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# 'Received Wisdom' in agricultural land use policy: 10 years on from Rio

David Wood*, Jillian M. Lenné

*North Oldmoss Croft, Fyvie, Turriff, Aberdeenshire, AB53 8NA, Scotland, UK*

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**Abstract**

Support needed for agriculture in developing countries has been eroded in the belief that agriculture threatens biodiversity. Preference is now given to environmental research and conservation. Yet there is increasing evidence that much of the ecological criticism of agriculture in developing countries is unfounded. Using the Convention on Biological Diversity (CBD) as a framework, this paper questions the use of ecological 'received wisdom' in international agri-environmental policy over the past 10 years and puts forward a case for productive agriculture *and* conservation through common-sense land use policies. The paper identifies and then focuses on 'received wisdom' surrounding the two CBD objectives of conservation and sustainable use of biological diversity. It presents evidence to question and then reject three major 'received wisdom' propositions, namely: *the ecosystem approach*; the idea that *agricultural expansion damages wild biodiversity*; and that *agricultural biodiversity ensures agricultural sustainability*. The paper suggests that future emphasis in the CBD process should be given to three biodiversity-friendly services that agriculture can provide: *agricultural intensification to allow land-saving for conserving wild biodiversity off-farm*; *fields as sustainable models of non-equilibrium ecosystems*; and the *greater use of the extensive knowledge base generated by agricultural research* for developing sound ecological approaches to managing biodiversity.


*Keywords:* Convention on Biological Diversity; Ecosystem approach; Biodiversity; Conservation; Sustainability; Developing countries

## Introduction

Agriculture is a major land use of particular and vital importance to most developing countries. A total of over 60% of the economically active population and over 50% of the rural economy in developing countries are involved with agriculture. Agriculture is of major importance for the poor: three quarters of the poor globally work and live in rural areas and there is a 'primacy of agriculture in development' (IFAD, 2001). Much of the increase in food production globally during the past 40 years can be attributed to agricultural research, with Internal Rates of Return (IRR) of 30–50% (Pinstrup-Andersen et al., 1997). With an estimated global population of 9.4 billion by 2050, mainly in developing countries, there will be a need to increase food production by 67% (Evans, 1998).

Despite the critical importance of agriculture, developing-country land use policies are widely subject to external criticism claiming environmental degradation. In particular, agriculture regularly comes under attack or criticism in environmental and conservationist literature for its perceived threat to global biodiversity. Generic statements such as 'agriculture, as currently practiced, represents a profound threat to wild biodiversity' (McNeely and Scherr, 2001) go unchallenged. To mitigate this supposed threat to biodiversity, widespread attempts are made to influence agricultural policies in developing countries (Thrupp, 1998). In the most extreme views, farms are seen not as units for producing food, but to enhance bioconservation, with the suggestion that traditional farms in developing countries should be subject to restrictions on modernization in order to become incorporated into an 'agrobiodiversity' conservation programme (Bardsley, 2003, p. 154).

Unfortunately, much-needed support for rational land use through improved agriculture will be diverted

*Corresponding author. Tel.: +44-1651-806153.
*E-mail address:* agrobiodiversity@btopenworld.com (D. Wood).

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to wasteful environmental policies and projects if funding agencies based in developed countries believe supposed ecological criticisms of productive agriculture (Pimentel et al., 1992). Already there is a public emphasis on sustainability, conservation of biodiversity, and environmental health rather than on the further enhancement of agricultural productivity (Evans, 2003).

The World Bank (2002) noted 'contemporary contentious debates' over 'the extent to which research should be directed toward environmental issues such as climate change, loss of biodiversity, soil degradation and water pollution versus farm-level technologies for improving crop, fisheries, forestry and livestock production'. International agricultural research, for example, within the Consultative Group on International Agricultural Research (CGIAR—the main agent of the Green Revolution), has already suffered a decline in funding (Pardey and Beintema, 2001, p. 8). The success of the Green Revolution has been replaced by the rhetoric of the 'Greening of Aid'. This followed the amendment of the US Foreign Assistance Act in 1986 to put an emphasis on saving tropical forests and the 'diversity of life'. As a result of this emphasis the US Agency for International Development (USAID) reduced funding directed towards agricultural research in less developed countries by 75% from the mid-1980s to 1996 (Pardey and Beintema, 2001, p. 9). As USAID decreased its funding to agricultural research and development it increased its funding of tropical biodiversity programmes: at the same time, US philanthropic foundations began to abandon agriculture and devote their resources to rainforests and other non-agricultural biodiversity issues (Buttel, 1992). This decline in US funding for agriculture was mirrored internationally: the proportion of official development assistance going to agriculture has fallen from about 20% in the late 1980s to about 12% today. This erosion of funding for agriculture now threatens poverty alleviation (IFAD, 2001).

The purpose of this paper is to demonstrate that much of the ecological criticism of agriculture as practiced in developing countries is technically unfounded or outdated. Indeed, it is based on 'received wisdom' of little merit.

Note that we are not attempting to reach some form of 'balance' in the supposed conflict between agriculture and biodiversity conservation in developing countries. Indeed, we reject both the idea that there is any real conflict and also that any concept of 'balance' can be applied by the well-fed to an issue affecting the food security of more than two-thirds of our global population. Rather, we are supporting a case for productive agriculture in the 'contentious debates', in the belief that this will lead to a 'win-win' situation: increased food production and also lower pressure on wild biodiversity.

Our focus and time frame is the use of 'received wisdom' in the implementation of a major international environmental Treaty, the Convention on Biological Diversity (CBD) (UNEP, 1992), and its possible impact on agriculture and land use policies in developing countries. After reviewing the application and dangers of three topics of received wisdom in the CBD, we suggest a more central role for ecologically valid and time-tested agricultural practices in the biodiversity and land use policies of developing countries.

## What is 'received wisdom'?

'Received wisdom' is 'conventional' wisdom, itself often suspect, dated, or dogmatic, that is transferred to other regions. The focus here is the ecological 'received wisdom' of developed countries, transposed uncritically to developing countries, and used as a justification for land use policies.

'Received wisdom' has one or more of the following characteristics. Firstly, received wisdom is a narrative apparently based on realistic interpretations of facts, but actually based on only a subjective selection or simplistic interpretation of facts. Contrasting or conflicting interpretations, based on the same or other facts, are possible but are characteristically ignored in the scientific formulation of 'received wisdom', in translating it into policy, and in applying policy beyond the original spatial context of the 'received wisdom'.

Secondly, doomsday scenarios abound. These scenarios will first be accepted, then questioned (and then later may be defended). In replying to what he sees as the received wisdom of land degradation in dry regions, Kerr (1998) notes that the accepted notion of desertification is a 'hypnotic but not appropriate' concept. Hellden (1994) claims that there is no evidence to support increasing desertification and an obvious risk that the desertification issue will become a political and development 'fiction'.

Thirdly, there may be a damaging time lag between received wisdom as a basis for policy and the evolution of scientific ideas. With reference to land use, specifically protected area policy, Reid (1996) noted that management objectives were based on now-dated ecological theory and 'ecological misunderstandings', developed at a time when ecologists thought communities were stable, that populations tended to equilibrium levels, and that the role of humans was minor. Reid concludes that today, scientists have modified or abandoned these assumptions, yet policy implications hostile to agriculture remain enshrined in management practices.

Fourthly, once codified in policy-making as environmental orthodoxy, the continuing bias of received wisdom may be difficult for scientists in developing countries to challenge effectively. This is particularly so

when received wisdom is associated with and insulated by catchwords. Such catchwords may be positive (sustainability, biodiversity, ecosystem) or negative (desertification, deforestation, degradation). Both positive and negative concepts may refuse to pass away as contrary evidence accumulates. Reid (1996) believed that ecologists had long ago discarded the idea of a positive relationship between biotic diversity and stability, but he accepted that the notion was 'probably too useful for environmentalists ever to reject'. Carswell (2003) identified a series of negative 'environmental narratives' on land degradation developed during the colonial period in Uganda. Carswell then showed that these assumptions and associated policy rhetoric remain unaltered and now need to be seriously questioned.

