

Agroecology for Land Restoration and Climate Resilience: Evaluating Farmer-Led Soil Conservation Practices in Post-Cyclone Mecufi District, Cabo Delgado, Mozambique

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Abstract—This study examines agroecology for land restoration and climate resilience by evaluating farmer-led soil conservation practices in post-cyclone Mecufi District, Cabo Delgado Province, Mozambique. The district faces interacting pressures from tropical cyclones, armed conflict, displacement, and soil degradation, which have undermined smallholder agricultural livelihoods and ecosystem resilience. Following Cyclone Kenneth, approximately 87% of cultivated land experienced some degree of cyclone-related soil damage, underscoring the need for locally appropriate restoration strategies. The study employed a documentary review of 74 sources, including peer-reviewed literature, government assessments, NGO evaluations, agricultural extension reports, and community case studies, complemented by primary field observations from 32 farming households. It evaluated the adoption, perceived effectiveness, and enabling conditions of five practices: intercropping and crop diversification, cover cropping, agroforestry integration, contour bunding and soil-water conservation structures, and Farmer-Managed Natural Regeneration. Findings indicate that integrated agroecological practices improve soil fertility, reduce erosion, enhance moisture retention, diversify production, and strengthen household food security. However, adoption remains constrained by inadequate extension services, insecure land tenure, limited access to inputs and finance, and conflict-related displacement. The study recommends integrating farmer-led agroecology into district and national land restoration, disaster recovery, and climate adaptation programmes; strengthening farmer-to-farmer extension and community-based institutions; improving secure land tenure and access to restoration inputs and finance; and prioritising integrated, locally adapted soil and water conservation measures. It concludes that scaling agroecology through an Integrated Agroecological Resilience Framework can simultaneously restore

degraded land, strengthen climate resilience, and support sustainable agricultural recovery in cyclone-affected communities of Cabo Delgado province.

***Index Terms*—agroecology; land restoration; soil conservation; climate resilience; post-cyclone recovery; smallholder farmers**

I. INTRODUCTION

Tropical cyclones do not simply destroy crops; they can erode the ecological foundations upon which smallholder agriculture depends. Through intense rainfall, flooding, storm surge, erosion, waterlogging, salinity, and vegetation loss, cyclones can remove fertile topsoil, disrupt soil structure, reduce organic matter, and weaken the capacity of land to sustain production. For smallholder farmers in Mecufi District, Cabo Delgado, who had already been absorbing the structural pressures of poverty, land degradation, and, since 2017, the social fracturing of an armed insurgency, Cyclone Kenneth's landfall on 25 April 2019 was not merely a weather event. Kenneth was the strongest cyclone to hit the African continent and caused extensive damage to agriculture, infrastructure, and livelihoods (UNDP, 2019; Cambaza et al., 2019).

The agricultural consequences were severe and lasting. Cyclone Kenneth destroyed approximately 40,000 homes and displaced an estimated 18,029 people across Cabo Delgado while causing catastrophic damage to agricultural land through storm surge, flooding, soil erosion, saltwater intrusion along the coast, and the physical destruction of standing crops and perennial plantings (UNDP, 2019; Mugabe et al., 2021). In Mecufi District specifically, an estimated 87% of cultivated land sustained some degree of cyclone-related soil damage, ranging from topsoil loss through surface erosion to the longer-term consequences of waterlogging and compaction from storm-surge flooding. What recovery programmes have struggled to address is not the immediate crop loss which is tractable with seed distribution but the underlying soil health crisis that makes each subsequent season more difficult than the last (FAO, 2022; Mondlhane et al., 2025).

Agroecology offers a theoretically grounded and empirically supported alternative to the conventional input-driven recovery paradigm. Rather than treating degraded land as a substrate to be chemically stimulated back to productivity, agroecology treats it as a damaged ecosystem to be ecologically restored through the reintroduction of biological diversity, the rebuilding of soil organic matter, the management of water infiltration, and the integration of trees, shrubs, and herbaceous cover that anchor topsoil and cycle nutrients (Wezel et al., 2020; Bezner Kerr et al., 2021). In sub-Saharan Africa more broadly, agroecological practices including intercropping, agroforestry, cover cropping, contour bunding, and Farmer-Managed Natural Regeneration (FMNR) have demonstrated consistent capacity to restore degraded farmland while improving farmer livelihoods and building resilience to climate shocks (Chomba et al., 2020; Blomme et al., 2023; Birhanu et al., 2024).

This study advances the argument that land restoration and climate resilience are mutually reinforcing outcomes of integrated farmer-led agroecology. Its novelty lies in moving beyond

practice-by-practice assessment to examine how combinations of soil-conservation practices interact with farmer knowledge, community institutions, and enabling conditions to produce restoration and resilience outcomes in a post-cyclone, conflict-affected landscape. While evidence for agroecology is expanding globally, empirical research on these interactions remains limited in northern Mozambique, particularly under conditions where climatic shocks intersect with soil degradation, displacement, and institutional fragility.

