2024
https://fupress.org/journal

Biodiversity Conservation in Protected Areas: Policy Successes and Failures

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ARTICLE INFO

Received: 10 Feb 2024
Accepted: 27 Apr 2024

ABSTRACT

Traditional agro-ecosystems—landscapes shaped by centuries of human cultivation and pastoralism—harbor remarkable levels of biodiversity, often equaling or surpassing nearby formally protected areas. Yet conservation strategies have historically focused on parks and reserves, overlooking the critical contribution of working landscapes. This paper synthesizes global evidence on how traditional farming and pastoral practices maintain genetic, species, and ecosystem diversity outside protected areas. Drawing on case studies from Mediterranean dehesas, Andean terraces, Southeast Asian swidden fields, African pastoral savannas, and agroforestry systems, we identify key ecological processes and social institutions that underpin biodiversity conservation. We review threats posed by policy neglect, market pressures, and tenure insecurity, and examine policy frameworks at local, national, and international levels for integrating traditional agro-ecosystems into conservation planning. Finally, we propose an adaptive governance framework that embeds traditional land-use practices within broader biodiversity strategies, ensuring ecological resilience, cultural continuity, and local livelihoods.

Keywords: Traditional Agro-Ecosystems, Biodiversity Conservation Policy, Customary Tenure, Dehesa, Swidden Agriculture.

INTRODUCTION

Humans have coexisted with and shaped terrestrial ecosystems for millennia, creating a mosaic of cultural landscapes that blend agricultural production with biodiversity conservation. Traditional agro-ecosystems such as Mediterranean dehesas, Andean terraces, Southeast Asian swidden fields, East African pastoral savannas, and Southeast Asian agroforestry systems exemplify this human – nature synergy. These landscapes are underpinned by centuries-old practices, local ecological knowledge, and customary governance systems that regulate land use, promote habitat heterogeneity, and sustain species-rich communities outside formally protected areas.

Across these diverse contexts, traditional agro-ecosystems maintain multiple ecological processes — cyclical disturbance regimes through rotational fallows and grazing, mixed-species cropping that enhances niche diversity, agroforestry structures that provide vertical habitat stratification, and low-intensity fire regimes that mimic natural disturbance patterns. Such processes foster genetic, species, and ecosystem diversity at scales that often rival adjacent national parks and nature reserves. For example, dehesas harbor over 250 bird species and myriad lichens and invertebrates, Andean terraces conserve hundreds of potato landraces alongside endemic amphibians, and swidden mosaics support a unique assemblage of forest-edge species and early-successional plants.

Despite their ecological significance, policy frameworks have historically marginalized traditional agro-ecosystems. Conservation policy has prioritized fortress approaches — establishing protected areas with strict exclusion of agricultural activities — while agricultural policies have incentivized monocultures and intensive inputs, undermining polyculture practices and customary fallow management. Land tenure reforms have further eroded communal institutions, leading to land concentration, habitat loss, and species declines. The resulting fragmentation of ecological and social systems reduces resilience to environmental change and threatens the livelihoods and cultural heritage of rural communities.

Global policy instruments such as the Convention on Biological Diversity's Aichi Targets and post-2020 Global Biodiversity Framework recognize the concept of 'other effective area-based conservation measures' (OECMs) but lack practical guidelines for integrating working landscapes. Sustainable Development Goals implicitly call for supportive policies but often remain sectorally siloed, leaving a policy gap between agricultural development and biodiversity conservation.

This study aims to fill this gap by examining the ecological contributions and governance systems of traditional agro-ecosystems and evaluating policy instruments that can support their conservation. Specifically, it addresses three questions: (1) What ecological processes in traditional agro-ecosystems sustain biodiversity across multiple taxonomic groups? (2) How do customary tenure systems and local institutions enable these practices? (3) Which policy instruments at local, national, and international scales effectively recognize and enhance biodiversity outcomes in working landscapes? Through comparative case studies, policy analysis, and stakeholder interviews, we develop an adaptive governance framework that aligns agricultural and conservation objectives, promoting integrated landscape stewardship that secures both biodiversity and livelihoods.

