Matrix Matters:

Biodiversity Research for Rural Landscape Mosaics

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"It is certain that the…...…park and reserve system will be totally inadequate for conservation of the products of four billion years of evolution…..…...a new ecocentric paradigm, that integrates biodiversity conservation with the totality of human activities, is long overdue" (Nix, 1997)

"….the study of biodiversity is still largely in a Linnaean phase of discovering and naming species. Although our tools are more advanced, in many ways the science of biodiversity is not much farther along than medicine was in the Middle Ages. We are still at the stage, as it were, of cutting open bodies to find out what organs are inside. The low investment in and slow pace of biodiversity research might be tolerable were it not for the overwhelmingly rapid destruction of the natural world. Without hyperbole we can truthfully say that we are almost out of time to save much of the diversity of life on Earth" (Hubbell, 2001).

"Systems are groups of interacting, interdependent parts linked together my exchanges of energy, matter and information. Complex systems are characterized by strong (usually non-liner) interactions between the parts, complex feedback loops that make it difficult to distinguish between cause and effect, and significant time and space lags, discontinuities, thresholds, and limits. These characteristics all result in scientist's inability to simply add up or aggregate small-scale behaviour to arrive at large-scale results. Ecological and economic systems both independently exhibit these characteristics of complex systems. Taken together, linked ecological and economic systems are devilishly complex". (Constanza et al., 1993).

"Dost thou not know, my son, with how little wisdom the world is governed?"….Count Oxenstierna, letter to his son, 1648 in J.F. Lundblad, Svensk plutarik (1826) (in Spilsbury and Kaimowitz, 2000)

COVER PHOTO : Terraced agricultural fields in the densely populated (250 – 300 people/km2) landscape immediately adjacent to Bwindi-Impenetrable National park, Uganda – part of the Albertine Rift centre of biodiversity and a location where ICRAF are working within the African Highlands Initiative. In 1950, this entire slope was forested and INSET, a young mountain gorilla within Bwindi-Impenetrable National Park.

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Recommendations for a Joint CIFOR-ICRAF Initiative

Summary

A joint CIFOR-ICRAF biodiversity initiative should aim to advance our understanding of, and capacity to manage biodiversity in human-dominated landscape mosaics in the tropics. This is most effectively achieved through a strategic research focus and by building on the complementary strengths of both ICRAF and CIFOR. The **goal** of the joint initiative would be:

> "*to promote biodiversity conservation, restoration and use through integration of biodiversity management, local livelihood improvement and governance at multiple scales by doing research that influences key conservation and development groups and by building capacity of developing country individuals and institutions"*.

The five **objectives** to achieve this goal are: (a) to provide better scientific information for biodiversity management in landscape mosaics; (b) to improve incentive strategies for stakeholders, including rural people, to sustainably manage biodiversity in working landscape mosaics; (c) to provide strategic support for pilot study sites promoting biodiversity conservation in working landscapes; (d) to undertake capacity building and development of training and resource materials for training in biodiversity management and conservation at multiple-scales, and (e) to influence global and national policies supporting biodiversity conservation in working landscapes

The CIFOR-ICRAF initiative should pursue these objectives over a 10-year period, through **five closely-linked projects**: (1) Ecological principles and practices for biodiversity management in tropical landscape matrix (comparative research and synthesis, 30% of resources); (2) Strategies to engage and benefit local people for biodiversity management in working landscapes - comparative research and synthesis (25%); (3) Strategic support for pilot studies at research and implementation sites promoting biodiversity conservation in working landscapes (20%); (4) Capacity-building through information dissemination and training (10%); (5) Policy analysis and influence to promote biodiversity conservation in working landscapes (15% of resources). The joint initiative should utilise resources of 6 full-time equivalent senior staff, 3 in each Institute, working with consultants and researchers in other institutions. For projects 1 and 2, the Institutes will partner with agencies and local people seeking to jointly promote biodiversity conservation and agriculture or forest development on a large scale in 8-10 diverse, representative landscapes.

Geographic and thematic foci for research are suggested in this report. In terms of the CG mandate linked to poverty alleviation, priority regions are South Asia, which has the greatest **number** of poor people, and sub-Saharan Africa, which has the highest **proportion** of poor. CIFOR and ICRAF should focus on landscapes of high local and global biodiversity importance, starting with countries where they both have staff (Brazil, Cameroon and Indonesia (tropical lowland forests), Malawi and Zimbabwe (miombo woodlands)). In addition, they should jointly plan work where one, but not the other is working. Examples of this are found within the African Highlands Initiative (AHI) and Madagascar, in SE Asia (Philippines, Sumatra and Java) and the Peruvian Amazon. Additional work on dry forests (such as the *cerrado*) and mono-dominant forests should be considered in addition to joint work in miombo woodlands.

1. Introduction

This report reviews the problems and research opportunities in terms of biodiversity conservation at the forest-agriculture interface. It has been prepared to assist the International Centre for Research in Agroforestry (ICRAF) and the Centre for International Forestry Research (CIFOR) prioritise their future activities and achieve synergy in joint biodiversity research. The content of this review is explicitly forward-looking over a 15-20 year time-frame, rather than being an evaluation of past and current activities (terms of reference in Annex 8.1). Inputs to the report included meetings with 56 individuals active in biodiversity conservation research and action outside the Centres (Annex 8.2). In addition, we met another 24 individuals now working in CIFOR, ICRAF and IPGRI, attended two professional meetings on related topics, undertook a selected review of recent literature, and drew on our own professional experience.

