International Journal of
Environmental Science
(IJES)

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International Journal of Environmental Sciences
ISSN 2519-5549 (online)
Vol.8, Special Issue 1, pp 80-99, 2025

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Harnessing Nature's Resilience through Farmer-Managed Natural Regeneration for Climate Change Adaptation in the Central Rift, Kenya

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Article History

Received 11th November 2024
Received in Revised Form 17th December 2024
Accepted 14th January 2025

How to cite in APA format:

Korir, J., Munyao, C., Kigen, C., Too, P., & Chesire, M. (2025). Harnessing Nature's Resilience through Farmer-Managed Natural Regeneration for Climate Change Adaptation in the Central Rift, Kenya. *International Journal of Environmental Sciences*, *8*(Special Issue 1), 80–99. https://doi.org/10.47604/ijes.3163

Special Issue on Farm Managed Natural Regeneration (FMNR)
Vol 8, Special Issue 1, pp80-99, 2025

Abstract

Purpose: Climate change affects nations differently according to their natural environment and economic structure. Communities living in arid and semi-arid lands, such as in Central Rift Valley of Kenya, who heavily rely on natural resources for livelihood, bear the heavy brunt of climate change impacts. This study focuses on these regions, where communities face challenges of water scarcity, erratic rainfall patterns, land degradation, increased frequency of floods and droughts. These climatic changes negatively affect crop yields, diminish animal fodder production, and reduce availability of firewood, exacerbating the vulnerability of these communities to food insecurity and economic instability. FMNR (Farmer-Managed Natural Regeneration) is a land restoration method where farmers foster growth of native trees and shrubs on their land by selectively pruning and protecting existing vegetation. It enhances soil fertility, water retention, and biodiversity while providing benefits of increased crop yields and additional income sources for farmers. Despite promotion of FMNR, a systematic presentation of evidence regarding its success in enhancing adaptation to climate change impacts in Central Rift, Kenya, has been notably absent.

Methodology: Using theory-based evaluation, key informant interviews, focus group discussions, transect walks, questionnaire, and documentary reviews, this study sought to assess the effectiveness of FMNR as an adaptation strategy in World Vision implementation sites within the Central Rift Valley including; Ndabibi in Nakuru; Marigat in Baringo and Ng'oswet in Elgeiyo Marakwet Counties. The study's quantitative data was analyzed using statistical package for social sciences (SPSS) while the qualitative data was analyzed using NVivo software.

Findings: The findings revealed notable improvements in forest cover with direct impacts of FMNR in forest cover from 500 acres at baseline to 6938 acres at the end line, increased average tree cover in farmlands from 79.5% to 122.6%, and in community lands from 89.9% to 109.2%. The indirect impacts, which may not solely be attributed to FMNR, include improved food security from 42.6% at the baseline to 73.6% at the end line, improved livelihoods by about 68% per annum, and improved capacity building/stakeholder engagement, all positively contributing to climate change adaptation. A situational analysis before the implementation of FMNR had highlighted environmental deterioration; food insecurity, increased poverty and negative effect on livelihoods.

Unique Contribution to Theory, Practice and Policy: The study concludes that FMNR is an effective strategy for mitigating and adapting to the adverse impacts of climate change. Policymakers are urged to integrate FMNR into national agroforestry and climate change policies, ensure broader adoption and long-term sustainability, while further research is needed to address existing limitations constraining the technique.

Keywords: *Adaptation, Climate Change, FMNR, Food Security, Resilience*

International Journal of Environmental Sciences
ISSN 2519-5549 (online)
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INTRODUCTION

The climate change impacts are characterized by a myriad of environmental stresses in the form of unpredictable weather patterns; extreme climatic conditions like drought and floods and the general environmental deterioration (Kimani et al., 2014). According to Chomba et.al., (2020), approximately 65% of productive land in Africa is degraded due to deforestation, out of these an estimated 132 million hectares is degraded crop land. The consequent impact of environmental degradation includes food insecurity, loss of forest cover; and loss of biodiversity which cumulatively result in climate change. Fagan et al., (2020) and FAO, (2020) note that the annual deforestation in Africa continues to exceed forest restoration; with some countries according to Francis, (2015) recording deforestation and tree planting rates at a disproportionate ratio of 300:1. In an effort to increase food production small holder farmers in Africa are increasingly expanding agricultural land to marginal areas and abandoning key traditional conservation practices like fallowing hence, they are the key players in contributing to deforestation and the ultimate climate change (Kissinger et al., 2012). Climate change in Sub-Saharan Africa is severely affecting the weather patterns and causing perceptible unpredictable weather variations for instance, increased frequency of drought that used to be experienced after every ten years, now occur every two years at times on a yearly basis and the trend continues to worsen (Arslan et al.,2016).

According to Ole Saitabau (2014), the annual rainfall received currently in Kenya is more erratic and figures continue to decline as warmer dry months continue to be experienced in many parts of arid and semi-arid lands of the country. In addition, Kuyah et.al., (2023) noted that climate change and erratic weather conditions are expected to contribute to land degradation in most African countries and therefore, will expand dryland ecosystems. Land degradation in Kenya is a pressing issue, exacerbated by factors such as deforestation, overgrazing, and improper agricultural practices, leading to the loss of fertile soil and reduced productivity (Wanjira et al., 2020). These challenges are clearly evident through soil erosion, declining agricultural yields, and the depletion of natural resources, posing significant threats to food security, rural livelihoods, and overall environmental sustainability (Gomiero, 2016). Consequently, this scenario undermines the spectrum of ecosystem services crucial for the well-being of dryland communities, consequently raising concerns regarding livelihoods, food security, and the sustainability of socio-economic and environmental aspects.

However, the report on climate change impacts by the International Panel of Climate Change (IPCC) in 2007 highlights the African nations who are heavily reliant on natural resources and rain-fed agriculture, and experiencing significant degradation, are particularly susceptible to the adverse effects of climate change. Moreover, according to the findings of Njoka et al. (2016), the communities most significantly impacted by climate change are those residing in arid and semi-arid areas in Kenya and other global regions. These communities, being highly dependent on natural resources, experience heightened vulnerability due to the variability in rainfall and recurrent cycles of drought. According to Makuna (2013), climate change impacts on the environment and natural resource degradation has already been experienced in many parts of the globe with approximately 480 million people in Africa projected to be residing in water stressed areas by 2025. Adverse impacts of climate change have also led to indirect impacts that are exemplified by reduced agricultural production leading to reduced rural incomes and reduced food

security (Breisinger et al., 2010). In the context of environmental challenges and climate vulnerabilities, Kenya faces specific issues related to land degradation and the dependence of communities on natural resources (Flintan et al., 2013). Thus, the better part of the Central Rift valley which is characterized by arid and semi-arid conditions and the livelihoods that are dependent on natural resources have faced climate change impacts like in other regions. A study by Lelanguyah (2013), in Baringo found out that loss of crops, displacement of people, death of livestock and destruction of crops are some of the major effects of climate change related hazards on the livelihoods as well as other means of income for the local people in the County.

