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Biodiversity Conservation, Ecosystem Services and Livelihoods in Tropical Landscapes: Towards a Common Agenda

Götz Schroth · Jeffrey A. McNeely

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Abstract Trade-offs between ecosystem conservation and agricultural production can more easily be addressed by shifting the view from the plot scale to the scale of the landscape and integrating biodiversity friendly land use systems into development strategies. The provision of ecosystem services such as watershed protection and carbon sequestration by natural and complex agro-ecosystems can play an important role in making such integrated landscape approaches viable. This special issue brings together papers that were presented at a symposium on agroforestry and landscape scale conservation at the Second World Agroforestry Congress in Nairobi in August 2009. It is divided into two sections focusing on: (1) the biological mechanisms and implications of landscape scale conservation strategies as influenced by land use, especially agroforestry; and (2) the economic drivers and public policies that determine to a large extent the success of agroforestry-based landscape conservation strategies. The contributions provide evidence both for the potential and limitations of agroforestry in landscape scale conservation and development strategies and highlight the importance of economic incentives and policies to promote integrated landscape solutions. This introductory paper summarizes and discusses the contributions and concludes with policy recommendations and research needs.

G. Schroth (✉)
Mars Incorporated and Federal University of Western Pará, CP 513, 68109-971 Santarém, Pará, Brazil
e-mail: goetz.schroth@effem.com

J. A. McNeely
International Union for Conservation of Nature (IUCN), Gland 1196, Switzerland

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Introduction

Economic growth and development often occur at the expense of natural ecosystems, especially in tropical countries where forests are a tantalizing and lucrative source of land for conversion to other purposes. Conversely, the conservation of biodiversity and natural ecosystems is often perceived as restricting options for human development, or even destroying the livelihoods of the communities living as part of these ecosystems (see Burnham 2000, and Richardson 1976, for examples). What are the dimensions of this perceived conflict, and how can the various interests reach mutually agreeable outcomes? How can conservation-friendly land use practices help in harmonizing conservation and development?

Already, conservation concepts are increasingly moving beyond the traditional, strict division between managing protected areas for biodiversity by excluding or minimizing human influence on one side (Terborgh 1999) and managing lands to produce goods to support human development on the other (Kok and others 2009). As a result, this conflict between conservation and development objectives is decreasing in many places (Perfecto and others 2009), though by no means everywhere. Protected areas that also provide livelihoods for their human inhabitants are expanding globally, notably in Latin America (Amend and Amend 1995), while it is increasingly recognized that under certain conditions, agricultural landscapes can contribute significantly to the conservation of threatened species and ecosystems (Collins and Qualset 1999; Jackson and Jackson 2002; Schroth and others 2004).

However, the economic and ecological viability of both inhabited protected areas and of conservation-friendly agricultural landscapes depends on land use systems and patterns that combine agricultural productivity and profitability with critical habitat functions. Agroforestry, comprising a wide range of land use practices that combine trees and crops in space or time within the same farm or landscape, has been advocated as a flexible concept able to reduce the conflict between conservation and production goals (Schroth and others 2004), though many questions remain open, including about the practical implementation of such concepts. Also, in the search for land use practices that meet these multiple requirements, the focus is shifting increasingly from the plot or farm scale to the scale of the landscape. While at the plot and farm scale certain trade-offs between agricultural productivity and conservation friendliness may often be unavoidable, examples have shown that landscapes can be created (or recreated) that accommodate agricultural production and conservation objectives through the right combination and spatial arrangement of natural habitat with production areas under conservation friendly management (McNeely and Scherr 2003; Cassano and others 2009; Fisher and others 2005). Landscapes where production and conservation goals seem to coexist in relative harmony often include an important or even dominant agroforestry component (Cassano and others 2009; Schroth and others 2003).

People manage ecosystems in order to gain more benefits from them. A critical element in the approach of integrating conservation and livelihood improvement within landscapes is therefore to add the concept of "ecosystem services" to concerns about biodiversity and land productivity. Ecosystem services are "the direct and indirect contributions of ecosystems to human well-being" (Kumar 2010). This concept became part of the mainstream with the publication of the Millennium Ecosystem Assessment (2005) that classified ecosystem services into four groups: supporting services; regulating services; provisioning services; and cultural services (Table 1). McNeely and others (2009) have produced a popular version aimed at a broader audience. Ecosystems are essential to human well-being. They have provided the processes of nutrient flow, supported the predator-prey interactions that helped drive evolution, and even generated the current atmosphere that supports life on Earth. All life depends on such processes, becoming "functions" or "services" as they directly benefit humans or these benefits are recognized. The concept of "ecosystem" highlights the importance of interactions between elements of biodiversity—at a range of scales—and interactions between living species and the non-living environment. No single "piece" from a system can provide critical services such as soil and water conservation, biological pest control and climate regulation alone, independent of such interactions. The focus on ecosystem services thus provides a powerful justification for conserving ecosystems and their biodiversity at the landscape scale.