The report, following this introduction, is divided into four sections. Part 2 covers the major challenges facing biodiversity conservation over the next 15-20 years, and related research questions. Part 3 assesses CIFOR and ICRAF's' comparative advantages as research organisations, in relation to the challenges, and proposes 5 priorities for an ICRAF/CIFOR research partnership. Part 4 proposes five key components for a 10-year action plan, and Part 5 suggests options for implementation, in terms of organisation, staffing, partnerships, and funding sources.

For practical and policy reasons (such as the ecosystem approach stressed within the Convention on Biodiversity (CBD)), strategic thinking on partnerships with regard to biodiversity conservation comes at an important time. All of the major conservation NGOs are moving rapidly into a landscape/ecosystem approach in their work, and are seriously working with concepts of landscape mosaics. Good examples of this are work being done by Conservation International (CI), IUCN, The Nature Conservancy (TNC) and WWF. A lot of this is, in our view, way ahead of what the CGIAR has been doing in these areas. At the same time, it would be beneficial for them to be able to work with ICRAF and CIFOR scientists who could play an important role in bridging conservation and development interests and helping to create a shared vision, while identifying and promoting strategic research priorities.

2. Biodiversity challenges and research issues in the next 15-20 years

Conservation of biodiversity faces major threats and opportunities over the next 15-20 years. Conservation and land use science are also changing the way we think about biodiversity and seek to manage it. Technological advances enable types of biodiversity management previously impossible. In responding to these challenges, conservation institutions have begun to re-focus and re-organise their efforts. All these changes lead to demand for new types of research. In this section we consider the key directions for biodiversity research in the next 15-20 years. To derive this agenda we have first summarised the major trends that are likely to occur in the next decade or two (section 2.1) and then identified some of the main changes in how we think about biodiversity management (section 2.2). On the basis of this, some directions for biodiversity research and key questions can be identified (section 2.3). This leads to a wide agenda. In section 3, we narrow down the agenda to what can be achieved by a joint CIFOR/ICRAF initiative.

2.1 Important challenges affecting biodiversity in the next 15-20 years

The largest threats to biodiversity are widely acknowledged (Box 1). These firstly are habitat loss and fragmentation, secondly, global climate change and thirdly, introductions of invasive species. Fragmentation due to human effects is more likely where the climate is hospitable, access is easy and the soil has high arable potential. As a result, most temperate forest in Europe and eastern North America was cleared. In addition, land set aside for protected areas usually does not contain representative examples of ecosystems, communities or species, but typically is biased towards

steep sites and unproductive soils. Reserves systems in the United States (Scott *et.al*., 2001a,b) and Australia (Pressey, 1995) provide good examples of this bias (Figure 1).

Box 1. Anticipated changes and challenges in the next 15-20 years[1]

Biophysical changes:

- Global climate change and increase in greenhouse gases, with more variable climate, reduced rainfall in some areas and higher rainfall in others and modified plant growth conditions;
- Fragmentation and scale effects: What are the critical ecological factors that maintain forest ecosystems? The relative roles of pathogens, pollinators, and parasites need additional research, including on questions like density dependence.
- Increased threat from invasive species, with more movement of people, goods and species across countries.
- Protected area boundaries are often insufficient to protect some of the species within them unless the land-use and conservation issues in the surrounding matrix are taken into account,
- Possible changes in below ground biodiversity, although this remains very poorly known, as is their role in terms of ecosystem function or link to changes in above-ground biodiversity at different time and spatial scales.

Major socio-economic changes:

- Continued growth in demand for land for settlement and for agricultural production, making it difficult to segregate separate land areas for biodiversity conservation and for productive use;
- Growth in demand for ecosystem services with population and income growth;
- Deforestation caused by large-scale actors as element of economic globalisation;
- High levels of population, poverty and malnutrition in biodiversity “hot spots”. There currently many major cities in these "hotspots" and continued high rural population growth rates.
- Several large "hot-spots" or "Global 200 ecoregions" will experience a high influx of farmers (eg: the miombo ecoregion, due to removal of tsetse flies) or high input agriculture (eg: soya bean production in the *cerrado*);
- Reduction of available potable freshwater sources, yet increased demand at constant supply;. Pollution, eutrophication and salinization of water sources will increase;
- Expanded hydrological, communication and transport infrastructure;
- Pollution from manufacturing and extractive industry;
- Domestication of commercially valuable forest plants for food, medicines, wood, etc.

Major institutional changes that have already begun and are likely to increase:

- Decentralisation to local control and governance of many natural resources;
- Devolution of forest resources to indigenous and local people;
- Increased public oversight of natural resource management (transparency);
- Rise of markets for sustainably managed products (including biodiversity);
- Establishment of local, state, national and international institutions (public and NGO) to address biodiversity conservation;
- International treaties and agreements to support biodiversity conservation.
- Reduced political will and capacity to establish large protected areas in many countries.