RELATED WORKS

Conservation policy has historically emphasized protected areas—national parks, wildlife reserves, and sanctuaries—as the primary means of safeguarding biodiversity. Yet these areas cover less than 30 percent of global terrestrial ecosystems and often fail to represent the full range of ecological and cultural variation, particularly in human-modified landscapes (Chape, Harrison, Spalding, & Lysenko, 2005). Over the last decade, a growing body of scholarship has highlighted the indispensable role of traditional agro-ecosystems—landscapes maintained through mixed cropping, rotational fallows, pastoral grazing, and agroforestry—in conserving species and ecosystem functions outside formal reserves (FAO, 2019; CBD, 2018).

Traditional agro-ecosystems sustain both wild and domesticated biodiversity. They maintain genetic diversity—such as the dozens of potato landraces in Andean terraces (Brush, 1995)—while supporting intact ecological processes like nutrient cycling, pollination, and successional dynamics (Altieri, 2004). These multifunctional landscapes also underpin cultural heritage, as local communities develop knowledge systems, ritual calendars, and customary governance institutions that reinforce sustainable land use (Toledo & Barrera-Bassols, 2008). Recognizing these values is crucial for designing conservation strategies that extend

beyond “fortress” reserves and embrace cultural landscapes as complementary conservation tools.

Policy Instruments for Biodiversity in Agro-Ecosystems

A range of policy instruments have been introduced to align agricultural production with biodiversity objectives. Agri-environment schemes, pioneered in the European Union under the Common Agricultural Policy (CAP), offer per-hectare subsidies for practices that maintain landscape elements—hedgerows, fallow margins, rotational grazing—and have been shown to halt farmland bird declines and boost pollinator abundance (Kleijn et al., 2006; Batáry et al., 2015). Similarly, payments for ecosystem services (PES) programs in Costa Rica and Mexico compensate landholders for conserving shade-grown coffee and agroforestry systems, leading to a 25 percent increase in tree canopy cover and significant improvements in habitat connectivity (Jayachandran et al., 2017; Blackman & Rivera, 2011).

Reverse auctions—borrowed from renewable-energy policy—have been adapted to agricultural contexts to drive cost-effective conservation. In Brazil, auctioned contracts for cacao agroforestry corridors generated average cost savings of 30 percent compared to fixed-rate PES schemes, while ensuring high technical standards for habitat restoration (Schmidt, Perrings, & Sternberg, 2019). These market-based approaches introduce competitive pressures that can reduce public outlays while maintaining ecological outcomes.

Legal and regulatory measures also play a vital role. The Convention on Biological Diversity’s Decision 14/8 formally recognized “other effective area-based conservation measures” (OECMs) as a complement to protected areas, creating space for indigenous territories, community forests, and traditional agro-ecosystems to be designated for conservation purposes (CBD, 2018). National policies in Canada and Australia have since incorporated OECM guidelines, enabling co-management agreements with First Nations communities to conserve forest–agriculture mosaics (Parks Canada, 2020).

Governance and Institutional Arrangements

Policy instruments alone cannot succeed without robust governance frameworks. Transparency, accountability, and stakeholder participation are strongly correlated with positive conservation outcomes in agricultural landscapes (World Bank, 2020). In Spain’s dehesas, collaborative governance among farmer cooperatives, municipal councils, and environmental agencies underpins adaptive management of oak savannas. Annual cooperative assemblies set stocking rates, agree on oak regeneration quotas, and monitor understorey vegetation, fostering compliance with ecological guidelines (Navarro & Pereira, 2012).

In the Peruvian Andes, communal landholdings known as ayllus administer reciprocal labor exchanges (mink’a) for terrace maintenance. These assemblies enforce rotational cropping cycles, preserve multiple potato landraces, and coordinate irrigation schedules, sustaining both soil fertility and genetic diversity (Brush, 1995). Kenyan pastoralist councils, guided by elders’ customary laws, designate seasonal grazing areas and watering points, preventing over-concentration of herds and promoting recovery of grass species (Homewood & Rodgers, 1991). In Indonesia’s Kalimantan, adat (customary law) villages regulate fallow periods in swidden systems, balancing rice cultivation needs with forest regeneration to maintain understory plant communities (Mertz et al., 2009). The strength of these institutions, and their formal recognition in national legislation—as in Kenya’s Community Land Act (2016)—directly influences the longevity of biodiversity-friendly practices (UNDP, 2018; Banerjee & Iyer, 2005).

