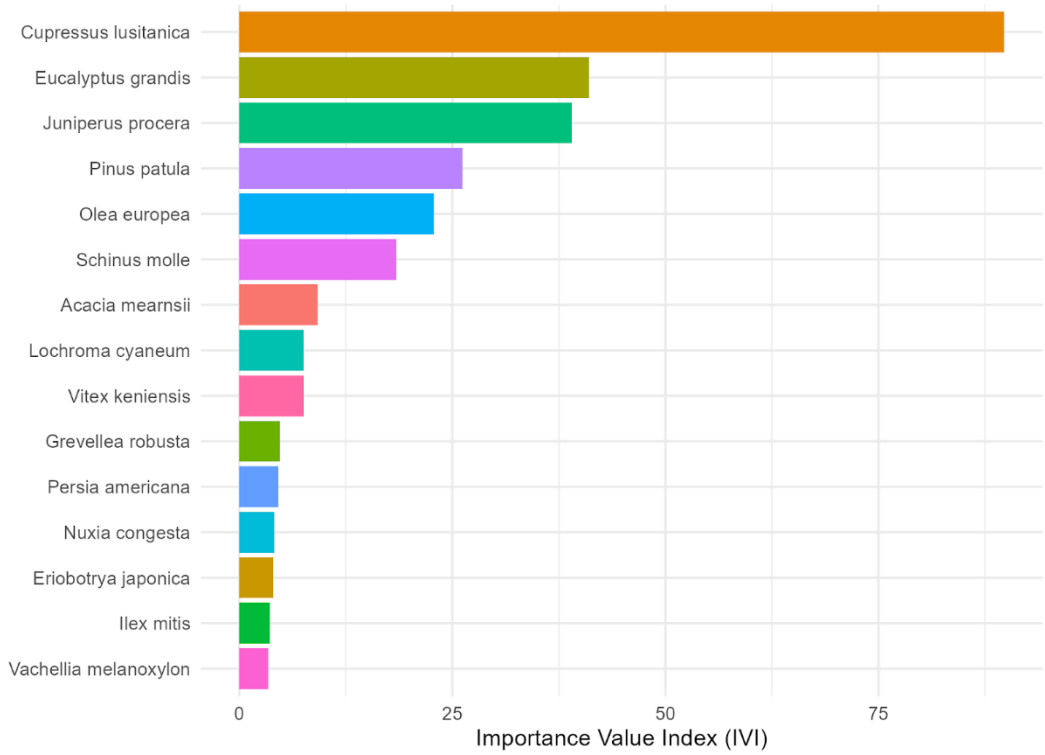


Figure 3.5.2. IVI of tree species in Ol' Joro Orok Sub County

Table 3.5.3. IVI of various tree species in Ol' Joro Orok Sub County

Species	Frequency	Density	Basal area_m2	Relative frequency	Relative density	Relative dominance	IVI
Cupressus lusitanica	8	143	3.94	19.51	37.14	33.11	89.76
Eucalyptus grandis	5	52	1.82	12.19	13.51	15.32	41.03
Juniperus procera	4	53	1.85	9.76	13.77	15.51	39.03
Pinus patula	3	39	1.04	7.32	10.13	8.73	26.18
Olea europea	4	41	0.29	9.76	10.65	2.44	22.85
Schinus molle	1	9	1.62	2.44	2.34	13.63	18.41
Acacia mearnsii	2	11	0.17	4.88	2.86	1.45	9.19
Lochroma cyaneum	1	11	0.27	2.44	2.86	2.26	7.56
Vitex keniensis	2	4	0.19	4.88	1.04	1.62	7.54
Grevellea robusta	1	4	0.15	2.44	1.04	1.28	4.75
Persia americana	1	2	0.19	2.44	0.52	1.63	4.59
Nuxia congesta	1	5	0.05	2.44	1.30	0.40	4.14
Eriobotrya japonica	1	4	0.06	2.44	1.04	0.53	4.01
Ilex mitis	1	1	0.10	2.44	0.26	0.88	3.58
Vachellia melanoxylon	1	1	0.08	2.44	0.26	0.67	3.37
Polyscia spp	1	1	0.05	2.44	0.26	0.41	3.11
Dovyalis abbysinica	1	1	0.01	2.44	0.26	0.10	2.80
Locroma cyaneum	1	1	0.00	2.44	0.26	0.02	2.72
Dodonea viscosa	1	1	0.00	2.44	0.26	0.00	2.70
Maytenus senegalensis	1	1	0.00	2.44	0.26	0.00	2.70

Of these species, *Cupressus lusitanica* (IVI=94.77), *Juniperus procera* (IVI=48.9), and *Eucalyptus grandis* (IVI=45.43) were dominantly in forest land as compared to *Cupressus lusitanica* (IVI = 92.39), *Schinus molle* (IVI=42.58), and *Eucalyptus grandis* (IVI=29.87) that were more present in croplands (Figure 3.5.3)

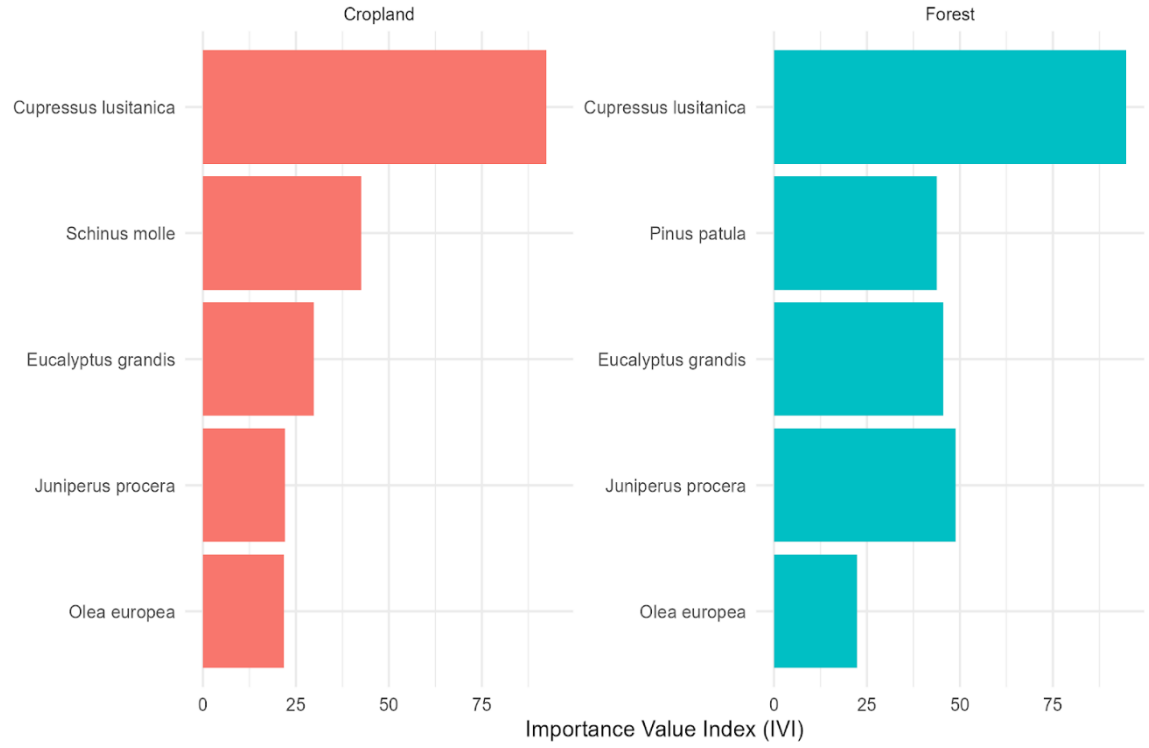


Figure 3.5.3. Top 5 dominant tree species by IVI in forestland and croplands

Further, of the 18 plots assessed, 16 of them contained a total of 385 individual trees, representing a mean tree density of 140.74 trees ha^{-1}, mean basal area of 3.19 m^2 ha^{-1}, average diameter at breast height (DBH) of 16.12 cm, mean height of 13.57 m, and mean crown diameter of 4.71 m. In these assessments, forestland had higher tree densities and basal area relative to cropland and grassland, reflecting reduced disturbance and higher tree retention. Cropland plots were characterised by fewer trees per hectare, consistent with selective retention and management for agricultural production (Table 3.5.4).

Table 3.5.4. Tree structure metrics across forestland, cropland and grasslands at Ol' Joro Orok Sub County

Vegetation structure	No. plots	Total trees	Mean tree density/ha	Mean basal area /ha	Mean DBH (cm)	Mean height (m)	Mean crown (m)
Cropland	3	107	35.7	1.89	21.84	11.54	6.76
Forest	13	278	165.0	3.50	14.80	14.04	4.23
Grassland	2	0	0.00	0.00			

The overall diameter class distribution across vegetation categories was dominated by smaller diameter classes, indicating active tree planting in croplands, forest plantations and active regeneration in natural forests (Figure 3.5.4). The presence of larger diameter classes suggests the retention of mature trees, particularly within forest vegetation structures, contributing to ecological stability.

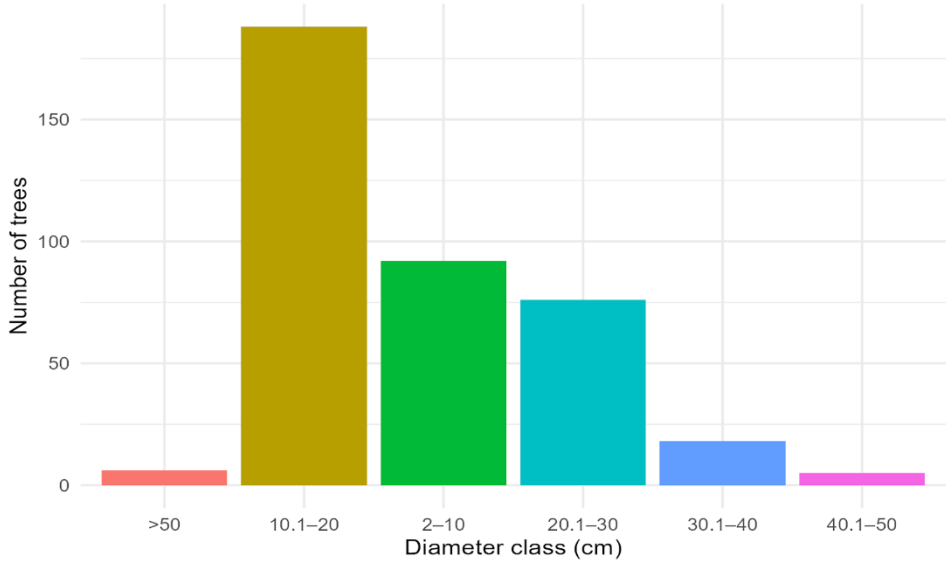


Figure 3.5.4. Overall diameter class distribution across vegetation categories.

Soil health assessment

The soil assessment entailed soil chemical properties, soil organic carbon, soil moisture content, soil colour, rock/gravel cover, soil infiltration, soil texture and bulk density in respective vegetation types/structures/categories. The study revealed that Soil Organic Carbon (SOC), soil organic matter (SOM) and soil moisture were higher in the topsoil layer (0-20 cm deep) across the selected vegetation types as compared to 20-50 cm depth (Table 3.5.5). This is likely to be associated with organic matter accumulation from plant residues and biological activities. However, there were no significant differences ($p>0.05$) in SOC and SOM between 0-20 cm and 20-50 cm depth as compared to soil moisture that significantly varied ($p<0.05$) between the two depths (Table 3.5.6). Overall, SOC in the area was within the good range of 1-3%, a good indicator of soil fertility, crop productivity and resilience to climate change. This is because SOC fuels microbial activities that support release of essential nutrients like nitrogen and phosphorous. It also improves soil aggregation, reducing soil erosion and enhancing root penetration. Higher levels of SOC were evident in forestland (2.4%) and cropland (2.2%) as compared to lower levels in grassland (1.6%). This did not significantly vary across vegetation categories and soil depths. Therefore, maintaining higher levels of SOC through regreening practices will be essential to strengthen the ability of rural farmers in the study area to cope with impacts of climate change.

Table 3.5.5. Soil healthy assessment in different depths and across vegetation categories at Ol' Joro Orok Sub County

	C (%)	SOM (%)	Moisture (%)	pH	EC (mS/cm)	N (%)	P (ppm)	K (ppm)	Mg (ppm)	Fe (ppm)	Cu (ppm)	Ca (ppm)
	Mean values and statistical tests											
Soil depth												
0-20 cm	2.69	36.61	22.38	5.63	0.0509	0.21	25.07	692.3	226.7	5.62	0.03	2530
20-50 cm	1.91	33.51	19.95	5.67	0.0419	0.18	15.90	672.6	229.0	5.91	0.03	1999
S.e.d	0.635	2.561	1.050	0.15	0.00975	0.028	10.45	54.115	65.97	0.526	0.03	254.6 sig*
	NS	NS	Sig*	NS	NS	NS	NS	NS	NS	NS	NS	
Vegetation category												
Cropland	2.22	38.45	21.19	6.12	0.0638	0.18	55.66	701.0	143.2	5.54	0.03	
Forest land	2.44	33.51	21.28	5.59	0.0438	0.21	14.40	665.3	261.2	6.05	0.03	
Grassland	1.59	39.28	20.45	5.31	0.0358	0.15	4.25	757.2	154.7	4.43	0.02	
S.e.d	0.449	4.033	1.654	0.24	0.01379	0.044	16.46	85.205	103.87	0.828	0.002	
	NS	NS	NS	Sig*	Sig*	NS	Sig*	NS	NS	NS	NS	

NS=Not significantly different (p>0.05); Sig*=Significant at 5% (p<0.05)

Table 3.5.6. Soil health assessment at Ol' Joro Orok Sub County

Soil parameters & Chemical properties	Soil depth	Cropland	Forestland	Grassland	
		Mean	Mean	Mean	S.e.d
Soil carbon (%)	0-20 cm	2.57	2.83	2.03	0.635
	20-50 cm	1.87	2.04	1.14	
Soil Organic Matter (%)	0-20 cm	40.45	34.97	40.63	5.703, NS
	20-50 cm	36.44	32.05	37.93	
Soil moisture (%)	0-20 cm	22.05	22.72	20.84	2.339, NS
	20-50 cm	20.33	19.84	20.06	
pH	0-20 cm	6.01	5.59	5.32	0.344, NS
	20-50 cm	6.23	5.60	5.30	
EC (m S/cm)	0-20 cm	0.070	0.047	0.042	0.0138, NS
	20-50 cm	0.058	0.040	0.029	
Nitrogen (%)	0-20 cm	0.19	0.22	0.17	0.062, NS
	20-50 cm	0.16	0.19	0.13	
Phosphorous (ppm)	0-20 cm	67.31	17.79	5.41	23.280, NS
	20-50 cm	44.02	11.00	3.09	
Potassium (ppm)	0-20 cm	709.0	671.7	790.8	120.49, NS
	20-50 cm	693.1	790.8	723.6	
Magnesium (ppm)	0-20 cm	144.8	258.0	161.5	146.89, NS

Soil parameters & Chemical properties	Soil depth	Cropland	Forestland	Grassland	
		Mean	Mean	Mean	S.e.d
	20-50 cm	141.6	264.4	147.8	
Iron (ppm)	0-20 cm	5.41	5.90	4.26	1.171, NS
	20-50 cm	5.67	4.26	2.61	
Copper (ppm)	0-20 cm	0.03	0.03	0.02	0.03, NS
	20-50 cm	0.03	0.03	0.02	

Further analysis based on regression model revealed that of the three study locations, Gathanji had significantly higher ($p<0.05$) SOC (2.55%) as compared to Gatimu (1.57%) and Weru (2.46%) across soil depths and vegetation categories (Table 3.5.7). Fields that were characterised by *Pinus patula* plantations had higher SOC (2.72%) followed by mixed species (2.11%), *Cupressus lusitanica* plantations (2.48%), agroforestry (2.11%), Eucalyptus plantations (1.90%) and least from grass and shrubs (1.67%) across soil depths where SOC was consistently higher in 0-20 cm depth (Table 3.5.8). This is because *Pinus patula* plantations tend to have higher SOC due to their dense canopy, high litterfall, slower decomposition rates, and favorable microclimate conditions that promote greater carbon accumulation compared to mixed species, *Cupressus lusitanica*, Eucalyptus spp, agroforestry systems, or grasslands. Specifically, *Pinus patula* produces abundant needle litter that decomposes slowly (as pine needles are rich in lignin and resins that resist microbial breakdown), allowing carbon to accumulate rather than being rapidly mineralised resulting in continuous adding of organic matter to the soil. This contrasts with fields characterised by Eucalyptus species whose leaves decompose faster and release allelopathic compounds that suppress microbial activity, reducing SOC. Other species with more labile leaf material and faster decomposition rates such as grass and shrubs *and Cupressus lusitanica* that also produces less litter.

The closed canopy of *Pinus patula* reduces soil temperature fluctuations and evaporation creating cooler, moister conditions favouring carbon preservation as compared to agroforestry systems and grasslands that expose soils to higher temperatures and faster organic turnover. Pines also have extensive root systems that contribute to below-ground biomass where root turnover adds stable organic carbon fractions to the soil, enhancing SOC. This is in contrast with shallow-rooted grasses or fast-growing eucalyptus species with lower litter quality and mixed species characterised by higher diversity that enhances nutrient cycling that may dilute carbon inputs associated with species of fast-decomposing rates. Equally, agroforestry systems balance crops and trees where there are frequent soil disturbance and harvests that reduces SOC accumulation. Overall, these variations of SOC suggest the need to promote site species matching essential in building up SOC especially in croplands to improve resilience to climate change.