Technological advances impacting biodiversity management:

- Biotechnology offering opportunities for genetic enhancement to increase survival of threatened species, or to accelerate land rehabilitation, but also offering threats to wild genetic diversity
- Technological advances in methods for genetic analysis, landscape and biodiversity monitoring, models for multi-functional landscapes that greatly enhance environmental analysis.
- Advances in agroecology leading to new approaches to resource management that reduce trade-offs between economic use and productivity and conservation.

[1] Based on the interviews held and literature consulted during this review

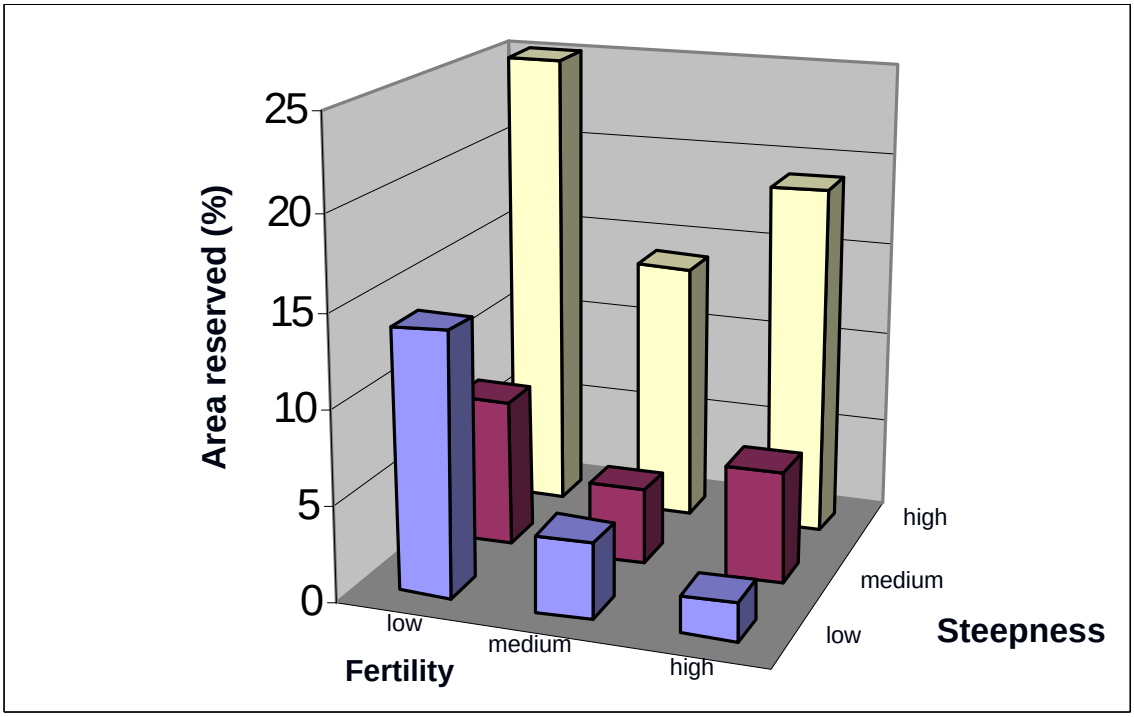

Figure 1. Systems of forest protected areas typically are not representative, either at the ecosystem, communities or species levels. Forest on high fertility flat lands are least represented in protected area systems, whereas forested protected areas on poor soils and steep sites are more common. The forest conservation areas of northern New South Wales are a good example of this. The vertical axis shows percentage within reserves (Pressey, 1995).

By contrast, large areas of boreal forests are still intact (Ritters *et.al*., 2001). Until access was made easier, tropical forests also remained relatively intact, apart from low intensity swidden farming. In the Rondonia region of Brazil, for example, residual forest pattern is relates directly to the occurrence of roads (Dale and Pearson 1997). The greatest levels of habitat loss will occur in Latin America and sub-Saharan Africa, with large proportional declines in Asia. As projected population increases will be fastest in species-rich tropical areas with high proportions of endemic taxa, biodiversity losses will be unprecedented. Effects will be seen in greater habitat loss, fragmentation and other forms of species specific overexploitation (such as the effects of bush-meat trade on slow growing, slow reproducing mammal species) will be unprecedented due to forest clearing for agriculture, plantation monocultures and developments such as large dams and highways.

In 1900, there were only 1.6 billion people on Earth, but nearly quadrupling by the end of the century (Ehrlich, *et.al.* 1995) expected to reach 7.5 billion by 2020 (Anon, 1999), mainly to rapid growth in developing nations where most of the world's biodiversity is located. In addition, average per capita consumption increased by 460% over the last century, with current values projected to increase by 240% by the year 2050, as more of the world's population understandably strive to adopt the consumptive lifestyles of industrial nations (Maddison, 1995; National Research Council, 1999). As a result, human impacts on the world's ecosystems are increasing exponentially. Tilman *et.al*. (2001) provide a detailed (and alarming) series of future projections for a likely future over the next 25-50 years which is highly relevant here. We currently appropriate 40% of terrestrial productivity (Vitousek *et.al*., 1986) and exploit half of the useable freshwater (Tilman *et.al*, 2001). We have also caused huge changes to global bio-geochemical cycles (particularly carbon, nitrogen and phosphorus), one of the reasons being the high input requirements of the Green Revolution, which has had high environmental costs (Box 2). Primarily due to the use of synthetic fertilizers, we already release as much nitrogen and phosphorus to the environment as all natural sources combined - yet global nitrogen fertilization is projected to rise by 270%, phosphorus use by 240% and agricultural demands for irrigation water by 190% by 2050. Tilman *et.al* (2001) also point out that global pesticide production has risen at least ten-fold in the past 40 years and will rise by 270% from current levels by 2050.