Financing Mechanisms and Market-Based Approaches

Beyond direct subsidies, innovative financial mechanisms are emerging to support traditional agro-ecosystems at scale. Green bonds—debt instruments earmarked for environmental projects—have begun to fund agroforestry initiatives. Indonesia’s 2018 issuance of green sukuk mobilized US \$1.25 billion for renewable energy, with pilot extensions exploring agroforestry corridors to restore degraded lands (Shishlov, Morel, & Cochran, 2018). Brazil’s public–private partnerships combine BNDES (Brazilian Development Bank) concessional loans with corporate investment to establish cacao-based agroforestry corridors, creating habitat links in the Amazon while generating income for smallholders (Schmidt et al., 2019).

Certification schemes provide market premiums that reward biodiversity conservation. Rainforest Alliance and Fair Trade premiums have enabled coffee farmers in Guatemala to invest in shade trees, yielding a documented 25 percent increase in bird species richness over ten years (Méndez, Bacon, & Cohen, 2010). These private-sector approaches complement public PES, diversifying revenue streams for sustainable land management.

Theoretical Framework

Two theoretical debates underpin the integration of agriculture and conservation. The land-sparing versus land-sharing hypothesis contrasts intensive, high-yield agriculture coupled with separate protected areas (sparing)

against wildlife-friendly farming across landscapes (sharing) (Phalan et al., 2011). Critics argue that in smallholder contexts—where livelihoods depend on multifunctional landscapes—land-sharing through traditional practices better balances food security and biodiversity (Green et al., 2005).

Political ecology frameworks highlight how power relations, institutional incentives, and cultural norms shape land-use decisions (Robbins, 2012). Feminist and decolonial perspectives stress the importance of indigenous and local knowledge systems in sustaining agro-ecosystems, cautioning against top-down policies that marginalize customary authorities (Whyte, 2018; Escobar, 1999). Ecosystem services frameworks link biodiversity to human well-being, advocating for integrated policies that recognize provisioning, regulating, and cultural services provided by traditional systems (MEA, 2005).

Case Studies in Developing Countries

Empirical case studies reveal diverse outcomes under different policy and governance regimes. In Spain, dehesas enrolled in CAP agri-environment schemes sustained cork oak regeneration and high levels of understorey biodiversity, with oak recruitment increasing by 15 percent over ten years (Bugalho et al., 2011). In Peru, despite terrace recognition in national biodiversity plans, the absence of dedicated PES or agri-environment payments led to gradual terrace abandonment and collapse, accompanied by soil erosion and loss of endemic amphibians (López et al., 2012).

The Philippines' National Greening Program incorporated communal agroforestry agreements, resulting in a 20 percent increase in tree cover across pilot landscapes; however, bureaucratic delays and complex reporting requirements limited farmer participation and delayed ecological benefits (Lasco et al., 2014). Kenya's PES pilot for rangeland restoration engaged 15 pastoralist communities, improving grass biomass and reducing bush encroachment, but funding shortfalls and capacity challenges constrained scale (Emerton & Tessema, 2016). In Indonesian adat regions, community forest tenure reforms under the Village Law (2014) empowered local management of swidden-forest mosaics, sustaining understory plant diversity, although palm oil expansion incentives created external pressures that undermined swidden practices in fringe areas.

Research Gaps and Policy Recommendations

Although numerous case studies document ecological and social dimensions of traditional agro-ecosystems, systematic cross-country analyses linking biodiversity metrics with policy evaluations remain scarce. Comparative, mixed-methods research combining remote sensing, participatory monitoring, and policy experiments is needed to derive generalizable lessons (Sayer et al., 2013). Standardized biodiversity indicators for OECMs should be developed in collaboration with local communities and integrated into national reporting under the CBD.

Policymakers should: develop clear OECM guidelines tailored to agro-ecosystems; align subsidy regimes with ecosystem-service outcomes; legally secure communal tenure; incentivize polyculture and fallow management through co-designed agri-environment schemes; and establish landscape governance platforms that unite agricultural, environmental, and financial ministries for coherent policy implementation. By bridging sectoral silos and embedding traditional knowledge within modern policy instruments, governments can harness the conservation potential of working landscapes at scale.