Table 3.5.7. Predicted mean values from regression model on soil healthy assessment

	C (%)	SOM (%)	Moisture (%)	pH	EC (mS/cm)	N (%)	P (ppm)	K (ppm)	Mg (ppm)	Ca (ppm)	Fe (ppm)	Cu (ppm)
Location												
Gathanji	2.55	36.44	22.22	5.61	0.045	0.229	11.80	607.9	272.8	2191	6.56	0.027
Gatimu	1.57	26.24	18.58	5.53	0.049	0.129	13.72	835.2	175.7	1771	4.29	0.022
Weru	2.46	36.88	23.43	5.88	0.055	0.171	17.52	728.6	159.7	2745	6.31	0.025
S.e.d	0.445 Sig*	2.462 Sig*	1.323 Sig*	0.216 NS	0.0063 NS	0.044 Sig*	14.82 Sig*	67.13 Sig*	120.9 NS	360.8 sig*	0.510 Sig*	0.002 Sig*
Texture grade												
Clay	2.41	36.54	22.42	5.68	0.047	0.213	7.09	636.0	242.6		6.55	0.027
Clay loam	3.07	33.67	21.61	5.53	0.049	0.227	49.59	649.0	288.8		5.70	0.028
S.e.d	0.362 NS	1.978 NS	1.064 NS	0.174 NS	0.0051 NS	0.035 NS	11.91 Sig*	53.96 NS	97.2 NS		0.410 Sig*	0.001 NS
Vegetation Description												
Agroforestry	2.11	38.25	21.20	6.14	0.063	0.173	45.96	713.0	127.2	2806	5.48	0.026
C. lusitanica plantation	2.48	36.65	23.74	5.51	0.044	0.215	11.72	625.0	243.6	2205	6.89	0.028
Eucalyptus Plantation	1.90	20.82	16.68	5.31	0.027	0.122	15.54	924.9	185.0	1632	2.88	0.021
Grass and shrubs	1.67	41.36	20.45	5.26	0.029	0.174	6.96	722.2	160.5	1438	4.37	0.024
Mixed species enrichment planting	2.61	34.36	21.65	5.45	0.028	0.184	6.27	667.9	377.6	1738	6.74	0.028
P. patula plantation	2.72	37.28	20.71	6.10	0.066	0.257	13.72	584.6	230.0	3364	6.16	0.025
S.e.d	0.519 NS	2.843 Sig*	1.529 Sig*	0.250 Sig*	0.0073 Sig*	0.050 NS	17.12 NS	77.54 NS	139.7 NS	457.6 Sig*	0.589 Sig*	0.002 NS

NS=Not significantly different (p>0.05); Sig*=Significant at 5% (p<0.05)

Table 3.5.8. Predicted means from regression model on soil parameters and chemical properties in different species configuration

		Predicated Mean values of soil parameters and chemical properties across tree farming systems						
Soil parameters & Chemical properties	**Soil depth**	**Agroforestry**	**C.lusitanica plantation**	**Eucalyptus plantation**	**Grass& shrubs**	**Mixed planting Species enrichment**	**P. patula plantation**	**s.e.d**
Soil carbon (%)	0-20 cm	2.46	2.97	1.85	2.12	2.57	3.22	0.725
	20-50 cm	1.76	1.88	1.95	1.23	2.66	2.04	NS
Soil Organic Matter (%)	0-20 cm	40.26	36.62	24.53	40.01	34.78	39.84	3.966
	20-50 cm	36.24	36.70	17.11	33.69	33.69	33.79	NS

		Predicated Mean values of soil parameters and chemical properties across tree farming systems						
Soil parameters & Chemical properties	**Soil depth**	**Agroforestry**	**C.lusitanica plantation**	**Eucalyptus plantation**	**Grass& shrubs**	**Mixed planting Species enrichment**	**P. patula plantation**	**s.e.d**
Soil moisture (%)	0-20 cm	22.06	24.70	18.87	20.84	22.88	22.10	2.133
	20-50 cm	20.34	22.52	14.49	20.06	20.41	18.82	NS
pH	0-20 cm	6.03	5.56	5.18	5.27	5.51	6.04	0.349
	20-50 cm	6.25	5.44	5.44	5.25	5.39	6.18	NS
EC (m S/cm)	0-20 cm	0.069	0.047	0.030	0.035	0.033	0.068	0.010
	20-50 cm	0.057	0.040	0.024	0.022	0.225	0.064	NS
Nitrogen (%)	0-20 cm	0.189	0.225	0.150	0.195	0.203	0.273	0.071
	20-50 cm	0.156	0.203	0.094	0.154	0.165	0.234	NS
Phosphorous (ppm)	0-20 cm	57.61	15.37	13.22	8.12	5.02	11.60	23.88
	20-50 cm	34.31	7.13	17.86	5.80	7.53	16.60	NS
Potassium (ppm)	0-20 cm	721.0	639.4	886.9	755.8	703.7	591.8	108.2
	20-50 cm	705.0	606.9	962.9	688.6	632.1	574.8	NS
Calcium (ppm)	0-20 cm	2999	2576	1611	1455	2063	3768	639.8
	20-50 cm	2613	1835	1752	1420	1412	2960	NS
Magnesium (ppm)	0-20 cm	128.8	267.5	177.2	167.3	345.5	189.2	194.9
	20-50 cm	125.5	213.5	192.8	153.6	409.7	285.6	NS
Iron (ppm)	0-20 cm	5.36	6.76	2.82	4.19	6.62	5.91	0.822
	20-50 cm	5.61	7.05	2.94	4.55	6.85	6.52	NS
Copper (ppm)	0-20 cm	0.025	0.029	0.021	0.024	0.027	0.024	0.003
	20-50 cm	0.026	0.027	0.021	0.025	0.030	0.027	NS

Soil Organic Matter (SOM) was above the expected range of 2-10%, which is very unusual implying that the values are likely to be wrong requiring re-assessment. Soil moisture was within the range of 20-60% across vegetation and soil depth, except for 20-50 cm. This showed that soils in the study area were of good quality that need to be maintained and improved through regreening practices, especially in soil moisture that was at minimum level. For instance, the study revealed that soils were largely clay and clay loam with average moisture content of 22.4% and 22.6%, respectively. This showed that clay soils had below the expected moisture content (MC) of 30-60% as compared to loamy soils with a range of 20-40% MC that were within, but at close to minimum (Table 3.5.7). This may point to challenges of maintaining adequate moisture that is essential in nutrient uptake key for crops directly affecting yield and biodiversity, regulation of microbial activities as well as decomposition rates, influencing SOC and SOM dynamics and resilience against drought. Notably, monitoring soil moisture helps farmers to manage irrigation efficiently, reducing water stress to crops and other priority tree species or agroforestry systems.

Bulk density values varied from 0.72 g/cm³ to 1.88 g/cm³, reflecting differences in soil texture, structure, compaction, and organic matter content. It increased with depth, which is typical in most soils due to lower organic content and increased compaction. The analysis of chemical properties (pH, N, P, K, Mg, Cu and Fe) revealed no significant differences ($p>0.05$) across soil depths. Overall, the mean soil pH was 5.65 with a minimum value of 4.72 and maximum value of 6.56 across selected vegetation categories and study sites. This implied that overall, the soils were moderately acidic suitable for many crops as. This was buttressed by lower quartile (LQ) of 5.20, upper quartile (UQ) and median value of 6.05, implying that at least half of the soils were near neutral, suggesting good conditions for most crops whereas a quarter of the soils were more acidic, which may require management interventions such as liming, addition of organic matter and other appropriate regreening practices. This is evidenced by instances where some samples recorded a minimum of 4.72, showing strongly acidic soils that may point to the presence of aluminium and manganese toxicity. This is most likely to contribute to reduction of phosphorous, calcium and magnesium nutrient uptake by plants, resulting in poor yields and increased vulnerability of households to food insecurity, if in cropland.

Comparisons of soil pH regardless of soil depths revealed significant differences ($p<0.05$) where cropland soils tended towards neutral (6.12) as compared to forestland (5.59) and grassland (5.31) that were more acidic. The minimum soil pH in cropland was 5.64 and maximum was 6.56 with LQ of 5.76 and UQ of 6.38. This demonstrated that cropland favours a variety of crops that thrive in different soil acidity levels. For example, in moderately acidic soils (pH 5.5-6.0), food crops such as maize, sorghum, beans, groundnuts, cowpeas and other staple crops that balance productivity with soil acidity tolerance performs better as compared to citrus, bananas, lucerne/alfalfa and high yielding maize varieties that grow well in near-neutral soils (pH 6.0-6.5). The ranges of soil pH in croplands also favours agroforestry systems like integration of *Grevillea robusta* and beans/maize (pH 5.5-6.0), avocado and bananas (pH 5.0-6.5), mango and groundnuts (pH 5.5-6.5) among others; forage grasses such as Napier grass and drought tolerant Rhodes grass (pH 5.0-6.5) and lucerne legume fodder that performs best when soil pH is at 6.0. These improve soil fertility, carbon storage, livestock nutrition and soil cover, reducing soil erosion contributing to household food security.

The soil pH in forestland ranged from a minimum of 4.72 to a maximum of 6.53 with median of 5.58, LQ of 5.18 and UQ of 5.93 demonstrating high acidity levels that favour growth of some tree species. For instance, *Pinus patula* and *Cupressus lusitanica* grow well in acidic soils (pH 4.7-5.5) as compared to *Grevillea robusta* and Eucalyptus spp that thrive well in moderately acidic near neutral (pH 5.5-6.5). Grassland soil pH varied from a minimum of 5.16 to a maximum of 5.48 with median of 5.30, LQ of 5.18 and UQ of 5.43, effectively favouring forage and legume fodder. These demonstrate potential of identified green value chains from validation and upscaling in realising the expected outcome of regreening practices.

The analysis of primary macronutrients Nitrogen (N), Phosphorous (P) and Potassium (K) that are essential in plant growth showed that overall N was an average of 0.194% with a minimum of 0.082%, maximum of 0.387%, median of 0.190%, LQ of 0.144% and UQ of 0.229% across all vegetation categories, soil depths and study sites. This implied that on average N was within the best range of 0.1-0.2%, showing medium to high fertility range for total soil nitrogen, suggesting that most soils had adequate nitrogen reserves, supporting good vegetation growth. Samples that had a minimum value of N were below the set range indicating nitrogen-deficient soils. In such samples, if in cropland, crops are likely to show poor leaf growth, yellowing and stunted development unless supplemented with N

fertilizers or organic matter. Samples with maximum N that was above the set range indicated very fertile soils with abundant organic matter, more likely in topsoil. Such soils can supply sufficient N for most crops with heavy fertilizer. The amount of N did not significantly differ ($p>0.05$) across cropland, forest land and grassland as well as between soil depth and vegetation characterisation (Table 3.5.9) except among the study locations where Weru had the least N (0.171%) as compared to Gatimu (0.129%) and Gathanji (0.229%).

The average Phosphorus (P) across cropland, forest land and grassland and between soil depths was 20.49 ppm with median of 9.653 ppm, minimum of 0.772 ppm, maximum of 166 ppm and LQ of 5.405 ppm and UQ of 19.31. This implies that on half the soils tested, P was within the best range of 10-25 ppm, but half of the soils were below 10 ppm meaning that soils in the area were largely P deficient and the average was skewed toward maximum value of 166 ppm which is extremely high and outside the expected range, implying such soils will not respond to additional P fertilizer causing nutrient imbalances like zinc or iron. The minimum value showed that such samples were extremely P deficient resulting in poor root growth and purpling of leaves. The higher values of P were recorded from samples taken from cropland, largely practising agroforestry with *C. lusitanica* dominating followed by *J. procera* and *Eucalyptus grandis* (166.02 ppm from 0-20 cm and 113.51 ppm from 20-50 cm), and forest land of *Pinus pat*ula plantation (66.64 ppm from 0-20 cm and 33.59 ppm from 20-50 cm, 30.89 ppm from 0-20 cm depth). These results skewed the mean and pooled the data outside the expected range, resulting in significant differences of P among the vegetation categories.

Soils sampled across study location, soil depths and vegetation categories had the highest amount of exchangeable Potassium (K) that was well above the optimal range of 100-250 ppm. The average K was 682.4 ppm with median of 658.8 ppm, minimum of 435.7 ppm, maximum of 993.5 ppm, LQ of 612.2 and UQ of 755.3. The K estimates were not significantly different ($p>0.05$) among vegetation categories (forestland, cropland and grassland) and soil depths except in study locations where Gatimu had highest average of P (835.2 ppm) followed by Weru (728.6 ppm) with least from Gathanji (607.9 ppm). This indicated that soils in the study areas were very rich in K, far exceeding the levels typically required for most crops. Whereas this ensures crops will not suffer K deficiency, excessive K could interfere with the uptake of other nutrients, especially Ca and Mg leading to potential imbalances. This implies that the management of these soils should focus on balancing nutrients by ensuring adequate N and P and monitoring Ca and Mg to avoid antagonism from excess K as these soils do not need potash fertilizers. High levels of K are beneficial to crops like bananas, potatoes and cassava.

The secondary macronutrients Calcium (Ca) and Magnesium (Mg) that support structural and metabolic activities in plants and micronutrients Iron (Fe) and Copper (Cu) that help enzyme and physiological functions were varied. Specifically, Ca and Fe were within best ranges as compared to Mg which was exceedingly higher from the range and Cu was very low and not within required best ranges, implying that soils were very Cu deficient, a critical micronutrient (Table 3.5.9). Ca, Fe and Cu significantly ($p<0.05$) differed across study locations, vegetation descriptions and soil depths (Tables 3.5.9). Small amounts of Cu demonstrate that crops in the study locations are more likely to suffer from grain filling, dieback of shoots and weak plant structure, demanding strong copper responsive farm inputs.

Table 3.5.9. Mean statistics for secondary macronutrients and micronutrients across vegetation types and soil depths

Chemical properties	Mean	Median	Minimum	Maximum	LQ	UQ	Required range
Ca (ppm)	2296	1910	1102	4471	1524	3077	1000-3000
Mg (ppm)	227.9	148.1	88.99	795.2	132.1	191.7	50-120
Fe (ppm)	5.768	5.848	2.24	8.153	5.108	6.674	2-10
Cu (ppm)	0.026	0.0258	0.0169	0.0354	0.0237	0.0278	0.2-2

Overall mean Ca implied that most soils were fertile supporting good soil structure and plant growth as compared to those samples with minimum Ca requiring monitoring to avoid deficiencies. In contrast, samples with high Ca exceeding range may cause nutrient antagonism, reducing availability of Mg and K, which was not evident in the data as the soils demonstrated they were magnesium rich.

3.6 Green value chain assessment on forest and tree-based productions

3.6.1 Overview

This assessment aimed to address the research question on identifying, testing and validating promising green value chain enterprises for landscape restoration to improve livelihoods and build resilience to climate change across selected study sites/agro-ecological zones. This is to be achieved through:

i. Identifying green value chain enterprises for landscape restoration.
ii. Examining how identified green value chain enterprises could contribute to livelihood improvement and resilience to climate change.
iii. Assessing how green value chain enterprises for landscape restoration are promoted.
iv. Evaluating determinants for adoption of green value chain development for landscape restoration and resilience to climate change.
v. Identifying suitable pathways for promoting and scaling up re-greening options and green value chain enterprises for landscape restoration and resilience to climate change.
vi. Establishing market options for improved access to green value chain products.
vii. Synthesis of the barriers/constraints that will affect promotion of green value chain enterprises for landscape restoration and adaptation to climate change.
viii. Identifying policy-based incentives required to accelerate uptake of re-greening options and green value chain enterprises.

This baseline focused on identification of green value chain enterprises for landscape restoration, livelihood improvement and building resilience to climate change, policy-based incentives, effects of climate change on green value chain enterprises and barriers affecting uptake of green value chain enterprises. The other areas will be assessed on the basis of baseline results.

3.6.2 Results

Categories of green value chain actors and their demographic characteristics

Majority (42%) of the green value chain (GVC) actors interviewed were Distributors, followed by Processors with least from service providers. Of these respondents, most (69%) of them were men as compared to their female counterparts. These were mainly drawn from Gatimu Ward (68%) in contrast with other wards. The highest education level of the GVC actors varied from primary to university with the majority (46%) having attained secondary education. The age category of the value chain actors varied from 25 to over 55 years, with the majority (39%) over 55 years. These results as shown in Table 3.6.1 imply that most of the green value chain actors in the study area were engaged in production and marketing of the various products from their farm produce with little processing and input from service providers such as extension, training, access to market information among others. Considering that of the sampled respondents, all had basic education, it shows that the GVC actors had knowledge of what they were doing and can easily be informed about their business. In addition, the age bracket demonstrated that GVC had some reasonable experience in their business.