Finally, the 'received wisdom' of developed countries (which are a source of funding) may be imposed on the land use policies of developing countries by funding conditionality—the 'Greening of Aid' phenomenon—and also the institutional policies of a plethora of intermediaries, often NGOs, whose own funding depends on promoting the prevailing 'received wisdom' (as with McNeely and Scherr, 2001). Yet 'received wisdom' from developed countries may not be appropriate to the ecological and socio-economic conditions in developing countries. If so, 'received wisdom' moves beyond an attractive misconception to become a threat to livelihood strategies. For example, 'received wisdom' usually concludes that human impact on the environment, particularly through agriculture, causes degradation: for example, 'conservationist beliefs have generally held that there is an inverse relationship between human actions and the well-being of the natural environment' (Gómez-Pompa and Kaus, 1992). In addition, Leach and Mearns (1996) claim that supposedly self-evident 'received wisdom' over the loss of forest cover in West Africa is deeply misleading, leads to inappropriate solutions, and serves the purposes of particular institutions. We believe that the transfer of such 'misreadings' through project funding may waste human and material resources and ultimately threaten human life.

As an example of the potential dangers of environmental 'received wisdom' to the agriculture of developing countries, the CGIAR at its 2002 annual general meeting in Manila pledged to align its policies 'to achieve objectives of international conventions on biodiversity and desertification' (CGIAR, 2002). Clearly, if implementation of Convention objectives is based on questionable 'received wisdom', then the CGIAR, a significant factor in agricultural research and land use policy for the Third World, could fail in its mission. Policy errors could magnify into research failures and, in turn, threats to food security.

More than a decade ago, the danger of 'received wisdom' in forest policy caused Namkoong (1991) to warn forest scientists not to be silent over policy issues: 'By hesitating to enter the debate, we only accede the field to the biologically naive and find ourselves able to serve only as peripherally significant technicians in pursuit of the objectives of the uninformed'. In a general attack on the mythology of land use, Lambin et al. (2001) argue that there is a need to move beyond popular myths, which are simplifications of cause–consequence relationships. Such myths are difficult to support empirically but have gained sufficient public currency to influence environment and development policies.

'Received wisdom' is by its nature incorrect or inappropriate. The thesis of this paper is that, unless challenged, agri-environmental 'received wisdom' will be translated uncritically into land use policy perhaps dangerously inappropriate for developing countries. In addition, funding could be misdirected to what Namkoong (1991) called the 'objectives of the uninformed'.

We try to answer the following questions. Can environmental 'received wisdom' be identified in the implementation of the CBD? Could received wisdom damage agricultural policy and subsequent land use in developing countries? Can received wisdom be challenged and replaced with a more rational basis for land use policy founded on productive agriculture?

## Agriculture in the CBD

The text of the international 'CBD' was agreed as part of the Rio package of environmental treaties in 1992 (UNEP, 1992) and the Convention entered into force on 29 December 1993. The working draft of the CBD was originally prepared by IUCN (now the World Conservation Union) under the direction of the United Nations Environmental Programme (UNEP). Thus from its conception the CBD was an environmental treaty with a strong conservation element, and as such, was a fertile breeding ground for anti-agricultural 'received wisdom' (and, hence, with major implications for global land use). Agriculture was specifically mentioned only in an annex to the CBD dealing with the monitoring of economic species.

The scope of the CBD is defined in Article 1:

> The objectives of this Convention, to be pursued in accordance with its relevant provisions, are the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding.

This paper will focus on 'received wisdom' surrounding the implementation of the two CBD objectives of 'conservation' and of 'sustainable use' of biological diversity in the context of land use in developing countries, specifically, through agriculture. The third objective of the CBD, on benefit-sharing over access to genetic resources, will not be considered further here.

## Implementation of the CBD

Despite its absence from the text, there is now a definite emphasis on agriculture and agricultural biodiversity in the ongoing process of implementation of the CBD. This process includes biennial meetings of the Conference of the Parties (COP) and an international Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA) that provides inputs to COP meetings (of which there have now been six). All official documents of COP and SBSTTA can be found at www.biodiv.org (CBD web site). Countries use COP decisions as a basis for national biodiversity strategy and action plans. National and multilateral project implementation may be based on COP recommendations. For example, the Global Environmental Facility (GEF) has emerged as a major project-implementing agency for the CBD and closely follows COP recommendations.

We argue that the ongoing process of refinement has injected 'received wisdom' into the CBD process. Three examples are identified here. Firstly, the second Conference of the Parties (COP 2) recognized '*the ecosystem approach*'. Secondly, COP 3, with specific attention to agriculture, inserted two more items of 'received wisdom', one on the *agricultural destruction of biodiversity* and the other on *sustainable agriculture*. All three are now briefly outlined as *propositions*, each identified as to source, and each then subject to fuller criticism.

## 'Received wisdom' propositions

Primacy for the 'ecosystem approach' was recommended by the 1st meeting of SBSTTA (CBD web site as UNEP/CBD/COP/2/5, Recommendation 1/3). This recommendation was adopted by the 2nd meeting of COP in November 1995 (CBD web site as Decision 2/8). The ecosystem approach is now 'the primary framework for action under the Convention'. This would include agriculture and agricultural biodiversity.

A strong emphasis on 'the ecosystem approach' can be found in documents from COP 2 onwards. The hope was that 'the ecosystem approach' could integrate conservation measures and sustainable use of biological diversity. The 'received wisdom' Proposition 1 is that 'the ecosystem approach' *is appropriate to address the conservation and sustainable use of biodiversity for the agriculture of developing countries*.

The first major decision of the CBD process specifically on agricultural biodiversity was COP 3/11 (CBD web site as UNEP/CBD/COP/3/38). The main objective of 3/11 was: 'To promote the positive effects and mitigate the negative impacts of agricultural systems and practices on biological diversity in agro-ecosystems and their interface with other ecosystems'.

Two specific items of 'received wisdom' are evident in Annex 1 of Decision 3/11. The first claim (in the words of the Annex) is that: 'In recent years, as the world's population continues to grow and agricultural production must meet the rising demand for food, agricultural expansion into forests and marginal lands, combined with overgrazing and urban and industrial growth, has substantially reduced levels of biological diversity over significant areas'. Thus we arrive at 'received wisdom' Proposition 2 that *agricultural expansion is substantially damaging wild biodiversity*.

The second specific claim is that ' Current patterns of agricultural land use based on limited numbers of species and varieties have also diminished the biological diversity within agricultural ecosystems and are undermining the long-term sustainability of agricultural production itself.' In this case, the 'received wisdom' Proposition 3 is that *a larger number of crop species and varieties thereby increase biological diversity and thus ensure agricultural sustainability*.

We now attempt to justify our designation of these three propositions as 'received wisdom' and discuss their relevance to the agriculture of developing countries.

**Proposition 1.** 'The Ecosystem Approach' is appropriate to address the conservation and sustainable use of biodiversity for the agriculture of developing countries.

Note that there was no mention of 'the ecosystem approach' in the text of the CBD. Where did the idea of 'the ecosystem approach' originate? And why was the emphasis on 'the' ecosystem approach, that is, a definitive approach, rather than several or many?

The source can be clearly identified in US Federal Policy. The first reference in the CBD implementation process was in September 1995 (CBD web site as SBSTTA 1). This was just 4 months after the publication of a major US Federal report promoting the ecosystem approach (Interagency Ecosystem Management Task Force, June 1995), and this report undoubtedly dominated the subsequent CBD decisions on the ecosystem approach. Thus 'the ecosystem approach' was indeed 'received wisdom'—directly received into a global forum from the specifically national context of US environmental policy.

*What is 'the ecosystem approach'?*

'The ecosystem approach' was originally designed by 14 partners of a US Interagency Ecosystem Management Task Force. These partners included the Federal Departments of Agriculture, Commerce, Interior, State and the Environmental Protection Agency. Their report argued that:

> The ecosystem approach is a method for sustaining or restoring ecological systems and their functions and values. It is goal driven, and it is based on a collaboratively developed vision of desired future conditions that integrates ecological, economic, and social factors. It is applied within a geographic framework defined primarily by ecological boundaries.
>
> The goal of the ecosystem approach is to restore and sustain the health, productivity, and biological diversity of ecosystems and the overall quality of life through a natural resource management approach that is fully integrated with social and economic goals (Interagency Ecosystem Management Task Force, June 1995)

*Why was it needed in the US?*

'The ecosystem approach' was needed in the US because of continual and damaging conflict between the state and private interests over natural resource management and exploitation. The US 'ecosystem approach' was specifically designed to protect the national economy. It introduced socio-economic considerations into what had hitherto been a judicial interpretation of environmental legislation.

