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Beyond tree planting: complementary roles of agroforestry and rainforestation in reducing tropical deforestation pressure

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Abstract

Tree-based interventions are increasingly promoted as responses to tropical deforestation, yet the term “tree planting” conceals major differences among forest protection, natural regeneration, ecological restoration and agroforestry. This critical narrative review examines how agroforestry and rainforestation can contribute to reducing deforestation pressure, using the Philippines as a principal case while drawing lessons for tropical landscapes more broadly. Agroforestry can diversify farm income, improve selected ecosystem services and increase the permeability of agricultural matrices. Rainforestation—a Philippine approach based on diverse native tree species and site-appropriate production components—can rebuild forest structure and recruitment processes on degraded land. However, neither intervention recreates intact forest, and neither automatically prevents displacement of clearing, commodity-driven expansion or biodiversity loss. Evidence indicates that outcomes depend less on the number of trees planted than on prior land cover, spatial placement, species composition, tenure security, market incentives, long-term management and credible monitoring. We propose a landscape hierarchy: protect intact and recovering natural forests first; enable natural regeneration where ecological recovery is feasible; use rainforestation where active native-species restoration is necessary; and concentrate agroforestry within established farms, buffers and connectivity zones. A common monitoring framework should track forest-cover change, carbon, native-species composition, farm profitability, tenure and leakage. Agroforestry and rainforestation are therefore best treated as complementary components of integrated forest-landscape governance, not interchangeable substitutes for avoided deforestation.

Introduction

Tropical forest policy has entered an era of ambitious tree-cover commitments. Governments, development agencies, companies and communities increasingly support agroforestry, reforestation and restoration as measures for climate mitigation, biodiversity conservation and rural development. This attention is welcome, but the language of “planting trees” can obscure a decisive ecological distinction: conserving an existing forest, assisting the recovery of a disturbed forest, establishing a native-species restoration planting and integrating trees into a farm are not equivalent interventions. They begin from different land-cover baselines, serve different people and ecological communities, and create different risks and benefits. Treating them as substitutes can reward increases in tree cover while leaving the drivers of forest conversion untouched (Holl and Brancalion 2020).

Agroforestry is the deliberate integration of woody perennials with crops or livestock. Its environmental case rests on multifunctionality: trees can influence soil processes, microclimate, water regulation, carbon storage, habitat structure and the diversity of farm outputs (Jose 2009). Yet agroforestry covers a wide spectrum, from species-rich home gardens and shaded perennial crops to simplified arrangements with one commercial tree species. Its conservation value consequently varies. Complex agroforests may retain more plant and bird diversity than monoculture plantations, but forest-dependent species usually remain less well represented than in natural forest (Beukema et al. 2007; Bhagwat et al.

2008). Agroforestry can improve the production matrix around forest remnants; it cannot make conversion of those remnants ecologically acceptable.

Rainforestation developed in the Philippines as a response to degraded uplands and conventional reforestation dominated by a small set of fast-growing exotic species. The approach combines site-adapted native trees of different successional and use groups, sometimes with fruit trees and understory crops, to recover forest-like structure while providing livelihood opportunities (Göltenboth and Hutter 2004; Asio 2017). Long-term studies in Leyte indicate that restoration type influences seedling recruitment and functional diversity, and that native-species plantings can create conditions intermediate between plantations and remnant forest (Wills et al. 2017, 2021). Rainforestation therefore joins ecological restoration with production, but it remains an active intervention for degraded sites—not a license to replace intact or naturally regenerating forests.

The central policy question is not whether agroforestry or rainforestation is universally “effective.” It is where, for whom and against which counterfactual each intervention can reduce pressure on natural forest. Agroforestry may reduce livelihood-driven clearing when it raises and stabilizes returns from land already under production. It may also increase land values, stimulate commercial expansion or displace pressure if safeguards are weak. Rainforestation may restore native-tree structure where seed sources, soils or disturbance regimes constrain recovery, but active planting can be unnecessarily expensive where natural regeneration would succeed. Effectiveness must therefore be evaluated at landscape and livelihood scales rather than inferred from seedling counts or plot-level biomass alone.