Box 2. Major environmental impacts of modern agriculture (from Laurence, 2001)

- **Nitrogen (N) and phosphorus (P)** from synthetic fertilizers enter surface and groundwaters (either through leaching or via untreated livestock or human wastes), and N is also volatilized to the atmosphere and deposited regionally. P pollution causes eutrophication of freshwater streams and lakes, whereas N causes eutrophication of estuaries and coastal seas, biodiversity losses in terrestrial and aquatic systems, groundwater pollution, increases in the greenhouse gas nitrous oxide, which also destroys trophospheric ozone, and acidification of sensitive soils and freshwaters.
- **Irrigation** increases salt and nutrient loading to downstream aquatic ecosystems, can cause salinization of soils and has impacts via damming of rivers and water harvesting. Many areas have insufficient water to meet projected demands.
- **Pesticides (insecticides and herbicides)** can cause environmental degradation or affect human health. Some pesticides, such as chlorinated hydrocarbons, persist for long periods and bioaccumulate in food chains and surface waters. Many insect pests and some weeds have evolved pesticide resistance.
- **Habitat conversion** for agriculture is a key driver of species extinctions and is also the leading cause of habitat fragmentation. Interactions among habitat loss, fragmentation and other simultaneous environmental changes will undoubtedly lead to many future extinctions.

At the same time, sparsely populated “frontier forests” which remain will increasingly be subject to industrial logging. This is happening at the moment in parts of the Guyana Shield, the Amazon and Congo basins, and parts of Sumatra, Borneo and New Guinea. Despite the effectiveness of timber certification schemes in some parts of the world, a high proportion of tropical hardwoods in the international trade still comes from illegal sources in Indonesia and elsewhere in Asia, South America and Africa.

In part, this illegal trade, like the trade in diamonds from the "biodiversity hotspots" of Liberia, Sierra Leone, the eastern Congo and Angola, is related to the overlap between conflict, conservation and resource rich frontiers. As Klare (2001) has pointed out:

> *"Just as a map showing the world's tectonic faults is a useful guide to likely earthquake zones, viewing the international system in terms of unsettled resource deposits -- contested oil and gas fields, shared water systems, embattled diamond mines -- provides a guide to likely conflict zones in the twenty-first century.*
>
> *A better analysis of stresses in the new international system, and a better predictor of conflict, would view international relations through the lens of the world's contested resources and focus on those areas where conflict is likely to erupt over access to or the possession of vital materials……this map would indicate major concentrations of gems, minerals, and old-growth timber in the developing world".*

This may be an interesting policy area for CIFOR to examine. The frequency of armed conflicts around the world has risen substantially during the past 50 years, with 160 wars recorded since the end of the Second World War (Dudley *et.al*., 2002). In the 1990's, there were three times more wars being carried out than in the 1950's and twice as many as in the 1960's (Kane, 1995; Collier, 2000). In developing countries, the likelihood of civil wars occurring is directly correlated with the importance of resource commodities in the national economy (Collier & Hoeffler, 1998; le Billon, 2000). The majority of these are also countries where global priority sites for conservation (EBA's, Global 200 ecoregions and biodiversity hotspots) are located.

In a recent report, Transparency International pointed out that forest-rich countries also top the list of the world's most corrupt countries[2]. What tools can be used to get positive biodiversity conservation outcomes in places international researchers can't easily visit? Are there innovative ways of dealing with cases where there is little or no governance, such as the eastern Congo, Liberia or Angola? Is the interface between biodiversity conservation and conflict a reason to steer clear of these countries? Or does it provide a great opportunity for synthesis and creative policy tools? This is a strategic question which ICRAF and CIFOR need to take into account, as conflicts over resources are likely to increase, not decrease in the next 15-20 years. Conservation areas in conflict certainly affect the feasibility of research projects based in those areas: but does that mean that CIFOR and ICRAF should totally avoid anything to do with them? Or do they present a great opportunity for examining creative policy tools – "long levers" – that can work from a distance and lead to positive changes for both people and conservation? The recent CIFOR study dealing with logging and pulpwood plantations in Indonesia (Barr, 2001) did not shy away from dealing with awkward issues of how broad issues of corruption, large conglomerates and corporate lenders can affect forest conservation. By addressing underlying causes in a well researched way, it also had impact. The same attention to broader issues can apply to forest conservation elsewhere, with tropical Africa as a prime example.

2.2 New thinking and directions in managing biodiversity

Over the past decades, the pendulum has swung back and forth between 'conservation based on protected areas' and 'conservation in integration with human land use'. In response to the above changes, a new paradigm is emerging that integrates protected areas into broader landscapes of human use and biodiversity conservation, particularly in agricultural areas that now constitute the principal land use in most of the developing world (Figure 2). In response to this the very nature of conservation organisations are changing (Box 3).