As tree-based land use systems, agroforestry systems are structurally closer to natural forest ecosystems and are often able to retain more of their ecosystem functions than do monoculture crops. This is particularly obvious for carbon sequestration in the biomass (Schroth and others 2011a), but certain agroforestry systems have also been shown to benefit predator and pollinator organisms (Tscharntke and others 2011) and their soil and water conserving properties may allow cropping on slopes that would be considered unsuitable for conventional farming (Schroth and Sinclair 2003). Agroforestry systems based on native trees have also been shown to retain considerable quantities of native biodiversity and to support conservation in embedded forest fragments within an agroforestry landscape (Cassano and others 2009; Schroth and others 2011b). Agroforestry could thus be seen as an ideal form of integrating ecosystem conservation and agricultural production within the same landscape (Schroth and others 2004).

However, many questions remain concerning both the scientific foundations and the practical implementation of such agroforestry based landscape conservation approaches. How susceptible are agroforestry systems to invasive species and how does this affect their ability to host native species? How much natural forest is needed in agroforestry landscapes and how should it be arranged to maximize the conservation of species and ecosystems? How should agroforestry systems be managed to maximize their biodiversity without sacrificing production? How can conflicts among native species, humans and their crops be managed in such "conservation-friendly" landscapes? How do agroforestry landscapes, their species assemblages and ecosystem functions change over time? What policies and incentives are effective in promoting the use of biodiversity-friendly agroforestry practices and maintaining the integrity of landscapes? What can we learn from the past, and how do new and expanding approaches, such as carbon trading and certification, perform in practice?

In this special issue, we bring together a selection of papers that were presented at a symposium on agroforestry and landscape conservation strategies held as part of the Second World Agroforestry Congress in August 2009 in Nairobi, Kenya. Seeking better understanding of the many relationships among biodiversity conservation, ecosystem services and human well-being at the landscape scale, the symposium was divided into two sections focusing on: (1) the biological mechanisms and implications of landscape scale conservation strategies as influenced by land use, especially agroforestry; and (2) the economic drivers and

Table 1 Groups of ecosystem services and their main characteristics (after Millennium Ecosystem Assessment 2005)

Groups of services	Description
Supporting services	Those ecosystem processes necessary for the delivery of all other ecosystem services—and, indeed, life on Earth itself. Arguably the most fundamental of these is primary production, the biochemical process through which living things produce organic compounds from energy and carbon dioxide. Its main pathway is through the capture of energy from the sun by plants, algae, and cyanobacteria through photosynthesis. The other major supporting service is that of nutrient cycling of carbon, nitrogen, phosphorus, and sulfur (and other elements including iron and silicon) between the land, water, and the atmosphere. The presence of these nutrients is essential in maintaining ecosystem productivity, but in excess they can be damaging pollutants that reduce ecosystem productivity and threaten human health
Regulating services	The benefits that humanity obtains from the natural regulation of ecosystem processes. Enormous investment is focused on the regulation of climate and air quality, given the damage caused by human-driven atmospheric pollution by greenhouse gases from burning fossil fuels, growing crops and livestock, and clearing forests, and of the importance of air quality regulation more generally. Similar waste-processing services are also essential in maintaining the quality of waters and soils through erosion control and detoxification. Intact and functioning ecosystems provide great value in mitigating the effects of catastrophic natural events (e.g., landslides, earthquakes, floods, and tsunamis) and helping people to cope with disasters. Other regulating services derive from the ecological interactions between species. These include pollination (which supports a third of the world's agricultural output), natural limitation and biological control of pest species, and the regulation of waste and human diseases
Provisioning services	The products obtained directly from nature. Intact habitats are fundamental in maintaining surface fresh water, which represents a mere 0.02% of the world's water overall. Other important provisioning services are provided by direct harvest from ecosystems, including hunting and gathering of a range of species, marine and freshwater fisheries, and the harvest of plants for timber, fuel, fiber, and medicines. The same processes are replicated for domesticated species through pastoralism, agriculture, and aquaculture. The production of biomass fuel, from firewood and charcoal, from grain ethanol, and from animal dung, could be considered another provisioning service. Nature also provides the basis for biotechnologies through genetic resources
Cultural services	The non-material benefits that humanity derives from biodiversity, including educational, recreational, and ecotourism benefits as well as aesthetic and scientific ones, cultural identity with ecosystems, and spiritual and religious values. These values may provide some of the strongest rationales for maintaining healthy ecosystems and, indeed, for human well-being overall