METHODOLOGY

This study employs a qualitative comparative case-study design to investigate how policy instruments and institutional frameworks influence biodiversity outcomes in traditional agro-ecosystems. Comparative case studies allow for in-depth, context-rich analyses of complex socio-ecological systems, isolating how different governance arrangements and policy mixes affect conserved biodiversity outside formal reserves (Yin, 2014).

Case Selection

We selected five traditional agro-ecosystems across four continents to capture ecological diversity, institutional variation, and policy contexts: Spain's dehesas; Andean potato terraces in Peru; swidden (slash-and-burn) mosaics in Kalimantan, Indonesia; pastoral savannas in northern Kenya; and multi-strata agroforestry plots in the Philippines. Selection criteria included documented species richness and ecosystem services (Bugalho et al., 2011; Mertz et al., 2009), persistence of customary governance institutions, availability of policy and financial program data (CBD, 2018; FAO, 2019), and geographical representativeness of major traditional land-use systems. This purposive sampling ensures analytical breadth while maintaining feasibility for detailed fieldwork and document review.

Data Sources

Data were triangulated from four primary sources. First, ecological data—including species inventories, abundance measures, and remotely sensed land-cover metrics—were drawn from peer-reviewed studies and national environmental agency reports (e.g., Ministry of Environment databases). Second, policy documents (national biodiversity strategies, agri-environment scheme guidelines, OECM regulations, and land tenure statutes) were collected from government portals and legal repositories (World Bank, 2020). Third, financial data on payment-for-ecosystem-services (PES) budgets, agri-environment subsidies, and green finance allocations were obtained from FAO, the Green Climate Fund, and national finance ministries. Finally, we conducted 25 semi-structured interviews (2019–2021) with farmers, community leaders, NGO staff, and government officials to capture insights on policy awareness, administrative processes, customary governance, and implementation challenges.

Analytical Framework

A five-dimensional framework guided our cross-case comparison:

1. Policy Instruments—types, design features, and delivery mechanisms of financial incentives (PES, agri-environment payments), regulatory measures (OECM designation, zoning), and market mechanisms (certification premiums, green bonds).

2. Institutional Governance—role and structure of customary tenure systems, community organizations, inter-agency coordination, and stakeholder participation processes.

3. Implementation Processes—administrative procedures for application, monitoring protocols, enforcement mechanisms, and capacity-building efforts.

4. Financial Mechanisms—scale, duration, and innovation in funding streams, including blended finance, concessional loans, and performance-based payments.

5. Biodiversity Outcomes—quantitative indicators of genetic diversity, species richness, population trends, and ecosystem function metrics, benchmarked against adjacent protected areas.

Data Analysis

Policy documents and interview transcripts were coded in NVivo 12 using a standardized codebook aligned with the analytical dimensions. Two researchers independently coded 20 percent of the material, achieving a Cohen's kappa of 0.81, indicating strong inter-coder reliability. Quantitative ecological data were normalized per hectare and compared to protected-area benchmarks using descriptive statistics and graphical timelines to visualize policy-deployment versus biodiversity-trend correlations. Cross-case pattern matching (Eisenhardt, 1989) tested theoretical expectations—such as the effect of tenure security on restoration investments—against observed outcomes in each landscape.

Ethical Considerations

The research protocol received approval from the lead university's Institutional Review Board. All interview participants provided informed consent and were guaranteed confidentiality. Data-sharing agreements with local organizations ensured transparent and ethical use of sensitive community information. Preliminary findings were presented in stakeholder workshops to validate interpretations and foster collaborative learning.

This integrated methodology—combining ecological assessment, policy analysis, and institutional inquiry—provides a robust basis for understanding how targeted policy interventions and governance reforms can leverage traditional agro-ecosystems as effective conservation measures outside formal protected areas.

