



Assessing the Ecological Impacts of Agricultural Eco-Certification and Standards

A Global Review of the Science and Practice

Jeffrey C. Milder

Lee H. Gross

Alexandra M. Class



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EcoAgriculture Partners

EcoAgriculture Partners
730 11th St. NW
Suite 301
Washington, DC 20001
Telephone: +001 202 393 5315

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EXECUTIVE SUMMARY

Eco-standards and eco-certification systems for agricultural products have developed and proliferated widely around the world in the past two decades, with an estimated 2010 global market value of US \$64 billion. The rapid uptake of agricultural eco-standards testifies to their value for consumers, producers, businesses, and investors in defining best practices for sustainability and differentiating more sustainable products in the marketplace. However, as agricultural eco-standards mature and grow in scope and scale, there is rising demand for evidence about whether they are indeed achieving their purported social and environmental benefits. Such evidence is needed to strengthen the credibility of eco-standards systems, to demonstrate their impact to various stakeholders, to improve their design and implementation, and to link eco-certification to broader initiatives for social advancement and ecosystem conservation.

In the past few years, corporate as well as non-profit standards-setters have begun to work individually and collectively on the challenges of impact assessment. Increasingly, the eco-standards community recognizes that it is no longer sufficient to assume that the adoption of a set of sustainability standards or best management practices automatically results in the achievement of desired results. Rather, these outcomes and impacts must be measured directly to assess the link between the adoption of an eco-standard and desired conditions or changes on the ground. Historically, this link has been particularly challenging to demonstrate in the domain of environmental impacts, which are often more difficult to monitor or attribute to eco-certification activities than social or economic impacts.

In this context, the International Finance Corporation and EcoAgriculture Partners collaborated to review and assess the science and practice of ecological impact assessment for agricultural eco-standards. The goals of the study were to review current ecological impact assessment activities, methodologies, and tools related to agricultural eco-standards; to understand key opportunities, challenges, and barriers to rigorous ecological impact assessment; and, based on the present situation, to identify ways in which the agricultural eco-standards community could move toward improved impact assessment, accountability, and demonstration of results within the environmental domain.

The study included a literature review of research on the ecological impacts of agricultural eco-standards, as well as a survey of methods and tools for assessing ecological impacts of agricultural practices. It also included interviews with approximately twenty eco-standards practitioners. The study focused on five dimensions of ecological impact: 1) watershed functions and services, including water quantity and water quality; 2) impacts on biodiversity of conservation interest, such as rare and endangered species; 3) impacts on ecosystem composition and function; 4) impacts on soils; and 5) carbon sequestration and greenhouse gas emissions.

Impact Assessment Practices, Methods and Tools

Overall, impact assessment of the environmental effects of agricultural eco-standards has been relatively limited, with most of the work to date comprising one-off research studies as opposed to systematic assessment strategies. We identified a total of 36 past and ongoing ecological impact assessment studies, the focus of which was split roughly equally among the five ecological impact domains listed above. More than two-thirds of these studies focused on eco-certified coffee, with just a few examining cacao, bananas, palm oil, non-timber forest products, and others. The majority of ecological impact assessment work has taken place in the Americas, with only a few studies in Africa or Asia. Assessments of impacts on soils, greenhouse gases, ecosystem composition, and water resources have tended to focus on the certified farm unit itself. However, impact evaluations of biodiversity have tended also to consider farm context or landscape dynamics. Several studies combined data from many farms across a landscape or region with the aim of inferring impacts over larger areas.

There is a wide range of suitable methods and tools available to assess the ecological impacts of agricultural eco-standards and their component best management practices. Some of these methods have already been used in eco-standards impact assessment work, while many more have been developed and applied in other contexts, but could be adapted to support impact assessment efforts. Among the most promising methods and tools for supporting cost-effective impact assessments are environmental proxy measures, calculator tools, and remote sensing tools. Proxy measures have been developed for numerous environmental attributes including soil erosion risk, water quality impacts, nutrient pollution from agricultural runoff, and biodiversity conservation value. Some of these proxies are based on simple field measurements or farm records, while others require more extensive field work, spatial analysis, or modeling.

Calculator tools are computer- or web-based software applications that integrate and process data from multiple sources to generate estimates of specific impacts, such as net greenhouse gas footprint or water quality impacts. By combining data related to farm management and/or basic field measurements with information on a farm's biophysical properties and context, such tools can generate a relatively high level of accuracy through a cost-effective, user-friendly data input interface. Finally, new remote sensing tools combined with geospatial analysis provide a vast frontier of potential opportunities for cost-effective monitoring of ecological impacts of agricultural eco-standards over large areas. For instance, recent work has developed assessment protocols for aboveground biomass, soil erosion or erosion risk, canopy vegetation diversity, and habitat potential for biodiversity of conservation concern.

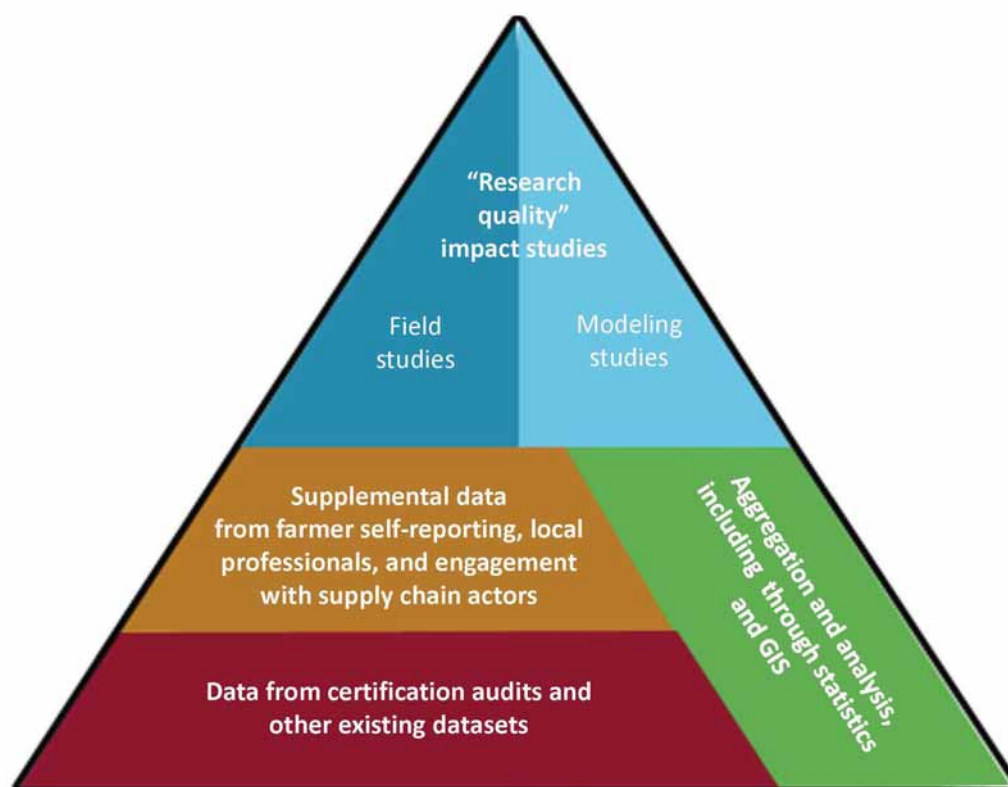
Despite the availability of such promising methods and tools, eco-standards practitioners identified the need for better assessment tools that were specifically tailored to the context of agricultural eco-standards. In practice, this means that tools must be cost-effective, capable of being applied across large areas or supply chain portfolios, well-integrated into existing audit and verification processes, and not too demanding of human resources.

Toward Improved Impact Assessment Approaches and Methods

To meet these goals, the practice of ecological impact assessment for agricultural eco-standards should combine a variety of approaches, data types, and methodologies to strike an optimal balance between relevance for multiple stakeholders, cost-effectiveness, and rigor. To this end, we propose a “pyramid” strategy of approaches to monitor the environmental impacts of agricultural eco-standards.

At the base of the pyramid are efforts to characterize some simple impact measures across much or all of the portfolio of production units or supply chain nodes certified or verified by a particular eco-standard. These assessments are informed by data that are already being collected, including farm-level audit/verification data and existing datasets from other sources, such as government data or satellite images. In many cases, enabling audit data to serve the additional function of impact assessment will require changing how these data are collected, stored, and analyzed. For instance, data could be collected electronically on handheld mobile devices instead of on paper forms, georeferenced through the use of the Global Positioning System within the mobile device, and uploaded to a central data repository for processing and analysis through statistical and spatial analysis.

A second level of the pyramid involves the collection and use of supplemental data from farmer self-reporting, local professionals (including auditors), and supply chain actors. Such data are outside the scope of routine certification audits but may be provided with only a moderate amount of additional effort and cost, relying mainly on local actors. As with audit data, these



data should be collected electronically in a standardized manner, for subsequent aggregation and analysis. For instance, such data could inform the use of calculator tools to assess greenhouse gas emissions, carbon sequestration, soil health, and water quality.

At the top of the pyramid are “research quality” impact studies, which typically require the involvement of a trained scientist. Such studies serve to calibrate and validate the proxy measures and calculator tools on the lower levels of the pyramid. They also evaluate impacts that are more challenging to assess, such as the landscape-level impacts of mosaics of certified farms and non-certified land uses on water quality, water quantity, biodiversity, and other ecosystem services. The agricultural eco-standards community has just begun to collaborate with the scientific research community to conduct such studies, but there are significant opportunities to broaden and deepen the scope of such collaboration.

With the recent proliferation of interest and activity to mainstream monitoring, evaluation, and impact assessment within the agricultural eco-standards field, the present moment offers an excellent opportunity to build a strong framework, infrastructure, and partnerships to support strategic approaches to ecological impact assessment. Much of this work could be conducted in a “pre-competitive” mode in which private and non-profit eco-standards setters all benefit from the development and testing of appropriate methods and tools, data management and analysis infrastructure, and sharing of monitoring results. Efforts to enhance the rigor and cost-effectiveness of ecological impact assessment could be led by technical teams in support of recent monitoring and evaluation initiatives by groups such as the ISEAL Alliance and SAI Platform.

By adapting scientific tools that already exist to the context of agricultural eco-standards—supported by modern technology and data analysis capabilities—the eco-standards community can greatly enhance the credibility, rigor, and results of its efforts to conserve ecosystems and protect the environment.

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I. INTRODUCTION

Eco-standards and eco-certification systems for agricultural products have developed widely around the world in the past two decades, and are considered a promising means of increasing the environmental and social sustainability of agriculture while maintaining or increasing profits for farmers, processors, traders, food manufacturers, and retailers. As of 2010, the market value of certified agricultural products exceeded US\$64 billion worldwide, and, based on recent trends, could grow to nearly US\$100 billion by 2013 and US\$190 billion by 2020 (Majanen and Milder 2011). The following statistics illustrate the broad and growing reach of agricultural eco-standards into nearly all segments of food, beverage, and personal care product markets:

- Global sales of organic products doubled between 2003 and 2008, to nearly US\$51 billion (IFOAM 2009).
- In the agriculture sector, over one million hectares and 200,000 operations are now certified by Rainforest Alliance (RA), while the number of companies registered to buy and sell RA-certified agricultural products jumped 24% from 2009 to 2010 (Rainforest Alliance website).
- RA-certified coffee sales increased 31% from 2009-2010, reaching 114,884 metric tons (2.5% of the global supply), while certified cacao production skyrocketed to 56,000 metric tons, a 319% increase over 2009 (Rainforest Alliance website).
- The Sustainable Agriculture Network (SAN) now certifies 100 different agricultural products, with new ones being added continuously (SAN 2011).
- Fairtrade certified products are now sourced from farmers in 58 developing countries, and sales were projected to grow 5.5% in 2011 (Fairtrade Foundation website).
- Large corporations such as American Airlines and McDonald's have incorporated eco-certified products into their food and beverage supplies. Major global food companies such as Unilever and Nestlé have developed their own internal sustainability standards while also committing to increase significantly their purchases of third-party certified agricultural commodities.

These examples and trends testify to the evolution of eco-standards from a niche market segment catering mainly to socially and environmentally conscious consumers, to a mainstream feature of international business and trade. A 2011 study of global business leaders commissioned by the ISEAL Alliance revealed that the 80 businesses surveyed were using an average of four sustainability standards each, and relying on them to manage sustainability outcomes, enhance marketing and reputation, and increase operational efficiencies, among other purposes (ISEAL 2011). Eco-standards are also now used as criteria for international lending and investment, as well as in the implementation of trade policies and policy directives, such as the European Union's revised 2009 Renewable Energy Directive and Fuel Quality Directive on biofuel blending and production standards. In short, eco-standards are now heavily relied-upon as sustainability proxies in international business, and appear poised to become even more so in the future.

During the initial development of agricultural eco-standards, in the 1990s, the adoption of these standards (and their component practices) was accepted as *prima facie* evidence of progress

toward sustainability. Relatively little effort was made to quantify the actual impacts of the newly adopted practices on people and the environment. Third-party eco-certification bodies focused their energies on increasing the uptake of standards throughout the value chain, and, overall, have achieved great success in this regard.

However, as agricultural eco-standards mature and grow in scope and scale, there is rising demand for evidence about whether they are indeed achieving their purported benefits of increasing social and environmental benefits, while reducing or eliminating harms. Such evidence is needed for a multitude of reasons: for instance, to strengthen the credibility of the systems, to demonstrate their impact to various stakeholders, to improve their design and implementation, and to link eco-certification to broader initiatives for social advancement and ecosystem conservation (Figure 1; Box 1).

In response to this demand for improved evidence on the impacts of agricultural eco-standards, some certification bodies and consortia have recently begun to develop impact assessment initiatives, conduct assessment research, or establish frameworks to monitor and evaluate the

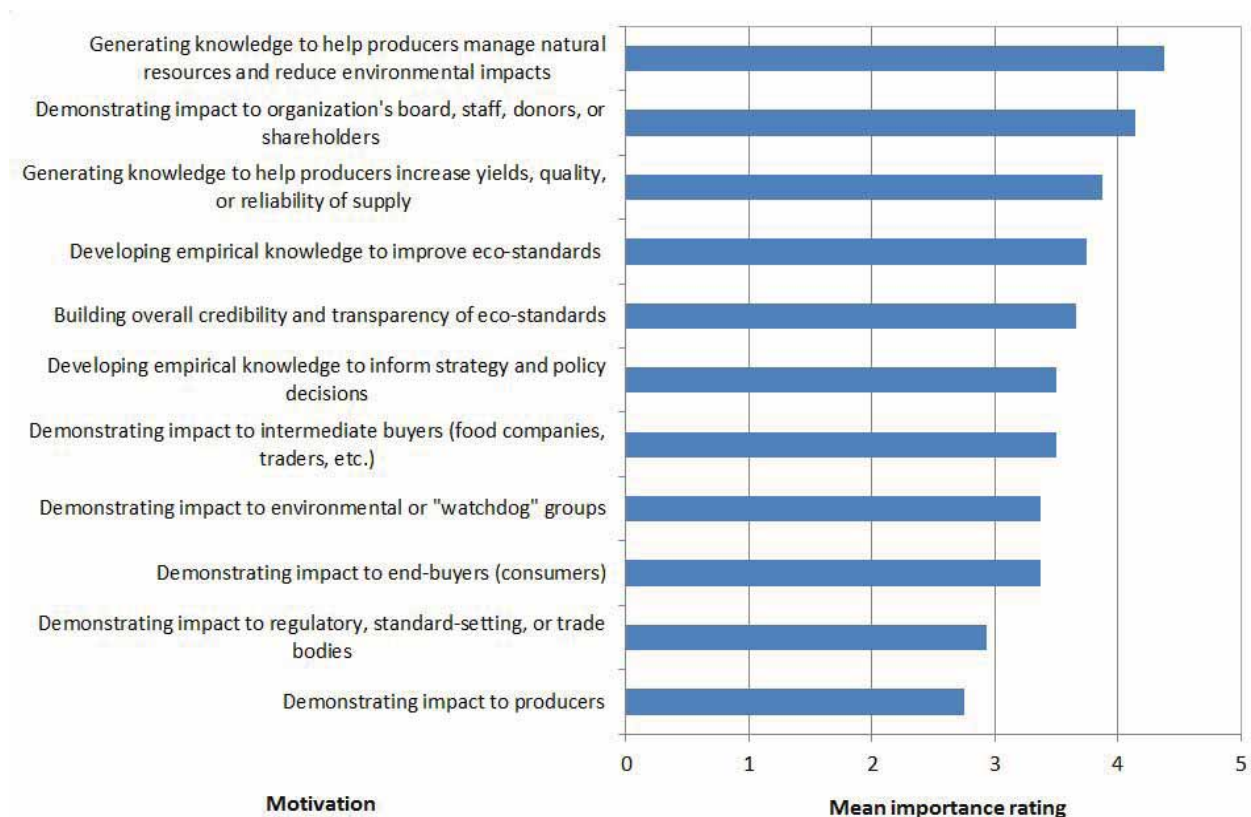


Figure 1: Motivations for improving impact assessment of agricultural eco-standards.

As part of the interviews conducted for this study, we asked respondents to rate the importance of each of eleven possible motivations for improving the assessment of ecological impacts of agricultural eco-standards, as “very important,” “important,” “somewhat important,” or “not important.” All eleven of the possible motivations were seen as important or very important by the majority of respondents. Responses were scored as follows: very important = 5, important = 3, somewhat important = 1, not important = 0. Mean importance ratings equal the total scores for each motivation divided by the number of respondents.

Box 1: Motivations for improving impact assessment of agricultural eco-standards

While the eco-standards community holds a generally shared interest in improving evaluation and impact assessment of standards, motivations differ somewhat between private sector eco-standards setters, non-profit eco-standards setters, and non-profit support and advocacy organizations. Representatives of private companies who we interviewed expressed the need to ensure that their producers and supply chain partners were not engaged in overtly harmful social or environmental practices that could lead to reputational damage. Others were interested to understand whether certification could help reduce risk—for instance, by making producers more resilient to climate change. Many non-profit standard-setting and supporting organizations identified the need for evidence to establish a compelling storyline of positive benefits for decision-makers or funders. Across all sectors, there was broad interest in accurately measuring the results of field interventions, and in assisting farmers with sustainable practices through the provision of better information. Indicative interview quotations follow:

“From what we see very little has been done to prove impact. Why? Because it’s complicated, it costs money, and it takes time. But it is something we have to do to stay credible.”

“There is a huge assumption that the best management practices outlined in the standards will bring results. The standards and the audits are practice-based and we have been focused on getting farmers to adopt these practices. Nobody is doing the research to see if sustainability results are being achieved.”

“Being impact-oriented can help producers improve operationally, such as improved water management, improved resilience of farming systems...”

impacts of agricultural eco-certification. The recently released ISEAL Impacts Code (ISEAL 2010) requires ISEAL Alliance members (who include many of the leading agricultural eco-certification bodies and standard-setters) to develop internal monitoring and evaluation systems that collect and report data on the social and environmental impacts of their certification system. ISEAL member representatives interviewed for this study confirmed that they were in the process of establishing these systems. Similarly, the SAI Platform—a sustainability consortium for private food and agribusiness companies—has developed a set of Principles and Practices to benchmark and guide corporate sustainability standards related to agriculture.

At the same time, there has been a proliferation of new tools and methods that are well-suited to help farmers and agricultural value chain actors better understand farming systems and their impacts—both within and outside of the context of eco-standards. These efforts represent positive steps toward understanding whether agricultural sustainability efforts are achieving the desired results. However, most such efforts are in the early stages of development and there has been little sharing of knowledge and experience, and little critical peer or scientific review.

In addition, the focus has been mainly on understanding impacts at the farm scale, or, at the most, aggregated across groups of farms (as in the case of agricultural cooperatives or raw commodity supplies for food companies). Yet, for many environmental factors in particular, impact depends on the interaction between farms and the surrounding landscape. Thus, impacts

of agricultural eco-standards on ecosystem services and biodiversity have proven difficult to measure or model. Furthermore, unlike evaluation of socioeconomic impacts, environmental impacts can rarely be discerned reliably through interviews or self-reporting. The sum result is a situation where—despite large and growing demand—actual evidence of the environmental impacts of agricultural eco-standards schemes is quite limited and most of the evidence that does exist is anecdotal and of questionable broader applicability.

Box 2: Some key terms

Throughout this study, we use the following terms, which take on the meanings below in the context of agricultural eco-standards:

Eco-certification: A voluntary procedure that assesses, monitors, and gives written assurance that a business, product, process, service, or supply chain is managed according to environmentally responsible practices.

Eco-standard: A set of rules, guidelines, or characteristics for products or related processes and production methods to be produced or managed according to improved social and environmental practices.

Verification: Methods applied to review, audit, or verify compliance with standards.

Practices: Methods or techniques applied to the operational management of agricultural production units or supply chains (e.g. application of fertilizers, inter-cropping, maintaining soil and tree cover, processing methods).

Processes: Established routines or sets of steps and procedures applied to operational management of agricultural production units or supply chains (e.g. record keeping of volumes of applied fertilizers, inputs and/or outputs).

Proxy: An indicator, quantity, or condition that is believed to correlate strongly with a separate indicator, quantity, or condition of interest for management or evaluation. The proxy is measured and reported as means for inferring the status of the indicator, quantity, or condition of interest.

Outcomes: The biophysical, social, or economic conditions associated with or created as a result of the adoption of agricultural eco-standards.

Impacts: The net change in biophysical, social, or economic conditions attributable to the adoption of agricultural eco-standards, relative to a plausible baseline scenario in which such standards were not adopted.

Results-orientation: An approach to designing, managing, assessing, and adapting eco-certification and eco-standards systems that has the specific goal of attaining positive outcomes and impacts. A results orientation is contrasted with a practices and processes orientation, which focuses on achieving and documenting changes in operational management systems (e.g., adoption of environmental best management practices).

Note: Definitions for “eco-certification” and “eco-standard” are adapted from the ISEAL Alliance’s Code of Good Practice Report (2010), http://www.isealalliance.org/sites/default/files/P04I_ISEAL_Impacts_Codev1.0.pdf.

In light of these critical gaps, the goal of this study is to assess the degree to which agricultural eco-standards have been—and could be—linked to actual impacts on key dimensions of environmental sustainability. The study also seeks to identify practical and cost-effective tools and strategies by which eco-certification bodies and other stakeholders could work to make agricultural eco-standards more results-oriented and more effective with respect to their environmental benefits.