Table 3.6.1. Type of Green Value Chain Actors and their demographic characteristics Ol' Joro Orok sub-County

Category	Descriptors	Frequency	Percentage (%)
Green Value Chain Actors	Producers	9	29
	Processors	8	25.8
	Distributors	13	41.9
	Service Providers	1	3.2
	Total	**26**	**100**
Administrative Wards	Gathanji	5	20
	Gatimu	17	68
	Weru	3	12
	Total	25	100
Gender of respondent	Male	18	69.2
	Female	8	30.8
	Total	**26**	**100**

Category	Descriptors	Frequency	Percentage (%)
Highest education level	None	0	0
	Informal education	0	0
	Primary	7	26.9
	Secondary	12	46.2
	Tertiary colleges	5	19.2
	University	2	7.7
	Total	**26**	**100**
Age category of respondent (years)	18-24	0	0
	25-35	3	11.5
	36-44	5	19.2
	45-55	8	30.8
	Over 55 years	10	38.5
	Total	**26**	**100**

Status of green value chain enterprises for landscape restoration

The analysis of the potential of the green value chain for landscape restoration was based on the activities undertaken by producers, processors, distributors and service providers as described in each of the following.

a) Producers in green value chain for landscape restoration

The producers were mainly engaged in producing tree and fruit seedlings followed by timber products and least on non-timber forest products/fodder trees as shown in Table 3.6.2 and Table 3.6.3. They have been engaged in production for an average of 14.7 years (std. error of the mean, 2.963) with a minimum of one year to a maximum of 30 years. This aligns well with socio-economic household survey data that revealed 62% (n=136) linked their regreening products to green value chain enterprises such as fruits, edibles, bee keeping, timber forest products (poles, posts) and firewood among others as compared to 38% (n=83) who did not (Figure 3.6.1). The reasons that constrained farmers to link their farm produce to green value chain enterprises included the following:

- Focusing on other ventures that can generate money easily.
- Growing for domestic use only.
- Inadequate land.
- Lack of enough capital to invest in green value chain enterprises.
- Lack of groups/associations participating in green value chain enterprises.
- Lack of market for green value chain enterprises.
- Lack of fruit tree seedlings.
- Growing trees for aesthetic purposes.

Table 3.6.2. Type of green products produced by producers in Ol' Joro Orok sub county

Type of green products produced	Frequency (n)	Percentage
Fodder trees	1	5.9
Fruit tree seedlings	5	29.4
Tree seedlings	6	35.3
Non timber forest products	1	5.9
Timber products	4	23.5
Total	17	100.0

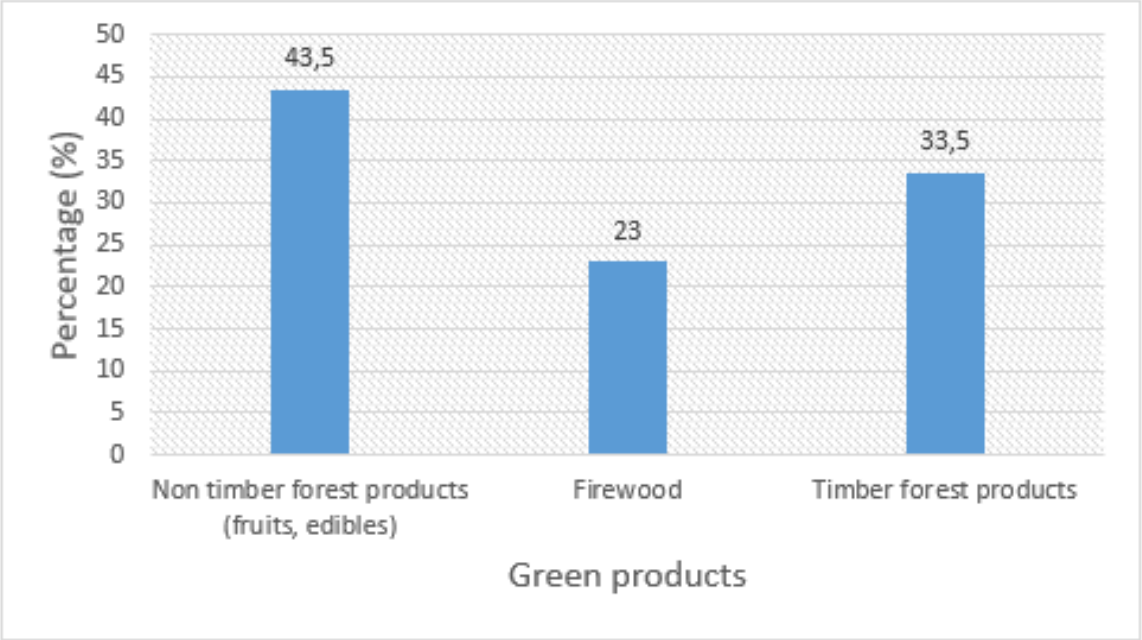


Figure 3.6.1. Products linked to green value chain enterprises from the socio-economic household survey in Ol' Joro Orok sub county

Table 3.6.3. Summary of most preferred green products

Product category	Type	Frequency (n)	% frequency
Fruit tree seedlings and products	Avocado, Tree tomato, oranges	9	50
Timber tree seedlings and timber products	*Grevillea robusta, Eucalyptus spp, Cupressus lusitanica*	9	50
Total		18	100

The reasons stated for their preference for fruit trees and products included but were not limited to the following:

- Adaptable to the climate.
- Cost effective.
- High demand in the market.
- Medicinal benefits.
- Minimal attacks by pests and diseases.
- Nutritional value.
- Profitability.
- Easy transport.
- Conservation advantages.

For the timber tree species and timber products, the following reasons for their preference were reported by the interviewees:

- Grows faster as compared to indigenous species.
- Better prices of timber products and seedlings.
- Medicinal benefits especially for *Eucalyptus spp.*
- Minimal attacks from pests and diseases.
- Conservation advantages.

Further, the GVC actors also considered medicinal benefits, conservation of riparian ecosystems, adaptable to the climate and resistance to pests and diseases as reasons for preferring indigenous tree species.

Overall, these reasons align with motivation factors (Table 3.6.4) that enable the producers to engage in the production of green products. These included profitability, employment creation, interest in environmental conservation, contribution to restoration of degraded landscapes and challenges of climate change in the area.

Table 3.6.4. Motivations for developing green products

Motivation factors	Frequency (n)	Percentage
Profitability	7	22.6
Employment creation	8	25.8
Interest in environmental conservation	7	22.6
Contribution to restoration of degraded landscapes	2	6.5
Challenges of climate change	5	16.1
Total	17	100.0

Further, of the producers, some were engaged in different regreening practices (Table 3.6.5) such as use of eco-friendly inputs (15%), restoration of degraded landscapes (10%), sustainable farming practices (35%) and agroforestry (40%). These demonstrated the potential of upscaling green value chains to realise the benefits of regreening practices. For instance, of the sampled producers, 92% indicated they have plans to upscale the production of green products as compared to 8% who did not. Some of their reported strategies laid down included but are not limited to the following:

- Planting and growing high demand varieties of fruit trees and timber tree species.
- Adoption of new farming methods that are climate responsive.
- Increasing capital for investment in production of green products.
- Access of more land for regreening activities.
- Using irrigation to increase production.
- Ensure timely planting of high-quality germplasm.
- Raising awareness of the community on regreening activities.

Table 3.6.5. Types of regreening practices producers in green value chains were engaged

Type of regreening practices	**Frequency (n)**	**Percentage**
Agroforestry	8	40
Restoration of degraded landscapes	2	10
Sustainable farming	7	35
Use of eco-friendly inputs	3	15
Total	20	100.0

The engagement of producers in tree and forest-based activities such as fruit tree growing, provision of raw materials for production of timber, poles, posts and other related timber products, growing of indigenous trees for medicinal benefits and aesthetic values, using of sustainable farming practices in crop production and producing non timber forest products have significant contribution to landscape restoration. For instance, the involvement of producers in using eco-friendly inputs is likely to contribute to reduction of reliance on harmful chemical fertilizers and pesticides that degrade the landscapes. Equally, shifting to regenerative agriculture is likely to contribute to restoration of soil fertility and reduction of soil erosion. Overall, the integration of trees into farming systems/adopting agroforestry, organic farming and other climate responsive techniques with optimal ecosystem services are more likely to contribute to landscape restoration and build resilience of social and biophysical systems against the shocks of climate change. This is because evidence has shown that creating tree-based value chains such as timber, fruits, nuts, honey, and medicinal plants directly contributes to conservation of such valuable species that results in the restoration of degraded landscapes (Dissanayaka et al., 2025; FAO, 2017). In addition, growing forage shrubs and grasses such as *Leucaena*, *Calliandra*, *Pennisetum purpureum* along contours restores soils and provides livestock feed. These value chains enhance livestock productivity and reduce grazing pressure on fragile lands (FAO, 2021).

Consequently, successful tree based green value chains have led to producers complying with the requirements of market-driven restoration and processing of green products. Specifically, there are instances where producers have been pushed to align with buyers and cooperatives that demand products from sustainably managed landscapes that integrate certification schemes. These have

proved to reward producers who restore landscapes by engaging in organic, fair trade and forest-friendly productions. This has resulted in producers ensuring long-term adoption of green practices. Notably, this led to producers organizing themselves into groups/associations acting as local stewards of restoration where they mobilize other farmers to grow and protect valuable trees in their farmlands and communal lands, resulting in reducing pressure on degraded lands. This has yielded to other environmental services such as engaging in carbon market or payment of ecosystem services schemes like The International Small Group and Tree Planting Program (TIST) in Nyandarua that is offering financial incentives for landscape restoration. TIST encourages farmers to plant and grow indigenous and multipurpose trees that restore degraded soils, reduce erosion and improve water cycles. They also encourage farmers to diversify their income streams through production honey, fruits, timber and carbon credits. This has resulted in the creation of microclimates that reduces drought impacts, improves crop yields and minimizes vulnerability to the vagaries of climate change.

b) Processors in green value chain for landscape restoration

There was ineligible processing of green products in the study area. Out of the eight (8) processors identified, only six (6) responded that they were involved in extraction of non-timber forest products, eco-friendly packaging, furniture making, making of beds and sofa sets, sustainable wood treatment and timber production. Of these processors, they obtained their raw materials from forests and farmlands and sourcing them from timber yards. They have been engaged in this value chain for a minimum of 3 years and a maximum of 35 years resulting in an average of 16.5 years with standard error of 4.127. Whilst this shows a long period of experience that could have inspired many in the area, there is much to be done to profile green value chain actors. This demonstrated a significant gap of linkage between producers and processors. It further showed inadequate data that requires follow-up so to align or organize the players in green value chains for effective tracking and assessment to gain from some of the emerging industries in the area like improved technologies for furniture making using different machinery and fabricated materials.

Some of the key players in these emerging industries include Timsales and Comply processing companies and individual investors in green value chains. This continued to demonstrate limited scope of processing green value chains that require to be promoted in line with production. For instance, there was no evidence of processing fruit-based products, yet farmers are slowly engaging in fruit tree growing. This offers an opportunity to experiment with some of the prioritized fruit tree species such as harsh avocadoes to encourage value addition as a pathway towards adaptation to climate change. The other emerged product was production of oil from Chia seeds from *Salvia hispanica* plant that contains high fiber, omega-3 fatty acids, antioxidants among other nutrients.

This can be experimented and monitored over time to quantify its contribution to landscape restoration, provision of income and other nutritional benefits. Notably, evidence has demonstrated that elsewhere *Salvia hispanica* plant contributes to restoration of degraded lands by improving soil health, supporting biodiversity and offering farmers a sustainable high-value crop that reduces pressure on fragile ecosystems. Specifically, *Salvia hispanica* plant has a deep root system that helps to reduce erosion, improving soil aeration and enhance organic matter. It also reduces depletion of the soil organic nutrients when used as a crop rotation. It is also a drought tolerant species with high water user efficiency making it suitable for semi-arid lands that stabilize the soil, reducing runoff, promotes infiltration and biodiversity. The flowers of *Salvia hispanica* attract pollinators thus enhancing local biodiversity and ecosystem services.

Overall, the processors in green value chains have a significant role in restoration of degraded landscapes by ensuring that raw materials processed, marketed and consumed reinforce ecological recovery rather than driving degradation. In this manner they contribute to sustainability standards and provision of market incentives that spur community to engage in productive green value chains. For example, by promoting sustainable sourcing and certification, they encourage farmers to adopt restorative practices such as agroforestry, soil conservation and organic farming, thus creating incentives for producers to restore degraded landscapes. Equally processing of green products like timber, chia seeds, honey grown under restoration systems increases income to households and reduces environmental pressures.

Consequently, processors are key in connecting producers to regional and global markets to scale up adoption of regreening practices that contribute to restoration of degraded landscapes. They are also

instrumental in promoting access to innovation and ecological technologies that are rewarding the environment. In this way, they ensure that producers follow prescribed standards and certification that aligns to ecological restoration. There exist such cases in Kenya, for example honey cooperatives in Baringo and Kitui that are contributing to reduction of land degradation by promoting regreening activities such as relying on health indigenous tree species for honey production. Others are coffee processors in central Kenya and rift valley who demand coffee beans grown under shade trees and agroforestry systems. These processors promote certification schemes like Rainforest Alliance and Fairtrade that ensure producers maintain biodiversity and soil health. The other case is Chia seed enterprises emerging in Kajiado and Narok counties that encourages farmers to grow *Salvia hispanica* in degraded soils. Fruit and nut processors of mangoes, macadamia and avocado depend on tree-based value chains that restore soil fertility and hydrological patterns. This resonates with timber and wood product processors who work with community woodlots to reduce pressure on natural forests and source raw materials from restored landscapes. These activities offer opportunities of linkage to various initiatives such as Regreening Africa, Justdiggit and AFR100.

c) Distributors in green value chain enterprises for landscape restoration

There was an overlap in distributors/marketers of green products with producers and processors whereby some of those that were engaged in production as well as processing were also involved in marketing their products. This category of green value chain was motivated by their quest on environmental conservation, improving the country's wealth, income generation, rising demand of wood products and reducing poverty in the area. The sampled distributors were involved in the green value chain business for a minimum of one year to a maximum of 40 years resulting in an average of 10.8 years with standard error of 3.446. This showed a wide range of experience on business that guided its development by considering various strategies for upscaling business, better incentives to spur growth of green value chains, and a required financing mechanism to support the development of the green products. For instance, they reported that affordable prices, branding/eco-labelling and quality products remain critical in attracting and influencing their customers to purchase processed or produced green products.

Equally, they stated the following strategies to upscale their green value businesses.

- Offering products as affordable and competitive prices,
- Attending training to improve their marketing skills,
- Engagement in tendering of green products,
- Good communication skills with customers,
- Good display of products,
- Selling high quality products,
- Maintaining better referrals and networks,
- Offering discounts on their green products,
- Ensuring proper businessman management such as display of products, marketing etc., and
- Working with the local cooperative to pool resources and reduce transportation costs.

These strategies align well with the results from the socio-economic household baseline survey where they recognized the following should be in place to ensure market access for regreening enterprises (Table 3.6.6.) where most of the interviewed households preferred to have cooperatives (53%) and organizing regreening champions into groups (66%).

Table 3.6.6. Strategies to ensure market access for regreening enterprises

Strategies to ensure market access for regreening enterprises	Frequency (n)	Percentage (%)
Developing bulking and processing/industrial parks/zones/centres	25	8.4
Development/strengthening of appropriate input-output distribution systems	21	7.0
E-commerce promotion	26	8.7
Formation of networks distribution systems	53	17.8
Forming cooperative networks of regreening champion groups	158	53.0
Improve access markets including export market	99	33.2
Improving road networks to open market centres	1	0.3
Individual empowerment rather than through self-help groups	1	0.3
Introducing and improving green product branding	69	23.2

Organizing regreening champions into groups	197	66.1
Strengthening government procurement policies supporting regreening	53	17.8
Value of addition of fruit trees e.g. production of jam from plum tree	1	0.3

These strategies corroborate with findings from other studies that reported development of market linkages and cooperatives connect producers to buyers resulting in scaling up of green value enterprises (Global Landscapes Forum (LDF), 2022). Use of financial incentives and payment of ecosystem services (Ecotrust 2022), strengthening technical capacity through training and collaborative research, improving processing infrastructure to add local value (FAO, 2021), securing enabling policies and tenure through national restoration strategies (World Bank, 2024), fostering public private partnerships, ensuring inclusivity by prioritizing women, youth and indigenous communities and leveraging on global initiatives such as AFR100 and UN Decade on Ecosystem restoration (WRI, 2023) have proven strategies to up-scale green value enterprises for restoration of degraded lands and enhancing resilience to climate change in different landscapes.

d) Service Providers in green value chain enterprises for landscape restoration

In this baseline, there were limited respondents of service provision of green value chain products. Only one responded, whose views will not be representative of the targeted actors in the value chain. Further assessment will be undertaken after promoting prioritized green value chain products.

Despite limited data from service providers, this category of actors in GVC remain critical in advancing best regreening practices for landscape restoration, resilience to climate change and improving livelihoods for local communities. Specifically, service providers offer knowledge, infrastructure and support systems crucial in linking restoration activities among producers, processors and distributors. Some of the interventions offered include technical and extension services that were dominantly raised during the focused group discussion. This includes training on agroforestry, soil and water conservation practices, climate responsive agriculture, tree species site matching, pests and diseases management, reseeding techniques, certification and advisory services, Information communication, technology and digital services, research and innovation, financial and credit services.

Contribution of green value chain enterprises to livelihood improvement and resilience to climate change

a) Effects of climate change and climate variability on green value chain development

Climate change has affected the green value chain enterprises in different ways. The respondents perceived these effects of climate change and climate variability vary ranging from increase on emergencies of new pests and diseases, rising of temperatures resulting to reduction of timber products and low survival of tree seedlings. Temperature rising and changes on rainfall patterns have resulted in decline of water in rivers/springs and boreholes leading to reduction of production of seedlings both for fruits and timber species. The effects of climate change were also reported to have resulted in rising prices/market fluctuations of green value chain products due to scarcity of products because of unpredictable weather patterns. The same effects were noted on crop yields that were significantly declining in most the areas in the county. These effects have been experienced for more than 10 years.

Consequently, the green value chain actors identified the following human activities resulting in environmental degradation.