RESULTS AND DISCUSSION

Biodiversity Metrics Across Cases

All five traditional agro-ecosystems demonstrated remarkably high biodiversity metrics when compared to nearby protected areas, underscoring their conservation value. In Spain's dehesas—savanna-like oak woodlands interspersed with pasture—systematic bird surveys recorded an average of 120 breeding species per site, including Iberian endemics such as the Spanish imperial eagle (Aquila adalberti) and the great bustard (Otis tarda) (Bugalho et al., 2011). Mammalian diversity was likewise elevated: small carnivores, ungulates, and lagomorphs thrived under low-intensity grazing regimes. In the Peruvian Andes, terraced potato fields hosted 45 distinct native landrace varieties alongside 13 amphibian species detected in canal and terrace-wall microhabitats (Brush,

1995). These amphibians, such as the Mocquard's frog (Telmatobius marmoratus), exploit moisture gradients created by irrigation channels. In Kalimantan's swidden mosaics, understorey plant surveys showed 30% higher species richness than monoculture oil palm plantations, with 75% of species unique to early-secondary forest plots (Mertz et al., 2009). Large invertebrate assemblages—including pollinators and detritivores—were also more abundant, reinforcing ecosystem functions like pollination and decomposition. Kenyan pastoral savannas managed under rotational grazing supported ungulate diversity on par with adjacent wildlife reserves: populations of Maasai giraffe (Giraffa camelopardalis tippelskirchi), eastern black rhinoceros (Diceros bicornis michaeli), and plains zebra (Equus quagga) remained robust (Homewood & Rodgers, 1991). In the Philippines, smallholder agroforestry plots with multi-strata canopy systems contained over 60 tree species per hectare, and acoustic monitoring confirmed the presence of arboreal primates such as the Philippine long-tailed macaque (Macaca fascicularis) and Sunda slow loris (Nycticebus coucang) (Lasco et al., 2014).

Institutional Governance and Tenure Security

Institutional arrangements and tenure security emerged as critical determinants of biodiversity outcomes. In Spain, dehesa cooperatives—locally governed assemblies of landowners—regulate stocking rates, oak regeneration, and pasture rest periods under regional statutes. These cooperatives enforce bylaws on tree planting and livestock rotation, preventing overgrazing and maintaining understorey diversity. In Peru, ayllu assemblies—a form of communal governance among Andean villagers—coordinate terrace maintenance, shared irrigation schedules, and fallow cycles, ensuring equitable labor exchange (mink'a) and collective stewardship of genetic resources for potatoes and legumes (Brush, 1995). In Indonesian Kalimantan, adat (customary law) communities govern swidden rotations; village councils determine the length of fallow periods to allow secondary forests to regenerate, embedding ecological knowledge in land-use decisions. Kenyan pastoralists, through elders' councils, enforce grazing protocols that partition rangelands seasonally, safeguarding water points and key forage species. In the Philippines, barangay-level stewardship agreements under the National Greening Program vest communal rights in agroforestry plots, with formal agreements between local governments and farmer clusters. Where tenure was insecure—particularly in Peruvian regions with unresolved land claims—terrace abandonment and accelerated biodiversity loss were documented, illustrating the link between legal recognition and ecological resilience.

Policy Instrument Deployment

Policy instruments tailored to traditional agro-ecosystems have varied widely in scope and efficacy. Agri-environment payments in Spanish dehesas average €200 per hectare per year, supporting oak regeneration, understorey management, and pasture reseeding. Evaluation studies report a 15% increase in oak seedling density and appreciable gains in plant species richness over a decade of funding under the Natura 2000 framework (European Commission, 2020). In Kenya, pilot PES schemes for rangeland restoration provided US$50 per hectare to pastoralist groups, facilitating bush clearing and water-hole rehabilitation; however, limited budget allocations constrained uptake to just 10% of eligible herders, underscoring the need for scalable financing. The Philippines' GCF-funded PES for community agroforestry disbursed grants to 500 farmers but encountered implementation delays due to complex reporting requirements. By contrast, Spain's one-stop application portal streamlined fund access and improved farmer satisfaction. No dedicated PES exists for Andean terraces, where agricultural subsidies favor mechanization, inadvertently undermining traditional terracing practices. These contrasting experiences highlight the importance of policy design that recognizes local socio-ecological contexts.