To do so, we conducted a literature review and practitioner interviews to evaluate the science and practice of ecological impact assessment for agricultural eco-certification and standards. In part, the study seeks to bridge the established scientific sub-field of ecological indicators with the specific need and demand for practical impact assessment tools for agricultural eco-standards. The study focuses particular attention on ecological impacts that occur or are mediated beyond the scale of individual farms. This scale of analysis is often highly relevant for ecological impacts but has proven especially challenging to consider in the context of agricultural eco-standards, which typically certify production at the farm level. The study addresses three sets of questions:

1. To what extent has the adoption of agricultural eco-standards been empirically linked to impacts on key dimensions of biodiversity and ecosystem services?
2. What methods and tools exist to demonstrate such linkages? How adequate are these tools, and how widely have they been used in the context of agricultural eco-standards?
3. What are the main motivations and needs of the eco-standards community for assessing and demonstrating ecological impacts more rigorously? What are the key opportunities and challenges for doing so?

We focus on five key aspects of biodiversity and ecosystem services: a) watershed functions and services, including water quantity and water quality; b) impacts on biodiversity of conservation interest (e.g., rare, threatened, and endangered species); c) impacts on ecosystem composition and function, including functional diversity supporting ecosystem services such as pollination and biological pest control; d) impacts on ecosystem services mediated by soils and soil management; and e) carbon sequestration and greenhouse gas emission reductions. These categories align generally with types of environmental impacts considered in recent work on eco-standards metrics and indicators, such as the ISEAL Impacts Code.

This report is structured in five main sections. Following this **Introduction**, we briefly describe the **Study Methodology**. Next we describe the existing state of **Impact Assessment Practices, Methods and Tools** now in use. The following section, **Toward Improved Impact Assessment Approaches and Methods**, presents a framework and set of options for future impact assessment activities. Finally, we propose a set of tangible next steps for **Making it Happen**. Throughout the report, several Boxes provide additional perspectives, including summaries of other key studies on impact assessment for sustainable agriculture. The **Literature Cited** and eight **Appendices** provide more detailed information on the study methodology and information sources, as well as information on specific impact assessment methods and tools. Throughout the document, we refer to the terms defined in Box 2.

2. STUDY METHODOLOGY

We used two principal methods to assess the science and practice of ecological impact assessment for agricultural eco-standards: 1) a review of the literature on this topic; and 2) input from eco-certification practitioners collected through interviews and a questionnaire. Each of these components is described briefly below. The full Terms of Reference for the study is provided in Appendix A.

Literature Review

The literature review examined the extent to which the adoption of agricultural eco-standards has been empirically linked to impacts on biodiversity and ecosystem services (study question 1). It also surveyed the availability, adequacy, and use of methods and tools for assessing such impacts (study question 2). For both of these questions, we reviewed a wide variety of peer-reviewed studies and grey literature in English and Spanish, including reports by certification bodies and consortia. To find relevant studies, we used a combination of search tools including digital databases (Google, Google Scholar, and Web of Science), cited literature searches, and webpages of agricultural eco-standards. We also searched library catalogues including those of Cornell University and the Center for Tropical Agricultural Research and Training (Centro Agronómico Tropical de Investigación y Enseñanza, CATIE) in Costa Rica, which contains a collection of studies about agricultural eco-certification. For all searches, we used combinations of keywords to identify relevant studies (see Appendix B for the list of search terms).

The focus of the research was on agricultural eco-standards and eco-certification systems that adopt and implement standards for improving the environmental and social sustainability of agricultural production. (An indicative list of such standards, certifications systems, and standards-setting bodies is provided in Appendix B.) Because the environmental performance of organic agriculture has already been the subject of several reviews, in the case of organic certification, we relied mainly on these existing reviews. We also conducted a less intensive survey of ecological impact assessment practices for forestry eco-certification to identify any methods or approaches from this field that might help inform impact assessment for agricultural eco-standards.

For study question 1, we searched exhaustively for studies on the environmental impacts of specific agricultural eco-standards. We did not review literature on the impacts of specific best management practices, as this is a much broader field of investigation and has already been the subject of various reviews and meta-analyses (Box 3; Box 4). For study question 2, we sought to identify key impact assessment methods, tools, and innovations with respect to each of the five dimensions of biodiversity and ecosystem services addressed by this review (watershed functions, biodiversity of conservation interest, ecosystem composition and function, soils, and carbon sequestration and greenhouse gas emissions). We focused particularly on methods that either have already been used to evaluate the impacts of agricultural eco-standards or appeared well-suited to doing so.

To identify methods that met the above criteria, we read the abstracts of a large number of studies on the impacts of sustainable production systems. We then conducted a more detailed

review of potentially relevant methods, in which we characterized the following aspects of each method or tool: a) outcomes or impacts the methodology seeks to address; b) data types and sources on which the evaluation is based; c) type, degree, and ways in which proxy relationships or relationships between practices and ecological outcomes are used in the assessment; d) experiences with the methodology to date; and e) peer or external assessments of the methodology, if any.

Interviews and Questionnaire

We also contacted leaders in the eco-standards community to collect additional information on impact assessment activities, tools, and methods and to understand key motivations, opportunities, and challenges for the eco-standards community to improve the results-orientation of eco-standard adoption with respect to ecological outcomes. We collected this information through a combination of an online pre-questionnaire (administered via the online service Survey Monkey) and semi-structured interviews conducted by Skype teleconference and lasting approximately one hour each. (See Appendix C for a copy of the pre-questionnaire and Appendix D a copy of the interview template.)

We administered the pre-questionnaire and conducted interviews with 20 individuals during October, November, and December 2011. Eight of the respondents represented specific eco-standards or eco-certification entities, while the remaining twelve respondents represented eco-standards umbrella organizations, advocates, or partners. In identifying prospective respondents, we selected eco-standards and eco-certification entities that command significant certification market share and/or demonstrate leadership in the agricultural or forestry commodities sectors. We selected umbrella organizations, advocates, or partners that play a prominent role in the eco-standards field (e.g., ISEAL) or have been leaders in developing and implementing impact assessment methods, tools, or systems (e.g., the Committee on Sustainability Assessment [COSA]). Individual respondents within each organization were identified through the authors' professional networks and through recommendation of colleagues and initial interviewees. A list of interviewees and their affiliations is provided in Appendix E.

3. IMPACT ASSESSMENT PRACTICES, METHODS AND TOOLS

Our research revealed that there has been relatively little assessment of actual ecological impacts of agricultural eco-standards to date, despite a plethora of methods and tools that appear suitable for carrying out such assessments. This section first reviews the existing literature to describe the extent and manner in which agricultural eco-standards have already been empirically linked to impacts on biodiversity and ecosystem services. It then reviews the availability of methods and tools to demonstrate such linkages, assesses the adequacy of these tools, and summarizes the extent to which such tools have been or could be applied in the context of agricultural eco-standards.

Existing Impact Assessment Activity

To understand the existing array of claims, data, and evidence related to the ecological effects of agricultural eco-standards, it is helpful to differentiate several types of reporting measures. As defined in Box 2, above, outcome and impact measures refer to actual on-the-ground conditions or changes associated with, or attributable to, the adoption of eco-standards. Such results may be measured directly or through the use of proxies—that is, changes in other system conditions that are believed to correlate strongly with changes in the conditions of interest. By contrast, the adoption of practices and processes (also referred to as best management practices, or BMPs) is commonly reported, but is usually not a direct measure of outcomes or impacts. When the adoption of eco-standards or their component BMPs is reported as an indicator of environmental performance, the assumption (stated or unstated) is that the standard or the BMPs are themselves a suitable proxy for key environmental outcomes and impacts.

This spectrum of assessment approaches (practices and processes; proxy measures for outcomes and impacts; and direct measures of outcomes and impacts) can be applied at a range of scales (Figure 2). For instance, information on the adoption of an eco-standard or its component BMPs may be reported at the level of an individual farm, a group of farms (e.g., an agricultural cooperative), or an entire region or supply chain. Similarly, farm-scale outcome and impact measures may be helpful for assessing local changes related to soil quality, erosion, or vegetation diversity, while landscape or regional scale outcome and impact measures can help reveal the contribution of agricultural eco-standards to goals such as improving water quality or reducing deforestation.

Ecological assessment of agricultural eco-standards is currently conducted through all of the above approaches and at all of the above scales (Figure 2). However, practice and process based measures are used much more commonly than outcome and impact measures. This is because they are generally less expensive, require less effort, and, historically, have often satisfied many eco-standards stakeholder groups, such as food companies and investors seeking to avoid association with unsustainable practices. On the other hand, outcome and impact assessment studies tend to be costly and time-consuming, and may require specialized expertise that some eco-standards bodies lack. The most rigorous assessment approaches, which conduct experimental or quasi-experimental scientific research on specific outcomes or impacts, are

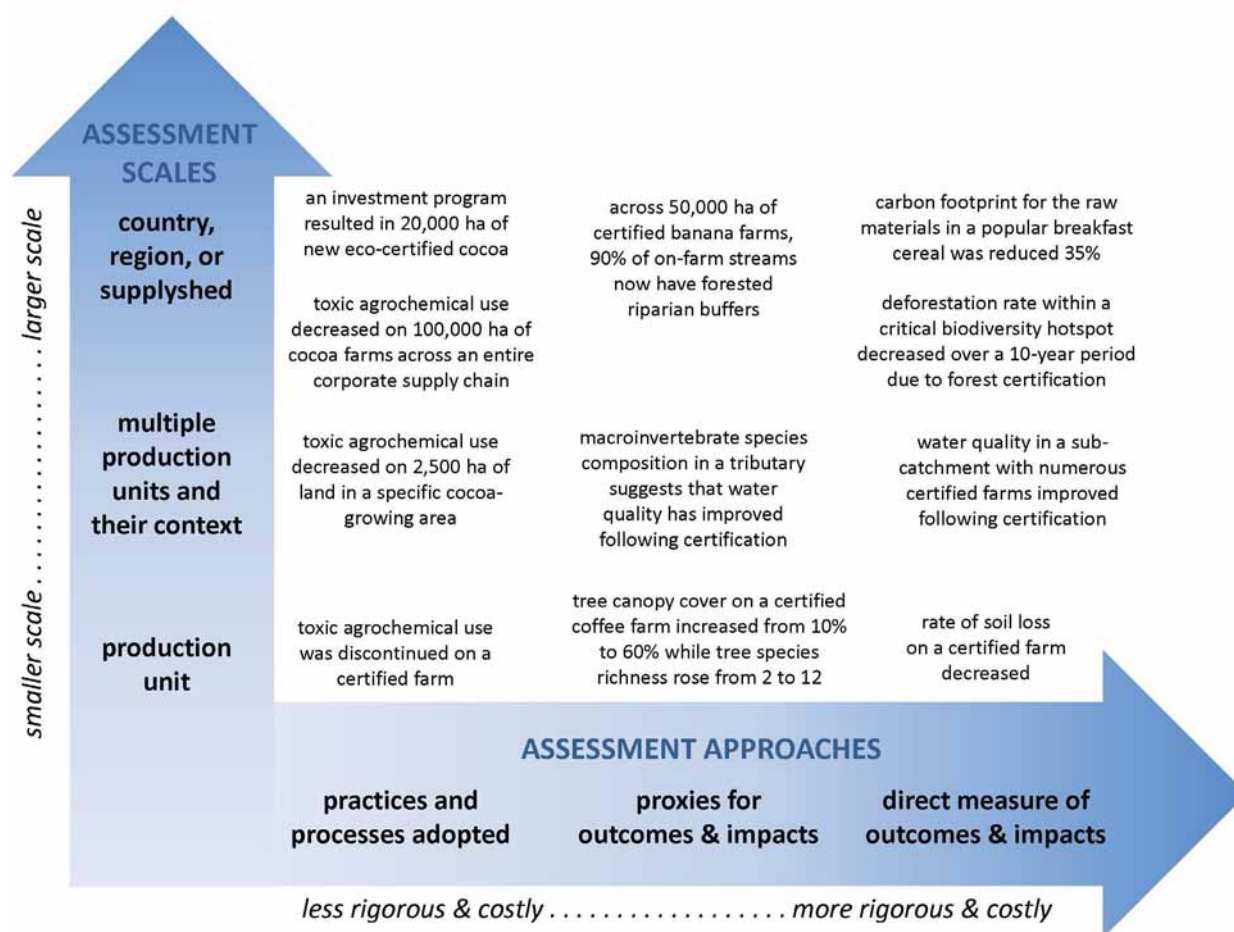


Figure 2: Range of approaches for assessing ecological effects of eco-standards.

The horizontal axis represents a spectrum of assessment approaches from low-cost methods that simply document or quantify the adoption of improved practices, to more rigorous and costly methods that indirectly or directly assess ecological outcomes and impacts themselves. The vertical axis shows the range of scales and levels of aggregation over which the results of eco-certification may be evaluated. Within this space, eleven examples are arrayed according to their positions on these two axes. Some of the examples shown in the figure (e.g., tree canopy cover or adoption of riparian buffers) may function both as a direct measure of one outcome of interest and as a proxy measure for different outcome(s) or impact(s) of interest.

particularly uncommon, in part because of the challenge of establishing appropriate baseline or control scenarios against which to compare eco-certified systems (Blackman and Rivera 2010).

The relative emphasis on practice/process measures versus outcome/impact measures within eco-standards themselves differs significantly by certification scheme and by crop. A few of the newer eco-standards schemes require measurement of and compliance with various environmental outcomes in order to achieve certification. For instance, the Better Sugar Cane Initiative's Bonsucro standard sets upper limits on greenhouse gas emissions per unit of production, and on acceptable levels of biochemical oxygen demand¹ in plantation streams.

¹ Biochemical oxygen demand is the amount of dissolved oxygen needed by aquatic organisms to break

The Roundtable on Sustainable Biofuels (RSB) Standard requires assessments of soil organic matter and habitat connectivity, as well as detailed impact assessment reports in some cases. In these instances, outcome measures are, to some degree, already built into the standards themselves. The outcome orientation of these two standards reflects recent scientific thinking on the impacts of agriculture. It may also reflect the fact that sugar and biofuels plantations are typically large and may therefore be able to afford more rigorous environmental management and assessment efforts.

By contrast, most of the longer-standing certification and standards systems—particularly those that engage small-scale producers or that began as principally social certifications—tend to rely heavily on practice and process measures in the environment domain. For instance, farmers may be required to reduce or eliminate the use of certain agrochemicals, increase soil cover, or refrain from hunting on certified properties. We refer the reader to Appendix II of 2010 State of Sustainability Initiatives Review (Potts et al. 2010) for additional information on the types of environmental BMPs and/or outcomes contained within each standard. For standards that are heavily or exclusively based on BMPs, separate research and evaluation work—outside of the usual certification and audit process—is generally required to assess environmental outcomes and impacts.

One approach to link practice-based eco-standards to environmental outcomes and impacts has been to “dissect” such standards into their component BMPs and review evidence on the effects of these specific BMPs from the broader scientific literature (see Box 3). In theory, this approach may help standard-setters to select and evaluate BMPs that provide robust proxies for the desired environmental benefits. However, for the most part, it has proven difficult to establish robust generalized relationships between BMP adoption and environmental benefits. This situation stems in part from the important role of context in mediating environmental impacts (e.g., excess nitrogen application might be much more problematic in sandy soils than in loamy soils) and in part from the lack of standardization or coordination of research methods and metrics related to BMPs and their impacts.

Because of the limited capacity of most eco-standards bodies to conduct scientific research themselves, the majority of ecological impact assessment work has been done by scientists in universities or other NGOs—sometimes independently and sometimes under contract or arrangement with an eco-standards organization. Interviewees reported that such partnership arrangements can be challenging to establish and maintain. Nevertheless, examples where such partnerships have occurred (e.g., Starbucks and Conservation International) have led to substantial improvements in assessment of environmental impacts recognized by both parties (Semroc et al. 2011).

Our literature review and interviews turned up 36 studies specifically focused on assessing ecological outcomes or impacts associated with the adoption of agricultural eco-standards. This set of studies is comparable in size (and substantially overlapping with) the studies reviewed by Blackman and Rivera (2010) as part of their recent review on the evidence base

down the organic matter present in a water body. This quantity is influenced strongly by levels of excess nutrient runoff (e.g., nitrogen and phosphorus) into water bodies, and is widely used as a proxy for the suitability of a water body to support native fish and other fauna.

Box 3: Banking on BMPs: how much do we know about their impacts?

In a recent effort to understand the impact of the adoption of agricultural eco-standards, Rainforest Alliance (2011) conducted a literature review of the specific best management practices (BMPs) that comprise many eco-standards. This BMP-oriented approach seeks to address the problems associated with treating a set of eco-standards as a “black box” in which sustainability results from a large set of activities that are not examined individually. To do so, the study identified and reviewed the impacts of seven sets of environmental BMPs that are common to many eco-standards:

- Creation and restoration of natural ecosystem set-asides
- Creation of streamside management zones (in agriculture and forestry)
- Increased tree/canopy cover (in agroforestry systems)
- Use of low-water irrigation and processing methods (in coffee, cocoa, and bananas)
- Adequate treatment of residual waters from processing (in coffee, cocoa, and bananas)
- Use of natural fertilizers (including compost)
- Use of fishing methods that minimize bycatch and adverse habitat impacts

The analysis revealed several important findings on the selected sets of BMPs:

- With the exception of tree cover/agroforestry studies in Mexico and Central America, the majority of studies focused on North America or Europe, with a bias toward temperate regions.
- Studies were entirely absent for two of the sets of BMPs: use of low-water irrigation and processing methods and adequate treatment of residual waters from processing.
- More than 50% of the studies were short term, although there were 27 studies (29%) whose duration exceeded five years, including 15 studies related to agricultural BMPs.
- While negative results from the BMPs were uncommon, natural fertilizer was shown to negatively affect soil quality in one third of the studies reviewed.

This review is an important contribution to understanding the mechanisms by which the BMPs contained within eco-standards may lead to environmental impacts. However, the variability in findings across the studies reviewed—including a non-trivial number of studies showing negative impacts from purportedly eco-friendly BMPs—indicates the need for significant additional research. It also illustrates the potential pitfall of treating the adoption of BMPs as an indicator of success without further place-specific empirical validation. Finally, research of the type reviewed in this study may help standards-setting bodies to select for inclusion in their standards those BMPs that most consistently and cost-effectively yield environmental benefits.

for environmental and socioeconomic impacts of “sustainable” certification schemes. Below we summarize key aspects of these 36 studies, including which ecological attributes were assessed, which cropping systems were evaluated, in which geographic regions the studies took place, and at which scale the studies were focused.

Which ecological impacts are being assessed?

We identified assessment studies for each of the five categories of ecological impacts included in this review (Table 1). For most of the impact categories, the focus was on the farm or production unit. For instance, few studies evaluated downstream water quality or plant or animal communities outside of the production unit. This finding appears to reflect the fact that most eco-standards and certifications treat the farm as the unit of certification and thus the focus of efforts to determine compliance and impact. The main exception to this pattern was for studies that assessed impacts on rare, threatened, and endangered species. These studies tended to consider impacts both on and off of the production unit (Table 1).

Which cropping systems are being evaluated?

The majority of ecological impact assessment work on eco-certified agriculture has taken place in coffee systems (Figure 3). This emphasis likely reflects three factors: 1) the longer time period over which coffee certification standards have been in place relative to those for many other crops; 2) the large number of different standards and certification labels focused on coffee, including some with a strong emphasis on conservation benefits; and 3) the demonstrated ability of coffee agroforestry simultaneously to conserve many components of tropical biodiversity and fulfill a market demand for superior product (Blackman and Rivera 2010). In short, shade-grown

Table 1: Ecological attributes assessed in impact studies of agricultural eco-standards.

Boldface lines represent the five broad categories of impacts examined in this review. Italicized lines are sub-categories of the preceding boldface line. Totals exceed the sum of individual lines because some studies examined more than one category or sub-category of impact.

Ecological attributes assessed	Number of studies examining attribute (n=36)
Watershed functions and services	9
Water quality on the farm/production unit	6
Water quality downstream/off the farm	1
Water quantity (e.g., flow rates, seasonality, or flood storage)	8
Rare, threatened, or endangered biodiversity	6
Rare, threatened or endangered species on the farm/production unit	6
Rare, threatened or endangered species in the surrounding landscape	5
Ecosystem composition and function	9
Animal species assemblages on the farm/production unit	6
Animal species assemblages in the surrounding landscape	3
Plant species assemblages on the farm/production unit	7
Plant species assemblages in the surrounding landscape	1
Soil characteristics	10
Soil quality and erosion risk potential on the farm/production unit	10
Greenhouse gas emissions or carbon sequestration	6
Greenhouse gas emissions or carbon sequestration on the farm/production unit	6

coffee has offered the possibility to tell a compelling story of environmental improvement, and researchers as well as eco-standards bodies have taken this opportunity to amass a substantial body of knowledge on the impacts of shade-grown coffee, including in eco-certified systems.

We identified only a few studies on the ecological impacts of eco-certified cacao production (Figure 3). However, there is a larger literature on the biodiversity conservation value of shade-grown cacao, including comparisons of different cacao cropping systems (e.g., Rice and Greenberg 2000; Donald 2004; Bissuela and Vidal 2007). Most of these studies were not evaluating the impact of certification per se—and many were not conducted in certified systems. Nevertheless, because shade-grown cacao includes many of the same BMPs as eco-certified cacao, such studies are relevant to this review.

The environmental impacts of sustainably harvested non-timber forest products have received some study recently, as a growing number of certification bodies hope to promote and support such practices. These studies suggest that the dynamics of sustainably harvesting different forest products are complex, such that careful case-by-case research is important for understanding impact.