This is reflected in the Convention for Biodiversity reference to "agrobiodiversity", which is defined now to include crop/livestock genetic diversity, non-domesticated species that are closely associated with domesticated species (e.g., pollinators, soil micro-organisms), as well as other wild species that inhabit agricultural areas. The question of how best to achieve a balance between production and biodiversity conservation ("to integrate or segregate") is also at the centre of much of ICRAF's work, particularly in SE Asia (eg: van Noordwijk *et. al*, 1997, 2002).

The challenge of trying to attain the CBD's goals through balancing biodiversity conservation objectives with those of sustainable use, development and livelihoods requires attention to the landscape and for conservation to take place at multiple-scales with multiple stakeholders (Box 4).

In terms of the CG poverty mandate and geographic priorities, poverty rates have declined in most regions, except for the transition economies of Europe and Central Asia. The greatest number of poor people live in South Asia, but the proportion of poor is highest in Sub-Saharan Africa, where civil conflict, slow economic growth, and the spread of HIV/AIDS have left millions at the margins of survival.

[2] see http:/www.transparency.de/documents/newsletter/2000.3/third.html

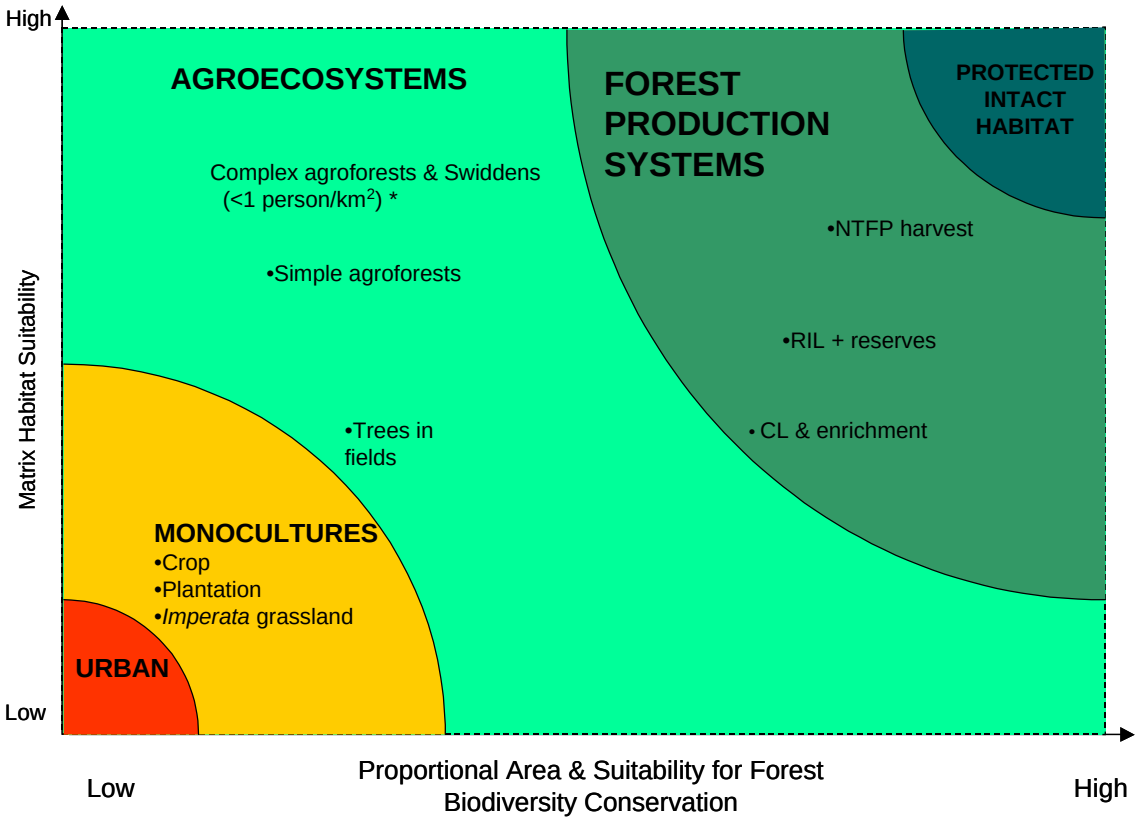

Figure 2. A conceptual representation of forest biodiversity conservation in relation to the different habitat qualities and relative areas and suitability of different land-uses across the landscape matrix that need to be considered when taking a multi-scaled approach. CL = conventional logging. RIL = Reduced impact logging.

Box 3. New directions for conservation organisations

- Adoption of conservation strategies that embrace large areas of land and integrated protected areas ("landscapes" of TNC, "heartland's" of African Wildlife Federation, "living landscapes" of Wildlife Conservation Society; "ecoregions" of WWF; "biological corridors" of CI)
- Major private funding for some large-scale initiatives for biodiversity conservation in working landscapes (e.g., The Nature Conservancy, World Resources Institute, Conservation International)
- Democratisation of biodiversity planning, through multi-stakeholder processes, rather than top-down approaches
- Radical changes in biodiversity objectives for different groups, in diverse directions from "zero biodiversity loss" (CI) to "sustainable use" (Megadiversity Country coalition)
- Ecosystem rehabilitation initiatives as a response to livelihood threats from land degradation in rural areas (not necessarily through restoration of natural species)
- "Natural systems agriculture" and "sustainable forestry" where productive land use systems themselves are modified to enhance their biodiversity value.
- Direct financial or non-financial compensation to local people based on positive conservation outcomes in land under their control.