Farmers in Kenya have responded to the challenges of climate change and food insecurity through various adaptation strategies, including changes in cropping patterns, water management practices, and the adoption of drought-resistant crop varieties (Mwangi et al., 2017). Despite these efforts, shortcomings and failures in farmers' responses are evident, as some adaptation measures may prove insufficient in the face of rapidly changing climate conditions. Issues such as limited access to technology, financial constraints, and inadequate knowledge transfer hinder the effectiveness of these responses (Nkonya et al., 2016; Bryan 2020). Additionally, traditional farming practices and reliance on conventional agricultural methods often contribute to soil degradation, exacerbating the challenges faced by farmers in adapting to climate change (Place et al., 2013). However, the shortcomings in the implementation of existing agricultural policies and programs further hamper farmers' ability to effectively respond to climate-related challenges and food insecurity (FAO, 2018). Wanjira et. al, (2020), opine that Farmer Managed Natural Regeneration (FMNR) has the potential to diversify income and livelihood sources since trees have the potential to improve the situation for the many rural households who face food shortage in Kenya by providing additional nutrition like fruit trees, or diversifying household income sources which can then be used to meet their dietary needs

Moreover, natural regeneration on agricultural land has a great potential in contributing to the overall tree cover that consequently help in biomass restoration; increased biodiversity; improved ecosystem functions and increased soil organic carbon among other environmental benefits (Lohbeck et. al., 2020). In Ethiopia, natural regeneration on the hillsides supports livelihoods by increasing productivity and biodiversity of fragile ecosystems while reducing the risks of flooding and drought in vulnerable ecosystems which further helps to enhance the sustainable utilization of agricultural land down streams, (Mebrat, 2015). All these benefits seem to coincide with the prime role of Farmer Managed Natural Regeneration (FMNR) which is the protection and management of re-growth of trees by farmers in their fields. Chomba et al., (2020) emphasize that the said protection and management practice by farmers in FMNR particularly entails; selection, protection, pruning and maintenance of shoots growing from tree stumps or regenerating plants arising from re-sprouting rootstock.

Farmer Managed Natural Regeneration (FMNR), being a set of practices farmers use to foster the growth of indigenous trees on agricultural land according to Haglund et.al. (2011), is therefore one of the land regeneration systems that has the potential to restore vegetation cover that can be an adopted as both adaptation and mitigation strategy to climate change impacts. Accordingly, the FMNR theory of change illustrates the process by which increased tree cover leads to improved soil fertility and crop productivity, thereby enhancing food security and livelihoods. Here's a brief

summary along with a simple diagram (Figure 1). This clearly show that increased tree cover through FMNR practices, farmers selectively prune and manage regrowth of trees and shrubs on their land in order to improve their soil fertility due to the fact that regrowth of trees and shrubs helps to increase organic matter in the soil through leaf litter and root systems. This organic matter enriches the soil, enhancing its fertility and structure. At the same time, they will also enhance water infiltration and retention because the presence of trees improves water infiltration and retention in the soil, reducing erosion and surface runoff. In addition, trees provide shade and modify local microclimates, mitigating temperature extremes and reducing moisture loss from the soil and thus enhace the regulation of microclimate. All these activities will eventually lead to increased crop productivity: Improved soil fertility, water availability, and microclimate regulation contribute to increased crop productivity and resilience to climate variability. On the other hand, it will enhance food security and livelihoods: Higher crop yields and resilience to climate shocks improve food security for farming households. Additionally, surplus produce can be sold, generating income and improving livelihoods.

FMNR has been fronted as a rapid, low cost and easily replicated community-led approach to restoring and improving agricultural, forested and pasture lands. FMNR has been used by World Vision as a sustainable land management practice for around three decades (CRIFSUP, 2021). The practice is not new per se as it is a form of the traditional practice of coppicing and pollarding which was periodically used in wood management in the ancient days, (Rinaudo, 2007). Since its inception in Niger in the early nineties FMNR has spread to around 29 countries across Sub-Saharan Africa (Francis, 2015). The practice has also been adopted in arid and semi-arid areas of countries in Southern and Eastern African including Zambia, Malawi, Ethiopia, Sudan, Somalia, Tanzania and Kenya (Ndegwa et. al., 2017).

The Kenya Central Rift Farmer-Managed Natural Regeneration Scale-up project (CRIFSUP) which began in July 2012 is geared towards the promotion of FMNR in Kenya as part of the wider five-year East Africa FMNR Pilot Project. The project was implemented by the World Vision Australia (WVA) in seven Area Development Program (ADP) areas in central Rift Valley Region of Kenya. The project was funded by the Australian Department of Foreign Affairs and Trade (DFAT) and covered some parts of Nakuru, Baringo and Elgeiyo-Marakwet Counties (CRIFSUP, 2021). CRIFSUP baseline and End line evaluation reports of ADPs focused on the implementation of the FMNR and other ever green practices in land restoration among some small holder farmers and pastoralists in Central Rift Valley of Kenya. The evaluation study laid its basis on previous pilot studies in the two World Vision development program areas where FMNR existed and five development program areas where the FMNR was newly introduced (CRIFSUP, 2021).

International Journal of Environmental Sciences
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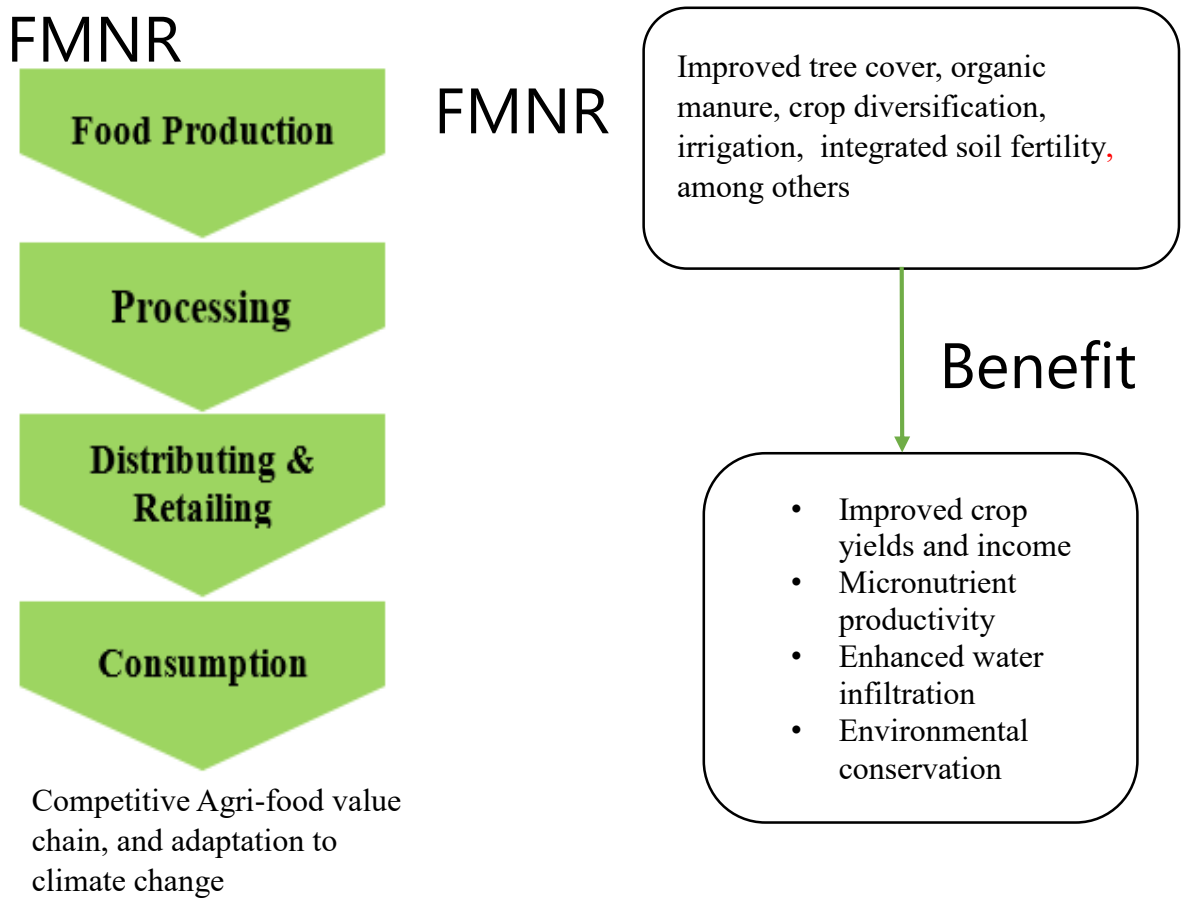

Figure 1: Effects of FMNR on Food and Nutrition Security and Other Welfare Indicators

Intergovernmental Panel on climate change (IPCC, 2007) assessment report underscores two critical issues about communities living in arid and semi-arid lands, that they bear the heavy brunt of climate change given their high dependent on the natural resources and that they need to explore adaptation and natural resource management strategies to help build their adaptive capacity to climate change impacts. Raygorodetsky (2011), also appreciated the potential of certain adaptation strategies that are cost effective; participatory and sustainable. Nkonya et al., (2016), observed that restoration of the degraded lands through increased forest cover contributes significantly towards carbon sequestration; recharge of ground water while reversing biodiversity loss among other benefits.