This review develops a conditional framework for aligning agroforestry, rainforestation, natural regeneration and forest protection. The Philippines provides a valuable test case because highly diverse and fragmented forests coexist with smallholder agriculture, long experience in community-based restoration and a locally developed native-tree restoration model. The framework is nevertheless intended for broader tropical application. The argument is that agroforestry and rainforestation can be complementary: the former primarily improves multifunctionality and livelihood resilience in production areas, whereas the latter primarily rebuilds native forest structure on selected degraded sites. Their combined contribution to avoided deforestation depends on secure protection of remaining forests, careful spatial targeting, viable local institutions and monitoring that can detect leakage and distributional effects.

Review approach

This article is a critical narrative review rather than a systematic review or meta-analysis. Literature was identified through combinations of the terms agroforestry, deforestation, forest pressure, biodiversity, restoration, natural regeneration, native species, rainforestation and Philippines. Recent studies were combined with foundational rainforestation publications and reference chaining from relevant reviews. Peer-reviewed evidence was prioritized; official publisher records and DOI registries were used to verify bibliographic metadata. The synthesis gives particular attention to articles in Agroforestry Systems

because they directly address the journal's biophysical and socioeconomic scope, but inclusion was based on relevance to the argument rather than journal provenance alone.

The review evaluates five linked questions. First, what mechanisms could connect farm-level tree integration to reduced forest conversion? Second, what does the evidence show about biodiversity, ecosystem services and livelihood outcomes in agroforestry systems? Third, what ecological role can rainforestation play relative to natural regeneration and conventional plantations? Fourth, how should the interventions be placed within heterogeneous landscapes? Fifth, what governance and monitoring conditions are necessary before local gains can be interpreted as reduced deforestation pressure? Because the available rainforestation literature is concentrated in the Philippines and contains relatively few long-term counterfactual studies, conclusions are framed as conditional propositions and research priorities rather than universal effect sizes.

We use deforestation pressure to mean the interacting incentives and constraints that make conversion or repeated degradation of natural forest more likely. This includes livelihood needs, commodity markets, insecure tenure, infrastructure, weak enforcement and displacement of extraction. Reduced pressure is not assumed from increased tree cover. It requires evidence that natural-forest conversion or degradation is lower than under a credible alternative, without merely shifting the activity to another site. The distinction is important because an agroforestry plot, a plantation and a recovering native forest can all appear as tree cover in coarse monitoring systems while differing substantially in carbon permanence, habitat quality and social function.

Distinguishing protection, agroforestry and rainforestation

A useful hierarchy begins with ecological irreplaceability. Intact and old secondary forests contain accumulated carbon, complex structure, soils, seed sources and species assemblages that cannot be recreated within policy-relevant time frames. Their protection must therefore precede claims about compensation through planting. Recovering secondary forests can also regain diversity and structure rapidly when disturbance is removed, as documented after shifting cultivation in Philippine uplands (Mukul et al. 2020). In such settings, controlling fire, grazing, repeated clearing and timber extraction may be more effective than intensive planting. Across tropical studies, natural regeneration often performs well relative to active restoration, although site history and the outcomes measured strongly affect the comparison (Crouzeilles et al. 2017).

Rainforestation occupies the active-restoration portion of this hierarchy. It is most defensible where degradation has reduced native seed sources, arrested succession, compacted or eroded soil, or created a persistent grass or shrub layer that prevents desired recovery. Its defining ecological value is not simply high stem density. It is the deliberate use of locally appropriate native species, functional and successional diversity, and a design that can develop a more forest-like canopy and understory. The original model tested numerous native forest and fruit-tree species in Leyte and combined ecological rehabilitation with differentiated livelihood products (Göltenboth and Hutter 2004; Asio 2017). This

makes rainforestation closer to mixed native-species restoration or restoration-oriented agroforestry than to conventional monoculture reforestation.

Agroforestry primarily addresses land already committed to production. Trees may be arranged in multistrata perennial systems, home gardens, boundary plantings, riparian buffers, improved fallows, alley systems or silvopastoral configurations. These systems can supply food, timber, fuel, fodder and market crops while delivering some ecosystem services. A global evidence map found broadly positive or mixed effects across agricultural productivity, ecosystem services and human well-being, but also substantial gaps in rigorous causal evidence (Miller et al. 2020). Global meta-analysis indicates that carbon accumulation varies with tree diversity, system age and regional climate, warning against uniform coefficients for “agroforestry” (Ma et al. 2020).