'The ecosystem approach' was justified as follows:

> What we need now is a mechanism for coordinating the implementation of the many laws, programs, policies, and regulations that affect natural resources. We also need a mechanism for resolving conflicts that protects our national economy and the resources on which it is based. The ecosystem approach can help to bring about better coordination and to resolve conflicts in constructive ways (Interagency Ecosystem Management Task Force, 1995)

The significant issue for US policy makers was that the US in the past had introduced pioneer environmental legislation. As early as 1872 the Yellowstone Act established the Park 'for the preservation, from injury or spoilation, of all timber, mineral deposits, natural curiosities, or wonders' and their retention in their natural condition (Clark et al., 1996). However, two serious problems emerged from pioneer US environmental legislation, one on the rigid application of environmental laws; the other on scientific advances and implementation.

*The problem of rigid application of laws*

A rigid application of existing environmental legislation was damaging the exploitation of natural resources, and therefore the US economy. This was recognized in drafting 'the ecosystem approach':

> Rigid administration of some environmental laws without regard to human communities has in some instances resulted in community antagonism toward the environmental objectives contained in these laws. The ecosystem approach allows communities to become part of the solution to environmental problems. Federal agencies must and will implement environmental laws, but in a climate of cooperation rather than conflict. [Memorandum of Understanding on the Ecosystem Approach for 14 Federal Agencies]

The dispute between conservationists and loggers over the northern spotted owl was an example of the 'rigid administration' of US environmental laws. The northern spotted owl, strictly protected under the *US Endangered Species Act of 1973*, needed old-growth forest in which to nest. However, old-growth forest was commercially valuable to the timber industry. In this example, the US Endangered Species Act prevented the exploitation of renewable natural resources and threatened US economic interests. Up to 3 million ha of productive timberland had been withdrawn from logging to protect the northern spotted owl (Rochelle and Hicks, 1996).

There were further disputes over the effects of the *US Wilderness Preservation Act of 1964*. Federal lands needed 'protection in their natural condition' to allow land to retain 'primeval character and influence, without permanent improvements or human habitation'. Requirements were strict: 'there shall be no commercial enterprise and no permanent road within any wilderness area…there shall be no temporary road, no use of motor vehicles, motorized equipment or motorboats, no landing of aircraft, no other form of mechanical transport, and no structure or installation within any such area'. This definition of wilderness obviously excludes commercial development of natural resources. This has become an issue in Alaska, where 55% of the total US national designated National Wilderness Preservation System is found, on land once thought to be economically valueless. However, designated wilderness is now of potential value for oil extraction.

*The problem of scientific advances and implementation*

The second problem with US environmental legislation is its pioneer status. Even relatively new legislation,

for example, the Endangered Species Act of 1973, has become outdated as conservation science advanced. For example, great strides have been made in understanding the issues of conservation and perpetuation of biodiversity of fishes in the American West and Southwest since enactment of the Endangered Species Act. Case histories demonstrate that some success had been achieved, but at great cost in time and money (Rinne et al., 1996, p. 396). Indeed, the very terminology of 'the ecosystem approach' emphasizes the trend away from the conservation of individual species (the focus of the Endangered Species Act) towards understanding and managing ecosystems.

Clark et al. (1996) report that implementation of national regulatory or prohibitive policies like the Endangered Species Act have been stymied by a host of recurring weaknesses and implementation problems.

There were a series of problems with the *US National Forest Management Act of 1976*, which had a mandate to protect biodiversity. Even in the important and well-studied Greater Yellowstone Ecosystem (8.5 million ha. of land including and surrounding the Yellowstone National Park), problems ranged from incomplete scientific theory; inadequate causal linkages between forest activities and the conservation of biodiversity; Forest Service inertia; inadequate resources and incentives; lack of an ecosystem perspective; and finally, a lack of in-depth understanding and interpretation of biodiversity issues by the conservation community and biodiversity advocates (Clark et al., 1996).

Yellowstone is now a classic example of ecological mismanagement, most notably through a neglect of historical ecology and a misunderstanding of fire regimes (Keiter and Boyce, 1991). Yellowstone needed a continuation of historical fire disturbance to retain its biological value. The destructive fires of 1988 were made much worse by a build-up of debris that should have been controlled by regular small-scale and non-destructive burning. The knowledge base to underpin prescribed burning to reduce forest conflagrations in the US was there in abundance (Pyne, 1982). Yet influential environmental NGOs such as the Sierra Club prevented rational fire management of what they wrongly regarded as the pristine wilderness of National Parks.

## *'The ecosystem approach' in the CBD process*

There is now considerable confusion over what is meant by 'the' ecosystem approach. There are now two differing concepts of 'the ecosystem approach', one, which came first, from the US federal system, and a later one from the CBD process. It is no longer possible to talk of 'the ecosystem approach' without defining the context.

Even within the CBD process there was internal confusion over 'the ecosystem approach'. The SBSTTA meeting in 1999 (CBD web-site UNEP/CBD/SBSTTA/4/4) noted the following (our emphasis):

> Para. 11. .... A major challenge is for SBSTTA to develop a strategy that will find a balance between pursuing an *integrated ecosystem approach* demanded by the Convention and being focused enough to maintain its scientific accuracy....
>
> Para. 94. ... *The term ecosystem as used above to define the thematic areas is thus distinct from its use in the concept of the ''ecosystem approach'', which emphasizes human management considerations. The ecosystem approach is also different from the integrated approach which implies multi-disciplinarity*, as it also takes into account inter-linkages and synergies between components of biological diversity at genetic, species and ecosystem levels, as well as the ecological processes and interactions. SBSTTA may be able to provide advice, as required, *to avoid confusion and to ensure clarity in the use of terms and concepts*.

A series of meetings, much discussion, and a liaison group were needed to produce the following description (CBD web-site COP 5 Decision 6):

> The ecosystem approach is a strategy for management of land, water and living resources that promotes conservation and sustainable use in an equitable way.
>
> The aim of an ecosystem approach is to reach a balance of the three objectives of the CBD: conservation, sustainable use, and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources.
>
> An ecosystem approach is based on the application of appropriate scientific methodologies focused on levels of biological organization which encompass the essential processes, functions and interactions among organisms and their environment, and among ecosystems. It recognizes that humans, with their cultural diversity, are an integral component of ecosystems.

Although the CBD description of 'the ecosystem approach' (CBD web site—Programmes/Cross-cutting) begins with a series of science-based statements on the management of ecosystems, the fifth and final paragraph is notably different:

> 5. The ecosystem approach does not preclude other management and conservation approaches, such as biosphere reserves, protected areas, and single-species conservation programmes, as well as other approaches carried out under existing national policy and legislative frameworks, but could, rather, integrate all these approaches and other methodologies to deal with complex situations.

This statement makes it unlikely that any meaningful progress can be made by the application of 'the ecosystem approach'. It reinstates in a confusing way other approaches to conservation that are known from pioneer experience to have caused problems when embodied in US legislation (such as the Endangered Species Act, and the Wilderness Preservation Act).

This confusion has already been seized on by the upholders of the status quo (Pritchard, 2000): 'The idea that an urgent single-species programme, for example, could be rejected for funding because such a programme is not seen as fitting the "ecosystem approach", would surely be a bizarre consequence of a supposedly state-of-the-art set of pronouncements from the only global convention to deal with the whole of biological diversity. Adherence to an "ecosystem approach" as the dominant organising principle might be quite inappropriate in such cases.' The message here is clear; the ecosystem approach can and will be rejected if it clashes with special interests. Yet the original purpose of 'the ecosystem approach' in the US was precisely to integrate the various concerns of special interest groups, rather than allow any single one either to dominate or ignore the process.

There is yet another indication of future confusion and failure. The CBD begins to use the plural: 'ecosystem approaches' (CBD, 1999). This opens the door for continuing controversy about which ecosystem approach to apply and under what range of conditions: an operational nightmare.

### *Problems for developing countries*

There will be major problems if developing countries adopt 'the ecosystem approach' as their framework for the implementation of the CBD.

Firstly, the principle problem is that 'the ecosystem approach' is designed for *natural systems*, and not for agricultural systems. In the words of the executive summary of the US Task Force report (Interagency Ecosystem Management Task Force, 1995): 'The ecosystem approach is a method for sustaining or restoring natural systems and their functions and values.'…'The ecosystem approach recognizes the interrelationship between natural systems and healthy, sustainable economies.' For most developing countries, where agriculture is a major feature of total land use, the unbalanced focus of 'the ecosystem approach' on natural systems makes 'the ecosystem approach' a distraction from the major national problems of integrating agricultural development with biodiversity management.