The practice of FMNR, like other agro forestry and land restoration practices has huge potential in land restoration and the general environmental protection that can be help farmers adapt to impacts brought about by climate change. Chomba et al., (2020), affirm that there has been immense positive livelihood improvement in areas where FMNR is practiced evidenced by increased crop production occasioned by the improved soil fertility; reduced soil erosion and increased soil water retention capacities. Increased crop production translates to improved food

security and incomes form the sale of surplus food. Furthermore, the practice enhanced resilience to climate change impacts in the project areas reduction of carbon dioxide effluents; reduction of high temperatures and the overall soil erosion control. The recent enormous positive aspects in FMNR has made it be fronted the most cost-effective adaptation and mitigation strategy to impacts of climate change compared to other techniques like tree planting that is faced with a myriad of challenges including low survival rates (Chomba et al., 2020). Kuyah et.al., (2023), pinpoint FMNR as an adaptation strategy since it restores the degraded ecosystem services such as the provision of goods to local communities facing shocks as well creating resilient production systems against extreme weather events, but as a mitigation strategy since it contributes to carbon sequestration in plant biomass and soils while reducing greenhouse gas emissions.

The success of natural restoration methods primarily depends on the extent of soil degradation and the availability of forest vegetation in the area for regeneration. Moreover, for agricultural land still under cultivation, the presence of root stock or remnant vegetation available for regeneration is crucial, as it determines the feasibility of implementing Farmer-Managed Natural Regeneration (FMNR). Additionally, active management by farmers is essential during the regeneration process to ensure its success. (Chazdon and Guariguata, 2016). In some areas where the technique has been practiced, environmental constraints and damage of unprotected trees by livestock could as well constrain FMNR especially in grazing lands. and therefore, measures to protect the trees are needed to be put in place. This evaluation was crucial because FMNR implementation in these areas having active farming distinguishes it from other natural regeneration techniques. The aim was to assess how FMNR performs in such agricultural landscapes, considering the unique challenges and dynamics associated with various active farming practices in the Central Rift Valley of Kenya.The aim is to assess how well FMNR performs in such agricultural landscapes, considering the unique challenges and dynamics associated with various active farming practices in Central Rift Valley of Kenya. The overall goal of this paper therefore, was to evaluate the effectiveness of FMNR in enhancing communities 'adaptation to impacts of climate change in in Central rift valley Area Development Projects (ADPs), in order to guarantee the projects' effectiveness.

The paper specifically assessed particular vulnerabilities and risks that caused marginalization in the target communities as a result of climate change impacts and investigated the specific benefits of FMNR program to the ADP communities in terms of improvement in forest density, food security and improvement of livelihood means. The benefits were critical in ascertaining the projects' effectiveness in building adaptive capacity of the community to impacts of climate change.

The Underlying Theoretical Framework

The paper adopted the theory of change which was relevant to the evaluation of the Central Rift Farmer-Managed Natural Regeneration Scale-up project (CRIFSUP). The theory was relevant since it is an evaluation study. According to Reinholz, and Andrews (2020), a theory of change is a particular approach for making underlying assumptions explicit, and using the desired outcomes of a project as a mechanism to guide planning, implementation and evaluation. Weiss (2018), indicates that an evaluation study seeks is to measure the effects of a program against the goal it is set out to accomplish as a means of informing subsequent decision making and improving future programs. The theory of change is basically a road map for change that guides those engaged in

the change process to remain focused without changing direction. The theory employs the techniques of an outcome map which entails a visual diagram that spells out relationships between initiative, strategies and intended results and the technique of list of assumptions about change (Weiss, 2018). Therefore, the theory of change is generally an approach that shows why an initiative works or does not work.

The theory of change was significant in this evaluation study as it described how the activities undertaken by the project interventions contributed to a chain of results that led to the intended or observed impacts. The theory of change became a perfect approach in analyzing intervention by CRIFSUP in implementing the Farmer-Managed Natural Regeneration (FMNR) and other evergreen land restoration techniques in the central Rift Counties of Kenya. Adaptation to climate change impacts was one of the likely outcomes of the intervention and critical contributions made by FMNR and other evergreen agricultural practices. Since situational analysis around the globe indicates that populations are beginning to experience the impacts of climate change with the ever-growing intensity, Central rift valley region of Kenya is not an exception and therefore adaptation to climate change is imperative.

Overall Objective

The overarching objective of the paper was to comprehensively assess the effectiveness of Farmer-Managed Natural Regeneration (FMNR) as an adaption strategy to impacts of climate change across various Area Development Projects sites (ADPs) in the Central Rift Valley.

Specific objectives

1. To establish the variation on vulnerabilities and risks faced by the targeted communities in ADPs areas of Central Rift Valley
2. To assess the impact of FMNR adoption on vegetative cover in ADPs of Central Rift Valley.
3. To assess the specific benefits of FMNR technique in ADPs of Central Rift Valley.
4. To identify the main challenges faced by farmers in adapting FMNR technique in ADPs of Central Rift Valley.

METHODOLOGY

The study employed a theory-based evaluation survey design where baseline and end line data were reviewed together with primary data in the project area and the control sites. The theory-based evaluation design was ideal for the study as it allowed for the review of intervention; inputs and observed outcomes that formed a basis for climate change adaptation. Both qualitative and quantitative data were used to investigate and analyze the effectiveness of FMNR as adaptation strategy to impacts of climate change in ADPs in central rift Valley. Primary and secondary data were collected from the three ADPs of Ndabibi in Nakuru County, Marigat in Baringo County, and Ng'oswet in Elgeyo Marakwet. Scope of methodology and data was shaped by the aim of determining the extent of the achievement of project goals, outcomes and outputs, as well as the extent of FMNR Adoption by State and Non-State Actors.

The study used multi-stage cluster sampling technique where the first stage involved purposive random selection of clusters of enumeration areas/villages (primary sampling unit) where

International Journal of Environmental Sciences
ISSN 2519-5549 (online)
Vol.8, Special Issue 1, pp 80-99, 2025
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inaccessible villages due poor road network as well as insecurity aspects were excluded. The second stage involved purposive selection of beneficiaries within the selected enumeration areas where training and adoption of FMNR practices have been done during project implementation. Finally, a proportionate to size random selection was used to identify the beneficiaries.

Furthermore, purposive sampling was also used in the selection of schools and the key informants for the interviews based on the project stakeholder matrix provided by the World Vision Kenya (WVK). Accordingly, the study collected data via Smartphone KOBO Toolbox collect phone application from 384 households based on Cochran's (1977) formula, and 15 focus group discussions (Ngoswet ADP-5 FGDs, Marigat ADP-5 FGDs, and Ndabibi ADP-5 FDGs). In addition, a total of 29 key informant interviews (5 females and 24 male) were reached; 10 from Elgeyo Marakwet County- Ng'oswet, Baringo, 8 from Baringo County- Marigat, 9 from Nakuru County- Ndabibi 4 from World Vision staff were interviewed. The collected quantitative data was coded, categorized, cleaned and analyzed using statistical package for social sciences (SPSS), version17, while the qualitative data or notes from key informant interviews and focus group discussions were typed in Microsoft Word2010 and then analyzed using NVivo software for thorough identification of the main themes and underlying causes as well as explanations of reported experiences and observations, particularly on effectiveness of FMNR as adaptation strategy to impacts of climate change.