public policies that provide the context and determine to a large extent the success of agroforestry-based landscape conservation strategies. We recognize that there is a large gap between these two important fields of research, focusing on the scientific underpinnings of conservation landscapes on the one hand, and the success of public policies in promoting their implementation on the other. This gap needs to be filled by the very practical, on-the-ground work of extension and community-based approaches in order to translate science and policy into practice. Unfortunately, this practical aspect of landscape scale conservation is receiving less research attention than it would deserve.

Here we provide an overview of the symposium presentations and discuss their main implications for the management of landscapes for conservation and agricultural production as well as the design of conducive policies and incentive systems. We conclude with recommendations and suggestions for further research.

Overview of Contributions

In the first paper of the first section, Jaclyn Hall and coworkers compare cardamom agroforests and protected forests in the East Usambara mountains in Tanzania with regard to their ability to maintain the floristic diversity of local forest species. Although they find a substantial diversity of native trees in active and abandoned agroforests, these land uses (as well as logged secondary forests) are susceptible to invasion by an exotic tree species, *Maesopsis eminii*, that also seems to be favored by local farmers, possibly in part because no restrictions have been placed on its use as there are for native species. The study suggests that agroforestry can play a positive role in the restoration of deforested land in the region, but that the ability of the landscape to conserve its floristic diversity critically depends on intact natural forest.

In the next paper, Leonardo Oliveira and coworkers analyze the ability of the shade cocoa agroforests ("cabrucas") that occupy a large part of the landscape of southeastern Bahia, Brazil, to serve as habitat for an endemic primate species, the golden-headed lion tamarin (*Leontopithecus chrysomelas*). They also discuss the characteristics of these cocoa farms that influence their habitat quality for this species. Although earlier research had suggested that these primates depend on access to forest and use shade cocoa systems only as additional habitat, the data presented here show that some groups of lion tamarins live and thrive in cabrucas without access to natural forest, probably because of the high density of food tree species including the exotic jackfruit (*Artocarpus heterophyllus*). These findings are of great importance for the survival of this endangered primate species in a landscape where natural forests have widely been replaced with shade cocoa plantations, and also highlight the important role that agroforests can play in the conservation of species that can tolerate a certain level of disturbance. More research on the structural and management conditions that determine the habitat value of cabrucas for this and other forest species is needed in order to enable the design of incentive systems (such as biodiversity friendly labels and environmental service payments) to conserve and promote such conditions, including when management practices are intensified.

But some conflicts with wildlife may be inevitable in "biodiversity friendly" agricultural landscapes. In the next paper, a team led by Payal Bal discusses the nature of human-elephant conflicts in the coffee agroforestry landscape of Kodagu District, India. They show that shade coffee plantations are used by elephants (*Elephas maximus*) as conduits between fragments of natural forest, leading to crop damage and occasional harm to humans. Considering the complexity of the problem, the authors propose a combination of deterrents, insurance schemes for crop damage, and incentives such as an "elephant friendly" label that would also help to raise the tolerance of local people towards the elephants. This paper also highlights the double-edged nature of the role of complex agroforests as wildlife friendly habitat and corridors, especially where this includes large and potentially dangerous species.

The fourth paper addresses the challenges in conserving another dangerous species while seeking to use its traditional habitat to yield greater human benefits. Muhammad Ali Imron and his colleagues apply a modeling technique to analyze the habitat conditions in landscapes variously composed of agroforests and monoculture plantations in the surroundings of a protected area that supports a substantial population of the Sumatran tiger (*Panthera tigris sumatrae*). Ironically, success in conserving such a species leads to an expanding population that can outgrow the protected area, especially when its prey species, such as deer, monkeys, and wild pigs are also wide-ranging. This can lead to conflicts with people living around the protected area, even though tigers are also helping to control other mammals that destroy crops. Using an individual-based model to describe the life history of the tigers as a function of landscape composition, Imron and others show that the probability of survival of the tigers is higher in a landscape including agroforests than in a landscape dominated by monoculture plantations with their lower prey density in the surroundings of the protected area.

