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Agroforestry and biodiversity conservation – traditional practices, present dynamics, and lessons for the future

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Abstract. The environmental services that agroforestry practices can provide, and especially their potential contribution to the conservation of biodiversity, have only recently attracted wider attention among agroforestry and conservation scientists. This new view is consistent with the ecosystem approach to natural resource management advocated by the Convention on Biological Diversity. This collection of six papers, which is based on a Workshop held in June–July 2004, brings together studies of biodiversity impacts of traditional agroforestry practices from Central and South America, Africa and Asia. The contributions highlight the considerable potential of traditional agroforestry practices to support biodiversity conservation, but also show their limits. These include the importance of sufficient areas of natural habitat and of appropriate hunting regulations for maintaining high levels of biodiversity in agroforestry land use mosaics, as well as the critical role of markets for tree products and of a favourable policy environment for agroforestry land uses. In combination the case studies suggest that maintaining diversity in approaches to management of agroforestry systems, along with a pragmatic, undogmatic view on natural resource management, will provide the widest range of options for adapting to changing land use conditions.

Introduction

From the very beginnings of agriculture, many farmers maintained or actively included trees as part of their agricultural landscapes. Trees provided shade, shelter, energy, food, fodder and many other goods and services that enabled the farmstead to prosper. Especially in the tropics, trees were essential components of the fallow vegetation on temporarily abandoned fields, and many trees were also retained without specific purpose on farm land where they did not interfere with the use of the land. In some humid tropical regions trees have such a prominent place in farming systems that the difference between forest, old fallows, and extensively managed traditional tree crop plantations is not immediately evident to the untrained eye. However, despite the presence of

trees in tropical farming systems since the very beginnings, knowledge about their use in farms and farmed landscapes has only relatively recently been consolidated into the science of agroforestry, and much still remains to be learned about the relationships between trees, crops and their environment.

For the first roughly two decades of agroforestry research, agroforestry scientists were mostly concerned with the sustainable production of agricultural goods, especially food, and this line of research has lost none of its relevance. However, over the last decade or so, scientists have also become interested in the environmental services that agroforestry practices may provide to local and even global society by maintaining watershed functions, retaining carbon in the plant–soil system, and, most recently, by supporting the conservation of biological diversity (McNeely and Scherr 2003; Schroth et al. 2004).

Parallel to this widening interest in the services of agroforestry practices, the understanding of what agroforestry really is has evolved as well. While 10–15 years ago most agroforestry research still focused on researcher designed arrangements of trees and agricultural crops on the scale of an individual field (usually sited on a research station), we have now come to appreciate those tree based practices that are so wide-spread in traditional tropical land use as agroforestry practices in their own right. Examples include complex, tree crop-based agroforests (Michon and de Foresta 1999), parkland savannas (Boffa 1999), and extractively managed, and often enriched, forest and fallow vegetation. In parallel to the recognition of such traditional, tree based practices as 'mainstream agroforestry,' the agroforestry scientist's spatial focus shifted from the scale of the field to that of the landscape within which tree-dominated and crop-dominated patches are arranged in a dynamic mosaic in accordance with biophysical and socioeconomic forces (Leakey 1996).

A new focus on biodiversity

The increased consideration of traditional, tree-based land use practices and the widening of the focus from the field to the landscape scale in agroforestry science have made links between agroforestry and the conservation of biodiversity more relevant and more obvious. In an extensive review of the subject, Schroth et al. (2004) identified and discussed three roles of agroforestry in biodiversity conservation on a landscape scale: the provision of supplementary, secondary habitat for species that tolerate a certain level of disturbance; the reduction of rates of conversion of natural habitat in certain cases; and the creation of a more benign and permeable 'matrix' between habitat remnants compared with less tree-dominated land uses, which may support the integrity of these remnants and the conservation of their populations. Agroforestry practices have often been shown to increase levels of wild biodiversity on farm land, and it is hypothesized that they are also able to play a supporting role in the conservation of biodiversity in remnants of natural habitat that are

interspersed with farm land in tropical land use mosaics. Little research has, however, focused specifically on this latter question, which is particularly relevant for species that depend on natural habitat and that require relatively large areas.

These considerations gain additional relevance on an international political level in view of the Convention on Biological Diversity (CBD) of 1992, which directed attention toward ecosystem approaches to resource management, including conservation, sustainable use, and equitable sharing of benefits. From the CBD arise important questions for agroforestry. For example, what is the role of trees in croplands as a contribution to conserving biological diversity? When is it appropriate to plant non-native trees that may subsequently become invasive, or alter ecosystems profoundly? What are the economic implications of planting various species of trees on farms? To what extent do farmers planting agroforests depend on forces over which they have little control, such as commodity prices?

To help expand this understanding and to chart a course for future research, we convened a workshop at the First World Agroforestry Congress held in Orlando, Florida, in June–July 2004. Some of the papers that follow were presented in draft form at that Workshop and have now been substantially revised and updated, others were specifically invited for this collection.