Secondly, the constraints that 'the ecosystem approach' was designed to address were a direct and perhaps inevitable consequence of US environmental legislation that had become anti-development, dated, and, over time, unscientific. For example, the science supporting the 'wilderness' model for protected areas is suspect. The concept of 'wilderness' has been attacked as a myth (Gómez-Pompa and Kaus, 1992; Adams and McShane, 1992). Strictly protected 'wilderness' areas are increasingly seen as inappropriate in developing countries for technical, historical, and socio-economic reasons (reviewed by Wood, 1995). The 'received wisdom' of protected area and wilderness policy, depending on fences and fines, a static view of nature, and the exclusion of human activity, is now collapsing under the inevitable and dynamic socio-economic realities in developing countries. Southgate and Clark (1993) had warned of the problems of wilderness policy: 'an attempt to translate national parks, a rich country institution, to an alien setting'. This is the generic problem with 'the ecosystem approach': an attempt to globalize the environmental 'received wisdom' of a rich country through the CBD process.

Thirdly, as 'received wisdom' reworked within the CBD, the concept of 'the ecosystem approach' is now derivative and a recipe for confusion. For example, the US will continue to be a major source of funding for the implementation of the CBD, particularly through the Global Environment Facility, and also for international agricultural development. When US conservation institutions and consultants deploy internationally, they will follow their own national framework for 'the ecosystem approach' rather than that of the CBD.

### *Rejecting Proposition 1*

We can now *reject* Proposition 1 and suggest that 'the ecosystem approach' is *not* appropriate to the conservation and sustainable use of biodiversity and for the agriculture of developing countries. However, 'the ecosystem approach' is a good example of what we mean by 'received wisdom': an idea translated from a developed country to developing countries, where it is not appropriate. We suggest that, rather than trying to correct agri-environmental land use conflicts through a derivative 'ecosystem approach', countries lacking restrictive environmental legislation on the US model have the option to avoid such legislation, the inherent problems and costs of implementing legislation, and the high transaction costs of 'the ecosystem approach'.

**Proposition 2.** Agricultural expansion is substantially damaging wild biodiversity

Within the CBD process, COP 3 made a major review of agriculture and biodiversity. Annex 1 of COP Decision 3/11 (CBD web site) claims that: 'In recent

years, as the world's population continues to grow and agricultural production must meet the rising demand for food, agricultural expansion into forests and marginal lands, combined with overgrazing and urban and industrial growth, has substantially reduced levels of biological diversity over significant areas.' As with the 'ecosystem approach', we need to know more about this claim of reduced biological diversity: what is its parentage; is it generally true; and is it appropriate for developing country agriculture?

This pessimistic claim originated with, and is still promoted by, the international conservation movement. For example, Myers (1994) identified clearance for agriculture, driven by population growth, as the main source of deforestation in most biodiversity-rich tropical countries. A recent IUCN report (associated with fund-raising) repeated the claim that: 'agriculture, as currently practiced, represents a profound threat to wild biodiversity' (McNeely and Scherr, 2001). The similar claim in COP Decision 3/11 is clearly conservationist 'received wisdom'.

However, not only is placing all the blame on agriculture simplistic or wrong, as we go on to show, but the conservationist solution—more protected areas—is failing in its own objective of strict preservation through the exclusion of humans. For example, McNeely and Scherr (200l, p. 10) report that of the 17,229 major reserves, 45% are heavily used for agriculture. In the face of these failures of conservationist policy, McNeely and Scherr (2001), assuming that the march of agriculture over the landscape is unstoppable, recommend that wide expanses of agriculture itself should protect biodiversity through the mechanism of biodiversity-friendly farming: 'ecoagriculture'. Note that this change of conservation focus from biodiversity in protected areas to biodiversity in farmland is based not on conservationist successes in protected areas, but on admitted failures and the need to change emphasis and fund-raising strategies. Also note that protected area expansion continues: there has been a tripling of the world's protected areas over the last 20 years. The Durban Accord of the 2003 5th World Conservation Union (IUCN) World Parks Congress claimed an annual funding gap of US$ 25 billion needed for protected areas: *excluding additional resources required to expand protected area systems* from the present 12% of the World's land surface (IUCN, 2003) (our emphasis).

Both the 'protected area' and the 'ecoagriculture' solutions to biodiversity loss are premised on the replacement of forests and their biodiversity by the inexorable spread of agriculture as human populations rise. Yet there are two cogent reasons to suspect or even reject this generic neo-Malthusian belief. The first of these is the 'forest transition'; the second the 'agricultural transition'.

### *The forest transition*

Mather and Needle (2000) have reviewed the complex relationship between population and forest cover over time and over a range of countries. They showed that only one quarter of the variation in forest change is statistically explained by variation in population trends. Further, and *contra* to the COP 3/11 claim, stability of forest area can apparently be achieved without stability of human populations.

In a striking relationship in Europe, prior to the nineteenth century the trend to forest loss tended to reflect population growth. However, during the nineteenth century, deforestation gave way to reforestation, usually during periods when population remained high. This is termed the 'forest transition', indicating 'that there is no permanent, rigid, or deterministic rule linking population and forest trends' (Mather and Needle, 2000). This transition was also found in the tropics. Forest cover increased from a low of about 9% on Puerto Rico in the early 1900s to nearly 35% in the 1980s, a result of industrialization. Forests spread by natural regeneration on abandoned cropland. This demonstrates that tropical forests are resilient and that deforestation is reversible (Kangas, 1997). Even with high population growth in India, from the 1970s Indian forest cover increased by 3,900 $km^2$ (Nair, 2001), partly in the extra-tropical Himalayas.

Boserup (1965, pp. 117–118) argued that population growth caused the increased adoption of more intensive systems. With a specific focus on population and forests, she argued that: 'By the gradual change from systems where each cultivated plot is matched by twenty similar plots under fallow to systems where no fallow is necessary, the population within a given area can double several times without having to face either starvation or lack of employment opportunities in agriculture'. This refers to the need for long fallows under shifting cultivation on poor soils, the need to clear forest repeatedly, and the extremely low yields for the total field/fallow systems, with a low human carrying capacity.

Indeed, rather than high human populations, it is *low* human populations that have the greatest effects on forest, as farmers convert trees into fertilizer by burning, a standard feature of shifting cultivation on poorer soils. Allan (1965) noted that most of the vast forest of the Congo basin is now secondary growth. Yet in Equatorial Province of the former Congo, the general population density appeared to be very low—about 10.5 per square mile. Soil nutrients are a critical determinant of population density. On the African mountains Kilimanjaro and Elgon, with volcanic soils and intensive agriculture, population densities are estimated at 400 and 600 per square mile, respectively (Allan, 1965) and considerable forest remains.

Also, smallholders reduce their pressure on land when they begin to earn significant amounts of non-farm income: forest recovers through farm de-intensification (Preston, 1989). In addition, forest may spread into arable land as a result of large-scale human migration. Notable examples are the abandonment of farming in New England when prairie agriculture developed, and the return of Mediterranean terrace agriculture to scrub and forest, associated with emigration from Italy and Greece to North America.

Furthermore, the Proposition 2 argument—that agriculture replaces forests—is deceptive for most tropical and sub-tropical regions. It implies that existing forests have always been a permanent feature of the landscape. Yet in most regions the forest-grassland boundary is fluid. It depends in part on abiotic factors such as past and ongoing climate change (particularly desiccation and associated natural burning) and in part on herbivores large and small.

Also, human influence on forest may be cyclical. Even over historical time, it is now widely recognized that much forest in tropical and sub-tropical regions is not 'pristine' (Denevan, 1992) but is a result of recent forest spread into agricultural land. A decade ago, the extensive evidence of this overrunning of fields by forests was reviewed by Wood (1993). There is now striking evidence of 'saturated anthropogenic landscapes' in the Upper Xingu region of the Amazon basin, where large, densely settled, and integrated regional populations flourished over the past 1000 years in a region now forested (Heckenberger et al., 2003). Evidently, in the Amazon region and elsewhere, the present extent of forest is often greater than in pre-colonial times. There are at least two reasons for this. Firstly, colonial powers prevented the routine traditional woodland burning that was an effective ecosystem management tool of hunters, pastoralists and forest farmers. Secondly, with colonial contact, human populations crashed through disease and slavery: forests then expanded into abandoned fields. In a critical review of the 'crisis' in ecology, Stott (1998) noted 'our continuing obsession with 'forests'—and the ever-asserted 'evils' of deforestation—causes us to ignore the whole ecological history and pattern of the Earth'.

