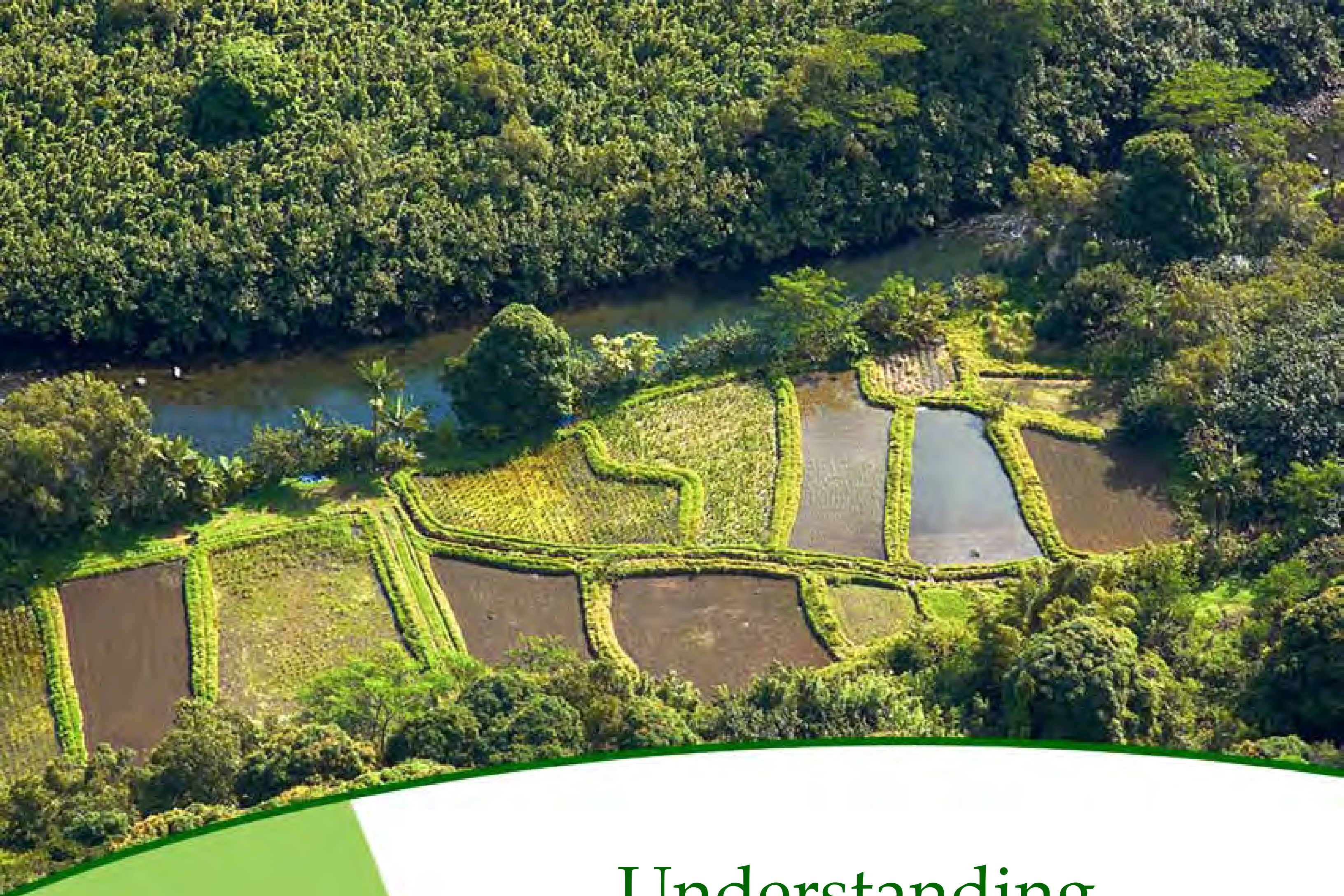
UNDERSTANDING ECOAGRICULTURE: A FRAMEWORK FOR MEASURING LANDSCAPE PERFORMANCE



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A Framework for Measuring Landscape Performance

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Ecoagriculture Discussion Paper Number 2

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Ecoagriculture Discussion Paper Series

The Ecoagriculture Discussion Paper Series is an initiative of Ecoagriculture Partners, a nonprofit organization dedicated to supporting innovators from the agriculture, conservation, and rural development sectors to strengthen and upscale their ecoagriculture management approaches. Ecoagriculture Partners aims to improve understanding and knowledge of ecoagriculture, facilitate collaboration among innovators and practitioners, and mobilize strategic institutional change. Ecoagriculture is a landscape approach to natural resource management that pursues three goals: conservation and sustainable use of biodiversity and ecosystem services, sustained agricultural production, and improved rural livelihoods.

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Executive Summary

Humans in the 21st century will place unprecedented demands on the world's finite land base, seeking to increase global food production by 50 to 100% and improve living standards for billions of poor people while simultaneously protecting wild biodiversity and the ecosystem services that sustain human life. The concept of ecoagriculture emerged from the recognition that these demands could be met only if addressed in concert based on land use systems that advance multiple goals in the same geographic space.

In this context, ecoagriculture is a vision for improving human management of the land and natural resource base so that it simultaneously meets three goals: (a) conserves a full complement of native biodiversity and ecosystem services, (b) providies agricultural products and services on a sustainable basis, and (c) supports viable livelihoods for local people. The concept frames an approach for managing natural areas and agricultural landscapes in complementary ways. Empirically, ecoagriculture is predicated on a growing body of evidence that tradeoffs among conservation, food production, and livelihoods are not always necessary. Instead, significant synergies are achievable using known and emerging management techniques.

Ecoagriculture is already being practiced in hundreds of locations worldwide, with promising results for regions where biodiversity conservation, food production, and poverty alleviation are all high priorities. In particular, given that protected areas alone are often inadequate to conserve unique species and ecosystems, ecoagriculture is a promising approach for accommodating significant biodiversity in the inhabited parts of biodiverse regions. Yet our understanding of ecoagricultural systems and our ability to improve them, replicate them, and scale them up is hindered by the lack of a comprehensive framework for measuring and monitoring the performance of ecoagriculture landscapes over time.

The goal of this paper, therefore, is to propose such a framework and discuss how it may be implemented in diverse landscapes worldwide. Over the past year and a half, many people have contributed to a dialogue about how best to measure the performance of ecoagriculture landscapes. The culmination of this dialogue, which has occurred through interviews, literature reviews, two workshops, and a graduate seminar at Cornell University, is the framework proposed in this discussion paper.

The framework provides an approach to measuring the performance of entire landscapes with respect to the goals of ecoagriculture. The purpose is not to determine whether a given landscape has attained some desirable end condition, but whether it is moving in the right direction—that is, whether the management practices and resulting mosaic of land uses across the landscape are yielding progress toward the goals, individually and collectively. Locally, stakeholders who have interests in the performance of a particular landscape can set targets for meeting specific goals.

The framework uses a hierarchical approach to measuring landscape performance. At the highest level, it begins with a normative framework of four goals and twenty criteria (i.e., sub-goals) that are considered to be desirable in any landscape worldwide. This normative framework defines the ecoagriculture concept and provides a set of "20 questions" for stakeholders to consider when conducting and assessing ecoagriculture activities. The normative structure of goals and criteria is then applied locally through the selection of context-specific indicators and means of measure that allow monitoring and assessment efforts to be tailored to the conditions and needs of particular places, and to involve local stakeholders in indicator selection and evaluation.

The specifics of this framework are predicated on several principles, which are also important tenets of ecoagriculture. First, ecoagriculture monitoring and assessment seeks to identify and document synergies as well as tradeoffs among conservation, agricultural production, and livelihoods. Thus, integrative indicators that elucidate more than one goal are particularly valued. Second, ecosystem services such as water purification, pollination, and the maintenance of soil fertility provide a tangible link among the goals of ecoagriculture, and are considered an important focus of monitoring. Third, monitoring and evaluation must be conducted as a nested series of scales from individual sites and communities up to landscapes, and even looking beyond to consider exogenous influences. While the ultimate goal is to assess ecoagriculture at a landscape scale, fine-grained analysis as well as broad policy considerations contribute to this understanding. Finally, as in most monitoring protocols, proxies are often necessary and useful when direct measurement of the system is not possible. Thus, the framework incorporates measures of process, interventions, and threat reduction in addition to direct measurement of system parameters of interest.

To maximize its utility for project teams, donor organizations, and other potential user groups, the framework is designed to complement existing project-based monitoring and evaluation. Project-based monitoring typically focuses on the parameters and the spatial scale that will reveal the effectiveness of particular interventions. Supplementing these efforts with periodic landscape scale status assessments, as proposed in the framework, can help reveal interactions among multiple interventions, analyze effects of public policies, and identify important exogenous influences. This information can help contextualize project-based work, thereby informing science-based planning and adaptive management and allowing project staff to design more effective interventions.

This paper is the first step in the process of creating a final field-tested framework and a complementary "Ecoagriculture Landscape Measures Sourcebook" for wide dissemination. In the upcoming two years or so, Ecoagriculture Partners and their affiliates in the research, donor, and NGO sectors will test and refine this provisional framework by working with local stakeholders in diverse ecoagriculture landscapes worldwide. This effort will require identifying, adapting, or developing rigorous yet cost-effective indicators and means of measure that are appropriate to particular landscapes, as well as multi-stakeholder participatory processes to define and implement the measurement activities. We intend the final product to be a reliable and easy to use system for measuring the progress of landscapes toward simultaneously conserving wild biodiversity and providing ecosystem services, sustaining or increasing agricultural production, and enhancing local livelihoods. We hope that this document helps to inform the thinking of those ready and willing to participate.

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We thank the many people who contributed time, ideas, and insight to the creation of this framework. These include the members of the Ecoagriculture Landscape Measures Project International Steering Committee, the many professionals and researchers who shared their experience and insight through interviews, participants in the June 2005 and February 2006 review workshops, and the Cornell University students and faculty who contributed ideas during the spring 2005 Seminar in Ecoagriculture. We also extend our deep appreciation to The World Bank, The Nature Conservancy, and Forest Trends for funding this work and facilitating the two workshops.

Preface

When ecoagriculture innovators from around the world gathered at the first International Ecoagriculture Conference and Practitioners' Fair in Nairobi in September 2004 to identify priorities for action to promote ecoagriculture, there was near-universal agreement that a key priority was the development of practical, comparable methods to measure and document ecoagriculture systems at a landscape scale. Based on the specific recommendations made at the Conference, and the self-nomination of interested partner institutions, Ecoagriculture Partners organized a provisional International Steering Committee (ISC) in March 2005 and drafted a concept note. The project officially began with an ISC meeting in April 2005, where it was decided that the first step was to commission a background paper to articulate key issues and a draft framework for assessing and documenting ecoagriculture systems, drawing on lessons learned from those undertaking such assessments from diverse perspectives.

Assessment is difficult not only because ecoagriculture landscapes are, by definition, complex. But assessment also needs to be embedded within a process of multi-stakeholder planning and negotiation among farmers/producers, conservationists, and other local and external interests, about how ecosystems in that landscape should be used and managed. Any framework will take stakeholders into territory that is outside their own "comfort range." The ecoagriculture movement actively seeks synergies among conservation, sustainable rural livelihoods, and sustainable agricultural production—indeed ecoagriculture initiatives are justified in places where all three are critically important—yet some tradeoffs may be unavoidable, at least in the short term.

Monitoring and assessment systems must be shaped to function in highly dynamic social and economic environments, and to assist in adaptive collaborative management processes where the stewardship of ecosystem health, as well as agricultural production and livelihoods, will be largely in the hands of local communities, local businesses, and local governments. If we are to meet the Millennium Development Goals, as well as the commitments made under international environmental conventions, it will be essential to pursue such integrated approaches.

There is a plethora of diverse ecosystem, agricultural, and livelihood indicators and methods available upon which ecoagriculture practitioners can usefully draw. What is often missing is a truly integrated analysis at a landscape scale. Thus, our current work to design an ecoagriculture monitoring and assessment approach focuses particularly on the identification or (where needed) development of indicators that explicitly address the interactions. We anticipate that this analysis will also help to suggest priorities for research by identifying gaps in our existing knowledge about how to select targets and indicators. We are fortunate to be able to build on the recently published Millennium Ecosystem Assessment.

This paper is an initial step, based on the authors' research and interviews as well as the consensus of technical experts from diverse sectors who convened at workshops in June 2005 and February 2006 to review drafts of this paper, to agree on a basic framework and identify next steps for developing an "Ecoagriculture Landscape Measures Sourcebook." In the upcoming months and years, project partners will adapt and test this provisional framework in numerous, diverse ecoagriculture landscapes around the world. In the process, we hope not only to develop a set of useful tools, but also to achieve credible documentation of the impacts of ecoagriculture innovation that can help guide the next generation of initiatives.

Sara J. Scherr
President, Ecoagriculture Partners

1. Introduction

Ecoagriculture is a vision for improving human management of the land and natural resource base so that it simultaneously meets three goals: (a) provides agricultural products and services on a sustainable basis, (b) supports viable livelihoods for local people, and (c) conserves a full complement of native biodiversity and ecosystem services. Ecoagriculture is already being practiced in hundreds of locations worldwide, with promising results for regions where food production, poverty alleviation, and biodiversity conservation are all high priorities. Yet our understanding of these systems and our ability to improve them, replicate them, and scale them up is hindered by the lack of a comprehensive framework for measuring and monitoring the performance of ecoagriculture landscapes over time. The goal of this paper, therefore, is to propose such a framework and discuss how it may be implemented in diverse landscapes worldwide.

Ecoagriculture: An Approach to Managing Multi-Functional Landscapes

Humans in the 21st century will place unprecedented demands on the world's finite land base, seeking to increase global food production by 50 to 100% and improve living standards for billions of poor people while simultaneously protecting wild biodiversity and the ecosystem services that sustain human life. The concept of ecoagriculture emerged from the recognition that these demands could be met only if addressed in concert based on land use systems that advance multiple goals in the same geographic space. Fortunately, as documented by Jeffrey McNeely and Sara Scherr, who originated the ecoagriculture concept in their 2003 book *Ecoagriculture*, recent innovations in land management are demonstrating that tradeoffs among conservation, food production, and rural livelihoods are not always necessary. Instead, significant synergies are achievable using known and emerging management techniques.

Ecoagriculture concerns itself not just with a diversity of agricultural systems but with entire mosaics of land use that also encompass forests, human settlements, coastal zones, and waterways. Taking into account the natural and semi-natural systems that interact with agricultural systems is critical for identifying and fostering synergies between conservation and production. For example, a nature reserve may benefit nearby farms by providing clean water and agricultural pest control, while sustained high levels of production on existing farms may alleviate pressure to expand agriculture into the park. Ecoagriculture also takes a broad view of food production and rural livelihoods. Thus, food production includes not just traditional agricultural products but also products from hunting, gathering, and fishing; and rural livelihoods may benefit from revenue streams tied directly to the protection of natural capital, such as ecotourism and payments for ecosystem services.

Ecoagriculture does not specify a target condition or minimum threshold that a landscape must attain to qualify as "ecoagriculture." Rather, it focuses on improving the performance of any landscape relative to the trio of goals for conservation, agricultural production, and livelihood support. Thus, the concept applies equally well to intensively farmed regions, heavily degraded landscapes, agricultural frontiers, and a range of settings in between.

Although ecoagriculture does not propose a rigid set of management prescriptions, McNeely and Scherr (2003) have identified six sets of strategies that can advance the goals of ecoagriculture:

1. Creating biodiversity reserves that benefit local farming communities
2. Developing habitat networks in non-farmed areas of agricultural landscapes
3. Reducing land conversion to agriculture by increasing farm productivity
4. Minimizing agricultural pollution

5. Modifying the management of soil, water and vegetation to increase natural capital
6. Designing farm systems to mimic natural ecosystems

At first glance, ecoagriculture is similar to earlier concepts such as sustainable agriculture, agroecology, and integrated natural resource management. In fact, ecoagriculture draws heavily on these and many other innovations in rural land use planning and management to create a synthetic framework with three particularly important characteristics:

1. **Large Scale:** Ecoagriculture moves beyond the plot scale to help detect and plan for interactions among different land uses at the landscape scale. In addition, important attributes such as wildlife population dynamics and watershed functioning can be meaningfully understood only at the landscape scale. Also, in recognition of the fact that short-term tradeoffs may lead to long-term synergies, ecoagriculture advocates conducting analyses over longer temporal scales than is commonly done.