We identified only a few studies on the ecological impacts of eco-certified bananas or palm oil (Figure 3). One likely reason that these crops have seen little impact assessment research is that it is more difficult to grow them in biodiversity- and ecosystem-friendly systems that also generate profitable levels of production. For instance, high market quality bananas require sunny, canopy-free environments, which typically equates with less biodiversity, higher risk of

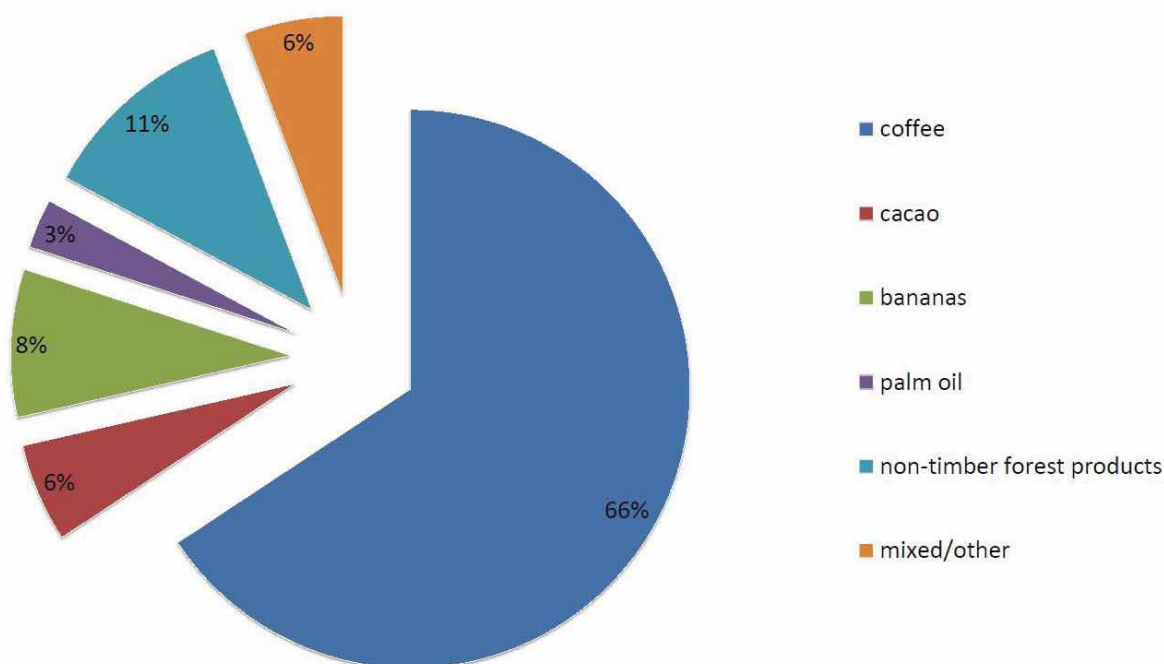


Figure 3: Cropping systems evaluated.

The chart indicates the percentage of the 36 reviewed ecological impact assessment studies that focus on each of the indicated crops or products.

Box 4: Organic farming, biodiversity, and ecosystem services: a review of the evidence

Much can be learned about the science, practice, and challenges of agricultural eco-standards impact assessment from the sizable body of literature on the ecological impacts of organic agriculture, most of which pertains to farm-level outcomes. Here, we summarize a handful of the key recent meta-analyses of impacts of organic production practices (whether certified or not) on biodiversity and ecosystem services.

Recent reviews have found that organic farms frequently—but not uniformly—support higher levels of biodiversity than conventional farms. For instance, a meta-analysis by Bengtsson and colleagues (2005) found that 53 of 63 studies (84%) showed higher species richness in organic agriculture systems than conventional systems. Few comparative studies of vertebrates exist, but there is some data to suggest organic practices may increase bird abundance and species richness; however, there is no evidence of a similar pattern for mammals (Hole et al. 2005). Bengtsson and colleagues (2005) also found that organic farming fostered higher species richness and abundance of predatory invertebrates, but a meta-analysis by Fuller and colleagues (2005) only found infrequent evidence for the same relationship. A review of eastern European literature found greater carabid beetle species richness in organic versus conventional systems (Döring and Kromp 2003). On the other hand, the U.S. Department of Agriculture found no difference in species richness of carabid beetles in the Farming Systems Project in Maryland, USA (Clark et al. 2006). In contrast to the varying conclusions on the effects of organic farming on animal diversity, many reviews have found a more consistent effect of organic practices for increasing plant diversity, relative to conventional farming (Bengtsson et al. 2005; Hole et al. 2005; Fuller et al. 2005).

With respect to ecosystem services, reviews of organic versus conventional agriculture suggest that organic farming is superior in preserving or improving both the abiotic and the biotic aspects of soil quality (e.g., soil organic matter and biodiversity) (Gomiero et al. 2011). Birkhofer and colleagues (2008) found that organic farming supports microbial and faunal diversity and sustains more generalist predators, thereby increasing natural pest control. In a nine-year study in Washington, USA, Kramer and colleagues (2006) showed that organic integrated fertilization practices supported more active and efficient denitrifying bacterial communities and reduced environmentally damaging nitrate losses relative to conventional practices. Longer-term European data on soil characteristics (studies from 20 to 150 years in duration) support the idea that organic methods decrease topsoil loss, and maintain soil nutrients and carbon more effectively than conventional methods (Gomiero et al. 2011). Soils in organic systems also capture and retain more water—up to 100% more in the crop root zone—and thus can produce higher yields under drought conditions than analogous conventional systems (Gomiero et al. 2011).

Many reviews argue that differing results of different studies with respect to biodiversity may stem, in part, from the influence of landscape context and habitat heterogeneity. For instance, well-managed conventional agriculture (e.g., using BMPs such as buffer strips, integrated pest management, reduced tillage, and continuous soil cover) can contain moderately high levels of biodiversity if the surrounding landscape includes a heterogeneous mix of habitats (Weibull et al. 2003; Fuller et al. 2005; Gibson et al. 2007). In such settings, organic farming will not necessarily increase species richness because the landscape already includes significant complexity and diversity. On the other hand, in simplified, intensively managed agricultural landscapes, organic farming will likely increase species richness (Bengtsson et al. 2005). Discerning effects on taxa with greater mobility is particularly difficult because such species may roam from organic farms to conventional farms to non-farmed habitats, thus making it difficult to assess impacts

of management practices in just one portion of an animal's home range (Hole et al. 2005). These caveats and questions suggest some frontiers for future research on the response of biodiversity and ecosystem services to organic farming.

Identified weaknesses of the existing body of literature comparing the ecological impacts of organic agriculture include (Hole et al. 2005):

- Criteria for what constitutes organic farming are defined differently in different studies and regions.
- Many studies lack controls or good scientific design, thus limiting the reliability of conclusions.
- Few studies have repeated measures, so observed results may not hold true over longer time periods.
- Studies focusing on different taxa tend to look at different habitat scales (e.g., studies of vertebrates rely on larger scale assessments, while those of invertebrates focus on plot or transect levels).
- Definitions and measures of biodiversity also differ by study, and may include species richness, abundance, fecundity, and population density. This irregularity limits the ability to compare or generalize across multiple studies addressing similar sets of questions.
- Landscape-scale effects of organic production may be impossible to test in most regions because the large majority of land is under conventional production or other land uses.
- Few studies have controlled for the length of time since certification, which may significantly affect levels of biodiversity and ecosystem services maintained by organic farms.

soil erosion, high agricultural pollution, lower natural pest protection, and more intensified agricultural management (Wilsey and Temple 2011). Many other tropical commodities such as oil palm, sugar cane, and soy are similarly best suited to monoculture production. Eco-standard bodies may therefore have chosen to invest less in assessing positive ecological impacts from certification of these crops. Nevertheless, there is a recent push to understand, reduce, and monitor the impacts of oil palm production on tropical deforestation (Laurance et al. 2010; ZSL 2011) as well as to understand environmental benefits that may be possible from eco-certified sugar production (Bonsucro 2011). Ecological impacts of organic production have been assessed for a variety of crops, mainly in temperate settings; see Box 4 for a summary.

Where have impact assessment studies taken place?

The majority of the 36 studies reviewed (68%) took place in the Americas (Figure 4). In part, this distribution reflects the geography of eco-certified coffee, the best studied crop. Africa has received considerably less study of eco-certified systems despite the growing supply of eco-certified agricultural products from the continent. Southeast and South Asia have seen a recent increase in agricultural eco-certification, but little ecological impact assessment work. A number of recent studies have examined environmental impacts of certification across multiple

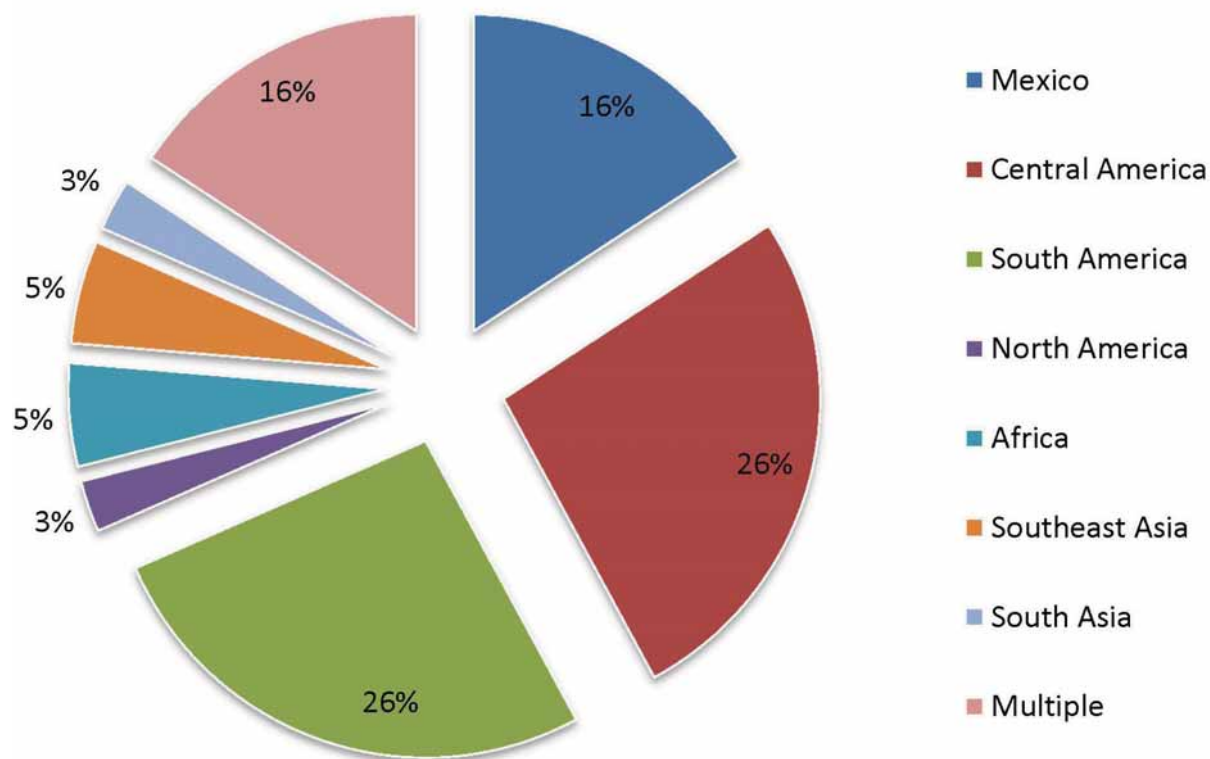


Figure 4: Location of impact assessment studies.

The chart indicates the geographic distribution of the 36 impact assessment studies reviewed.

regions, or even globally, but methodologies for assessing regional impacts tend to rely on a conglomeration or synthesis of individual studies in specific regions (Figure 4).

At what scale have impact assessment studies taken place?

For the 36 studies reviewed, we classified the primary scale of assessment as one of the following: plot, farm, cluster of farms, landscape, or region. The largest number of studies (39%) took place at the farm level (Figure 5). This is not surprising since the farm is the level at which certification is usually conducted, and therefore the scale at which it is easiest to link certified practices to impacts. Farm-level studies generally compared one farm or group of farms to another farm or group of farms with respect to the response variables(s) of interest.

Nevertheless, a substantial number of studies took place at each of the five scales, including a total of 44% of studies beyond the farm scale (Figure 5). Most of the landscape-scale studies focused on biodiversity impacts, and most were either funded or conducted by researchers affiliated with Rainforest Alliance. Interestingly, no studies addressed watershed dynamics or soil erosion at a landscape or regional scale, though these topics are of great concern to the future of tropical farming.

Landscape-scale assessments commonly combined ground surveys with geographic information systems (GIS) and remote sensing imagery to assess ecological characteristics and impacts. For example, a 2004 study examined the potential impact of prototype Roundtable for Sustainable Palm Oil (RSPO) standards and High Conservation Value Forest (HCVF) guidelines on forest

management and human-wildlife conflict in a mosaic landscape consisting of oil palm plantations, protected areas, and other HCVFs (Darussamin et al. 2004). The study design included comparisons of impacts on HCVF from plantations managed with and without best management practices, based on GIS, satellite imagery, and surveys of conservation practices and hunting behavior.

Rainforest Alliance has several landscape-level studies currently in-progress in shade coffee landscapes with certified and uncertified farms in Colombia and in El Salvador. Rainforest Alliance also conducted comparisons of conventional and certified land in the Minas area of Brazil, where they used a combination of structured interviews, satellite imagery, ground transects of plant species richness, and water quality assessments based on macroinvertebrate assemblages. In Colombia, Rainforest Alliance is partnering with outside researchers to conduct ground surveys and radio telemetry to assess the use of shade coffee farms as habitat and dispersal corridors by endangered night monkeys (Rainforest Alliance website).

On the part of private companies, Unilever commissioned a study of land under its Sustainable Agriculture Programme that examined bird species richness and abundance in and around tea plantations in Kenya (Githiru et al. 2009). The study compared bird species richness and abundance in transects and aural and visual point counts among distinct habitat patches

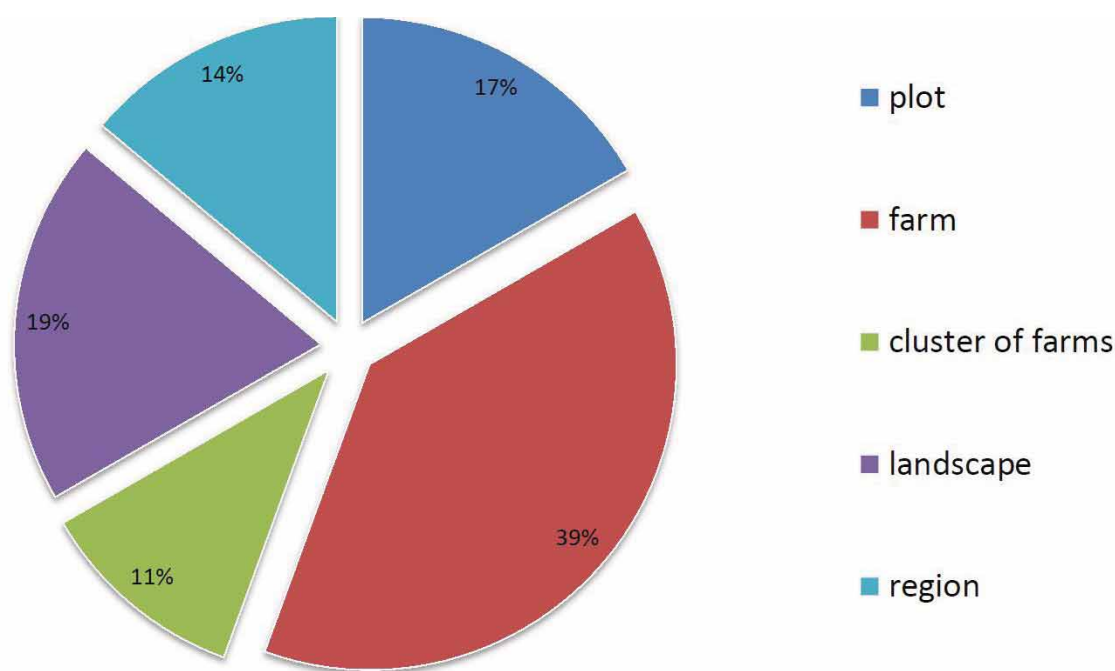


Figure 5: Scale of impact assessment studies.

The chart indicates the proportion of the 36 reviewed impact assessment studies that was conducted at each of five scales. Plots refer to sub-farm units such as individual fields, production plots, or survey transects within a farm. Farm scale refers to studies looking at a single farm while “cluster of farms” refers to studies examining many small or a few large farms in a specific area. Landscape scale generally refers to a survey area greater than 5,000 ha but less than 100,000 ha. Any study examining an area more than 100,000 ha (1,000 km²) was categorized as regional.

including heavily managed plantations, eucalypt forests, riparian buffer strips, and intact forest (Githiru et al. 2009). Transect and survey results in each management zone were compared to historical references to infer the ways in which management changes and landscape-level spatial arrangement of habitat patches influenced avian species richness and abundance.

Similar to landscape scale studies, regional assessments mostly used remote sensing imagery combined with field-based transects to sample different parts of the study region. For instance, the *Projet de Production Durable de Cacao Certifié* (Certified Sustainable Cocoa Production project) surveyed plant species richness and conducted household interviews with a structured questionnaire on and off of certified plantations in six different cocoa cooperatives in the Ivory Coast to assess regional impacts (Abel and Vogel 2009).

In two other regional-scale studies, the sustainability of certified Brazil nut harvesting under “agroextractive settlement projects” (PAEs) and forestry management areas was examined. One of the studies examined the effect of the PAE on sustainability of Brazil nut harvesting, compared to non-certified plantations and surrounding land. Variables assessed included the frequency of wildfires in and around plantations (based on statistical records and interviews), rate of deforestation, wildlife trapping, quantity of garbage, overgrazing, and illegal logging (de Lima et al. 2008). The other study conducted an intensive regional assessment of the impact of Brazil nut harvesting in the main Peruvian and Brazilian harvesting areas to compare seedling recruitment in heavy versus low harvest areas (Peres et al. 2003). Areas of heavy harvesting showed little to no new tree recruitment, suggesting long-term risks for tree populations. The study demonstrates the importance of non-timber forest product standards that require more sustainable, diffuse harvesting practices (Peres et al. 2003).

In sum, the body of evidence on the ecological impacts of agricultural eco-standards is quite limited—a conclusion that has been reached by prior reviews as well. As a result, there are simply too few data to characterize with confidence the ecological impacts of different agricultural eco-standards on different crops in different regions. Particularly lacking are longer-term studies that seek to detect changes over a period of years as a result of the adoption of agricultural eco-standards.

Impact Assessment Methods and Tools

Despite the relatively small number of ecological impact studies, collectively these studies have applied a broad range of impact assessment methods and tools. In addition, there is an even wider array of potentially suitable methods and tools available from scientific research in fields such as conservation biology, landscape ecology, water resource management, remote sensing, and ecological impact assessment. In this sub-section, we review the methods and tools that have been used in ecological impact assessment for agricultural eco-standards related to each of the five impact categories (watershed functions, biodiversity of conservation interest, ecosystem composition and function, carbon sequestration and greenhouse gas emissions, and soils). We also discuss the suitability of these existing methods and tools, and, where appropriate, identify other methods and tools that have not yet been used to evaluate the impact of agricultural eco-standards but appear promising for doing so.

To conduct this review, we used the search terms in Appendix B to identify an initial pool of about 800 peer reviewed articles, grey literature studies, and reports that we considered possible sources of relevant information on methods, tools, or approaches to assessing ecological impacts of sustainable agriculture. We screened this initial set of studies by reading the abstracts to arrive at a narrowed pool of 120 studies for more detailed review. Of these, 88 presented methods and/or tools that were currently being used to assess environmental impacts of specific interest to this report.

Types of methods and tools for ecological impact assessment

As described earlier, efforts to quantify and report the environmental effects of agricultural eco-standards span a wide range of scales, levels of rigor, and types of measurement (see Figure 2). Similarly, there is a corresponding diversity of assessment methods and tools (Figure 6). At the most detailed level, a method may refer to the specific protocol that is used to measure a component of an agroecosystem or a landscape. For instance, bird species richness in a coffee plantation may be measured using aural and/or visual point counts, mist netting, or other methods. Land use change may be measured through various remote sensing and GIS analysis protocols, through periodic ground-based data collection with Global Positioning System units, or through farmer interviews about historical land use patterns. We refer to these as “building block” methods because they provide much of the foundational data for more complex or multi-dimensional assessment approaches. Building block methods are also used on their own to assess the response of specific environmental variables to management changes such as the adoption of eco-standards or their component BMPs.

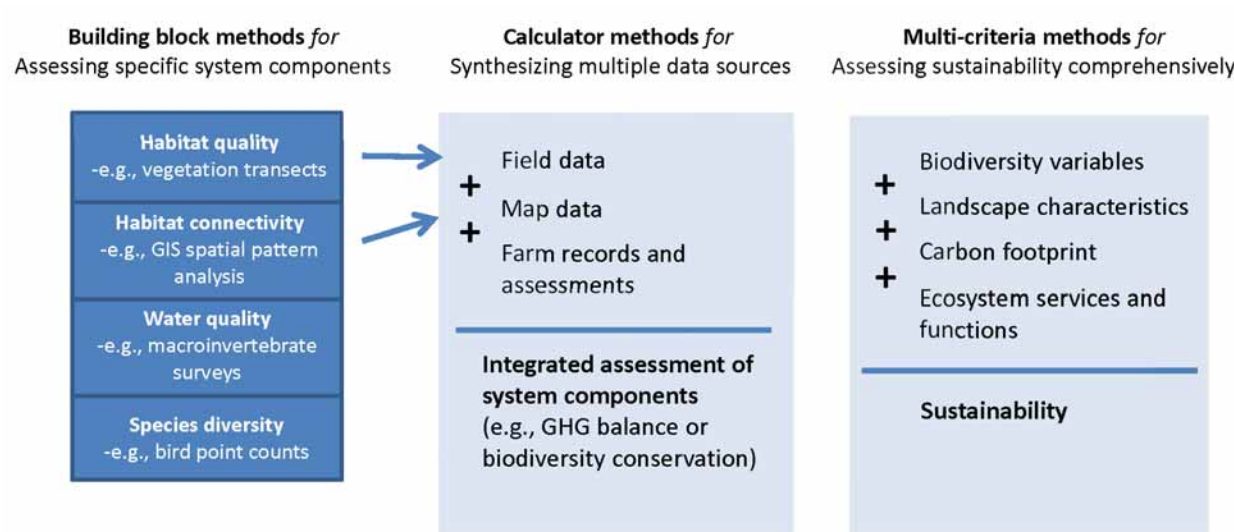


Figure 6: Types of methodologies to evaluate ecological impacts of sustainable agriculture. Building block methods are detailed protocols for assessing specific system components, usually based on field and/or remotely sensed observations. Calculator methods synthesize multiple data sources or measures—including data from building block methods, farm records, and pre-existing data sets—to provide an integrated assessment of a given system component. Multi-criteria methods compile and integrate data on several system components to provide a more comprehensive assessment of sustainability. Spatially explicit models may fall into any of these categories, depending on their purpose and scope.