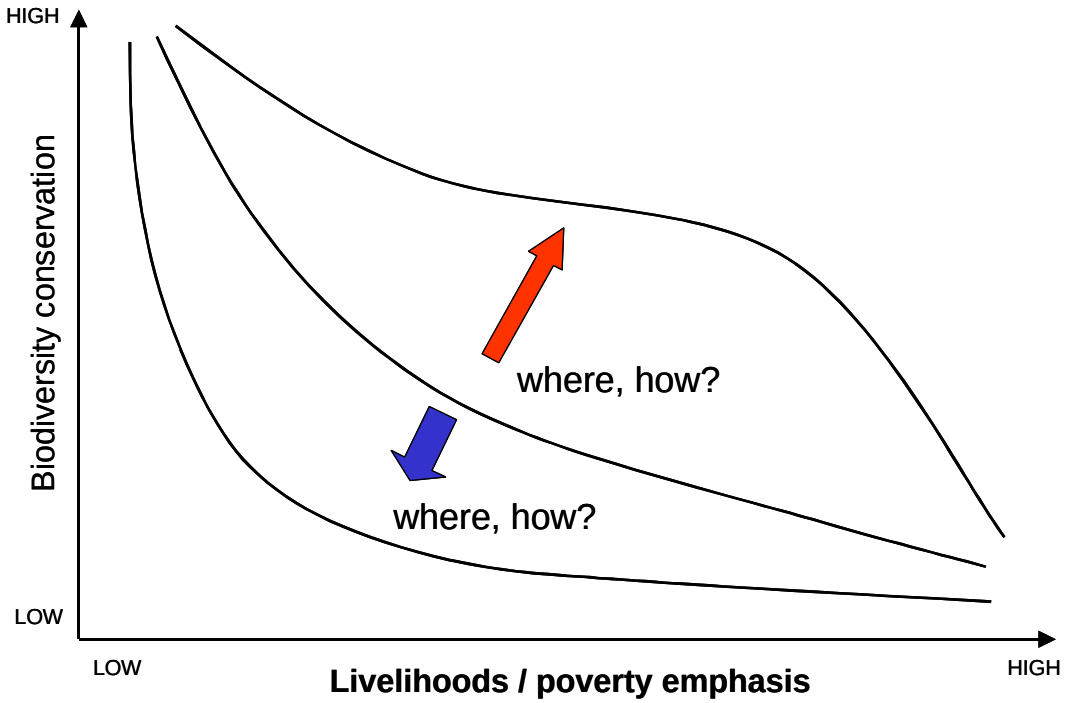

Figure 3. Tensions exist between biodiversity conservation and the short-term goals of people's livelihoods. Where and under what circumstances can a better balance be reached? (source: modified from M van Noordwijk, 29 July 2002 workshop).

As the hypothetical graph in Figure 3 suggests, conventional wisdom is that biological diversity decreases as demands on resources to support human livelihoods increases. Taking account the specific, forest/agroforest and poverty-linked mandates of CIFOR and ICRAF, a joint biodiversity initiative should be considering questions such as: Where and under what circumstances can the curve be shifted "outwards" to attain better biodiversity conservation outcomes while meeting livelihood needs? Or conversely, "Under which circumstances does the curve (and lack of balance between biodiversity conservation and livelihoods) worsen?

Research undertaken over the past decade has challenged many earlier ideas about what “biodiversity conservation” means and how to achieve it. Island biogeography theory (Macarthur and Wilson, 1963) has been very influential in the past in the development of general principles of protected area design (eg: Diamond, 1974). It can also recently provided the stimulus for Hubell (2001) to add speciation to the theory of island biogeography and develop an overarching theory of biodiversity and biogeography.

The six principles of island biogeography that strongly influenced protected area and nature reserve design are:

1. Large reserves are better than small reserves;
2. A single large reserve is better than a group of small ones of equivalent total area;
3. Reserves close together are better than those far apart;
4. A compact cluster of reserves is better than a line of reserves;
5. Circular reserves are better than long, narrow ones;
6. Reserves connected in a corridor are better than reserves not connected by a corridor.

As Lindemayer and Franklin (2002) point out, however, these principles were based on the "*unrealistic assumption that there are identical places from which protected areas can be selected…effects of the matrix on biodiversity are ignored, whether positive or negative. Yet, matrix conditions can significantly influence biodiversity conservation. For example, the outcomes of Principles 2, 3 and 4 (reserve size and spatial location) depend upon interacting factors*" that include:

- demographic interactions between populations in reserves and populations from the surrounding lands;
- disturbance regimes in both the matrix and those parts of the landscape set aside for conservation.

Excellent progress has been in designing methods and planning protocols for the design and selection of protected areas (eg: Margules *et.al*., 1995; Margules and Pressey, 2000; Pressey *et.al*., 1993). More recently, however, attention has been paid to how the management of the matrix surrounding forest conservation areas (reserves and protected areas) influences the viability and size of forest organisms and how these organisms move between reserves (Bierregard *et.al*., 2001; Lindemayer and Franklin, 2002).