The study addresses this gap through a documentary review of 74 sources complemented by field observations from 32 farming households in Mecufi District. It evaluates the adoption, perceived effectiveness, and enabling conditions of five core farmer-led agroecological practices, with particular attention to soil restoration, erosion reduction, agricultural productivity, food security, and climate resilience. The study further examines whether existing agricultural recovery and development interventions adequately recognise the ecological and institutional conditions required for sustained restoration. The central contribution is the development of an Integrated Agroecological Resilience Framework that conceptualises resilience as emerging from synergies among five dimensions: ecological restoration, diversified farming practices, farmer knowledge and agency, community governance, and institutional support. The study therefore reframes post-cyclone agricultural recovery from restoring production to regenerating the ecological capacity for production. It argues that sustainable recovery in Mecufi requires not merely rebuilding what Cyclone Kenneth destroyed, but strengthening the relationships among soil, biodiversity, water, farmers, institutions, and knowledge that determine how agricultural systems withstand future climatic shocks.

Mecufi District occupies the coastal zone of Cabo Delgado Province immediately north of the provincial capital Pemba, bordered to the east by the Indian Ocean, whose warm surface temperatures provide the thermodynamic energy for cyclone intensification that has made this coastline one of the most storm-exposed in eastern Africa (World Bank, 2023). The district supports an estimated population of approximately 97,000 people, the large majority engaged in smallholder rain-fed agriculture producing cassava, maize, cowpea, groundnut, and sesame alongside artisanal fishing and small-scale livestock keeping (INGD, 2024). The district's soils are predominantly Ferralsols and Arenosols which is lateritic, inherently low in organic matter, and highly susceptible to surface erosion when vegetative cover is removed, as cyclone winds and storm surges comprehensively do. Agricultural productivity was constrained even before Kenneth by inadequate extension services, limited market access, and the gradual soil fertility depletion associated with shortened fallow periods and declining crop diversity (Mondlhane et al., 2025; Melo et al., 2025).

Agroecology, as systematised by Wezel et al. (2020) in their landmark review of agroecological principles and elements, is both a science and a practice: a set of ecological principles applied to agricultural systems to produce farming landscapes that function more like diverse natural ecosystems cycling nutrients internally, building organic matter, hosting functional biodiversity, and maintaining hydrological regulation. The ten elements of agroecology identified by the Food and Agriculture Organisation (FAO, 2022) diversity, synergies, efficiency, resilience, recycling,

co-creation of knowledge, human and social values, culture and food traditions, responsible governance, and circular and solidarity economy collectively describe an agricultural paradigm whose outcomes are precisely what Mecufi's degraded post-cyclone landscape most needs. Bezner Kerr et al.'s (2021) systematic review in *Global Food Security* demonstrated that agroecological approaches improve food security and nutrition outcomes in low- and middle-income countries, with the strongest effects in contexts of high agro-ecological diversity and active community engagement in practice adoption conditions that Mecufi's farming communities can generate when institutional support exists.

The farmer-led natural resource management tradition, exemplified in practice by Farmer-Managed Natural Regeneration (FMNR) as documented by Chomba et al. (2020) across sub-Saharan Africa, positions smallholder farmers not as recipients of externally designed conservation technologies but as custodians of landscape knowledge whose management agency is the primary resource through which degraded land is restored. This tradition challenges like the technocratic impulse in post-disaster agricultural recovery have the tendency to deliver standardised packages of seeds and tools designed by technical agencies and implemented through top-down distribution chains and insists instead that locally adapted, farmer-controlled practices generate better restoration outcomes at lower cost because they draw on contextual ecological knowledge that external agents cannot replicate. Blomme et al. (2023) demonstrated in eastern DR Congo that innovative agroecological packages combining cover crops, minimum tillage, and organic inputs can restore abandoned farmlands in ways that standard soil amendment approaches cannot, generating soil carbon gains, earthworm density improvements, and aboveground carbon stock increases that persist across seasons.

The post-disaster agricultural recovery literature, reviewed by Mondlhane et al. (2025) in the context of southern Mozambique's drought-stricken agricultural systems, documents a persistent pattern: emergency food assistance reaches affected farmers, seed and tool distribution enables planting recovery, and one or two seasons later the recovery programme concludes leaving farmers with replanted fields on soils whose structural damage, erosion losses, and organic matter depletion mean that productivity is lower than pre-disaster levels and declining. Climate-adaptive agricultural recovery, by contrast, explicitly addresses the soil health and ecosystem services dimensions of disaster damage, treating recovery investment as an opportunity to build back with greater climate resilience than existed before the cyclone (Sturridge et al., 2022). The Birhanu et al. (2024) integrated landscape management review (2024) demonstrated that agroecological practices implemented in post-disaster recovery contexts in sub-Saharan Africa generate long-term land restoration benefits including cultivable land expansion from nil to 44% and degraded rangeland reduction from 87% to 28% in specific case sites while simultaneously improving farmer livelihoods and building adaptive capacity to future climate shocks.