“Calculator” methods synthesize data from multiple sources—including building block methods, farm records, interviews, or pre-existing datasets—to generate an integrated assessment of one or more system components. For instance, the Cool Farm Tool, developed by Unilever, the Sustainable Food Lab, and the University of Aberdeen, consists of a Microsoft Excel spreadsheet into which the user enters information about a farm and its management and context. The spreadsheet applies formulas to these raw data to produce a composite portrait of the farm’s greenhouse gas emissions in total and disaggregated by component (e.g., fertilizer emissions, livestock methane emissions, energy use, etc.). (For additional examples of calculator tools, see Appendix F.) By applying various conversion factors and environmental relationships previously established through detailed research, calculator tools are designed to provide relatively accurate impact estimates without the need for extensive field investigations. We refer the reader to a recent report by Kuneman and colleagues (2011) for additional review of current calculator tools for assessing agricultural sustainability.

“Multi-criteria” methods aggregate information on several system components to provide a more comprehensive assessment of a system’s sustainability. Similar to calculator tools, multi-criteria methods often combine data from field-based assessments, pre-existing datasets, and land manager records. These tools usually provide outputs as either a series of sustainability scores (e.g., represented in a radar diagram to indicate relative performance for different dimensions of sustainability) or as an aggregate measure that seeks to combine “apples and oranges” data into a single score. Multi-criteria methods may also rely heavily on calculators to assess system components. For instance, the Keystone Center’s Field-to-Market tool uses an Excel-based calculator to help farmers organize data and analyze impacts related to land use, soil loss, soil carbon, irrigation water use, energy use, and greenhouse gas emissions. For additional examples of multi-criteria methods, see Appendix F.

Within the five impact assessment categories that we reviewed, studies in some categories had relied mainly on building block methods, while others contained a greater proportion of studies based on calculator or multi-criteria approaches. For instance, the majority of studies assessing rare, threatened, and endangered species relied on basic field biology survey methods. In contrast, studies to assess watershed services, ecosystem composition and function, or ecosystem services mediated by soils and soil management were more likely to use calculator or multi-criteria approaches that combined multiple data sources and types, including data generated through the use of building block methods.

Using proxies to assess impacts

Proxies are commonly used in assessing ecological impacts of agricultural eco-standards. As discussed above, one of the most common, though indirect, proxies, is simply the adoption of an eco-standard or certification itself. However, a range of more sophisticated proxies is also used in impact assessment research. Proxies are used for a variety of reasons. Perhaps most commonly, they substitute a costly or time-consuming set of measurement with one that is simpler and easier. Proxies are also used to assess system components that may not be possible to measure directly.

Several types of proxies are used to assess the sustainability of agriculture. Typically proxies are adopted with some prior research to back their reliability. For instance, measurement

of a few soil physical and biological traits—some of which can be assessed qualitatively with minimal training—can provide a suitable proxy for assessing the impact of farming practices on soil health and farm sustainability (e.g., Gugino et al. 2009). However, proxies are sometimes adopted before adequate testing and validation has occurred. This is often the case when it is very difficult or impossible to measure the actual impact or phenomenon that the proxy seeks to estimate. For instance, land area in natural habitat is sometimes used as a first-order proxy for conservation value for biodiversity and ecosystem services in agricultural landscapes. While there has been a large amount of research on the general topic of habitat-biodiversity-ecosystem service relationships in agricultural areas, it is difficult to derive generalized relationships that can substantiate generic proxies for use across a wide range of crops and contexts.

A large amount of literature has explored the potential and pitfalls of nearly all conceivable manner of biodiversity proxies, including indicator species, indicator taxa, species as proxies for habitat quality, and habitat conditions as proxies for species. In short, this literature suggests that different plant and animal taxa respond to management changes in different ways, making it difficult to use just one taxon as a proxy for all others. The most cost-effective approach to derive an overall biodiversity status indicator may be to survey combinations of the lowest-survey-cost taxa within a given environment (Kessler et al. 2007). In addition, the indicator used to quantify species assemblage characteristics may affect how well a proxy taxon functions: community similarity measures are likely to be a more effective than species richness or abundance (Barlow et al. 2007).

Another approach is the use of remote sensing images and spatial statistics and metrics to provide proxy assessments of environmental and ecosystem characteristics. Such approaches have improved remarkably in recent years and offer great potential for cost-effective impact assessment of land management activities. Examples include new satellite and remote sensing technologies that can assess changes in land, water, carbon, tree species, and greenhouse gas emissions (e.g., Asner et al. 2010). Other proxies under revision and freely available online include greenhouse gas emissions calculators and soil erosion risk calculators (e.g., RUSLE 2011). Appendix G summarizes an illustrative set of proxies that may be of particular interest for ecological impact assessment of agricultural eco-standards.

Methods and tools to assess watershed functions and services

Watershed functions and services were most frequently assessed using one-time tests of water bodies or surveys of freshwater indicator species in water bodies near production units (Table 2). Participatory methods such as farmer interviews of water quality perception were also commonly used. However, there has been little attempt to assess watershed impacts of eco-standards at a larger scale: downstream water sampling was conducted in only a few studies, and we did not identify any studies that had conducted watershed modeling. In sum, assessments of eco-standards impacts on watershed services have been locally-focused, and generally have not considered the interactive effects of farm management and farm context (e.g., position in the watershed). Cumulative effects on watershed health, functioning, and provisioning of clean water to downstream users has also not been evaluated. This finding is not surprising given the challenges of conducting off-site impact assessment—including attaining permission

Table 2: Methods and tools to assess watershed functions and services.

Frequency of use categories are as follows: common = more than five studies; infrequent = 1-5 studies (out of n = 36).

Method or tool	Frequency of use
Chemical and/or biological water quality testing of water bodies near production units	common
Use of freshwater indicator species in water bodies near production units	common
Field-based monitoring of erosion, sedimentation, or turbidity (e.g., sediment traps or fences)	infrequent
Field sampling/testing at locations downstream or distant from production units	infrequent
Micro-catchment or watershed level hydrologic modeling	none
Participatory community methods (e.g., timelines, local expert opinion, etc.)	common

to sample sites outside of a production unit, lack of resources to conduct repeat sampling at multiple locations, and the difficulty of attributing changes in watershed services to agricultural management changes in a small portion of the watershed.

Given the importance of careful soil management and erosion control for ensuring the long-term fertility and viability of tropical agricultural lands, it is surprising that assessment studies only infrequently measured sedimentation or erosion through methods such as sediment traps or fences (Table 2). These are among the best methods to assess the impact of farming practices on soil loss—a measure that can have dual value for producers and impact evaluators. A few of the studies used turbidity measures as a proxy for sedimentation.

Although it has not yet been used in eco-standards impact assessment, hydrological modeling appears to hold significant potential for estimating watershed impacts of agricultural management practices across multiple scales. In addition, such modeling can combine field data (e.g., farm-level soil loss) with information on farm management changes and biophysical data that provide information on risks to watershed services (e.g., soil type, slope, adjacent land uses). Quite a bit of scientific research has gone into developing and testing such models (e.g., Krupnik 2004; Kirby and Durrans 2007; Brisbois et al. 2008). For example, a new eco-hydrologic forest and agricultural model (PnET-II3S) is able to predict the hydrologic response to land use and climate change dynamics over heterogeneous areas at landscape to regional scale (Kirby and Durrans 2007). This model has been applied in a few disparate settings, including the southeastern United States (Kirby and Durrans 2007) and mountain regions of South Korea (Park et al. 2011). See Appendix F for some additional examples of hydrological modeling tools with potential applicability to eco-standards impact assessment.

Methods and tools to assess rare, threatened, and endangered species

Impact assessment studies that examined rare, threatened and endangered species tended to focus on characterizing species assemblages in or near eco-certified production units (Table 3). In other words, these studies conducted field assessments to document all observed species within given taxa, such as birds or trees. Much less common were efforts to assess or monitor the populations of individual species of conservation interest, such as endangered or endemic species (Table 3). However, Rainforest Alliance is currently conducting some detailed studies

of species of conservation concern, including an assessment of habitat use by an endangered species of night monkey (Rainforest Alliance website).

Biodiversity is not as universally addressed by the major agricultural eco-standards as are some other environmental factors, such as soil and water (Potts et al. 2010). In addition, to the extent that biodiversity is addressed, impacts are often particularly challenging to assess because plant and animal populations are subject to natural fluctuations, multi-scale dynamics, and changes over long time horizons, such that the adoption of an eco-standard for a short period of time is just one of many factors affecting local and regional biodiversity (Treves and Jones 2010; Walrecht et al. 2012). In part due to these challenges, a recent review of the effects of eco-certification on biodiversity that stated, in sum: "...there is not enough evidence to support whether the use of certification schemes specifically enhances biodiversity or prevents biodiversity loss" (Walrecht et al. 2012:25). Nevertheless, in their review of wildlife-friendly eco-labels, Treves and Jones (2010) identified a few eco-labels (mainly minor ones) in which the presence or successful reproduction of particular species of conservation concern is embedded within the eco-standard or its verification process. Many years of experience from the forestry certification sector provide additional insights into the challenges and opportunities for monitoring biodiversity impact of eco-standards (see Box 4).

Although they are generally less time-consuming than detailed studies of individual species, assessment of animal species assemblages may not be a reliable way to identify or assess animals of conservation concern, which may be difficult to observe due to their rarity. Nevertheless, species assemblage data may provide an overall indication of the quality of a habitat on or near an eco-certified production unit. When repeated over multiple years (as many such assessments were), assemblage data can help indicate whether management changes (such as the adoption of agricultural BMPs) are abetting or harming the integrity of native ecosystems.

Assessment of eco-standard impacts on particular species of conservation concern is likely to remain challenging and, therefore, uncommon. As a general matter, it is time-consuming

Table 3: Methods and tools to assess rare, threatened, and endangered species.

Frequency of use categories are as follows: common = more than five studies; infrequent = 1-5 studies (out of $n = 36$).

Method or tool	Frequency of use
One-time field assessments of plant or animal assemblages (e.g., bird point counts or vegetation transects)	common
Repeat field assessments of plant or animal assemblages (e.g., bird point counts or vegetation transects)	common
Surveys of plant or animal indicator species	common
Long-term monitoring and/or population studies of particular rare, threatened, or endangered species	infrequent
Surveys (including via household interviews) of levels of hunting or poaching in or near certified production units	infrequent
Assessment of habitat proxies for particular rare, threatened, or endangered species (e.g., habitat size, condition, and landscape context)	infrequent
Participatory community methods (e.g., mapping, historical baselines, etc.)	common

and costly to monitor the status of animal populations through traditional methods such as mark-recapture or radio telemetry. The fact that many tropical species lack good basic natural history data would make it even more difficult to develop and implement efficient population monitoring protocols. Camera traps (motion-activated weather-proof cameras that are deployed in the field for extended periods) may be an effective way to monitor reclusive mammals, and have recently become more popular among researchers as the cost of the equipment has dropped.

In light of these challenges of single-species monitoring, assessment of species assemblages is an appealing alternative. Since different taxonomic groups of plants and animals tend to respond to human land management activities in different ways, it is best to survey several taxa, if possible. Taxa that are both relatively cost-effective to monitor and frequently more predictive of overall biodiversity status include butterflies, ants, birds and wasps. Assessment of tropical plant

Box 5: Insights from the forestry sector

Scaling-up of eco-certification occurred earlier and more rapidly in the forestry sector than in the agriculture sector: as of 2012, nearly 150 million hectares were under Forest Stewardship Council (FSC) certification and 245 million hectares were certified under one of the national forest certification systems endorsed by the Programme for the Endorsement of Forest Certification (PEFC) (source: FSC and PEFC websites). This vast extent of certification activities, combined with the obvious importance of standing forests for biodiversity and ecosystem conservation, has led to considerable interest in assessing the ecological impacts of forestry certification. Several recent documents provide helpful overviews of key literature and issues related to ecological impact assessment of forestry certification:

- A 2009 FSC report entitled “FSC reflected in scientific and professional literature” (Karmann and Smith 2009) conducted a broad review of the literature on the environmental, social, and economic effects of FSC certification. Some of the reviewed studies addressed impact-level environmental results, while others focused on documenting management changes implemented to comply with forestry certification requirements.
- A 2009 study on the effects of forest certification on biodiversity reviewed 67 studies to assess whether forest biodiversity is higher in well-managed forest units than in conventional forest management units (van Kuijk et al. 2009). The review highlights the difficulty of arriving at a generalized answer to this seemingly simple question. Despite the large number of studies reviewed, the lack of comparative data (e.g., from control management units) confounds clear conclusions, while the wide range of forestry systems, contexts and biodiversity targets studied results in large variations in both forest BMPs and their impacts. In sum, the authors find suggestive but not conclusive evidence that forest certification benefits biodiversity.
- Gullison (2003) addresses the question of local versus aggregate impacts in his paper entitled “Does forest certification conserve biodiversity?” His analysis suggests that FSC certification benefits biodiversity in the places where the standard has been adopted, but, on aggregate level, has not been widespread or influential enough to address the much larger problem of tropical deforestation and its associated biodiversity loss. Gullison’s broad framing of the question of

biodiversity impacts poses a challenge to those who seek to assess impacts of eco-certification at a systemic level, not just at the producer level.

- A 2008 synthesis paper by Auld and colleagues gives further consideration to the above-mentioned issue of broader impacts by exploring the geographic distribution and uptake of forestry certification, as well as mechanisms driving these patterns and consequences for the conservation of High Conservation Value Forests. The review notes that the uptake of forestry certification is heavily skewed toward temperate and boreal forests, and may have little benefit for slowing tropical deforestation. The analysis highlights the need to understand direct impacts of certification systems, as well as indirect, long-term, and spillover effects that may have quite different implications.

The preceding examples are just a sample of the work that has been done to evaluate ecological impacts of forestry certification; citations in the above papers will direct the reader to other key literature.

Going forward, there appears to be interest and commitment on the part of the forest certification community to continue improving the impact orientation of its activities, subject to the same limitations of cost and administrative burden to producers (forest managers), auditors, and certification bodies that are observed in the agriculture sector. Because of the large scale of many certified forest operations, remote sensing offers a particularly appealing set of tools to monitor changes in forest species composition, carbon stocks, and other ecosystem properties. Both FSC and PEFC are members of the ISEAL Alliance and are in the process of developing internal M&E systems pursuant to ISEAL's Impact Code.

diversity should incorporate lianas (vines), as these are a major component of many tropical forests, and are often indicative of disturbance.

Although we did not identify any studies that had used remote sensing proxies to assess impacts of agricultural eco-standards on biodiversity, several new remote sensing technologies and methods hold promise for cost-effective biodiversity monitoring. For instance, remote spectroscopy and light detection and ranging (LiDAR) appear on the verge of being viable monitoring methods for large tracts of diverse tropical forest. Such technologies rely on building knowledge of individual species' spectral signatures, which may then be used as proxies to deduce forest species composition from remote sensing imagery (Asner and Martin 2009). Researchers have focused on using this technology to map tropical forest canopies and understand species turnover. For instance, with just 11 chemical traits derived from leaf spectra, Asner and Martin (2011) were able to discriminate over 300 Amazon rainforest canopy tree species. Such technologies could be a fast and informative way to infer biodiversity impacts in agroforestry systems and agriculture-forest mosaic landscapes.

Methods and tools to assess ecosystem composition and function

Recent years have seen a proliferation of interest in linking biological diversity to the provision of ecosystem services. Many agricultural eco-standards require farmers to retain habitat remnants (e.g., riparian buffers or forest patches) on their properties and/or manage production plots in ways that more closely mimic natural habitats (e.g., coffee agroforestry). Several of the reviewed studies assessed ecosystem composition through one-time or repeat field

assessments of ecosystem composition and structure, such as tree diversity or forest structure (Table 4). There is a wide range of established methods in community ecology to conduct such assessments. Within the scientific community, there has been much effort to link biodiversity to ecosystem functions through the use of plant functional characteristics (Chapin et al. 1998); however, this set of methods was not used in any of the studies we reviewed.

Interestingly, we did not identify any assessment studies specifically addressing invasive species in eco-certified farming areas, although a plethora of building block methods and tools are available to conduct such assessments (e.g., Maitima et al. 2009; Kellner et al. 2011; Parker et al. 2011). Nevertheless, invasive species may be a significant threat to agriculture in some regions, and assessments may thus be important for management as well as evaluation purposes. Of particular interest is whether eco-certified farms that use fewer or no chemical control mechanisms are able to control invasive species as well as conventional farms that may deploy additional chemical defenses.

Assessment studies only infrequently investigated particular species that are believed to provide ecosystem services (e.g., crop pollinators, leguminous tree species, crops known to deter pests in plantations) (Table 4). Nor did studies often employ remote sensing techniques to evaluate ecosystem services, although there are currently several technologies that could make such measures faster and more cost effective (e.g., Feng et al. 2010; Lautenbach et al. 2011). In lieu of these biophysical measures, evaluators were more apt to use interviews and structured questionnaires to assess ecosystem services. Such methods can be fraught with problems, including lack of knowledge on the part of respondents, bias or misperceptions, variability in individual perceptions and memories of environmental change, and intentional distortions on the part of respondents for strategic reasons. On the other hand, farmers are able to observe local ecosystems continually and may have a longer historical perspective than outside scientists. Thus, interviews and participatory methods may provide a good starting point to characterize ecosystem changes and formulate hypotheses about production-ecosystem service relationships. In addition, there is ample guidance available in the social science literature about how to structure such data collection to reduce bias and increase reliability. However, biophysical studies are usually still required to reveal causal relationships between eco-standard adoption and the provision of ecosystem services.

Table 4: Methods and tools to assess ecosystem composition and function.

Frequency of use categories are as follows: common = more than five studies; infrequent = 1-5 studies (out of $n = 36$).

Method or tool	Frequency of use
One-time field assessments of ecosystem composition and structure	common
Repeat field assessments of ecosystem composition and structure	common
Field-based assessments of invasive species	none
Field-based assessments of species believed to provide ecosystem services (e.g., native pollinators or species that contribute to biological pest control)	infrequent
Assessments of ecosystem composition and/or function based on remote sensing imagery or data	infrequent
Participatory community methods (e.g., mapping, timelines, etc.)	common

Methods and tools to assess soil characteristics

Assessments of soil quality and characteristics have obvious value to farmers—particularly those seeking to farm with a minimum of chemical fertilizer application. The current trend is to measure soil characteristics in one-time surveys or field assessments (Table 5). The use of qualitative assessment measures (household surveys and questionnaires) and proxy measures for soil characteristics (e.g., tilling methods) were also common (Table 5). Repeat assessments or longer-term monitoring of soil characteristics and impacts were infrequent.

Given the value of soil monitoring information for farmers and other supply chain actors, there may be a credible business case for institutionalizing soil impact assessment widely throughout eco-standards systems. To do so, however, will require the adoption and mainstreaming of more cost-effective data collection and analysis methods. Proxies, calculator tools, and remote sensing may all have a role to play (see Appendices F, G, and H for some specific examples). Some proxies and calculator tools may be implemented mainly by farmers or auditors, while remote sensing requires specialized expertise and is more appropriate for monitoring large eco-certified farms or portfolios of small certified farms in specific regions.

In the remote sensing domain, new sensors and analysis techniques are now permitting high-quality surface and sub-surface soil mapping, which may be deployed at scale for much lower cost than field-based measurements. At a plot scale, several technologies could be applied to gather very accurate information about farming impacts on soil. For example, a study by Wells and colleagues (2007) used infrared laser scanning to characterize the soil surface micro-relief during a rainstorm to predict erosion potential and variability in soil surface characteristics. At a catchment scale, light detection and ranging LiDAR technology has the potential to provide detailed overland water flow and erosion maps of the soil surface, but sensor outputs currently require some data processing to account for slope and topography (Lloyd and Atkinson 2002; Davenport et al. 2003). Radar interferometry may be used to measure subtle changes in the ground surface over time, as would be expected due to soil erosion or accretion associated with farm management practices (Massonnet and Feigl, 1998). While such emerging technology will require some effort to adapt to the context of agricultural eco-standards, its promise is the

Table 5: Methods and tools to assess soil characteristics and soil ecosystem services.

Frequency of use categories are as follows: common = more than five studies; infrequent = 1-5 studies (out of n = 36).

Method or tool	Frequency of use
One-time field assessments (e.g., of soil pH, organic matter, or percent ground cover)	common
Repeat field assessments or long-term soil monitoring (e.g., of soil pH, organic matter, or percent ground cover)	infrequent
Surveys and interviews to assess farmer perception of soil quality	common
Assessment of soil proxies (e.g., tilling methods) for ecosystem services mediated by soils and soil management	common

ability to provide more efficient, more replicable, and more scalable assessments of the impacts of agricultural practices.

Methods and tools to assess carbon sequestration and greenhouse gas emissions

In recent years, there has been increasing awareness of the important role of agriculture in climate change and its mitigation, and a corresponding interest in assessing the greenhouse gas (GHG) implications of agriculture. Consistent with this trend, a sizable number of eco-standards impact assessment studies have evaluated on-farm aboveground carbon stocks (Table 6). These studies have generally involved a substantial amount of field work, including plant identification and measurement to apply allometric equations that approximate above-ground biomass. (Allometric equations for carbon assessment are formulas or lookup tables that relate a tree's biomass to its dimensions—often easily measured dimensions such as diameter at breast height—based on pre-established relationships for different species.)

The past several years have witnessed great improvements in the accuracy, cost-effectiveness, and accessibility of tools to monitor GHG emissions from agriculture. Free online farm GHG calculator tools are currently available (e.g., Hillier et al. 2010; Pandey et al. 2011). Within the context of agricultural eco-standards, such tools have been used mainly in an exploratory manner, and few formal impact assessments have been published (Table 6). Nevertheless, such tools are now beginning to be incorporated into farmer self-diagnosis as well as assessment studies by some eco-standards setters and verifiers.

While calculator tools are appealing for their potential to be applied relatively easily and cost-effectively by farmers or auditors, an additional set of new remote sensing tools holds great potential to increase the speed, accuracy, and efficiency of carbon stock and greenhouse gas emissions estimations over larger areas (Asner et al. 2010; Castillo-Núñez et al. 2011). To our knowledge, these have not yet been applied in the context of agricultural eco-certification. Among these tools are new radiowave, microwave, and satellite imaging technologies (e.g., Asner et al. 2010; Saatchi et al. 2011). For instance, satellite imagery may now be used to identify tree

Table 6: Methods and tools to assess carbon sequestration and greenhouse gas emissions.