2. **Emphasis on Synergies:** Ecoagriculture emphasizes both the need and the opportunity to foster synergies among conservation, agricultural production, and rural livelihoods. The ecoagriculture research and monitoring agenda seeks, in part, to identify and document these synergies.

3. **Importance of Conservation:** Building on the Millennium Assessment, ecoagriculture brings conservation fully into the agricultural and rural development discourse by highlighting the importance of ecosystem services in supporting continued agricultural production. Ecoagriculture also identifies the conservation of native biodiversity as an equally important goal in its own right. Conversely, it challenges conservationists to find more effective ways to conserve nature outside of protected areas by working with the agricultural community and developing conservation-friendly livelihood strategies for rural land users.

In light of the preceding definition, a framework for understanding ecoagriculture must assess how well a given landscape is delivering three sets of benefits: conservation, agricultural production, and livelihood support. To do so, the measurement system must provide a holistic view of the landscape over time, considering the effects of individual management interventions as well as the complex interactions among disparate interventions, policies, and trends across the landscape. The monitoring results should enable planners to tailor the selection and development of management practices—and incentives for employing them—to best serve the three objectives individually and collectively. The results should also help decision-makers formulate strategic choices in cases where the three goals must be balanced against one another. And they should inform those who fund ecoagriculture initiatives about the returns on their investments.

Overview of this Paper

The goal of this paper is to propose a framework for assessing ecoagriculture at a landscape scale by building on existing assessment frameworks from relevant fields. The paper is intended for the full spectrum of individuals and organizations involved in planning, implementing, researching, or funding ecoagriculture-related activities, yet we recognize that different groups have different interests in understanding the performance of ecoagricultural practices. For example, donors who fund conservation, agriculture, and rural development projects need to account for their investments: are they getting what they pay for or are there more efficient ways to achieve their goals? Implementing agencies need to know whether their programs are working, and therefore when and how to expand or modify their activities.

Land users need information that will help them adapt their management practices to changing conditions. And scientists seek information that will enable them to understand processes from which fundamental principles may be derived. All of these groups are important audiences for this paper.

We envision two particularly important applications of a framework for measuring and understanding ecoagriculture. First, it can facilitate collective decision-making by multiple stakeholder groups working in the same landscape by elucidating interactions, synergies, and tradeoffs among goals and landscape components. Second, when ecoagricultural practices are successful, the framework can help document these successes, bolstering the case for adopting and scaling up ecoagricultural practices in critical landscapes worldwide.

Methods

Four main sources informed this paper: 1) correspondence and telephone interviews with practitioners involved in developing and evaluating ecoagriculture-related programs; 2) academic and grey literature, including project and program documents that reflect cutting edge activities; 3) discussions and analysis by students and faculty in Cornell University's spring 2005 Seminar in Ecoagriculture; and 4) input from a wide range of leaders from the international conservation, agriculture, and rural development communities provided at two workshops—the first sponsored by Ecoagriculture Partners and the Nature Conservancy in June 2005 and the second sponsored by the World Bank in February 2006. (People and organizations that provided input are listed in **Annex A**.) With these inputs, we conducted an iterative, consultative process that led to the framework proposed in this paper.

Structure of this Paper

This paper begins with broad theoretical and methodological considerations and then moves to more specific discussions of desirable ecoagriculture outcomes and how they may be measured. **Chapter 2** considers some of the conceptual and theoretical issues relevant to the development of a framework for assessing ecoagriculture outcomes. Here we consider the spatial scale over which ecoagriculture initiatives should be assessed, the differences between status measures and effectiveness measures, and the appropriate role of local participation in the development and implementation of assessment systems. We also present the broad structure of the proposed framework.

In **Chapter 3**, we define and justify criteria for each of the three goals of ecoagriculture—conservation, agricultural production, and livelihoods—as well as a fourth goal of creating and maintaining effective institutions. Criteria are sub-goals that are appropriate in any landscape, and are not context-specific.

Chapter 4 explains how the universally applicable criteria presented in **Chapter 3** can be applied in the field through the selection of relevant, place-specific indicators and means of measure. We also present some of the more relevant existing approaches to assessing conservation, agricultural production, and livelihoods. Finally, **Chapter 5** identifies next steps for field testing and refining the framework, and for creating an Ecoagriculture Landscape Measures Sourcebook for practitioners.

Annex A lists those who were involved in the creation of this framework, including members of the Ecoagriculture Landscape Measures Project International Steering Committee, interviewees we consulted, and attendees at the two project workshops. **Annex B** summarizes some key existing monitoring frameworks and indicator sets that were influential in informing this paper.

2. Conceptual Issues

An initial response to the task of formulating assessment measures might be to think, "Let's just go out and measure what we're interested in." The following quotation from The Biodiversity Partnership, however, quickly dispels this naïve approach to assessment (in this case, assessment of changes in biodiversity):

> Measuring many elements at frequent intervals is too expensive and time consuming. Ecosystems are subject to a certain degree of natural variability from one season to the next, or over many years or decades, so it is difficult to separate human effects from natural ones. Most scientists tend to specialize, so developing an integrated approach requires more interdisciplinary cooperation than is common in academic or agency cultures. Policy-makers complain that monitoring efforts seldom produce meaningful and relevant information to support management decisions. Funding for monitoring is never adequate, and it is unlikely to be available consistently over ecologically meaningful time periods (The Biodiversity Partnership 2005).

Because it is evident that assessment measures for a system as complex as an ecoagricultural landscape cannot realistically hope to measure all relevant components of the system, we are forced to confront several questions: At what scale or scales should assessments be conducted? To what extent should assessments combine more accurate direct measures with more cost-efficient proxy measures? Should assessments be tied into specific conservation and rural development projects or independent from them?

This chapter explores these conceptual issues, proposes a suitable approach to each issue, and integrates these approaches to define a framework for measuring landscape performance in the context of ecoagriculture.

Definition of a Landscape

As discussed in the Introduction, ecoagriculture takes a landscape scale view of land use and its consequences. The book *Ecoagriculture* defines a landscape as:

> A mosaic where a cluster of local ecosystems is repeated in similar form…A landscape is characterized by a particular configuration of topography, vegetation, land use, and settlement pattern that delimits some coherence of natural, historical, and cultural processes and activities (McNeely and Scherr 2003:275).

This definition is helpful in conceiving of a landscape as a biophysical as well as a cultural and political entity. However, since biophysical and cultural processes rarely coincide spatially, it is important to delineate a landscape functionally—that is, within the context of a particular issue or problem. For example, if the objective were to conserve elephants, one might define the landscape as the space within which an elephant population moves; if it were to protect the culture of indigenous people, one would define a different landscape in the same area in which the elephants exist. Furthermore, the scale of a landscape depends on the graininess of the mosaic: in the Congo Basin, landscapes are often huge because there are vast stretches of apparently undifferentiated land, whereas in Europe they are much smaller because the landscape is more finely grained (J. Sayer, pers. comm.). A final point to note is that when we use the term *landscape* throughout this paper, we are referring to the "ecoagricultural landscape"—a mosaic of natural, semi-natural, and agricultural lands occurring in an area of importance for conservation and for rural development.

Project-Level versus Landscape-Level Assessments

One aspect of ecoagriculture that differentiates it from earlier approaches is its focus on the landscape scale when setting goals and measuring results. Although there are several advantages to taking a landscape view of the system, landscape level assessment alone is usually poorly suited to guiding adaptive management at the project level. Most projects[1] or management interventions that seek to advance the goals of ecoagriculture (such as rural development initiatives, conservation efforts, or eco-certification schemes) occur at scales other than the landscape scale—some are much smaller in extent whereas others address broader-scale public policy issues. A mismatch between the scale of a project and the scale at which monitoring and evaluation (M&E) occurs can be a serious problem. For example, a village-level project, even if quite successful, will probably have a negligible impact on landscape-scale indicators.

Put more generally, project-level M&E usually focuses on the spatial scale and the set of indicators that will reveal the success or failure of project activities, and for good reason. Conservation Measures Partnership notes that "by focusing your M&E efforts squarely and almost exclusively on your goals, objectives, and activities, you are more likely to collect only the information that will be useful to you as you adaptively manage your project." They recommend, furthermore, that M&E efforts be matched "to the scale you expect to influence with your intervention" (Conservation Measures Partnership 2004:13).

M&E targeted to the scale and purview of project interventions is essential for responsive and cost-effective adaptive management. In addition, donors and project officers value the type of cause-and-effect validation for their work that this type of M&E can provide. Yet, ecoagriculture seeks to transcend the sometimes mechanistic, single-objective thinking of project-level M&E to understand the interactions and potential synergies among the three goals of ecoagriculture. It also seeks to move beyond individual projects to create collaborative initiatives in which different types of interventions, led by different types of organizations, contribute to a whole that is greater than the sum of its parts.

These considerations suggest that ecoagriculture measurement framework should include project-level evaluations of specific interventions as well as landscape-scale assessments that can tease out interactions, synergies, tradeoffs, and the effect of outside forces beyond the control of individual projects.

Status Measures versus Effectiveness Measures

The previous section hinted at the distinction between monitoring that is directly linked to project interventions, and monitoring that seeks to understand a system more generally. The former approach, *effectiveness measures*, answers the question: "Is our project or program helping, and, if so, how?" The latter approach, *status measures*, answers the question: "How is the system doing overall?" Typically, status measures are conducted repeatedly to discern changes in the system over time. Rather than pre-supposing which aspects of the system are most important or most likely to change over time, status measures assess a system more comprehensively. The advantage of this approach is that it is more likely to reveal the indirect or unexpected effects of a project (e.g., a poverty alleviation initiative focused on livestock health might indirectly protect native wildlife populations by reducing disease transmission from domestic to wild animals) as well as the interactions among multiple projects and other outside factors. A disadvantage is that comprehensive status measures usually require much more data than targeted evaluations around the direct effects of an intervention. **Table 2-1** summarizes key aspects of effectiveness measures and status measures.

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1 Conservation Measures Partnership's *Open Standards in the Practice of Conservation* defines a project as "a set of actions undertaken by any group to achieve defined goals and objectives." Projects can occur at a wide variety of scales from individual farms or villages up to entire landscapes or regions.

Table 2-1. Key distinctions between effectiveness measures and status measures as they apply to ecoagriculture.

Effectiveness Measures	Status Measures
Evaluates the outcome of a project or program • Is the project/program helping? How much and in what ways? • Direct assessment of cause and effect.	Inventories a system without specific reference to a project or program. • How is the performance of the entire system changing over time? • Cause and effect may be difficult to demonstrate given complex systems and interactions. • Direct assessment of the ecoagriculture landscape.
Need not consider the full set of ecoagriculture goals; more important to focus the evaluation on aspects of the system that the project or program is designed to influence.	Should consider the full set of ecoagriculture goals to observe interactions and cumulative effects from various projects, and to discern system changes attributable to other factors.
Conducted at a scale commensurate with the scale of the project or program.	For ecoagriculture, should be measured at the landscape scale.
Data generated is at the project level. Context can be understood by referencing landscape-level status measures.	Data from the project level is transferred up to the landscape level and supplemented with other landscape-level data.

To understand ecoagriculture systems, both targeted effectiveness measures and more comprehensive status measures are necessary. The inclusion of landscape-scale status measures—though likely to be costly, complex, and demanding of interdisciplinary technical expertise—can help differentiate ecoagriculture from other land management paradigms by providing a clearer picture of how entire systems (not just artificially demarcated parts of systems) respond to multiple interventions and outside forces. This information could greatly facilitate scaling up ecoagriculture.

Types of Project Effectiveness Measures

Project effectiveness can be measured in terms of *process measures*, *intervention measures*, *threat reduction measures*, and *outcome measures*. These are discussed in sequence below.

Process Measures

Process measures consider the conceptual, analytical, institutional, and human guidance and capacity behind a project—in other words whether a project has the ingredients for success. Of the four types of effectiveness measures, process measures are generally the least difficult to measure but also the furthest removed from the ultimate interest of the evaluation—the system itself. Well-established examples of process measures include the International Organization for Standardization (ISO) 14001 standard for environmental management in industrial production and the Sustainable Forestry Initiative (SFI) established by the United States forest industry. Recently, the Conservation Measures Partnership developed process standards for conservation projects, entitled *Open Standards in the Practice of Conservation* (Conservation Measures Partnership 2004). These standards recommend a framework for planning, conducting, monitoring, and reporting on conservation projects. Key points of this framework include:

- Creating a conceptual model and situation analysis that indicates: a) what problem the project seeks to address; b) what types of threats, opportunities, stakeholders, and other factors could lead to the exacerbation or amelioration of this problem; and c) a logically linked set of goals, objectives, strategies, and actions that will address the problem by diminishing threats and/or capitalizing on opportunities.

- Defining the project stakeholders, including members of the project team and external stakeholders.

- Defining the project timeline and a means for the project to become institutionalized and self-sustaining.

- Implementing projects using an adaptive management approach.

While process measures such as these may seem obvious and somewhat trivial, in fact they are only sometimes adopted. For example, many so-called sustainable agriculture projects are hindered by dubious or poorly conceived conceptual links between project interventions and desired environmental outcomes. Thus, adherence to basic process standards might be considered a necessary, though not sufficient, condition for the success of ecoagriculture initiatives, and process measures could be valuable in verifying this adherence. Process standards can ensure that donors, project staff, and local stakeholders are all "speaking the same language" when they talk about conservation and development projects, and that the workings of such projects are transparent to observers. Another advantage of process standards is that they are likely to be similar across all the goals of ecoagriculture, since good project management is always characterized by certain traits. Thus, it may be possible to adopt a single set of ecoagriculture process standards.

Intervention Measures

Intervention measures assess the extent to which a desirable set of actions has been implemented. In general, intervention measures are a closer proxy for project outcomes than are process measures.They are typically more time-consuming to monitor than process measures because they require field verification. The Rainforest Alliance/Sustainable Agriculture Network certification standards and monitoring framework use primarily intervention measures. These standards require, among other things, that certified farms:

- Protect existing remnants of natural ecosystems and restore remnants not suitable for agriculture.

- Connect forest fragments with a greenway or forested corridor.

- Establish environmental education projects.

- Promote reduced water use and water reutilization.

- Avoid the use of fire to clear land or control weeds or pests.

To monitor the adoption of these standards, one would need to verify whether, in fact, the farm engaged in each of these actions. However, the ultimate effect of these actions (e.g., Did the environmental education project lead to improved stewardship?) is beyond the scope of the intervention measures assessment.

This example illustrates some of the pros and cons of using intervention measures to assess project effectiveness. One advantage is the relative ease of measurement. Through farmer interviews, simple documentation, or visual inspection, one could assess whether a farm adhered to most of the standards listed above. In addition, when intervention measures are closely correlated with desired outcomes, they can be a cost-effective proxy for more expensive outcome measures.

Perhaps the greatest concern about relying on intervention measures is that the link between the intervention and the desired outcome is often dubious or poorly established. For example, the ecological value of greenways can range from very significant to virtually nil depending on the greenway's purposes and design. Knowing that a greenway was established (or omitted) tells us little about our ultimate concern: whether functional connectivity has been maintained for target plant and animal species. Another disadvantage is that an over-adherence on intervention measures can promote a "command-and-control" approach in which projects are judged based on their use of specific strategies, even if other strategies could attain the same goal in a more cost-effective way. In light of these issues, there remain concerns about evaluation systems that only consider the interventions themselves, without having first established a strong causal link between the intervention and a desired outcome.

Threat Reduction Measures

Threat reduction analysis (TRA) was developed for use in conservation projects (Margoluis and Salafsky 2001). Most conservation projects seek to reduce the degree of threat to target biodiversity by addressing the human activities that directly and indirectly threaten biodiversity. TRA seeks to provide a relevant, sensitive, and cost-effective means to assess the degree of threat reduction over time. Compared to the direct measurement of changes in biodiversity, TRA has several potential advantages:

- It is sensitive to changes over short time frames, whereas elements of biodiversity may take years or even decades to respond to changes in human management. The amelioration or exacerbation of threats may provide an early indicator of project success or failure.
- It can drastically reduce sampling effort since assessing a handful of threats may be an adequate proxy for assessing the numerous species or ecological communities affected by these threats.
- It generally provides a more reliable proxy for a project's impacts on the system of interest than intervention measures or process measures.
- It can allow for a comparison of project effectiveness across numerous projects in disparate contexts (Margoluis and Salafsky 2001).