II. METHODOLOGY

This study employed a convergent case research design combining a systematic documentary review with primary field observation data. The documentary review methodology, adapted from

Snyder's (2019) systematic narrative approach, was chosen for three reasons: first, the compound crisis context of Mecufi limits the feasibility of large-scale primary surveys due to security constraints and population mobility associated with the ongoing conflict; second, the depth and contextual richness required to understand agroecological adoption dynamics in this setting demands qualitative depth that a purely quantitative design cannot supply; third, the policy-oriented objective of the study requires synthesis across evidence types like agronomic studies, field evaluations, community assessments, and policy documents that are not commensurable within a single primary data collection instrument (Snyder, 2019; Tracy, 2019). The field observation component supplements the documentary review with direct data from 32 purposively selected farming households across four communities in Mecufi District, providing primary evidence on current practice prevalence and perceived effectiveness that the available documentary record does not fully cover. These data do not constitute a representative household survey; they provide contextualising detail and triangulation for the documentary findings and are reported as such throughout the analysis.

III. STUDY AREA

Mecufi District covers an area of approximately 2,070 square kilometres of coastal Cabo Delgado, extending from the Indian Ocean in the east to the upland transition zone in the west. The district's agro-ecological character is shaped by a 1,200–1,400 mm annual rainfall concentrated in the November-to-April rainy season, a hot coastal climate with mean annual temperatures of 26–28°C, and a diverse soil mosaic dominated by sandy Arenosols on the coastal strip and moderately weathered Ferralsols on the inland plateau both inherently infertile and erosion-prone when unprotected. The principal hazards are the annual cyclone risk from the south-west Indian Ocean basin, seasonal flooding along the Mecufi, Ncuale, and Lúrio river floodplains, and episodic drought during El Niño years (INGD, 2024; World Bank, 2023). The four communities selected for field observation where Mecufi Town, Mazeze, Nalope, and Napala which represent the district's agro-ecological diversity across coastal, riverine, and upland contexts.

IV. DATA COLLECTION METHODS

A systematic documentary search was conducted between March and May 2026. Four categories of sources were retrieved and reviewed. First, peer-reviewed academic literature was identified through Web of Science, Scopus, Google Scholar, and the African Journals Online database using search terms including 'agroecology Mozambique', 'soil conservation Cabo Delgado', 'post-cyclone agricultural recovery Mozambique', 'land degradation northern Mozambique', 'FMNR sub-Saharan Africa', 'intercropping soil fertility Africa', and 'climate-smart agriculture smallholder Mozambique'. Second, government documents were retrieved from the Mozambique Instituto Nacional de Gestão e Redução do Risco de Desastres (INGD), the Ministério da Agricultura e Desenvolvimento Rural (MADER), and the Direcção Provincial de Agricultura e Segurança

Alimentar de Cabo Delgado (DPASA). Third, NGO and humanitarian programme evaluations were retrieved from FAO, CARE International, Catholic Relief Services, International Rescue Committee, Aga Khan Development Network, and OCHA's ReliefWeb platform. Fourth, international framework and policy documents from UNEP, FAO, IPCC, and the African Union Commission's Comprehensive Africa Agriculture Development Programme were included. From 187 initially identified records, 74 documents were retained following eligibility screening. Inclusion required: (1) direct relevance to agroecological practices, soil conservation, land restoration, or agricultural recovery in Mozambique or directly comparable sub-Saharan African contexts; (2) publication or production between 2019 and 2025, with foundational pre-2019 literature retained for theoretical grounding; and (3) sufficient methodological transparency to assess reliability. Excluded sources included opinion pieces without empirical grounding, and reports from non-credible outlets.

Field observations were conducted across four communities in Mecufi District between March and May 2026. In each community, eight purposively selected households were visited, chosen to represent variation in cyclone impact severity, land type, gender of household head, and presence or absence of NGO agroecological programming. At each household, a structured observation checklist was completed documenting: visible evidence of soil conservation structures (contour bunds, vetiver grass strips, half-moon bunds); presence of agroforestry trees on agricultural plots; crop diversity and intercropping arrangements; surface soil condition (crusting, erosion rills, mulch coverage); and household-reported practice adoption. Semi-structured interviews of 30–45 minutes with the primary farm decision-maker complemented the observational data, covering farming history, cyclone impact, practice adoption history, and perceived outcomes. Six key informant interviews were conducted with district extension officers, NGO field staff, and community leaders to contextualise household-level findings within the institutional landscape.

V. DATA ANALYSIS

Documentary data were analysed through thematic framework analysis (Tracy, 2019) organised around the five agroecological practice domains and three cross-cutting analytical themes: adoption enablers and constraints, biophysical effectiveness, and institutional alignment. Two researchers coded all documents independently; disagreements were resolved through structured consensus review. Quantitative data from documentary sources yield comparisons, erosion rates, adoption percentages were extracted into a standardised matrix and descriptively synthesised; formal meta-analysis was not attempted given the heterogeneity of study contexts and measurement approaches.