Frequency of use categories are as follows: common = more than five studies; infrequent = 1-5 studies (out of n = 36).

Method or tool	Frequency of use
Assessment of changes in carbon stocks over time within the production unit	common
Estimation or modeling of greenhouse gas emissions associated with agricultural operations	infrequent
Assessments of the impacts of certification on off-site land-use and carbon dynamics (e.g., reduced or avoided deforestation or forest degradation)	infrequent
Use of High Conservation Value (HCV) approach tools	Infrequent

species, canopy height and density of forest wood, and such methods are becoming increasingly accurate at estimating changes in carbon stocks (e.g., Asner et al. 2010; Pandey et al. 2011).

A recent study by Asner and colleagues (2010) demonstrates the value of new airborne light detection and ranging (LiDAR) technologies for monitoring Reduced Emissions from Deforestation and Degradation (REDD) and other conservation programs. These researchers used LiDAR combined with field calibration plots and satellite imagery to create high-resolution maps of large tracts of forest and to estimate aboveground forest carbon densities. The study also provided data on carbon emissions by comparing the present condition to retrospective forest maps. Although LiDAR itself is still an expensive technology, this study demonstrates that combining it with satellite images and ground calibration plots may decrease the cost and increase accuracy of monitoring aboveground carbon stocks and emissions at landscape to regional scales (Asner et al. 2010).

Plot and landscape scale assessments of carbon stocks and GHG emissions each have their benefits and drawbacks. Plot based studies may provide very accurate local assessments but generally require considerable time and effort to complete. Calculator tools decrease cost but also accuracy, especially on heterogeneous plots with diverse vegetation. Plot-based studies of GHG dynamics may be difficult to extrapolate to landscape or regional scale, not only because of heterogeneity within and between land use types, but also because sample plots themselves may not reflect the most important landscape dynamics, such as deforestation. Nested sampling that combines plot scale assessments with remote sensing tools may provide the best combination of cost and accuracy, while linking the adoption of eco-standards to broader landscape and regional dynamics. Standards setters and environmental advocates have recently become more interested in this broader perspective, particularly as new efforts to certify bulk tropical commodities (e.g., soybeans and oil palm) recognize that the sine qua non of success is to arrest the process of tropical deforestation in areas with high carbon stocks and high conservation value.

4. TOWARD IMPROVED IMPACT ASSESSMENT APPROACHES AND METHODS

The literature review and interviews shed light on both the need and the opportunities for expanding and improving the assessment of ecological impacts of agricultural eco-standards. Despite this mandate, however, the field remains in its infancy. To move beyond general statements about what could be done to more specific proposals for what should be done and how, it is helpful to analyze operational needs and barriers with greater precision. Figure 7 provides a heuristic for doing so, by examining three important questions about how the costs, benefits, and opportunities for enhanced impact assessment:

1. Which impact measures are likely to be useful for farmers—for instance, to enable them to manage their farms more efficiently and profitably? Which measures are useful mainly for other supply chain actors—for instance, to help food companies increase the reliability of agricultural raw material supplies or demonstrate social responsibility to consumers? And which measures are of limited direct interest to farmers or supply chain actors, but must nonetheless be assessed to maintain the long-term credibility of agricultural eco-standards?
2. Which ecological impacts can be assessed to a meaningful degree with existing audit data? Which would require additional data collection and analysis either by non-experts or by trained scientists?
3. Which impacts can be measured satisfactorily at site scale? Which require aggregation of site level data to broader scales? Which require consideration of spatial context and configuration at a landscape scale or beyond?

The answers to these questions can help point the way to realistic, scalable, and cost-effective impact assessment programs. For instance, with respect to the first question, several interviewees noted the importance of developing impact metrics that are sources of value for farmers and supply chain actors, rather than simply additional costs of becoming certified:

“We need to find sustainability metrics that simultaneously provide value for producers and companies. There is a lot of resistance from farmers to additional data collection. The big question with impact assessment is: what’s in it for farmers?”

—Eco-standard/certification entity

Several ecological indicators are likely to be of interest to farmers because they can help increase input use efficiency, reduce waste, and maintain fertile soils (Figure 7, Panel A). Some farmers may voluntarily conduct such assessments as a farm management tool, provided that they have access to technical assistance, as is beginning to be seen with some of the farm calculator tools. The resulting data could also serve an evaluation purpose. At the same time, it is important to recognize that not all of the environmental indicators needed to assess the performance of eco-standards are likely to be of great interest to farmers. For instance, demonstrating the benefits of certification for endangered species conservation or reduction of tropical deforestation may be seen as the “holy grail” for conservation-oriented certification schemes. But the cost of conducting such assessments is likely far to exceed the direct benefit

to any individual farmer or to most supply chain actors. Such studies should therefore be considered as “public goods” for the eco-standards community that benefit the entire field, but are likely to require a dedicated source of funding.

For most eco-standards, the potential to use audit data that are already being collected through the routine verification process to assess key ecological impacts appears to be fairly limited (Figure 7, Panel B). But this does not necessarily mean that costly commissioned research is needed. Reliable data on many ecological impacts could be collected by local para-professionals, supplemental data collection by auditors, or through farmer self-reporting. “Research quality” scientific studies are most likely to be needed to demonstrate impact on watershed health or on biodiversity, including particular species of conservation concern.

Now that agricultural eco-standards have begun to be mainstreamed, at least for certain crops and certain segments of the food and beverage market, there is a commensurate interest in assessing the impact of scaling up such commitments to sustainability. In some cases, larger-scale impacts may be understood adequately simply by aggregating farm-scale impacts across a region, value chain, or investment portfolio, for instance. This is often the case for social and economic benefits, and for assessments of greenhouse gas dynamics; it may also be the case for certain soil, water, and vegetation metrics (Figure 7, Panel C). Conversely, rigorous understanding of impacts on biodiversity and on the provision of watershed services is likely to require consideration of the context and configuration of certified production units, relative to other land uses, within a landscape or region. This broader focus, in turn, introduces challenges of attribution because landscape outcomes are influenced not only by eco-standards adoption but also by changes on nearby land parcels and beyond.

Linking Approaches to Maximize Relevance and Cost-Effectiveness

The analysis above suggests that the practice of ecological impact assessment for agricultural eco-standards should combine a variety of approaches, data types, and methodologies to strike an optimal balance between relevance for multiple stakeholders, cost-effectiveness, and rigor. This overall “portfolio” of impact assessment approaches may be thought of as a pyramid (Figure 8).

At the base of the pyramid are sources of data that are already being collected, including farm-level audit/verification data and existing datasets from other sources, such as land use maps, satellite images, or government records or monitoring programs. As indicated in Figure 7B, certain ecological outcomes and impacts could be assessed through the use of such data. The extent to which audit data may be suitable for impact assessment varies quite a bit from standard to standard, depending on the set of practices and outcomes required to achieve certification. In most cases, “re-purposing” audit data to serve the additional function of impact assessment would require changing how these data are collected, stored, and analyzed. For instance, data might need to be collected electronically on handheld mobile devices instead of on paper forms, georeferenced through the use of the Global Positioning System within the mobile device, and uploaded to a central data repository for processing and analysis. Such analysis may include the use of calculator tools (e.g., for certain soil, water, or greenhouse gas impacts) or the generation of descriptive statistics on aggregate impact measures across specific crops, supply chains, or geographies. Because audits tend to be conducted regularly

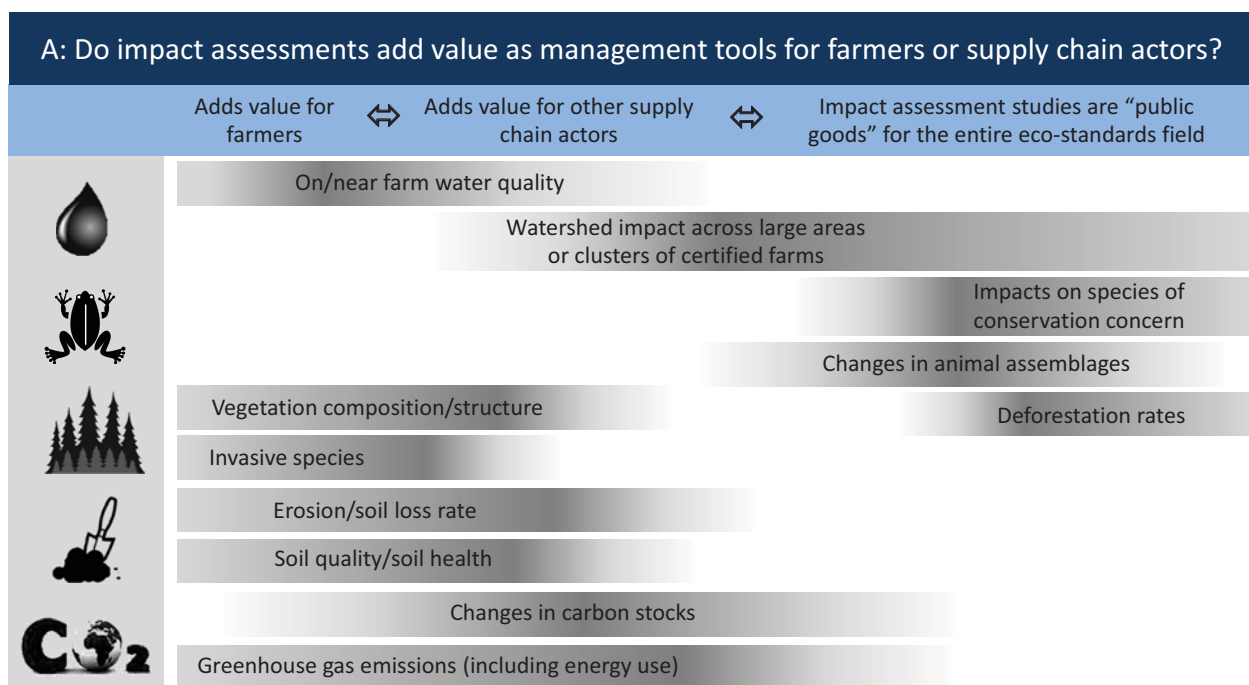
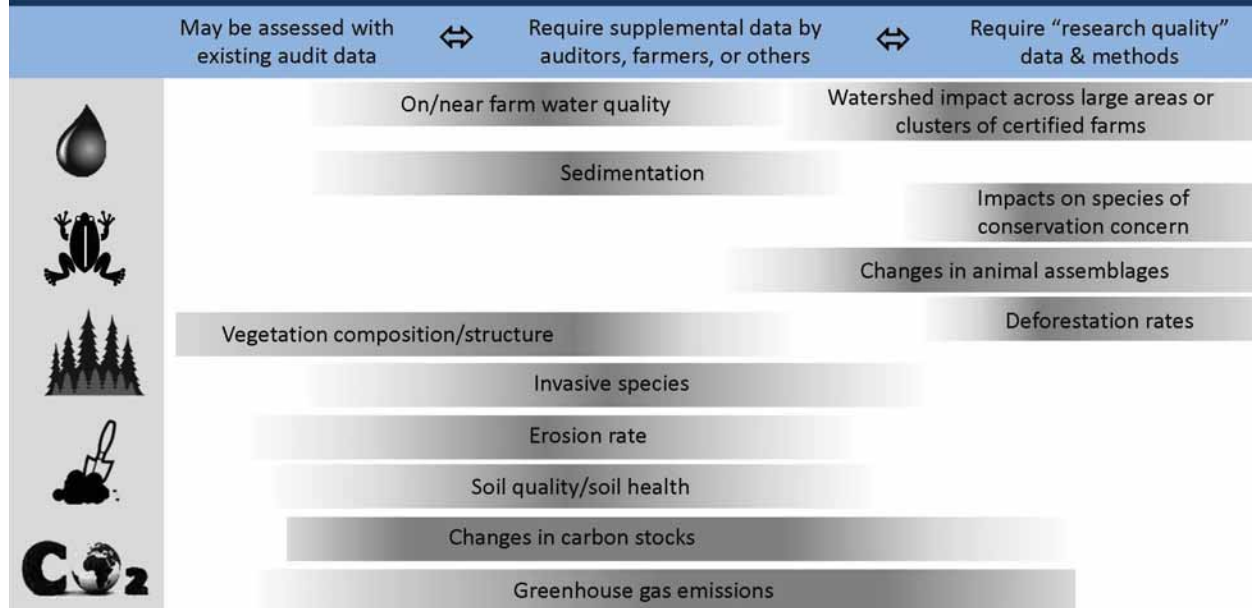


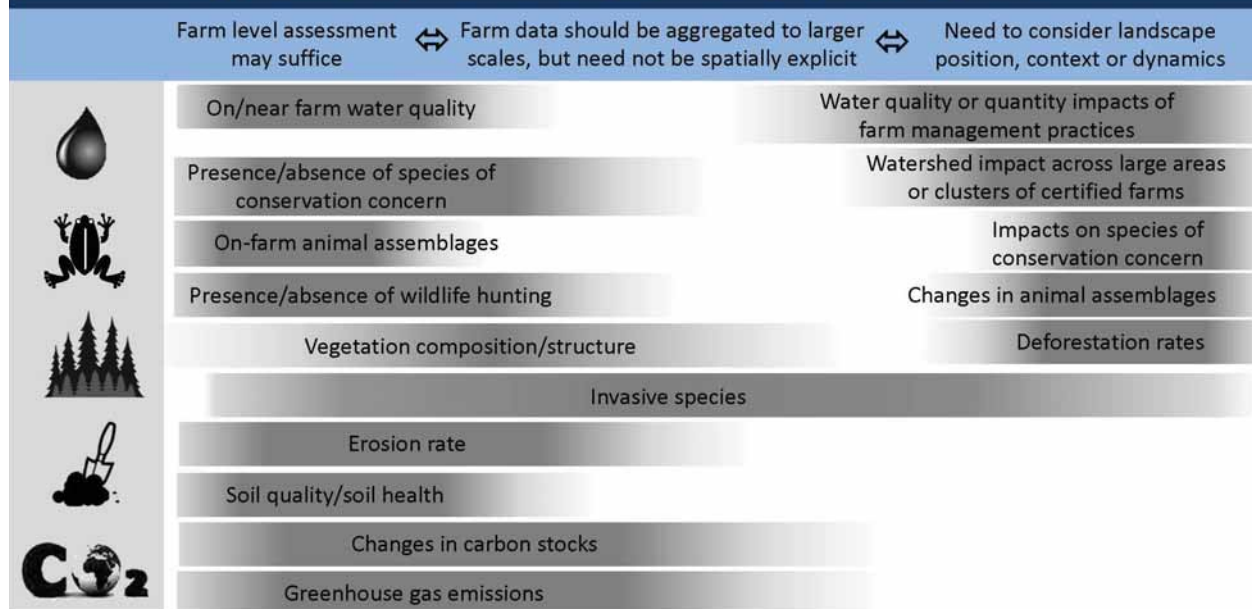
Figure 7: Heuristic for understanding impact assessment opportunities and constraints.

The three-panel series indicates key opportunities and constraints for assessing different types of ecological impacts of agricultural eco-standards. **Panel A** analyzes whether assessments add value for farmers and/or other supply chain actors, or whether they are of general benefit to the eco-standards field but little incremental value to individual entities. **Panel B** analyzes the extent to which each impact assessment category might be satisfactorily evaluated using existing audit data or supplemental data collected by local actors, or whether rigorous scientific research must be conducted. **Panel C** analyzes whether a landscape scale perspective is needed to understand impacts, and, if so, whether this must be spatially explicit, considering the location and configuration of certified farms within the landscape or watershed and relative to other land uses. The icons on the left side of the figure indicate (from top to bottom) measures related to watershed services, biodiversity of conservation concern, ecosystem composition and function, soil, and greenhouse gas emissions/carbon sequestration. The placement of each of the ecological measures within these figures is indicative, and not meant to be definitive; it could vary depending on the particular crop, eco-standard, or context. Please see the text for additional discussion.

B: Can impacts be assessed with existing data, or are new data needed?



C: Does impact assessment require a landscape-scale perspective?



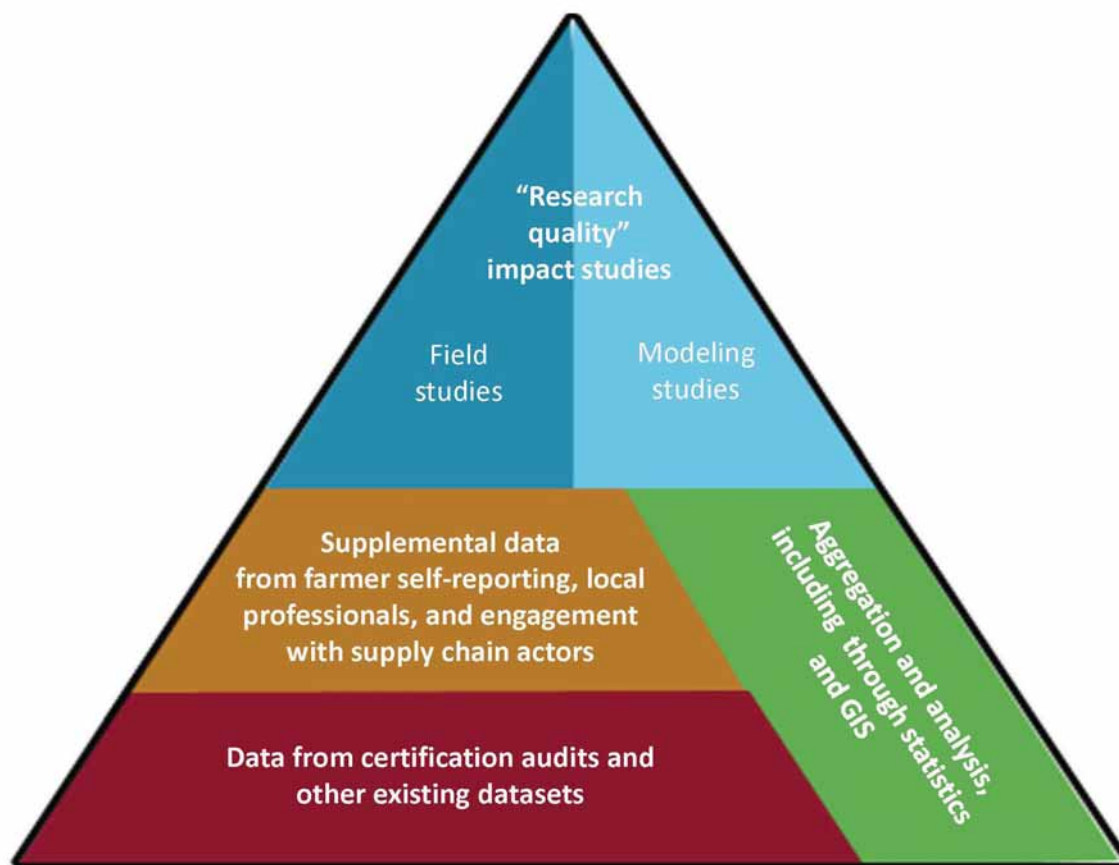


Figure 8: Pyramid of impact assessment approaches.

The diagram suggests a model by which impact assessment efforts may combine multiple approaches, data types, and methodologies to strike an optimal balance between relevance for multiple stakeholders, cost-effectiveness, and rigor. Please see the text for additional explanation

for all certified producers (or groups of producers), this foundation of the “impact assessment pyramid” could inform broad, system-wide impact measures for certain ecological impacts.

The next level of the pyramid consists of supplemental data collection that is outside of the scope of routine certification audits but may be provided with only a moderate amount of additional effort and cost, relying mainly on local actors. For instance, farmers or supply chain intermediaries may self-report on certain management practices (such as quantities of applied agricultural inputs), auditors may be trained to conduct certain limited field data collection (such as measures of stream turbidity or canopy cover estimates), or local para-professionals may be trained and hired to conduct farmer interviews or carry out relatively simple measures of soil, water, or vegetation. As with the audit data, these data would be most useful if collected electronically in a standardized manner, for subsequent aggregation and analysis. Because they will usually entail some additional cost, these supplemental measures would not necessarily be applied across an entire portfolio of eco-certified production units, but rather for some representative sample thereof.

At the top of the pyramid are “research quality” impact studies, which typically require the involvement of a trained scientist. Such studies are essential for increasing the credibility of environmental claims related to agricultural eco-standards. And they are helpful for validating the accuracy of more cost-effective impact assessment methods, such as greenhouse gas or biodiversity calculator tools, such as those described in Appendix F. Methodologies for research quality studies may involve field-based assessments, landscape or watershed modeling, or some combination of the two. In the experience to date, research quality studies have rarely been funded through the regular operating income (e.g., certification fees) of eco-standards or certification bodies. Instead, they have required dedicated funding sources (such as grants or one-off “special project” allocations) and/or the formation of partnerships with researchers who can bring some of their own funding. The position of research-quality studies at the top of the pyramid indicates that these studies are too costly to constitute the major portion of a comprehensive impact assessment approach. But they are essential and should be strategically linked to the lower levels of the pyramid such that the research quality studies validate and calibrate the less costly assessments that are being applied more widely across the full array of eco-certified producers.

Standardization and Collaboration

Among the interview respondents, there was considerable interest in exploring the potential advantages of establishing standardized ecological impact metrics that could be agreed upon by a wide range of stakeholders and applied industry-wide. The following quotation exemplifies many of the main motivations of those in the eco-standards field to pursue standardization:

“Every stakeholder group realizes the limits of where they can go on their own. We need standardized metrics that can be measured through the audit, as well as others that can be measured through additional research conducted by third parties. This would include not only farm-level work, but also aggregated work. Multi-stakeholder efforts can help overcome the challenges of measuring sustainability and demonstrating impact at scale.”

-Evaluation officer for a non-profit eco-certification body

In fact, efforts to standardize environmental performance metrics for agricultural eco-standards are already underway. For instance, among private sector agricultural standard-setters and food companies, the SAI (Sustainable Agriculture Initiative) Platform has initiated efforts to align all of its members around a common set of Principles and Practices—including outcome and impact measures—for major crops. In the environment domain, this effort is oriented around soil fertility/loss, water, biodiversity, energy, and waste, in addition to a unit on sustainable farming systems, which is also relevant to environmental outcomes. On the side of civil society eco-standard setters, the ISEAL Alliance’s Impacts Code also seeks to standardize monitoring and evaluation systems to include the following six environmental themes: water, soil, biodiversity, energy, carbon, and natural resources (which includes ecosystem services and ecosystem

management). Thus far, ISEAL's initiative has provided less specific guidance on standard environmental outcome/impact metrics than the work of the SAI Platform.