For these reasons, TRA holds considerable appeal for cost-effectively measuring landscape performance. In addition, because agriculture is often cited as a leading threat to biodiversity worldwide, TRA could be helpful for measuring the degree to which ecoagriculture practices reduce biodiversity threats. The use of TRA to assess the other two goals of ecoagriculture may require some creative thinking. On the surface, the challenges of agricultural production and livelihood enhancement are not to reduce threats but rather to increase opportunities (for profit-making, for nutrition, for health care, etc.). However, embedded within these goals may be threats to advancement such as soil erosion in the production realm or insect-borne diseases in the livelihoods realm. A TRA framework may be useful for assessing changes in such threats over time.

Furthermore, the TRA framework could be adapted to consider not just threats but also opportunities for advancing all three ecoagricultural goals. This addition could help practitioners elucidate the synergies among these goals. For example, the adoption of agroforestry practices in a degraded landscape could simultaneously increase agricultural production, wild biodiversity, and subsistence welfare and income opportunities for local people. This example illustrates how using an opportunities framework could help dispel the mindset among some conservationists that agricultural activities always threaten biodiversity.

The major challenge of TRA, as with any proxy indicator, is to establish the nature of the causal relationships between the amelioration of threats (or the increase of opportunities) and the improvement in the system or outcome target of interest. Some researchers are exploring these connections—mostly with respect to threats to the persistence of wild biodiversity—but it is unclear to what extent context-specific findings may be generalized. Projects predicated on an imprecise threat reduction framework are unlikely to be successful. For example, it is unwise to assume that agricultural practices that appear in the abstract to be "good for the environment," such as no-till agriculture, will in fact significantly reduce threats to wild biodiversity that is of interest to conservationists. Even if such practices do no harm, or help at the margin, they should not be touted as biodiversity conservation strategies until there is scientific evidence to demonstrate this—or unless they are being tested as possible strategies within an adaptive management framework with rigorous outcome monitoring.

Outcome Measures

Outcome measures directly assess the system of interest itself. In the case of biodiversity, for example, outcome measures might include numbers of individuals of a particular species, size of a particular type of habitat, or density of invasive species. Even within the realm of outcome measures, it is possible to have indicators that measure a system more directly or less directly. For instance, well-chosen indicator species are a direct measure of one aspect of biodiversity as well as a proxy measure for a much wider set of biodiversity.

On the whole, outcome measures are the most precise and most reliable of the four sets of effectiveness measures discussed here. However, they also tend to be the most difficult to monitor and the most data-intensive. For this reason, in practice almost all outcome measures examine only a subset of the actual system of interest. This may be done using a sampling scheme or through proxy measures such as indicator species.

Given the cost of developing and applying outcome measures, it is worth considering who may be sufficiently interested in this type of information to justify the effort of doing so. First, many large international conservation organizations and other NGOs are placing increased emphasis on project evaluation and monitoring to determine whether their programs are achieving the desired outcomes. In the agricultural and rural development sectors there is growing interest in scaling up the effects of local project initiatives to regions or landscapes, and interest by consortia of donors and development agencies in evaluating the cumulative effects of coordinated interventions over time. Recognizing that impacts may manifest themselves differently at larger spatial and temporal scales, interest is growing in developing regional and landscape performance measures. Furthermore, as the global community comes to view environmental services as a valuable product of land use systems, practitioners are seeking new methods to measure and value these services, often at the landscape scale. Thus, while rigorous efforts to examine landscape scale effects of conservation and development initiatives are in their infancy, interest in doing so is growing rapidly for a variety of overlapping reasons.

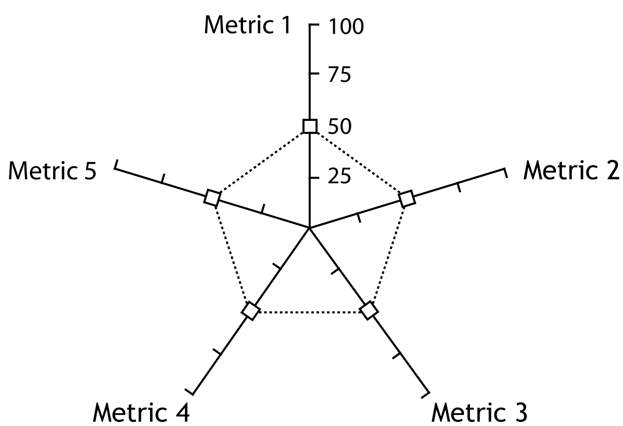
Methods for Synthesizing Information

The question of how to integrate disparate indictors is a complex one that has been addressed in different ways by different practitioners. A notable effort to integrate the measurement of livelihood and conservation outcomes at a landscape scale currently is being field tested by the World Conservation Union and World Wide Fund for Nature (J. Sayer, pers. comm). So far, however, this work has not attempted to incorporate agricultural performance measures. Thus, the integration of disparate indicators remains an important subject for future work.

This challenge is especially salient for understanding ecoagriculture, which requires synthesizing information about different system components to arrive at a composite picture of the landscape. By doing so, a more holistic view of the entire system—including tradeoffs, synergies, and net outcome—can be obtained. However, excessive synthesis may mask important data on individual system components and lead to specious "apples to oranges" comparisons. For this reason, when documenting landscape performance it may be beneficial to combine indicators to some degree without distilling all data into a single "performance score" for the entire landscape.

Radar diagrams accomplish just this by visually depicting the performance of an entire system in terms of a few key variables (see **Figure 2-2**). Applied to ecoagriculture monitoring, radar diagrams could aggregate the many indicators used in any given landscape into a smaller number of factors. The number of factors could be as few as three—one for each of the ecoagriculture goals—or each goal could be sub-divided further. These factors would then be shown graphically in the radar diagram as a "landscape scorecard" that could be tracked over time. The unaggregated indicator ratings that inform the radar diagram would not be discarded, but could be reported in a more detailed format that accompanied the radar diagram.

Figure 2-2. A basic radar diagram (sometimes referred to as a spider, star, or pentagon diagram). Campbell et al., 2001.



Participatory Versus "Expert" Indicators and Methods

An effective ecoagriculture monitoring and assessment program must involve local participants as well as technical experts. These groups provide complementary sets of skills and knowledge. Technical experts (local as well as outside experts) tend to be well-versed in the theoretical and methodological aspects of monitoring and assessment and have knowledge of relevant fields such as economics or conservation biology. Local laypersons, on the other hand, are likely to have intimate knowledge of their surroundings and how they have changed over the years. Some types of information—such as data on human-wildlife interactions—may be obtainable only from local farmers or landowners.

The involvement of multiple stakeholders is also essential to lend maximum legitimacy to monitoring and assessment results. To earn credibility within the scientific, academic, and donor communities, such results must be the product of a methodologically sound monitoring program led by one or more experts in the relevant field(s). To attain credibility among local communities, local participants should play a role in formulating and/or implementing the monitoring program. Technical experts from local communities (such as staff at local NGOs) can be especially valuable by contributing to both types of credibility.

Local participation in ecoagriculture monitoring and assessment can come in two forms, either or both of which might be appropriate in any given context. First, local people can participate in developing indicators and means of measure. Livelihood indicators are an obvious place for local stakeholders to shape the monitoring and assessment framework. On the other hand, biodiversity indicators may be more appropriately developed by conservation experts who have a detailed knowledge of ecosystems, taxonomy of flora and fauna, ecological interactions, and so forth.

Second, local people can participate in the actual monitoring process, especially by helping with data collection. This approach is known as participatory M&E. Participatory M&E tends to work best when local people have a clear motivation to engage in this process—in other words, when the monitoring efforts are directly linked to potential improvements in their livelihoods. This link is most likely to be present in a situation of resource co-management, when local people can use monitoring results to manage a resource more effectively and more profitably. Local people could also be paid to conduct monitoring, essentially employing them as research assistants in the assessment effort.

Participatory M&E poses several limitations and challenges. First, it is necessary to use very simple, easy-to-observe indicators when working with minimally trained local people—indicators that may not always be the most appropriate. Second, it may be difficult to standardize data provided by many different people if these data were not collected according to standard protocol. Third, experts may need to verify the reliability of data collected by laypersons, which adds additional expense. These considerations suggest that local participation in data collection is likely to be most valuable when local people can report on factors with which they are quite familiar, and which they do not have to go far out of their way to monitor, such as human-wildlife interactions near the agricultural frontier, or the amount and type of insect damage on farms.

Integration with Planning

To maximize its value, ecoagriculture monitoring and evaluation should be conducted as an integral part of planning ecoagriculture landscapes. Planning encompasses the essential functions of defining the boundaries and the elements of a landscape, setting goals, and identifying strategies for moving toward these goals. Many sound frameworks already exist for integrating planning, monitoring and evaluation in the context of conservation and rural development (Buck et al. 2004, Conservation Measures Partnership 2004, Bolwig et al. 2003, Cowles et al. 2001)—frameworks on which ecoagriculture assessment activities can usefully build. To achieve such integration in practice, it is essential to understand the planning and decision-making processes for which municipal and other local or regional administrative units may be responsible in an ecoagriculture landscape. Coordinating the design of a monitoring and evaluation program with these public entities can help build capacity for adaptive, cross-sectoral planning and implementation of ecoagriculture activities.

3. Framework for Measuring Landscape Performance

In this chapter, we first present the framework's broad structure, based on the discussion of conceptual issues in **Chapter 2**. We then discuss approaches to understanding conservation, agricultural production, livelihoods, and institutions within ecoagriculture systems. We follow these definitions and considerations with the goals and criteria for the four elements of the framework.

Organizing Principles

When developing a measurement framework, it is pointless to identify specific indicators until one has defined the goals, or desired outcomes, against which to measure a system, program, or project. In the context of ecoagricultural systems, some of these goals are dictated by the very definition of ecoagriculture, whereas others must be place-specific. That is, some ecoagricultural goals are so universally applicable that they should be embedded in the framework itself whereas others must be formulated according to the particular needs and context of each ecoagricultural landscape. Once the goals have been agreed upon, context-appropriate indicators and means of measure can be identified to measure progress toward these goals.

These considerations point to the benefit of a hierarchical framework—an approach used in many other measurement frameworks, such as The Nature Conservancy's framework summarized in **Annex B**. The ecoagriculture measurement framework is organized into a hierarchy with four levels.

Level 1: Broadest-level **goals** of ecoagriculture – *universal*

Four goals define the ecoagriculture concept, and are therefore the foundation of the measurement framework:

a. Conserve, maintain, and restore wild biodiversity and ecosystem services.

b. Provide for sustainable, productive, and ecologically compatible agricultural production systems.

c. Sustain or enhance the livelihoods and well-being of all social groups in the landscape.

d. Establish and maintain institutions for integrated, ongoing planning, negotiation, implementation, resource mobilization, and capacity-building in support of the goals of ecoagriculture.

Level 2: Sub-goals, or **criteria** – also *universal*

Under the four goals are a total of 20 criteria—or sub-goals—that are presumed to be desirable in any landscape. While some criteria may be more important than others in any given landscape, the criteria provide a useful set of "20 questions" for stakeholders to consider when planning, implementing, and measuring ecoagriculture activities. Criteria are stated as descriptors or characteristics of a highly successful ecoagriculture landscape. As such, they are desirable endpoints that can help guide an ecoagriculture project or intervention, even though these endpoints may be unattainable in any given landscape.

Level 3: Indicators of each criterion – *usually place-specific*

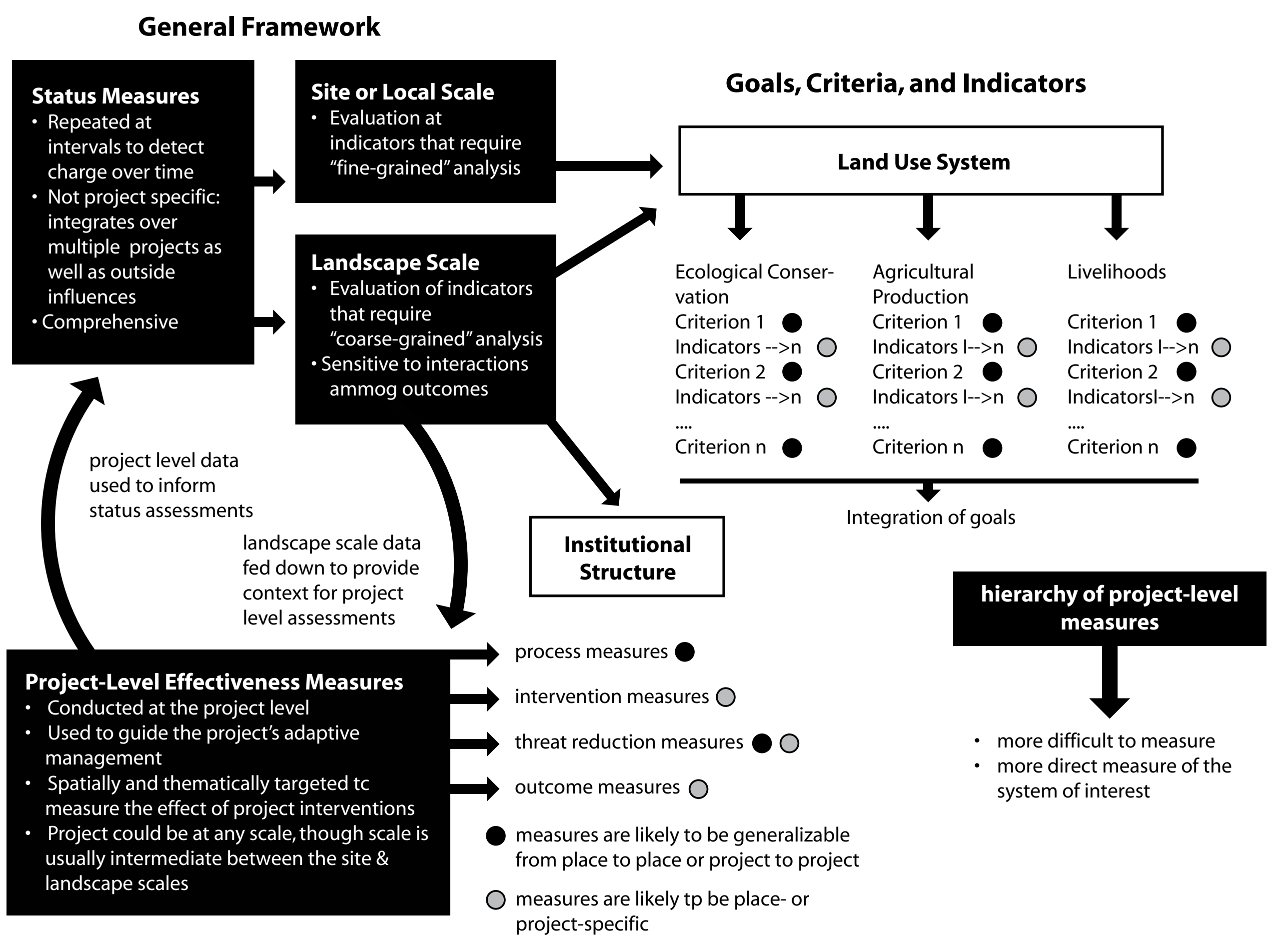
Indicators are the actual factors that are measured to reveal how well each criterion is being fulfilled. Some indicators—especially "integrative" indicators that provide information about all three ecoagriculture goals—may be so important or useful as to be universally applicable. However, most indicators will be place-specific as well as scale-specific. For example, appropriate indicators of human health in the United States might include rates of obesity and diabetes, whereas appropriate indicators in the Amazon Basin might include incidence of malaria. Each of these indicators only makes sense in a specific context where it is measuring a health issue of local concern. In many cases, indicators can or should be developed collaboratively with local stakeholders. This is particularly true for livelihood indicators, when the goal is the wellbeing of these very stakeholders. **Chapter 4** discusses the process of indicator selection and provides some sample ecoagriculture indicators.

Level 4: Means of measure – *place-specific*

Means of measure are used to evaluate each indicator on a quantitative or qualitative scale. Examples of means of measure include wildlife censusing techniques, land cover analysis, and farmer interviews.

A second key aspect of the framework is its integration of project-level evaluations with more comprehensive landscape status evaluations. As shown in **Figure 3-1**, status measures are intended to provide a relatively comprehensive assessment of landscape performance. The scope of the status

Fig. 3.1 Conceptual framework for measuring ecoagriculture landscape performance



measures exceeds the scope of any particular project to reveal synergies and tradeoffs among the different goals of ecoagriculture as well as the effects of outside forces. This assessment framework integrates data and monitoring results from a variety of projects and initiatives across the landscape from the sub-local, local, and landscape scales, typically likely supplemented by additional data collected specifically for the landscape status assessment. The goal is to repeat this assessment at regular intervals.