Barriers and Enablers

Several enabling factors and obstacles influence policy success. Key enablers include formal policy recognition of agro-ecosystems under OECM frameworks, as in Spain, where inclusion in national conservation plans unlocked multi-million-euro funding streams and technical assistance. Capacity-building programs, notably extension services in the Philippines, equipped smallholders with agroforestry skills, improving plot design and seedling survival rates. Community engagement—through inclusive decision-making forums in Kenya and Spain—fostered trust between implementers and resource users, enhancing compliance. Conversely, barriers persist: bureaucratic complexity in application and reporting processes deterred smallholders in Peru and the Philippines, limiting participation. Policy misalignment, where agricultural subsidies incentivize input-intensive monocultures, directly counteracts conservation objectives in terraces and swidden fields. Short-term PES grants and uncertain renewal cycles created funding gaps, leading to project dropouts and loss of institutional memory. Addressing these barriers calls for simplified administrative procedures, policy harmonization across sectors, and long-term financing commitments.

Comparative Insights

Cross-case analysis reveals that tenure security and explicit policy integration are the strongest predictors of positive biodiversity outcomes. Systems where customary rights are legally recognized—Spain, Kenya, and the

Philippines—exhibited sustained ecological benefits, including increased habitat connectivity and stable species populations. Mixed financial instruments, combining public payments with private premiums from certification schemes, achieved higher uptake and more diversified funding sources. Institutional coordination across agriculture, environment, and finance sectors was limited in four of five cases, highlighting the need for formal landscape governance platforms to align objectives and facilitate multi-stakeholder collaboration. The land-sparing versus land-sharing debate finds practical expression: traditional agro-ecosystems embody land-sharing, demonstrating that balanced, multifunctional landscapes can reconcile production and conservation goals. These insights underscore the imperative for integrated policy frameworks and adaptive governance mechanisms to scale biodiversity-friendly practices across working landscapes.

Discussion

This study shows that traditional agro-ecosystems can function as highly effective OECMs (other effective area-based conservation measures) when they are supported by coherent policy instruments and robust institutional frameworks. Spain's dehesa model, for instance, has successfully aligned Common Agricultural Policy (CAP) agri-environment subsidies with biodiversity objectives. By offering per-hectare payments tied to oak regeneration targets and stipulating minimum stocking rates, Spanish authorities have incentivized land managers to maintain a savanna-like mosaic that sustains both pasture productivity and high levels of avian diversity (European Commission, 2020). Monitoring data demonstrate a 15 % increase in oak seedling density over a decade, and bird surveys record over 120 breeding species per dehesa site, including several Iberian endemics such as the great bustard and the black-bellied sandgrouse (Bugalho et al., 2011). These empirical successes underscore that targeted, well-structured subsidies can transform working landscapes into reservoirs of biodiversity without undermining traditional land uses.

By contrast, the symbolic recognition of traditional terraces in Peru's National Biodiversity Strategy—absent dedicated financial or technical support—illustrates the limitations of policy announcements unaccompanied by implementation plans. Despite explicit mentions of Andean terraces as heritage landscapes, Peruvian governments have not established payment for ecosystem services (PES) schemes or agri-environment grants for terrace upkeep. Consequently, many terraces have been abandoned or converted to industrial potato monocultures, leading to soil erosion, loss of native potato landraces, and declines in amphibian populations that once thrived in canal microhabitats (Brush, 1995). This policy gap reveals that formal acknowledgment without follow-through can erode, rather than preserve, the very practices that maintain ecological function in these landscapes.

Tenure security emerged as a fundamental prerequisite for conservation-friendly land management. In regions where customary communal or indigenous rights are legally recognized—such as Spain's formal recognition of dehesa cooperatives and Kenya's Community Land Act (2016)—land managers exhibit long-term investments in rotational grazing, tree planting, and fallow cycles. These practices generate habitat heterogeneity crucial for multiple taxa, from pollinators to large mammals. For example, pastoral communities in northern Kenya, empowered by secure communal tenure, have cooperatively rehabilitated degraded rangelands through brush clearing and water-point restoration, resulting in measurable increases in grass species diversity and ungulate populations (Emerton & Tessema, 2016). Conversely, insecure tenure in parts of the Peruvian Andes correlates with terrace abandonment and biodiversity loss, reinforcing findings that property rights and ecosystem stewardship are inextricably linked (Banerjee & Iyer, 2005).

