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Farmer managed natural regeneration (FMNR) for climate resilience and livelihood improvement in drylands of Kenya

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Abstract

Dryland ecosystems in Mandera, Kenya, are characterized by low and erratic rainfall (250–350 mm annually), severe land degradation, and unsustainable fuelwood extraction. Livestock rearing remains the primary livelihood but is highly vulnerable to climate extremes. To address these challenges, from 2014 to 2021, Adventist Development and Relief Agency and the Canadian Foodgrains Bank implemented a rangeland restoration project promoting Farmer Managed Natural Regeneration (FMNR) among 2,000 households. FMNR, which encourages natural regrowth of trees through systematic pruning and management, was implemented through participatory, behavior change–oriented approaches, including farmer champions, Pastoral Field Schools, FMNR learning sites, and peer exchange visits. The approach integrated FMNR with broader rangeland management practices, including enrichment planting, grazing planning, dry season fodder production, and herd management. Learning sites played a crucial role in demonstrating visible changes, promoting peer-to-peer uptake. Results demonstrate substantial ecological and livelihood benefits. The area under FMNR expanded to over 11,000 acres, with improvements in fodder availability, particularly during the dry period. Participating households reported a twofold increase in milk production alongside increased herd sizes. A mixed-methods post-project assessment in 2025 confirmed continued adoption and spontaneous expansion of FMNR practices beyond initial participants. Among five soil health characteristics, soil organic matter was significantly higher in FMNR plots (0.95 %) compared to non-FMNR plots (0.56 %). However, no significant differences were observed in slake, hoe, and Solvita tests or bulk density. While plant diversity was not assessed and insect measurement was inconclusive, community observations consistently reported increased species and the return of small fauna, alongside emerging concerns over human–wildlife interactions. Qualitative assessment showed that FMNR enhanced climate resilience through improved drought preparedness from fodder stockpiles, reduced soil erosion through vegetative cover, and better soil moisture retention. Livelihood diversification emerged through honey production, fodder and gum arabic sales, reduced reliance on purchased feed, and decreased seasonal livestock migration due to improved dry-season fodder availability. The approach also stimulated locally developed rules for managing regenerated areas and increased youth engagement in beekeeping. These findings highlight FMNR as a scalable, low-cost nature-based solution for restoring degraded drylands and strengthening agro-pastoral resilience in arid and semi-arid lands.

***Keywords**:* Agro-pastoral resilience, arid and semi-arid lands, climate change adaptation, farmer managed natural regeneration, Kenya

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Introduction

Dryland ecosystems in Mandera, Kenya, are characterized by low and erratic rainfall (250–350 mm annually), high temperatures (33 to 45 degree Celsius) and recurring droughts. This harsh climate, coupled with a high poverty rate (89.1%) and heavy reliance on livestock as a source of livelihood (more than 84% of the population), makes the county highly vulnerable to climate risks (MoALE, 2017). Climate-induced disasters, combined with unsustainable land-use practices, including overgrazing and high demand for wood fuel, have accelerated land degradation, thereby undermining the food security of agro-pastoralist communities. The Adventist Development and Relief Agency (ADRA) and the Canadian Foodgrains Bank implemented a rangeland restoration project from 2014 to 2021 to promote Farmer Managed Natural Regeneration (FMNR). FMNR is a systematic regrowth and management of trees and shrubs from felled tree stumps, sprouting root systems or seeds (Rinaudo, Miller & Moriis, 2019). Instead of planting seedlings, FMNR draws the living root stocks of trees that were felled but whose underground systems remain biologically active and capable of rapid regrowth (Haglund et al., 2011). The paper discusses the environmental and livelihood outcomes of FMNR interventions in Mandera, Kenya.