- Deforestation (42%),
- Unsustainable land management practices and firewood collection (32%),
- Encroachment to wetlands and other sensitive ecosystems (11%),
- Poor waste management practices (5%),
- Illegal tree cutting (4%),
- Charcoal burning (2%),
- Cultivating along the riparian areas (2%), and
- Poor management of water resources (2%).

b) Contribution of green value chain enterprises to livelihood improvement and resilience to climate change

The findings from quantitative assessment, focused group discussions by men, women, youth and mixed group of men, women, youth and people with disabilities revealed the following regreening practices that are enabling the communities to cope with impacts of climate change.

- Growing high valued tree species and establishment of woodlots to fetch income from timber products and non-timber forest products like carbon credits mechanisms such as enrolment with TIST.
- Growing of indigenous tree species for water and soil conservation as well as medicinal benefits.
- Practicing agroforestry as a method of diversifying livelihood options from their farms to fetch more income and enhance sustainable land management.
- Engagement in kitchen gardening and other food production systems like growing of Irish potatoes through organic farming.
- Change to crop varieties that are resistant to pest and diseases.
- Fruit tree growing and diversification of livelihood sources like livestock keeping provide manure for improving soil fertility and crop yields, beekeeping, establishment of tree and fruit tree nurseries.
- Engagement in PELIS.

In view of these regreening practices implemented in the area, the study revealed how green value chain enterprises are contributing to improving livelihood and resilience to climate change in the following ways, namely.

- Increasing access to income to support the families (53%) such as raising revenue from kitchen gardening.
- Creating employment among vulnerable groups in the communities (18%).
- Enhancing soil and water conservation for better crop productivity (15%).
- Improving food availability and better living standards (12%), especially through organic farming practices like use of manure from poultry keeping and using high yielding certified seeds.
- Improving water catchment areas (3%) and practicing agroforestry.

It is in this respect that actors in the green value chain enterprises proposed the following for their upscaling to cope with impacts of climate and climate variability.

- Capacity building and skills development in green value chain development,
- Encouraging growing fruits and vegetables for value addition,
- Promoting environmental conservation practices,
- Encouraging more farmers to register with TIST for carbon credits and participate in other value chains,
- Promoting access to drought tolerant species and crops,
- Ensuring availability of high-quality germplasm,
- Promoting high efficiency machines for processing and
- Promoting good forestry management practices.

Barriers/constrains affecting development and promotion of green value-chain enterprises for landscape restoration and adaptation to climate change

The data from quantitative assessment and focused group discussions across all targeted groups revealed the following barriers hindering the adoption of green value chain enterprises.

- Unfavourable market competition and inadequate market linkages.
- Inadequate capital/financial resources.
- High taxes.
- Inadequate knowledge of the management of crops and tree pest and diseases.
- Lack of access to quality/certified germplasm for priority fruit trees such as avocado, timber and medicinal tree species.

- Corruption among middlemen and forest guards.
- Poor infrastructure and equipment for tree nurseries.
- Limited skills and poor access to modern technological innovations as well as extension services in green value chain enterprises.
- Pricing of green products affecting returns on investments.
- Scarcity of water.
- Overreliance of *Cupressus lusitanica* for supply of timber products.
- Poor infrastructure limiting accessibility and availability of green products.

These barriers resonated with the findings from the household socio economic survey on constraints facing farmers to access markets for green value chain enterprises where majority of the respondents reported limited financing, pricing, limited scope of markets among others (Table 3.6.7).

Table 3.6.7. Challenges farmers face to access market for their regreening enterprises

Challenges farmers face to access market for their regreening enterprises	Frequency (n)	Percentage (%)
Lack of certification or standardization	67	22.5
Lack of market information and intelligence	57	19.1
Limited financing	122	40.9
Limited infrastructure for value addition	59	19.8
Limited scope of markets	122	40.9
Poor infrastructural networks	74	24.8
Pricing and competition	122	40.9
Seasonality in production and low uneconomical volumes	38	12.8

In view of this analysis, the results from FGDs and GVCs enterprises showed that the identified challenges have persisted for long time and require immediate attention. Some of the proposed strategies on how to address these challenges include the following.

- Awareness creation on the importance of green value chain enterprises in landscape restoration and better livelihoods,
- Building trust systems among actors and other players in green value chain development,
- Engaging in table banking,
- Diversifying sources of livelihoods and income options,
- Access to information on climate responsive green value chain enterprises, and
- Farmers to access high quality germplasm.

Policy-based incentives required to accelerate uptake of re-greening options and green value chain enterprises

The analysis of policy-based incentives centred on expected support from both national and county governments in green value chain and enabling environment for financing and upscaling the production, processing, distribution and service provision. The key findings are as highlighted in the following sub sections.

a) Policy-based incentives to encourage investment in green value chain enterprises for landscape restoration and better livelihoods

The key incentives identified to encourage production of green products included support from both national and county governments on green value chains, educating the public on sustainable benefits of green products and provision of extension services (Table 3.6.8). Some of the expected government support include reducing overreliance on rain fed agriculture and introducing irrigation farming especially for fruit tree growing, establishment and management of tree nurseries, increasing access to extension services and affordable financial services among others. The latter is also critical considering that majority of the producers were financing their production through personal savings (50%) with the least borrowing from friends (Table 3.6.9). The provision of these incentives is expected to boost the morale of the communities to fully engage an upscale in their regreening activities.

Table 3.6.8. Incentives to encourage production of green products

Incentives to encourage production	Frequency (n)	Percentage (%)
Access to government support for production of green products	14	61
Provision of extension services	3	13
Educating public on sustainable benefits of green products	6	26
Total	23	100.0

Table 3.6.9. Financing methods on production of green products

Financing methods	Frequency (n)	Percentage (%)
Merry-go-round	2	10
Profit from service provision	4	20
Savings	10	50
Table banking	3	15
Borrowing from friends	1	5
Total	20	100

The policy-based incentives for producers were also consistent with processors' motivation to engage in green value-chain such as creating employment for the local communities and youths, engagement in environmental conservation and profitability. This will be realized if the following incentives are integrated in the development of green value chain enterprises.

- Access to affordable, subsidized and advancing processing machines.
- Access to raw materials.
- Better infrastructure, especially local roads for transporting raw materials and processed goods.
- Enforcement of better quality and standard materials for processing to make products like furniture among others.
- Lowering prices of forest plantations to avail raw materials for processing of timber and other by products.
- Provision of seed capital to invest in business and promote market linkages.
- Reducing taxes on green value chain products.

These will enable them to strengthen their financing mechanisms such as access of loans from banks/micro financial institutions (27%) and savings and profits from business (67%). In addition, such incentives are expected to inspire their strategies and plans to upscale the processing of green value chains. For instance some of the strategies they were having in place included buying timber directly from farmers at cost effective price to have customer friendly prices, integration of sustainable farming and green value chain businesses, improving quality of products to attract customers, re investing of proceeds by increasing volume of processed products like timber and training on emerging technologies especially on furniture making. In addition, the distributors stated the following incentives that will enable them to upscale their distribution/marketing of green products for landscape and ecosystem restoration:

- Better government policies that will stimulate green value chain development.
- Better infrastructure such as shades, market sale points etc from county government for selling their green products.
- Reduced taxes and effective government support, from national and county levels.

4 Gender, equality, disability & social inclusion assessment

4.1 Overview

This GEDSI assessment provides the evidence base to understand the gender, disability, and social inclusion dynamics that influence regreening and FMNR outcomes across the three counties. Specifically, the assessment examines roles and responsibilities, access to and control of assets, participation and leadership, decision-making power, and structural barriers (institutional, physical, attitudinal, and communication), and uses these insights to inform practical recommendations and a GEDSI Action Plan for implementation.

The assessment for Regreening for the Future is survey-based, drawing on household data across target counties to analyse differences by sex, age, disability status, and location. Findings are interpreted through a GEDSI lens to identify county-specific inequalities and cross-cutting trends that matter for program design (e.g., participation in decision-making spaces, access to services and resources, and exposure to exclusion).

Insights from this assessment will be integrated into program design, delivery, and MEL, guiding:

- Inclusive training and capacity-building for Regreening and sustainable land management;
- Equitable representation and meaningful participation of women, youth, and Persons with disabilities in community structures;
- Targeted actions to address barriers to assistive technology, information, financial inclusion, water, and asset access; and
- A practical GEDSI Action Plan with measurable indicators for tracking inclusion outcomes in the counties. These steps help ensure the project's climate adaptation pathways are locally relevant and socially equitable, reinforcing community ownership and the long-term sustainability of regreening outcomes.

4.2 Findings

This section presents the findings of the GEDSI assessment conducted for the Regreening for the Future project. The findings provide a comprehensive analysis of gender and social dynamics in Nyandarua county, highlighting the gender-specific vulnerabilities, social norms, and community roles and responsibilities that influence participation in regreening and FMNR-related activities. The assessment also explored gendered power relations between men and women, examining differences in their access to resources, participation in decision-making, priorities, and the constraints that shape their engagement in land restoration and climate adaptation initiatives. In addition, the GEDSI analysis reviewed the existing policies, systems, structures, and practices that either promote or hinder gender equality and disability inclusion within the project counties.

Furthermore, the assessment identified the key institutional, physical, attitudinal, and communication barriers faced by women, men, boys, girls, and persons with disabilities, and how these barriers limit equitable access to opportunities and benefits within the regreening agenda. Understanding these structural challenges is essential for ensuring that subsequent phases of project implementation remain responsive to community needs and inclusive of all groups. Finally, the study provides targeted recommendations aimed at addressing the identified inequalities, exclusion risks, and vulnerabilities. These recommendations are designed to strengthen the participation and influence of women, men, youth, and particularly persons with disabilities and other socially excluded groups, thereby informing the development of the project's GEDSI Action Plan and ensuring that regreening interventions are both equitable and sustainable.

Gender of Respondents

The numbers were almost equal between women (51.52%) and men (48.48%) as shown in Table 4.2.1.

Table 4.2.1. Gender of Respondents

Gender	Percentage
Female	51.52%
Male	48.48%

Age of Respondents

The largest share of people is aged over 55, making up about 20.20% overall (Table 4.2.2). Most respondents fall in the working age groups, with notable portions in the 25 to 30 and 35 to 40 age brackets. The share of people aged 50 to 55 sits around 14.14%.

Table 4.2.2. Age of Respondents

Age	Nyandarua
Above 55 years	20.20%
Below 18 years	0.00%
Between 18-24 years	7.07%
Between 25-30 years	14.14%

Between 31-34 years	8.08%
Between 35-40 years	14.14%
Between 41-45 years	11.11%
Between 46-49 years	11.11%
Between 50-55 years	14.14%

Level of Education

Understanding the level of education of respondents is key in enhancing initiatives towards the regreening initiatives in the county. Nyandarua has the more educated population, with a very small portion (6.12%) having no formal schooling. Overall, secondary school education is the most common in the county (29.59%) (see Table 4.2.3.

Table 4.2.3. Level of Education

Level of education	Percentage
Adult education	0.00%
None	6.12%
Primary completed	26.53%
Secondary completed	29.59%
Tertiary College	25.51%
University	12.24%

Residence

The populations surveyed are overwhelmingly based in rural areas as shown in Table 4.2.4

Table 4.2.4. Residence

Household Type of Residence	Percentage
Rural	95.96%
Urban	4.04%

Marital Status

Marriage is very common for people in the Nyandarua county with 59.6% of the people married (Table 4.2.5).

Table 4.2.5. Marital Status of Respondents

Marital status	Percentage
Cohabiting/ living together	0.00%
Married	59.60%
Never married/ single	22.22%
Separated/ Divorced	7.07%
Widowed	11.11%

Disability status

The assessment purposed to examine the disability status of the respondents. The types of disability assessed by the study included; vision impairment, hearing difficulty, physical disability, difficulty in remembering or concentrating, self-care difficulties, and communication difficulty or difficulty being understood.

Nyandarua county has high percentage of PWDs at 21.2% as shown in Figure 4.2.1. Most people were aware of the cause of their disability at 95%.

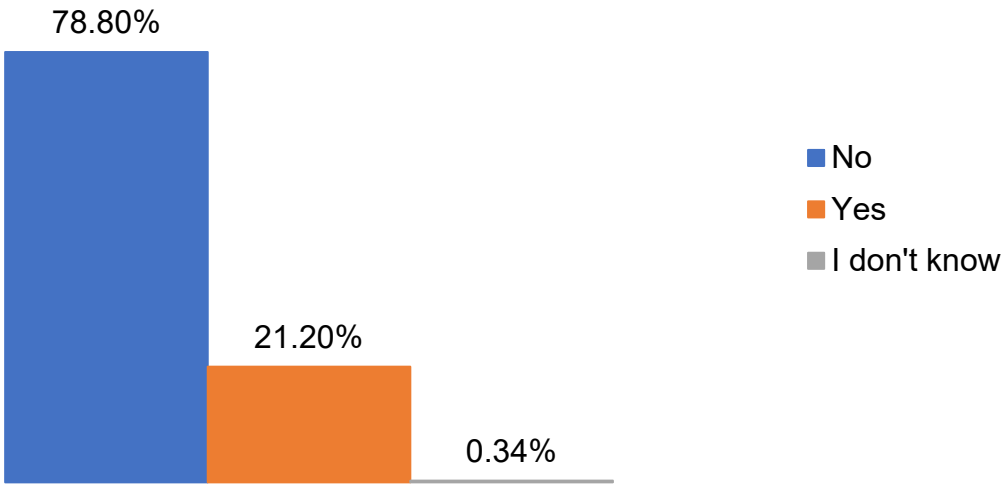


Figure 4.2.1. Disability status

Regarding disabilities, people in Nyandarua reported no challenges with seeing (76.1%) and hearing (90%). But they reported a lot of difficulty walking or climbing steps (38.1%) and with self care tasks like washing and dressing (10%). Walking and climbing steps with a lot of difficulty was identified Nyandarua (38.1%). Also, taking care of themselves, like washing or getting dressed, is a big challenge in Nyandarua where 45% find this somewhat difficult.

For remembering things and talking to people, most adults were doing well. As high as 90.48% had no trouble remembering or concentrating. Only 10% of people reported some difficulty communicating or being understood.

For other household members with disabilities, Nyandarua had (10%). A smaller number of people do have some kind of difficulty. The most common challenge was with seeing, even when wearing glasses. About 10% of people said they have some or a lot of difficulty seeing. Difficulty walking or climbing steps was also mentioned.

When asked if anyone else in their home is a PWD, most households said no. There was 10.20% of households who reported having a PWD member. In terms of how many households have registered a person with a disability, half of the households (50%) say they have already completed this registration, and most others are in the process (40%). Very few households there say "no" (10%) (Figure 4.2.2). In short, registration is common and complete in Nyandarua.

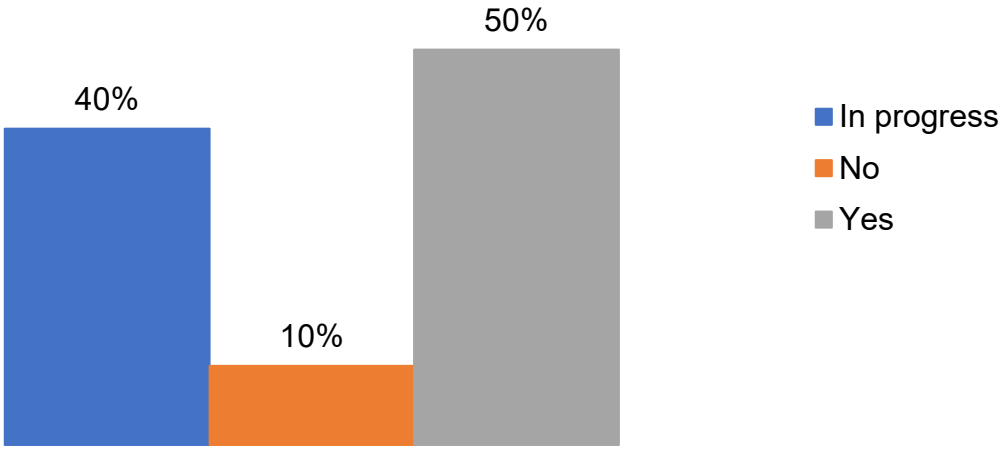


Figure 4.2.2. Disability Registration

Households that have registered PWDs reported having received support from a government program. Five (5) respondents 'Yes' to having benefited as shown in Figure 4.2.6. This suggests that, among this limited group, participation in and awareness of government programs appears higher in Nyandarua.

Table 4.2.6. Disability Registration

If registered, have they ever benefited from any government program?	Number
No	0
Not aware	0
Yes	5

Occupation

Most people in Nyandarua county, either for someone else or for themselves. The percentage of people who work is 82.83% as shown in Figure 4.2.3.