Highlights of contributions

In the first contribution, Celia Harvey and coworkers explore the importance of indigenous agroforestry systems for biodiversity conservation by comparing the abundance, species richness and diversity of dung beetles and terrestrial mammals across a land use gradient from plantain monoculture through cocoa and banana agroforestry systems to forests in the BriBri and Cabécar indigenous reserves in Talamanca, Costa Rica. The study indicates that the indigenous agroforestry systems maintain a level of biodiversity that is lower than that of the original forest but higher than that of monocultures, and that they provide suitable habitat for a number of forest-dependent species. However, heavy hunting pressure in the reserves tends to offset the beneficial effect of the agroforestry systems. This study illustrates that diversified land use systems by themselves are not sufficient to maintain high levels of biodiversity in agricultural landscapes, but need to be complemented with other measures such as hunting control.

Deborah Faria and coworkers take this point further in the second paper of this collection. They compare bird and bat communities in shaded cocoa plantations (so-called cabrucas) and forest fragments in two landscapes in the Atlantic forest region of Bahia, Brazil. One landscape is dominated by forest with interspersed cocoa plantings, and the other is dominated by cocoa with interspersed forest fragments. In accord with the previous paper, the authors find relatively high levels of species richness of birds and bats, including many

forest species, in the traditional shaded cocoa plantations. However, both forest fragments and cabrucas in the cocoa-dominated landscape are species-poorer than in the forest-dominated landscape. The authors conclude that the shaded cocoa systems are no full substitutes for natural forest but are dependent upon nearby forest for retaining high levels of forest species. In other words, landscapes characterized by a high degree of substitution of forest by shaded cocoa systems are likely to lose species even if these may be present in cocoa systems in more forest-dominated landscapes.

In the third contribution, Xavier Augusseau and coworkers take us to the semiarid savanna of Burkina Faso, where population growth, immigration and new market opportunities create a highly dynamic land use situation. Traditional parklands and fallows hold significant levels of tree diversity, but these agroforestry practices are in decline. Farmers do not plant native trees while orchards of introduced fruit trees are expanding rapidly. In this situation, the authors advocate neither a position of resignation nor of trying to maintain a status quo against the land use trend, but rather to build on the value that farmers see in a variety of tree products and work with them to identify new niches for native tree (and associated) biodiversity in the dynamic land use systems. This paper illustrates well the need for an undogmatic, pragmatic and flexible approach to natural resource management.

In the fourth contribution, Krishna Prasad Acharya highlights the substantial diversity of trees in traditional agroforestry systems in the Middle Hills of Nepal, which complements their important role for the sustainability of agricultural production. Traditional agroforestry practices benefit biodiversity through *in-situ* conservation of tree species on farms, reduction of pressure on remaining forests, and the provision of suitable habitat for plant and animal species on farmland. The author identifies government policies and land use trends that threaten farm tree diversity, including the promotion of a few (not necessarily well adapted) species, emigration of male family members, urbanization, and the availability of forest products from community forests which may be less diverse than farm tree communities. He recommends a series of measures to counter this trend within which improved marketing opportunities for farm tree products figure prominently.

In another half-turn around the globe, Thora Martina Herrmann takes us to the Andes of southern Chile, where indigenous Mapuche Pewenche manage forests of officially protected monkey-puzzle trees (*Araucaria araucana*), on whose seeds they depend for food, with practices that straddle the limits between natural forest management and agroforestry. As often, the detailed but non-scientific knowledge of the indigenous people is not recognized by government agencies, and restrictions to traditional tree seed collection have led to tensions in the past. The author highlights traditional practices that limit the removal of seeds and increase tree regeneration, such as the use of family territories, incomplete harvesting of cones and collection of seeds, and recently the active cultivation of the trees. She advocates recognition of this traditional knowledge of tree management and cooperation between local people and

scientists in the management of this spectacular, but vulnerable tree species and the ecosystems dominated by it.

In the final paper, Rebecca Ashley and her colleagues focus on the policy terrain that affects the use of agroforestry by local people around five protected areas across sub-saharan Africa. She thereby takes up the point made by the authors of several previous papers in this collection about the essential role of government policies both for the conservation of traditional and the adoption of new agroforestry practices. Across sites in Uganda, Cameroon and Mali, the authors find a rough policy terrain for agroforestry, characterized by systemic market constraints, contradictions between development approaches and conservation objectives, and inconsistencies in institutional and regulatory frameworks. She makes the important point that, in order to overcome these constraints, both land use and conservation planners need to have greater appreciation of and confidence in the potential of agroforestry for conservation and livelihood improvement. This conclusion is particularly relevant for traditional agroforestry practices, as shown by several other papers in this collection.

Conclusions

Among the conclusions that we can draw from these papers are that traditional, often complex agroforestry systems are more supportive of biodiversity than mono-crop systems, although even they are no substitutes for natural habitat on whose proximity they may often depend for high levels of wild biodiversity. The relationship between forests, agroforestry and wild biodiversity can be made most productive through applying adaptive management approaches that recognize local knowledge and practice and incorporate ongoing research and monitoring in order to feed information back into the management system, with farmers and local populations included as active participants. Maintaining diversity in approaches to management of agroforestry systems, along with a pragmatic, undogmatic view on natural resource management, will provide the widest range of options for adapting to changing economic, social, and climatic conditions. Finally, we need clear government policy frameworks to support alliances among the many interest groups involved in agroforestry research and development.

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