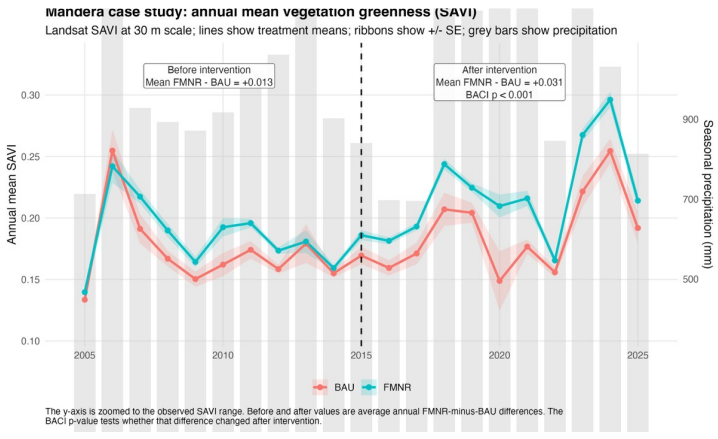
Material and Methods

During the project period, ADRA worked with approximately 1,000 households, organized into 50 community groups. Key interventions were training community extension agents/champions, experimental learning in Pastoralist Field School (PFS) setting, farmer-to-farmer learning through facilitated and informal exchanges, and complementary livelihood activities. The paper draws data from project baseline and endline data, project documentation and a post-project case study conducted in May 2025. For the case study, qualitative data were collected through five semi-structured key informant interviews involving government extension staff, farmers and an ADRA staff member. Interviews explored implementation processes, perceived impacts and lessons learned. Biophysical assessments were conducted in 25 FMNR-adopting fields and five business-as-usual (BAU) fields to compare vegetation, soil health and insect biodiversity. Soil samples were collected from three points per plot at a depth of 15 cm and analyzed for physical, chemical and biological indicators. Insect biodiversity was assessed using pitfall traps and bee bowls to capture ground-dwelling and pollinator activity. These field assessments were complemented by satellite-based remote sensing using the Soil Adjusted Vegetation Index (SAVI) to examine changes in vegetation across FMNR and BAU sites over time.

Results and Discussion

Rangeland rehabilitation and vegetation recovery: The FMNR interventions contributed to the rehabilitation of more than 11,000 acres of degraded rangeland. By protecting naturally regenerating trees and shrubs, combined with selective pruning and improved rangeland management, the project helped restore vegetation cover and improve pasture availability. Satellite-based vegetation analysis provided further evidence of landscape recovery. The SAVI showed a 134% increase in the relative vegetation greenness advantage of FMNR sites over BAU sites since 2015. This finding

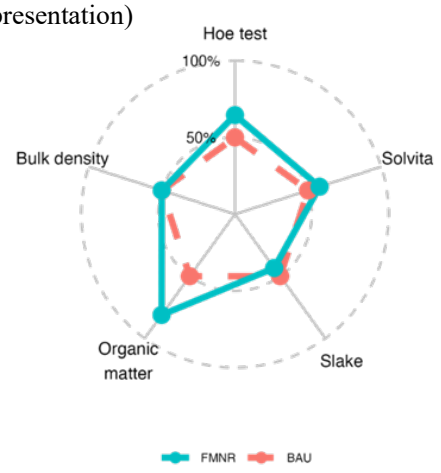
Figure 1: Mean SAVI on FMNR and BAU plots



supports farmers' observations of improved vegetation cover and suggests that the benefits of FMNR extended beyond individual demonstration plots to broader landscape-level vegetation recovery.

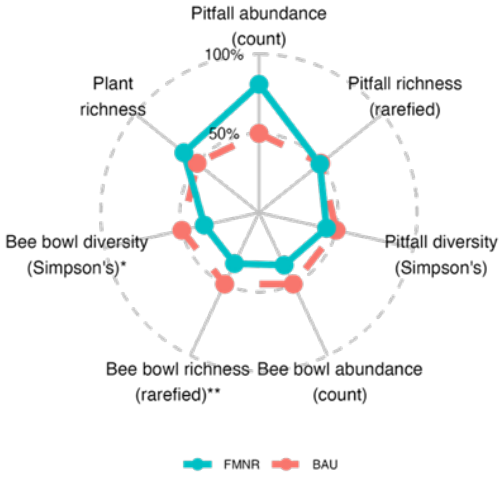
Improvements in soil health: Soil organic matter was significantly higher in FMNR plots (0.91%) than in BAU plots (0.56%). Although not statistically significant, positive trends were also observed in microbial activity and soil penetration, suggesting improvements in aspects of soil biological functioning and physical condition. No notable difference in bulk density was observed between FMNR and BAU plots, while aggregate stability showed a slight decline in FMNR sites. These findings indicate that although vegetation recovery was associated with improvements in organic soil matter and some soil health parameters