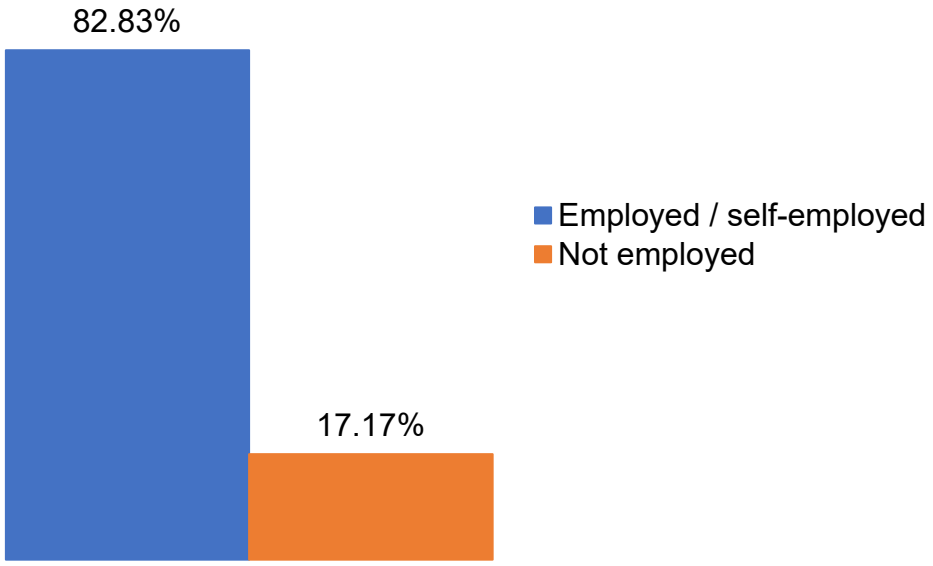


Figure 4.2.3. Occupation

For the people who work, the most common type of job is being self-employed. This means they run their own small businesses or farms. Formal employment is also common (17.07%) as shown in Table 4.2.7.

Table 4.2.7. Occupation

Occupation	Percentage
Factory worker (own farm, other farm)	2.44%
Formal employed (Specify)	17.07%
Other	4.88%
Self-employed (Specify)	75.61%

A smaller group of people do not have a regular job. The main way they get money is through remittances, this is when family or friends who live elsewhere send them money. As shown in Table 4.2.8, some people also mentioned getting money from 'Cash for Work' programs, which are short-term jobs.

Table 4.2.8. Other sources of income

If NO occupation what are your sources of income? - Counts	Percentage
Borrowing	0
Cash for Work	0
Cash Transfer	1
Donor aid	0
Remittance from family and friends	7
Student	3
Other	6

Income

As shown in Table 4.2.9. 55.79% of people earn more than Kenyan Shillings (Ksh) 10,000 per month, and 15.79% earn above Ksh 30,000.

Table 4.2.9. Average monthly income

Average monthly income- Ksh	Percentage
Below Ksh.1,000	8.42%
Ksh.1,001 – 5,000	9.47%
Ksh.5,001 – 10,000	26.32%
Ksh.10,001- 30,000	40.00%
Above Kshs.30,000	15.79%

Expenditure

What people spend each month generally matches their income as shown in Table 4.2.10. In Nyandarua, spending is much higher. Most people (87.76%) spend more than Ksh 5,000 each month, and many (33.67%) spend between Ksh 10,000 and Ksh 15,000.

Table 4.2.10. Average monthly spending

Average monthly spending in Kenyan Shillings?	Percentage
Below Ksh. 2500	1.02%
Between Ksh.2,501 - 5000	11.22%
Between Ksh.5001 - 10000	34.69%
Between Ksh.10001 - 15000	33.67%
Between Ksh.15001 – 20000	9.18%
Between Ksh.20001 – 25000	2.04%
Between Ksh.25001 – 30000	7.14%
Above Ksh. 30,000	1.02%

Understanding vulnerabilities

Most respondents (76.53%) said that women, men, boys, girls, elderly people, and PWDs face specific challenges as shown in Table 4.2.11. A smaller number of people, about 16.33% overall, said 'No', they do not think these groups face extra challenges. A majority of people in these

communities recognize that some members of society, like women, children, the elderly, and PWDs, often have a harder time or face unique problems compared to others.

Table 4.2.11. Understanding vulnerabilities

When you think about women, men, boys, girls, elderly and PWDs are there more specific challenges you think they face?	Percentage
I don't know	7.14%
No	16.33%
Yes	76.53%

When asked if people in the community feel left out or ignored when it comes to community or social matters, like meetings, decisions, or local activities, just over half of all people (about 50.51%) said Yes, there are people in their community who feel excluded (Table 4.2.12). This shows that there is a clear sense among many people that some members are not fully included or heard when it comes to community life.

Table 5.2.12. Exclusion

Are there people in this community who feel excluded when it comes to community issues/ social issues?	Percentage
No	49.49%
Yes	50.51%

Decision making

As shown in Figure 4.2.4, most people said women are engaged in decision-making at the community level (86%).

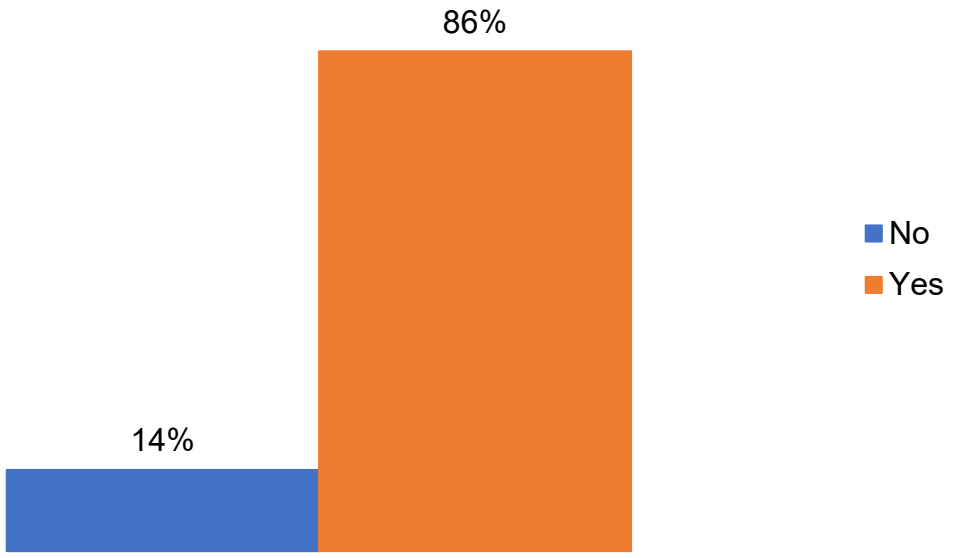


Figure 4.2.4. Decision Making

When asked who makes community decisions, women were ranked at 9.8%, behind men (10.6%), county officials (29.7%), and community leaders (24%). This shows that even when women are said to participate, they are not seen as primary decision-makers. This pattern suggesting deep-seated gender norms and a gap between participation and influence that is important for project design.

Table 4.2.13. Decision Making

	Percentage
Community	24.0
County/ local administration	29.7
Religious leaders	9.3
Men	10.6
Women	9.8

Youth	6.5
PWDs	4.5
Other	5.7

However, a significant minority said women do not have the freedom to participate in development programs (21.43%) as shown in Table 4.2.14. This gap suggests that even when women are included in discussions, they may not have equal freedom to join programs or projects.

Table 4.2.14. Women freedom to participate in development

Do women have the freedom to participate in development programs?	Percentage
No	21.43%
Yes	78.57%

The following analysis is presented collectively for Homabay, Nyamira, and Nyandarua counties to enable cross-county comparison and identification of shared trends and patterns. Where relevant, county-specific findings are highlighted to reflect contextual differences and provide more targeted insights.

Youths, Women and Persons with Disabilities' representation

When asked who makes decisions in the communities, respondents across all counties most frequently identified community leaders and county administration. Youth and PWDs were perceived to have comparatively limited influence in community decision-making. Although representation of youth was reported through community groups (77%), educational institutions (81%), government institutions (83%), and empowerment programs (79%), only around 10% felt youth were represented 'very much' as shown in Figure 4.2.5. These findings suggest that representation does not necessarily translate into influence and reinforces traditional gender roles where older men hold power.

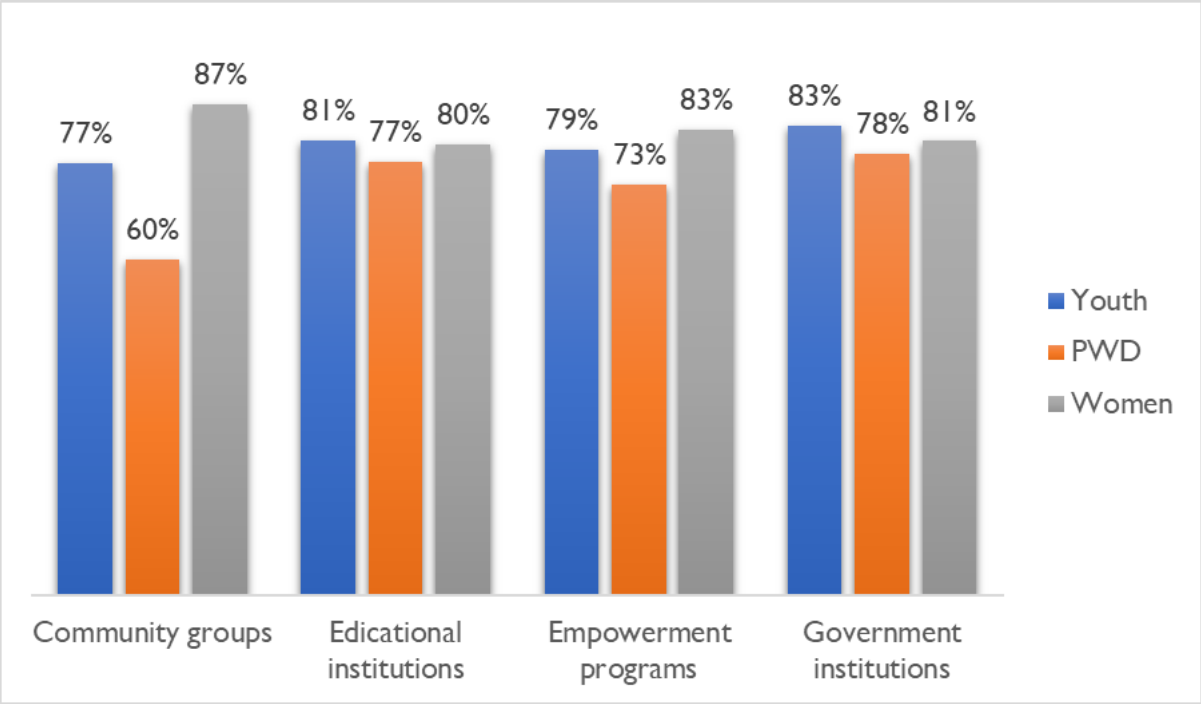


Figure 4.2.5. Youths, women and PWDs representation

Economic Activities

Most respondents reported participating in a range of economic activities. Participation was highest in agricultural farming, household gardening, household spending, and self-earned cash activities, where more than 85% reported making decisions to participate in the past year. Participation was lower for employment opportunities (52%) and the use of formal financial services (68%) as shown in Table 4.2.15. Overall, the findings suggest stronger participation in household, agricultural, and informal livelihood activities than in more formal economic opportunities.

Table 4.2.15. Economic activities

Activity	In the past 12 months did you make decision to participate in the activity listed below?	
	No	Yes
Agricultural farming	12%	88%
Community-Based Enterprises	31%	69%
Employment opportunities	48%	52%
Household gardening	12%	88%
Household spending	12%	88%
Livestock rearing	15%	85%
Natural Resource Management (e.g., FMNR)	12%	88%
Non-farm economic activities	26%	74%
Savings and loan group	14%	86%
Self-earned cash activity	5%	95%
Selling agricultural crops	12%	88%
Selling livestock	22%	78%
Skills and capacity training or workshops	14%	86%
Utilizing formal financial services	32%	68%

Decision-making patterns within economic activities are mixed. For activities such as self-earned cash activity and selling agricultural crops, a relatively large share of respondents (59% and 35% respectively) reported deciding by themselves. By contrast, decisions on household-level activities such as agricultural farming and livestock rearing were more often reported as joint (24%), and in some cases respondents reported that their spouse or partner had the greater say (38%) (Table 4.2.16). This indicates that participation in an activity does not necessarily imply equal control over decisions related to that activity.

Table 4.2.16. Joint decision making

Activity	Jointly but I made most of the decisions	Jointly but my spouse/partner made most of the decisions	Other	Self
Agricultural farming	38%	27%	8%	27%
Community-Based Enterprises	14%	14%	38%	34%
Employment opportunities	8%	11%	4%	38%
Household gardening	22%	28%	6%	44%
Household spending	37%	27%	10%	27%
Livestock rearing	25%	38%	14%	24%
Natural Resource Management (e.g., FMNR)	18%	3%	18%	61%
Non-farm economic activities	15%	23%	26%	36%
Savings and loan group	22%	14%	10%	55%
Self-earned cash activity	25%	16%	0%	59%
Selling agricultural crops	28%	23%	14%	35%
Selling livestock	17%	25%	25%	33%
Skills and capacity training or workshops	7%	21%	9%	63%
Utilizing formal financial services	32%	14%	25%	29%

A large share of respondents reported having a ‘large’ or ‘medium’ extent of freedom to make personal decisions, particularly in self-earned cash activities (84% combined) and household spending (80% combined) as shown in Table 4.2.17. However, a smaller but consistent share across several activities reported having little or no input, indicating that some respondents remain constrained in socio-economic decision-making.

Table 4.2.17. Individual decision making

Activity	Large extent	Medium extent	Not at all	Small extent
Agricultural farming	38%	41%	5%	16%
Community-Based Enterprises	21%	38%	7%	34%
Employment opportunities	27%	35%	8%	30%
Household gardening	42%	34%	4%	20%

Household spending	51%	29%	5%	15%
Livestock rearing	36%	36%	8%	20%
Natural Resource Management (e.g., FMNR)	36%	42%	3%	18%
Non-farm economic activities	32%	30%	8%	30%
Savings and loan group	45%	31%	8%	16%
Self-earned cash activity	56%	28%	2%	14%
Selling agricultural crops	41%	41%	6%	13%
Selling livestock	33%	39%	11%	17%
Skills and capacity training or workshops	50%	36%	12%	2%
Utilizing formal financial services	25%	46%	7%	21%

Participation Community Activities

Participation in community activities is generally high, with more than 60% of respondents taking part in most groups. Community meetings and forums recorded the highest participation (90%), while youth groups also showed very high participation (98%). Participation was notably lower in more formal structures such as CFAs (20%) and Parent-Teacher Associations (PTAs) or school committees (48%) (Table 4.2.18). This suggests that broad community participation does not necessarily extend equally to more formal governance spaces.

Table 4.2.18. Participation in community activities

In the past 12 months did you make decision to participate in the activity listed below?

Activity	No	Yes
Agricultural Cooperatives or Farmer Groups	30%	70%
Community development committee	36%	64%
CFAs	80%	20%
Community meetings and forums	10%	90%
Disability or Inclusion groups	32%	68%
Health Committees or Clinics	30%	70%
Natural Resource Management Committees	30%	70%
Nyumba Kumi committees	37%	63%
PTAs or School Committees	52%	48%
Project management committee	38%	62%
Water user committees	26%	74%
Women's Groups or Associations	33%	67%
Youth Groups or Organizations	2%	98%

For several committees, a substantial share of members reported having ‘no input’ or that ‘no decision was made’ by them (Table 4.2.19). For example, in Parent-Teacher Associations or school committees, 50% said they made no decision and 20% said they had no input, while 54% of respondents in CFAs said they made no decision. These findings indicate that membership does not necessarily translate into meaningful voice or influence.

Table 4.2.19. Level of decision making per committee

Activity	Input in few decisions	Input into most or all decisions	Input into some decisions	No decision made	No input
Agricultural Cooperatives or Farmer Groups	23%	5%	40%	16%	16.28%
Community development committee	16%	27%	28%	16%	12%
CFAs	8%	4%	8%	54%	25%
Community meetings and forums	29%	24%	39%	3%	5%
Disability or Inclusion groups	14%	21%	32%	7%	26%
Health Committees or Clinics	47%	9%	13%	25%	6%
Natural Resource Management Committees	15%	15%	37%	17%	15%

Nyumba Kumi committees	17%	7%	34%	24%	17%
PTAs or School Committees	7%	3%	20%	50%	20%
Project management committee	12%	29%	20%	34%	5%
Water user committees	32%	16%	26%	13%	13%
Women's Groups or Associations	22%	25%	28%	10%	15%
Youth Groups or Organizations	31%	24%	43%	2%	0%

When asked about freedom from coercion, most respondents reported a 'large' or 'medium' extent of control over their participation. Community meetings and forums scored particularly highly (90% combined). However, for more formal committees such as CFAs and PTAs or school committees, a notable share reported only a 'small extent' of freedom (54% and 43% respectively) (Table 4.2.20). This suggests that some formal spaces may be less enabling for meaningful participation as such environments can be intimidating or controlled by a few powerful individuals.

Table 4.2.20. Freedom from coercion

Row Labels	Large extent	Medium extent	Not at all	Small extent
Agricultural Cooperatives or Farmer Groups	26%	38%	7%	29%
Community development committee	29%	37%	7%	27%
CFAs	17%	4%	25%	54%
Community meetings and forums	33%	57%	2%	9%
Disability or Inclusion groups	35%	28%	12%	26%
Health Committees or Clinics	13%	47%	9%	31%
Natural Resource Management Committees	22%	41%	4%	33
Nyumba Kumi committees	20%	25%	15%	40%
PTAs or School Committees	13%	40%	3%	43%
Project management committee	17%	39%	12%	32%
Water user committees	26%	32%	8%	34%
Women's Groups or Associations	30%	38%	7%	25%
Youth Groups or Organizations	33%	48%	2%	17%

Participation Community Activities: Disaggregated for Women, Youth, and Persons with Disabilities

For women, participation is relatively high in women's groups (67%) and health committees (70%), where they often feel a strong sense of autonomy. However, participation does not consistently translate into influence, particularly in mixed-gender or more formal committees, where decisions are more often reported as joint or shaped by others. For example, in women's groups, 37% decide by themselves how to use benefits. However, in mixed-gender or more powerful committees, their influence reduces. In community development committees, while 64% of women participate, they have less individual decision-making power, with only 23% deciding by themselves. This suggests that women's presence in community structures should not be assumed to represent equal decision-making power, as they may be excluded from the highest levels of leadership and decision-making within mixed-gender groups.