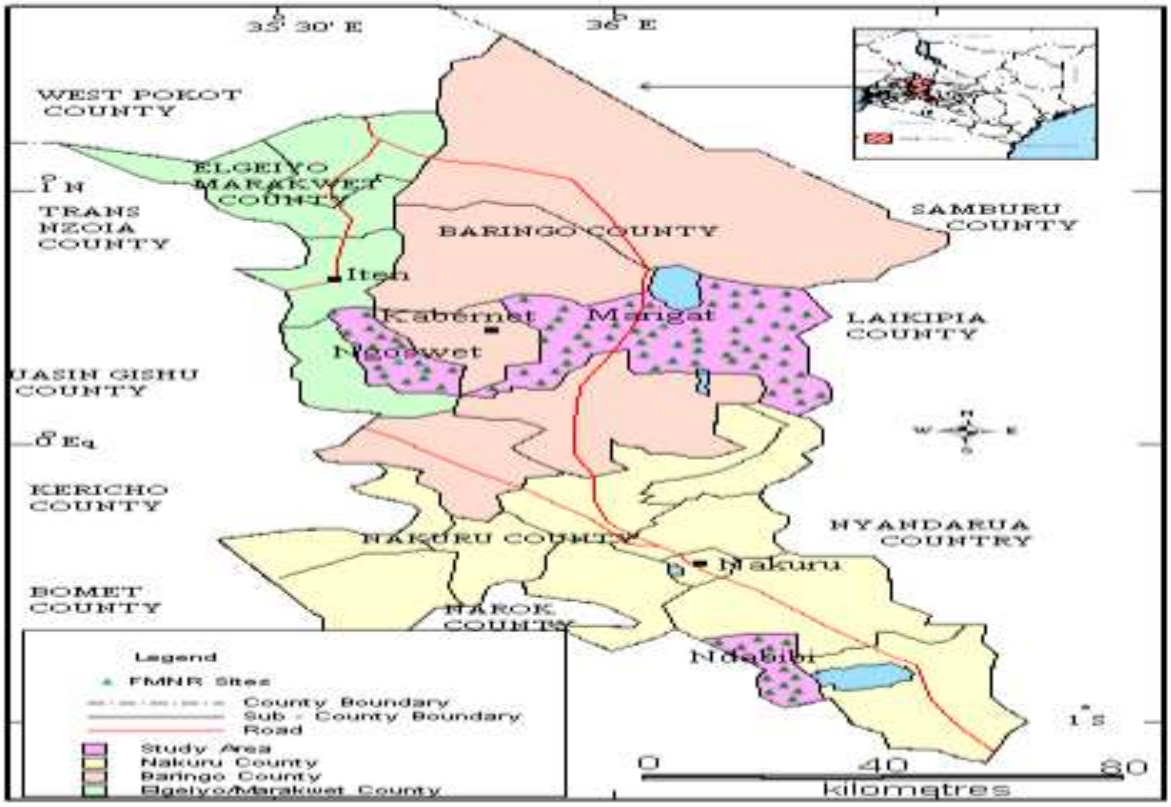

Figure 2: Study Area

Source: Moi University Department of Geography and Environment Studies GIS Lab, 2023

International Journal of Environmental Sciences
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RESULTS AND DISCUSSIONS

Communities' Vulnerabilities to Climate Change

During baseline evaluation the community members in the study areas prioritized challenges faced which were social, economic and environmental in nature. The challenges that featured prominently were; increased poverty levels; decreased access to portable water; drying up of rivers; inadequate supply of food and poor roads.

According to the end line of the project report, the Progress out of Poverty Index (PPI) alongside household per-PPI levels (USD$1.90 per day) stood at 22.65%, down from 45.3% recorded during the baseline survey. This indicates a significant reduction in the overall poverty index following the implementation of the FMNR technique. Moreover, the percentage of households experiencing severe hunger decreased from 7% at baseline to 0% at end line, while those with year-round access to food increased from 42.6% to 73.6% during the same period. However, it's important to note that since this study relied on baseline data without a control site, it's not definitively clear if these improvements are solely attributable to better adaptation to climate change or increased food production.

The situation is in line with the sentiments by Breisinger et al., (2010), who claimed that adverse impacts of climate change are exemplified by reduced agricultural production due to land degradation, which ultimately, leads to reduced rural incomes and heightens food insecurity. The same sentiments were later confirmed by Lelenguya (2013) who noted a strong correlation between poverty and vulnerability to climate change shocks, and that any attempt to reduce poverty had to consider the inter-linkages between climate change and livelihood systems such as FMNR, particularly in arid and semi-arid areas.

The study further sought to explore the effect of FMNR on other environmental vulnerabilities like soil erosion and soil degradation, which was reported in the study area at the baseline survey as among the challenges. According to the evaluation report the number of households who observed that soil erosion had reduced increased from 32.6% at baseline to 62.4% at the end line whereas the number of households that observed enhancement of soil fertility increased from 15.6% to 62.4% from the baseline to end line respectively. The evaluation looked at the extent of uptake of FMNR farming and land management practices as a contributor to environmental outcomes. There were relatively high percentage of participants doing FMNR on home/farmland. Among practices used to improve soil fertility, 65.9% (205) used manure to improve soil fertility, 10.4% (32) used mulching, 21.1% (85) practiced Intercropping or rotating with legumes, 28.1% (114) grew trees, and 35.6% used commercial fertilisers to improve soil fertility. In total 74.6% practiced FMNR for purpose of controlling soil erosion in the project area.

The evaluation survey study also recorded some indicators of climate change impacts in agricultural production in the project area during the baseline report which varied from County to County. These included the impact on crop productivity, which showed that over the 5-year period that preceded the baseline, a majority of households being 84.8% in Ndabibi, 80.7% in Marigat and 59% in Ng'oswet, were of the view that cereal crop production had decreased. Figure 2 illustrates project and control sites against perceptions of change in cereal crop production in percentage in the last five years before the baseline study.

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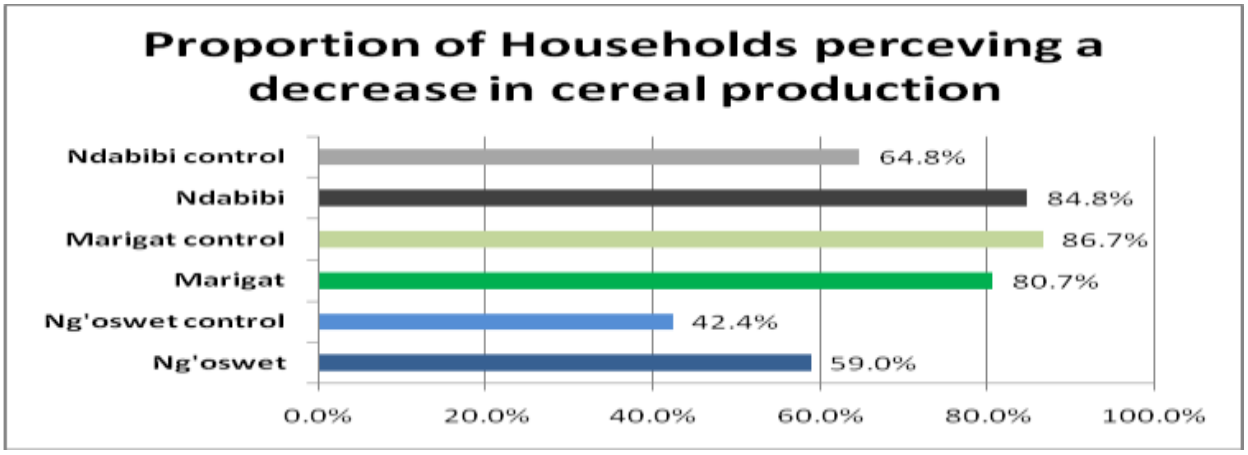

Figure 3: Perceptions of Change in Cereal Crop Production in Percentage in the Last Five Years before the Baseline Study

Source: CRIFSUP Final Report 2021

In terms of livestock productivity, milk production over the five years preceding the baseline survey was reported to have reduced by 53.1% of the households in the three ADPs which included: 42.7% of households in Ng'oswet, 54.0% households in Ndabibi and 62.6% in Marigat. Figure 3 shows the percentage of households reporting a decrease in number of livestock over previous five years preceding the baseline survey in both the project and control sites.

