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REVIEWS

Conserving Biodiversity Through Certification of Tropical Agroforestry Crops at Local and Landscape Scales

Teja Tscharntke[1], Jeffrey C. Milder[2], Götz Schroth[3], Yann Clough[1], Fabrice DeClerck[4], Anthony Waldron[5,6], Robert Rice[7], & Jaboury Ghazoul[8]

[1] Agroecology, University of Göttingen, Germany
[2] Rainforest Alliance, 233 Broadway, 28th Floor, New York, NY 10279, USA
[3] Rainforest Alliance, 6708 LT Wageningen, the Netherlands
[4] Agrobiodiversity and Ecosystem Services Program, Bioversity International, Montpellier, 34397, France
[5] Department of Zoology, Oxford University, South Parks Rd, Oxford UK OX1 3PS, UK
[6] Departamento de Ciencias Biologicas, Universidade Estadual de Santa Cruz, km16 Rodovia Ilheus-Itabuna, Bahia, Brazil
[7] Migratory Bird Center, Smithsonian Conservation Biology Institute, Washington, DC, USA
[8] Institute for Terrestrial Ecosystems, ETH Zürich, Switzerland

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Correspondence
Teja Tscharntke, Professor of Agroecology, Georg-August-University, Grisebachstr. 6, D-37077 Göttingen, Germany.
Tel: +49-551-399209; fax +49-551-398806.
E-mail: ttschar@gwdg.de

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Abstract

Voluntary sustainability standards and certification offer a promising mechanism to mitigate the severe negative impacts of agricultural expansion and intensification on tropical biodiversity. From a conservation standpoint, certification of tropical agroforestry crops, especially coffee and cocoa, is of particular interest given the potentially high biodiversity value of agroforestry systems and the substantial market penetration of coffee and cocoa certification in recent years. Here, we review experience with coffee and cocoa certification, summarize evidence on conservation impacts, and explore future needs. While there is much evidence that environmental criteria behind certification support biodiversity conservation, it is less clear to what extent certification is the cause of improved conservation outcomes. Additionally, the farm-scale focus of current certification models may limit delivery of biodiversity conservation benefits, as maintenance of biodiversity depends on processes at larger landscape scales. To address this scale mismatch, we suggest that investment and innovation in certification over the next decade prioritize landscape conservation outcomes. This may be achieved by (1) linking existing certification mechanisms with broader landscape and ecosystem service management approaches and/or (2) expanding current certification models to consider the landscape itself as the certified unit.

Introduction

Agricultural expansion and intensification are the main drivers of the current biodiversity crisis (Norris 2008; Butchart *et al*. 2010; Kleijn *et al*. 2011). At the same time, agricultural landscapes represent an important focus for conservation progress, given that 40% of the Earth's land is under agricultural management (vs. 12% under protected status) and many species depend on the quality of the agricultural matrix (Perfecto & Vandermeer 2010). Accordingly, effective strategies to combine efficient and productive agriculture with biodiversity conservation are needed.

Measures to increase biodiversity in agricultural landscapes often reduce yield or increase costs (Norris 2008). As a consequence, there are often strong disincentives for farmers to adopt biodiversity-friendly practices (Waldron *et al*. 2012). These disincentives might be overcome by economic incentives or internalized by legal obligations. In the developed world, governments have implemented agri-environmental schemes that couple legal obligations and economic subsidies to achieve biodiversity-friendly management in agricultural settings (Cooper & Baldock 2009). Legislation to set aside land for protection also exists in tropical countries, but usually only for large-scale development of, for example logging and oil palm companies. Nonetheless, much tropical agriculture is undertaken in landscapes dominated by smallholder farming where individual land holdings range from less than a hectare to around 100 hectares. On such lands, governments often have limited resources to provide such incentives, and the transaction, administration, and enforcement costs would render such government-sponsored schemes highly inefficient. Yet it is in these landscapes where much of the Earth's biodiversity is located (Hoffmann *et al.* 2012), and where biodiversity-friendly farming practices might be most rewarding. A promising alternative for developing countries with limited institutional and financial capacity is the implementation of nonstate governance approaches and market incentives whereby private companies, consumers, and civil society support conservation-friendly agriculture.