Social Activities

Participation in social activities was generally high, particularly for issues related to family well-being and the environment (Figure 4.2.6). More than 80% of respondents reported participating in decisions related to children's schooling (85%), improving children's well-being (91%), and supporting regenerative agriculture (84%). Participation was comparatively lower for reporting deforestation and other climate change causes (60%), indicating an area where engagement may be less consistent.

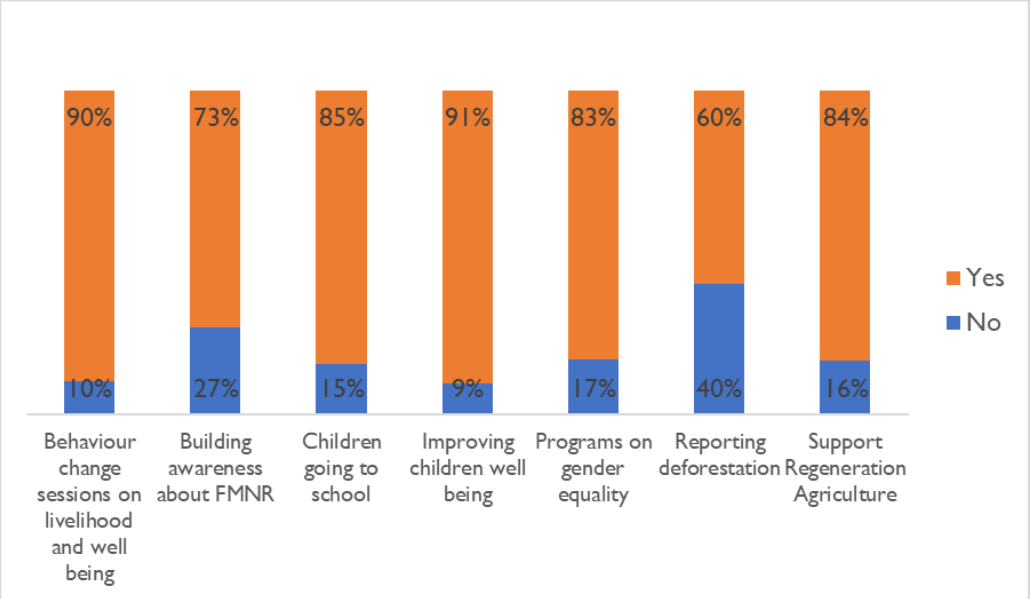


Figure 4.2.6. Social activities participation

Respondents generally reported having meaningful input in a range of social activities as shown in Table 4.2.21. For improving children's well-being, 46% reported input into some decisions and 36% into most or all decisions. Final decision-making patterns were more mixed. For children's schooling, decisions were most often reported as joint between spouses, while for supporting regenerative agriculture 58% of respondents reported deciding by themselves.

Table 4.2.21. Child involvement in decision-making

Row Labels	Input in few decisions	Input into most or all decisions	Input into some decisions	No decision made	No input
Behaviour changes sessions on livelihood and well-being	16%	28%	50%	3%	3%
Building awareness about FMNR	25%	22%	31%	12%	10%
Children going to school	15%	43%	27%	2%	13%
Improving Children well-being	8%	36%	46%	1%	8%
Programs/sessions on gender equality	25%	19%	39%	7%	10%
Reporting deforestation and other climate change causes	23%	13%	25%	10%	28%
Support Regeneration Agriculture	8%	29%	41%	5%	17%

Across all activities listed, more than 75% of respondents reported a 'large' or 'medium' extent of control over their decisions (Table 4.2.22). This was particularly evident for improving children's well-being (85.13% combined) and programmes or sessions on gender equality (83% combined), indicating comparatively stronger perceived agency in these areas.

Table 4.2.22. Control

	Large extent	Medium extent	Not at all	Small extent
Behaviour changes sessions on livelihood and well-being	34%	50%	2%	14%
Building awareness about FMNR	22%	42%	12%	24%
Children going to school	35%	43%	6%	16%
Improving Children well-being	43%	42%	3%	12%
Programs/sessions on gender equality	34%	49%	8%	8%
Reporting deforestation and other climate change causes	21%	49%	10%	20%
Support Regeneration Agriculture	42%	40%	8%	10%

Participation in Specific Programs

Participation in specific programmes was more commonly reported as 'sometimes' or 'most of the time' rather than 'always' as shown in Table 4.2.23. For example, 64% reported participating in disability-inclusive programmes 'sometimes,' and 65% reported participating in youth-led initiatives 'sometimes'. This suggests that participation may be intermittent rather than continuous across a number of programme areas. Programmes related to agriculture and finance showed relatively more frequent participation. Farm management and activities recorded a combined 59% participating 'always' or 'most of the time', while microfinance, savings and loan groups recorded 60% in those categories. By contrast, activities such as community-based reporting and referral mechanisms recorded very low 'always' participation (4%). These findings suggest that livelihood-linked activities may currently offer stronger entry points for sustained engagement than more formal reporting or referral mechanisms, as they are not yet fully embraced or supported in community life.

Table 4.2.23. Participation in specific programs

	Always	Most of the time	N/A	Never	Sometimes
Any other	18%	18%	9%	36%	18%
Attending forums on Income Generating Activities (IGAs) establishment through youth/women groups/ Self Help Groups (SHGs)	8%	46%	0%	4%	42%
Attending training on FMNR	11%	41%	0%	7%	41%
Attending training on gender equality and inclusion	6%	44%	0%	12%	38%
Attitude/behaviour change sessions on FMNR	25%	13%	0%	19%	44%
Building awareness about harmful climate changing activities such as deforestation	12%	33%	0%	17%	38%
Community based Natural Resource Management	10%	19%	0%	10%	60%
Community based reporting and referral mechanism to promote gender equality and inclusion	4%	46%	0%	8%	42%
Community based support, referral for violence prevention or safety programs/groups	0%	33%	0%	8%	58%
Disability Inclusive Programs	18%	15%	0%	3%	64%
Disaster preparedness and response	8%	29%	0%	8%	54%
Farm management and activities	23%	37%	1%	5%	34%
IGAs	26%	26%	0%	7%	41%
Microfinance, Savings and loan groups	31%	29%	0%	16%	24%
Networking with government and non-state actors on promoting livelihood and climate change	0%	35%	0%	13%	52%
Positive attitude toward agriculture and climate change	24%	51%	0%	3%	22%
Private sector engagement such as processing, aggregation, off taking etc	12%	24%	4%	20%	40%
SHGs	15%	44%	0%	3%	38%
Support Regeneration Agriculture	21%	29%	0%	6%	44%
Water Resource Management	18%	32%	0%	5%	45%
Women Empowerment Programs/self-help groups	7%	45%	0%	7%	40%
Youth led initiatives/clubs	9%	22%	0%	4%	65%

The participation pattern also has implications for safe and inclusive engagement. Where participation in referral mechanisms, safety programs, and inclusion-related activities is reported as irregular or only occasional, the project will need to ensure that information about available support pathways is communicated clearly and accessible through community structures. This is particularly important for women, youth, and persons with disabilities, whose participation may be affected not only by interest or availability, but also by safety concerns, accessibility barriers, and unequal influence within community spaces.

Access To services/resources (Applicable to Persons with Disabilities and Persons without Disabilities)

The findings indicate marked differences in access to land, water, information, savings, jobs, assets, and assistive devices across counties and social groups. Men generally report stronger access in several categories, while women, girls, boys, and especially persons with disabilities report lower or more constrained access in multiple domains. These differences are important for project targeting

because they point to where barriers are most likely to affect participation in regreening, FMNR, training, and livelihood-related opportunities.

Access for Women

Women in Nyandarua face the biggest and most constant problems with nearly every resource. While access to land is mostly "Medium" (58.16%), getting water is hard, with 44.33% reporting "Low" access. Finding a formal job is difficult, with 52.58% saying they have "Low" access. Owning assets is also very hard, with 50.00% reporting "Low" access. The situation for assistive devices is the worst in Nyandarua. A huge 55.21% of women report "Low" access, and 33.33% say they have no access at all. This means women in Nyandarua, especially those with disabilities, face inclusion barriers.

Access for Men

While men in Nyandarua still have better access than women or youth in the county, their access is noticeably lower than men in Homabay and Nyamira. Only 47.96% say they have "High" access to land, which is much lower than the 80% in the other counties. Getting water is a problem, with 38.78% reporting "Low" access. Finding a job is also hard, with 35.42% reporting "Low" access. Access to public meetings is mixed, with 35.79% "High" but 45.26% "Low." Access to assistive devices is extremely poor, with 56.12% of men reporting "Low" access, the highest among all men for this resource.

Access for Girls

Access to land is almost universally "Low" (76.84%). Access to savings is extremely low (75.27% low). Finding a formal job is a big challenge, with 70.21% reporting "Low" access. Access to information (57.45% low), water (51.06% low), and assets (63.44% low) are all critically low. While education access is mostly "Medium" (47.37%), being shut out from economic resources means that education may not lead to economic opportunity. Access to assistive devices is also low, with 55.79% reporting "Low" access.

Access for Boys

Access to land is very low (55.32% low). Access to savings is low (58.06% low). Formal job opportunities are limited, with a huge 65.96% of boys reporting "Low" access. Access to water is also a major issue (48.39% low), as is access to assets (60.87% low). Access to public meetings is also very low (65.93% low). This shows that boys in Nyandarua are growing up with very little access to the resources they need to build a future.

Access for Persons with Disabilities

PWDs in Nyandarua have the very worst access levels. Access to land is very "Low" (70.83%). Access to savings is low (69.07%). Formal Jobs are difficult to get, with 74.23% reporting "Low" access. Access to information is also extremely low (62.89% low). Access to water is a challenge, with 67.01% reporting "Low" access. Access to education is low (54.17% low). Access to assets is the worst, with 77.08% of Persons with Disabilities reporting "Low" access. While access to assistive devices is a little better than in other counties, with only 23.71% reporting no access, the numbers for "Low" access (52.58%) are still the highest. This data shows that Persons with disabilities in Nyandarua are being left behind and cannot get the most basic resources they need to live with dignity.

5. Synthesis of key results towards adaptation pathways planning

Presented here is a synthesis of key results coming from each of the tools to map and diagnose the decision context for adaptation pathways planning in Nyandarua county.

The county showed strong connectivity among county government departments, NGOs, and national agencies at the county level, while village-level actors such as farmers, chiefs, and CBOs remained largely poorly connected. Connections across stakeholders in the counties were largely valuable and bidirectional, covering regreening knowledge/education, inputs, policy, and value chains. Key gaps and missing actors were identified in each county, and field validation workshops strengthened the networks further. Engaging existing community structures is consistently recommended to bridge the divide

between local and county levels. A brief overview of the stakeholders' analysis results is elucidated hereunder.

The network was highly fragmented into 17 clusters, with NGOs, national government, and county departments best connected, and individual farmers and self-help groups least connected. Of 103 valuable, bidirectional connections, regreening education and inputs were most frequently cited. Key actors like COPiCAD, KFS, and NEMA ranked high, and field validation workshops enriched the network further.

Table 5.1.1. Synthesis of Key Results for Adaptation Pathways Planning from the Stakeholder Assessment Chapter

County	Who makes key decisions (adaptation & regreening)	Decision-making misalignments	Actors and networks critical for pathway shifts but weakly connected
Nyandarua	NGOs and technical agencies (forestry, environment, extension) held most influence; community and CFA actors played a limited coordination role Highest Power: Kenya Forest Service (KFS), National Environment Management Authority (NEMA), County government extension, Community Forest Association (CFA), COPiCAD, Teacher, Civil Servant and Stephen Njagi.	More fragmented network with minimal policy, investment and value-chain coordination; private sector largely absent from decision-making Initial proposal was to work through the CFAs for adaptation pathway planning. Other actors that could also be included in the adaptation pathways planning include the farmers cooperative societies such as Weru Farmers Cooperative Society given their level of influence over farmers, agricultural extension officers, and CoPiCAD which focuses on capacity development of farmers and other community based organisations (CBOs) across the county	Private sector actors, value-chain organisations, financial institutions, climate information services and policy coordination platforms

Stakeholder engagement plan for the project teams, cross-cutting objectives:

- Keep the county government and key actors informed and engaged to align to county priorities and ensure integration in county planning
- identifying organisations that can support or enable implementation of adaptation options
- Introduce adaptation pathways into ward and county level planning through a process of training and co-development
- Local level socialization of the project and progress and support for regreening actions as well as sharing back research results

Proposal to follow these mechanisms for stakeholder engagement as they were identified through the mapping and validation process. The research team can assess these approaches over time to understand if they are effective for a) awareness raising and sensitisation; b) to enhance support of county governments and other stakeholders both for the pathways approach and to support adaptation options, and c) integration of adaptation pathways as an approach for county level climate change planning.

Integration of evidence (from the baseline studies and additional sources) for co-production of adaptation pathways (including options) will take place with FMNR+ or CFA groups, individual farmers and at county level. Research questions will focus on the process for decision-making, stakeholder engagement approaches and evidence consideration.

5.2 Desk Review

A central finding in the desk review is the absence of existing research or projects explicitly focused on adaptation pathways in all four counties. This represents a critical knowledge gap, but also a strategic opportunity for the Regreening for the Future project to advance pathways.

Livelihoods are already undermined by interacting stressors, notably water scarcity and variability**,** land degradation, and high dependence on climate-sensitive value chains**,** particularly rain-fed agriculture and livestock. These pressures are expected to intensify under climate change, with compounding impacts on food security, income stability, health, and migration. Even in relatively high-rainfall counties, infrastructure constraints, erosion, and seasonal variability are driving water stress. Women, youth, older persons, persons with disabilities, and female-headed households face disproportionate risks, compounded by rising labour burdens linked to male outmigration. Despite these differentiated impacts, much of the existing literature remains dominated by technical narratives, with limited attention to household-level preferences, agency, and trade-offs.

Uncertainty is highest around localized climate projections**,** market dynamics**,** and governance capacity, constraining long-term decision-making. Several counties lack sufficiently granular climate data to guide targeted adaptation, while weak access to finance, extension services, and climate information limits uptake of available options. Across sites, interacting challenges such as environmental degradation, poverty, and institutional gaps reinforce locking households into low-productivity, high-risk livelihood pathways.

Policy and planning frameworks broadly recognize climate risks and promote nature-based and climate-smart solutions, but adaptation visions remain largely generic and insufficiently contextualized at county and sub-county levels. Overall, the review underscores the need for context-specific, inclusive adaptation pathways. Nyandarua priority adaptation pathways suggest integrating agroforestry, soil and water conservation and climate-smart dairy and potato systems. Table 5.2.1 summarises the key findings from the desk review

Table 5.2.1. Synthesis of key results for Adaptation Pathways Planning from the Desk Review chapter

County	Key Climate & System Stressors	Priority Pathway Options (Regreening & Livelihoods)	Limits, Trade-offs & Lock-ins	Pathways Design Implications	Key Enabling Conditions for Pathways
Nyandarua	Rising temperatures, increasing flood frequency and severity, recurrent drought and fire risk affecting dairy and potato value chains	Crop diversification, early-maturing varieties, agroforestry, soil and water conservation, irrigation Regreening pathways integrating agroforestry, soil and water conservation and climate-smart dairy and potato systems	Strong lock-in to climate-sensitive value chains, infrastructure exposure to floods, uneven access to adaptation resources	Pathways should be value-chain specific, balance flood and drought risk, and enable gradual shifts away from high-risk production systems	Mainstreamed climate planning, stable budget allocation, early warning systems, strong community engagement

5.3 Adaptation pathways focus group discussions

Key lessons for pathways planning

Nyandarua's risk landscape is shaped by the interaction of multiple drivers, including rainfall variability, drought and cold spells compounding with land fragmentation, forest degradation and riparian cultivation, meaning single-issue interventions will be insufficient and pathways must address biophysical and socio-economic stressors together. Water security and catchment restoration are foundational: regreening of upper watershed areas and protection of riparian zones are prerequisite steps for stabilising water availability, and without them other livelihood interventions face an unstable base. Land restoration and farm productivity must be sequenced together rather than treated as separate agendas, with agroforestry, soil fertility management and continuous regreening needing to accompany crop and livestock interventions to prevent lock-in to further degradation. Livelihood diversification through dairy, poultry and fruit value chains is promising but depends entirely on functioning cooperatives, market access and value addition, as production gains without market development will not translate into improved resilience. Skills, extension services and tailored climate information are binding constraints, particularly for cold-spell management and dry spell planning in a context where training access is extremely limited. Finally, finance, reliable inputs and coordinated institutions determine whether pathways scale: communities cannot move from coping to sustained transformation without accessible credit, timely provision of certified seeds and germplasm, and governance structures they trust.