Figure 2: Soil health parameters in BAU and FMNR plots (Results were standardized from 0-100% with BAU being set to 50% for presentation)



Vegetation and insect biodiversity: FMNR sites generally supported greater biodiversity than BAU sites across several of the assessed indicators. Ground-dwelling insect abundance was higher in FMNR plots (~10 vs, 6 pitfall trap). Although statistically not significant, woody plant diversity was also higher in FMNR sites (19–21 vs, 16–18 species). This is consistent with farmers' observation of increased plant diversity and the return of small fauna in areas where vegetation had recovered. An exception was flying insect abundance, which was unexpectedly higher in BAU plots. The positioning of bee bowls above the vegetation canopy may have influenced insect capture rates and could partly explain this finding.

Figure 3: Plant and insect biodiversity across FMNR sites, compared to BAU sites



Livelihood improvements and household resilience: FMNR contributed to improvements in livestock production and household livelihood opportunities. Project monitoring data indicated an increase in the average number of goats per household as well as normal and dry season milk production (Table 2). Improvements in fodder availability from the baseline and endline data (Table 3) may have contributed to the increase in milk production. Nearly 59% reported availability for more than two months and 6.8% for more than three months in end line compared to none in the baseline data. FMNR also created opportunities for livelihood diversification. Increased availability of flowering trees and other vegetation provided favorable conditions for beekeeping, which emerged as an additional source of household income. Similarly, gum Arabic harvesting and sales provided another livelihood opportunity linked to the restored vegetation. These activities helped broaden the economic value of FMNR beyond fodder and fuelwood.

Table 1: Percentage of households with dry-season fodder availability

	Baseline	Endline
< 1 month	87.9%	12.8%
1-2 months	13%	28.5%
2-3 months	0%	52%
> 3 months	0%	6.8%

Table 2: Improvement in herd size and milk production

	Baseline	Endline
Goat/household	4.5	7
Milk production (L/day) Normal season Dry season	 2.9 0.8	 8.8 5.8

Source: Endline survey report, ADRA Kenya

Climate resilience and complementary interventions: Farmers reported that increased pasture and fodder reserves helped reduce the vulnerability of livestock to seasonal feed shortages. Vegetation recovery was also perceived to reduce soil erosion and improve soil moisture retention, supporting the longer-term productive capacity of rangelands. Kitchen gardening provided relatively quick benefits through improved household food availability and opportunities for income generation. Village Savings and Loans Associations (VSLAs) improved access to savings and credit while strengthening community organization and social cohesion. These complementary activities provided tangible household-level benefits while the ecological benefits of FMNR developed over time.

Conclusions and Outlook

Beyond the ecological benefits of restoring degraded rangelands, the findings indicate improvements in fodder availability, livestock productivity and livelihood diversification, contributing to greater household resilience to recurrent droughts. The spread of FMNR beyond directly supported households provides encouraging evidence of its sustainability and potential for wider adoption. Community bylaws and locally developed grazing plans also helped address challenges associated with communal land management, while engagement with government extension services strengthened local institutional support. Communal land governance and difficulties in enforcing grazing restrictions, particularly illegal grazing during the dry season, continue to threaten the protection of regenerating areas. Stakeholders also considered the project period insufficient for achieving wider adoption and consolidating community-based management systems. Furthermore, vegetation recovery brought some unintended challenges, including increased exposure to wildlife such as monkeys, warthogs and snakes. Looking ahead, wider adoption of FMNR will require sustained community engagement, stronger local governance and continued collaboration with government institutions. Integrating FMNR with complementary interventions that deliver relatively quick livelihood benefits can further strengthen community participation and commitment.

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