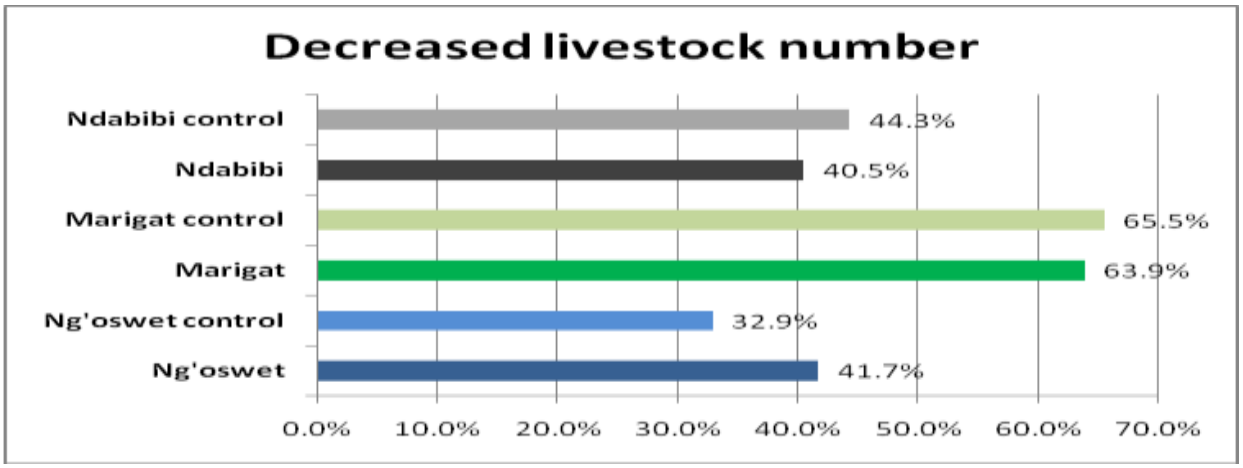

Figure 4: Percentage of Households Reporting a Decrease in Number of Livestock over Previous Five Years

Source: CRIFSUP Final Report 2021

To understand the extent of the levels of vulnerabilities and risks faced by the communities under ADPs, focus group discussions (FGDs) were carried out to supplement the survey data. In Baringo County, the main challenges reported by male FGD were persistent drought which led to famine and death of livestock. They pointed out flooding which washed away crops and even caused death of livestock. They also highlighted pest and diseases which affected crops and livestock, high cost

of living and a lack of job opportunities for the youth as other challenges facing them prior to FMNR interventions. These findings were similar to that of Korir (2019), who found out loss of livestock together with livestock disease outbreak as well as famine as the main impacts of climate change in Narok County.

While in Elgeyo Marakwet County, the women participant in the FGDs said that the main challenges were shortage of water mostly during dry season, droughts, drug and substance abuse, scarcity of water, soil erosion, unemployment, and disasters such as bush fires and landslides. They added that burning of bushes led to death of animals and destruction of natural environment, climate change contributed to food insecurity in the area due to unusual weather patterns and unemployment. Furthermore, the evaluation survey study recorded a number of outcomes as a result of the intervention of Farmer Managed Natural Regeneration and other evergreen agricultural practices in the Area development programme (ADP) sites covering Ndabibi in Nakuru; Marigat in Baringo and Ng'oswet in Elgeiyo Marakwet Counties. Key informant data confirmed that the outcomes that contributed significantly to climate change adaptation includes; increased tree cover and density; improved food security; improved livelihoods; capacity building and advocacy to improved climate change adaptation and resilience.

The Role of the FMNR in Increasing Tree Cover and Density

The results indicated a significant increase in the area of land managed by FMNR and other ever green agricultural practices. This is evident by the increase in the regenerated area under FMNR and other ever green agricultural practices. The average tree density (trees per hectare) on farmland increased from 75.9% to 112% and the average tree density (trees per hectare) on communal land increased from 89.9% to 109.9% between the baseline and end line surveys. The hectares of land under regenerative management rose from 500 to 6938 during the baseline and end line surveys respectively which is indicates significant impact of FMNR technique in increasing tree cover. Table 2 illustrates the improved tree cover and density after the implementation of FMNR and other evergreen agricultural practices.

Table 1: Improved Tree Cover and Density and Other Agricultural Practice after the Implementation of FMNR

SDG15: Life on land	2018 Baseline	2021 Evaluation
Average tree density (trees per hectare) on farmland	79.5	122.6(control: 87.2)
Average tree density (trees per hectare) on communal land	89.9	109.9 (control: 69.9)
Hectares of land under regenerative management	500	6,938

Source: CRIFSUP Final Report 2021

FGDs responses revealed that increased vegetation cover had minimized climate change impacts in the study area by promoting reduced massive soil erosion; reduced landslides; reduced excessive runoffs; reduced intensity of storms; protection of water catchment; improvement of soil fertility and ground water recharge among others. The findings above corroborated with that by Chomba et al., (2020), who had pointed out that mitigation and enhanced resilience to climate change

impacts had been promoted by the Farmer Managed Natural Regeneration practice in the areas where it was practiced through reduction of carbon dioxide effluents (sequestered in tree biomass and in the soil); reduction of wind speed; reduction of high temperatures and the overall soil erosion control. The same sentiments concurred with those of Mebrat, (2015), who noted that forest regeneration enhances biodiversity of fragile ecosystems while reducing the risks of flooding and drought in vulnerable ecosystems which further helps to enhance climate change mitigation and adaptation.

Role of FMNR Technique in Improving Food Security

The evaluation study findings indicated that there was a significant improvement in the food security of the communities in the study area. The number of households who reported sufficient food year round increased from 42.6% to 73.6%. And most of the households produced enough to feed their members through storage of food. Furthermore, 60% of the farmers trained under FMNR were able to preserve their cereal crops to minimize post-harvest losses and sale of surplus. Food insecurity is one of the global menaces that is largely a consequent of climate change. The improvement of food security in the study area resulting from the FMNR intervention has greatly contributed in the climate change adaptation by the community members. Contributions of FMNR to food security resulted from more consistent crop yields, diversified food options, improved nutrition, increased quantity and availability of food, improved access to food, increased availability of fodder needed for livestock production and improved soil fertility.

According to the results, 7% of families experienced severe hunger (on a Household Hunger Scale) at baseline whereas no household reported having experienced severe hunger at end line and while 97.3% reported no hunger at end line 70% had reported no hunger at baseline. The percentage of households with year-round access to sufficient food for the family's needs increased from 42.6% (at the baseline) to 73.6% (at the end line). As per the findings, multiple food security indicators confirmed positive impact of the project over the last four years. The hunger scale at the end line report of the project was compared to the baseline as shown in figure 4.