The Biological Dynamics of Forest Fragments Project (BDFFP) in Brazil, in line with the theory of island biogeography, for example, found that large forest fragments always had more species than smaller ones. However, several other results, recently documented in a publication by Bierregard *et.al* (2001), were contradictory. The diversity of butterflies, frogs and small mammals, for example, increased in abundance following fragmentation, being able to exploit the changed conditions of the matrix (such as open-habitat butterfly species which replaced closed canopy forest species). An important lesson from the BDFFP experiment is that it showed that if we are to be able to predict the biological responses to fragmentation across the landscape, then we have to understand the relationships between all the component parts; and that lessons (and the resilience) of Amazonian forests can be very different to those in Asia or Africa.

Two main conceptual models have be used in thinking about biodiversity conservation in heterogenous landscapes. Firstly, the *landscape continuum model* (McIntyre and Hobbs, 1999) and secondly, Forman's (1995) *corridor-patch-matrix model*. These have recently been reviewed by Lindemayer and Franklin (2002), who pointed to the limitations in both of these conceptual models and suggest an alternative approach, the following five general principles to meet forest biodiversity conservation. In making this suggestion, they fully recognise that "*since species loss is predominantly driven by habitat loss, the overarching goal of matrix management must be to prevent habitat loss*". These principles are the maintenance of:

- connectivity
- landscape heterogeneity
- stand structural complexity
- the integrity of aquatic systems by sustaining hydrologic and geomorphological processes; and
- risk-spreading (adoption of strategies linked to principles listed above and ensuring that strategies vary between different stands and landscapes don’t do the same thing everywhere”).

These can be applied at multiple scales, including managed forests or forestry plantations and are detailed in Lindemayer and Franklin (2002).

With more than 250 000 higher plant species, the majority in the tropics, there also are good reasons for thinking about the great diversity of species is ways which enable generalizations and predictions to be made. Considerable recent effort has gone into this, which is relevant here, particularly given the possibly devastating impacts of global change. Recent experimental work on

plant functional types **(**PFTs) indicates that there is some prospect of a system being both rapid and useful. Examples are the recent book on Plant Functional Types (Smith *et.al* 1997), a dedicated recent edition of Journal of Vegetation Science (Vol 10; 1999), a recent review on PFTs (Lavorel *et.al* 1997), a review by Wilson (1999) on functional types and a review on the importance of persistence (e.g. resprouting) as opposed to recruitment, in many biomes (Bond & Midgley 2001). Despite the pressing need, much progress needs to be made, especially in tropical forests. There are several different reasons for determining plant functional attributes (PFAs) (Westoby 1998, Wilson 1999). These include; facilitating meta-analyses or generalizations of field experiments, placing ecophysiological results in a comparative context and the need to be able to predict global changes in vegetation dynamics under various impacts of global change. To this list could be added other reasons; understanding community assembly rules (e.g. does plot level species richness correlate with functional richness?) and community response rules to disturbance (e.g. which species will go extinct first if mutualisms fail?) (Bond 1994, Wilson 1999). We suggest that a joint CIFOR-ICRAF biodiversity initiative should take advantage of these new approaches in dealing with the objectives and components outlined in Section 4 below.

Box 4. Elements of an Enabling Environment For Biodiversity Conservation and Sustainable Use Across the Landscape (from Byers and Nasi, 2002)

1. Resource base sufficient to allow for choices about management strategies (i.e. resource base can still meet demand at the local scale in a sustainable way)
2. Demographic changes (population growth, migration, urbanization, etc.) and pressures do not undermine conservation
3. Broad-based awareness and understanding of the value(s) of biodiversity
4. Adequate science, information and knowledge for decision-making
5. Political will and commitment
6. Understanding of and respect for other stakeholder values
7. Land tenure and land use systems are agreed upon and respected by all stakeholders; adequate processes for negotiating/agreeing on multiple land uses among diverse stakeholders
    - Adequate social processes for co-operation and conflict management
    - Adequate institutional environment and capacity
    - Capable institutions and individuals
    - Effective civil society
    - Appropriate (suitable, relevant, effective) private sector participation
    - Inter-sectoral harmonization
    - Systemic integration of private sector, public, and civil society institutions; inter-institution partnerships
8. Appropriate policies at all levels (*national to local*)
9. Favourable legal framework that is implemented
10. Equitable distribution of costs and benefits from biodiversity resources
11. Favourable international policy and trade
    - Adoption of best practices
    - Best/appropriate practices (*may need science, research and consensus*)
    - Capacity to implement best practices
12. Incentives for the adoption of best practices and adaptive management capacity

2.3 Implications for the biodiversity research agenda

Most of the people we spoke to during the consultation process for this report agreed on the need for a landscape (or ecosystem) approach. Nevertheless, "big questions" related to successful biodiversity conservation at a landscape level remain. For example:

- How can conservationists negotiate local and global biodiversity values in developing landscape management strategies?

- How to reconcile the need for more systematic regional conservation planning, with the devolution of decision-making to the local level?
- How much biodiversity is needed to produce different types of ecosystem services in different environments – as it is possible that some of the 'ecosystem functions' valued as 'environmental services' may not require high local biodiversity;
- What is the role of biodiversity in ecosystem services for local livelihoods, national and global environmental security?