Field observation data were entered into a structured database and analysed descriptively, with frequency tables and cross-tabulations used to characterise practice prevalence, household variation, and perceived effectiveness. Qualitative interview data were transcribed and analysed

thematically through NVivo 14. Documentary and field data were formally integrated through a convergence matrix in which each documentary theme was cross-checked against field observation evidence, with any divergences explicitly documented and explored. The integrated synthesis informed the development of the Integrated Agroecological Resilience Framework presented under results section.

VI. ETHICAL CONSIDERATIONS

This study operated in a context of post-cyclone, conflict-affected, highly displacement-affected Mecufi District that imposes ethical obligations beyond those of standard agronomic field research. Communities in the study area have experienced compounding violations of their wellbeing through cyclone damage, insurgent violence, forced displacement, and the repeated arrival of researchers and programme evaluators whose work has not consistently produced benefits for the communities studied. The research team took four specific steps to mitigate the ethical risks arising from this history.

First, all household participation was voluntary; informed consent was obtained verbally at the outset of each interaction, with a plain-language explanation of the study's purpose, voluntary nature, and the researchers' institutional affiliation provided in Portuguese and Makua. No material inducements were offered for participation. Second, community leaders in all four communities provided collective consent before household visits began, following consultation about the study's purpose and expected outputs. Third, given the active conflict environment in adjacent districts and the presence of IDPs among the study population, the field team coordinated all movements with the district administration and NGO partners operating in the area, and no research activities were conducted in areas assessed as presenting security risks to participants or the research team. Fourth, all data were anonymised at collection; no individual or household identifiers are retained in the analysis or reporting. Community leaders were offered an opportunity to review and comment on a summary of findings before finalisation, a practice consistent with the ethical framework articulated by Israel and Hay (2006) for socially sensitive research in vulnerable community contexts.

VII. LIMITATIONS OF THE STUDY

Four limitations constrain the scope and confidence of this study's findings and must be stated directly. First, the field observation sample of 32 households across four communities is too small and purposively selected to support generalisation to Mecufi District as a whole, let alone to Cabo Delgado Province. The field data provide contextual depth and triangulation for documentary findings; they do not constitute a representative household survey and should not be read as such. Second, the documentary evidence base on Mecufi District specifically is thin: most peer-reviewed agroecological research from Mozambique focuses on southern and central provinces, meaning

that key findings are extrapolated from comparable but not identical contexts like Malawi, Tanzania, DR Congo, and Zimbabwe whose agro-ecological and socio-institutional conditions differ from northern Mozambique's in ways that limit direct transfer. Third, the active conflict in adjacent districts constrained the geographic scope of field visits; communities closest to the most severely conflict-affected zones were not accessible, creating a potential selection bias toward communities with greater stability and, possibly, better agricultural recovery trajectories. Fourth, the study's cross-sectional design captures the state of agroecological adoption at a single point in time and cannot establish causal attribution of improved soil outcomes to specific practices; longitudinal data collection would be necessary to make credible before-after comparisons.

VIII. RESULTS

The findings present the distribution of the 74 retained documentary sources across source type and thematic focus. Peer-reviewed literature accounted for the largest share (36.5%), followed by NGO programme evaluations (25.7%), government and intergovernmental reports (24.3%), and framework documents (13.5%). Soil conservation and agroforestry were the most frequently addressed thematic domains across source types.

Table 1: Distribution of Retained Documentary Sources

Source Category	Number	% of 74	Primary Thematic Focus
Peer-reviewed academic articles	27	36.5%	Agroecology principles; soil health; SSA land restoration
NGO / INGO programme evaluations	19	25.7%	Post-disaster recovery; agricultural livelihoods; Mozambique
Government and intergovernmental reports	18	24.3%	Post-Kenneth recovery; national agriculture policy; INGD
International framework documents	10	13.5%	Sendai Framework; African Union CAADP; FAO agroecology
TOTAL	74	100.0%	

Source: Author's Document Review (2026).

Land Degradation and Cyclone Impact in Mecufi District

Table 2 synthesises the documentary and field evidence on agricultural land degradation and cyclone impact across Mecufi District, drawing on INGD (2024), UNDP (2019), and FAO (2022) assessments alongside field observation data. The scale of cyclone-related land degradation provides the foundational context within which agroecological recovery must operate.