An additional key effort to develop standardized operational metrics for assessing impacts of agricultural eco-standards is the work of the Committee on Sustainability Assessment (COSA). Through a consultative process involving scientific experts as well as standard-setting bodies and a wide range of agricultural value chain stakeholders, COSA has developed a large list of indicators of economic, social, and environmental sustainability. The intent is for those interested in impact assessment to apply either the full set or sub-sets of these indicators to address their specific assessment needs. COSA has been facilitating the pilot testing and initial implementation of this assessment approach through a model that seeks to develop in-country capacity to carry out assessments well into the future.

All three of these standardization efforts exemplify the important principle of “global consistency and local applicability.” In other words, the initiatives recognize that there is value in standardizing the categories of impacts that are measured across all standard-setters, crops, and geographies. However, the specific indicators used to assess each impact category are likely to differ by crop and region. For instance, biodiversity assessment is included as an environmental impact category by SAI Platform, ISEAL, and COSA, but the indicators of biodiversity impact will differ between an agroforestry system (e.g., shade-grown coffee) and a crop that is commonly grown in extensive monoculture (e.g., sugar or soy). Specific indicators of relevance may also differ among standard-setters, depending on the degree to which each standard-setter is oriented toward producers, donors, end-consumers, or intermediate buyers (business-to-business).

On balance, although the idea of having a universal set of environmental impact indicators is appealing in concept, it has historically proven impractical in reality due to the difficulty of achieving consensus across a diverse group of stakeholders. There is little reason to believe that this situation will change. Nevertheless, there may be certain universal indicators that are relevant across all crops, regions, and standards; a possible example is net greenhouse gas emissions per unit of product. In addition, groups of standard-setters that have very similar orientations (such as the private companies represented by the SAI Platform) are more likely to be able to agree on common indicators. Existing coordination platforms such as the ones described above are well-positioned to identify and promote the adoption of such universal indicators. In addition, there is much to be gained through pre-competitive collaboration among non-profit and private sector standard-setters related to the sharing of impact assessment methods, tools, and results. In this vein, the efforts described above could be expanded upon in the following ways:

- Sets of standard-setters together with scientific experts could collaborate to develop and test additional calculator tools (such as has already been done with the Cool Farm Tool and Field-to-Market) that could be applied industry-wide.
- Sets of standard-setters could collaborate to develop a versatile information technology infrastructure to facilitate impact assessments. This infrastructure would serve to manage and analyze audit and field data to derive synthetic and aggregate impact metrics, as depicted in the bottom two-thirds of the impact assessment pyramid (Figure 8). Since many standard-

setters would have similar needs and uses for such infrastructure, the costs of development could be split among several users.

- Establishment of a network or learning platform of impact assessment specialists that would work to develop common protocols for impact assessment work such that results could be compared across sites and systems. Without dictating which indicators are used to measure a given environmental impact area, the network would help to standardize the way in which each type of indicator is actually measured.
- An open-access “knowledge asset base” could be created to amass and share information about the ecological impacts of eco-standards. This resource could facilitate the derivation of broader lessons through systematic review of agricultural eco-standards impact assessment studies, as well as the establishment of a comprehensive evidence base from which impact assessment messages could be crafted for different audiences.

Are New Tools and Methods Needed?

As enumerated in the earlier section on Impact Assessment Methods and Tools, a plethora of methods and tools has been developed to assess the ecological sustainability of agroecosystems and rural landscapes. To help understand why these tools have barely been applied in the context of agricultural eco-standards, we invited respondents to characterize what they perceived to be the needs for better or more practicable tools (Figure 9).

Overall, respondents perceived the need for new assessment tools at both the farm scale and the landscape scale, as well as tools that are more cost-effective and more suitable for application by auditors and verifiers. This result suggests that respondents are either unaware of existing tools that were developed and applied in a scientific research setting, or feel that these tools are not readily applicable in the context of eco-standards. Of the needs identified, the development of more precise farm-scale assessment tools was viewed as the least important improvement (but still relatively important), except in the soils category, where it was viewed as quite important (Figure 9). With respect to water, biodiversity, and ecosystem composition and function, respondents perceived a high need for more precise landscape-scale tools. Also very important was the development of tools that are less expensive to apply and better suited to implementation by certification auditors. Eco-standards practitioners see such tools as a critical mechanism for helping to overcome funding and personnel limitations, which now constitute the greatest barriers to impact assessment work. Overall, as the following quotation suggests, such “operational” tools constitute perhaps the greatest need, even though other needs were also identified:

“It’s not so much a challenge of the precision of the tools, but how we get them into practice in a real way.” - Eco-standard/certification entity

The needs identified in Figure 9 correspond well with the analysis in Figure 7C of the relative importance of farm- versus landscape-scale metrics for each of the impact assessment categories. For assessment of soil condition, soil-related ecosystem services, and greenhouse gas dynamics, the greatest need is to increase the applicability and uptake of cost-effective farm-scale tools. For instance, the Field-to-Market tool offers good potential as a farm-scale impact assessment calculator, but is applicable only to a few major crops in the United States, and has

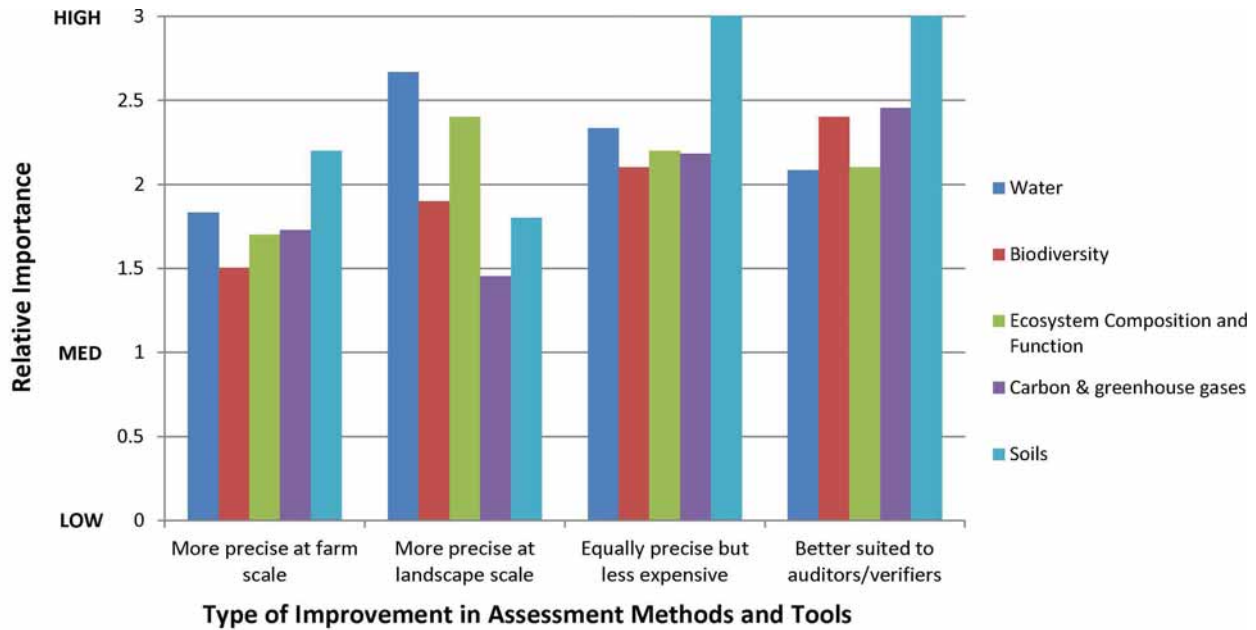


Figure 9: Importance of improvements in assessment methods and tools.

The graph summarizes responses from representatives of ten eco-standards bodies and nine eco-standards support organizations. Responses were scored as follows: top priority = 3, medium priority = 1, less important = 0. Total scores were divided by the number of respondents to generate mean importance ratings.

been applied mainly on a voluntary pilot basis. If farm-scale calculator tools could be developed that were suitable for a wider range of tropical crops, these could be mainstreamed to improve impact assessment across many agricultural eco-standards. An additional need for most of the farm-scale calculator tools is to conduct additional research to test the accuracy of the tools against in-depth field measurements.

For assessment of biodiversity, watershed services, and other ecosystem services, respondents identified a particular need for new landscape level tools that can estimate the impact attributable to eco-standards adoption over larger areas. Whereas the cost and labor-intensiveness of landscape and regional scale studies has been a significant barrier to date, new remote sensing technologies may make larger-scale assessments significantly more cost effective, transparent, and feasible to certification and standards bodies in the near future (for examples, see Appendix H). In just the past few years, great gains have been made in the accuracy and precision of remote sensing technologies to monitor features such as soil moisture and texture, carbon stocks, and forest species composition. Predictive watershed models also offer the potential to estimate the specific contributions of eco-certified farm parcels to watershed health at larger scales. Although it will require dedicated effort to adapt these types of technologies to develop specific methodologies for assessing agricultural eco-standards, such investment is likely to be cost-effective in the long run, as certifiers and supply chain actors seek to understand impacts over large areas.

Another strategy is to invest in studies that test the accuracy vs. cost tradeoffs of multiple methods for tracking a particular impact. For instance, one simple proxy that is used to approximate biodiversity impacts is the quantity of habitat conserved, set aside, or restored within agricultural management units (e.g., King et al. 2010). More elaborate biodiversity proxies such as the Habitat Hectares metric (Parkes et al. 2003; see Appendix G) will be more expensive to apply but will likely provide more nuanced information on conservation outcomes. Field measurements of plant and animal species are the most direct measure of biodiversity, but also the most expensive to conduct. By testing multiple types of proxies and measures in the same location, researchers can help to identify the “good enough” point at which eco-standards bodies are able to tell a compelling and credible story about their impacts, at a minimum of cost.

Across all environmental impact categories, the appeal of calculator tools is evident. Such tools can combine relatively easy-to-collect data from farm records, management practices, and simple outcome measures with context data from various sources that help to interpret the significance of management practices within the given context. However, to serve widely as credible impact assessment methods, such tools must be validated through testing across the range of contexts in which they will be applied.

5. MAKING IT HAPPEN

This review highlights a clear need for a stronger results orientation and enhanced impact assessment activities within the agricultural eco-standards field. This final section discusses the practicalities of how such a change might come about.

We invited the practitioners who we interviewed to assess the most important opportunities and barriers for moving the agricultural eco-standards field toward a more rigorous, outcome-based approach to assessment, monitoring, and improvement of ecological outcomes over the next 5-15 years. Not surprisingly, many practitioners indicated the shortage of funding and human capacity to be the most significant limitations (Figure 10). However, the availability of partners outside eco-standards bodies was felt to be a significant opportunity. Interestingly, respondents from eco-standards setters and certification bodies suggested that the existing culture of such bodies was conducive to a greater impact-oriented focus. On the other hand, respondents from groups that support or facilitate the work of standard-setters tended to think that the culture within standard-setting bodies was not conducive to a greater impact-orientation because the emphasis is on scaling up adoption of the standard itself.

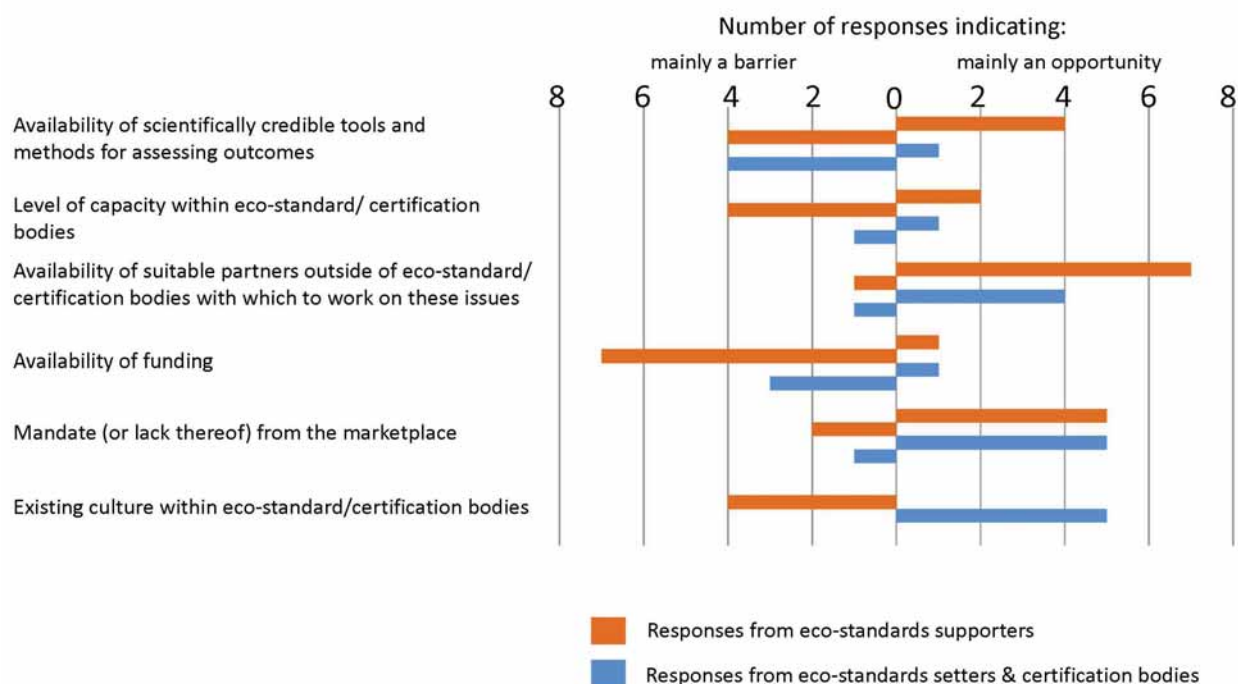


Figure 10: Key opportunities and barriers.

The chart indicates opportunities and barriers to moving toward a more rigorous, outcome-based approach to assessment, monitoring, and improvement of ecological outcomes over the next 5-15 years, as identified by representatives of 10 eco-standards bodies and 9 eco-standards support organizations. Respondents were asked to characterize each factor as “mainly an opportunity,” “mainly a barrier,” or “not important either way.”

Below we discuss options for addressing two of the key identified barriers—financing and human capacity. We also present a series of possible next steps for fostering collaboration within the eco-standards community to tackle the challenge of ecological impact assessment.

An interesting and surprising set of results from the ISEAL Alliance’s recent “ISEAL 100” survey of business sustainability leaders suggests that companies are likely to be interested in funding impact assessment work mainly for their own internal standards, not for third-party standards. The survey reported that 95% of private sector respondents were confident that third-party standards deliver on social and environmental objectives, while only 11% mentioned the ability to demonstrate impacts as a key ingredient in trust of such standards (ISEAL Alliance 2011). Furthermore, businesses tend to choose standards more based on reputation and perceived fit with the company’s goals than for actual demonstrated impact. These results suggest that most businesses prefer to treat third-party eco-standards as “turnkey” solutions for sustainability management and public perception, and have little interest in delving into the details of actual impacts of these standards. Most agriculture sector investors are likely to take a similar stance. On the other hand, quite a few food companies are investing in assessing the impacts of their own internal standards, or environmental impacts of their supply chains.

In contrast to the position of the corporate sector, the third-party standard-setters themselves are likely to have an important incentive to invest in impact assessment, as standards continue to compete among one another, with the possibility of a future market “shake out” to a smaller number of standards. On the side of most third party eco-standards, there has been a perpetual shortfall of funding to conduct monitoring and evaluation work. To the extent that data collection is being done, many of the interview respondents agreed that costs were currently being levied disproportionately on producers at the time of the audit. One solution presented was to distribute those costs more equitably by moving them upward through the value chain. For instance, Rainforest Alliance has recently decided to move its administrative fees for certified coffee from producers to the first buyer (e.g. exporters). As shown in Figure 7A, many environmental data collected at the farm level could provide value to farmers, especially if these data are presented in easy-to-understand formats that aid in decision-making. However, there is no clear funding source for larger-scale impact assessments—particularly on water and biodiversity—which are of limited direct value to producers or buyers but are necessary to undergird the credibility of the standard (Figure 7A). For such impacts, grants from foundations, bi- and multi-lateral donors, and others—as well as partnerships with academic researchers—are likely to remain very important.

As noted earlier, some of the newer third-party standards that focus on large tropical plantations (e.g., Bonsucro and the roundtables for soy, palm oil, and biofuels) hold greater potential to internalize the costs of impact assessment because the proportional burden of these costs on a large producer is much smaller than it would be on a small-scale farmer. In this case, the impact assessment may provide an indirect benefit to producers by guaranteeing access to critical markets (e.g., food companies that have strict sourcing standards for tropical commodities). Thus, it is reasonable to expect that eco-standards that cater mainly to large plantations may be able to implement more rigorous and comprehensive impact assessment strategies as part of their ordinary operations than those that work mainly with small-scale farmers. Nevertheless, impact assessment is important in both contexts, and eco-standards

focused on small-scale farmers can pursue cost-effective strategies including management of audit data to help assess impacts; establishing community-led monitoring initiatives; and applying some of the types of proxies and calculator tools profiled earlier.

Partnerships

Partnerships for agricultural eco-standards impact assessment may be worthwhile for addressing challenges and needs that are common to many eco-standard setters, advocates, or supporters. In these cases, groups may collaborate on a “pre-competitive” basis to solve common problems by pooling resources and expertise. Examples of areas where pre-competitive partnership may be beneficial include:

- developing a common set of methodologies and tools for assessing particular ecological impacts;
- testing and validating impact assessment tools that are being used by multiple organizations;
- developing an infrastructure for managing and analyzing audit data to derive impact assessment indicators—in effect turning audit data into the data inputs for a farm sustainability calculator; and
- developing a common monitoring and evaluation approach—for instance, in response to the requirements of the ISEAL Alliance’s Impacts Code.

In multi-stakeholder pre-competitive partnerships, information is usually shared freely within the group, if not more widely.

Another model that some standard-setters have pursued is to partner with scientific or research institutions. For instance, Starbucks has partnered with Conservation International to assess the impacts of its Café Practices in Latin America, while Unilever partnered with the Sustainable Food Lab and University of Aberdeen to develop the Cool Farm Tool. COSA has adopted a partnership-based model in which in-country research institutions carry out impact assessments based on the standard set of impact metrics developed through COSA’s consultative process.

These promising examples suggest the possibility for a much greater role for universities and research institutions in supporting eco-standards impact assessment, especially in the areas where there are major gaps in funding and personnel, as identified above. Eco-standards bodies that seek to forge such partnerships could develop lists of research topics and questions to post on their website or share with pre-identified professors or universities that work in the area of sustainable agriculture and its impacts. Designating an internal liaison officer to direct researchers to the sites and field offices where the research will take place could make such research opportunities very appealing to faculty and students who already have funding to cover their salary and even expenses, but seek meaningful research questions and settings.

Next Steps

In just the last two or three years, there has been a flurry of interest and activity related to impact assessment for agricultural eco-standards. The ISEAL Alliance has launched its Impacts Code; the SAI Platform has developed standard Principles and Practices for many crops; the

Assessment of Standards and Certification Systems initiative is conducting an industry-wide assessment of eco-standards impact and performance; major agricultural investors such as the International Finance Corporation are actively seeking improved sustainability metrics; and COSA has launched field tests of its impact assessment methodology in several countries.

In this environment, there is an opportunity to accelerate progress by forming partnerships around some of the themes identified above. This process should commence by scoping the interest and willingness of eco-standards setters, supporters, and researchers to collaborate on topics of mutual interest. This scoping phase could begin with structured interviews, followed by a planning workshop of interested parties.

From this process, it is envisioned that a technical working group or network might emerge to develop and implement specific projects related to ecological impact assessment. This network would function, in effect, as a technical service provider to the existing agricultural eco-standard umbrella organizations identified above. Its core membership of scientists and personnel from eco-standards organizations could be supplemented with additional specialized expertise for particular projects. For instance, the network might choose to design and build a common data infrastructure for streamlining the collection, management, and analysis of audit data to inform impact assessments. Or it might be asked by a group of standard-setters to evaluate the relative accuracy and cost-effectiveness of several different approaches to monitoring biodiversity impacts of agricultural eco-certification with the aim of informing these standard-setters as to which proxy measures to use in their impact assessment work.

A second function of the network could be to aid in the compilation and standardization of research related to agricultural eco-standards impact assessment. Currently, such research is widely scattered, and often conducted using different methodologies that limits the ability to make cross-site comparisons. As the field of eco-standards impact assessment burgeons in the coming decade, this function should prove increasingly relevant.

By adapting scientific tools that already exist to the context of agricultural eco-standards—supported by modern technology and data analysis capabilities—the eco-standards community can greatly enhance the credibility, rigor, and results of its efforts to conserve ecosystems and protect the environment.

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APPENDIX A: STUDY TERMS OF REFERENCE

Following are the terms of reference for this study:

1. *Literature review of the state of the art and science of impact assessment for eco-certification and standards.* This review will examine the science and practice of impact assessment for agricultural eco-certification and standards. The focus of the review will be on impacts of eco-certification on ecosystem services and biodiversity, specifically including: a) watershed functions and services, including water quantity and water quality; b) impacts of biodiversity of conservation interest (e.g., rare, threatened, and endangered species); c) impacts on ecosystem composition and function, including functional diversity supporting ecosystem services such as pollination and biological pest control; and d) carbon sequestration, to the extent carbon stocks are mediated by landscape-level dynamics influenced by eco-certification (i.e., the review will not assess the carbon or greenhouse gas impacts of site-level management practices in isolation, as significant recent work on such assessment has already been done); and e) impacts on ecosystem services mediated by soils and soil management (excluding impacts of management practices on soil fertility and soil quality, for which adequate methodologies and indicators are generally available). These biodiversity and ecosystem service impacts will be considered in context of social and financial impacts (though the latter will not be included in the review) since all play an important role in sustainable development at the landscape scale. To conduct this review, the Consultants will survey the peer-reviewed and grey literatures using relevant Internet search terms. The review will also incorporate studies and project and program reports obtained from or identified by eco-certification practitioners and experts consulted as part of task (2) below. For the identified methodologies (including existing, in-development, or proposed approaches), the Consultants shall identify salient key characteristics of and experience with the approach, including: a) the outcomes or impacts that the methodology seeks to address; b) the data types and sources on which the evaluation is based; c) the type, degree, and ways in which proxy relationships or relationships between practices and ecological outcomes are used in the assessment; d) experiences with the methodology to date; and e) peer or external assessments of the methodology, if any. While this review will focus on methodologies for agricultural eco-certification, it will also provide a more limited review of the field of forestry eco-certification to incorporate relevant experience and lessons learned from this field.