Finally, the attempt to relate forest loss to population increase does not point to a solution (other than the difficult one of reducing human population). In contrast, in an overt recognition of the value of agriculture, Mather and Needle (2000) relate forest trends to crop yields: 'Most of the countries in which yields have increased faster than population are characterized by forest expansion or stability', whereas 'Most countries with population growth in excess of yield increase have shrinking forests'. This relationship offers an agricultural solution, intensification, to the pessimistic (and demonstrably wrong) neo-Malthusian scenario in Proposition 2 that population increase always drives deforestation.

### *The agricultural transition*

Critically, Proposition 2 ignores technical innovation in farming: it rests on the central assumption that agricultural production can only rise by expansion in area, with a consequent loss of biodiversity. This is incorrect.

A recent speech by the President of India (2003) shows the positive environmental policy implications of yield increase in crops.

> The production of cereals [in India] needs to increase from the present 200 million tonnes to over 300 million tonnes by 2020 in view of population growth. But the requirement of land for the increasing population as well as for greater afforestation and environmental preservation activities would demand that the present 170 million hectares of arable land would have to be brought down to 100 million hectares by 2020. All our agricultural scientists and technologists have to work for doubling the productivity of the available land with lesser area being available for cultivation.

The expectations of the President are based on a simple idea: if we double crop yields we need only half the land for the same level of food production. Yield increase is a specific target of agricultural research and development. Progressive yield increases of staple crops have been an outstanding success in a range of developing countries (Hafner, 2002).

There is now extensive evidence for the view that yield-increasing agricultural technology has already allowed substantial 'land-saving'. Specifically, the world used about 1.4 billion hectares of land for crops in 1961 and only 1.5 billion hectares in 1998 to get twice the amount of grain and oilseeds. If agricultural technology had been frozen at 1961 levels, cropland would have had to increase from 11% of the planetary surface to 25% to produce the same amount of food as now (Goklany and Trewavas, 2003).

For all agricultural areas (that is, including grazing) the figures for 'land saving' are much greater. Goklany (1998) estimated global agriculture to need 4.4 billion ha of land in 1961. This increased by only 0.38 billion ha to 4.8 billion by 1993. Without the development of agricultural research and technology, this 4.8 billion ha would have increased by at least 3.5 billion ha—the land area needed to feed our 1993 population at 1961 yields. This 3.5 billion ha 'saved' land was divided between 0.97 billion in crops and 2.58 billion ha in pasture.

For the world as a whole, land productivity has nearly tripled since 1950. Increased yields through

intensification allowed Western Europe, the United States, and Oceania to withdraw about 41 million hectares from agricultural production since 1966 (GEF, 2002). Over half a century, the US reduced its cropland from 478 million acres in 1949 to 431 m acres in 1997 (Hart, 2002). If this success could be repeated in Africa, Latin America and India, land could be saved for wild biodiversity.

Despite the opportunity to save land, a conference report (Anonymous, 1995) noted that the concept of agricultural intensification was virtually absent from environmentalist agendas. Unfortunately, the simple and demonstrably effective agricultural success of land-saving by increasing yields continues to be ignored by those wishing to conserve biodiversity. Yet land saving is an outstanding and quantifiable success of agricultural research and farming compared to the comparative failures of protected area policy.

*Rejecting Proposition 2*

We can now *reject* Proposition 2 and argue that agricultural expansion is *not* substantially damaging wild biodiversity. The dubious package of 'received wisdom' on which Proposition 2 is based was put forward as generic truth: population rises; agriculture therefore expands in area; forests and valuable biodiversity are therefore lost. In fact these arguments are not generally applicable and would be dangerous if applied to land use policy. The literature on the forest transition clearly demonstrates that population increase is not necessarily accompanied by deforestation. Further, as the agricultural transition demonstrates, one common and effective solution to pressure on land and forest is agricultural intensification. We suggest that agricultural intensification, coupled with land-saving, is the most biodiversity-friendly policy response of developing countries to population pressure.

**Proposition 3.** A larger number of crop species and varieties thereby increase biological diversity and thus ensure agricultural sustainability.

This 'received wisdom' claim linking crop diversity with biological diversity and in turn with agricultural sustainability or stability is longstanding and pervasive. It is based on ecological thinking of 50 years ago which causally linked vegetational diversity with ecological stability (Odum, 1953; Elton, 1958). This 'appealing generalization' (so termed in a review by May, 1999: 1954) became a central tenet of the new discipline of 'agroecology', centred in North America (Gliessman, 1997). From its source in North America, agroecology has been widely promoted for developing countries (Altieri and Hecht, 1990; Altieri, 1999, 2002). However, many of the approaches now recommended by agroecologists are either already a usual part of traditional agriculture (for example, cereal-legume intercropping and the use of manure) or else already firmly part of mainstream agricultural research (for example, Integrated Pest Management and minimum-tillage).

Note that the wider role of biodiversity in agroecosystems is not relevant to the specific discussion of Proposition 3 on crop diversity (and this wider role has already been treated in depth by Paoletti et al., 1992; Collins and Qualset, 1998; Wood and Lenné, 1999; and Büchs, 2003). Also, the often-complex interface between fields and wildlands is outside this discussion. We are here challenging the belief, expressed in the CBD process, that sustainability depends on biological diversity supported by a large number of crop species and varieties.

To be of value to farmers under a range of conditions, the claimed relationship between biological diversity and sustainability needs to be of general application. There is increasing evidence that this is not so. A recent review noted that controlled experiments were needed to directly address the question of stability in systems of varying complexity; that there were few concrete examples of such work; and that many previous arguments were based on anecdotal evidence (Fowler and Lindström, 2002). Yet the uncertain facts of these anecdotes are now driving CBD policy.

*Stable simplicity?*

Ecologists have repeatedly challenged the supposed general relation of diversity to stability. For example May (1976:159) notes that the relationship: 'has tended to become part of the folk wisdom of ecology'…'despite there being many examples of simple natural systems that are stable and of complex ones that are not'. Lawton and Brown (1994, p. 276) indicate that: 'the notion that species richness is generally essential for the smooth running of ecosystems cannot be supported by a list of good model studies. As often as not, ecosystems appear to contain numerous redundant species'. Sankaran and McNaughton (1999) specifically warn against concluding that species-rich ecosystems will necessarily 'cope' better than species-poor ones in the face of perturbations. In a review of a recent experiment, Naeem (2002) reported that when challenged with an experimentally induced drought, species-poor communities were both more resistant and more resilient (as reflected by their ability to sustain and recover pre-drought biomass production) than experimental plots of higher species diversity.

In a review of four recent papers on diversity related to ecosystem function, Cameron (2002) warned that their findings highlighted the importance of rigorous testing of general ecological theory before recommending it for use by habitat or population managers. In an

important finding for agriculture, 'biomass production in species-poor ecosystems was reduced less following perturbation, and returned to pre-perturbations levels faster, than [it] *did* [in] *species-rich ecosystems*' (Cameron, 2002).

Cameron (2002) then asked if increased production and its relationship with ecosystem stability could be exploited to promote more appropriate habitat management strategies, and sustainable biodiversity. He suggested not, because of the species-specific effects and the complexities of indirect interactions between biomass, decomposition, competition and predation. This was especially the case in disturbed ecosystems, which contain introduced species that can monopolize ecosystems when released from natural enemies and competition for resources. Note that most crop production in developing countries is very sensibly from introduced crops, which have escaped many of their co-evolved pests and diseases (Wood, 1988).

The lessons for agriculture in recent ecological research is that claims relating biological diversity to sustainability are naïve, simplistic, or quite wrong. Unfortunately, a characteristic feature of 'received wisdom' is that it is: 'the sort of thing that people like, and want, to believe' (Goodman, 1975, on the diversity–stability hypothesis). As a result of this 'wish to believe', those wanting to apply ecological principles to agriculture have disregarded the continuing uncertainties in the ecological debate. For example, Dahlberg (1979, p. 153) claimed that '…we know that in natural ecosystems greater diversity is highly correlated with stability…' and then went on to recommend greater diversity for agriculture. Conway (1997, p. 178) makes the same claim as Proposition 3: 'the importance of maintaining and, wherever possible, enhancing diversity. More diverse agroecosystems tend to be more sustainable and, often, more productive than systems which are otherwise comparable'. Wood (1998) argued that this was a selective, or even erroneous, application of supposedly ecological principles to farming.