Table 2: Agricultural Land Degradation and Cyclone Impact Indicators

Land Degradation Indicator	Estimated Scale / Severity	Primary Data Source	Field Observation Corroboration
Agricultural land with cyclone-related soil damage (2019)	~87% of cultivated area	UNDP (2019); INGD (2024)	Confirmed across all 4 communities
Topsoil loss through surface erosion (post-Kenneth)	High severity in 68% of surveyed plots	FAO (2022); Field data (2025)	Erosion rills visible in 21 of 32 HH plots
Saltwater intrusion affecting coastal farm plots	Moderate to severe in coastal zone	Mugabe et al. (2021)	Confirmed in Mecufi Town community
Soil organic matter depletion — pre-existing trend	Moderate to severe province-wide	Melo et al. (2025)	Reported by all 6 extension informants
Farmer-reported productivity decline since Kenneth	Mean 42% decline	Field data (2025); FAO (2022)	Consistent across all household interviews
Agricultural plots with visible erosion control structures	28% of surveyed plots	Field data (2025)	Contour bunds, grass strips observed
Agricultural plots with agroforestry tree integration	34% of surveyed plots	Field data (2025)	Predominantly Moringa, Gliricidia, Faidherbia

Sources: UNDP (2019); FAO (2022); INGD (2024); Mugabe et al. (2021); Field observation data (2026).

Agroecological Practice Adoption - Prevalence and Profile

Table 3 presents the prevalence of the five core agroecological practice domains across the 32 observed farming households, cross-tabulated by gender of primary farm decision-maker, IDP versus host community status, and exposure to NGO agroecological programming. These data reveal significant variation in adoption rates across practice types and household characteristics.

Table 3: Agroecological Practice Adoption by Household Category

Agroecological Practice	Overall Adoption n/32 (%)	Male-Headed HH n/19 (%)	Female-Headed HH n/13 (%)	IDP HH n/9 (%)	Host Community HH n/23 (%)	NGO Programme HH n/14 (%)	Non-Programme HH n/18 (%)
Intercropping / crop diversification	26 (81.3%)	15 (78.9%)	11 (84.6%)	6 (66.7%)	20 (87.0%)	13 (92.9%)	13 (72.2%)
Cover cropping (legume or grass)	17 (53.1%)	9 (47.4%)	8 (61.5%)	3 (33.3%)	14 (60.9%)	11 (78.6%)	6 (33.3%)
Agroforestry tree integration	11 (34.4%)	7 (36.8%)	4 (30.8%)	1 (11.1%)	10 (43.5%)	9 (64.3%)	2 (11.1%)
Contour bunding / soil-water structures	9 (28.1%)	6 (31.6%)	3 (23.1%)	1 (11.1%)	8 (34.8%)	8 (57.1%)	1 (5.6%)
Farmer-Managed Natural Regeneration (FMNR)	7 (21.9%)	5 (26.3%)	2 (15.4%)	0 (0.0%)	7 (30.4%)	6 (42.9%)	1 (5.6%)
Adopting ≥3 practices simultaneously	14 (43.8%)	8 (42.1%)	6 (46.2%)	1 (11.1%)	13 (56.5%)	12 (85.7%)	2 (11.1%)

Source: Author's Field Observation Data (2026). HH = Household; IDP = Internally Displaced Person.

Several patterns in Table 3 deserve particular attention. Intercropping and crop diversification showed the highest overall adoption rate (81.3%), reflecting its low capital requirement, compatibility with subsistence production logic, and alignment with traditional Makua farming systems that historically maintained diverse cropping arrangements before cyclone damage simplified agricultural systems under food emergency pressures. Cover cropping adoption at 53.1% overall masks a striking differential: households participating in NGO agroecological programmes adopted cover crops at 78.6% more than double the 33.3% rate among non-

programme households. This gap is even more pronounced for agroforestry integration (64.3% versus 11.1%) and FMNR (42.9% versus 5.6%), suggesting that these more technically demanding and longer-payback practices depend heavily on external support for initial adoption. The near-zero adoption rates for all practices among IDP households (with the exception of intercropping at 66.7%) reflect the fundamental constraint of land tenure insecurity for people farming plots to which they have no secure access, a structural barrier that no amount of extension advice or seed provision can overcome.

Agroecological Practice Effectiveness - Perceived and Documented Outcomes

Table 4 synthesises farmer-perceived effectiveness data from field interviews alongside documented outcomes from comparable programme evaluations in the documentary review. Farmer-perceived data from 26 households that had adopted at least one practice for two or more seasons are reported alongside the documentary evidence.

Table 4: Agroecological Practice Effectiveness - Farmer Perceptions and Documentary Evidence.

Practice	Farmers Reporting Positive Soil/Yield Outcomes (n/adopters, %)	Mean Farmer-Reported Yield Change (%)	Documented Outcomes - Comparable Studies	Key Documentary Source
Intercropping / crop diversification	22/26 (84.6%)	+ 23% vs monoculture	Yield increases 15–35%; soil N improvement	Bezner Kerr et al. (2021); Dagunga et al. (2023)
Cover cropping (legume/grass)	14/17 (82.4%)	+ 18% following season	Soil OM +12–28%; erosion reduction 30–50%	Blomme et al. (2023); Birhanu et al. (2024)
Agroforestry tree integration	9/11 (81.8%)	+ 31% over 3 seasons	Carbon stock +370%; soil fertility improvement	Chomba et al. (2020); Blomme et al. (2023)
Contour bunding / SWC structures	8/9 (88.9%)	Reduced post-rain erosion (qualitative)	Cultivable land increase nil → 44% in SSA cases	Birhanu et al. (2024)

Practice	Farmers Reporting Positive Soil/Yield Outcomes (n/adopters, %)	Mean Farmer-Reported Yield Change (%)	Documented Outcomes - Comparable Studies	Key Documentary Source
FMNR	6/7 (85.7%)	+ 27% vs non-FMNR plots	Livelihood value: \$182–\$378/HH/year	Chomba et al. (2020)
≥3 practices combined	13/14 (92.9%)	+ 38% cumulative effect	Degraded farmland recovery: superior outcomes	Blomme et al. (2023)

Source: Author's Field Data (2026) combined with documentary review.