One example of such an approach is the application of voluntary sustainability standards and certification (Potts *et al.* 2014). Sustainability standards are sets of social, environmental, and/or economic criteria that define best practice in primary production, processing, trading, and consumption of goods. These standards are typically adopted voluntarily and paired with compliance verification, traceability, and labels ("eco-labels") to differentiate sustainable products in the marketplace (Milder 2013). Market differentiation presupposes a substantial company or consumer demand for sustainable products. This demand might be reflected in willingness to pay higher prices for products certified as sustainable, or in expectations that certain product lines will be derived only from sustainable sources. Producers may benefit from higher prices for certified products, hence generating an economic incentive to adopt sustainability practices (Ferraro *et al.* 2005), or from securing access to a market from which they might otherwise be excluded. Hereafter, we use the term "certification" to refer to a full set of linked components including sustainability standards, verification, and eco-labeling; see Box 1 for additional detail.

Most agricultural certification schemes include biodiversity protection requirements or address biodiversity impacts (UNEP-WCMC 2011). This is true not only of standards that have an explicit biodiversity focus, such as Smithsonian's "Bird Friendly" coffee certification (Perfecto et al. 2005), but also of standards that include strong foci on social and productivity dimensions of agriculture. In recent years, uptake of agricultural certification (including schemes that are not principally focused on biodiversity) has risen rapidly and now accounts for significant portions of tropical crops such as coffee (38% of global production), cocoa (22%), palm oil (15%), and tea (12%) (Potts *et al.* 2014). Given this rapid increase, and the fact that agricultural certification has been in use for over a decade, it is timely to reflect critically on certification's effectiveness to promote conservation, and to suggest how certification might be adjusted to achieve greater conservation benefit.

In this article, we focus on two major tropical agroforestry crops: coffee and cacao. Coffee and cacao agroforests have received considerable attention from both conservation and certification practitioners due to several factors: (1) their potentially high biodiversity value, (2) the risk of agricultural intensification diminishing that value, (3) the importance of cocoa and coffee as tropical cash crops, and (4) the substantial market penetration of certified products in recent years (Donald 2004; Millard 2011; Tscharntke *et al.* 2011, 2012a; Waldron *et al.* 2012).

Although our interest is in how well certification contributes to biodiversity conservation, there are several necessary intermediate outcomes that certification must achieve to ultimately be effective. One critical step includes acceptance by producers and supply chain actors, such as consumers or product manufacturers. We therefore consider the effectiveness of certification as a conservation tool in three parts. First, we ask how successful certification has been in achieving its proximate market and institutional goals, without which it would simply remain an idea on paper. Second, we review existing evidence on the conservation effects of certification. Finally, we discuss how certification might evolve in the future to help scale up key conservation benefits from the farm to the landscape level, thereby supporting the long-term viability of tropical ecosystems and their services.

Market and institutional effectiveness

When certification first attracted the attention of major environmental advocates in the 1990s, a goal was to transform market systems by establishing certification as a voluntary mechanism that would fill critical gaps in international environmental governance (Steering Committee 2012). In line with these hopes certification has achieved substantial and growing market penetration for key tropical crops in the past few years. Consumer recognition of certification, one potential driver of demand, has also risen to mainstream levels in developed-country markets. For instance, consumer awareness of Rainforest Alliance's green frog label in the UK and Ireland rose from 27% in 2008 to 54% in 2009, and stands between 25% and 50% in other major consuming countries of

Box 1: An overview of certification in practice

The terms *certification*, *eco-certification*, and *eco-labeling* are often used interchangeably to refer to the process of verifying the sustainability of production or business practices relative to a specific standard and then applying a label to differentiate compliant products in the marketplace. However, certification is just one component of a sustainability standards system, and is best understood in view of the entire system. Standards systems are voluntary mechanisms by which producers and companies demonstrate performance according to norms for environmental, social, ethical, or other issues. The systems generally include three key components (Steering Committee 2012):