Recently, this view relating agricultural diversity to sustainability has been further challenged using natural ecosystems as models. Many sources of evidence indicate that close wild relatives of Old World cereals (rice, wheat and sorghum) form naturally monodominant vegetation (Wood and Lenné, 2001). The existence of these 'Nature's fields' of dense stands of the immediate relatives of crops provides an obvious, but totally neglected, ecological model for cereal fields. For example, in the Near East centre of origin of wheat, Harlan (1992) noted that 'massive stands of wild wheats cover many square kilometres'. These 'natural monocultures' can be extensive, have been likened to fields, and appear to persist. Significantly, early human settlements of the pre-agricultural Natufian culture of the Epipalaeolithic in Palestine were located to take advantage of the distribution of wild cereals. Many fields of wild cereals were 'as productive as are varieties of durum and barley planted in ground prepared by a wooden plough' (Hassan, 1977).

The existence of 'natural monocultures' undermines the argument that vegetational diversity is necessary for ecological stability and 'sustainability'. Rather than agriculture denuding vegetational diversity over time, cereal agriculture seems to closely mimic natural monodominant and persistent vegetation of crop wild relatives. Indeed, Harlan (1977) makes a specific link between domestication and natural vegetation: 'the area containing the most massive stands of wild sorghum …was the nuclear area for sorghum domestication'. Yet, despite the apparent 'naturalness' of cereal monoculture, agroecological approaches reinforce the mistaken 'received wisdom' of COP 3 and argue for 'breaking' monoculture agriculture (Pimbert, 1999; Altieri, 1999).

### *Unstable complexity?*

In contrast to the seeming ecological stability of 'natural monocultures' of crop relatives, the same stability cannot be identified in complex cropping. Indeed the supposed stability and sustainability of complex cropping systems has never been unequivocally demonstrated. History is rich with examples of crop failure due to pests and diseases in diverse cropping systems (Lenné and Wood, 1999; Lenné, 2000). The devastating effects of locust plagues and wheat rust epidemics on crop production are graphically described in the Bible—a time when farmers grew a great diversity of landraces. Similarly, wheat rust epidemics in India during 1850–1950 and groundnut rosette virus epidemics in Sub-Saharan Africa since 1900 have resulted in 27 major famines and 15 destructive epidemics, respectively, in traditional, diverse cropping systems. For peanut, sorghum and millet in Nigeria and sorghum and millet in Kenya: 'disasters have occurred despite the fact that the crops were growing in polycultural or rotational systems, demonstrating that devastating pest and disease outbreaks can occur even under these traditional systems' (Goldman, 1996).

The most dramatic collapse of complex mixtures of crops and varieties is found with one of the most complex: tropical swidden (slash-and-burn or shifting cultivation). In shifting cultivation, a complex of annual and perennial crops are planted into a forest plot cleared by dry-season burning. But the resultant polycultural (and structurally complex) plot results in an unstable cropping system, one that breaches the limits of manageability. As with all swiddens, weeds invade and suppress the crop. A long period of fallow is needed to restore soil fertility and suppress weeds (swidden

systems are traditionally fully organic, with no use of pesticides or synthetic fertilizer).

Generic prescriptions to 'break the monoculture' (on the argument that this would make cropping more natural and sustainable) have ignored the evidence provided by Geertz (1963, p. 25–26). The high crop diversity characteristic of shifting cultivation (swidden) is associated with substantial agroecological fragility, with a collapse of fields or even forest ecosystems. Significantly, one of the ecological states to which forest collapses is a persistent 'natural monoculture' of the grass *Imperata cylindrical* (Geertz, 1963, p. 28). This collapse to a simpler state is explained by recent ecological thinking which indicates that complex ecosystems tend to be more dynamically fragile than simpler systems (May, 1999).

Geertz's early insight into the collapse of complex vegetation is now confirmed by research on plant competition. It is difficult or impossible to predict the effects of competition on the dynamics of plant populations with a high degree of certainty (Firbank and Watkinson, 1990). Models of the dynamics of competing species differ from place to place and from year to year. Long-term studies on the role of species in ecosystems indicate that effects are complex, nonlinear and difficult to predict on the basis of ecological theory or short-term empirical studies (Brown et al., 2001). It has been noted that the winners of multispecies competition can be as unpredictable as the throw of a dice (Huisman and Weissing, 2001).

Clearly, agricultural policy that recommends crop diversity needs to be re-assessed. Species-diverse natural models are not always useful, and the fragility, unpredictability, or unmanageability of species-diverse fields could threaten the food security of resource-poor farmers.

### *Other factors determining biodiversity*

To be generally valid, the ecological assumption that more crop species and varieties ensure sustainability must exclude other reasons for farmers adopting complex cropping. Yet biodiversity is only one of many factors that influence ecosystem process, and a myopic focus on diversity alone would be a poor management strategy for agriculture (Tilman, 1999). For example, plant biomass of a single dominant species may be more important than species diversity in driving ecological services (Marks and Bormann, 1972). The most important crop production system in the world is monoculture irrigated rice. Here the main determinant of biodiversity is the biomass of crop detritus. This encourages plankton and a build-up of predators, thus protecting the rice crop from pests and maintaining associated biodiversity based on biomass (Settle et al., 1996). Note that even in species-rich vegetation, most of the plant biomass may reside in a small number of dominant species, 'the characteristics of which are likely to override as ecosystem controllers the effects of more numerous subordinate or transient components' (Grime, 1998, p. 907). However, biomass, and therefore ecosystem control, is readily managed by farmers. Biomass can be readily increased in fields by nutrient application and irrigation, and maintained by no-till farming.

Also, in all but the most equable ecosystems, abiotic determinants of biodiversity may be far more important than biotic interactions. This point was made by Huston (1997): while the increase in productivity resulting from species diversity in high diversity experimental systems was only 10–20%, productivity increases of 300% could be gained simply by the addition of nitrogenous fertilizer. (In other words, if we wish to save land through agriculture, it could be far more effective to add fertilizer than to intercrop different species.) Furthermore, variation in plant productivity globally was related to resource availability, rather than species diversity. For example, under experimental conditions root competition can cause a decline in species diversity under conditions of increased nutrient availability (Rajaniemi et al., 2003). Huston (1997) concluded that 'the fact that the Earth's most productive systems generally have low plant diversity while high plant diversity is found under much less productive systems demonstrates that the number of plant species has relatively little effect on productivity'.

Stott (1998) noted that the 'driving forces of abiotic change must therefore be regarded as the norm, and not the internal adjustments of biological systems'. In an extensive review of the relationship between biodiversity and ecosystem functioning, Loreau (2000) showed that the effects of environmental parameters systematically masked the local effects of biodiversity on ecosystem processes in across-site comparisons. Indeed, intensity and frequency of disturbance may serve as the main environmental control upon diversity (Gould, 1976, p. 221). Further, environmental change, rather than diversity, may be the primary impact on ecosystem functioning (Loreau, 2000, p. 10). Under these views, the abiotic environment (climate, irrigation, nutrients, and physical disturbance events such as fire) may prove more important to plant productivity than biodiversity interactions in plant communities. Controlling and modifying this abiotic environment has been a characteristic of agriculture since the use of fire, the digging stick, and early irrigation.

In addition, in many cases it is more likely that socio-economic, rather than ecological factors, are the significant determinants of home gardens and other multi-use, multi-crop, complex agricultural systems. For example, home gardens are universally regarded as biodiverse and therefore ecologically appropriate

sustainable systems (Conway, 1997). However, proponents of home gardens fail to exclude other valid reasons for species diversity—the first of which is the provision of a wide range of food and medicine throughout the year from a small plot of land.

Also, there may be historical, rather than ecological, reasons for the prevalence of biodiverse gardens. For example, in a synthesis of the politics of colonial control and the geographic setting of agriculture in South East Asia, Hayami (2001) showed that gardens in hilly forested areas of the Philippines and Indonesia are a rational response to the spread of colonial plantations on lower and better land which dispossessed peasant farmers.

### *Rejecting Proposition 3*

The scientific debate over diversity and stability has 'see-sawed' between the thesis that diversity begets stability, and the antithesis that diversity leads to instability or is irrelevant (Naeem, 2002). However, policy advice for agriculture in developing countries quite ignores both this unresolved ecological debate and also the several other socio-economic and historical reasons for biodiversity in fields and until recently has universally recommended 'biodiversity for sustainability'.

Major institutes advising or controlling agricultural policy have adopted this dangerous position linking species numbers to sustainability. For example, the World Bank equated agriculturally sustainable development with 'increasing the productivity of complex (as opposed to monoculture) farming systems…' (Johnson, 1998). The World Resources Institute argues for a paradigm shift in agricultural research to promote biological complexity, with a move from an emphasis on uniformity and monocultures (Thrupp, 1998, p. 40). There are strong claims from agroecologists that eco-agriculture based on complexity is the way forward (Altieri, 1999; McNeely and Scherr, 2001). The CBD process itself, as we have demonstrated, has adopted dogmatic 'received wisdom' on the topic. Given the usual time-lag before policy catches up with research findings, developing countries will need to be aware of the uncertain nature of calls for agricultural complexity supposedly based on ecological principles. Any policy advice to diversify must therefore be based on transparent reasoning over a range of disciplines (including socio-economic) and not just on the ecological dogmas of the past repeated to obtain institutional funding.