These categories can overlap. A farm may contain a rainforestation block, a shaded perennial crop and a remnant forest patch; a restoration site may permit limited harvesting; and agroforestry can use native trees. The important distinction is the primary objective, baseline and management trajectory. Protection seeks to retain natural forest; natural regeneration removes barriers to spontaneous recovery; rainforestation actively rebuilds native-tree structure on degraded land; agroforestry integrates trees into production. Clear categories make it possible to assign appropriate safeguards and indicators rather than judging every intervention by hectares planted.

How agroforestry can reduce—and sometimes relocate—deforestation pressure

The strongest mechanism linking agroforestry to reduced forest pressure is livelihood substitution. When households obtain food, fuelwood, timber or income from established farms, they may rely less on clearing new fields or extracting products from nearby forests. Evidence from Bangladesh suggests that agroforestry alternatives to swidden agriculture can improve livelihood options and may reduce pressure on remaining forest, but the effect depends on land access, labor, markets and the broader institutional setting (Rahman et al. 2017). Comparative evidence from tropical drylands similarly indicates that multistrata agroforestry, improved fallow and woodlots can improve aspects of productivity and soil fertility relative to shifting cultivation, although results differ among systems and contexts (Cangela et al. 2026). The relevant outcome is not merely higher plot yield; it is whether the livelihood system becomes sufficiently secure and attractive to change land-use decisions.

Income diversification can also reduce vulnerability. A mixture of products harvested at different times can buffer crop failure and price volatility. Coffee-based systems in Brazil illustrate how economic outcomes depend on management strategy, labor and market conditions rather than tree presence alone (de Souza et al. 2012). Diversification may be particularly important for smallholders facing climatic shocks, but delayed tree returns and uncertain product markets can make adoption difficult. A systematic review in Agroforestry Systems identified knowledge, markets, labor, up-front investment and technical support among the most frequently reported adoption barriers (Tranchina et al. 2024). These

are not peripheral implementation issues: if farmers cannot manage or sell the additional products, the expected forest-pressure pathway is unlikely to operate.

A second mechanism is ecological matrix improvement. Forest fragments are embedded in farms, settlements and infrastructure. Increasing vegetation complexity within farms can provide movement routes, feeding habitat, shade and microclimatic buffering for some organisms. Jungle rubber in Sumatra retained greater plant and bird diversity than rubber monoculture, although it remained inferior to primary forest for several forest-associated groups (Beukema et al. 2007). Mammal responses in Brazilian Atlantic Forest landscapes likewise depended on both forest and traditional shade plantations, underscoring the importance of multiple spatial scales (Ferreira et al. 2020). In Thailand, rubber agroforestry provided modest benefits for butterflies without reducing reported rubber yields, but did not support forest-dependent or conservation-priority birds; the authors explicitly concluded that agroforestry could not offset forest encroachment (Warren-Thomas et al. 2020).

Meta-analyses reinforce this qualified interpretation. Coffee and cacao agroforests generally support more biodiversity and ecosystem services than simplified plantations, but their performance varies with shade structure, management intensity and landscape forest cover (De Beenhouwer et al. 2013). Multifunctional shade-tree management can generate co-benefits, yet trade-offs arise among crop yield, tree products and conservation outcomes (Tscharntke et al. 2011). Thus, “agroforestry” should not be treated as a binary land-cover class. Tree density, native-species representation, vertical structure, understory management, pesticide use, harvest cycles and proximity to natural forest all influence value. Biodiversity-friendly management within farms matters most when natural habitat is retained at the landscape scale.

A third mechanism is the recovery of soil and hydrological functions. Trees can add litter, redistribute nutrients, reduce wind exposure and erosion, and increase infiltration under suitable management. These functions may stabilize production and reduce the perceived need for land expansion. However, the magnitude and direction of change depend on tree traits, density, soil and competition for water or nutrients. Agroforestry is therefore a design problem, not a guarantee. Decision-support systems that combine ecological, agronomic and local knowledge can improve species selection (Gosme et al. 2025), while analyses under uncertainty can identify portfolios that reduce economic–ecological trade-offs rather than optimizing a single outcome (Knoke et al. 2025).