(1) *The standard itself* defines a set of social and environmental good practices for a specific industry, crop(s), or product(s). It also establishes criteria for compliance (e.g., compliance indicators and a scoring system) as well as implementation guidelines. Standards are generally revised every few years to incorporate new information with the aim to improve effectiveness.
(2) *The compliance verification process* comprises a set of mechanisms to ensure that products commercialized as certified sustainable in fact meet the requirements of the associated standard. At the production-unit level (e.g., farms), auditors assess social and environmental practices and/or performance through on-site inspection, interviews, farm records, and other corroborating information. Integrity of the audit process is generally overseen by independent, third-party accreditation bodies. Traceability systems (chain-of-custody) track certified products from origin to point-of-sale to ensure that only certified products are sold as certified. In the case of crops grown by smallholders (as much coffee and cacao are), certification is usually awarded at the level of a producer group or cooperative. The group is responsible for ensuring that all of its members comply with the sustainability standard, and such compliance is verified by external auditors, usually by visiting a sample of member farms.
(3) *Sustainability labels (eco-labels)* or other means of communication may be used to differentiate sustainable products at the consumer level. While most standards systems have their own labels, certified products are not always labeled as such at the consumer level, but may still be differentiated in business-to-business transactions. As anyone involved in day-to-day purchases can attest, eco-labels have proliferated in a number of sectors in recent years.

In addition to these core components, standards systems generally involve a wider set of stakeholders and partners that provide training, technical assistance, and other support to assist producers in attaining certification. These associated functions are often critical in the context of smallholder agriculture, where farmers may have the interest but not the means to comply with sustainability standards without such technical support.

Finally, standards systems engage in monitoring and impact assessment to understand the degree to which the system is delivering the sought-after sustainability gains and to inform continual improvement of the system (ISEAL Alliance 2010a). In practice, the effects of standards systems on social, economic, and environmental outcomes are likely to flow from all of the system components (including training and technical assistance) acting in synergy—making it difficult to disentangle the effect of any single component.

From the standpoint of governance, certification falls into three categories, ranging from first party to third party. First-party systems are based on self-assessment (e.g., by a company) whereas second-party systems are governed by interested groups such as industry associations. Third-party certification involves external, independent groups charged with rule making and compliance evaluation (Steering Committee 2012).

North America and Europe (Rainforest Alliance 2012). These outcomes are important tactical successes for certification, given that strong market penetration is a prerequisite for (although not a guarantee of) the large-scale delivery of conservation benefits.

Despite this recent success in tropical crop certification, consumer-driven demand for specific sustainability credentials, particularly environmental credentials, remains thin. Instead, much of the recent demand for certification of products such as cocoa and tea stems from corporate managers seeking branding advantages or economic risk reduction (SAI Platform *et al.* 2013). Although the advantages of branding propel eco-labeling, the market differentiation by an eco-label could be eroded if the label is widely used. On the other hand, a critical mass of uptake may serve to establish certain standards as a new norm acceptable by industry, thereby pressuring laggards also to improve their performance.

Further, there is potential tension between efforts to scale up certification and efforts to increase the rigor of social and environmental standards. If rigorous standards significantly increase the cost of production without compensating benefits, then fewer farmers or companies will find them worthwhile. The risk to rigorous standard systems is not only that market actors could try to water down such standards (if they are perceived as being too costly) but that they would abandon rigorous standards altogether and pursue sustainability objectives through weaker standards, other channels, or not at all. Indeed, as major food companies develop their sustainability initiatives, many are relying on a variety of strategies, including independent or internal standards, policies, and verification systems (e.g., Unilever 2013). The choice among these options hinges on a variety of factors, with cost and value being salient; "greenwashing" is a risk as companies seek to achieve sustainability outcomes (or the public perception thereof) that will satisfy their stakeholders without carrying major new costs. A more subtle tension pertains to the spatial location of crop certification. Whereas conservation-driven targeting might prioritize certification where it is best suited to mitigate specific conservation threats (e.g., forest encroachment or water pollution), current spatial targeting of certification is heavily market-driven and apt to focus on areas with attractive agronomic or supply chain attributes as well as low social and environmental risk.

An additional key intermediate outcome required to attract and retain farmer interest is to make certification more economically attractive than business-as-usual (Priess *et al.* 2007; Steffan-Dewenter *et al.* 2007; Waldron *et al.* 2012). Economic benefits may come in the form of higher net income, reduced vulnerability to environmental change, or other measures of net wellbeing (Waldron *et al.* 2012). A review by Blackman & Rivera (2011) identified 13 evaluation studies of socioeconomic effects of coffee certification with rigorous or moderately rigorous design, of which only two reported significant social or economic benefits. However, more recent studies suggest that the benefits of certification extend beyond the price premiums normally studied. For example, certification may support improved agricultural management, market access, and crop quality, which all can increase farmer income (Clough *et al.* 2011; Rueda & Lamblin 2013).