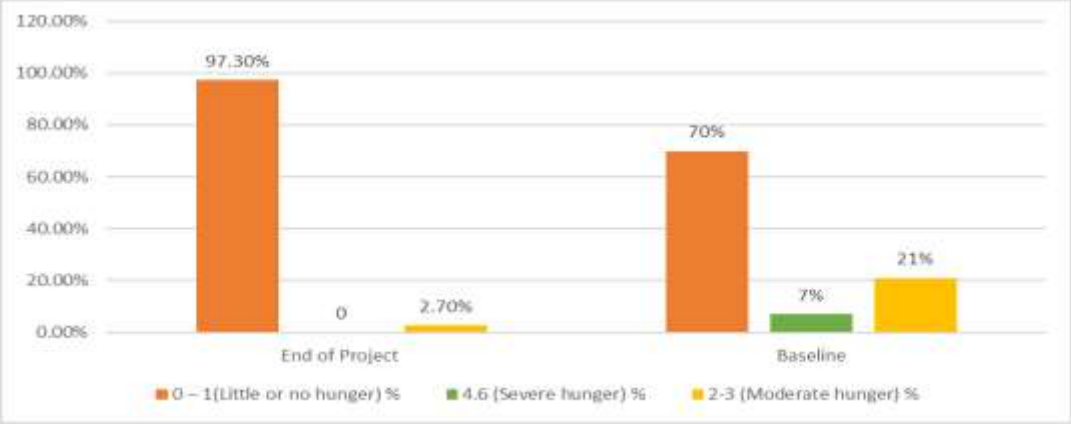

Figure 5: Household Hunger Scale Score at the End of the Project as Compared to the Baseline

Source: CRIFSUP Final Report 2021

International Journal of Environmental Sciences
ISSN 2519-5549 (online)
Vol.8, Special Issue 1, pp 80-99, 2025
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The increase in food security is therefore attributed to the practice of FMNR and other ever green agricultural practices that led to increased soil conservation and pasture management. Better soil conservation and pasture management translated to the increased soil fertility and improved cattle feeding with a consequent increase in agricultural production hence improved food security. This is also supported by Chomba et al., (2020), who indicate that there have been experiences of increased crop production occasioned by the improved soil fertility; reduced soil erosion and increased soil water retention capacities in areas where FMNR is practiced. Increased food production translates to improved food security and income from the sale of food surplus. Edible tree products for human and livestock consumption like nuts, fruits and plant leaves and wood sale helps in improving nutrition, fodder availability and incomes respectively.

Role of FMNR in Improvement of Livelihoods

The findings recorded that farm-related income increased from average KES. 32,574 to 54,714 per annum (an average change of 147.60 USD with a rate of KES 150 per USD) between baseline and end line measures, most of which was still derived from cereal agriculture, cash crops, charcoal, livestock, other animal products, and tree products. A total of 52.5% (211) of respondents at end line perceived that their income had increased by more than double the baseline income of 25.2%. Figure 4 illustrates reports by households on increased income.

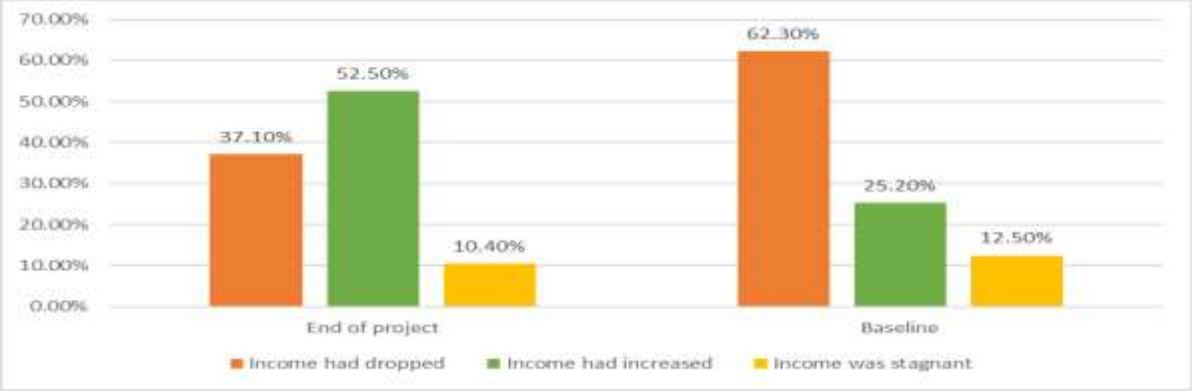

Figure 6: Percentage of Households Reporting Increased Income at the End Line Compared to Baseline Evaluation

Source: CRIFSUP Final Report 2021

The livelihoods of the communities living in the study area also recorded a significant improvement. As per the findings the proportion of parents/caregivers/farmers/members able to provide well for their children increased with 77.4% (311) of the respondents reported that they could provide for their children compared to 71.3% reported in the baseline. The household respondents reported that they got more income from selling livestock and livestock products, crops and tree products. This is attributed to the increased agricultural productivity brought about by the adoption of FMNR and other ever green agricultural practices in the study area. According to Chomba et al., (2020), the communities where FMNR is practiced records a significant improvement in livelihoods through increased nutritional/ food security and incomes. The FMNR and other ever green agricultural practices intervention in the study area has greatly enabled the

community to mitigate and adapt to the climate change impacts that have adversely affected the livelihoods of the communities particularly those that are entirely dependent on natural resources as a source of livelihoods.

Consequently, FMNR has emerged as a powerful tool in improving livelihoods, particularly in regions facing environmental degradation and climate change impacts. By enabling the regeneration of native tree species on agricultural land, FMNR contributes to enhanced soil fertility, increased water retention, and improved microclimates. These positive environmental effects, in turn, result in increased agricultural productivity and diversified income sources for farming communities (Garrity et al., 2010). FMNR promotes sustainable land management practices, allowing farmers to derive economic benefits from non-timber forest products, such as fruits, nuts, and medicinal plants, thus contributing to income diversification and improved household food security (Gebrekirstos et al., 2009). Moreover, FMNR's role in improving livelihoods extends beyond agricultural productivity. The practice empowers local communities by providing them with a sense of ownership and control over their natural resources. Through active participation in the regeneration process, farmers develop a stronger connection to their environment and a vested interest in its sustainability. This sense of empowerment fosters resilience in the face of climate uncertainties and economic challenges, as farmers become more adept at adapting to changing conditions (Place et al., 2018). In essence, FMNR serves as a catalyst for sustainable development, intertwining environmental stewardship with improved livelihoods in communities facing ecological degradation.

Capacity Building and Advocacy to Improved Climate Change Adaptation and Resilience

According to reports from FGDs, FMNR and other ever green agricultural practices complimented with other capacity building interventions such as land reclamation, selling of seedlings to members of the community, and visiting farms to check whether they were practicing what they were taught. These practices also promoted trainings on FMNR together with other ever green agricultural practices and engagement with wide range of stakeholders to advocate for the wider adoption of the FMNR. Stakeholders involved included; County Governments of Nakuru, Baringo and Elgeyo Marakwet; Ministry of Agriculture, Livestock and Fisheries; Ministry of Environment and Natural Resource; Ministry of Energy and Petroleum; Ministry of Water and Irrigation; Ministry of Interior and Coordination of National Government and Ministry of Education which included 160 schools. Reports from FGDs revealed that adoption of FMNR practices was effective in strengthening other local community income generating activities (IGAs) such as poultry, coffee production, bee keeping and pasture seed production across the project sites.