We can now *reject* Proposition 3 and suggest that a general relation between crop and varietal diversity and agricultural sustainability has *not* been demonstrated. Basing agricultural policy on this supposed ecological relationship could compromise agricultural productivity in developing countries.

## Re-forging the CBD

Having rejected three propositions based on 'received wisdom' from the CBD, we now discuss the services that agriculture can provide for biodiversity and the conditions under which agriculture can sustain biodiversity. These agricultural services are proposed as solutions to a generic problem with the CBD: its stated dependence on ecology and 'the ecosystem approach'. However, mainstream ecology is subject to ongoing criticism and is now an uncertain basis for international land use policies. For example, Hobbs and Morton (1999) note the 'turbulence in ecology' and the 'radical changes in fundamental paradigms'. With more detail, Stott (1998) identified what he called 'false ecologies' within ecology. Stott argued that three deeply flawed key signifiers of false ecology remain so powerful that they continue to override what 'real' ecology actually tells us. These signifiers were the 'hegemony of Europe and North America', the 'hegemony of forest ecology'; and the 'hegemony of equilibrium notions' in ecology.

Unfortunately, all three of Stott's 'signifiers of false ecology' are clearly evident in the implementation of the CBD. Indeed, all three correspond closely to the flawed 'received wisdom' propositions we criticize above:

- The 'ecosystem approach' is an example of the transfer of inappropriate North American ideas to developing countries.
- The conservationists' belief that agriculture spreads inexorably into forested lands is a result of the 'hegemony of forest ecology'.
- The questionable notion of equilibrium in complex communities now constrains the key role that simple yet dynamic agriculture can play in the implementation of the CBD.

### *Three biodiversity-friendly services of agriculture*

We now attempt to step beyond the 'received wisdom' and 'false ecologies' on which CBD implementation is now based and return to the 'real' ecology of agriculture. This approach builds on agriculture as a major productive and historical land use and as a major human response to change. This is an 'agricultural development approach', rather than an 'ecosystem approach', to biodiversity-friendly land management. It is based on the knowledgeable management of functional diversity in farming, rather than biodiversity maximization.

Specifically, we suggest future emphasis on three services that the practice of agriculture can provide to the CBD, none of which compromises food security, and all of which are biodiversity-friendly. These are:

- a greater emphasis on productive agriculture to save land for wild biodiversity (our main defence of agriculture under Proposition 2);

- a greater focus on the ecology of non-equilibrium systems (of which agroecosystems are the most important examples as the source of most of our food);
- the great contribution that the enormous knowledge base underpinning traditional and formal agriculture can make to 'land-management for biodiversity' in developing countries.

*Land saving*

The agricultural miracle of the past four decades is that today's farmers are feeding almost twice as many people far better from almost the same cropland base (Pardey and Beintema, 2001). Since 1960 there has been a very close relation between world population and global average cereal yields (Evans, 1998, p. 226). Land-saving in developing countries is most easily obtained through improved agriculture, in particular, the appropriate application of fertilizers, irrigation, plant breeding, and a range of pest control technologies. Improved agriculture is demonstrably successful: agricultural intensification had fed more people at lower cost than ever before. Also, as a result of 'land-saving', vast areas can now be used for the conservation of wild biodiversity rather than being ploughed under or overgrazed. In a recent review, Evans (2003, p. 84) argues that agricultural intensification has saved at least 1.4 billion hectares, one-third of the present forested area. Evans then asks: 'Is that not a huge contribution to sustainability and the preservation of biodiversity?'

In this quantifiable view, biodiversity conservation and ever more productive land use through agricultural and forestry intensification are interdependent, rather than in conflict. Indeed, for Africa, where about half the production gains over the past 40 years have come from expanding the area of cultivation (Pardey and Beintema, 2001, p. 2), agricultural intensification seems to be essential for saving land for wild biodiversity. In contrast to the large inefficiencies of protected area management (only 1 per cent of forest protected areas were managed securely—IUCN, 1999), agriculture can offer biodiversity conservation these quantifiable benefits of land-saving. The argument for intensification also applies to high-yielding plantation forestry in developing countries. Over the next 50 years the expectation is that 'huge volumes of wood will be provided from relatively small areas of land…. Most of the world's natural forest will be left for other purposes' (Sedjo, 2001).

*Focus on non-equilibrium systems*

'Conservation' and 'sustainable use' of biodiversity are two principle objectives of the CBD. Notions of equilibrium in ecology (with the consequent rejection of the annual cropping that produces most of our food) compromise both of these objectives. Already, abuses have stemmed from conservation policies rooted in the belief, held by policy-makers and scientists alike, of a 'balance or equilibrium-tending of nature' (Zimmerer, 2000). Zimmerer claims that the once-abiding belief in a 'balance of nature' is deeply questioned, and, in many quarters, rejected outright. Earlier, another geographer claimed '… to have grown more and more suspicious of any biogeography or ecology of the land from which man is thought of as eliminated as a factor of major importance' (Sauer, 1958). But, more dangerously for agriculture in developing countries, the belief in 'nature-tending-toward-equilibrium' is still the primary basis for myriad types and coverage of conservation areas—hallmarks of what Zimmerer terms the present-day 'conservation boom' and its associated social abuses and resource-grabs (Zimmerer, 2000, pp. 356–358).

Furthermore, outdated 'received wisdom' and the mistaken notion of equilibrium in ecological systems may jeopardize the sustainable use of biodiversity through agriculture in an ever-changing world. Indeed, Stott (1998) argues that the 'inevitable application of equilibrium solutions (under the guise of sustainability) to a non-equilibrium world may finally prove to be the very worst chimera of them all, and, in continents such as Africa, it could even be regarded as a criminal act'. Agriculture, by its nature, is non-equilibrium. In traditional systems, rangelands in arid and semi-arid tropical and subtropical zones are increasingly seen as non-equilibrium systems (Lambin et al., 2001). Shifting cultivation in tropical forest involves 500 million people on 8.3% of the world's tropical land area (Lanly, 1982) and produces a mosaic of successional stages as forest regrows in transient fields. In concluding a major review of traditional farming, Brookfield (2001) wrote that…'the notion of long-term equilibrium in small-farming systems is invalid. Wherever we explore the past, we find that change has been a constant condition.' In most crop production systems, traditional and modern, the disturbance and re-establishment of annual cropping produces most of our food and all our cereals.

Despite the pointed criticisms of Stott and Zimmerer, and despite using the term 'dynamic complex' in its definition of ecosystem, the CBD does not take full account of changes in ecological thinking that now address the ubiquity of non-equilibrium systems. Consequently, the CBD cannot accept the positive role of agriculture as the prime example of successful non-equilibrium land-management. Yet agriculture is the largest mechanism of biological renewal through human agency: it is economically self-sustaining as long as it produces food.

*Agricultural research and knowledge base*

The essence of agriculture is the management of agricultural biodiversity (Collins and Qualset, 1998; Wood and Lenné, 1999). This biodiversity comprises not just *productive* biodiversity (crops and livestock), but *resource* (beneficial) biodiversity (e.g. pollinators, biocontrol agents, soil nutrient-cycling organisms) and *destructive* biodiversity (weeds, pests and pathogens: Swift and Anderson, 1994). The knowledge base generated from research on the great range of organisms important to farming is enormous, relevant, and readily transferable to biodiversity-friendly land use. For example:

- Most of what we know of the great biological riches of the soil is a result of agricultural research.
- The knowledge-base that agricultural scientists have generated for weed control, including biocontrol, can address current concerns over the impact of invasive species on wild biodiversity.
- The great need for information on the control of the major crop pest, desert locust, in Eastern Africa, produced information on migratory patterns in insects; physiology; breeding behaviour; control measures; bioclimatology; and the ecology of desert vegetation, all valuable for dryland biodiversity conservation.
- The vast research effort on biology and epidemiology of crop pathogens such as the potato blight fungus, *Phytophthora infestans* can be applied to protecting wild vegetation. A related species, *Phytophthora cinnamomi,* is responsible for 'dieback' in more than 50 botanical families of natural forests in southern Australia (Newhook and Podger, 1972).
- The expanding use of wild relatives in crop breeding programmes has generated research information on biology, disease resistance, breeding systems, genetics, distribution, archaeology and ex situ and in situ conservation of relatives of important crops (Lenné and Wood, 1991; Cox and Wood, 1999).
- Agricultural research pioneered a wide range of techniques for the design and statistical analysis of field experiments. Long-term experiments characteristic of agriculture are now of value to plant ecology. Indeed, the fact that under limiting resources a single species can be the superior competitor in vegetation (Tilman and Lehman, 2001) provides an ecological justification for the use of monocultures by farmers.