Farmers are more likely to benefit from certification if costs can be better controlled and distributed. Farmers themselves often bear the cost of certification audits, although other supply chain actors (such as commodity traders) sometimes underwrite these costs as well as investments in training to help farmers achieve certification. Burdens may be proportionately greater for smallholders, and many of the economic benefits of certification may be captured by end-sellers or intermediaries rather than passed down to farmers. A more equitable approach might recognize that the demand for sustainability is strongly associated with the brand, retailer, and consumer ends of food value chains, and therefore distribute certification costs accordingly.

Some of these challenges could be remedied through incremental adjustments to standard systems and sustainable supply chains, whereas others are more endemic to existing certification models. What seems likely is that increasing numbers of companies that source shade-tolerant tropical crops will develop sustainability strategies to guarantee future product supplies, reduce economic risk, improve public perception, and pursue brand advantages (ISEAL Alliance 2010b).

Conservation effectiveness

Evidence on the conservation effectiveness of certification can be generated at two levels: indirect evidence (proof of concept) and direct evidence (proof of outcome). With a few exceptions, coffee and cocoa certification standards do not specify the level of biodiversity conservation that must be achieved but rather require sets of improved practices that are hypothesized to benefit biodiversity. Because it is predicated mostly on practices and not outcomes, certification itself generally cannot be taken as direct evidence of conservation effectiveness.

Indirect evidence of conservation benefit is based on a two-part test: (1) that certification has resulted in the adoption of putatively conservation-friendly practices (see examples in Table 1); and (2) that such practices deliver conservation benefits compared to alternative practices. Regarding the first part of the test, there is accumulating evidence of conservation-friendly practice adoption in certified coffee and cocoa systems. For instance, Blackman & Naranjo (2012) found that organic coffee certification in Costa Rica significantly reduced chemical input use and increased adoption of environmentally-friendly management practices. Rueda & Lambin (2013) found improvements in environmental management by Rainforest Alliance coffee certification in Colombia and Martinez-Torres (2008) found improved soil and shade management on certified organic versus uncertified farms in Chiapas, Mexico. Regarding the second part of the test, extensive research has documented both benefits and limitations of improved agricultural management to support conservation goals. For instance, De Beenhouwer *et al.* (2013) provide in their meta-analysis evidence of both biodiversity and ecosystem service benefits of shaded coffee and cocoa agroforestry compared to unshaded systems (Figure 1; Perfecto et al. 2005). Bhagwat *et al.*

Table 1 Examples of biodiversity-friendly criteria contained in some existing certification systems for tropical agroforestry crops

Certification criterion	Farm scale	Landscape scale
High shade tree density in agroforestry crops	X	
High shade tree diversity in agroforestry crops	X	
Multiple vertical strata in shade canopy trees	X	
Prioritization of native shade trees over exotic species	X	
Protection of associated natural vegetation such as epiphytes	X	
Prohibitions on using highly toxic pesticides (or, for some standards, any synthetic pesticides)	X	
Requirements to protect or restore residual natural ecosystems on certified farms	X	
Restrictions on hunting, harvesting threatened plants, and holding wild animals in captivity	X	X
Maintenance or restoration of natural ecosystem connectivity through certified farms, e.g., wildlife corridors	X	X
Maintenance of vegetated riparian buffers	X	X
Prohibition on destroying or degrading primary forest or high conservation value areas	X	X
Requirements to avoid negative impacts on nearby protected areas, reserves, or biological corridors		X

(2008) reviewed species richness and community composition of (uncertified) agroforests in comparison to old-growth forests, finding substantial evidence for the conservation value of agroforests, with high species richness and often high floristic and faunal similarity. However, the habitat value of diversified agroforestry systems is limited, as many species of conservation concern are unlikely to use disturbed habitat at all (Mas & Dietsch 2004; Maas *et al.* 2009; Waltert *et al.* 2011).