Four countervailing processes can reverse these benefits. First, a profitable tree commodity can increase expected returns to land and stimulate expansion into forest. Second, higher yields may release labor or capital for further land acquisition—the rebound effect—unless expansion is constrained. Third, reduced extraction in one community can be offset by clearing or harvesting elsewhere, producing leakage. Fourth, poorly specified tree-planting incentives can encourage replacement of secondary forest or diverse farms with simple plantations. None of these outcomes is inevitable, but they show why project boundaries are insufficient. Monitoring must combine farm performance with land-cover change in the

surrounding landscape and, where commodity supply chains are involved, traceability beyond the project area.

The policy implication is that agroforestry should be coupled with explicit forest-retention rules. Incentives should be conditional on a verified pre-intervention land-cover baseline; conversion of natural forest or recovering secondary forest should be ineligible; and support should prioritize established farms, degraded production land, riparian buffers and connectivity zones. Public or private finance should reward measurable performance—such as retained forest, diversified income, native tree survival and soil cover—rather than seedling distribution alone. Agroforestry can then complement protection by making production landscapes more resilient and permeable without being represented as a substitute for natural forest.

Rainforestation as native-tree restoration with production functions

Rainforestation emerged from the recognition that conventional tree planting in the humid Philippines often prioritized rapid establishment and timber volume over native biodiversity and long-term ecosystem development. Its near-to-nature design combines pioneer and shade-tolerant native trees, high-value timber and fruit species, and in some models understory crops. The system seeks early canopy closure, suppression of disturbance-prone grasses and later structural differentiation (Göltenboth and Hutter 2004). It therefore offers a practical bridge between ecological restoration and smallholder land use. Asio (2017) documents its development in Leyte and subsequent uptake by public and nongovernmental programs.

The strongest ecological evidence comes from comparisons among remnant forest, native-species restoration and plantations. In a human-dominated Philippine landscape, reforestation type affected recruitment and functional diversity: native-species restoration supported a seedling community that differed from exotic plantations and moved some attributes toward those of remnant forest, although it did not reproduce remnant-forest composition (Wills et al. 2017). Subsequent work showed that both actively and passively restored understories contained substantial seedling diversity, but restoration pathway and landscape context influenced composition (Wills et al. 2021). Mixed-species plantations in Leyte also demonstrated that stand age, composition and adjacent forest influence recovery, and that rainforestation cannot replace natural forest (Veridiano et al. 2020). In degraded tropical forests elsewhere, active restoration has accelerated above-ground carbon recovery relative to unassisted recovery, although this does not establish equivalence with intact forest (Philipson et al. 2020).

Native-tree plantings can contribute to soil recovery, but evidence remains site-specific. At a rainforestation site in Leyte, native trees were associated with variation in soil fertility indicators, supporting the rationale for evaluating below-ground processes alongside survival and growth (Ceniza et al. 2023). Studies of reforested limestone quarry landscapes in Luzon and Mindanao further show that exotic tree-based reforestation and remnant forests have different plant-diversity patterns, reinforcing the need to measure species composition rather than canopy cover alone (Galindon et al. 2018). These

findings argue for locally adapted mixtures and reference ecosystems, not a single national planting recipe.

Rainforestation can also generate livelihood value through fruit, timber and non-timber products. Qualitative work with adopters in the Visayas indicates that motivations and perceived benefits include environmental rehabilitation and household or community value, but adoption occurs within particular institutional and livelihood circumstances (Fernandez and Bande 2019). Product rights, harvest regulations, technical knowledge, nursery supply and market access determine whether the production component becomes credible. If farmers bear years of establishment and maintenance costs but cannot legally harvest or profit from selected trees, restoration may be abandoned or converted to another use.

Three limitations require emphasis. First, native does not automatically mean site-suitable. Provenance, successional role, soil, climate, exposure and future climate risk must guide selection. A highly diverse but poorly matched planting can suffer mortality and high maintenance costs. Second, active planting is not always necessary. Philippine secondary forests can recover diversity and structure after shifting cultivation when repeated disturbance is removed (Mukul et al. 2020). Assisted natural regeneration may therefore be the lower-cost and ecologically appropriate option where seed sources and resprouting capacity remain. Third, short-term survival is an inadequate measure. The desired trajectory involves recruitment, structural development, native-species persistence, soil recovery and sustained local stewardship over decades.