Many ecoagriculture-related projects already conduct monitoring and evaluation activities as part of their adaptive management cycle or reporting requirements. These assessments typically focus on measuring the success of project activities, but data from project-level assessments could be used to inform landscape-scale status assessments. Conversely, landscape-scale monitoring could inform the context and situation analysis of various projects within the landscape, as shown in **Figure 3-1**.

The remainder of this chapter describes the framework's approach to measuring each of the ecoagriculture goals and presents the criteria for each.

Conservation Goal and Criteria

In the context of ecoagriculture, the term 'conservation' encompasses two closely linked environmental assets: wild biodiversity and ecosystem services. Before presenting the conservation measures framework below, it is worth defining these two assets and their relationship.

Biodiversity can be defined simply as "the variety of life on Earth and the natural patterns it forms" (CBD 2000) but it is helpful also to consider a richer definition that identifies three components of biodiversity:

1. All forms of life: biodiversity includes all living things—including bacteria, fungi, plants, and animals—regardless of how similar they are to other species or how useful they are to people.

2. All levels of organization of living things: biodiversity includes individual organisms and their genetic material; groups of similar organisms, such as populations and species; and groups of species in communities, ecosystems, and landscapes (groups of adjacent ecosystems).

3. All the interactions among the forms of life: biodiversity is more than just the parts of a living system; it also includes the ways the various parts interact with each other, including competition, predation, and symbiosis.[2]

As implied by this definition, wild biodiversity (i.e., native biodiversity) has a spatial component: genes, populations, species, and ecosystems form naturally occurring patterns that are often differentiable from the patterns that humans bring about through large-scale changes such as intensive agriculture and the introduction of invasive species. From a conservation standpoint, genes, populations, species, and ecosystems are generally considered desirable when they occur in their naturally occurring patterns and undesirable when they occur elsewhere (as is the case with exotic species).

The discussion of natural pattern, of course, begs the question of what "natural" means, given that communities are always in flux due to the processes of evolution, climate change, and other influences. This is a challenging issue that has been much debated. In general, though, a consensus holds that the pace and magnitude of changes to ecological communities is qualitatively different under modern human management regimes than under pre-modern regimes. In many landscapes, therefore, it is reasonable to

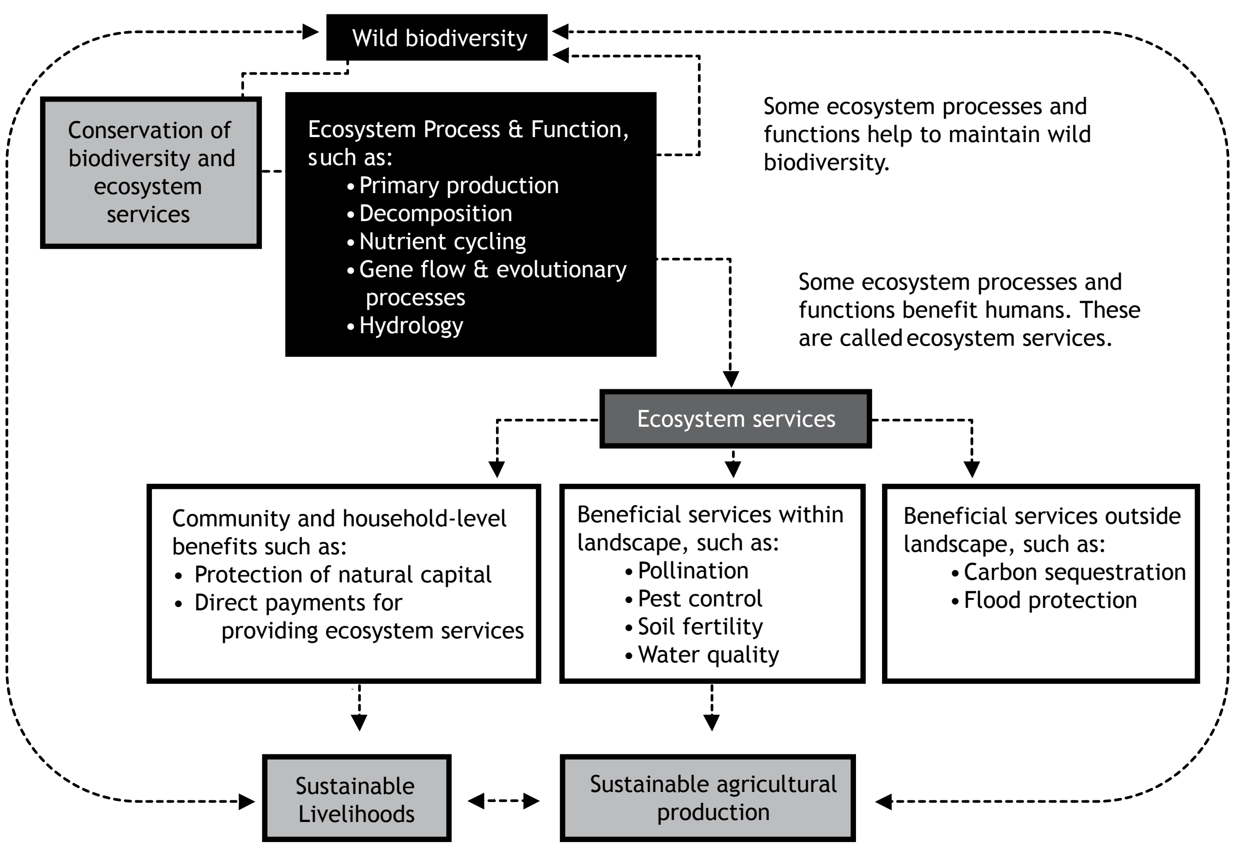
2 This definition is paraphrased and adapted from the definition presented on the website of the Society for Conservation Biology (http://conbio.net/SCB/Services/Education/faq.cfm). It is also substantially similar to the longer definition espoused by the Secretariat of the Convention on Biological Diversity (CBD 2000).

define the reference condition for wild biodiversity as the condition of ecological communities prior to the advent of modern land use practices that removed or transformed natural ecosystems on a large scale, such as intensive agriculture and urbanization. Ecological communities that approximate this reference condition still exist in many ecoagricultural landscapes (e.g., national parks, wildlife refuges, nature reserves), and, where they do not, reference conditions may be inferred by historical records and remnant fragments. However, in some places, such as western Europe, ecosystems have been shaped by such intensive and long-lasting human use that it may not be possible or useful to define the reference condition in terms of naturally occurring patterns of biodiversity. In such places, the goals for biodiversity conservation must be informed by cultural values, but can be heavily guided by scientific analysis.

Ecosystem services—the second part of the conservation goal—are ecological processes and functions that sustain and improve human life (Daily 1997). These can be divided into four categories: 1) *provisioning services*, or species that provide us with food, timber, medicines, and other useful products; 2) *regulating services* such as flood control and climate stabilization; 3) *supporting services* such as pollination, soil formation, and water purification; and 4) *cultural services*, which are aesthetic or recreational assets that provide both intangible benefits and tangible ones such as ecotourist attractions (Kremen and Ostfeld 2005).

Ecosystem services play a central role in multi-functional landscapes, and are a key tenet of the ecoagriculture concept. As shown in **Figure 3-2**, ecosystem services represent an important "bridge" among the goals of ecoagriculture (and their respective advocates). For example, services such as water cycling, nutrient cycling, and the maintenance of soil fertility benefit sustainable agricultural production, which, in turn, contributes to viable livelihoods. Wild plant and animal species may also contribute

Figure 3.2 Links between the goals ofecoagriculture and ecosystem services



directly to sustainable livelihoods by providing food, medicine, building materials, and other natural provisions. Conversely, efforts to enhance agricultural output by, for example, reducing soil erosion or maintaining native pollinators, may require or facilitate the protection of wild biodiversity. Finally, payment for ecosystem services programs that compensate rural landowners and communities for maintaining ecosystem services offer a direct link to livelihood enhancement.

Although wild biodiversity and ecosystem services are closely linked, they are not synonymous. A landscape with relatively intact wild biodiversity is likely to provide a full complement of ecosystem services. However, there is evidence that many ecosystem services can also be provided by non-native species, or by combinations of native and non-native species in heavily managed settings such as permanent farms. The implication is that even where wild biodiversity has been significantly reduced to make way for food and fiber production, high levels of ecosystem services can often still be provided through intentional land management practices. On the other hand, managing an ecoagriculture landscape for ecosystem services does not ensure that wild biodiversity will be adequately protected. Thus, wild biodiversity and ecosystem services both require explicit consideration in ecoagriculture systems.

Based on these definitions, the framework includes five criteria for the conservation goal. The rationale for and explanation of each criterion is provided in italics.

Conservation Goal: Conserve, maintain, and restore wild biodiversity and ecosystem services.

Criterion C1: Land use patterns across the landscape optimize habitat value and landscape connectivity for native species. *The relative habitat value of different land uses across the landscape for native biodiversity ultimately determines the condition and persistence of this biodiversity. The size, shape, and spatial pattern of land use elements are also important factors. The term "landscape connectivity" refers to the functional connectivity of the landscape for the native species that inhabit it; thus, it is a function of the needs of the species as well as the physical layout of the landscape.*

Criterion C2: Natural and semi-natural areas within the landscape[3] are highly intact. *Intactness refers to the biological and physical condition of ecosystems and includes factors such as species composition (native vs. non-native) and vertical and horizontal community structure. Intactness is evaluated relative to the desired condition of an area for conservation purposes. As discussed above, this desired condition will often be a clearly defined reference condition, but where the reference condition is not obvious additional dialogue and scientific analysis may be needed to define the desired condition.*

Criterion C3: All critical populations, species, and ecosystems that occur within the landscape are conserved. *Whereas criteria C1 and C2 focus on broad scale land use patterns and habitat condition, this criterion focuses on biodiversity elements of particular conservation importance, be they above-ground, below-ground, or aquatic. For example, it ensures that the conservation of endangered, threatened, or endemic species is given adequate attention. The term "conserved" means that the biodiversity element is in good condition and has a high probability of long-term persistence; this concept is operationalized in practice using various indicators and analyses, such as population viability analysis.*

Criterion C4: The landscape provides a high level of locally, regionally, and globally beneficial ecosystem services. *This criterion encompasses ecosystem processes and functions of direct value to humans including the provisioning services, regulating services, supporting services, and cultural services discussed above—particularly services that support agriculture.*

3 To reiterate an earlier point, the term landscape refers to the "ecoagricultural landscape"—a mosaic of natural, semi-natural, and agricultural lands occurring in an area of importance for conservation and for rural development

Criterion C5: Productive areas of the landscape do not degrade near-by natural areas, upstream or downstream. *The spread of invasive species is prevented, as is soil erosion, toxicity and other damaging effects of agriculture on biodiversity. The mosaic pattern of natural areas and agricultural lands in many ecoagriculture landscapes creates considerable risk of species invasions as well as high potential costs to biodiversity if such invasion is not curtailed.*

Agricultural Production Goal and Criteria

At least two characteristics differentiate ecoagriculture landscapes from more conventional agricultural landscapes. First, ecoagriculture landscapes consist of a mutually interdependent set of agricultural, semi-natural, and natural ecosystems, and land management practices actively acknowledge and foster this interdependence. Second, ecoagriculture landscapes usually include a wide variety of production systems, which could include annual and perennial cropping, various livestock systems, agroforests, wild forests, and fisheries.

Agricultural production is critically dependent upon healthy ecosystems to provide groundwater and surface water for irrigation, to sustain wild pollinators of crops, to regulate crop and livestock diseases, to maintain soil fertility; to protect crops or livestock from the sun or wind, and to decompose wastes. Wild species also play an important role in providing livestock fodder, fuel, medicines, soil nutrient supplements, and construction materials. Historically, though, agricultural practices have often degraded the very biodiversity and ecosystem functions on which they depend, through impacts ranging from land conversion and hydrological modification to pollution and sedimentation to the elimination of beneficial species and the introduction of nuisance invasive species.

In contrast to many aspects of conventional agricultural practice, ecoagriculture promotes synergies between agricultural production and ecosystem functioning. Rather than turning to artificial substitutes, ecoagriculture practitioners seek to capture the value of natural services by taking specific management actions to sustain biodiversity and ecosystem functions that support agricultural production. For example, native species may be conserved by protecting undisturbed areas for nesting and protective cover, maintaining species' access to food and water sources, minimizing water pollution from farm runoff, providing functional habitat corridors, and maintaining biologically active soils. Watershed functions can be conserved by maintaining natural soil structure to promote rainfall infiltration, maintaining native riparian vegetation, preventing agricultural pollution and wastes from entering streams or groundwater, maintaining soil cover year-round, protecting wetlands, and allowing streams and rivers to meander in their natural course.

The following five criteria for agricultural production are consistent with this vision of agricultural production. They also recognize that for agricultural systems to deliver benefits over the long run, they must be financially viable and meet the needs of people who depend on them. Otherwise they are likely to be abandoned or lead to over-exploitation, and thus be unsustainable.

Agricultural Production Goal: Provide for sustainable, productive, and ecologically compatible agricultural production systems.

Criterion A1: Agricultural production systems satisfy food security and nutrition requirements of producers and consumers in the region. *Agricultural products provide adequate supplies of food, fiber, and fuel to sustain healthy local populations, or adequate income to allow people to purchase these necessities.*

Criterion A2: Agricultural production systems are financially viable and can dynamically respond to economic and demographic changes. *Producers are tied into markets that enable a high portion of the value of production to be retained locally.*

Criterion A3: Agricultural production systems are resilient to natural and anthropogenic disturbances. *Disturbances could include drought, flood, mudslides, disease, and climate change.*

Criterion A4: Agricultural production systems improve or have a neutral impact on wild biodiversity and ecosystem services in the landscape. *By emphasizing the use of biological inputs, crop rotations, soil cover, and diverse assemblages of plants, while limiting chemical inputs, habitat values can be conserved or enhanced.*

Criterion A5: Agrobiodiversity is optimally managed for current and future use. *Agrobiodiversity is conserved globally, but is managed locally to enhance and sustain agricultural production.*

Livelihoods Goal and Criteria

Historically, the goals of conservation and livelihood support were commonly viewed to be in conflict. Ecoagriculture seeks opportunities to move beyond either-or approaches to land use where possible, or to zone land use such that conservation and economic activity are appropriately balanced on the landscape.

In the context of ecoagriculture, three aspects of livelihood viability are important to evaluate. The first is basic subsistence and human welfare, which includes adequate nutrition, health care, and housing necessary for individuals and communities to survive and function.

The second aspect pertains to sustainability—that is, whether the resources, assets, and conditions necessary for ongoing livelihood sustenance are being decreased, maintained, or increased (Carney 1998). Another way of framing this point is in terms of the various types of capital necessary to support future livelihoods, including human, natural, physical and financial capital. A critical dimension of sustainability is whether households can cope with and recover from environmental or economic stresses and shocks without undermining the natural resource base (Scoones 1998).

Third, the framework embraces financial as well as other social aspects of livelihood support. As households and communities become increasingly connected to regional and global economies, cash income enables them to improve their standard of living by investing in health, nutrition, housing, infrastructure, and economic development. The role of income generation in the framework is tied to the effect that it has on securing social, cultural, and environmental well being.

Equity or equality is an important mediating factor when considering any livelihood parameter. A relatively equal distribution of food, income, access to resources, or access to services can maximize the number of persons and households benefiting from the aggregate wealth within a community or landscape. On the other hand, stark inequalities are likely to exacerbate poverty, curtail opportunities for livelihood improvement, and undermine participatory projects. Thus, it is important for livelihood outcome measures to consider equity across many variables including gender, ethnicity, and class.

Livelihood performance in an ecoagriculture landscape needs to be considered at both the household level and the community level. In some cases, multiple indicators of the same theme may be needed to account for the different scales. With these considerations in mind, we present the following livelihoods goal and criteria.

Livelihoods Goal: Sustain or enhance the livelihoods and well-being of all social groups in the landscape.