Generally, capacity building and stakeholder involvement towards development of strong resilience are both complimenting interventions that play a critical role in creating long term diversification of revenue streams. This is because they allow the community to effectively and efficiently adapt to the ever-increasing impacts of climate change and improve the sustainability of the FMNR and other evergreen agricultural activities. Moreover, capacity building and advocacy play pivotal roles in enhancing climate change adaptation and resilience within communities. Capacity building involves empowering individuals and communities with the knowledge, skills, and resources needed to understand and respond effectively to climate change impacts. Through targeted training programs, workshops, and educational initiatives, individuals

can develop adaptive strategies, sustainable practices, and a deeper understanding of the changing climate. According to UNDP (2017), Capacity building is essential for fostering resilience at the community level, enabling them to implement and sustain adaptive measures over the long term.

Advocacy, on the other hand, involves promoting policies and practices that support climate change adaptation and resilience. Effective advocacy campaigns raise awareness about the impacts of climate change, mobilize resources for adaptation projects, and influence decision-makers to prioritize climate-resilient strategies. Engaging in advocacy efforts helps create an enabling environment for communities to implement adaptive measures, secure funding, and shape policies that address their specific vulnerabilities. By advocating for climate-resilient practices at local, national, and international levels, communities can strengthen their ability to cope with the challenges posed by a changing climate (IPCC, 2014).

The Main Challenges Faced by Farmers in Adapting FMNR Technique

The evaluation results showed that farmers may face challenges in adopting FMNR due to a lack of awareness and understanding of the benefits and proper implementation techniques. On the other hand, limited access to resources, such as land, training, tools, and financial support coupled with resistant to change as well as climate variability, could hinder the adoption of FMNR practices among farmers in central Rift valley region in Kenya. These findings corroborate with that of Garrity et al., (2010), and Place et al., (2018), who noted that uncertain land tenure or property rights, traditional farming practices and resistance to change can be a significant barrier, as farmers may be hesitant to invest in long-term practices like FMNR. They further stated that unpredictable climate patterns and extreme weather events can also pose challenges for farmers attempting to implement FMNR, as these factors can impact on tree growth and survival.

CONCLUSION AND RECOMMENDATIONS

Farmer Managed Natural Regeneration (FMNR), akin to other agroforestry and land restoration practices, holds significant potential in the restoration, rehabilitation, re-afforestation, and overall environmental protection of land. In the project areas, the combined implementation of Farmer Managed Natural Regeneration and other evergreen agricultural practices has yielded substantial positive impacts, as evidenced by the study. These impacts include notable improvements in tree cover, enhanced livelihoods, and environmental benefits. The study findings suggest that this approach has been instrumental in enhancing resilience to climate change in the areas where it was implemented. This has been achieved through the reduction of overall soil erosion, enhancement of soil fertility, and improvement of agricultural practices. The positive transformation in community livelihoods, marked by increased income through the sale of cereals, livestock, and cash crops, has been observed across many households. This underscores the appropriateness of the program's focus on utilizing the FMNR and other evergreen agricultural practices to boost income and improve livelihoods by enhancing crop and livestock productivity. Finally, World Vision Baseline and Endline Study Report spanning from 2018 to 2021, presenting extensive findings across various themes, including environmental protection, household incomes, well-being, and agricultural productivity, underscores the significant role played by the FMNR project in poverty alleviation and building communities' adaptive capacity to climate change.

In light of the observed successes and identified challenges of FMNR, it is crucial to target policies that can further enhance the efficacy and scalability of this practice. These can be achieved, if governments and stakeholders can create an enabling environment that supports the widespread adoption and sustainability of FMNR while contributing to broader environmental conservation and climate resilient goals. Therefore, policymakers should consider the following recommendations:

Incorporation of FMNR in Agroforestry and Climate Change Policies:

Advocacy and promotion of the integration of FMNR practices within national agroforestry and climate change policies. Recognition and support at the policy level can foster wider adoption and long-term sustainability.

Promotion of Research and Development Incentives: Encouragement of the development of policies that allocate resources and incentives for research and development aimed at addressing the existing grey areas of FMNR. This includes further investigations into its effectiveness in diverse farming contexts, adaptability to various land uses, and integration with other sustainable land management techniques.

Financial Support for Sustainable FMNR Implementation: Introduction of policies that provide financial support, subsidies, or incentives for farmers to implement and maintain FMNR practices. This can include funding for training, capacity building, and the protection of live stumps, ensuring the economic viability and widespread adoption of FMNR.

Community-Based Natural Resource Management Policies: The development or enhancement of policies that support community-based natural resource management approaches, recognizing the role of local communities in the success of FMNR. This includes establishing mechanisms for community engagement, empowerment, and shared governance over the existing natural resources.

Monitoring and Reporting Frameworks: Efficient and effective implementation of policies that establish monitoring and reporting frameworks to track the impact of FMNR at county and national levels. This data-driven approach can inform adaptive management strategies, policy adjustments, and the scaling up of successful FMNR practices.

Climate-Resilient/Smart Agriculture Policies: and integration of FMNR into broader climate-resilient and climate smart agricultural policies, will clearly emphasize the role of FMNR in enhancing soil fertility, reducing erosion, and improving overall agricultural sustainability in the face of climate change.

Institutional Collaboration and Coordination: Facilitation of policies that encourage collaboration and coordination among institutions, NGOs, and community-based organizations involved in FMNR initiatives, will promote knowledge sharing, capacity building, and the development of best practices that are location-specific and cost-effective.

While FMNR has proven effective in enhancing adaptation to climate change impacts at both household and community levels, certain limitations warrant further research. These include:

Investigating the effectiveness of FMNR in areas with active farming compared to other natural regeneration techniques.

Interrogating the claim that FMNR can be applied across diverse land uses and climates, requiring research and documentation beyond project localities.

Investigating the reliance on live stumps in FMNR, with emphasis on the importance of suitable species and exploring integration with other techniques.

Reassessing the notion that FMNR is a cost-effective and easily replicable practice, necessitating quantification of external intervention costs and labor expenses for protection and maintenance.

Conducting research to provide recommendations on enabling institutions and policies directly influencing the success of FMNR. Enabling institutions and policies are deemed essential for the effective implementation of FMNR.

Acknowledgement

This research was conducted as part of the Central Rift FMNR Scale Up (CRIFSUP) Project, implemented by World Vision Kenya and funded by the Australian Department of Foreign Affairs and Trade (DFAT) through the Australian NGO Cooperation Program (ANCP) under World Vision Australia.

The authors gratefully acknowledge the critical support from World Vision Australia, World Vision Kenya, and Moi University. We extend our sincere appreciation to the County Governments of Elgeyo Marakwet, Baringo, and Nakuru, as well as to the community members, particularly the FMNR lead and replicate farmers, whose participation was essential to the success of this project.

We also wish to thank World Vision staff members Titus Kimono, Winnie Jeritoch, Betty Kandargor, Daniel Makana, Faith Milkah Muniale, Willis Okumu, Anthony Mativo, Caroline Maua, and Fredrick Kasiku for their invaluable contributions to this work.

REFERENCES

Arslan, A., Belotti, F., & Lipper, L. (2016). Smallholder productivity under climatic variability: Adoption and impact of widely promoted agricultural practices in Tanzania.

Breisinger, C., Van Rheenen, T., Ringler, C., Pratt, A. N., Minot, N., Aragon, C., ... & Zhu, T. (2010). Food security and economic development in the Middle East and North Africa. Current State and Future Perspective. IFPRI Discussion Paper, 985.

Bryan, A. (2020). Affective pedagogies: Foregrounding emotion in climate change education. Policy and Practice: A Development Education Review, 30, 8-30.

Chazdon, R. L., and Guariguata, M. R. (2016). Natural regeneration as a tool for large-scale forest restoration in the tropics: prospects and challenges. Biotropica 48, 716–730. doi: 10.1111/btp.12381

Chomba, S., Sinclair, F., Savadogo, P., Bourne, M., & Lohbeck, M. (2020). Opportunities and constraints for using farmer managed natural regeneration for land restoration in sub-Saharan Africa. Frontiers in Forests and Global Change, 3, 571679.