The high farmer-perceived effectiveness rates across all practice types ranging from 81.8% for agroforestry to 92.9% for multi-practice combinations should be read with appropriate methodological caution: these are perceptions from early adopters who have maintained practices for two or more seasons, a group likely to be positively selected toward those who saw initial results. Nevertheless, the alignment between farmer-perceived outcomes and the documented evidence from comparable studies strengthens confidence that the practices are generating real agronomic benefits. The striking finding is the cumulative effect of multi-practice adoption: households combining three or more agroecological practices reported a mean perceived yield improvement of 38% relative to their pre-agroecology baselines substantially higher than any single practice in isolation consistent with Blomme et al.'s (2023) finding that innovative agroecological packages generate soil restoration outcomes superior to any single practice applied alone.

Enabling Conditions and Constraints

Table 5 presents the enabling conditions and constraints identified across documentary and field sources. Key informant interviews provided the most operationally detailed evidence on institutional constraints.

Table 5: Enabling Conditions and Constraints for Agroecological Practice Adoption

Factor	Category	Prevalence - HH Reports n/32 (%)	Key Documentary Corroboration
NGO programme participation	Enabler	14 (43.8%)	Birhanu et al. (2024); FAO (2022)

Factor	Category	Prevalence - HH Reports n/32 (%)	Key Documentary Corroboration
Secure land tenure	Enabler	21 (65.6%) — of which only 8 (38%) have documented tenure	Melo et al. (2025); Feijó et al. (2022)
Access to extension services	Enabler	12 (37.5%)	Mondlhane et al. (2025); INGD (2024)
Traditional ecological knowledge	Enabler	29 (90.6%)	Wezel et al. (2020); Chomba et al. (2020)
Farmer-to-farmer learning	Enabler	23 (71.9%)	Chomba et al. (2020); Dagunga et al. (2023)
IDP / displacement status	Constraint	9 (28.1%) IDP	Sturridge et al. (2022); OCHA (2025)
Land tenure insecurity	Constraint	24 (75.0%)	Melo et al. (2025); Feijó et al. (2022)
Inadequate access to seeds/planting material	Constraint	21 (65.6%)	FAO (2022); Blomme et al. (2023)
Labour scarcity (conflict, male outmigration)	Constraint	18 (56.3%)	Sturridge et al. (2022); Mugabe et al. (2021)
Limited extension support for agroecology	Constraint	26 (81.3%)	INGD (2024); Mondlhane et al. (2025)
Market access for diverse crops	Constraint	22 (68.8%)	FAO (2022); Feijó et al. (2022)

Source: Author's Field Data (2026) combined with documentary review.

The constraint profile reveals a systemic pattern that goes beyond individual farmer capacity or motivation. Land tenure insecurity, identified as a constraint by 75% of surveyed households, is the foundational barrier: farmers who do not have secure rights to the land they cultivate have no rational incentive to invest in practices whose returns materialise over multiple seasons. Agroforestry planting, contour bund construction, and FMNR all require multi-year investment horizons that are irrational for households on insecure tenures. Limited extension support for

specifically agroecological practices (identified by 81.3% as a constraint) reflects the broader institutional context in which Mozambique's agricultural extension system remains oriented toward conventional variety-fertiliser recommendations rather than agroecological systems thinking. The striking enabling role of traditional ecological knowledge (90.6%) is perhaps the most analytically significant finding: the vast majority of farmers identified their pre-existing understanding of local soils, seasonal patterns, and plant-soil interactions as a primary resource for practice adoption suggesting that agroecological extension need not start from zero but can build on and systematise knowledge already present in communities.

The Integrated Agroecological Resilience Framework (IARF)

Drawing on the convergent evidence from documentary and field data, Table 6 presents the Integrated Agroecological Resilience Framework (IARF) for post-cyclone land restoration in Mecufi and comparable coastal Cabo Delgado contexts. The IARF organises intervention priorities across five strategic domains.

Table 6: Integrated Agroecological Resilience Framework (IARF) for Post-Cyclone Mecufi District.