Criterion L1: Households and communities are able to meet their basic needs while sustaining natural resources. *Basic needs include access to food, clean water, energy, shelter, healing products and services, and, increasingly, cash.*

Criterion L2: The value of household and community assets increases. *Assets include infrastructure (buildings, roads, bridges), common property, renewable and non-renewable natural resources, human and social capital, and cultural knowledge. These assets allow households and communities to effectively manage risks to life, health, and well being.*

Criterion L3: Households and communities have sustainable and equitable access to critical natural resource stocks and flows. *Natural resources include soil, forests, grasslands, fisheries, and water. Equity is concerned with tenure and use rights according to factors such as gender, ethnicity, and class.*

Criterion L4: Local economies and livelihoods are resilient to changes in human and non-human population dynamics. *Population dynamics include human immigration and emigration, demographic changes in local populations, and the spread of domestic and invasive plant and animal species.*

Institutions Goal and Criteria

Although the role of institutions is discussed in earlier writings on ecoagriculture (McNeely and Scherr 2003, Buck et al. 2004) these publications do not identify institutional capacity as an explicit goal of ecoagriculture on par with conservation, agricultural production, and livelihoods. However, given the essential roles of institutions and supporting organizations in promoting ecoagriculture, institutional support is fully incorporated into the framework as its own goal and set of criteria.

In some settings, institutional capacity may be an important forward looking measure of landscape performance. That is, landscapes that are currently in good condition with respect to the other three ecoagriculture goals but lack adequate governance structures, markets, and social capital are prone to deteriorate, whereas those that benefit from effective institutions are likely to improve, even if their current condition is poor. Since the creation of robust institutions and organizations often precedes the realization of tangible benefits from these institutions, including institutions in the framework is important for predicting the trajectory of landscapes over time.

Institutions Goal: Establish and maintain institutions for integrated, ongoing planning, negotiation, implementation, resource mobilization, and capacity-building in support of the goals of ecoagriculture.

Criterion I1: Mechanisms are in place and functioning for cross-sectoral planning, monitoring, and decision making at a landscape scale. *Project and policy support is needed to integrate sector-based activities.*

Criterion I2: Farmers, producers, and communities have adequate capacity and are effective in supporting ecoagriculture innovation. *Farmers, nature reserve managers, community leaders, and others concerned with land stewardship need knowledge and incentives to engage in developing practices that support ecoagriculture.*

Criterion I3: Public institutions support ecoagriculture effectively: *This criterion includes four sub-parts: (a) local and regional government agencies provide support to ecoagriculture initiatives; (b) property rights laws and regulations(tenure systems) support ecoagriculture; (c) public resource management supports ecoagriculture; and (d) public sector incentives support ecoagriculture.*

Criterion I4: Markets provide incentives for ecoagriculture. *Producers need access to markets for products and services that return a profit as well as incentives to invest in sustaining ecosystem function. Examples include markets for certified agricultural products and markets for ecosystem services.*

Criterion I5: Supporting organizations are in place to facilitate ecoagriculture. *Critical support services include finance, technical assistance, research, cross-sector planning and monitoring, and information exchange that enable innovation and effective decision-making.*

Criterion I6: Knowledge, norms, and values support ecoagriculture. *This criterion captures the importance of ecological awareness, cultural values, behavioral norms, and symols in influencing land and resource management choices.*

Box 3.1. Twenty Questions for Understanding Ecoagriculture – checklist of goals and criteria for landscape performance

Conservation Goal: The landscape conserves, maintains, and restores wild biodiversity and ecosystem services	
❑	**Criterion C1:** Do land use patterns across the landscape optimize habitat value and landscape connectivity for native species?
❑	**Criterion C2:** Are natural and semi-natural areas within the landscape highly intact?
❑	**Criterion C3:** Are all critical populations, species, and ecosystems that occur within the landscape conserved?
❑	**Criterion C4:** Does the landscape provide a high level of locally, regionally, and globally beneficial ecosystem services?
❑	**Criterion C5:** Do productive areas of the landscape limit the degradation of near-by natural areas, upstream and downstream?

Agricultural Production Goal: The landscape provides for sustainable, productive, and ecologically compatible agricultural production systems.	
❑	**Criterion A1:** Do agricultural production systems satisfy food security and nutrition requirements of producers and consumers in the region?
❑	**Criterion A2:** Are agricultural production systems financially viable and can they dynamically respond to economic and demographic changes?
❑	**Criterion A3:** Are agricultural production systems resilient to natural and anthropogenic disturbances?
❑	**Criterion A4:** Do agricultural production systems improve or have a neutral impact on the wild biodiversity and ecosystem services in the landscape?
❑	**Criterion A5:** Is agrobiodiversity optimally managed for current and future use?
Livelihoods Goal: The landscape sustains or enhances the livelihoods and well-being of all social groups that reside there.	
❑	**Criterion L1:** Are households and communities able to meet their basic needs while sustaining natural resources?
❑	**Criterion L2:** Is the value of household and community assets increasing?
❑	**Criterion L3:** Do households and communities have sustainable and equitable access to critical natural resource stocks and flows?
❑	**Criterion L4**: Are local economies and livelihoods resilient to changes in human and non-human population dynamics?
Institutions Goal: Institutions are present that enable integrated, ongoing planning, negotiation, implementation, resource mobilization, and capacity-building in support of the goals of ecoagriculture.	
❑	**Criterion I1:** Are mechanisms in place and functioning for cross-sectoral planning, monitoring and decision making at a landscape scale?
❑	**Criterion I2:** Do farmers, producers, and communities have adequate capacity and are they effective in supporting ecoagriculture innovation?
❑	**Criterion I3:** Do public institutions support ecoagriculture effectively?
❑	**Criterion I4:** Do markets provide incentives for ecoagriculture?
❑	**Criterion I5:** Are supporting organizations in place to facilitate ecoagriculture?
❑	**Criterion I6:** Do knowledge, norms, and values support ecoagriculture?

4 . Indicators

The goals and criteria presented in **Chapter 3** define the framework for measuring the performance of the ecoagriculture landscape. These criteria by themselves, however, are too broad to measure directly. To operationalize the framework on the ground will require selecting measurable indicators of each criterion and tracking these indicators over time. This chapter begins by discussing the process of selecting indicators. It then presents sample indicators for each criterion to give a sense of how ecoagriculture monitoring and assessment could be conducted in the field. The discussion of sample indicators is organized according to the four broad goals: conservation, agricultural production, livelihoods, and institutions. In the discussion of sample indicators, we explore the conservation goal in particular detail to illustrate the relation between goals, criteria, indicators, and means of measure.

Box 4.1. Approaches to Selecting Indicators

A key to cost-effective monitoring is to strategically select the most accurate and cost-effective indicators for the criteria of interest. While often there are many indicators that potentially could work, it may be unnecessary and impractical to use more than a few. Effective indicators usually possess the following characteristics:

- Relevant: the indicator reveals something that you want to know about the system.
- Precise: you can reliably trust the information that the indicator provides.
- Sensitive: as the system changes, the indicator changes in a predictable fashion.
- Easy to understand: the indicator is intuitive to laypersons and decision-makers.
- Measurable: the indicator is based on accessible data that are already available or can be collected and interpreted with reasonable effort.

How should indicators be selected? As discussed in **Chapter 3**, indicators are generally place-specific. However, there may be a small number of indicators that are so useful that they would be relevant in most, if not all, ecoagriculture landscapes. Both technical experts and local stakeholders have important roles to play in selecting indicators. The role of technical experts generally should be proportionally larger when there is an objectively correct and incorrect way to measure a system component of interest. For example, for assessing wild biodiversity, some indicator species are much more useful than others, and a technical expert would be better qualified to select indicator species than a layperson. The role of local stakeholders generally should be proportionally larger for selecting system components that directly affect their lives, such as livelihood indicators.

What level of detail should indicators provide? Indicators can range from very broad to very specific. Furthermore, indicators may be layered such that an analysis begins with broad indicators and then adds increasingly specific indicators until either the information needs are met or the resources available for monitoring are exhausted. In this way, monitoring and assessment is not an all-or-nothing proposition, but can be adapted to the needs and opportunities of each place. For example, the broadest indicator of habitat fragmentation might be the total area of natural vegetation remaining in a landscape. A more detailed indicator would be a connectivity index, which could be calculated using a GIS program. Further detail could reveal the degree of functional connectivity for different species by examining the habitat quality of remaining natural vegetation relative to the needs of each species. Practitioners should consider the level of detail required to monitor each element of the landscape. With limited funding available for monitoring, it may be sensible to use coarse measures of some elements so that more resources can be devoted to detailed monitoring of others.

How can indicators be selected to take advantage of complementary data sources? Monitoring data can come from local laypersons and local experts as well as from outside technical experts utilizing advanced technological tools and analytical methods. Combining these data sources strategically is the key to a thorough and cost-effective assessment program. First, one should identify existing or readily obtainable data sources (for example, aerial photography that has not yet been analyzed or local landowners who are willing to monitor wild animal populations). New data sources can then complement these existing sources or, where necessary, provide ground-truthing.

Conservation Indicators

Much effort has already been devoted to assessing and monitoring biodiversity and ecosystem functioning at the landscape scale. In particular, conservation organizations such as Conservation International and The Nature Conservancy have developed systems that tend to be pragmatic and relatively cost-effective. Ecoagriculture monitoring can adapt and augment elements of these systems to focus specifically on the relationships between conservation and agricultural production. Here, we briefly discuss relevant existing conservation measurement frameworks, followed by a sample set of conservation indicators and means of measure.

Conservation International (CI) conducts biodiversity monitoring at three levels of organization—the species level, site level, and landscape/seascape level. At the species level, CI measures *extinctions avoided*, using the IUCN Red List as a guide to monitor the status of threatened species. At the site level, CI measures the *areas protected* by identifying the protection status of natural lands. Finally, at the landscape or seascape level, they conduct **s**patial analysis to identify *corridors consolidated* that benefit biodiversity and ecological functioning.

Two additional aspects of CI's monitoring approach are especially relevant for ecoagriculture assessments. First, in many terrestrial hotspots and high biodiversity wilderness areas, CI is conducting monitoring in collaboration with local and international partners. Through these collaborations, data from diverse sources can be pooled and shared, data "gap analyses" can be conducted, and missing high-priority data can then be collected. Second, CI's monitoring protocol provides for a level of standardization across hotspots that will help then demonstrate their effectiveness to local, national and international partners—while also including a site monitoring component that documents locally relevant variables at different scales. This structure is consistent with the approach proposed for ecoagriculture assessments.

The Nature Conservancy's (TNC's) monitoring protocol uses a flexible, hierarchical framework for assessing biodiversity at scales up to an entire ecoregion, as shown in **Table 4-1**. Based on scientific analysis, TNC identifies conservation targets to represent and monitor the entire native biodiversity of a project area. For each target, TNC scientists identify one or more key ecological attributes necessary to the persistence of the target. These attributes are then tracked over time using specific indicators and indicator ratings. Indicators are then tabulated and synthesized using a computerized "ecological scorecard" to characterize the condition of the area's biodiversity according to a small number of measurement categories (Parrish et al. 2003). Using this tool, managers can track the status of conservation targets over time, in response to conservation programs or other factors. An important second part of TNC's project evaluation framework is to monitor the severity and scope of threats to biodiversity over time, using the type of threat reduction assessment discussed in **Chapter 2**.

Table 4-1. Hierarchical structure of TNC's biodiversity assessments.

Hierarchical Unit	Description
All native biodiversity within project area	All native biodiversity within the site or region that is the focus of conservation efforts, and for which information is desired.
Conservation targets	Species, communities, and/or ecosystems that represent (*i.e.*, serve as a reasonable proxy for) the project area's entire native biodiversity.
Key ecological attributes	Ecological attributes that must be maintained and conserved to protect the conservation targets, such as biotic composition or interaction, landscape structure, environmental regimes and constraints, and ecosystem processes.
Indicators	One or more measurable characteristics used to assess the status of key ecological attributes. Indicators are usually measures of an attribute's size, condition, and landscape context, and should be measurable, precise, consistent, and sensitive (The Nature Conservancy 2004).
Indicator ratings	Ranges for indicator values corresponding to "poor," "fair," "good," and "very good" ratings.

Source: Milder 2005.

Sample Conservation Indicators

Table 4-2 provides some sample indicators and means of measure for assessing biodiversity and ecosystem functioning. Consistent with the conceptual framework provided in **Figure 3-1**, we show how the same six conservation criteria can be used to guide the development of status indicators at the site/local scale, status indicators at the landscape scale, or effectiveness indicators at the project level (a project could occur at any scale but usually occurs at a scale intermediate between the site scale and the landscape scale). As implied by the table, some of the status indicators are more amenable to measurement at the landscape scale, while others can be measured more effectively at the site scale. Status measures and effectiveness measures complement each other to reveal both how well the system is doing and how well management interventions are working.

Table 4-2. Possible indicators and means of measure for assessing the conservation of biodiversity and ecosystem services in ecoagriculture landscapes. Means of measure are given in italics, denoted by "*MM*." Note that the right and left columns focus on status indicators, at the site/farm scale and the landscape scale, respectively. The center column focuses on effectiveness indicators (in this case, indicators of threat reduction and opportunity enhancement) for project-level interventions. The arrows indicate that the spatial scale of a project can vary from local to landscape or even larger.

Sample Indicators for Landscape-Scale Status Assessment ◀	**Sample Indicators for Project-Level Effectiveness Assessment (Threat/Opportunity Measures)** ▶	**Sample Indicators for Site-Scale Status Assessment**
Criterion C1: Land use patterns across the landscape optimize habitat value and landscape connectivity for native species.		
• Land cover: portion of landscape in natural habitat, moderate use, and intense use.[1] *MM: remote sensing with ground truthing.* • Fragmentation & connectivity: size, shape, and functional connectivity of patches of natural and semi-natural habitat.[2] *MM: various indices presented in the literature; analysis with Fragstats or other spatial analysis software.* • Indicator species: presence and abundance of wide-ranging and/or multi-habitat species whose life histories integrate over many landscape variables. *MM: observation or censusing by experts and/or local laypersons.*[3]	• Deforestation: increase or decrease in the rate of deforestation at the agricultural frontier. *MM: remote sensing*. • Fragmentation: gain or loss of functional connectivity among patches of natural and semi-natural land. *MM: various indices presented in the literature; analysis with Fragstats or other spatial analysis software.* • Management of agricultural land for biodiversity: presence and quality of native habitats within agricultural systems. *MM: remote sensing and habitat quality measures.* • Road construction and management: change in road mileage or road density over time; management of roads. *MM: GIS analysis based on various data sources.*	• Contribution to large-scale conservation networks: connectivity of on-site natural areas to adjacent and nearby natural areas and reserves. *MM: various indices presented in the literature.* Note that indicator species could be a problematic indicator at the site scale because an organism could be observed at a site even though the site plays little or no role in sustaining that organism.

1 The purpose of this analysis is to classify land cover across the landscape according to its value for native biodiversity. This may be done using more than three classes, if desired; Scholes and Biggs (2005) use six classes for their biodiversity intactness index.

2 One challenge in such an analysis is to differentiate between natural and anthropogenic landscape heterogeneity, and to decide what significance to attach to each. In general, conservationists are concerned about anthropogenic fragmentation, but it is unclear that the two are always functionally distinct.

3 See **TEAM** 2005.

Sample Indicators for Landscape-Scale Status Assessment ◀	Sample Indicators for Project-Level Effectiveness Assessment (Threat/Opportunity Measures) ▶	Sample Indicators for Site-Scale Status Assessment
Criterion C2: Natural and semi-natural areas within the landscape are highly intact.		
• Indicator species: presence and abundance of wide-ranging and/or multi-habitat species whose life histories integrate over many landscape variables. *MM: observation or censusing by experts and/or local laypersons.* • Large-scale disturbance regime: similarity of the large-scale disturbance regime (fire, flooding, etc.) to that of relatively undisturbed ecosystems in the landscape. *MM: ecological analysis.* For aquatic systems • Indicator species: aquatic invertebrates, fish, or other indicators. *MM: sampling.* • Chemical characteristics: factors such as nutrient concentrations, biological oxygen demand, and concentrations of agricultural chemicals. *MM: sampling and chemical analysis.*	• Restoration: restoration of native ecosystems. *MM: key attributes of the native ecosystems.* For aquatic systems • Nutrient loading: concentrations of nutrients in surface water or groundwater. *MM: chemical analysis.* • Chemical contamination: quantity of toxic chemicals in surface water or groundwater. *MM: chemical analysis.* • Erosion and sedimentation: quantity of silt washing into water bodies. *MM: turbidity measurements.* • Dams: number and impact of dams in streams and rivers. *MM: various.*	• Community structure: vertical and horizontal structure of ecological communities compared to the condition desired for biodiversity conservation. *MM: various ecosystem properties.* • Dominant plant species: identity of dominant plant species; proportions of native vs. exotic plants. *MM: vegetation censusing techniques.* • Community regeneration: degree to which native species are regenerating naturally.[4] *MM: life history and age class analysis for key species.* • Soil biodiversity: species richness of select indicator taxa of soil organisms. *MM: sampling and censusing.* For aquatic systems • Riparian buffers: width and integrity of riparian buffers. *MM: aerial photography and/or ground observation.*

4 This indicator should reveal "relic" populations or communities in which, for example, a mature forest appears healthy but will deteriorate over time because key species are not regenerating, or in which the population of a long-lived species has many adults but few juvenile recruits.