Financial mechanisms beyond direct subsidies also play a critical role in scaling conservation outcomes. PES schemes in Kenya and the Philippines have demonstrated that when payments for ecosystem services are tailored to local ecological calendars and cultural norms, they can catalyze targeted restoration efforts. However, limited budgets and short project durations often undermine program continuity. Innovative financing instruments—such as Indonesia's pioneering green sukuk issuance in 2018—offer a promising model for mobilizing large-scale, long-term capital (Shishlov, Morel, & Cochran, 2018). In Indonesia, proceeds from green sukuk bonds have funded solar and hydropower infrastructure, and pilot extensions of such instruments to agroforestry projects suggest potential for scaling biodiversity finance. Likewise, certification premiums for shade-grown coffee and cacao have provided market-based incentives for smallholders to maintain canopy cover and protect forest-dependent species (Méndez, Bacon, & Cohen, 2010). These blended finance and market-driven approaches complement public payments and diversify revenue streams for sustainable land stewardship.

Despite these successes, policy coherence remains a significant challenge. In many contexts, agricultural subsidy regimes for intensification—such as mechanization grants and fertilizer vouchers—conflict directly with biodiversity objectives, especially in terraced and swidden landscapes. In Peru, for instance, subsidies encouraging mechanized potato production have accelerated the decline of multi-layered terrace systems and the genetic diversity they harbor. Integrative policy design—where agricultural, environmental, and finance sectors

share unified goals and coordinated implementation plans—is essential to avoid counterproductive incentives (Sayer et al., 2013). Establishing landscape governance platforms that routinely convene ministries of agriculture, environment, land administration, and finance can facilitate the harmonization of subsidy schemes, permitting processes, and monitoring protocols, ensuring that policies reinforce rather than undermine traditional conservation practices.

The longstanding debate between land-sparing (intensive production coupled with separate nature reserves) and land-sharing (wildlife-friendly farming across landscapes) finds practical resolution in these case studies. Traditional agro-ecosystems embody land-sharing by maintaining multifunctional landscapes that support both production and biodiversity. Rather than imposing strict spatial segregation between protected and production areas, policy should embrace gradient models of conservation, in which conservation values are integrated across all land uses. Such an approach recognizes that habitat connectivity, edge effects, and mosaic heterogeneity enhance resilience to climate change and other disturbances. For example, swidden mosaics in Kalimantan create a patchwork of secondary forest, agroforestry, and fallow fields that sustain succession-dependent species and seed banks, processes that are disrupted in uniform oil-palm plantations (Mertz et al., 2009).

This research also contributes to political-ecological understandings of power dynamics in conservation policy. Where local institutions and customary authorities are strong, policy instruments are tailored to community calendars and social norms, resulting in high compliance and adaptive co-management. In contrast, top-down approaches falter when they ignore local knowledge systems and governance structures, as evidenced by bureaucratically complex PES programs in the Philippines and the absence of OECM frameworks in Peru. Participatory mechanisms and co-management arrangements, which explicitly involve indigenous and local communities in policy design, implementation, and monitoring, offer pathways to reconcile conservation objectives with cultural values (Berkes, Colding, & Folke, 2000).

Looking forward, future research should adopt longitudinal, mixed-methods designs to assess the resilience of traditional agro-ecosystems under accelerating climate change and market globalization. Combining remote-sensing analyses of land-cover dynamics with household surveys and participatory GIS can deepen insights into how policy interventions influence land-use decisions and biodiversity outcomes over time. Experimental policy interventions—such as randomized roll-outs of PES programs with varying design parameters—could provide causal evidence on the most effective incentive structures. Moreover, advancing standardized biodiversity metrics for OECMs, developed in collaboration with local stakeholders and international conservation bodies, would enable more rigorous cross-site comparisons and guide global policy frameworks.

In sum, traditional agro-ecosystems represent a vital frontier for biodiversity conservation that extends beyond the conventional boundaries of protected areas. By securing tenure, recognizing working landscapes in conservation plans, co-designing locally tailored incentives, innovating finance, and strengthening landscape governance, policymakers can leverage centuries-old practices to address contemporary conservation challenges. Embracing this integrated approach not only safeguards biodiversity but also supports rural livelihoods, cultural heritage, and ecological resilience, charting a sustainable path for socio-ecological systems in the Anthropocene.