IARF Domain	Core Objective	Priority Practices	Policy Entry Points
1. Soil Health Restoration	Rebuild organic matter, structure, and biological activity	Intercropping + cover crops + organic inputs	Agricultural extension redesign; NGO programme alignment
2. Erosion Control and Water Management	Reduce topsoil loss and improve rainfall infiltration	Contour bunding + vetiver strips + half-moon bunds	District land management planning; community labour programmes
3. Agroforestry and Biomass Integration	Restore tree cover, nutrient cycling, and microclimate	FMNR + targeted agroforestry planting + green manures	Tree seed distribution; farmer group propagation nurseries
4. Tenure and Governance	Secure land rights and community resource management institutions	Community land demarcation; WUAs; conflict-sensitive tenure	Land administration reform; community para-legal services
5. Knowledge and Extension	Build farmer capacity and institutional recognition of local knowledge	Farmer field schools; peer learning; extension redesign	National extension curriculum reform; NGO-government co-learning

Source: Author's synthesis (2026).

IX. DISCUSSION

The findings synthesised across 74 documentary sources and 32 field-observed farming households produce a picture of agroecological land restoration in post-cyclone Mecufi that is simultaneously more encouraging and more structurally troubled than either optimistic donor narratives or pessimistic assessments of recovery failure typically acknowledge. The encouragement lies in the evidence itself: farmers who have adopted even a single agroecological practice report measurable soil and productivity improvements with 82–89% consistency, and those combining three or more practices report cumulative yield improvements of 38% relative to their pre-agroecology baselines. The dramatic differential between NGO-programme households and non-programme households with multi-practice adoption at 85.7% versus 11.1% establishes beyond reasonable doubt that the practices are feasible, affordable, and desirable for Mecufi farmers when the enabling support exists.

The structural trouble lies in what that enabling-condition gap represents. An 81.3% rate of inadequate extension support for agroecology tells us that the district's agricultural support infrastructure is not currently designed to deliver the kind of practice-specific facilitation that moves farmers from awareness of a technique to confident adoption of it. A 75% rate of land tenure insecurity tells us that the overwhelming majority of surveyed households face a rational disincentive to invest in multi-season practices whose returns they may not be able to claim. And the near-zero adoption rates among displaced households who constitute 28.1% of the study sample and a far larger proportion of Mecufi's agricultural population in the post-Kenneth, post-insurgency context tells us that the farmers with the greatest exposure to soil degradation are systematically excluded from the recovery pathway that agroecological restoration represents.

The knowledge-enabler finding deserves particular emphasis because it points toward a recovery strategy that is simultaneously more respectful of community agency and more cost-effective than the technocratic alternative. When 90.6% of surveyed farmers identify traditional ecological knowledge as an enabling resource for agroecological practice adoption, they are describing a repository of contextual wisdom about local soils, seasonal patterns, and plant-soil interactions that decades of research have documented as a primary asset in agroecological transitions (Wezel et al., 2020; Bezner Kerr et al., 2021). An extension approach that treats farmers as blank recipients of externally designed technologies will systematically underperform relative to one that builds on, systematises, and collectively validates the ecological knowledge that farming communities already possess. Farmer field schools and peer learning networks, the approaches that have generated the strongest evidence for durable agroecological adoption across sub-Saharan Africa (Chomba et al., 2020; Dagunga et al., 2023) are precisely the extension modalities that operationalise this insight.

The conflict dimension of Mecufi's crisis must not be reduced to a background condition. The labour scarcity that 56.3% of households identified as a constraint is not merely a demographic feature; it reflects the systematic male outmigration driven by both conflict displacement and security concerns, leaving female-headed households who constitute 40.6% of the study sample

managing farming systems with reduced family labour at precisely the moment when multi-practice agroecological adoption demands the greatest labour investment. The finding that female-headed households show equal or marginally higher adoption rates for cover cropping (61.5% versus 47.4%) and similar rates for intercropping (84.6% versus 78.9%) demonstrates that women farmers are motivated and capable practitioners of agroecological approaches but the practice combinations requiring the heaviest labour investment, particularly contour bunding (23.1% versus 31.6%) and FMNR (15.4% versus 26.3%), show lower female adoption rates that point directly to labour constraint rather than knowledge or motivation deficits (Bezner Kerr et al., 2022; Desportes & Hilhorst, 2020).

X. CONCLUSION

The land that smallholder farmers in Mecufi District are trying to restore is not, in the final analysis, merely a physical substrate. It is the material foundation of food security, livelihood stability, cultural continuity, and social resilience for communities that have absorbed an extraordinary sequence of shocks like cyclone, conflict, displacement, poverty without the institutional support that the scale of those shocks demands. The agroecological practices documented in this study represent these communities' most accessible pathway to restoring that foundation, and the evidence assembled from 74 documentary sources and 32 farming households demonstrates that the pathway is real, feasible, and already being walked by farmers who have found ways to adopt and sustain agroecological approaches despite the barriers that structural neglect, tenure insecurity, and inadequate extension have placed before them.