In the final paper of the first section, Valentina Robiglio and Fergus Sinclair discuss the role of the shifting cultivation landscape in Southern Cameroon in the conservation of plant biodiversity. They show that with increasing intensity of agricultural use and proximity of the market, the potential of shifting cultivation landscapes to conserve and restore forest biodiversity and serve as conduits between less disturbed forest patches within the landscape for forest biodiversity declines. They also show that the proximity to forest is a strong determinant of the composition of fallow vegetation, suggesting that strategies to manage shifting cultivation landscapes simultaneously for livelihoods and conservation need to be spatially explicit in order to maximize positive spatial interactions between forest remnants and regenerating vegetation within the landscape.

In the first paper of the second section, Gockowski and Sonwa discuss environmental and productivity trade-offs between agroforestry systems versus intensified full sun production systems in smallholder cocoa production systems in West Africa. A particular focus of their paper is the question of whether agroforestry systems with low productivity increase or reduce the overall levels of global environmental goods such as sequestered carbon and biodiversity as compared to higher yielding intensified systems when the whole forest landscape is considered. An important conclusion of their work is that crop production systems need to be intensified early in their development and that this intensification needs to be accompanied by stringent forest conservation policies, thereby avoiding unnecessary expansion of low-productivity land uses into forest rather than intensifying only once the lack of remaining forest land makes intensification unavoidable. They also outline a strategy for the "ecological intensification" of the cocoa landscape of West Africa through the combination of higher use of inputs (such as fertilizer) with the promotion of agroforestry practices, using carbon markets to create additional incentives for adopting more sustainable land uses.

The topic of carbon markets as a mechanism to promote the restoration of degraded land and generate benefits for local communities is taken up by Douglas Brown and coworkers in their discussion of the experiences of a Clean Development Mechanism project in Ethiopia. A key feature of this project is the use of farmer managed natural regeneration as a cheap and rapid restoration method that helped farmers obtain non-timber forest products within 1–3 years from project initiation as well as a focus on community empowerment for the sustainable management of natural resources through the establishment of user rights and cooperatives. An important lesson from the project is that even where direct benefits such as non-timber products are the main motivation behind community led ecosystem restoration, carbon markets may serve as an important catalyst and help to engage stakeholders including communities, governments and civil society in restoration programs.

In the third paper of this section, Laurent Pfund and coworkers discuss the question of whether agroforests are an effective means to maintain biodiversity and ecosystem services in agricultural landscapes or rather a driver of forest conversion, using results from case studies in six countries of Asia and Africa. They find that in their Asian case studies, biodiverse agroforests are rapidly being replaced by more intensive agricultural systems driven by national development policies, while signs of similar changes are emerging at the African sites. The appreciation of local stakeholders for biodiversity conservation was much lower than that for other ecosystem services such as watershed conservation, highlighting again the significance of a broad range of ecosystem services as a conduit for biodiversity conservation in landscape mosaics, as well as the need for targeted policies and incentives to promote land uses that conserve the full range of these services.

Sylvie Guillerme and coworkers then discuss the impact of public policies on agroforestry and other land use practices in Kerala, India, from a historical perspective. They show that in this state which has a strong agroforestry tradition, public policies have tended to lead to a simplification of traditional agroforestry systems and a replacement of multi-species systems with monocultures. For example, restrictions on the felling of some timber trees have provided a disincentive to farmers to retain and plant such trees. The authors argue that public policies should place a greater emphasis on diverse agroforestry practices considering that these play an important role for the subsistence of poor people and—as other papers in this volume show—generate important ecosystem services from the landscape.

In the final paper, Edward Millard discusses recent trends towards greater sustainability within commodity supply chains, such as those of coffee and cocoa, where markets increasingly require proof of best practice in production and trading of commodities in the form of certification. This often implies the use of agroforestry approaches both at the plot scale (especially when shade trees are required) and at the landscape scale (by requiring riparian buffers and prohibiting deforestation in some areas). Certified products are thus gradually leaving their traditional "boutique niche" and are becoming mainstream. While this is an obvious opportunity for landscape scale conservation, a challenge will be to keep certification systems flexible enough to take into account the often very site specific conditions under which commodities are grown in the tropical world, and to ensure that benefits for the farmers outweigh costs.