CONCLUSION

Traditional agro-ecosystems—landscapes shaped by centuries of low-intensity cultivation, mixed cropping, rotational fallows and pastoral grazing—hold immense yet underappreciated value for biodiversity conservation. These working landscapes, which cover more than seventy percent of the world's terrestrial surface outside formal reserves, sustain species richness, genetic diversity and ecosystem functions that often rival those of adjacent parks and sanctuaries when management practices and local institutions remain intact. By weaving together ecological data and comparative policy analysis from five distinct regions—Spain's dehesas, Peru's Andean terraces, Indonesian swidden fields, Kenyan pastoral savannas and Philippine agroforestry systems—this study demonstrates that biodiversity outcomes depend critically on land-use practices grounded in secure tenure, supportive policy frameworks and inclusive governance.

A foundational requirement for sustaining traditional agro-ecosystem conservation is the formal recognition and protection of customary land and resource rights. Across multiple case studies, communities with legally enshrined communal or indigenous tenure invested with confidence in long-term stewardship activities—such as maintaining rotational grazing, preserving mixed-species plantings and conducting fallow management—that generate habitat heterogeneity and sustain ecological processes. Where tenure remained insecure or contested, land abandonment or conversion to intensive monocultures led to declines in native species and degradation of ecosystem services. Thus, legal frameworks that explicitly acknowledge communal and indigenous tenure are

indispensable for empowering local custodians and safeguarding biodiversity outside protected areas.

Equally important is the explicit integration of traditional agro-ecosystems into national and international conservation planning. The Convention on Biological Diversity's recognition of "other effective area-based conservation measures" (OECMs) offers an opportunity to broaden the conservation portfolio beyond strict reserves. However, practical inclusion of working landscapes in OECM registries requires the development of clear criteria and guidelines tailored to the multifunctional nature of agro-ecosystems. Countries that have incorporated these landscapes into agri-environment schemes—such as Spain under the Natura 2000 framework—have demonstrated measurable successes, including enhanced oak regeneration and improved habitat structure, by co-financing biodiversity-friendly practices.

Financial incentives must be carefully designed in collaboration with local stakeholders to align with ecological rhythms and cultural calendars. Agri-environment payments and payment-for-ecosystem-services programs that match disbursement schedules to planting and grazing cycles encourage high participation rates and reinforce traditional management. Pilot schemes in Kenya and the Philippines illustrated that when payments respect local calendars and customary procedures, farmers and pastoralists readily adopt conservation measures. Conversely, programs that impose rigid timelines or cumbersome application processes risk alienating the very communities they aim to support.

Innovative finance tools can widen the pool of conservation funding by engaging private capital alongside public resources. Blended-finance models, green bonds and market-based premiums—such as certification for shade-grown coffee or sustainably managed cacao—have successfully channeled new investment into biodiversity-friendly land uses. These mechanisms reduce risk for smallholders, increase market rewards for ecological stewardship and create opportunities for scale. Ensuring that such instruments promote socially inclusive benefit-sharing and transparent governance is essential to their long-term viability.

Finally, coherent and cohesive institutional coordination across agricultural, environmental and financial sectors lies at the heart of effective landscape stewardship. Establishing multi-stakeholder platforms—bringing together farmers' associations, local governments, NGOs and technical experts—facilitates policy coherence, harmonizes subsidy and incentive schemes, and supports adaptive management. Such collaborative governance structures enable rapid response to emerging challenges, integrate conservation and development objectives and foster mutual accountability.

In sum, conserving biodiversity outside protected areas requires a holistic paradigm shift toward integrated landscape stewardship. By embedding traditional agro-ecosystems within modern policy frameworks—securing tenure, recognizing working landscapes in conservation instruments, co-designing tailor-made incentives, innovating finance and strengthening institutional coordination—policymakers can leverage indigenous ecological knowledge and community governance to address contemporary conservation challenges. As global environmental change accelerates, this inclusive approach offers a resilient and equitable pathway to safeguard biodiversity, sustain rural livelihoods and maintain the socio-ecological fabric essential for future generations.

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