Sample Indicators for Landscape-Scale Status Assessment	Sample Indicators for Project-Level Effectiveness Assessment (Threat/Opportunity Measures)	Sample Indicators for Site-Scale Status Assessment
Criterion C3: All critical populations, species, and ecosystems that occur within the landscape are conserved.		
• Protection of priority habitats: portion of priority habitats[5] that are protected from destruction or severe degradation. *MM: mapping based on various data sources.* • Unique microhabitats and ecosystem features: protection of landscape features that are especially important for uncommon species, such as wetlands, water bodies, caves, and unique geologic features. *MM: mapping based on various data sources.* • Species of conservation concern: presence and abundance of endemic, rare, and threatened species. *MM: censusing.* • Human-wildlife interactions: nature of the interactions, including hunting, poaching, provision of habitat in agricultural systems, and the spread of disease between domestic and wild animals. *MM: many options, from interviews to laboratory testing.*	• Unique microhabitats and ecosystem features: measures taken to prevent the destruction of such features in agricultural landscapes. *MM: evaluation of the effectiveness of such measures.* • Human-wildlife interactions: threat to wildlife from hunting and poaching. Benefit to wildlife from habitat in managed systems. *MM: interviews, law enforcement reports.*	• Protection of priority habitats: portion of priority habitats that are protected from destruction or severe degradation. *MM: mapping based on various data sources.* • Unique microhabitats and ecosystem features: protection of site features that are especially important for uncommon species. *MM: mapping based on various data sources.* • Species of conservation concern: presence and abundance of endemic, rare, and threatened species. *MM: censusing.* • Human-wildlife interactions: nature of the interactions, including hunting, poaching, provision of habitat in agricultural systems, and the spread of disease between domestic and wild animals. *MM: many options, from interviews to laboratory testing.*
Criterion C4: The landscape provides a high level of locally, regionally, and globally beneficial ecosystem services.		
• Carbon sequestration: quantity of carbon stored in the landscape's vegetation and soils. *MM: calculations based on remote sensing and field sampling.*	• Deforestation: increase or decrease in the rate of deforestation at the agricultural frontier. *MM: remote sensing*.	• Native pollinators: diversity and abundance of native crop pollinators. *MM: field surveys of pollinators.* • Soil health: soil quantity, structure, chemical composition, and biota. *MM: sampling and analysis.*
Criterion C5: The spread of invasive species within agricultural landscapes and into adjacent natural habitats is prevented.		
• Invasive species distributions: distribution and rate of advance of invasive species across the landscape. *MM: sampling and mapping of invasive species locations.*	• Species introductions: introductions of new invasive species into a landscape. *MM: field surveys, reports of species releases.* • Species eradications: local or regional eradication of invasive species. *MM: eradication programs and field surveys.*	• Invasive species density: density of invasive species at individual sites. *MM: field surveys.*

5 Priority habitats for biodiversity conservation, as identified from sources such as the Natural Heritage programs (U.S. & Canada).

Agricultural Production Indicators

In the past, monitoring of agricultural systems typically focused on crop yields and on the economic productivity of farms. These efforts yielded a plethora of indicators, many of which can be usefully incorporated into the ecoagriculture measures framework. However, as discussed above, ecoagriculture takes a broader view of the potential benefits and impacts of production land use systems. For the purposes of monitoring and evaluation, two differences are particularly noteworthy. First, ecoagriculture emphasizes the importance of ecosystem services as both a product of and a necessary input to healthy production systems. Second, given its landscape scale perspective, ecoagriculture requires that farm processes be evaluated with careful consideration of the surrounding context.

Neither of these characteristics are yet widely accepted and used in agricultural assessment, but nor are they unique to ecoagriculture. Both are increasingly being considered in a variety of contexts such as agricultural certification schemes and sustainable approaches to farm management. In addition, several recent research efforts have focused on developing indicators to measure the interaction of agricultural systems with ecological variables in the larger landscape, such as water flow, species diversity, and animal health. These state-of-the art indicators will be particularly valuable for ecoagriculture monitoring and assessment.

Below we identify and briefly discuss several of these emerging indicators, as well as two existing indicators frameworks of particular relevance to ecoagriculture. We then offer a set of sample agricultural production indicators.

Considerations in Developing Agricultural Production Indicators

Many organizations are now involved in studying the multi-functionality of agricultural systems. Recent research of particular relevance to ecoagriculture monitoring includes:

Linkages between agriculture and conservation: The Alternatives to Slash and Burn (ASB) program has taken a lead in efforts to understand and measure the relationships among agricultural production, biodiversity, and ecosystem services at a landscape scale, and to identify policies and practices that promote synergies among these (Tomich et al. 2004). For example, Swift et al. (2004) analyzes the functional roles of biodiversity in enabling agricultural production in landscape mosaics, identifying particular ecosystem functions and groups of organisms that are crucial to the productivity, sustainability, and resilience of agricultural systems. That the empirical basis for evaluating these linkages is in its infancy reinforces the importance of monitoring to enable adaptive management.

Relationships between agriculture and watershed functions: Pattanayak (2004) evaluated the interactions between agricultural systems and large scale watershed functions. As with biodiversity functions, a challenge in studying watershed functions is the long time lags between land cover change and its resulting effects on watershed functions. While the expense of establishing and maintaining high-quality monitoring networks to address such long term questions (especially regarding base flow and groundwater recharge) is a concern, conceptual advances presented in this work can inform the design of indicators for monitoring hypothesized linkages.

Water use and availability: Water availability and use will be an important issue in many ecoagriculture landscapes. The International Water Management Institute (IWMI) has developed widely applicable indicators of water use and water use efficiency. These indicators can be quantified to varying degrees depending on the level of specificity needed and resources available (D. Molden, pers. comm.)

Animal health: Another critical issue in mosaic landscapes and at the wildland-agriculture interface, is the health of people, domestic animals, and wild animals. Many wild animal diseases can be transmitted to domestic animals (e.g., foot and mouth disease), while domestic animals may harbor pathogens that can spread to wild populations. The consequences of landscape management for animal health are often complex:: for example, the designation of a nature reserve may have both positive and negative effects on the health of nearby domestic livestock. The Wildlife Conservation Society has developed indicators of animal health that are relevant for conservation, agriculture, and poverty alleviation. Effective animal disease and health indicators are highly quantitative, informed by sound epidemiology, and often expensive to measure (S. Osofsky, pers. comm.).

Agrobiodiversity: Wood and Lenné (1999) define agrobiodiversity as "all crops and livestock and their wild relatives, and all interacting species of pollinators, symbionts, pests, parasites, predators and competitors." Jackson et al. (2005) add to this definition by noting that agrobiodiversity "....performs functions and delivers services that sustain agriculture and the resources upon which agriculture depends," that it "encompasses the variety and variability of living organisms that contribute to food and agriculture in the broadest sense," and that it "includes many habitats and species outside of farming systems that benefit agriculture and enhance ecosystem functions." Assessing agrobiodiversity in ecoagriculture landscapes is important first, because agrobiodiversity strongly influences the viability and sustainability of agricultural production systems. Some forms of agrobiodiversity tend to enhance agricultural production or improve their resilience (e.g., a native bee species that pollinates an important crop) while other forms tend to reduce agricultural production (e.g., a helminth parasite of livestock, or a mold or rust that affects wheat). Second, the protection of agrobiodiversity in the form of land races, crop wild relatives, and genetic material constitutes a critical ecosystem service with regional or global benefits.

Spatial issues: A robust analysis of agroecosystems requires a spatial orientation to account for landscape heterogeneity. For example, nutrient runoff from farms in one part of a landscape may have a significant impact on water quality and aquatic species, while runoff from farms in another part of the landscape may have little impact. Establishing perennial vegetation may be more important for farmers along a biological corridor than for those far away. Furthermore, thresholds may determine the impacts of activities. For example, to protect a sub-watershed, it may be necessary for nearly all the farmers in the sub-watershed to change their soil management practices; if only half make this change there may be little improvement. To account for spatial position, monitoring often needs to be conducted at multiple scales including the plot, farm, community, and landscape. The Nature Conservancy and the US Geologic Survey are active in exploring spatial analysis methods and issues (R.Sayer, pers.comm.), as is the ASB program (T. Tomich, pers. comm.).

In addition to the preceding resources, two systems of indicators for measuring agricultural performance are especially relevant for assessing ecoagricultural systems. First, the Organization for Economic Cooperation and Development (OECD), in partnership with member country participants, has developed an agri-environmental indicators program to evaluate the effectiveness of policies promoting sustainable agriculture. The program offers a variety of tools to understand the complex dynamics among farm inputs and outputs, local natural resources, farm context, and the environmental impacts of agriculture. Second, the Pilot Analysis of Global Ecosystems (PAGE) created a system of agroecological indicators to help track progress toward meeting the Millennium Development Goals. This program's conceptual consistency with ecoagriculture makes it a valuable source for developing agricultural indicators. The OECD and PAGE indicator systems are explained further in **Annex B**.

Sample Agricultural Production Indicators

Based on the preceding discussion, the following are some examples of indicators that could be used to assess the agriculture production criteria.

Criterion A1: Agricultural production systems satisfy food security and nutrition requirements of producers and consumers in the region.

Examples of indicators:

- Total per-capita production of different products from farms, fisheries, and forests
- Percent of production used for local subsistence, local markets, and outside markets
- Percent of income expended on food
- Nutritional status

Criterion A2: Agricultural production systems are financially viable and can dynamically respond to economic and demographic changes.

Examples of indicators:

- Aggregate value of agricultural output
- Agricultural profits (income relative to costs)
- Returns to labor, capital, land, energy, water, germplasm, nutritional amendments, and pest and disease control inputs
- Security of market linkages for products and services

Criterion A3: Agricultural production systems are resilient to natural and anthropogenic disturbances.

Examples of indicators:

- Percent of production inputs that are locally-derived
- Diversity of agricultural products at farm, community, and landscape scales
- Diversity and origin of agricultural products sold in the region
- Soil health
- Animal health and disease
- Crop health and disease

Criterion A4: Agricultural production systems improve or have a neutral impact on the wild biodiversity and ecosystem services in the landscape.

Examples of indicators:

- Soil health

- Water quality
- Natural resource conservation practices
- Other biodiversity indicators identified in **Table 4-2.**

Criterion A5: Agrobiodiversity is optimally managed for current and future use.

Examples of indicators:

- Conservation status of land races and crop wild relatives
- Diversity of varieties, land races, cultivars used on the farm
- Abundance of parasites, pests, and pathogens that diminish agricultural productivity
- Genetic diversity within populations of important crops

Livelihood Indicators

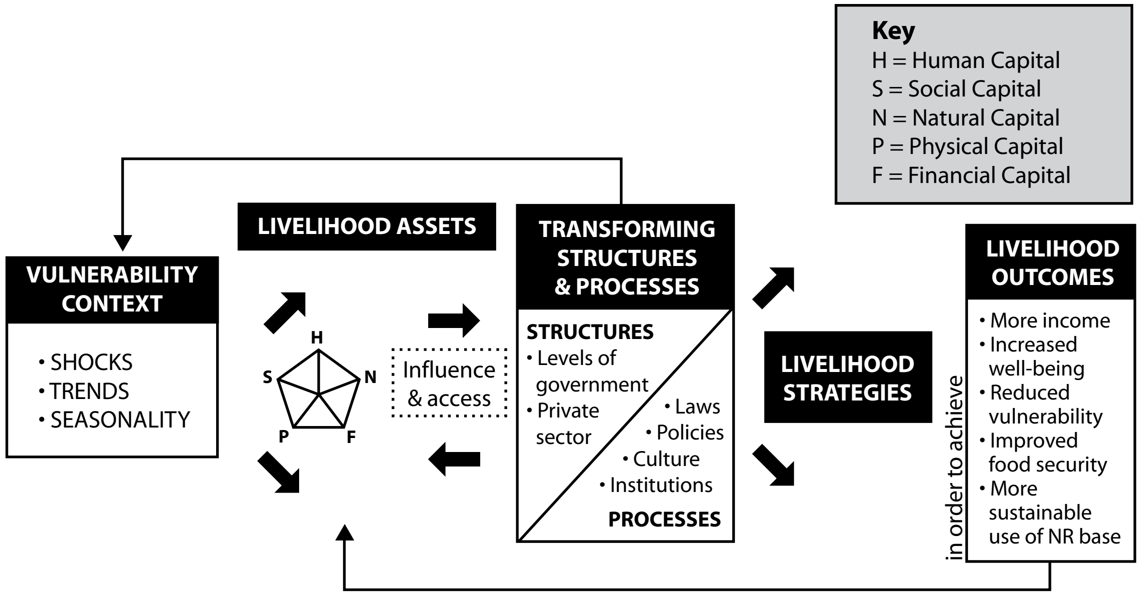
Considerable effort has been devoted to developing the conceptual basis and indicators for evaluating livelihoods in the context of sustainable development. Emerging from the early work of Chambers (1988) are two systems for assessing livelihood viability in the context of conservation and rural development that appear particularly well aligned with ecoagriculture thinking: 1) a framework developed by the UK's Department for International Development (DfID), and 2) a framework developed by the Alternatives to Slash and Burn (ASB) program. Both are concerned with food security and poverty alleviation, and both recognize the dependence of agriculturally-based livelihoods on sustaining the integrity of the natural resource base. These two systems are summarized below to provide a foundation for the livelihood component of the ecoagriculture measures framework. For additional information on the DfID framework, see **Annex B**.

DfID Sustainable Livelihoods Framework

The DfID Sustainable Livelihoods Framework is a robust and well-researched tool that is widely used to inform project-based monitoring and evaluation systems. The framework captures the dynamics of livelihood strategies and outcomes by tracking five types of capital assets that contribute to current and future livelihood viability. These include:

- Human capital: skills, knowledge, ability to work, and health.
- Natural capital: access to land, forests, water, and clean air.
- Financial capital: savings, credit, and other sources of investible resources, including migrants' remittances.
- Physical capital: infrastructure such as roads, buildings, water supplies, equipment, and transport.
- Social capital: friends, family, social organizations, and other people who can offer support.

Figure 4-1. The Department for International Development's Sustainable Livelihoods Framework.