2. *Consultations with key stakeholders and partners.* The Consultants will undertake in-depth consultations with key players in the field of eco-certification and impact assessment. The purpose of the consultations will be similar to the literature review: to review of the state of the art and science of impact assessment for eco-certification and standards. Of equal importance is to identify the participants for the workshops in Phase 2. The consultations will be conducted in collaboration with IFC (as schedules and staff availability permit) via telephone, Skype, and email, and through in-person interviews when possible. Organizations interested in participating in the proposed project include, but are not limited to, the Sustainable Trade Initiative of the Netherlands, Rainforest Alliance, Unilever Co.-East Africa, Wildlife Conservation Society, Sustainable Food Lab, ISEAL Alliance, Committee on Sustainability Assessment, and Root Capital. Others to be considered as participants include World Wildlife Fund, Business and Biodiversity Offsets Program, World Conservation Monitoring Centre, Integrated Biodiversity Assessment

Tool, Roundtable on Sustainable Palm Oil, Round Table on Responsible Soy, International Foundation for Organic Agriculture, Fairtrade International, UTZ Certified, Conservation International, Starbucks, stakeholders involved in International Biodiversity Assessment Tool and High Conservation Value Network, Nestle, and leading scientists working on monitoring of ecosystem services in agricultural landscapes.

3. Report on current practices and methodological challenges in impact assessment of agricultural eco-certification on ecosystem services and biodiversity. The report will include the following components:

- Introduction, study objectives and methodology
- Results of the literature review and synthesis
- Results of the stakeholder consultations
- Conclusions regarding key innovations as well as gaps in the science and practice of assessing landscape-level impacts of eco-certified agriculture on biodiversity and ecosystem services
- Recommendations for next steps, including main themes to be addressed through an international knowledge sharing workshop and network

4. Proposal for Phase 2 workshop. The Consultants will develop a proposal to IFC for the international knowledge sharing workshop. This workshop is expected to bring together approximately 30 participants from leading certification programs and research experts in ecological impact assessment in agricultural landscapes. The workshop's main goal will be to share knowledge, approaches, and challenges on different impact assessment methods for agricultural eco-standards and eco-certification. Through these conversations, workshop participants will identify key gaps and priorities for future research, development, and testing of methodologies, as well as opportunities for partnership in such endeavors. The workshop will also discuss methodologies developed by IFC, with the purpose of helping to refine them.

APPENDIX B: LITERATURE REVIEW SEARCH TERMS

Following are the lists of search terms used in Google, Google Scholar, and Web of Science to find impact assessment studies, tools, and methods. Search terms in the first list were used with one another in various combinations. These terms were also combined with the names of eco-standards systems in the second list.

Search terms used to find studies for assessing the ecological impacts of sustainable agriculture or eco-standards:

- agricultural assessment study
- agricultural sedimentation
- agriculture
- bananas
- biodiversity
- cacao
- carbon sequestration
- coffee
- eco-agricultural best management practices
- eco-agricultural methods
- eco-agriculture
- eco-certification
- eco-certification assessment
- eco-management impact assessment
- eco-services
- ecosystem diversity
- ecosystem services
- endangered species
- erosion
- emissions
- impact assessment
- impact-level eco-agricultural assessment
- landscape-level impacts
- oil palm
- rare, threatened, and endangered
- soil management
- soil quality
- sugar cane
- sustainable agriculture
- sustainable agriculture and tropics
- sustainable eco-agricultural assessment

- sustainable methods
- tropical eco-agriculture
- watershed function
- watershed services
- water management
- water use

Names of eco-standards and eco-standard/certification organizations used as search terms:

- 4C Association
- Fairtrade
- Forest Stewardship Council (FSC)
- Good Inside (UTZ)
- International Cocoa Organization (ICCO)
- International Federation of Organic Agricultural Movements (IFOAM)
- International Finance Corporation (IFC)
- Keystone Center / Field to Market
- Nestlé
- Programme for the Endorsement of Forest Certification (PEFC)
- Rainforest Alliance
- Roundtable for Sustainable Cocoa Economy (RSCE)
- Roundtable for Sustainable Palm Oil (RSPO)
- Smithsonian Migratory Bird Center (SMBC)
- Starbucks
- Sustainable Agricultural Initiative (SAI)
- Sustainable Forestry Initiative (SFI)
- Unilever
- World Cocoa Foundation (WCF)

APPENDIX C: PRE-QUESTIONNAIRE

Prior to their interview, respondents were asked to complete the following questionnaire, which was administered through the online survey tool Survey Monkey. Slightly different questionnaires were provided to eco-standards representatives versus eco-standards advocates/supporters to ensure that each group received a relevant set of questions. The following questionnaire is the one provided to eco-standards representatives.

Thank you for participating in this study on the state of tools and methodologies for assessing the ecological impacts of agricultural eco-standards. The study—which is being conducted by EcoAgriculture Partners and funded by the International Finance Corporation—will identify key opportunities, gaps, and needs for improving the science and practice of ecological impact assessment for eco-certification/standards. The study focuses particularly on watershed- and landscape-scale impacts, for which empirical evidence is particularly lacking. As a participant, you will receive a copy of the review study when completed, and will be invited to participate in an emerging community of practice of scientists and eco-standards experts interested in accelerating progress toward improving the credibility and effectiveness of eco-standards as a means of protecting or restoring biodiversity and ecosystem services.

Prior to your interview, we request that you complete the following 23-question survey. Please answer these questions in regard to the certification/standards system with which your work. Answers to this survey will be treated as anonymous. In other words, results will be aggregated to a level that responses cannot be associated with particular individuals or their organizations. If you have any questions about with this survey, please contact Lee Gross at (+1) 202-393-5315 or lgross@ecoagriculture.org. Thank you in advance for your participation!

A. Basic information

To begin, we request a bit of information about you and your organization:

A1. Your name:

A2. Name of your organization:

A3. What is the name of the certification system or system or standards with which you work?

A4. Your position/title:

A5. Briefly describe your role with respect to monitoring or impact assessment (if any):

A6. To what extent does your certification/standards system seek to achieve environmental / ecological benefits at each of the following scales (check the box that best applies for each scale):

Production unit (i.e., farm, field, or forest unit)	☐ A core focus of the standards system ☐ A secondary focus of the standards system ☐ Not considered or minor focus
Community (i.e., culturally-delineated area containing certified and/or non-certified production units and other lands)	☐ A core focus of the standards system ☐ A secondary focus of the standards system ☐ Not considered or minor focus
Watershed or landscape (i.e., ecologically delineated area on the order of 10s to 1000s of sq. km.)	☐ A core focus of the standards system ☐ A secondary focus of the standards system ☐ Not considered or minor focus

Regional, national, or global (i.e., addressing broader environmental problems and dynamics)	☐ A core focus of the standards system ☐ A secondary focus of the standards system ☐ Not considered or minor focus
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B. Current activities

Next, we would like to ask about the extent to which outcome-level data about the environmental effects of the certification/standards system are collected and analyzed. Outcome-level data are data on actual changes in environmental characteristics or systems attributed to the adoption of the certification/standards system. This is distinguished from data on practices or processes, which document changes in production or operational management systems (e.g., adoption of environmental best management practices). For instance, an example of a practice-based standard or result is the adoption of best management practices and application rates for chemical fertilizers; an example of an outcome-level result is the reduction in algal biomass or biological oxygen demand in a stream abutting the farm.

B1. Does the certification/standards system include outcome-level environmental criteria as a mandatory part of the standard and/or its audit/verification process? If so, please check all of the environmental outcomes that are included:

- ☐ Water quality ON THE FARM/PRODUCTION UNIT
- ☐ Water quality DOWNSTREAM/OFF THE FARM
- ☐ Water quantity (e.g., water flow rates, seasonality / water availability, or flood storage)
- ☐ Presence/absence of specific rare, threatened or endangered species ON THE FARM/PRODUCTION UNIT
- ☐ Presence/absence of specific rare, threatened or endangered species IN THE SURROUNDING LANDSCAPE
- ☐ Animal species assemblages (e.g., abundance or species richness of birds, mammals, or other taxa) ON THE FARM/PRODUCTION UNIT
- ☐ Animal species assemblages (e.g., abundance or species richness of birds, mammals, or other taxa) IN THE SURROUNDING LANDSCAPE
- ☐ Plant species assemblages (e.g., tree species richness) ON THE FARM/PRODUCTION UNIT
- ☐ Plant species assemblages (e.g., tree species richness) IN THE SURROUNDING LANDSCAPE
- ☐ Soil characteristics (e.g., pH, soil organic matter, percent ground cover) ON THE FARM/PRODUCTION UNIT
- ☐ Greenhouse gas emissions associated with agricultural / production operations
- ☐ Other outcome-level environmental attributes (please specify) _____
- ☐ None of the above

B2. Has the certification/standards system assessed outcome-level environmental effects for a sub-set of certified/verified production units? This includes studies of outcome-level effects conducted or commissioned by the certification/standards entity outside of the ordinary audit/verification process. If so, please check all of the environmental outcomes that have been included:

- ☐ Water quality ON THE FARM/PRODUCTION UNIT
- ☐ Water quality DOWNSTREAM/OFF THE FARM
- ☐ Water quantity (e.g., water flow rates, seasonality / water availability, or flood storage)
- ☐ Presence/absence of specific rare, threatened or endangered species ON THE FARM/PRODUCTION UNIT
- ☐ Presence/absence of specific rare, threatened or endangered species IN THE SURROUNDING LANDSCAPE
- ☐ Animal species assemblages (e.g., abundance or species richness of birds, mammals, or other taxa) ON THE FARM/PRODUCTION UNIT
- ☐ Animal species assemblages (e.g., abundance or species richness of birds, mammals, or other taxa) IN THE

SURROUNDING LANDSCAPE

- ☐ Plant species assemblages (e.g., tree species richness) ON THE FARM/PRODUCTION UNIT
- ☐ Plant species assemblages (e.g., tree species richness) IN THE SURROUNDING LANDSCAPE
- ☐ Soil characteristics (e.g., pH, soil organic matter, percent ground cover) ON THE FARM/PRODUCTION UNIT
- ☐ Levels of ecosystem services to agriculture (e.g., assessments of native pollinators or crop pest enemies)
- ☐ Availability for producers of non-crop ecosystem goods (e.g., fruits, timber, medicinal plants)
- ☐ Impacts on deforestation rates at the community, landscape, or ecosystem level
- ☐ Greenhouse gas emissions associated with agricultural / production operations
- ☐ Other outcome-level environmental attributes (please specify) _____
- ☐ None of the above

B3. To your knowledge, have **third-party researchers not commissioned by your organization** conducted studies of the outcome-level environmental effects of the certification/standards system? If so, please check all of the environmental outcomes for which such research has been conducted:

- ☐ Water quality ON THE FARM/PRODUCTION UNIT
- ☐ Water quality DOWNSTREAM/OFF THE FARM
- ☐ Water quantity (e.g., water flow rates, seasonality / water availability, or flood storage)
- ☐ Presence/absence of specific rare, threatened or endangered species ON THE FARM/PRODUCTION UNIT
- ☐ Presence/absence of specific rare, threatened or endangered species IN THE SURROUNDING LANDSCAPE
- ☐ Animal species assemblages (e.g., abundance or species richness of birds, mammals, or other taxa) ON THE FARM/PRODUCTION UNIT
- ☐ Animal species assemblages (e.g., abundance or species richness of birds, mammals, or other taxa) IN THE SURROUNDING LANDSCAPE
- ☐ Plant species assemblages (e.g., tree species richness) ON THE FARM/PRODUCTION UNIT
- ☐ Plant species assemblages (e.g., tree species richness) IN THE SURROUNDING LANDSCAPE
- ☐ Soil characteristics (e.g., pH, soil organic matter, percent ground cover) ON THE FARM/PRODUCTION UNIT
- ☐ Levels of ecosystem services to agriculture (e.g., assessments of native pollinators or crop pest enemies)
- ☐ Availability for producers of non-crop ecosystem goods (e.g., fruits, timber, medicinal plants)
- ☐ Impacts on deforestation rates at the community, landscape, or ecosystem level
- ☐ Greenhouse gas emissions associated with agricultural / production operations
- ☐ Other outcome-level environmental attributes (please specify) _____
- ☐ None of the above

B4. To your knowledge, are there any places where the **long-term** outcome-level environmental effects of the certification/standards system have been evaluated, over a period of at least four years? If so, please check all of the environmental outcomes for which such evaluation or research has been conducted:

- ☐ Water quality ON THE FARM/PRODUCTION UNIT
- ☐ Water quality DOWNSTREAM/OFF THE FARM
- ☐ Water quantity (e.g., water flow rates, seasonality / water availability, or flood storage)
- ☐ Presence/absence of specific rare, threatened or endangered species ON THE FARM/PRODUCTION UNIT
- ☐ Presence/absence of specific rare, threatened or endangered species IN THE SURROUNDING LANDSCAPE

- ☐ Animal species assemblages (e.g., abundance or species richness of birds, mammals, or other taxa) **ON THE FARM/PRODUCTION UNIT**
- ☐ Animal species assemblages (e.g., abundance or species richness of birds, mammals, or other taxa) **IN THE SURROUNDING LANDSCAPE**
- ☐ Plant species assemblages (e.g., tree species richness) **ON THE FARM/PRODUCTION UNIT**
- ☐ Plant species assemblages (e.g., tree species richness) **IN THE SURROUNDING LANDSCAPE**
- ☐ Soil characteristics (e.g., pH, soil organic matter, percent ground cover) **ON THE FARM/PRODUCTION UNIT**
- ☐ Levels of ecosystem services to agriculture (e.g., assessments of native pollinators or crop pest enemies)
- ☐ Availability for producers of non-crop ecosystem goods (e.g., fruits, timber, medicinal plants)
- ☐ Impacts on deforestation rates at the community, landscape, or ecosystem level
- ☐ Greenhouse gas emissions associated with agricultural / production operations
- ☐ Other outcome-level environmental attributes (please specify) _____
- ☐ None of the above

C. Methods & tools

Now, we would like to ask about the types of tools and methods that have been used to assess **outcome-level ecological effects** of the certification/standards system on which you work, and your perception of the adequacy of these tools and methods. When answering these questions, please consider any impact assessment work conducted by the certification/standards body itself as well as work by other partners or researchers.

C1a. To the best of your knowledge, what tools and methods have been used to assess the outcomes of the certification/standards system on **watershed functions and services, including water quality and water quantity?**

- ☐ Chemical and/or biological water quality testing of water bodies near production units
- ☐ Use of freshwater indicator species in water bodies near production units
- ☐ Field-based monitoring of erosion and/or sedimentation (e.g., sediment traps or fences)
- ☐ Field sampling/testing at locations downstream or distant from production units
- ☐ Micro-catchment or watershed level hydrologic modeling
- ☐ Participatory community methods (e.g., timelines, local expert opinion, etc.)
- ☐ Other tools/methods (please list): _____

C1b. Please indicate how important you think are each of the following **improvements** on existing tools/methods to assess impacts on **watershed functions and services, including water quality and water quantity**:

More precise methods for understanding impacts at the scale of the farm / production unit	☐ Top priority (great need) ☐ Medium priority (some need) ☐ Less important (little need)
More precise methods for understanding impacts beyond the scale of the farm / production unit (e.g., watershed effects)	☐ Top priority (great need) ☐ Medium priority (some need) ☐ Less important (little need)
Methods that are as precise as those currently used, but less expensive to apply	☐ Top priority (great need) ☐ Medium priority (some need) ☐ Less important (little need)

Methods that can be applied by field auditors/verifiers	☐ Top priority (great need) ☐ Medium priority (some need) ☐ Less important (little need)
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Other than those listed above, which other improvements are needed? Please describe: _____

C2a. *To the best of your knowledge, what tools and methods have been used to assess the outcomes of the certification/ standards system on **rare, threatened or endangered species**?*

- ☐ One-time field assessments of plant or animal assemblages (e.g., bird point counts or vegetation transects)
- ☐ Repeat field assessments of plant or animal assemblages (e.g., bird point counts or vegetation transects)
- ☐ Surveys of plant or animal indicator species
- ☐ Long-term monitoring and/or population studies of particular rare, threatened, or endangered species
- ☐ Empirical surveys (including via household interviews) of levels of hunting or poaching in or near certified production units
- ☐ Assessment of habitat proxies for particular rare, threatened, or endangered species (e.g., habitat size, condition, and landscape context)
- ☐ Participatory community methods (e.g., mapping, historical baselines, etc.)
- ☐ Other tools/methods (please list): _____

C2b. *Please indicate how important you think are each of the following **improvements** on existing tools/methods to assess impacts on **rare, threatened or endangered species**.*

More precise methods for understanding impacts at the scale of the farm / production unit	☐ Top priority (great need) ☐ Medium priority (some need) ☐ Less important (little need)
More precise methods for understanding impacts beyond the scale of the farm / production unit (e.g., watershed effects)	☐ Top priority (great need) ☐ Medium priority (some need) ☐ Less important (little need)
Methods that are as precise as those currently used, but less expensive to apply	☐ Top priority (great need) ☐ Medium priority (some need) ☐ Less important (little need)
Methods that can be applied by field auditors/verifiers	☐ Top priority (great need) ☐ Medium priority (some need) ☐ Less important (little need)

Other than those listed above, which other improvements are needed? Please describe: _____

C3a. *To the best of your knowledge, what tools and methods have been used to assess the outcomes of the certification/ standards system on **ecosystem composition and function**?*

- ☐ One-time field assessments of ecosystem composition and structure (e.g., with transects or quadrats)
- ☐ Repeat field assessments of ecosystem composition and structure
- ☐ Field-based assessments of invasive species
- ☐ Field-based assessments of species believed to provide ecosystem services (e.g., native pollinators)
- ☐ Assessments of specific ecosystem services provided by certified production units

- ☐ Assessments of ecosystem composition and/or function based on remote sensing imagery or data
- ☐ Participatory community methods (e.g., mapping, timelines, etc.)
- ☐ Other tools/methods (please list): _____

C3b. Please indicate how important you think are each of the following **improvements** on existing tools/ methods to assess impacts on **ecosystem composition and function**.

More precise methods for understanding impacts at the scale of the farm / production unit	☐ Top priority (great need) ☐ Medium priority (some need) ☐ Less important (little need)
More precise methods for understanding impacts beyond the scale of the farm / production unit (e.g., watershed effects)	☐ Top priority (great need) ☐ Medium priority (some need) ☐ Less important (little need)
Methods that are as precise as those currently used, but less expensive to apply	☐ Top priority (great need) ☐ Medium priority (some need) ☐ Less important (little need)
Methods that can be applied by field auditors/verifiers	☐ Top priority (great need) ☐ Medium priority (some need) ☐ Less important (little need)

Other than those listed above, which other improvements are needed? Please describe: _____

C4a. To the best of your knowledge, what tools and methods have been used to assess the outcomes of the certification/ standards system on **carbon sequestration, greenhouse gas emissions, and avoided deforestation**?

- ☐ Assessment of changes in carbon stocks (aboveground and/or belowground) over time within the production unit (i.e., through direct measurement, field samples of carbon pools)
- ☐ Estimation or modeling of greenhouse gas emissions using IPCC emissions factors related to agricultural / production operations
- ☐ Assessments of the impacts of certification on off-site land-use and carbon dynamics (i.e., reduced or avoided deforestation or forest degradation)
- ☐ Use of High Conservation Value (HCV) approach tools related to carbon sequestration or related to avoided deforestation.
- ☐ Other tools/methods (please list): _____

C4b. Please indicate how important you think are each of the following improvements on existing tools/methods to assess impacts on **carbon sequestration, greenhouse gas emissions, and avoided deforestation**.

More precise methods for understanding impacts at the scale of the farm / production unit	☐ Top priority (great need) ☐ Medium priority (some need) ☐ Less important (little need)
More precise methods for understanding impacts beyond the scale of the farm / production unit (e.g., watershed effects)	☐ Top priority (great need) ☐ Medium priority (some need) ☐ Less important (little need)
Methods that are as precise as those currently used, but less expensive to apply	☐ Top priority (great need) ☐ Medium priority (some need) ☐ Less important (little need)

Methods that can be applied by field auditors/verifiers	☐ Top priority (great need) ☐ Medium priority (some need) ☐ Less important (little need)
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Other than those listed above, which other **improvements** are needed? Please describe: _____

C5a. To the best of your knowledge, what tools and methods have been used to assess the outcomes of the certification/standards system on **soil characteristics**?

- ☐ One-time field assessments of soil pH, organic matter or percent ground cover
- ☐ Repeat field assessments of soil pH, organic matter or percent ground cover
- ☐ Surveys of soil characteristics (e.g. soil pH, organic matter or percent ground cover)
- ☐ Long-term monitoring of soil pH, organic matter or percent ground cover.
- ☐ Empirical surveys (including via household interviews) on perceptions of soil characteristics
- ☐ Assessment of soil proxies for ecosystem services mediated by soils and soil management
- ☐ Participatory community methods (e.g., mapping, perceptions, etc.) of soil characteristics and/or soil management
- ☐ Other tools/methods (please list): _____

C5b. Please indicate how important you think are each of the following improvements on existing tools/methods to assess impacts on **soil characteristics (e.g. soil pH, organic matter or percent ground cover)**.

More precise methods for understanding impacts at the scale of the farm / production unit	☐ Top priority (great need) ☐ Medium priority (some need) ☐ Less important (little need)
More precise methods for understanding impacts beyond the scale of the farm / production unit (e.g., watershed effects)	☐ Top priority (great need) ☐ Medium priority (some need) ☐ Less important (little need)
Methods that are as precise as those currently used, but less expensive to apply	☐ Top priority (great need) ☐ Medium priority (some need) ☐ Less important (little need)
Methods that can be applied by field auditors/verifiers	☐ Top priority (great need) ☐ Medium priority (some need) ☐ Less important (little need)

Other than those listed above, which other improvements are needed? Please describe: _____

C6. Who has conducted outcome-level assessments for the above categories of biodiversity and ecosystem services? Please check all that apply.