Direct evidence of conservation effectiveness requires monitoring certification (and its associated practices) with respect to its actual contribution to the maintenance or restoration of key biodiversity. While such direct evidence is generally of great interest, it is much more scant. For instance, a 2011 review found twenty empirical studies on the impacts of coffee certification, but only six of these focused on measures of biodiversity, with only half of these six judged to be moderately rigorous and with inconclusive results (Blackman & Rivera 2011). Several additional studies have examined conservation effects of coffee certification, with a focus on the Rainforest Alliance system. In El Salvador, Rainforest Alliance certified coffee farms were associated with higher migratory bird survival rates than noncertified coffee farms (Komar 2012). In other comparisons, however, the certified farms performed similarly to randomly-selected technified, noncertified coffee farms. In Colombia, Rainforest Alliance certified coffee farms displayed healthier riparian zones, higher levels of pollution-sensitive aquatic macroinvertebrates (at one of two sites studied), and higher soil arthropod species richness than comparable nearby uncertified farms (Hughell & Newsom 2013). In Ethiopia, researchers found that forests with Rainforest Alliance certified shade coffee were less likely to be deforested than forests without coffee; in contrast, forests with uncertified coffee were no less likely to be deforested than forests without coffee (Takahashi & Todo 2013).

Hence, there is system-specific evidence of certified farms being more biodiversity friendly than noncertified farms, and little or no evidence of negative conservation impacts. However, the overall evidence base is far from adequate in either extent or methodological robustness to draw generalized conclusions about the conservation benefits and additionality of agroforestry crop certification. Studies have rarely been designed to evaluate whether certification is more a cause of (newly adopted) conservation-friendly management or a result of (pre -existing) conservation-friendly management. While researchers are increasingly recognizing the need to develop credible counterfactual scenarios and account for self-selection bias when evaluating certification impacts, there are rarely perfect solutions to these methodological challenges. Future research should be designed with these issues in mind to evaluate whether conservation outcomes are attributable to certification, not merely associated with it.

Challenges and opportunities to deliver landscape-scale conservation benefits through certification mechanisms

Although coffee and cocoa certification have risen well beyond their previous niche market status (Millard 2011), there are important challenges for traditional certification approaches that need to be addressed if certification is to deliver robust benefits for biodiversity. Some of these challenges stem from a spatial scale mismatch: the incongruence between the scale at which farm management typically occurs and the scale at which key desired benefits are delivered (Tscharntke *et al.* 2005,

Figure 1 Shade coffee agroforestry (A, B) in contrast to unshaded sun coffee (C, D). Photos by Robert Rice (shade coffee: Nicaragua and Peru sun coffee: Costa Rica).

2012b; Ghazoul *et al.* 2009; Edwards & Laurance 2012; Fremier *et al.* 2013). Currently, certification generally occurs at the unit of a single plantation or a group of smallholder farmers. In the smallholder case, although certificates often cover hundreds or thousands of hectares, participating farms are not necessarily contiguous, and may be widely dispersed and intermingled with uncertified farms. Such heterogeneity may limit benefits for landscape processes such as biological connectivity, watershed functions, and other ecosystem services (Holzschuh *et al.* 2008; Estrada & DeClerck 2011).

Another challenge is the global nature of many certification standards, which typically consist of a core generic standard that may have difficulties doing justice to the highly variable conditions under which crops are produced across the tropics. While some standards provide local adaptation guidelines, these rarely cover all aspects of the standard. For example, criteria about minimum species richness of an agroforestry tree canopy may be ambitious in one region but far below common practice in another one (Neilson *et al.* 2010). Similarly, requirements for the quantity and type of natural habitats conserved or restored on certified farms are usually the same everywhere, even though conservation-friendly landscape design recommendations differ considerably between established agricultural landscapes and forest frontier settings (Lindenmayer *et al.* 2008; Schroth *et al.* 2011). At global scales, conservation of the genetic centers of crop origin (so-called Vavilov centers of diversity) could be encouraged through certification, for example, in the case of the wild coffee populations in the understory of Ethiopian forests and wild cacao in Mesoamerica. Certification efforts for *in situ* conservation of crop genetic diversity in centers of origin can in some cases be associated with the conservation of indigenous or traditional practices in crop centers of origin. For example, Payments for Agrobiodiversity Conservation Services (PACS) have been successful for supporting *in situ* conservation of crop genetic diversity (Krishna *et al.* 2013).

Third, the monitoring and attribution of conservation outcomes are complicated if certification is implemented on dispersed farms and biodiversity dynamics beyond the farm scale are poorly understood. Advances in remote sensing and models of landscape connectivity can facilitate better understanding of interactions among farms, targeting specific farms or landscape regions where certification would have greater conservation benefits. Finally, there are few instances where agricultural certification has been effectively integrated with other large-scale plans including carbon and watershed payments (Ghazoul *et al.* 2009; Schroth *et al.* 2011; Cortina-Villar *et al.* 2012).