Rainforestation is most compelling in degraded forest land, mined or severely eroded areas, wide buffers and strategic corridors where active enrichment is needed and where the reference condition is native forest rather than commercial plantation. On smallholder land, it may be implemented as a restoration-oriented agroforestry system, but objectives and harvesting rules should be explicit. Where production is primary, the intervention should be assessed as agroforestry; where native ecosystem recovery is primary, ecological indicators must dominate. This clarity reduces the risk that a project claims restoration benefits while being managed solely for short rotations or commodity production.

Alandscape placement framework

The complementary value of agroforestry and rainforestation becomes clearer when interventions are allocated by starting condition and desired trajectory (Table 1). The first zone is intact or old secondary forest. Here, the appropriate intervention is protection, tenure recognition, fire and extraction control, and support for locally legitimate stewardship. Planting inside a functioning forest should be exceptional and based on a demonstrated ecological need. The second zone is degraded but naturally recovering forest. Assisted natural regeneration—removing repeated disturbance, controlling invasive plants where necessary and facilitating seed dispersal—should be tested before intensive planting.

The third zone includes severely degraded forest land, broad buffers, corridors and sites where dispersal or soil limitations impede recovery. Rainforestation or another native-species restoration model can accelerate canopy development and introduce missing functional or successional groups. Planting

design should be informed by nearby reference ecosystems and should preserve natural recruits. The fourth zone is established farmland and other long-term production areas. Agroforestry is appropriate where trees fit household objectives, labor, tenure and market access. Native trees can be emphasized in riparian areas and connectivity zones, while fruit, timber, fodder and service trees can be selected jointly with farmers.

Placement is not a one-time map exercise. Land-use histories, tenure claims and community values may not align with remotely sensed categories. Participatory mapping and field verification are needed to distinguish fallows, recovering forests, long-established farms and disputed land. This is especially important in mosaic uplands where a label such as “idle” or “degraded” can erase existing use and create conflict. Social safeguards should identify who controls land, who provides labor, who receives products and who bears restrictions. Without these questions, landscape restoration can reproduce unequal access even when tree cover increases.

The framework also requires an explicit counterfactual. Success in an agroforestry zone is the combination of durable farm benefits and reduced conversion pressure relative to a plausible alternative, not comparison with a treeless plot chosen after intervention. Success in a rainforestation zone is movement toward a defined native-forest trajectory relative to passive recovery or an alternative planting. In a protection zone, the relevant benchmark is avoided loss or degradation. The same indicator cannot answer all three questions.

Table 1
Landscape placement of forest protection, natural regeneration, rainforestation and agroforestry

Starting condition	Primary intervention	Main mechanism	Principal risk	Minimum indicators
Intact or old secondary natural forest	Protection and locally legitimate stewardship	Avoided loss of accumulated carbon, habitat and ecological memory	Planting or production incentives legitimize conversion or degradation	Natural-forest area and condition; fire and extraction; tenure and enforcement
Degraded but naturally recovering forest	Assisted natural regeneration	Remove recurrent disturbance and use existing seed sources and resprouting	Unnecessary planting damages recruits or diverts limited funds	Recruitment; native composition; disturbance; recovery cost; reference-site similarity
Severely degraded forest land, strategic buffers or corridors	Rainforestation or comparable mixed native-species restoration	Reintroduce missing functional groups and accelerate forest-like structure	Poor site–species matching, high mortality, weak maintenance or unclear harvest rights	Survival and growth; natural recruitment; structure; soil; maintenance; local benefits
Established farms and long-term production areas	Agroforestry designed with landholders	Diversify products and income, improve selected services and matrix permeability	Commodity expansion, rebound, leakage, low profitability or simplified tree cover	Net income and labor; product diversity; tree structure; nearby natural-forest change; leakage

Enabling conditions for durable outcomes

Secure and legitimate tenure is the first enabling condition. Trees are long-lived assets, and households are unlikely to invest if future access or harvest rights are uncertain. Tenure security should include rights to products and transparent obligations for forest retention. Where customary, private and public claims overlap, agreements need conflict-resolution mechanisms and representation of women, Indigenous Peoples, tenants and resource users who may not hold formal titles. Tenure is not merely an incentive variable; it determines whose knowledge and objectives shape the intervention.