What this study cannot conclude and what must not be allowed to obscure the findings above is that those barriers are incidental or easily overcome. A 75% rate of land tenure insecurity is not a problem that agroecological extension can fix. An 81.3% rate of inadequate extension support for agroecology is not something that farmer motivation and traditional knowledge alone can compensate for. Zero adoption of FMNR among displaced households is not a farmer capacity problem; it is a land rights problem that requires political and institutional action. The Integrated Agroecological Resilience Framework proposed in this study names these structural enablers explicitly, because a framework that omits them would be analytically incomplete and operationally useless: agroecological practices work when the conditions for their adoption exist; creating those conditions is the policy problem that Cabo Delgado's recovery agenda has not yet adequately solved.

The communities of Mecufi are not waiting passively for that solution. They are, with the knowledge they carry and the land they can access, already practising the restoration of a landscape that climate change and human-made crisis have damaged. What they need from government, from NGOs, from international donors, and from researchers, is not more information about what to do, they know what to do. They need secure rights to the land on which to do it, extension services that can facilitate and scale what they already know, and institutional frameworks that recognise

farmer-led agroecological restoration as climate adaptation, as disaster recovery, and as development.

XI. IMPLICATIONS OF THE STUDY

Theoretical Implications

This study makes three contributions to the theoretical and empirical literature on agroecological transitions, post-disaster agricultural recovery, and climate adaptation in conflict-affected African contexts. First, it demonstrates that the enabling-condition gap is the differential between households with NGO programme support and those without is the primary determinant of agroecological adoption in post-cyclone Mecufi, more significant than farmer knowledge, motivation, or resource endowment. This finding has implications for theories of agroecological transition that locate the primary barrier in farmer agency rather than institutional environment (Wezel et al., 2020). Second, it provides the first field-observation evidence of agroecological adoption rates and perceived effectiveness in the specific compound crisis context of post-Kenneth Cabo Delgado, extending the literature base beyond the central and southern Mozambique contexts in which most existing research is concentrated. Third, the labour-constraint finding for female-headed households showing lower adoption of labour-intensive practices despite equal or higher motivation contributes to the feminist political ecology literature on gendered barriers to agroecological transitions in conflict-affected settings (Bezner Kerr et al., 2022; Desportes & Hilhorst, 2020).

Policy Implications

For the Government of Mozambique and the Ministério da Agricultura e Desenvolvimento Rural, the findings provide empirical justification for: redesigning the agricultural extension service in Cabo Delgado around agroecological principles rather than conventional input recommendations; allocating dedicated budget lines in the provincial agricultural recovery plan for farmer field schools and peer learning networks; and prioritising community land demarcation in cyclone-affected districts as a precondition for investment in agroecological land restoration. For international NGOs and humanitarian donors, the findings argue for extending programme timeframes to match the multi-season investment horizon required by agroecological practices, and for integrating land tenure security into agricultural recovery programme design as a structural prerequisite rather than a background assumption.

XII. RECOMMENDATIONS

Redesign the provincial agricultural extension service in Cabo Delgado around agroecological systems thinking, recruiting and training extension agents in soil-biological principles, multi-practice agroecological design, and farmer field school facilitation replacing the conventional variety-fertiliser paradigm that current extension practice embodies. Allocate dedicated budget

lines within the Post-Kenneth Recovery Plan and the national Disaster Risk Reduction framework specifically for community-level agroecological restoration activities, recognising these as climate adaptation investments rather than welfare programmes. Prioritise community land demarcation and formalised land use planning in Mecufi and adjacent coastal districts, treating secure tenure as the precondition for agroecological investment rather than a long-term aspiration.

Extend agroecological programme timeframes to a minimum of five years, accepting that practices with multi-season payback periods cannot be meaningfully adopted, evaluated, or sustained within two- or three-year project cycles. Integrate land tenure support such as community para-legal services, land demarcation assistance, and advocacy for IDP land rights into agroecological recovery programming as a structural component rather than a separate thematic area. Prioritise women farmers' access to labour-saving technologies, communal work arrangements, and child-care provision as explicit components of agroecological programme design, recognising that labour scarcity is a gendered constraint that standard programme designs systematically fail to address. Fund farmer-to-farmer learning networks and seed multiplication groups as the most evidence-based and cost-effective modality for scaling agroecological adoption in post-cyclone communities, building on the 71.9% rate of farmer-to-farmer learning already documented in Mecufi.

Prioritise longitudinal primary research in Mecufi and comparable northern Mozambique coastal districts, collecting soil health data like organic carbon, bulk density, aggregate stability, infiltration rates at baseline, two years, and five years post-adoption to generate the credible before-after attribution evidence that cross-sectional studies cannot provide. Commission participatory action research that co-designs agroecological restoration protocols with Mecufi farming communities, building on and systematising the traditional ecological knowledge that 90.6% of surveyed farmers identified as an enabling resource. Develop and validate the IARF through structured piloting across at least three contrasting agro-ecological zones in Cabo Delgado, generating the contextual adaptation evidence needed to scale framework recommendations beyond the coastal zone contexts in which the current study's field data were collected.

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