- ☐ Certification/standards auditors
- ☐ Other staff of the certification/standards program
- ☐ Producers (i.e., farmers or forest managers)
- ☐ Researchers contracted by the certification/standards program
- ☐ Researchers working independently
- ☐ Other _____

☐ Which of the above groups has conducted the largest amount of work to assess impacts of the certification/standards system on biodiversity and ecosystem services? _____

C7. How does your organization develop or select tools and methods for assessing outcome-level ecological results of your certification/standards system. Please check all that apply:

- ☐ We select existing tools and methods from established scientific practice
- ☐ We have adapted existing tools and methods to our specific context and needs
- ☐ We have developed new tools and methods to meet our impact assessment needs
- ☐ We have collaborated with outside researchers to develop new tools and methods to meet our impact assessment needs

D. Drivers, motivations, and barriers (2 questions)

This final set of questions asks about rationale and need for increasing a focus on outcome-level results within your organization's eco-certification/standards system. It also explores key opportunities and barriers to doing so.

D1. To the extent that you/your organization see a need to expand or improve outcome-level assessment of ecological impacts, what are the motivations for doing so? Please characterize each of the following motivations as very important, important, somewhat important, or not important:

Demonstrating impact to end-buyers (food or forest products consumers, etc.)	☐ Very important ☐ Somewhat important ☐ Important ☐ Not important
Demonstrating impact to intermediate buyers (food companies, buyers, traders, etc.)	☐ Very important ☐ Somewhat important ☐ Important ☐ Not important
Demonstrating impact to environmental or “watchdog” groups	☐ Very important ☐ Somewhat important ☐ Important ☐ Not important
Demonstrating impact to public sector or trans-national regulatory, standard-setting, or trade bodies	☐ Very important ☐ Somewhat important ☐ Important ☐ Not important
Demonstrating impact to your own organization’s board, staff, donors, or shareholders	☐ Very important ☐ Somewhat important ☐ Important ☐ Not important
Demonstrating impact to your producers / supplies	☐ Very important ☐ Somewhat important ☐ Important ☐ Not important
Developing an empirical knowledge base to improve the certification/standards system itself	☐ Very important ☐ Somewhat important ☐ Important ☐ Not important
Generating an empirical knowledge base to help producers better manage natural resources and reduce environmental impacts	☐ Very important ☐ Somewhat important ☐ Important ☐ Not important
Generating an empirical knowledge base to help producers increase production quality, yields, or reliability	☐ Very important ☐ Somewhat important ☐ Important ☐ Not important
Developing an empirical knowledge base to inform strategic and policy decisions	☐ Very important ☐ Somewhat important ☐ Important ☐ Not important
Building overall credibility and transparency of the certification/standards system	☐ Very important ☐ Somewhat important ☐ Important ☐ Not important

Please identify any other important or very important motivations not listed above: _____

D2. What do you see as the key factors that might support or hinder your organization and its partners—within the next 5-15 years—in moving toward a more rigorous, outcome-based approach to the assessment, monitoring, and improvement of ecological results of the certification/standards system? Please rate each factor as an “mainly an opportunity,” “mainly a barrier,” or “not important either way.”

Availability of scientifically credible tools and methods for assessing such outcomes	☐ Mainly an opportunity ☐ Mainly a barrier ☐ Not important either way
Level of capacity within your organization	☐ Mainly an opportunity ☐ Mainly a barrier ☐ Not important either way
Availability of suitable partners with which to work on these issues	☐ Mainly an opportunity ☐ Mainly a barrier ☐ Not important either way
Availability of funding	☐ Mainly an opportunity ☐ Mainly a barrier ☐ Not important either way
Motivation / mandate (or lack thereof) from your internal or external stakeholders	☐ Mainly an opportunity ☐ Mainly a barrier ☐ Not important either way
Existing setup, culture, or emphasis of your organization and its certification/standards system	☐ Mainly an opportunity ☐ Mainly a barrier ☐ Not important either way

E.Additional info/referrals (1 question)

To end, we would like to ask you to point us to any relevant studies, reports, methodologies, or other publications that reflect the work that has been done to assess outcome-level ecological impacts of the certification/standards systems. We will consult these documents for the literature review component of the review study. Please list these below: _____

APPENDIX D: INTERVIEW TEMPLATE

We used the following semi-structured interview template to guide conversations with interviewees to clarify and expand the information provided in the pre-questionnaire.

A. Basic information

Name of Interviewee:

Organization:

Position:

Date:

Interviewer(s):

B. Current activities

Pose follow-up questions on responses to survey questions B1 through B4, as appropriate.

- Ask about how often and where such assessments were done; also, by whom, how they were funded, whether they were one-time or ongoing efforts, etc.
- If needed, clarify the scale at which impacts were assessed (e.g., plot-level assessments; aggregation of impacts from multiple plots; or assessment of impacts of certification within a mosaic of certified units and non-certified lands)
- If needed, clarify the extent to which spatial configuration or spatial position of certified production units is considered in any outcome-level assessments
- To the extent that outcome-level work has not been done, why not? Are practice and process level results considered adequate proxies (for which ecological attributes are they / are they not)?

C. Methods & tools

Pose follow-up questions on responses to survey questions C1a, C2a, C3a, and C4a, as appropriate.

- Ask about specific tools in use (e.g., how were they developed, who applied them, how well they have worked in the eco-standards context, etc.)
- Ask additional questions, as needed, to fill in attributes of these tools/methods for the methods data matrix.
- When outcome-level results were assessed, was there additional cost for doing this? How much? How was it funded/absorbed?

Pose follow-up questions on responses to survey questions C1b, C2b, C3b, and C4b, as appropriate.

- Ask for more information about the types of tools and methods they want but do not currently have. Does your organization currently have any initiatives or plans to increase work on impact assessment, especially in the area of ecological impacts?
- If “less expensive” is identified as a top priority, inquire into whether interviewee sees such assessments as being used quite widely; how this would be funded; what resources could be brought to bear; and roughly how much could be spent to evaluate each unit area (farm, landscape, etc.). This provides a sense of the specific needs for cost-effective proxies and metrics.

D. Drivers, motivations, and barriers

Pose follow-up questions on question D1, as appropriate.

- Ask particularly about the “bottom line” case for outcome-level ecological impact assessment: in what ways it supports the business model and/or mission?
- With respect to this bottom line case, where is the value (if any) in moving beyond impacts/benefits at the scale of the production unit to consider impacts/benefits at the landscape level?
- Can your organization’s standards/certification system persist & thrive into the future without moving more toward an outcome-level impact assessments and results orientation? Why / why not?

Pose follow-up questions on question D2, as appropriate.

- What ideas do you have for the “way forward” to capitalize on the opportunities and overcome the barriers noted in your responses? What would others outside your organization (e.g., buyers, consumers, scientists, donors, etc.) need to do to support this?
- Do you have any ideas for how the costs of impact assessment and continual improvement can be supported?
- Are there any lessons from your experience with outcome-level assessment for social and economic results that could be applied to ecological results?

E. Additional info/referrals (approx 5 minutes)

- Ask for clarification (if needed) to make sure we know how we can get a hold of the sources listed. (Or, if left blank, ask the question again.)
- Ask for names of other individuals (eco-standard experts, advisors, etc.) who we should interview and/or invite to the learning workshop

APPENDIX E: LIST OF PERSONS INTERVIEWED

Organization	Interviewee	Title
Eco-standard and eco-certification entities		
4C Association	George Watene*	M&E Manager
Forest Stewardship Council	Marion Karmann	M&E Manager
Nestlé	Duncan Pollard	Sustainability Advisor
Programme for the Endorsement of Forest Certification	Sarah Price	
	Head of Projects and Development	
Rainforest Alliance	Elizabeth Kennedy	Director, Evaluation and Research
SAI Platform	Emeline Fellus	Deputy Manager
Starbucks Coffee Company	Julie Anderson*	Manager Ethical Sourcing
UTZ Certified	Tessa Laan	M&E coordinator
Eco-standards umbrella organizations, supporters, advocates, and partners		
Committee on Sustainability Assessment	Danielle Giovannuci	Director
Conservation International	Bambi Semroc and Elizabeth Baer	Senior Director, Food, Agriculture and Freshwater; Senior Manager, Food, Agriculture and Freshwater
Instituto de Pesquisa Ambiental da Amazonia	Oswaldo de Carvalho	Soy Project Manager
International Finance Corporation	Rick Vanderkamp	Operations officer, Sustainable Business Advisory
ISEAL Alliance	Kristin Komives and Patrick Mallet	M&E Manager; Credibility Director
Root Capital	Jesse Last	Senior Lending and Strategy Associate
Sustainable Food Lab	Don Seville	Director
World Conservation Monitoring Centre	Sharon Brooks	Head of Programme, Business, Biodiversity and Ecosystem Services
Zoological Society of London	Sophie Persey	Palm Oil Project Manager
Keystone Alliance (Field-to-Market)	Julie Shapiro	Senior Associate

* Responded to pre-questionnaire only.

APPENDIX F: INTEGRATIVE METHODS AND MODELS FOR ASSESSING ECOLOGICAL IMPACTS

The table summarizes an illustrative set of calculator tools, multi-criteria methods, and models for assessing ecological impacts of land management activities. These examples were selected for their potential applicability for impact assessment of agricultural eco-standards. In the second column from the right, “Level of data required” is categorized as: (1) low—requires data already published or already being gathered by farmers and/or uses interview or questionnaire methods; (2) medium—some original field or remote sensing data are required, in addition to pre-existing data; (3) high—considerable original data are required, such as interview data, ecological field studies, remote sensing, modeling and/or other methods.

Method/tool name (type)	Description, purposes, and strengths	Major data requirements	Potential limitations	Scale of application; range of uses	Level of data required	Relevant citation(s)
Habitat Hectares (multi-criteria model)	Rapid, broad-brush assessment of habitat quality for land use planning, management, and policy decision-making	Compares vegetation and habitat indicators to those of benchmark sites representing mature or undisturbed native stands of the same community type	Scoring and weighting factors are subjective and could strongly influence overall assessment ratings	Landscape scale. Developed and initially tested in Australia; has been used in other parts of the world as a proxy tool to evaluate habitat quality	2	Parkes et al. 2003

Method/tool name (type)	Description, purposes, and strengths	Major data requirements	Potential limitations	Scale of application; range of uses	Level of data required	Relevant citation(s)
Rise 2.0 (multi-criteria model)	Computer-based tool for holistic farm-level sustainability assessment including environmental, social, and economic dimensions; calculates 12 indicators based on 68 input parameters; designed as a diagnosis and management tool	Farmer interviews and pre-existing datasets, focused on current state and pending pressures on the farm system	Requires extensive farmer interviews, which must be administered by a knowledgeable advisor or agent	Farm scale. Tested and applied as a tool to structure farmer discussions about sustainability on 600 farms in 18 countries, in partnership with private sector and civil society partners	I	RISE 2011; Thalmann and Grenz 2010
Fieldprint Calculator (calculator tool)	User-friendly, secure online tool permitting growers to examine operational efficiency and environmental impact	Farm records and simple observational data on crops, context and soil type; water, energy, and input use; and other management practices	Limited to a few crops in the US; not intended to provide precise impact measures, but rather performance estimates relative to regional benchmarks; limited external testing or verification to date	Farm scale. Designed for rice, corn, cotton, soybeans, and wheat in the US.	I	Field to Market 2012

Method/tool name (type)	Description, purposes, and strengths	Major data requirements	Potential limitations	Scale of application; range of uses	Level of data required	Relevant citation(s)
Cool Farm Tool (calculator tool)	Open-source Excel-based calculator tool intended as a practical measurement resource for farmers and supply chain actors; input data is limited to information that farm managers would typically have	Information on farm operations and management such as crop and livestock production practices; fertilizer and residue management; energy use; initial processing; transport; and farm land use and vegetation	Relies mainly on self-reporting; limited verification of the accuracy of calculator results against actual field measurements in different contexts	Farm scale. Also intended to inform supply chain greenhouse gas footprint analyses; potentially widely relevant to eco-standards impact assessment	I	Hillier et al. 2010
GAIA (calculator type scoring tool)	Online tool to assess and score on-farm biodiversity in 11 categories of flora and fauna	Farmer self-assessment based on a series of 40 questions	Self-assessment may limit rigor and data accuracy; new tool, still being reviewed	Farm scale. Designed for application on dairy and croplands in the Netherlands, with adaptation possible for other northern European contexts	I	clm 2012

Method/tool name (type)	Description, purposes, and strengths	Major data requirements	Potential limitations	Scale of application; range of uses	Level of data required	Relevant citation(s)
Soil and Water Assessment Tool (SWAT) (spatial model)	Spatially explicit modeling tool to predict impact of management practices on water, sediment, nutrient, and agricultural chemical dynamics in watersheds with varying physical conditions and management activities	Weather, soil properties, topography, vegetation, land management practices, landowner interviews to assess land use change and history	Extensive data and expertise required to run the model	Landscape to regional scale. Underlying US Department of Agriculture model has been in use for 30 years; newer versions integrate GIS and remote sensing and can be calibrated to any region of the world; prior applications in Asia, Africa and the US	3	SWAT 2012
LASH (Lavras Simulation of Hydrology) (spatial model)	Spatially explicit watershed hydrology model used to predict stream flow at watershed outlets; example of a relatively simple watershed model with limited data requirements	Soil and land use maps and a digital elevation model for the subject watershed; five basic parameters of each land use within the watershed	Requires some long-term data on streamflow characteristics; accuracy of model results depends on the accuracy of the input parameters for watershed land uses	Landscape scale. Developed for tropical watersheds containing land use mosaics and having limited data availability; tested in eastern Brazil	2	Beskow et al. 2011

Method/tool name (type)	Description, purposes, and strengths	Major data requirements	Potential limitations	Scale of application; range of uses	Level of data required	Relevant citation(s)
Miradi (multi-criteria model and adaptive management tool)	Excel-based tool to conduct adaptive management for biodiversity conservation projects, including conservation target selection, threat analysis, and impact evaluation	Data on biodiversity status and threats, which can be based on field surveys, expert opinion, or other methods	Intended more as a management tool than as an impact assessment tool per se; useful mainly to monitor biodiversity and ecosystem variables	Landscape or regional scale. Used in biodiversity conservation projects in many contexts	2	Miradi 2011

APPENDIX G: SOME PROXIES FOR ASSESSING AGRICULTURAL SUSTAINABILITY

The table summarizes an illustrative set of proxy measures for assessing ecological impacts of agricultural practices. Some of these proxies have been developed specifically for use in eco-standards impact assessment, while others are measures from the scientific literature with high potential relevance for eco-standards impact assessment.

Proxy measure or tool	Main purpose	Use, suitability, and credibility for eco-standards impact assessment	Relevant Citation(s)
Greenhouse gas calculators	Estimate greenhouse gas emissions from farming operations, usually including CO2, CH4, and N2O from soil management, fertilizer use, fossil fuel combustion, and livestock emissions	Currently used mainly for farmer and supply chain self-evaluation and management, but potentially highly applicable to eco-standards impact assessment	e.g., Hillier et al. 2010
Percent soil surface cover in agricultural areas	Used as a proxy for soil erosion risk; may also be related to soil carbon sequestration and soil health	Soil cover by vegetation, mulches, or crop residues is used widely as an input parameter in soil loss and erosion models. Since many agricultural eco-standards include soil cover as a recommended BMP, proxy measures related to the efficacy of this BMP are highly relevant. Additional factors such as soil type, slope, climate, and root depth will influence relationships between surface cover and erosion potential. More reliable proxy models include these sorts of factors.	e.g., Renard et al. 1997

Proxy measure or tool	Main purpose	Use, suitability, and credibility for eco-standards impact assessment	Relevant Citation(s)
Buffer strip extent, width, and location	Used as a proxy to estimate ecosystem services provided by stream buffers, including water filtration, erosion and sedimentation control, and stream cooling	This proxy is highly applicable, given that riparian buffer strips are a common BMP within agricultural eco-standards. Consideration of buffer location increases data requirements and computational complexity, but likely provides a much more accurate proxy, compared to simple tallies of total buffer length.	Lautenbach et al. 2011
Pollinator habitat analysis	Predict the level of pollination services provided by wild pollinating insects. This proxy uses GIS to analyze data on the location and extent of potential pollinator nesting habitats and fields with pollinator-dependent crop species. Models incorporate recent scientific knowledge on pollinator habits and pollination activity in agricultural areas.	Quantifying pollination dynamics over a large area is effectively impossible without a proxy measure such as this one. However, pollination services may not be considered as a critical outcome/impact measure for many agricultural eco-standards.	Lautenbach et al. 2011
Nitrogen lost to the environment	Indicator of wasted fertilizer inputs (with their associated environmental footprint) as well as nitrogen pollution in surface and ground waters	Currently applied as part of the Unilever Sustainable Agriculture Code; similar metrics have been used in agricultural research for many years	King et al. 2010
Land spared through increased productivity	Estimate the amount of land “spared” for non-agricultural uses by increasing productivity on the lands used to supply raw materials for a food value chain	Currently applied as part of the Unilever Sustainable Agriculture Code	King et al. 2010

Proxy measure or tool	Main purpose	Use, suitability, and credibility for eco-standards impact assessment	Relevant Citation(s)
Hectares of natural habitat	Proxy for biodiversity conservation value attributable to the activities of farms providing raw materials in a food value chain; includes natural and semi-natural areas on farms (field margins, riparian buffers, fallows, etc.) as well as off-farm conservation areas protected, supported, or sponsored by growers	Currently applied as part of the Unilever Sustainable Agriculture Code; recognized as an initial, simplified metric, as it does not consider habitat quality or configuration	King et al. 2010

APPENDIX H: REMOTE SENSING TOOLS FOR ASSESSING AGRICULTURAL SUSTAINABILITY

The table characterizes several recent remote sensing technologies that may be particularly relevant to eco-standards impact assessment. Active remote sensing technologies emit electromagnetic radiation to “scan” surfaces, and have the advantage of being able to penetrate cloud layers. Passive remote sensing technologies record electromagnetic energy (e.g., light or heat) that is reflected or emitted from Earth surfaces. New advances are increasing the spatial resolution, spectral resolution, and return frequency (i.e., how frequently the same location is observed) of passive remote sensing sensors. However, these sensors cannot penetrate cloud layers. Combined technologies integrate data from both sensor types to create composite portraits of land and water features.

Technology	Description	Advantages	Limitations	Sample applications for monitoring eco-certified agriculture	Key citations
Active remote sensing technologies					
Synthetic aperture radar (SAR)	Emits microwaves and measures the strength of the return signal	High capability to measure surface roughness, structure, or texture (e.g., soil surface)	Difficult to analyze topography and shadows; random errors may require averaging four or more pixels to remove “noise,” thus resulting in lower effective resolution	Proxy for forest productivity (biomass production) and thus may be useful for carbon sequestration estimates	Curlander and McDonough 1991; Oliver and Quegan 1998; Rosen et al. 2000
Light Detection and Ranging (LIDAR)	Emits light in batches defined by areas of various dimensions, then measures the time to signal return; essentially functions as a laser altimeter or range finder	Can create very realistic three-dimensional models of the ground or vegetation canopy, including forest structure and height; aboveground biomass and other quantities can be estimated accurately from large-footprint LIDAR areas	Accuracy depends on density of footprints; footprints must be interpolated to make accurate maps, which takes time and planning	Useful for assessing forest tree species composition and richness, which may also be used to help assess aboveground carbon stocks, or as a proxy for rare, threatened, or endangered species	Drake et al. 2002; Lim et al. 2003

Technology	Description	Advantages	Limitations	Sample applications for monitoring eco-certified agriculture	Key citations
Flash LIDAR (also called flash lidar)	Generates 3-D images and videos from energy reflected back from a pulsed laser; distance to target is determined by the arrival time and intensity of the reflection; works at distances from 5 cm to 5 km	Laser pulses pass through clouds and dust, allowing for images even when targets are obscured	Lasers burn out after extended use and need to be replaced	Create high-resolution maps of agricultural areas, particularly in regions that are usually cloud-covered	Vandapel et al. 2004; Ramond et al. 2011
inSAR (Radar-derived height)	Generates maps of elevation; can be used to detect surface deformation or change at the scale of centimeters by comparing images from different dates	Can detect small changes in height or elevation over large areas and time periods	Requires some “control points” that do not change over time; not suited to constantly changing surfaces such as water-covered areas or agricultural fields unless there are boundary points that remain constant	Monitor soil erosion or restoration; current research is exploring opportunities to use changes in forest height to calculate biomass and carbon sequestration	Massonnet and Feigl 1998; Balzter 2001
Passive remote sensing technologies					
Multispectral sensing (e.g., Landsat, SPOT, ASTER)	Sensors measure the electromagnetic energy emitted by each point in an image for multiple spectrum bands (approximately 3-15 bands, depending on the sensor)	Images are widely available, often at affordable cost; many image analysis techniques have been developed and widely applied	Cloud cover limits image coverage, especially in the tropics; may be necessary to stitch together imagery from multiple dates to maximize cloud-free coverage	Provide aerial imagery for manual or automated classification; detect land use change; calculate vegetation quality metrics such as NDVI to monitor plant growth and characteristics	Cohen and Goward 2004

Technology	Description	Advantages	Limitations	Sample applications for monitoring eco-certified agriculture	Key citations
Hyperspectral sensing (also called imaging spectroscopy)	Hyperspectral sensors measure the electromagnetic energy emitted by each point in an image, across tens or hundreds of very narrow bandwidth spectra	The large number of spectra provide additional information about the ground surface compared with other sensors, such as Landsat TM, which use fewer bandwidths	Datasets produced by hyperspectral sensors are very large and may be difficult to analyze	Monitor land cover change, water content, and pollutants and chemicals	Treitz and Howarth 1999; Jensen 2007
Combined technologies					
GIS fusion	Images are tied to coordinate points and combined with spatial datasets to analyze composition, contribute greater detail and specificity to image, or provide ground-truthed data for aiding in image classification	Linking of images to spatial data allows for verification of image classification by ground-truthing selected points; allows for integration of image data with vector data	Images and datasets may vary in resolution or other characteristics; image resolution may not be fine enough for integration with small-scale datasets	Integrate imagery with landscape characteristics such as land cover, soil type, water availability, and other socio-economic or environmental data	McCracken et al. 1999; Jensen 2007
Image fusion	Combines images from multiple remote sensing technologies to produce higher resolution images that can be analyzed for a greater variety of characteristics than a single image	Results in higher resolution images with greater accuracy for classification and analysis	Various images may not be available for all locations or may be expensive to obtain	Track changes in species composition, forest height, species diversity, and water availability; potential for measuring carbon stocks in forests and agricultural lands	Walker et al. 2007; Dalponte et al. 2008; Saatchi et al. 2007