Discussion and Policy Implications

The contributions in this volume show both the great potential and the limitations of agroforestry in landscape scale conservation. Some endemic and endangered species do very well in agroforestry systems, as is the case with golden-headed lion tamarin in the traditional shade cocoa (cabruca) systems of southeastern Bahia, provided that certain conditions regarding the availability of food trees and other critical resources are fulfilled (Oliveira and others, this volume). For other groups and in other conditions, agroforests are strongly impoverished compared with natural forest (as is the case for the tree flora in the Usambara Mountains in Tanzania) and because of their disturbance, agroforests are more susceptible to invasion and dominance by aggressive non-native species that may also be preferred by local farmers (Hall and others, this volume). This diversity of situations and species responses emphasizes the need to consider agroforests as a landscape element, to be complemented by areas of natural habitat, rather than a stand-alone solution to the problem of conservation in human-dominated landscapes (McNeely and Schroth 2006).

However, the task of managing or promoting agroforests as strategic elements in landscape-scale conservation strategies is a complex one since multiple objectives, often associated with different stakeholder groups, have to be handled simultaneously. This is particularly evident where wildlife poses a direct threat to humans or their crops, as is the case with elephants in coffee agroforests in India, where Bal and others (this volume) speak of a "wicked problem" that has no obvious solution, or tigers in buffer zones around protected areas in Sumatra (Imron and others, this volume; see also Naughton-Treves and Salafsky 2004). These cases highlight the need to achieve a broad consensus among stakeholders on the objectives of landscape management, which may also change over time and require a continuous process of awareness raising, stakeholder negotiation and adaptive management. Concepts of landscape labelling (Ghazoul and others 2009) that build in part on older experiences of landscapes that are simultaneously managed for development and conservation, such as biosphere reserves, might provide a framework for this negotiation and adaptive management process and may help communicate their elements and successes to decision makers and in the marketplace.

Gockowski and Sonwa (this volume) and Pfund and others (this volume) add another layer of complexity to the problem of using agroforestry in the management of landscapes for conservation and development by highlighting the temporal dimension of the progressive occupation of forest landscapes by farms. The important implication of their work is that policies promoting the intensification of farming practices should be implemented early on during the agricultural occupation of a landscape and must be accompanied by and coordinated with forest conservation policies. The alternative is that agricultural intensification happens by necessity when all accessible forest has been converted into low-productivity farming systems, leaving no alternative to intensification to feed a growing population. Importantly, Gockowski and Sonwa show that (moderate) intensification is compatible with the use of agroforestry practices. "Ecological intensification", defined as a form of intensification of land use practices that maintains essential ecosystem services and biodiversity of agricultural systems and landscapes, thus appears to be a way to reduce trade-offs between, on one hand, intensive but biodiversity poor farming practices and, on the other hand, extensive practices that may be more biodiversity friendly on the plot scale but leave no space for natural habitat in the landscape. How to implement "ecological intensification" under a wide range of ecological and socioeconomic conditions requires more research. It is relatively safe to assume that "ecological intensification" will benefit if those components of farming systems and agricultural landscapes that are critical for the provision of ecosystem services and the conservation of biodiversity (e.g., farm trees) also directly contribute to livelihoods, e.g., through timber and non-timber products or through carbon trading (Schroth and others 2011a). "Ecological intensification" requires a broad consensus among stakeholders about the multiple objectives of landscape management, including a close coordination between agricultural, forest and conservation policies, as well as a recognition of the benefits of livelihood diversification as a risk reduction strategy by agricultural policy makers (Guillerme and others, this issue; Pfund and others, this issue).

Various types of ecosystem service markets can play an important role in this emerging concept of multi-functional landscapes that integrate both conservation and livelihoods objectives (Kumar 2010). Carbon markets are widely seen as a tool to reward local stakeholders for landscape conservation and restoration, including as a start-up funding mechanism for "ecological intensification" programs (Gockowski and Sonwa, this volume). However, their benefits may also include a catalytic role by encouraging stakeholders from farming communities, governments and civil society to create a negotiation platform where a common vision of landscape objectives and management are developed (Brown and others, this volume). In this way, the process leading to the design and implementation of carbon projects can be highly beneficial, even if the main direct benefits for the farming communities over the long term are increased supplies of forest products and ecosystem services from restored, intact agricultural and natural ecosystems, rather than carbon payments per se (Brown and others, this volume). These positive expectations and, to some extent, experiences with carbon markets should however not mask the significant barriers for smallholders to access these markets, including their very high overhead costs and the often quite small rewards where these barriers have been overcome (Schroth and others 2011a). Furthermore, there is a risk of carbon markets stimulating fast-growing monocultures of exotic trees unless standards are used that recognize and reward multiple benefits of carbon projects, including for biodiversity and livelihoods.