Table 5.3.1. Synthesis of key results for Adaptation Pathways Planning in Nyandarua from the Focus Group Discussion chapter

Category	Key issues	Impacts
Negative Impacts	• Soil and land degradation (soil erosion, fertility decline, loss of indigenous species) • Climate variability and erratic rainfall disrupting farming • Rising hunger and food insecurity • Poverty, low incomes and limited livelihood options • Youth unemployment and social stress • Health impacts (disease burden, mental stress, malnutrition) • Land scarcity and fragmentation	• Cold-related crop stress as key climate driver alongside drought • Greater impacts on potato and vegetable farming. • Water scarcity from catchment degradation rather than absolute aridity. • Greater stress from farmers on corruption and governance failures (lack of trust)
Drivers of risk & root causes	• Climate variability and increasing drought and erratic rainfall • Overreliance on rain-fed agriculture • Deforestation and land degradation (overgrazing, poor land use) • Land fragmentation and population pressure • Weak extension services and limited technical knowledge • Limited access to finance and quality inputs Weak governance and policy enforcement	• Catchment degradation and riparian cultivation as critical land-water drivers. • Continuous cultivation and lack of certified seeds as agricultural drivers. • Higher mention of social vulnerability (family separation, insecurity) as secondary impacts.
Community actions	• Agroforestry, fruit tree planting and boundary trees • Crop diversification and kitchen gardens • Natural regeneration (FMNR-like practices) • Soil and water conservation (mulching, contour farming, cover crops) • Livestock rearing (dairy, poultry) • Formation of savings groups and cooperatives • Beekeeping	• Stronger dairy orientation (cattle and goats) as both adaptation and income strategy. • Riparian and catchment protection actions more prominent. • Soil testing and improved soil management as near-term steps.
Enabling conditions	• Continuous capacity building and training • Access to certified seeds, quality germplasm and tree seedlings • Access to affordable credit and finance • Stronger governance and reduced corruption Improved market access and value chain development • Better road infrastructure	• Greater emphasis on water infrastructure and catchment protection as foundational enablers. • Extension service strengthening seen as critical gap. • Taxation relief on farm inputs flagged as institutional enabler. • Trust building is key as foundation

Future aspirations	Regreened and restored landscapes with indigenous tree cover Food security and productive farming systems Diversified incomes and better markets Improved schools, health services and infrastructure Stronger, more cohesive and self-reliant communities	• Restored forests and upper catchment watersheds as distinctive landscape aspiration. • Dairy value chains and fruit farming as specific livelihood aspirations. Improved access to finance and microfinance emphasised.

5.4 Socio-economic assessment at the household level

Communities engage to a large degree in some form of regreening practices. The types of regreening practices being adopted reflect underlying biophysical realities (Table 5.4.1). Nyandarua has the luxury to focus on a broader range of regreening actions given that water is not as much of a limiting factor there. In particular, Nyandarua residents engage to a much higher degree in tree planting and enrichment activities, which are likely not feasible in the other sites (Table 5.4.2).

Table 5.4.1. Type of regreening practices implemented

Types of regreening practices undertaken	Percentage
Agroforestry	46.9
Boundary tree planting	62.9
Community mobilization for regreening activities and advocacy for policy change	1.8
Contour farming	4.5
Enrichment planting	5.0
Establishment of woodlots	20.4
Farmer managed natural regeneration	12.7
Fruits production	25.3
Homestead tree planting	50.2
Managing water runoff from roads to reduce erosion and support vegetation growth (green roads)	3.6
Mulching	13.1
Soil Conservation	32.6
Terracing	16.7
Water conservation	39.4
Zai pits	0.0
Other: Bee keeping, kitchen gardening	-

Table 5.4.2. Water conservation practices being implemented

Water conservation implemented at study sites	Percentage
Rainwater harvesting	83.0
Construction of water pans	5.4
Riverbank protection	4.4
Riparian restoration	1.0
Drip irrigation	3.7
Efficient water uses	40.8
Construction of soil water conservation structures like tie and tie, half-moons etc	0.3
Use of hydrogels	0.3
Other	-

The ability to carry out such practices also depends on land tenure and cultural norms. Land tenure varies considerably between sites and this likely has an impact on the type and extent of regreening practices pursued (Table 5.4.3). In Nyandarua county, land is mostly purchased or rented. This suggests a higher degree of population turnover in Nyandarua, and a higher percentage of immigrants. Whether these immigrants are from neighbouring counties or within counties is an interesting question; it could suggest lower levels of local indigenous knowledge, which could impact their climate resilience and aspirations for the future. This is obviously just speculation at this point.

Table 5.4.3. Type of land ownership occupied

Type of landownership for regreening practices	Percentage
Purchased	54.5
Communal	0.9
Rented	7.3
Public land	2.3
Ancestral land	12.7
Inherited	26.4

Cultural norms, particularly views on the role of women and youth in agricultural and regreening activities is shown in Table 5.4.4. There appears to be a broader view of the role of women in these activities, with majority viewing engagement and even leadership in these activities as the purvey of women. This may be due to underlying cultural norms with respect to gender, but it also could just be

reflection of the harsher conditions that require active participation of all segments of the population for survival.

Table 5.4.4. Perceptions on roles of women in regreening practices

Roles women in regreening practices	Percentage
Advocacy & policy influence	16.4
Business enterprises in green value chains	13.8
Leadership in community-based conservation efforts	35.6
Marketing products	0.0
Providing Security	0.0
Provision of quality tree/fruit seeds	10.1
Smart agriculture	0.0
Sustainable farming practices	48.0
Transportation to planting venue	0.0
Tree nursery production	26.5
Tree planting & land restoration activities	67.1
Kitchen garden maintenance	-

The biophysical and socio-economic contexts give rise to different views and opinions on regreening activities, climate change, and adaptation options. Residents have a firm grasp of changes that have occurred, drivers of those changes, the threat of climate change, and the necessity of adaptation measures. There are, however, slight differences with regard to how they rank the challenges they face and ranking of the challenges they face (Table 5.4.5). There is a stronger emphasis on infrastructural challenges. The challenges are more framed in terms of knowledge and awareness- convincing residents of the benefits of regreening.

Table 5.4.5. Major challenges community face in implementation of regreening and accessing market

Major challenges hindering implementation of regreening practices	Percentage
Climate extremes such as floods and drought	10.1
High cost of technological equipment	6.4
Lack of access to digital infrastructure	4.0
Lack of financial resources	41.6
Lack of knowledge and awareness on regreening benefits	47.0
Lack of seedlings	52.0
Land tenure issues	26.5
Limited access to markets for green products	13.1
Poor soils	14.1
Resistance from local communities	2.0
Water access	26.2
Weak policy implementation	6.4

Nyandarua residents have a much more negative view on the effectiveness of a suite of different adaptation measures - viewing many as ineffective (Figure 5.4.1). Perhaps the value addition of these strategies in an already productive area is less obvious to residents. This makes the importance of awareness creation in more important: while Nyandarua has the greatest scope for adaptation biophysically, stakeholders may be the least receptive to engaging with climate adaptation.

Synthesise

The socio-economic findings from Nyandarua reveal that regreening is already widely practiced (over 70% of respondents), primarily by adults above 35 years and predominantly led by men, reflecting entrenched gendered decision-making around land, labour, and investment. Secure land tenure (largely through private ownership) emerges as a key enabling condition, allowing households to invest in longer-term practices such as agroforestry, fruit tree production, soil and water conservation, and water harvesting. These practices are closely linked to livelihoods, food security, and income diversification, making regreening economically durable.

However, current livelihood strategies are already under pressure from declining soil fertility, land fragmentation, vegetation clearance for settlement and infrastructure, and increasing climate variability. Respondents report prolonged droughts, erratic rainfall, rising temperatures, and shifting seasons and cold snaps, which undermine tree survival, disrupt planting calendars, increase water stress, and intensify pest and disease pressures. These stressors are expected to intensify under future climate

scenarios, raising uncertainty around the viability of long-term restoration investments. Water harvesting stands out as the most effective and trusted adaptation measure, while reliance on climate forecasting and early warning remains low, indicating a gap between climate information and on-farm decision-making.

For making adaptation pathways the following is key: The main climate stressors in Nyandarua are prolonged droughts, erratic rainfall, declining soil fertility, vegetation loss, water stress, pests and diseases, and weak market access. The priority pathway options for Nyandarua are hence, agroforestry and fruit tree systems, water harvesting, soil and water conservation as well as green value chains linked to fruit and tree products. Limiting conditions and trade-offs could be in the weak markets which reduce incentives, gender-inequalities in terms of land access as well as youth and PWD exclusion. Hence, enabling conditions can be created through secure land tenure, increased access to finance and markets, targeted training and capacity building, and disability- and gender-responsive programming as well as fostering strong community engagement.

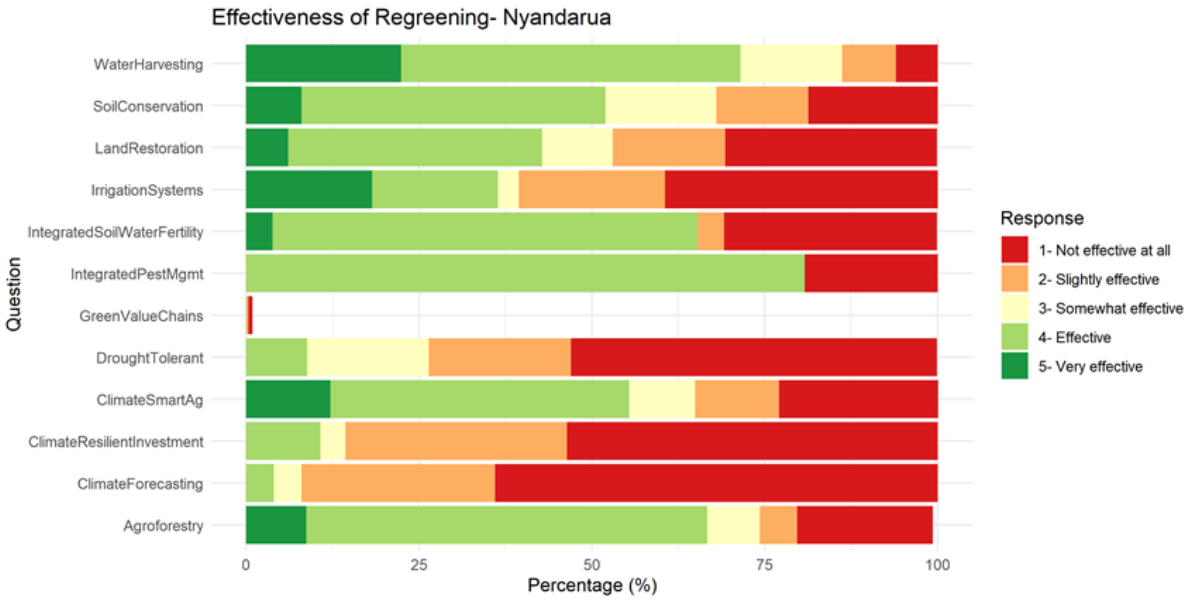


Figure 5.4.1. Effectiveness of Regreening

Table 5.4.6. Synthesis of key results for Adaptation Pathways Planning from the Socio-Economic Assessment chapter

Location	Key Climate & System Stressors	Priority Pathway Options (Regreening & Livelihoods)	Limits, Trade-offs & Lock-ins	Pathways Design Implications	Key Enabling Conditions for Pathways
Nyandarua	Prolonged droughts, rising temperatures, erratic rainfall, declining soil fertility, vegetation loss, water stress, pests and diseases, weak market access	Agroforestry and fruit tree systems; water harvesting; soil and water conservation; climate-smart species selection; green value chains linked to fruits and tree products	Self-financed regreening limits scale; weak markets reduce incentives; gendered land access; youth and persons with disability exclusion	Important to link to livelihood and the socio-economic conditions (e.g. gender inequalities)	Secure land tenure; access to finance and markets; targeted training and capacity building; disability- and gender-responsive programming; strong community groups; policy support and market facilitation

5.5 Biophysical assessment

Biophysical Overview

The Nyandarua county is located in southwestern Kenya, an area likely to be particularly climate sensitive. Projections suggest that in the near to mid-term climate change will bring about an increase in mean surface temperature, extreme heat events, heavy precipitation and floods, and tropical cyclones. Precipitation overall is likely to decrease, but this is likely to be accompanied by an increase in variability and erratic seasonal patterns. See Table 5.5.1 for a summary of biophysical strengths and limitations of the county.

Nyandarua is biophysically in a much better situation than the other sites (Table 6.5.1). Nyandarua is located in a high elevation, cool-humid site, with fertile soils. In the short term, climate impacts are expected to be relatively minimal. The area has high productivity and supports a large range of different agricultural and forestry activities. The scope for adaptation is correspondingly quite broad in Nyandarua. Makueni is biophysically a poorer site and likely to become worse with climate change, even in the short-term.

Table 5.5.1. Summary of Biophysical strengths and limitations

Soil and land health	Overall, SOC in the area is within the good range of 1-3% (topsoil mean 2.69%), a good indicator of soil fertility, crop productivity and resilience to climate change. Variations in SoC are observed across vegetation types, land cover types and wards, For example:: • Higher SOC under pine species than eucalyptus due to slow needle-litter decomposition. Eucalyptus is the lowest (1.90%) due to allelopathic suppression of soil microbes. • Forestland (2.44%) and cropland (2.22%) hold more SOC than grasslands (1.59%), reflecting the benefit of tree cover. • SOC also varies significantly by ward: Gathanji (2.55%) and Weru (2.46%) and. Gatimu (1.57%), indicating spatially differentiated intervention needs. Soil moisture is low in some cases. For example, it is near the lower optimal boundary in clay soils, posing a risk to nutrient cycling under drought. Mean soil pH is 5.65 (range 4.72-6.56) generally indicating moderately acidic soils. Half of soils are near-neutral (median 6.05); a quarter are more acidic (Lower Quartile 5.20) which may require management. The minimum of 4.72 signals aluminium/manganese toxicity risk in some plots, threatening Phosphorous (P), Calcium (Ca) and Magnesium (Mg) availability. The PH also varies across land cover/ land use type. Croplands are least acidic (pH 6.12), forestlands more so (5.59), grasslands most acidic (5.30), matching the dominant plantation species. Micronutrients levels vary: • Nitrogen is (N) generally sufficient on average 0.194% but locally deficient in Gatimu ward (0.129%). • Phosphorus (P) deficient in over half the soils. While the mean P levels appears adequate,the median reveals over half of soils are P deficient. The high outliers under pine/cypress skew the average hence targeted soil testing before P application is essential. • Potassium (K) levels very high throughout hence no potash fertiliser needed.
Optimal crops / agriculture	Existing (wheat, pyrethrum, barley, maize) remain well-suited. Near-neutral cropland soils and very high potassium additionally support bananas, avocado, citrus, potatoes and cassava.
Challenges, opportunities and options	Mostly cultivated land, including on steep slopes. High altitude potentially buffering some climate change impacts. High productivity and rich soils. High potential for regreening options such as agroforestry systems such as the integration of *Grevellia robusta* and maize/beans; avocado and bananas; mango and bananas; and mango with groundnuts. Viable forage options in areas where soil PH approaches 6.0 are Napier grass, Rhodes grass, lucerne. In addition, pine plantations offer strong carbon co-benefits. Key constraints: moisture deficits in clay soils risk nutrient cycling failures under climate stress; strongly acidic soils in some plots require liming to reduce the risk of aluminium/manganese toxicity and Calcium - Magnesium (Ca-Mg) antagonism ; over half of soils are Phosphorous deficient despite an adequate mean (targeted testing essential); excess Potassium (K) risks Calcium - Magnesium (Ca-Mg) antagonism. Gatimu ward (lowest SOC and N) is a priority intervention area.

Biophysical Assessment narrative

The site-specific analysis largely supports the overall picture of high productivity for Nyandarua. This is reflected in the vegetation characteristics- diversity, density, and dominance (Table 5.5.2), and in soil properties- elemental ratios and exchangeable cations (Table 5.5.3). There is variation according to vegetation category (cropland, grassland, or forest land), but the trends generally hold across all category types.

Nyandarua has high species diversity and richness, although with a high dominance of water-loving non-natives. Tree density and basal area is overall high, although the diameter class indicates non-natural forestry conditions with a high preponderance of the mid-sized (pole sized) trees. Soils are very productive with high carbon content, a healthy carbon/nitrogen ratio allowing for a rough equilibrium of nitrogen mineralization/ immobilization environments, high soil moisture, low bulk density, high levels of macronutrients, and adequate micronutrients. The only potential challenges are the low pH suggesting high turn-over of cations as well as potential toxic levels of some of the heavy metals.

Table 5.5.2. Summary of Vegetation Characteristics

Top 3 Dominant tree species	Cupressus lusitanica Juniperus procera Eucalyptus grandis
Richness	20
Shannon	2.007
Evenness	0.67
Density/Basal Area	100/ 2.7
Diameter Distribution	Skewed curve, fewer smaller size individuals

Table 5.5.3. Summary of soil characteristics - a) Carbon and Nitrogen conditions, and b) Exchangeable cations

a) Carbon and Nitrogen	C %	N%	C/N Ratio
Cropland	2.22	0.18	12
Forest*	2.44	0.21	12
Grassland	1.59	0.15	11

b) Exchangeable Cations	Ph	K (ppm)	Mg (ppm)
Cropland	6.12	701	143.2
Forest*	5.59	665.3	261.2
Grassland	5.31	757.2	154.7

5.6 Green value chain assessment on forest and tree-based productions

Green value chains in Nyandarua are dominated by production and self-marketing, with limited processing and weak service provision. The most promising enterprises cluster around fruit trees (avocado, tomato, citrus), timber trees (eucalyptus, grevillea, cypress) and beekeeping, with emerging interest in higher-value niches for chia. Pathway and option viability is constrained by water stress for nurseries, pests and diseases, weak market linkages, limited access to finance and inputs, and overreliance on narrow species portfolios (notably Cupressus and water-intensive eucalyptus). The synthesis points to value-addition (especially fruit processing), cooperative strengthening, improved nursery systems, and market access as priority enablers. For pathways design and enablers, species and enterprise diversification, sequencing investments from production to processing, establishing producer cooperatives and triggers linked to seedling survival and water reliability are critical to sustain incentives for regreening.