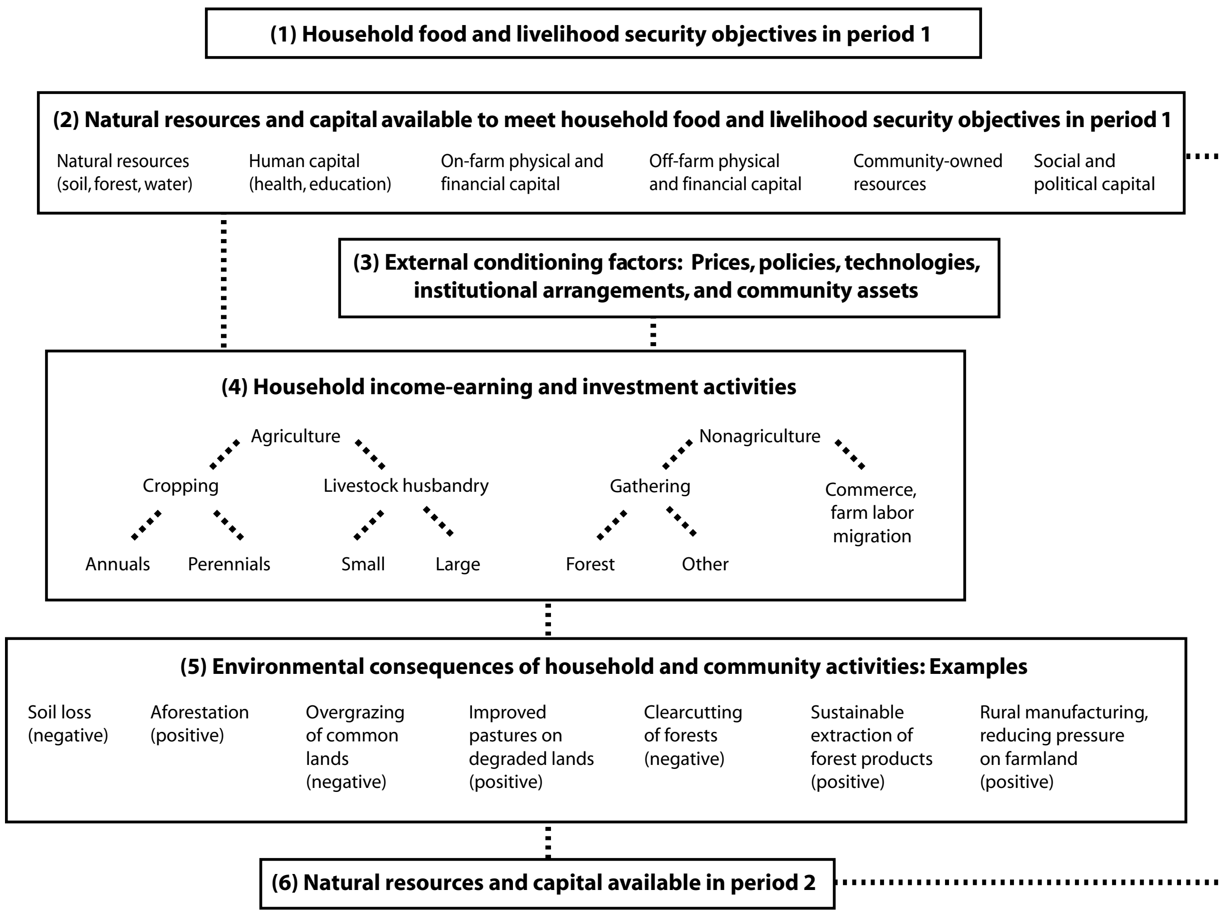
The framework explicitly considers several sets of variables that affect the availability of assets over time, as shown in **Figure 4-1**. The *Vulnerability Context* frames the external environment—***trends***, ***shocks***, and *seasonality* that are often beyond the control of households and communities but nonetheless directly affect asset status and, consequently, opportunities for realizing or enhancing livelihood goals. *Transforming Structures and Processes* are the institutions, organizations, policies, and legislation that shape livelihoods by "setting the rules" by which people can access various types of capital and convert this capital into livelihood benefits. *Livelihood Strategies* are the combination of activities and choices that people make in order to accomplish their livelihood goals, such as productive activities, investment strategies, and reproductive choices. *Livelihood outcomes*, then, are evaluated in terms of five key parameters: income, well-being, vulnerability, food security, and sustainable use of the resource base.

Alternatives to Slash and Burn Framework

Following a paradigm that is similar to DfID's, the Alternatives to Slash and Burn (ASB) program focuses its livelihood framework on poverty reduction, welfare improvement, and the relation between human welfare and biodiversity conservation (Vosti et al. 2004). The approach complements McNeely and Scherr's (2003) inspiration for ecoagriculture, which is based on the significant geographic overlap between areas of the world needed for food production and those needed for biodiversity conservation.

Although poverty reduction and livelihood enhancement can sometimes facilitate biodiversity conservation, in other cases they can accelerate the rate of biodiversity loss. Therefore, the ASB framework recognizes the imperative of understanding the decision making processes of user groups (such as policy makers, program managers, communities, and farmer groups) that lead to either synergies or tradeoffs between conservation and poverty alleviation. These decision flows rest upon an analysis of costs and benefits, considering the range of possible choices and the opportunity costs of each. The outcomes of the decisions made in one time period influence the state of the resource base and the livelihood options available in the next time period, as illustrated in **Figure 4-2** (Vosti et al. 2004). Similar to the DfID framework, the ASB framework emphasizes changes in the levels of different types of capital available to farmers that stem from interactions among different factors.

Figure 4-2. Feedbacks between household decision making and environmental conditions. Source: Vosti et al. 2004.



The ASB framework uses economic analysis to study tradeoffs by identifying the relation between the availability of natural assets and the livelihood activities that affect these assets (Reardon and Vosti 1997). Economic methods also help quantify the value of ecosystem services that could contribute to livelihoods through market or non-market value capture (Vosti et al. 2004).

Sample Livelihood Indicators

The following sample livelihood indicators are based on the foregoing discussion. While many of these indicators are broadly applicable, we reiterate the importance of involving local people to select meaningful livelihood indicators. Livelihood assessment is an inherently participatory process.

Criterion L1: Households and communities are able to meet their basic needs while sustaining natural resources.

Examples of indicators:

- Nutritional status
- Availability and quality of housing
- Portion of households living in poverty
- Presence of social safety nets
- Proportion of income spent on food and fuel
- Income sources, levels, and distribution
- Viability of non-agricultural economic activity
- Profitability of production activity

Criterion L2: The value of household and community assets increases.

Examples of indicators:

- Level of public infrastructure
- Level of social services
- Economic returns to land and/or labor
- Education levels of children, farmers, scientists, and managers working in agriculture and conservation
- Level of social capital
- Extent of forests, grasslands, and economically valuable plants
- Land values

Criterion L3: Households and communities have sustainable and equitable access to critical natural resource stocks and flows.

Examples of indicators:

- Extent and strength of access rights to different economic and cultural groups
- Access to fields, forests, and wild products
- Access to agricultural inputs
- Access to water

Criterion L4: Local economies and livelihoods are resilient to changes in human and non-human population dynamics.

Examples of indicators:

- Degree of household income diversification
- Degree of community economic diversification

- Land use plans and regulations
- Level of social capital
- Presence of social safety nets

Institutions Indicators

Sample indicators of institutional performance were developed based on literature reviews and input from participants at the June 2005 workshop. Participants noted that institutional development is more about the quality of institutions than the quantity, so numerical indicators can be misleading. Yet, meaningful indicators that measure institutional capacity qualitatively, in terms of governance and democratization, for example, can be difficult to design. A good understanding of local conditions is indispensable if the indicators are to be meaningful and useful. Sample indicators for the six institutional criteria are presented below.

Criterion I1: Mechanisms are in place and functioning for cross-sectoral planning, monitoring and decision making at a landscape scale.

Examples of indicators:

- Presence and functionality of landscape-scale planning processes
- Availability of baseline maps and data to assess landscape performance

Criterion I2: Farmers, producers, and communities have adequate capacity and are effective in supporting ecoagriculture innovation.

Examples of indicators:

- Existence of processes for establishing community plans and rules for natural resource management and ecosystem protection
- Density of organizational networks that support local innovation in production and conservation

Criterion I3: Public institutions support ecoagriculture effectively:

Examples of indicators:

- Expertise of local government agencies in ecoagriculture
- Existence of rules enabling community co-management of protected areas
- Level of protection for critical ecosystem areas

Criterion I4: Markets provide incentives for ecoagriculture.

Examples of indicators:

- Proportion of land/farmers receiving payments for ecosystem services
- Proportion of land/farmers/products under eco-certification schemes
- Level of farmer access to markets for diverse product mixes

Criterion I5: Supporting organizations are in place to facilitate ecoagriculture.

Examples of indicators:

- Proportion of farmers/communities receiving technical assistance in ecoagriculture
- Level of cooperation/coordination between organizations providing technical assistance, finance, education, biodiversity monitoring, and research

Criterion I6: Knowledge, norms, and values support ecoagriculture.

Examples of indicators:

- Proportion of community organizations that exhibit ecoagricultural thinking in their policies and actions
- Level of coordination among public, private, and civic organizations in conveying knowledge, information, and other support for innovation in ecoagriculture

Integrative Indicators

Integrative methods include indicators, categories of indicators, and means of measure that can simultaneously provide information about two or more of the ecoagriculture goals. A major benefit of integrative methods is their tendency to be cost-effective: a large number of conclusions can be drawn about landscape performance based on a relatively small amount of effort. Below we discuss two examples of types of integrative indicators: land cover and system resiliency.

Land Cover

Land cover is likely to be one of the most useful categories of indicators in any ecoagriculture setting. Land cover can be mapped for an entire landscape to reveal basic patterns of natural vegetation, conservation, agriculture, and settlement. Descriptive statistics can summarize the percentage of the landscape in different cover types, and these percentages can be tracked over time relatively inexpensively using aerial photography and/or satellite images such as Landsat.

Land cover change provides insight into all of the ecoagriculture goals, with the possible exception of the institutions goal. The amount of land devoted to natural habitat, semi-natural habitat, cultivated areas, and urban areas can serve as a proxy for the resources available to different species. The degree of landscape fragmentation or connectivity can also be quantified and tracked over time. Agricultural production can be estimated by measuring the areas of land devoted to different types of cropping systems. Although it may not be possible to measure livelihoods directly using remote sensing, such data might be helpful for studying the factors that affect livelihoods. For example, a GIS analysis of land cover data supplemented with other geographic data could reveal the median distance to a school for local residents or the prevalence of conditions favorable to the spread of insect-borne diseases. Estimates of agricultural output derived from land cover data can also inform livelihoods assessments.

Although a discussion of the use of land cover data and remote sensing technologies is beyond the scope of this paper, a few cutting-edge developments are worth mentioning for their potential applicability to ecoagriculture monitoring. One technique, known as "multi-spectral three-dimensional aerial digital imagery," or M3DADI for short, is being developed by staff at Winrock International to monitor the environmental outcomes of conservation and development projects (Brown et al. 2003). This technology provides ultra-high resolution aerial photography, capable of a pixel size of 0.5 meters across large areas or as small as 0.07 meters along transects. These images can be used to identify individual tree species and, in some cases, even animals on the ground. Thus, certain ecological monitoring tasks that once required field work may now be accomplished using remote sensing. In addition, using the three-dimensional feature of the photography, tree heights in the forest can be estimated, allowing researchers to infer the amount of aboveground carbon sequestered in a given plot of land.

A second technique, involves using Landsat data directly to infer ecological characteristics on the ground. Whereas Landsat images are commonly interpreted to classify a landscape into land cover types, this method involves correlating spectral characteristics directly to on-the-ground ecological attributes such as species composition (J. Ranganathan, pers. comm.). Thus, the intermediate (and often imprecise) step of land cover classification is omitted and the desired data can be obtained directly. Further testing will be needed to verify the efficacy of this method in diverse settings, and, even then, Landsat data may need to be calibrated for each landscape in which it is used.

A third technique—actually an application of land cover data—is the Biological Intactness Index (BII), a method for estimating the intactness of very large areas, up to millions of square kilometers (Scholes and Biggs 2005). This approach uses remote sensing to classify the study area into several land cover classes according to their relative utility for native species. Areas of each cover type are then summed and weighted to arrive at an overall BII for the entire study area.

System Resilience

Another promising category of integrative indicators are measures of system resilience. Virtually every landscape is subject to natural disturbances such as floods, windstorms, wildfire, or extreme drought. In a landscape with little resilience, these disturbances can devastate native biodiversity, agricultural systems, and livelihoods—in some cases with long-lasting consequences. On the other hand, a resilient landscape may sustain less damage in the first place (as natural systems mitigate the effects of the disturbance) and recover faster.

System resilience provides a good example of the layering of indicators discussed above. The broad concept of resilience can be resolved into several components, described below. Each of these components, in turn, could be further analyzed if they were thought to be important in a given landscape. Important components of resilience include:

- Buffering capacity: Are the natural systems that mitigate damage from natural disturbances present (e.g., wetlands that store floodwater, vegetative cover that protects against landslides during heavy rains)?
- Replication and redundancy: Are critical assets (natural and/or human) present in multiple places? For example, if a rare species depends on a single forest patch, a hurricane that destroys that forest will wipe out the species. Retaining several suitable patches across the landscape (replication) improves the species' odds of survival in the face of a major disturbance. Similarly, a region that depends on a single water source for irrigation or potable water is more vulnerable to disturbance than one with backup or alternative sources (redundancy).
- Excess capacity: Have humans fully utilized the landscape's natural resources? If so, a drought, fire, or other disturbance that destroys necessary resources will have devastating results. If not, alternative sources of water, food, and land can be utilized while the system is recovering.
- Susceptibility: Have humans created communities, infrastructure, and production systems in places where they are likely to be damaged or destroyed by disturbances?

5. Next Steps

The creation of this framework—and its review and validation by diverse experts in the fields of conservation and rural development—is the first step toward creating a robust, flexible, and cost-effective landscape measures tool that will be used in ecoagriculture landscapes worldwide. Through its Landscape Measures Project, Ecoagriculture Partners is organizing follow-up activities to develop, test, and disseminate an Ecoagriculture Landscape Measures Sourcebook. This Sourcebook will serve as a resource and guidance encyclopedia for project teams pursuing ecoagriculture initiatives worldwide. It will also enable indicators from different settings—and methods for measuring and evaluating them—to be synthesized within a common framework.

At this point, it is necessary to begin experimenting with the application of this framework in diverse field settings. The next steps are:

1. To compile a draft Sourcebook that translates this conceptual framework into tangible steps and tools for practical implementation. Based on input from experts and future users from diverse sectors, the draft Sourcebook will elucidate principles of monitoring and evaluation; discuss the process of planning and designing a measurement program and how this activity can relate to adaptive management and policy making; and identify specific indicators, means of measure, and methods suitable for different types of users, land use systems, and ecoagriculture objectives.

2. To identify important gaps in the availability of acceptable indicators and methods, and to identify and mobilize multi-sectoral teams to help fill these gaps.

3. To field test the framework, indicators, and methods in multiple sites around the world in a diversity of biophysical, cultural, and institutional contexts.

4. To use results of the field testing to examine the performance of ecoagriculture landscapes and inform adaptive management and policy making.

5. To use the experience of the field-testing to revise and refine the Sourcebook as part of an iterative process of continual improvement.

While researching and preparing this paper, we detected an overwhelming interest by project managers and technical advisors in enhancing their capacity to evaluate initiatives that combine conservation and human welfare objectives. The investment required to develop such capacity, however, usually is too high for a single project or even a single organization to justify.

In joining together to develop the Ecoagriculture Landscape Measures Sourcebook—which contributing organizations and their partners everywhere can utilize—we aim to substantially reduce the conceptual, financial, and operational barriers to implementing meaningful multi-sectoral evaluations. The gains from pooling knowledge, experience, and talent will be many, including the recognition of new opportunities to work together in creating and sustaining ecoagriculture landscapes. Finally, the development and widespread adoption of a common landscape performance measures approach will enhance our understanding of ecoagricultural systems and our ability to improve them, replicate them, and scale them up. We encourage readers of this document to consider how they may support this effort to help create a product that meets their needs.

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7. Glossary

Agrobiodiversity: All crops and livestock and their wild relatives, and all interacting species of pollinators, symbionts, pests, parasites, predators and competitors. Agrobiodiversity encompasses the variety and variability of living organisms that contribute to food and agriculture. See page 30 for discussion.

Biodiversity: The variety of life on Earth and the natural patterns it forms, including all forms of life, all levels of organization of living things, and all the interactions among the forms of life. See pages 14-15 for discussion.

Ecoagriculture: A vision for managing lands and natural resources so that they simultaneously conserve a full complement of native biodiversity and ecosystem services, provide agricultural products and services on a sustainable basis, and support viable livelihoods for local people. Ecoagriculture is concerned with entire landscape-scale mosaics that also encompass forests, grasslands, human settlements, coastal zones, and waterways. See pages 1-2 for discussion.

Ecosystem services: Ecological processes and functions that sustain and improve human life. Categories of ecological services include provisioning services, regulating services, supporting services and cultural services. See pages 15-16 for discussion.

Indicators: The factors or phenomena that are measured to reveal how well the criteria for landscape performance are being fulfilled. See pages 13-14, and Chapter 4 for discussion.

Institutions: The governance structures, markets, social capital, cultural norms and human capacities that enable an ecoagriculture landscape to be realized. See page 19 for discussion.

Intervention measures: A project effectiveness measure that assesses the extent to which a desirable set of actions has been implemented. See page 6 for discussion.

Landscape: A territory that is characterized by a particular configuration of topography, vegetation, land use, and settlement pattern that delimits some coherence of natural, historical, and cultural processes and activities. A landscape is best delineated functionally—that is, within the context of a particular issue or problem. See page 4-5 for discussion.

Means of measure: Methods of evaluating indicators through the collection of quantitative or qualitative data. Examples of means of measure include wildlife censusing techniques, land cover analysis, and farmer interviews. See page 14 and Table 4.2 for discussion.

Outcome measures: A project effectiveness measure that directly assesses the system of interest itself. As applied to ecoagriculture, these are measures of landscape performance. See page 9 for discussion.