The second condition is a functional seed and knowledge system. Rainforestation requires reliable native seed sources, provenance information, nursery standards and silvicultural knowledge across many species. Agroforestry requires advice that links tree traits with crop compatibility, labor, product demand and farm constraints. Species-selection tools can organize heterogeneous evidence, but local ecological knowledge and farmer experimentation remain essential (Gosme et al. 2025). Extension should continue beyond planting to formative pruning, thinning, fire control, pest management, enrichment and harvesting. Short project cycles are poorly matched to these needs.

The third condition is economic viability across time. Establishment costs arrive early, while many tree benefits arrive later and are uncertain. Financial support should bridge this timing gap without tying farmers to unsuitable species or single buyers. Options include staged payments for verified survival and management, credit matched to tree-crop cash flows, insurance, aggregation, shared processing and public procurement for legal, traceable products. Market development should follow credible demand assessment. The adoption literature shows that markets, labor, capital and technical support repeatedly constrain uptake (Tranchina et al. 2024), while agroecological transitions depend on relationships and institutions that connect actors across scales (Isaac et al. 2024).

The fourth condition is policy coherence. Agriculture, forestry, environment, land, infrastructure and local government agencies often classify the same mosaic differently. Conflicting rules can make native timber difficult to harvest, reward only plantation-style outputs, or finance planting without maintenance. A coherent policy package should protect natural forest, clarify product rights, certify nurseries, support diverse systems, and prevent incentives from subsidizing conversion. Coordination should be judged through operational decisions—shared baselines, compatible land classifications, linked budgets and common monitoring—not solely through inter-agency committees.

The fifth condition is performance-based monitoring. Plot inventories should measure survival, growth, recruitment, native-species composition, canopy structure, soil condition and management inputs. Farm monitoring should include yields, net income, labor, product diversity and exposure to price or climate shocks. Landscape monitoring should track natural-forest area and condition, conversion alerts, fire, connectivity and leakage. Socioeconomic monitoring should disaggregate benefits and decision-making by tenure status and gender where relevant. Sampling designs must be spatially explicit and reusable; recent guidance in Agroforestry Systems emphasizes documenting gradients, distances, management zones and metadata so that observations can support synthesis (Minarsch et al. 2025).

Causal claims require comparison. Before–after measurements should be combined, where feasible, with matched control or reference sites and transparent selection criteria. Remote sensing can detect canopy change, but field data are needed to distinguish native recovery, agroforest and plantation and to assess degradation beneath canopy. Carbon accounting should state land-cover baselines, pools, permanence assumptions and displacement risks. Biodiversity assessment should include composition or habitat-affinity groups rather than richness alone. A program that increases common generalist species while losing forest specialists should not report an unqualified biodiversity gain.

Finally, learning must be institutionalized. Uncertainty is unavoidable because trees, markets and climate change over long time horizons. Adaptive management should specify decision points: when mortality triggers replanting or a change in species mix; when natural recruits should replace planted stems; when harvest is compatible with restoration objectives; and when an intervention should stop because it is not viable. Portfolio analysis can help reveal robust combinations of economic and ecological benefits under uncertain prices and growth (Knoke et al. 2025). Transparent failure reporting is equally important,

because plantation survival averages can conceal sites where community incentives, species matching or maintenance collapsed.

Research and policy agenda

The evidence base supports a move from broad promotion to testable claims. The highest priority is to estimate whether interventions reduce forest conversion or degradation beyond project boundaries. Longitudinal landscape studies should combine household land-use decisions, commodity flows and remotely sensed forest change. They should test leakage and rebound directly, not assume that farm intensification produces land sparing. Designs can compare otherwise similar landscapes with different combinations of forest protection, agroforestry support and native-species restoration.