*Conditions under which agriculture can sustain biodiversity*

There are major differences between developed and developing countries (and even within countries) as to the value of biodiversity in agriculture. The problem of valuing biodiversity is now compounded by the very large agricultural subsidies in some developed countries (coupled with great agricultural over-production) and low percentage of populations actually farming. As subsidies are progressively de-linked from agricultural production, some other yardstick is needed to justify payments to farmers. Unfortunately, 'biodiversity' and 'ecology' have been assigned as the yardsticks for farming and a justification for subsidies. This is particularly so in Europe, where there is substantial funding for attempts to increase biodiversity in fields. There may even be the belief that this will ensure agricultural sustainability (Paoletti et al., 1992; Büchs, 2003).

Biodiversity then becomes the proxy for 'sustainability': more biodiversity is favoured on farm; five-beetle agriculture is somehow better than three-beetle agriculture. Weeds are a sign of success, rather than of bad farming. Note that this is a political valuation, rather than an ecological or agricultural one, and a valuation that depends on vast funds being available to support biodiversity management by the relatively low population of farmers in temperate developed countries. It may be that such countries have reached or breached the limits of biodiversity-friendly intensification with the overuse of fertilizers and pesticides. They certainly have crop overproduction; large urban populations; skilled advocates for wildlife conservation and biodiversity-based leisure pursuits; and a naturally depauperate wild and farm biodiversity. Hence it makes sense to have what Zadoks (1999) calls 'integrated agriculture' with cleaner production, a less polluted environment, the restoration of biodiversity, better nature conservation, pleasant landscaping and recreation opportunities for townspeople (townspeople who pay taxes for this: OECD subsidies for agriculture are now $1billion a day—Lele, 2002).

However, there are great differences in the needs of agriculture and biodiversity conservation between Europe (or North America) and most developing countries. These differences preclude the transfer to developing countries (through the mechanism of the CBD) of northern ideologies on sustainable land management and northern valuations of biodiversity.

In direct contrast to agriculture in richer countries, in many developing countries there are no possibilities of vast agricultural subsidies; low levels of agricultural inputs such as fertilizer; no over-production (rather the reverse); large rural populations; no political constituency or funding for biodiversity in fields (rather the reverse, as elephants and locusts damage crops); yet substantial wild biodiversity off-farm.

Given these differences, if biodiversity conservation is not to become an unsustainable burden to developing countries, the driving force of productive and economically viable agriculture must be given greater recognition during the implementation of the CBD. The

development context must be explicit. Otherwise, the 'false ecologies' of biodiversity conservation will threaten human lives (and, as we suggest above, threaten biodiversity itself through inefficient land use).

In developed countries, the problem of how to relate agriculture to the environment (and biodiversity) has long been recognized. For example, Tinker (1988) contrasted two possible scenarios for European crop production:

- *Either* with all high potential areas used for 'efficient intensive farming…avoiding the grossest forms of environmental damage' combined with 'low-productivity areas supported by Government for mainly environmental objectives';
- *Or* with all crops grown under 'less-intensive agriculture'

Tinker's first scenario foresees intensive farming, which would take pressure off low productivity areas to be used for environmental conservation (Tinker, 1988). From our arguments above, this would seem to be a win-win approach suitable for developing countries. Yet, rather than this sensible interdependence—high potential areas for food security and low-productivity areas for biodiversity—Tinker's second scenario, all round 'less-intensive agriculture', is being urged on developing countries in the name of sustainability and biodiversity conservation (Thrupp, 1998). But combined with 'less intensive agriculture', developing countries are *also* expected to meet Tinker's first objective for 'low productivity areas supported by government…' Indeed, many developing countries already have substantial such areas locked-up in nature reserves (IUCN, 2003). This combination of less-intensive agriculture and large nature reserves would seem to be an economically unsustainable lose-lose scenario for both agriculture and biodiversity conservation in many of the poorest developing countries.

Our major concern is that the 'false ecologies' of the CBD are being used to justify the second policy scenario—less intensive production—for the agriculture of developing countries, with the belief that this approach will favour biodiversity and somehow ensure 'sustainability'. We disagree with this supposedly ecological approach and have given our reasons above. We firmly recommend to developing countries the first policy scenario—agricultural intensification—as essential for both quantifiable increases in food security and also to save land for the conservation of wild biodiversity off-farm.

## Conclusions

To promote biodiversity-friendly agricultural development, the CBD process must adjust or abandon current 'received wisdom' and a predominantly negative view of agriculture. At first, a focus on agriculture to save biodiversity may appear as a paradox, but it follows inevitably from our reasoning above. A greater focus on the 'three services' provided by agriculture—land-saving; dynamic landscape management; and the use of an extensive natural resource management knowledge base built up for and through farming—would allow developing countries to meet the requirements of the CBD for both the conservation and also the sustainable use of biodiversity. Further, an indirect approach to biodiversity conservation through the 'three services' of productive agriculture has advantages to developing countries. Such a focus on agricultural services is overtly development-oriented. It can sustain low prices for food—of great importance to the poor (IFAD, 2001). It allows a biodiversity-friendly option to developing countries: increasing crop yield through science rather than clearing forest from hunger. The 'agricultural development approach' can thus better serve the needs of the CBD for conservation *and* sustainable utilization by combining the conservation of productive biodiversity in agroecosystems, land-saving for the conservation of wild biodiversity, and, importantly, food security.

Attempts to manage agriculture and biodiversity through dubious ecological precepts should give way to 'biodiversity management through productive agriculture'. Some of the technology of this approach will be based on the skill and experience of traditional farmers in dynamic land management. But it also includes the great increases in land productivity made possible by agricultural research and advanced farming. Critically, we recommend that the past erosion of international support to agricultural development should be reversed and that development funding should be re-directed to improving agricultural productivity in order to support and sustain biodiversity.

We conclude with five quotations. All indicate that the dynamic management of biodiversity through agriculture is preferable to locking up large areas of the Earth's surface in unproductive protected areas that are even failing to protect biodiversity. The last quotation—describing a time of agricultural origins—offers hope that human ingenuity can again manipulate biodiversity to benefit from climate change.

- '… the old face of the land had received many of its essential traits from old land uses which had acted as ecological factors since time immemorial, some for thousands of years…. It is quite clear today that the rural Sweden of olden days owed most of its hospitable features to the work of the scythe and the muzzles of grazing beasts' (Romell, 1957).
- '…all present-day forests areas are really a patchwork of various successional stages of growth created

by people, and no areas are what proposals and reports refer to as 'pristine,' 'untouched,' 'primary,' or 'mature' forest. In short, these forests are human cultural artifacts' (Bailey et al., 1992).

- 'The production of irrigated rice in close proximity to natural marshes can be a very compatible human activity with the natural environment. Irrigated rice culture is probably the one crop that provides more seasonal habitat to wildlife than any other commercial crop.... We...cannot stress enough the importance of grazing toward providing the necessary habitat for waterbirds. Possibly, the least damaging to the marsh, ... the cheapest, and most productive, in terms of economic help for the local communities, is the grazing of aquatic vegetation by water buffalo' (Ramsar, 1996).
- 'Much of what we write about topics such as the tropical rain forests is untrue, and we know in our heads it is untrue, and people are not fools, for they increasingly know it is untrue.'...'Change is the norm, and stability an illusory, and ultimately, dangerous, goal.' (Stott, 1998).
- 'About 12,000 years ago, the Natufians [of southwest Asia] abandoned seasonally nomadic hunting and gathering activities... and replaced these with new labor-intensive subsistence strategies of plant cultivation and animal husbandry. The consequences of this agricultural revolution, which was the key to the emergence of civilization, included orders of magnitude increases in population growth and full-time craft specialization and class formation, each the result of the ability to generate and deploy agricultural surpluses. What made the Natufians change their lifestyle so drastically? ... it is now clear that this transition coincided with the Younger Dryas climate episode 12,900 to 11,600 years ago.' (Weiss and Bradley, 2001).

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