Process measures: A project effectiveness measure that considers the conceptual, analytical, institutional, and human guidance and capacity behind a project—in other words whether a project has the ingredients for success. See page 6 for discussion.

Threat reduction measures: A project effectiveness measure that focuses on the human activities that directly and indirectly threaten biodiversity or a related conservation goal. See page 8 for discussion.

Annex A: People and Organizations Involved in Creating this Framework

This appendix lists the people and organizations who were involved in creating this framework by serving on the International Steering Committee, attending project workshops, or providing interviews with the authors.

Table A-1. Organizations comprising the International Steering Committee for Ecoagriculture Partners' Ecoagriculture Landscape Measures Project.

Organization and Country Headquarters
Alternatives to Slash and Burn Project (ASB, Kenya)
Tropical Agricultural Research and Training Center (CATIE, Costa Rica)
Conservation International (CI, U.S.)
Cornell University (U.S.)
Commonwealth Scientific and Industrial Research Organization (CSIRO, Australia)
International Consortium on Desertification, Drought, Poverty, and Agriculture (DDPA), led by ICRISAT (India) and ICARDA (Syria)
International Water Management Institute (IWMI, Sri Lanka)
M.S. Swaminathan Research Foundation (MSSRF, India)
Rainforest Alliance (U.S.)
The Nature Conservancy (TNC, U.S.)
The World Bank (U.S.)
Winrock International (U.S.)
World Agroforestry Centre (ICRAF, Kenya)

Table A-2. Persons who were interviewed during the preparation of this paper.

Name	Organization
Frank Casey	Defenders of Wildlife
Aaron Dushku	Winrock International
Andy Evans	Royal Society for the Protection of Birds
Celia Harvey	CATIE
Frank Bowman-Hicks	Rainforest Alliance
Tony Janetos	Heinz Center for Science, Economics and the Environment
Elizabeth Kennedy	Conservation International
Sarah Lynch	World Wildlife Fund
Karen Luz	World Bank
David Molden	International Water Management Institute
Steve Osofsky	Wildlife Conservation Society

Name	Organization
Frank Place	World Agroforestry Center (ICRAF)
Jai Ranganathan	Stanford University
Tim Reed	The Nature Conservancy
Chris Reij	International Resources Group
Nick Salafsky	Foundations of Success
Jeff Sayer	World Wildlife Fund
John Schelhas	U.S. Department of Agriculture
Sara J. Scherr	Ecoagriculture Partners
Jan Sendzimir	IIASA
Richard Thomas	International Centre for Agricultural Research in the Dry Areas (ICARDA)
Tom Tomich	World Agroforestry Center (ICRAF)
Steve Vosti	University of California, Davis
Norman Uphoff	Cornell University
Kadi Warner	Winrock International

Table A-3. Attendees at the Workshop on Assessing Ecoagriculture Outcome Measures in June 2005, organized and convened by Ecoagriculture Partners and The Nature Conservancy.

Name	Organization
Jill Blockhus	The World Bank
Keith Brown	The Jane Goodall Institute
Louise Buck	Cornell University
Anthony Cavalieri	The Nature Conservancy
Theo A. Dillaha	Virginia Tech
Thomas Gavin	Cornell University
Celia Harvey	CATIE
Frank Bowman-Hicks	Rainforest Alliance
Allen Kearns	CSIRO
Elizabeth Kennedy	Conservation International
Timm Kroeger	Defenders of Wildlife
Julie Kunen	USAID
Karen Luz	The World Bank
Sarah Lynch	World Wildlife Fund
Matthew McCartney	International Water Management Institute
Annette Meredith	University of Maryland
Doug Muchoney	U.S. Geological Survey
Tim Reed	The Nature Conservancy
Nick Salafsky	Foundations of Success
Roger Sayer	U.S. Geological Survey

Name	Organization
Sara J. Scherr	Ecoagriculture Partners
Norman Uphoff	Cornell University
Konrad von Ritter	The World Bank
Kadi Warner	Winrock International

Table A-4. Attendees at the Workshop on Ecoagriculture Outcomes: Assessing Trade-Offs and Synergies Between Agricultural Production, Rural Livelihoods and Biodiversity Conservation at a Landscape Scale in February, 2006, organized and convened by the Biodiversity Team of the World Bank's Environment Department and by Ecoagriculture Partners.

Name	Organization
Jill Blockhus	PROFOR/Forest Team, World Bank
Louise Buck	Cornell University
Catherine Cassagne	International Finance Corp.
Frank Casey	Defenders of Wildlife
Diji Chandrasekheran	World Bank, Agriculture & Rural Development
Marian de los Angeles	World Bank Institute
Erick Fernandes	World Bank, Agriculture & Rural Development
Tom Gavin	Cornell University
Hans Herren	Millennium Institute
David Hess	Conservation International
John Kadyszewski	Winrock International
Karen Luz	World Bank, Biodiversity Team
Kathy MacKinnon	World Bank, Biodiversity Team
Angela Martin	The Nature Conservancy
Jeff Milder	Cornell University
Augusta Molnar	Rights and Resources Initiative
Gunars Platais	World Bank, Latin American & Caribbean
Konrad von Ritter	World Bank Institute
Aimee Russillo	Rainforest Alliance
Sara Scherr	Ecoagriculture Partners
Goetz Schroth	Conservation International
Claudia Sobrevila	World Bank, Biodiversity Team
Pietronella Van den Oever	World Bank Institute-EN
Rob Wolcott	U.S. Environmental Protection Agency
Stanley Wood	International Food Policy Research Institute

Annex B: Selected Existing Frameworks

Frameworks and Indicators for Assessing Agricultural Production

Below we summarize agriculture performance indicators from two sources: the Organization for Economic Cooperation and Development (OECD) and the Pilot Analysis of Global Ecosystems (PAGE). Although both indicator sets were originally developed to be applied at national or global scales, many of the component indicators could easily be adapted to a landscape scale. The conceptual congruity of both indicator sets with ecoagriculture makes them especially relevant for this framework.

OECD Agri-Environmental Indicators

The complete set of OECD agri-environmental indicators are shown in **Figure B-1** (OECD 2001). The following summaries expand upon the indicators in Section III (use of farm inputs and natural resources) and Section IV (environmental impacts of agriculture).

Nutrient Use: The *nitrogen balance* indicator measures the difference between the nitrogen available to an agricultural system (inputs, mainly from livestock manure and chemical fertilizers) and the uptake of nitrogen by agriculture. A persistent surplus indicates potential environmental pollution, while a persistent deficit indicates potential agricultural sustainability problems. A second nutrient use indicator, the *nitrogen efficiency*, measures the nitrogen input/output ratio.

Pesticide Use and Risks: The *pesticide use* indicator measures trends in pesticide use by active ingredients based on sales and/or use data. The *pesticide risk* indicator combines information on pesticide hazard and exposure, pesticide use, and conditions that might affect risk.

Water Use: Three indicators relate to agriculture's use of surface and groundwater: 1) the *intensity* of water use by agriculture relative to other users in the economy; 2) the technical (volume) and economic (value) *efficiency* of water use on irrigated land, and, 3) water *stress*, gauged by the extent to which diversions or extractions of water from rivers affect aquatic ecosystems.

Soil Quality: Two indicators address on-farm soil quality: 1) *risk of water erosion* and 2) *risk of wind erosion*. These are estimates of the share of agricultural land affected at different risk intervals from low/tolerable to high/severe categories.

Water Quality: To assess impacts of agriculture on water quality *risk* and *state* indicators are used, with emphasis on nitrate and phosphorus pollution. Risk indicators estimate the potential contamination of water originating from agricultural activities. State indicators measure the actual trends in concentrations of pollutants in water against a threshold level.

Land Conservation: Two indicators address land conservation. The *water retaining capacity* indicator measures the ability of different land uses to retain water. A decrease in water retaining capacity implies a greater potential risk of flooding. The *off-farm sediment flow* indicator measures the quantity of sediment delivered to off-farm areas as a result of agricultural soil erosion.

Figure B-1. Complete list of OECD agri-environmental indicators. Source: OECD 2001

I. AGRICULTURE IN THE BROADER ECONOMIC, SOCIAL AND ENVIRONMENTAL CONTEXT		
1. Contextual Information and Indicators		2. Farm Financial Resources
• *Agricultural GDP* • *Agricultural output* • *Farm employment* • *Farmer age/gender distribution* • *Farmer education* • *Number of farms* • *Agricultural support*	• *Land use* – Stock of agricultural land – Change in agricultural land – Agricultural land use	• *Farm income* • *Agri-environmental expenditure* – Public and private agri-environmental expenditure – Expenditure on agri-environmental research

II. FARM MANAGEMENT AND THE ENVIRONMENT		
1. Farm Management		
• *Whole farm management* – Environmental whole farm management plans – Organic farming	• *Nutrient management* – Nutrient management plans – Soil tests • *Pest management* – Use of non-chemical pest control methods – Use of integrated pest management	• *Soil and land management* – Soil cover – Land management practices • *Irrigation and water management* – Irrigation technology

III. USE OF FARM INPUTS AND NATURAL RESOURCES		
1. Nutrient Use	2. Pesticide Use and Risks	3. Water Use
• *Nitrogen balance* • *Nitrogen efficiency*	• *Pesticide use* • *Pesticide risk*	• *Water use intensity* • *Water use efficiency* – Water use technical efficiency – Water use economic efficiency • *Water stress*

IV. ENVIRONMENTAL IMPACTS OF AGRICULTURE		
1. Soil Quality	3. Land Conservation	4. Greenhouse Gases
• *Risk of soil erosion by water* • *Risk of soil erosion by wind*	• *Water retaining capacity* • *Off-farm sediment flow*	• *Gross agricultural greenhse gas emissions*
2. Water Quality		
• *Water quality risk indicator* • *Water quality state indicator*		
5. Biodiversity	6. Wildlife Habitats	7. Landscape
• *Genetic diversity* • *Species diversity* – Wild species – Non-native species • *Eco-system diversity* (see Wildlife Habitats)	• *Intensively-farmed agricultural habitats* • *Semi-natural agricultural habitats* • *Uncultivated natural habitats* • *Habitat matrix*	• *Structure of landscapes* – Environmental features and land use patterns – Man-made objects (cultural features) • *Landscape management* • *Landscape costs and benefits*

1. This list includes all the agri-environmental indicators covered in the Report. For a detailed description of each indicator, see the Annex to this chapter.

Source: OECD Secretariat.

Greenhouse Gases: The *greenhouse gas (GHG)* indicator measures the gross agricultural emissions of three gases: carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), expressed in CO_2 equivalents. Most work to date on agricultural GHG has focused on emissions, but recent research has also begun to quantify the potential of agricultural systems to function as GHG sinks.

Biodiversity: Genetic diversity indicators measure the varietal and genetic diversity of crops and livestock used in agriculture. Species diversity indicators are measures of trends in population distributions and numbers of: 1) wildlife species dependent on or affected by agriculture, and 2) non-native species threatening agricultural production and agro-ecosystems.

Wildlife Habitats: Five indicators measure the state and trends of habitat in intensively farmed, semi-natural, and uncultivated natural habitats. A sixth indicator is a habitat matrix, which identifies and relates the ways in which wild species use different agricultural habitat types.

Landscape: Agricultural landscape indicators track: 1) the current state of the landscape and how its appearance, including cultural features, is changing; 2) the share of agricultural land under public/private schemes for landscape conservation; and 3) the cost of landscape provision by farmers and the value society attaches to landscapes.

PAGE Agroecological Indicators

The Pilot Analysis of Global Ecosystems (PAGE), was developed by the World Resources Institute and the International Food Policy Research Institute (Wood et al. 2000). The analysis uses the following indicators of agroecosystem performance.

- Agricultural extent and the climatic characterization of agricultural land
- Food, feed and fiber land use and yields
- Intensity of production input use
- Value of food outputs in monetary, nutrition, employment and income terms
- Soil resource quality
- Irrigation water use and efficiency
- Watershed modification in land cover
- Conversion by habitat type
- Habitat quality of agricultural land
- Tree cover in agricultural lands
- Agrobiodiversity (crop genetic diversity)

- Carbon storage in agricultural soils and vegetation
- Agriculture's role in greenhouse gas emissions

PAGE also provides detailed assessments of the source and quality of data related to these indicators, and suggests how indicators can be improved. The authors highlight the need for monitoring the following:

- Conversions to and from agricultural land as well as between land uses
- Agricultural conservation management practices under use
- Production and value of production by sub-region
- Soil nutrient balance by production system
- Remote methods of soil quality assessment at landscape scale (e.g. SOM and soil biota)
- Groundwater levels, river flow, water quality at meaningful intervals
- Satellite-derived rain-use efficiency
- Road network data overlaid by land use and landscape niche
- Abundance of wild flora and fauna in and around agricultural production areas
- Impacts of specific crop combinations and management changes on wildlife populations
- Remote sensing on incidence of fire
- Livestock numbers, ruminant livestock numbers
- Multi-season vegetative cover mapping, which provides indications of many variables of interest.

DfID Sustainable Livelihoods Approach

Here we provide additional information about the implementation of a monitoring and evaluation program under the DfID Sustainable Livelihoods Approach. More detailed guidance is available at www.livelihoods.org.

Table B-1. Key characteristics of monitoring and evaluation under DfID's Sustainable Livelihoods Approach. Understanding these characteristics is considered by developers of the approach to be essential for developing and using effective livelihood indicators.

Dimension	Characteristic
View of impact	• Broad, holistic and cross-sectoral • Direct and indirect, intended and unintended
Scope	• Tracks impacts over time, beyond life of project • Includes cumulative impacts
Purpose	• Focus on learning, not policing • Includes project progress and effectiveness
Levels	• Examines local and macro level changes • Makes linkages between levels
Responsibility	• Works in partnership • Strengthens internal commitment and capacity
Methods	• Participatory • Quantitative and qualitative
Outputs	• Information for corrective action within projects • Information for planning and policy making • Capacity developed for continuous learning

As in the ecoagriculture measurement framework, the sustainable livelihoods framework provides criteria for which locally specific indicators and measures need to be derived. Below is an example from a project in Bangladesh that used the sustainable livelihoods framework as a basis for developing its monitoring and evaluation system.

Table B-2. Example of sustainable livelihood criteria, indicators and means of measure for the Bangladesh Livelihoods Monitoring System. Source: Pasteur 2001.

Criteria and Indicators	Local Measure of Indicators
Vulnerability	
Seasonality	Most difficult time of the year, availability of food stocks
Shocks/stresses	Dowry; river erosion; cyclone; pest disease attacks; rainfall patterns; illegal possession of land
Resource trends	Permanent and seasonal migration; reduced income opportunities
Assets	
Land/trees	Proportion owned/rented/leased
Water	Access to irrigation facility
Livestock	Number of adult and young animals, owned or shared
Physical assets	Housing condition/furniture; bicycle, radio, TV; agricultural equipment
Human capital	Number in household; old age dependency ratio; literacy levels; disabled member; female headed; type of health service available, availability of prescription drugs
Financial	Value of remittances; savings, loans
Transforming structures and processes	
Local networks	Participation in community activity; membership in indigenous organizations; contact with other NGOs; access to financial institutions; access to extension; access to NGO loans
Markets	Access to local, regional, national markets. Supply chain characteristics
Caste	Access to markets for Muslims (as well as Hindus)
Gender	Frequency of women coming together; support networks for women and girls.
Conflict	Mechanisms for resolution in household and village
Strategies	
Income sources/ time allocation	Homestead agriculture, field agriculture, daily field labor, daily town labor, selling fodder grass, wholesale business, fruit and vegetable production, rickshaw pulling, short-term migration, poultry rearing, cattle rearing, selling milk, selling fried rice
Coping strategies	Selling land, ornaments, draft animals, tin sheets, trees, utensils; taking loans; child labor; migration to towns; illegal tree felling
Adapting strategies	Diversifying economic activity, migration
Labor	Number of days sold by gender; contract arrangement; wage rate in peak and lean seasons
Investment	Amount of cash savings, value of loans made and interest rates
Outcomes	
Food security	Number of months of secure food from own production; number of meals per day in difficult months
Education	Number of children in school; grade levels attained
Environmental sustainability	Use of pesticide/fertilizer; number of trees/household; livestock to land ratio; use of organic matter in field and for fuel; access to common property resources; energy use
Health	Under five wasting; under five stunting; incidence of diarrhea, night blindness, skin disease; medical expenses
Women's empowerment	Level of control over household and community decisions; freedom of movement