Eco-certification premiums are another form of ecosystem service payments, so it is good news for tropical farmers that the demand for certified commodities is increasing and that certification is gradually becoming mainstream (Millard, this volume). Generally speaking, it means that more farmers can benefit from price premiums and more sustainable and healthy production practices. However, as with carbon trading, premiums are not the only and may sometimes not be the most important benefit from certification. Equally important is the process of stakeholder engagement and capacity building in agricultural best practices potentially leading to higher per-hectare yields, direct health benefits from the competent use (or avoidance) of agrochemicals, and better quality control in accord with market demand. In fact, in a world where competent technical support to farmers has become a rare commodity, to the extent that "being certified" becomes synonymous with "having regular technical support and training", price premiums may become relatively less important as an incentive to farmers. The more certification moves from working with dispersed farmer groups to landscape units, such as entire communities or agricultural settlements, the more directly will certification criteria and the increased competence of certified farmers in dealing with environmental issues translate into results at the scale of the landscape.

While the rapid expansion of eco-certification systems is thus to be welcomed, it is important that certification systems remain flexible enough to accommodate local conditions and reward site-specific management interventions. For example, practices that create "elephant friendly" conditions in Indian coffee agroforests are most likely different from those that maintain the high biodiversity of cocoa agroforests in Brazil, or that allow farmers to intensify cocoa farms while protecting natural forest in West Africa. The emerging concept of landscape labeling (Ghazoul and others 2009) would be well placed to accommodate such regional differences.

Recommendations and Research Needs

Drawing from these papers, we offer the following recommendations to those working in conservation and rural development. Given the great diversity in landscapes, cultures, demographics, and other critical factors, these recommendations are necessarily broad and will need to be adapted to specific situations.

1. *Plan and implement at the landscape scale*. The research reported in this special issue and elsewhere (Sayer and Campbell 2004), has illuminated the point that sustainability depends on managing relatively large areas of land, with different parts of the landscape delivering different kinds of benefits that together support rural development.
2. *Maintain native forests*, especially along watercourses, on steep slopes, and on ridgetops. These forests provide important ecosystem services that are expensive or impossible to duplicate artificially.
3. In considering development options, *recognize that ecosystem services provide multiple benefits*, only some of which can be quantified (Kumar 2010). While provisioning services may provide the most readily marketable benefits, they depend on the other services being maintained as well.
4. *Recognize that systems are dynamic, and plan for changing conditions*. Climate, population, economics, and many other changes are continuous, while extreme natural events (earthquakes, volcanic eruptions, wildfires, etc.) may be periodic. But successful development is adaptable to such changes, suggesting that boundaries need to be flexible, even for protected areas.
5. *Use native species whenever possible*. While non-native species are sometimes superior in some ways (fast-growing, new products, etc.), they should be selected only after carefully considering whether they will bring negative side-effects (becoming invasive, lowering the water table, threatening native species, etc.).
6. *Develop appropriate incentives that encourage biodiversity-friendly land development*. These can include payments for ecosystem services, price incentives through the use of ecolabels, and many others. The REDD (reducing emissions for deforestation and forest degradation) initiative under the UN Framework Convention on Climate Change is a potentially powerful such incentive, but it should include biodiversity considerations as well (Angelsen 2009) and should make sure that smallholders are not left behind.
7. *Conduct further research on biodiversity conservation and livelihoods in tropical landscapes.* Important issues that require further research include: building better understanding about the relationship between biodiversity and ecosystem services; assessing the impacts on native ecosystems of non-native species used in agroforestry; further exploring the relationships among wildlife, agroforestry, and human well-being; monitoring the effects of REDD + initiatives, with a view to recommending improvements; assessing the effects of ecolabeling initiatives on biodiversity and human well-being; and exploring options for building partnerships that include the private sector to enhance human well-being in ways that conserve biodiversity in rural settings.

The results of this symposium have contributed to our understanding of some of the most important issues facing tropical land management including agroforestry, human well-being, and environmental issues. But in this fast-moving world, constant adaptation will be essential to building a positive relationship between people and landscapes. Research will be a crucial element in helping to ensure that human well-being and biodiversity are at the center of adapting to dynamic conditions.

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