Synthesis & implications for pathways planning

The most robust low-regret green value chain pathways options should combine fruit trees, timber/wood products, and beekeeping, layered with site specific crop production to support food security and nutrition, with additional food production supporting value addition (Table 5.6.1). Weak producer–processor–distributor linkages, initial finance and service provision gaps (e.g. saplings), market access

constraints, and chronic climate stress notably from droughts can limit regreening to support durable, climate resilient livelihoods. Pathways should therefore be enabling condition led and sequencing should focus on creating the right conditions before moving to new options to avoid maladaptation (e.g. ensuring water availability for specific fruit trees). Focus on markets, finance, processing, nurseries, and cooperatives can enable later pathway shifts toward higher value, restoration supportive green value chain enterprises. Monitoring for triggers including water reliability, seedling survival and market volatility, and diversification away from narrow, water-intensive species are essential to manage climate uncertainty and avoid lock-in.

Table 5.6.1. Synthesis of key results for Adaptation Pathways Planning from the Green Value Chains chapter

Location	Key Climate & System Stressors	Priority Pathway Options (Regreening & Livelihoods)	Key Enabling Conditions for Pathways	Limits, Trade-offs & Lock-ins	Pathways Design Implications
Nyandarua	Erratic rainfall, periodic flooding; rising temperatures; pests & diseases; water scarcity for nurseries; market volatility; land degradation	Agroforestry, fruit trees (avocado, tomato); timber trees (eucalyptus, grevillea, cypress preferred); beekeeping; emerging chia market;	Strengthen cooperatives & market linkages; access to affordable finance; processing equipment; quality seeds; extension services; county planning integration	Production + marketing heavy, weak processing; limited fruit processing/value addition; Overreliance on narrow species base (e.g. Cupressus); water-intensive options under rainfall variability like eucalyptus; weak value addition risks low incentives; biophysical water limits	Avocado promising option (although caution with water use) - establishing more cooperatives to improve market access, improve access to nurseries, capitalise on community forest associations
Synthesis	Chronic climate stress; market volatility; land degradation; weak value chain integration; finance & service gaps	Tree-based systems + Beekeeping + agroecology + Fruit trees	Markets, finance, services, institutions, infrastructure, cooperatives	Maladaptation via water-intensive or narrow-species pathways; lock-in to low ecosystem diversity	Pathways should be enabling condition led given lack of agencies and capacities

5.7 Gender, equality, disability & social inclusion

The GEDSI assessment for the Regreening for the Future project provides a critical evidence base for understanding how gender, disability, and social inclusion dynamics shape community participation, access to resources, and equitable benefit-sharing. The findings highlight that while communities demonstrate strong engagement in environmental and socio-economic activities, meaningful inclusion remains uneven, particularly for women, youth, and persons with disabilities (Persons with disabilities). Survey results indicate persistent disparities in decision-making power, economic opportunities, access to essential services, and representation in formal structures, with Persons with Disabilities consistently experiencing the highest levels of exclusion.

The assessment also underscores substantial county-level variations. Homabay exhibits the highest proportion of households with Persons with disabilities members and the greatest challenges in accessing assistive devices and formal employment. This pattern reinforce the need for localized, adaptable GEDSI strategies that respond to diverse social, economic, and environmental realities.

Despite the strong participation of community members in several activities, including community meetings, youth groups, and natural resource management, representation does not always translate into influence. A significant share of respondents reports limited input or decision-making power in formal committees, raising concerns about tokenistic inclusion. Women's participation in development programs varies widely by county, and persons with disabilities remain among the least represented in leadership and governance processes. These gaps highlight the structural, physical, attitudinal, and communication-based barriers that hinder equitable participation in regreening and FMNR-related initiatives.

Overall, the assessment reveals that while the project counties possess strong community structures and a willingness to engage, systemic inequities, driven by gender norms, socio-economic vulnerabilities, exclusionary practices, and limited access to supportive infrastructure, continue to restrict inclusive climate adaptation and regreening outcomes. Strengthening disability inclusion, enhancing women's agency, expanding youth opportunities, and addressing the unique barriers faced by households in each county will be essential to ensuring that the benefits of the Regreening for the Future project reach those who need them most. By integrating these insights into program design, implementation, and monitoring, the project is well-positioned to advance equitable climate resilience and contribute meaningfully to long-term, community-driven landscape restoration.

Recommendations

1. Training and Capacity Building: To ensure sustainable land restoration efforts, the GEDSI analysis recommends that World Vision Kenya enhance training and capacity-building initiatives targeting all project participants. These trainings should focus on FMNR techniques, sustainable land management, and community-level project management, with intentional emphasis on empowering women, youth, and PWDs. The project should incorporate the "Going Green Together" model, ensuring that training approaches are inclusive, participatory, and accessible to diverse groups.

2. Strengthening Partnerships and Collaboration: The project should deepen collaboration with county governments, local and international NGOs, grassroots organizations, DPOs, and community leaders representing women, youth, and Persons with Disabilities. Stronger partnerships will help ensure marginalized voices influence decision-making structures. Working jointly with forestry agencies and community-based natural resource groups will also reinforce women's and Persons with Disabilities' bargaining power in advocating for land rights, equitable access to forest resources, and inclusive regreening practices.

3. Inclusion of Women, Persons with Disabilities, and Youth: To enhance meaningful participation, the project should ensure that women, men, girls, boys, and persons with disabilities are actively involved in project design, decision-making, and implementation processes. This can be achieved through inclusive community meetings, targeted focus group discussions, establishment of representative community committees, and creating safe, accessible, and disability-friendly spaces for active engagement.

4. Enhancing Equity in Property Ownership: To address persistent gender inequalities in land control and access, the project, working alongside county authorities and legal aid institutions, should promote inclusive land tenure systems. This may include supporting women's access to land through:

- legal aid and paralegal support,
- public awareness campaigns on land rights,
- community sensitization on joint land titling,
- advocacy for gender-responsive county land policies.

These actions will ensure that women can access, manage, and benefit from land-based livelihood opportunities.

5. Addressing Gender-Specific Needs: The project should address gender- specific needs of all groups, it should identify and address the specific needs and challenges faced by women in managing natural resources. This can be done through the provision of training on topics relevant to women, such as sustainable land management practices, or developing tools and technologies that are easier for women to use.

6. Disability Inclusion: All FMNR and regreening activities should fully integrate disability inclusion principles. The project should:

- explore the use of Assistive Technologies (ATs),
- introduce adapted tools and equipment for individuals with mobility, visual, or hearing difficulties,
- train staff and community facilitators on inclusive communication,
- Promote digital and low-tech solutions to support information sharing among Persons with Disabilities.
- Ensuring accessibility in both design and implementation will enable persons with disabilities to contribute meaningfully to land restoration efforts.

6. Recommendations for pathways planning in regreening for the future

This final chapter of the baseline report translates the findings from the baseline assessment into a forward-looking set of recommendations to guide and inform adaptation pathways planning. It draws together the eight domains of evidence presented and the collective priorities that emerged from consortium reflection discussions, to inform the next phase of work with communities, county governments, and implementing partners.

The recommendations are structured around two levels, (i) Nyandarua county specific priorities that respond to the particular biophysical, socio-economic, and governance contexts, (ii) cross cutting recommendations that focus on pathways process, method, and enabling conditions. Pathways must weave biophysical, socio-economic, value chain and governance considerations into one coherent planning process that communities and partners can work on together.

6.1. Nyandarua county specific recommendations

Some key challenges, including water stress, land degradation, floods and droughts, weak market linkages, and gaps in extension services and climate information call for focus of pathways development. Table 6.1.1 summarises the recommended short term (1-2 years) and medium-term (3-5 years) and long term (6 years +) pathway recommendations as well as enabling conditions and critical risks which may be translated into trigger thresholds.

Table 6.1.1. County specific recommendations for pathways planning: Synthesis across all baseline tools

Location	Short-term priorities (1-2-years)	Medium-term priorities (3-5 years)	Long-term goals (6 years plus)	Key Enabling Conditions for Pathways	Critical risks
Nyandarua	Build awareness and trust for regreening, support seedling access and species diversification away from narrow exotic plantation focus, engage CFAs and cooperatives	Develop climate-informed species selection, scale avocado, fruit and timber value chains with value addition, connect to national policy targets on timber productions	Exotic plantation monocultures replaced by diversified indigenous and agroforestry systems across the landscape, dairy and horticultural value chains climate-proofed, regreening integrated into county statutory planning and self-sustaining beyond project support	Awareness raising on regreening benefits, restored trust with CFAs and institutions, policy integration into county climate action plans, access to high-quality planting material	Continued narrowing of species diversity, land tenure barriers (purchased vs. inherited), risk aversion and low receptivity to adaptation options

Nyandarua presents a paradox that was clearly articulated in the baseline. It is biophysically the most favourable of the four counties land restoration and has the broadest scope for adaptation, with high elevation, fertile soils, adequate rainfall, yet communities are the most pessimistic about regreening and the least receptive to adaptation interventions. Trust is a foundational challenge. Communities questioned the legitimacy of the project partners, expressed scepticism about regreening's relevance, and in some cases, the timing of surveys (coinciding with a national health insurance controversy) influenced willingness to engage.

The immediate priority in Nyandarua is therefore not technical, but is social. Awareness raising, trust building, and demonstrating tangible and proximate benefits of regreening are prerequisites before meaningful pathway co-design can occur. It is recommended building on existing community organisations (CoPiCAD, CFAs, farmer cooperatives such as Weru Farmers Cooperative Society) rather than creating new structures, and linking the project's work to upcoming county planning processes, specifically the Climate Change Action Plan (CCAP) and County Integrated Development Plan (CIDP) for 2028–2032, which is a significant policy opportunity.

Biophysically, while regreening is happening in Nyandarua, it is dominated by a narrow range of plantation species, primarily exotic water-intensive species such as eucalyptus and cypress, that deliver economic value in the short term but undermine long-term adaptive capacity and hydrological function. Boundary tree planting in Nyandarua is twice as high as in other counties, but these are predominantly fast-growing exotics. Species diversification, including more indigenous species and climate-informed selection based on future rainfall and temperature projections, is a priority next step. A climate suitability analysis for indigenous and introduced species under different land use types was recommended as an important evidence base to inform this work.

Value chains in Nyandarua offer opportunities, including avocado, tomatoes, citrus, beekeeping, and chia, but these are constrained by weak market linkages, limited processing, and over-reliance on self-marketing. Building producer cooperatives, improving nursery systems, and accessing quality planting material are recommended as enabling conditions that need to be invested in alongside the species diversification work. Pests and diseases, including those affecting avocado and other fruit trees, were identified as an important knowledge gap.

6.2 Cross-cutting recommendations

Beyond the county-specific priorities, a set of cross-cutting recommendations broadly apply. These concern the process and quality of adaptation pathways planning, rather than specific technical interventions. They respond directly to the knowledge gaps and to the cross-cutting themes that arose in the baseline work.

Table 6.2.1. Cross-cutting recommendations for adaptation pathways planning

Recommendation Area	Key Actions
Climate-informed species and option selection	Conduct climate suitability analysis for all priority regreening species and value chain crops under 10- and 20-year scenarios; develop site-specific guidance on species viability; share findings with communities in accessible formats
Strengthening green value chains	Map full value chains from production to market; identify processing and storage bottlenecks; support cooperative formation; conduct market intelligence studies for priority commodities (avocado, honey, bamboo, Melia)
Inclusive and equitable pathway design	Integrate GEDSI principles throughout pathway co-design; address land tenure barriers for women; create youth-specific livelihood entry points; ensure persons with disabilities participate in training, decision-making and benefit-sharing
Operationalise MEL for pathways	Develop shared outcome-oriented indicators for resilience, adaptive capacity and livelihood security; integrate evaluation and learning (E&L) alongside monitoring; establish cross-site learning mechanisms; define triggers and thresholds for pathway shifts
Stakeholder engagement and governance	Develop tailored engagement plans per county; integrate regreening and adaptation into county Climate Change Action Plan (CCAP) and County Integrated Development Plans (CIDP) planning cycles; build vertical linkages between community CBOs and county institutions

Recommendation Area	Key Actions
Indigenous knowledge and species conservation	Document and validate indigenous species and practices (e.g. use of Melia, baobab, bamboo); investigate role of indigenous knowledge in climate-resilient decision-making; address risk of disappearing indigenous tree species
Upstream and catchment level considerations	Assess off-farm and upstream drivers constraining on-farm regreening effectiveness (e.g. catchment land use, livestock grazing, water abstraction); design pathway ambitions that reflect realistic catchment-level conditions
Future climate scenario integration	Commission climate projections for each site at county and sub-county level; use these to stress-test priority regreening and value chain options; communicate findings to farmers using participatory methods that support decision-making

6.2.1 Bring climate scenarios into pathways planning

Climate projections at county and sub-county level, disaggregated to show likely changes in temperature, rainfall, and extreme events over 10–20 year time horizons, are needed for all four sites. These projections should be used to explore the climate resilience of priority regreening species and value chain options identified in the baseline. CIFOR-ICRAF's work on climate suitability analysis under different land use types will be a promising next step. Critically, climate information needs to reach communities in ways that are decision-relevant and accessible. What type of climate information actually enables farmers to make better decisions, and at what moment in the agricultural calendar that information is most useful, will be important to understand. This is itself an important research and engagement question that the project should explore as part of its pathways co-design process.

6.2.2 Consider maladaptation in pathways

The baseline findings consistently show that short-term livelihood pressures take priority over long-term decision planning. A clear pathway sequencing framework should be developed in consultation with communities and implementing partners as a central output of the project. Across the site, the sequencing that emerged from the FGDs and synthesis discussions suggests a broadly shared logic:

- Step 1: Stabilise water and food security
- Step 2: Restore land and ecosystems
- Step 3: Diversify livelihoods and green value chains
- Step 4: Transform market and governance systems

This does not imply that actions in later phases cannot begin earlier, but it does imply that enabling conditions for each phase need to be in place before investment in the next. Monitoring for triggers and thresholds (i.e. the signals that indicate a pathway shift is needed or an option is becoming unviable) must be built into MEL from the outset. These triggers might include soil moisture thresholds, market price collapses, seedling survival rates, or watershed-level vegetation change.

6.2.3 Integrate green value chains

A key insight from the green value chain assessment is that weak producer-to-market linkages, fragmented cooperatives, and limited processing capacity are the primary bottlenecks preventing regreening options from translating into improving livelihoods through income. The evidence base is clear that communities are producing in many cases more than markets can absorb at a fair price but are unable to capture the value of what they grow. It is recommended that a systematic market assessment is undertaken across all four sites, understanding who buys what, at what price, with what quality standards, and how climate change over the next decade may shift those demand trajectories. For example, this applies to honey in the county.

The contribution of value chains to ecosystem restoration and climate adaptation also needs to be systematically evaluated. There is the need to assess the environmental sustainability and climate co-benefits of different enterprise options alongside their economic viability. This analytical step should be integrated into the value chain assessment work planned for the next project phase.

6.2.4 Design pathways that are equitable and inclusive

The GEDSI assessment makes clear that across all four counties, women, youth, older persons, and persons with disabilities face persistent structural barriers that limit their participation in and benefit from regreening and livelihood activities. These barriers, including land tenure insecurity, exclusion from finance, gendered labour burdens, limited representation in governance, are not incidental to adaptation pathways planning; they are central to it. Pathways that do not address these barriers risk reinforcing inequity or even increasing vulnerability for already marginalised groups.

This is not only an ethical question but a practical one. Pathways that exclude women from land-based investments, or that assign the labour burden of regreening to youth and women without giving them access to associated income, will not achieve their adaptation goals.

Specific recommendations include:

- Land tenure: Support women's access to land through legal aid, joint titling, and county advocacy.
- Youth engagement: Design specific entry points for youth, including in FMNR, nursery management, beekeeping, and emerging digital/market-facing roles, and link these to the MSc, PhD, and Post-doctoral research agenda that the consortium is building.
- Disability inclusion: Ensure all pathway co-design workshops and training activities are physically accessible, use inclusive communication, and track outcomes for persons with disabilities as a distinct population group.
- GEDSI responsive MEL: The GEDSI assessment currently provides a detailed static picture; this needs to be converted into dynamic change metrics that track shifts in inclusion and equity over the project lifetime. The project should operationalise the GEDSI MEL indicators in chapter 5.

6.2.5 Operationalise monitoring, evaluation and learning for pathways

The baseline assessment highlights ongoing projects that have invested strongly in monitoring (e.g. counting trees, tracking households, mapping stakeholders) but have underinvested in evaluation and learning. This gap is critical for pathways planning. Without systematic evaluation of what is working and why, and without structured learning loops between communities, county institutions, and implementing partners, it will be difficult to justify or navigate pathway shifts.

Cross-site learning is an opportunity. If one site is successfully developing a value chain or applying a regreening approach, there should be a structured mechanism for sharing that experience with the other sites. Specific MEL recommendations arising from the baseline and synthesis discussions include:

- Develop shared, outcome-focused indicators that capture resilience, adaptive capacity, and livelihood security not just activity outputs (numbers of trees planted, households trained).
- Integrate trigger monitoring into the MEL framework from the start, so that pathway shifts can be evidence-based and timely rather than reactive.
- Establish annual reflection cycles with communities, partners, and county stakeholders to review pathway performance and identify course corrections.
- Document and share rationale for critical decisions, i.e. the 'why' behind pathway choice, so that the project builds a cumulative evidence base that is useful beyond the project period.
- Align MEL with county planning cycles so that evidence from the project feeds into CCAP and CIDP development processes.

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