Cochran, W. G. (1977). Sampling techniques. John Wiley & Sons.

CRIFSUP 2019-2021 Annual Report (This reference is not complete)

Fagan, M. E., Reid, J. L., Holland, M. B., Drew, J. G., and Zahawi, R. A. (2020). How feasible are global forest restoration commitments? Conserve. Lett. 13: e12700.

FAO (2020). Global Forest Resource Assessment 2020. Rome: FAO.

Flintan, F. E., Behnke, R. H., & Neely, C. (2013). Natural resource management in the drylands in the Horn of Africa: Brief prepared by a Technical Consortium hosted by CGIAR in partnership with the FAO Investment Centre. Technical Consortium Brief.

Francis, R., Weston, P., & Birch, J. (2015). The social, environmental and economic benefits of Farmer Managed Natural Regeneration. World Vision Australia, 6-23.

Garrity, D., Akinnifesi, F. K., Ajayi, O. C., Weldesemayat, S. G., Mowo, J. G., & Kalinganire, A. (2010). Evergreen agriculture: a robust approach to sustainable food security in Africa. Food Security, 2(3), 197–214.

Gebrekirstos, A., Haile, M., Stroosnijder, L., & Aynekulu, E. (2009). Restoration of Ecosystem Carbon Stocks Following Exclosure Establishment in Communal Grazing Lands in Tigray, Ethiopia. Soil Science Society of America Journal, 73(1), 291–299.

Gomiero, T. (2016). Soil degradation, land scarcity and food security: Reviewing a complex challenge. Sustainability, 8(3), 281.

Haglund, E., Ndjeunga, J., Snook, L., & Pasternak, D. (2011). Dry land tree management for improved household livelihoods: farmer managed natural regeneration in Niger. Journal of environmental management, 92(7), 1696-1705.

IPCC (2007). Climate change: The Fourth IPCC Assessment Report. Cambridge University Press.

IPCC. (2014). "Climate Change 2014: Impacts, Adaptation, and Vulnerability." Retrieved from https://www.ipcc.ch/report/ar5/wg2/

Kimani, E. W., Ogendi, G. M., & Makenzi, P. M. (2014). An evaluation of constraints in climate change indigenous coping and adaptation strategies for sustainable agro-pastoral based livelihoods in Baringo County, Kenya. IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSRJESTFT), 8(8), 38-58.

Kissinger, G., Herold, M., & De Sy, V. (2012). Drivers of deforestation and forest degradation. A synthesis report for REDD+ Policymakers, 48(10.1016).

Korir, J. C. (2019). Climate Change Stress on Pastoral Livelihoods in Narok County, Kenya. European Journal of Social Sciences Studies.

Kothari, C. R. (2004). Sample size determination. Research Methodology. New Age International Publications, 1, 74-1.

Kuyah, S., Buleti, S., Dimobe, K., Nkurunziza, L., Moussa, S., Muthuri, C., & Öborn, I. (2023). Farmer-Managed Natural Regeneration in Africa: Evidence for Climate Change Mitigation and Adaptation in Drylands. In Agroforestry for Sustainable Intensification of Agriculture in Asia and Africa (pp. 53-88). Singapore: Springer Nature Singapore.

Lelenguyah, G. L. (2013). Effects of climate variability on pastoral livelihoods in Marigat District, Baringo County, Kenya, M. Env. Studies thesis, Kenyatta University.

Lohbeck, M., Albers, P., Boels, L. E., Bongers, F., Morel, S., Sinclair, F., ... & Smith-Dumont, E. (2020). Drivers of farmer-managed natural regeneration in the Sahel. Lessons for restoration. Scientific reports, 10(1), 1-11.

Makuna, T. E. (2013). Integration of indigenous and scientific technology in disaster reduction education in Kenya: A Framework for Sustainable Development. In Proceedings of the International Conference on Education.

Mebrat, W. (2015). Natural regeneration practice in degraded high lands of Ethiopia through area enclosure. International Journal of Environmental Protection and Policy, 3(5), 120-123.

Mukuna, T. E. (2013). Assessing the Impact of Climate Change on Coping Strategies and Social Safety Networks among the Pastoralists of Narok District, Kenya. Informal and Formal Social Protection Systems in Sub-Saharan Africa, 191.

Mwangi, B., Macharia, I., & Bett, E. (2021). A multi-dimensional adoption approach for improved sorghum varieties in eastern Kenya: a climate change adaptation perspective. Climate and Development, 13(4), 283-292.

Ndegwa, G., Iiyama, M., Anhuf, D., Nehren, U., and Schlüter, S. (2017). Tree establishment and management on farms in the drylands: evaluation of different systems adopted by small-scale farmers in Mutomo District, Kenya. Agroforest. Syst. 91, 1043–1055. doi: 10.1007/s10457-016-9979-y New York, NY: UN.

Njoka, J. T., Yanda, P., Maganga, F., Liwenga, E., Kateka, A., Henku, A.,….& Bavo, C. (2016) Kenya:Country situation assessment. Pathways to resilience in Semi-arid Economies (PRISE).

Nkonya, E., Mirzabaev, A., & Von Braun, J. (2016). Economics of land degradation and improvement–a global assessment for sustainable development (p. 686). Springer Nature.

Nkonya, E., Mirzabaev, A., & Von Braun, J. (2016). Economics of land degradation and improvement–a global assessment for sustainable development (p. 686). Springer Nature.

Ole Saitabau, H. (2014). Impacts of Climate Change on the Livelihoods of Loita Maasai Pastoral Community and the Related Indigenous Knowledge on Adaptation and Mitigation. National Museums of Kenya. Nairobi, Kenya. Accessed on, 12 2022 practices in Tanzania, by Arslan, A., Belotti, F. & Lipper, L.; Rome, 2015.

Place, F., Adato, M., Hebinck, P., & Lazar, A. (2018). Understanding rural poverty and investment in agriculture: an assessment of integrated quantitative and qualitative research in western Kenya. World Development, 108, 196–207.

Raygorodetsky, G. (2011). Why traditional knowledge holds the key to climate change, climate variability, culture & religions.Japan: United Nations University

Reinholz, D. L., & Andrews, T. C. (2020). Change theory and theory of change: what's the difference anyway?. International Journal of STEM Education, 7(1), 1-12

Rinaudo, T. (2007). The development of farmer managed natural regeneration. LEISA-LEUSDEN-, 23(2), 32.

Rinaudo, T. (2007). The development of farmer managed natural regeneration. LEISA-LEUSDEN-, 23(2), 32.

Stame, N. (2004). Theory-based evaluation and types of complexity. Evaluation, 10(1), 58-76.

UN (2019). United Nations Decade on Ecosystem Restoration (2021–2030), Resolution adopted by the General Assembly on 1 March 2019. A/RES/73/284.

UNCCD (2013). Background Document: The Economics of Desertification, Land Degradation and Drought: Methodologies and Analysis for Decision-Making. Bonn: United Nations Convention to Combat Desertification.

UNDP. (2017). "Capacity Building for Climate Change." Retrieved from https://www.undp.org/publications/capacity-building-climate-change

Wanjira, E. O., Muriuki, J. O. N. A. T. H. A. N., & Ojuok, I. R. E. N. E. (2020). Farmer managed natural regeneration in Kenya. World Agroforestry. Nairobi, Kenya.

Wanjira, E.O., Muriuki, J., & Ojuok, I. (2020). Farmer Managed Natural Regeneration in Kenya.

Weiss, C. H. (2018). Theory-based evaluation: theories of change for poverty reduction programs. In Evaluation and poverty reduction (pp. 103-112). Routledge.

Weiss, C. H. (2018). Theory-based evaluation: theories of change for poverty reduction programs. In Evaluation and poverty reduction (pp. 103-112). Routledge.