A second priority is comparative restoration research. Rainforestation should be evaluated against assisted natural regeneration, mixed native-species alternatives and common plantation models across degradation gradients. Outcomes should include not only planted-tree survival and biomass but natural recruitment, functional and taxonomic composition, soil processes, maintenance costs and household benefits. The strong performance of natural regeneration in some tropical contexts (Crouzeilles et al. 2017) and the substantial recovery observed in Philippine uplands (Mukul et al. 2020) make the counterfactual scientifically and economically essential.

A third priority is long-term livelihood and equity analysis. Research should identify who adopts, who continues management after external funding, and how delayed benefits interact with debt, labor and land access. Evidence from global restoration reviews shows that agronomic performance alone does not establish adoption or permanence (Mogale et al. 2026). For the Philippines, studies should examine whether product regulations, nursery systems and local processing enable smallholders to retain value from native trees. Distributional outcomes should be reported alongside aggregate income.

A fourth priority is compositional biodiversity monitoring. Species richness is easy to communicate but can mask replacement of forest specialists by disturbance-tolerant species. Studies should measure native-species recruitment, functional traits, indicator groups and similarity to reference ecosystems. They should also test how agroforestry complexity and forest proximity interact. The literature already indicates that agroforests are most valuable as complements to remaining forest, not as replicas (Beukema et al. 2007; Ferreira et al. 2020; Warren-Thomas et al. 2020).

A fifth priority is decision support that links maps with institutions. Spatial models can identify erosion risk, connectivity opportunities, natural-regeneration potential and farm suitability, but recommendations must be negotiated with landholders and agencies. Tools should expose trade-offs and uncertainty rather than generate a single optimal map. Common minimum indicators, summarized in Table 2, would allow programs to compare outcomes while retaining locally specific measures. Open protocols and documented sampling geometry would improve reusability and cumulative learning (Minarsch et al. 2025).

For policy, the immediate step is to replace undifferentiated planting targets with a results hierarchy. Public reports should separately disclose hectares of natural forest protected, hectares under assisted natural regeneration, hectares under active native-species restoration and hectares of established farms adopting agroforestry. Budgets should include maintenance and monitoring beyond establishment. Procurement and carbon-finance claims should require traceability, verified land baselines and safeguards against natural-forest conversion. These changes do not diminish tree planting; they make it accountable to the forest, climate and livelihood outcomes used to justify it.

Table 2
Minimum evidence needed to claim reduced deforestation pressure

Evidence domain	Core question	Illustrative measures	Interpretive safeguard
Land-cover baseline	What occupied the site before intervention?	Verified natural forest, secondary forest, fallow, farm or severely degraded land	Exclude natural-forest conversion from restoration or agroforestry gains
Forest outcome	Did conversion or degradation decline?	Natural-forest area and condition; fire; extraction; matched or modeled counterfactual	Report uncertainty and separate avoided loss from new tree cover
Ecological trajectory	What kind of tree cover developed?	Native composition, functional groups, recruitment, structure, soil and carbon pools	Do not infer biodiversity from canopy or richness alone
Livelihood outcome	Is management durable and equitable?	Net returns, timing, labor, product rights, food and income diversity, benefit distribution	Disaggregate outcomes and include opportunity and maintenance costs
Displacement	Was pressure shifted elsewhere?	Household land use, commodity sourcing, extraction zones and surrounding-landscape change	Define spatial boundary and leakage period before making causal claims

Conclusion

Agroforestry and rainforestation address different parts of the deforestation problem. Agroforestry can strengthen livelihoods, diversify production and improve the ecological quality of agricultural matrices. Rainforestation can rebuild native-tree structure and recovery processes on degraded sites where active restoration is justified. Both can contribute to a more resilient tropical landscape, but neither replaces the carbon, biodiversity and ecological memory of intact or recovering natural forest.

Their effectiveness depends on sequence and placement: protect first, enable natural recovery where possible, restore actively where necessary, and integrate trees into established production systems where they are economically and socially viable. Secure tenure, native seed systems, long-term extension, product rights, coherent policy and landscape-scale monitoring determine whether planted

trees persist and whether forest pressure actually declines. Framed this way, the Philippines' experience with rainforestation and diverse agroforestry is not a universal template but a valuable foundation for comparative learning. The policy objective should move beyond counting trees toward maintaining forests, rebuilding native ecological function and improving livelihoods without shifting environmental costs elsewhere.

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