We suggest two ways to address these challenges: (1) linking existing certification mechanisms with broader landscape approaches (Sayer *et al.* 2013; Milder *et al.* 2014) that foster greater complementarity between farm-based certification and landscape-level management; and (2) adapting current certification models to consider the landscape itself as the certified unit and to award certification based on the achievement of key outcomes at this scale (Ghazoul *et al.* 2009).

Under the first approach, certification of production areas would be more effectively targeted, and coordinated with other conservation actions such as improved reserve management, law enforcement, and payment for ecosystem services to support entire landscapes that are conservation-friendly and that provide multiple benefits to local communities (Kessler *et al.* 2012). In this way, certification would contribute conservation value to certain parts of the agricultural mosaic, complementing other strategies to mitigate biodiversity threats on adjacent lands. Such complementarity can be achieved through a variety of mechanisms, including new partnerships between certification bodies, companies, conservation organizations, municipal leadership, and government agencies, as well as the incorporation of certification into local spatial planning or regulatory frameworks. Such integrated approaches targeting entire communities or larger spatial units are particularly advantageous where a high percentage of compliance is needed to achieve the desired conservation outcome (Schroth *et al.* 2011).

Ecosystem service management contributes to this first approach by underscoring the provision of landscape-wide services both to and from certified production systems. Recent studies demonstrate that managing tree cover in agricultural landscapes can influence pest control by limiting the movement of coffee pests (Avelino *et al.* 2012), or creating habitat for pest predators (Johnson *et al.* 2009; Karp *et al.* 2013; Maas *et al.* 2013; Wielgoss *et al.* 2014) with measurable impact on pest densities and crop yield. Similarly, adjacent forest provides pollination and yield increases in coffee plantations (Ricketts *et al.* 2004; Priess *et al.* 2007). Managing for biological connectivity may help ensure access to coffee and cacao plantations by the species that contribute pollination and pest control services. Certification may also support other ecosystem services from production areas, such as carbon storage, water purification and water flow regulation (Estrada & DeClerck 2011; Tscharntke *et al.* 2011; Kessler *et al.* 2012). Water-based ecosystem services are strongly dependent not only on the characteristics of a specific farm (certified or not) but also on landscape location and surrounding context (as are conservation benefits). Securing these services requires collective action that extends beyond the practices of single farmers. The delivery of ecosystem services is a compelling justification for landscape-scale approaches to certification (Ghazoul *et al.* 2009).

Under the second approach, standards for sustainable landscape management could be defined locally—following regional or global standards frameworks—to address the highest-priority threats to biodiversity, ecosystem services, and other critical issues in any given landscape. Local legal and planning mechanisms as well as environmental service reward schemes could be used to complement and partly substitute supply chain premiums that have often been found to provide insufficient incentives for sustainable practices. Certification of a landscape would entitle many or all of the crops produced in that landscape to claim certified status. In addition, where commodities lend themselves to single-origin marketing, certification could contribute to the branding of unique products associated with specific locales (Ghazoul *et al.* 2009). There are several precursors to such a system, including Biosphere Reserves and Geographic Indications, each of may be used to recognize products produced in a sustainable manner.

Conclusions

Agricultural expansion and intensification are the leading causes of global biodiversity loss, and certification of tropical crops is a promising mitigation strategy. We have described procedures and trends for certification of tropical agroforestry crops and reviewed available evidence for the effects of certification on biodiversity conservation. Certification of tropical agroforestry crops is now well established, and a major success in the past decade has been significant uptake and acceptance by farmers, food companies, and retailers. This suggests the strong potential of certification to deliver conservation benefits, but there is often only indirect evidence of positive biodiversity effects. In addition, most certification schemes do not explicitly aim at biodiversity conservation as a major goal, yet do include important safeguards of biodiversity conservation benefits. Conservation evidence on a local scale is important, but there is a need to better consider the dominant role of landscape-scale processes on sustaining biodiversity. Integrating certification into landscape approaches—through modifications to existing systems as well as development of new types of certification models—could greatly help in tying improved farm management practices more strongly to landscape conservation. We recommend that such landscape-oriented approaches to sustainable biodiversity conservation be a top priority for investment and innovation in certification over the next decade.

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