While there has been recent disillusionment with ICDP's (most notably within the World Bank) several others felt that ICDP's can (and are) making an important contribution to conservation at a landscape level. What is needed, however, was a predictive understanding of where and why ICDP's would succeed or fail so that they can be designed to function better in the long term over larger spatial scales. There certainly was consensus that ICDP's have had mixed results. Many, though claiming to be participatory, rarely were, and invested little in developing essential local human resources to implement innovative natural resource management approaches. Reasons for this were that most ICDPs did not focus enough on land tenure, and when they did, over-emphasized fully protected areas, rather than multi-functional areas and multi-functional strategies. ICDPs outside protected areas also typically lacked clear and specific biodiversity objectives. An additional problem was that ICDPs generally invested insufficient resources in developing new technologies, institutional innovations and markets that would allow them to reduce the trade-offs between conservation and development objectives (over-optimistic assumptions about existing availability of suitable alternatives). Similar concerns were also expressed about the effectiveness and sustainability of community forestry and Joint Forest Management systems.

To meet upcoming challenges, we still need to continue to pursue some standard research agendas, such as to document biodiversity resources, but in more management-relevant ways; and improve ways to protect large, contiguous areas of critical habitat that are under pressure from population increase and economic expansion. However, new threats, opportunities and new thinking about biodiversity, suggest that we also need to move in some important new directions, in particular to determine:

- How production systems can be modified to mimic natural ecosystem functions, especially where major aspects of biodiversity (e.g., top carnivores) are absent?
- Which strategies and under what conditions would particular monitoring methods be appropriate and adequate for monitoring biodiversity in the "other 90%"?
- What is the role of below-ground biodiversity in sustainable agricultural production across tropical landscapes and how does this change with altered above-ground cover? (a question which ICRAF, with GEF funding through TSBF, will address at ASB sites in seven countries);
- How does changing tree cover & species composition influence the diversity of other biota?

In terms of future research, it was also considered important to determine the extent and conditions under which it is possible, necessary and/or desirable to conserve biodiversity in agroecosystems (alpha, beta-diversity) – and to devise means to protect and manage biodiversity in dynamic, working rural landscapes in terms of technical, socio-economic, institutional and policy factors. This requires research on how agricultural, forest and aquatic production systems can be designed and modified so that they enhance biodiversity within larger landscapes, and more effectively support protected area systems.

Understanding the role of biodiversity in providing ecosystem services important for local livelihoods as well as national/global environmental security is an important part of this process.

3. Proposed goal, organizational strengths and objectives for the CIFOR-ICRAF biodiversity initiative

There is obviously an enormous range of relevant research activity required to advance the cause of biodiversity conservation and its contribution to human welfare. There are also many, diverse institutions involved in biodiversity research and conservation. Despite their global mandates, CIFOR and ICRAF are relatively small research organisations, presently staffed with only 30 and 26 senior researchers, respectively. The joint biodiversity initiative must have a sharp focus, contribute to a clearly defined goal and a few priority issues, benefiting from leveraging the unique institutional position of ICRAF and CIFOR. We suggest the goal of a joint programme should be:

"to promote biodiversity conservation, restoration and use through integration of biodiversity management, local livelihood improvement and governance at multiple scales by doing research that influences key conservation and development groups and by building capacity of developing country individuals and institutions".

3.1 Comparative advantages and disadvantages: CIFOR and ICRAF

As international organisations, mandated for strategic and applied research, CIFOR and ICRAF are well positioned to undertake management-oriented comparative research, analysis and synthesis across countries, regions and institutions. Between them, CIFOR and ICRAF cover a full spectrum of terrestrial productive land use systems, and can pull in component and specialist expertise as needed. In addition, CIFOR and ICRAF both have strong connections to international processes (for example through CPF, the CBD, UNFCCC, Global Environment Facility and the World Bank). CIFOR and ICRAF are also distinctive in being natural resource institutes whose mandate is poverty reduction, so that they have the staffing capacity to undertake inter-disciplinary research encompassing biophysical, socio-economic and policy issues. They can thus rigorously address the issues of "people and biodiversity", while also focusing on issues, such as extra-sectoral influences on land use, that are not addressed in many sector-specific research institutions.

As organisations mandated to provide input into international policy dialogues, their input is considered legitimate, and they have strong convening power and scientific credibility. They have access to major global players. Their perceived neutrality, even-handedness, and objectivity gives their policy analysis additional legitimacy, and positions them well to address many conflictive issues. Between them, the two Centres provide expertise on the entire spectrum of tropical tree and forest management in the landscape, from scattered trees in crop or grazing land, to closed canopy production forest, to riparian restoration, as well experience in tree improvement research for non-conventional species. The Centres also have access to expertise from other Future Harvest Centres on crop and livestock genetic resources and management.

CIFOR and ICRAF both have depth of experience and data in strategically interesting and diverse field sites, which allow them to assess issues from local to national and international perspectives, to work across scales, and to provide in-depth analysis. Long-term presence in some research sites offers major advantages for biodiversity research. In addition, CIFOR and ICRAF:

- Have strong experience in organising, managing and participating in inter-institutional partnerships with diverse types of institutions, increases the likelihood of success in developing new types of partnerships to deal with linkages between agriculture and biodiversity.
- Have mandates for capacity-building not specific to any sector or type of institution, but can be flexibly directed to whatever clients and methods are considered to be most effective in achieving final goals.
- Are well-positioned to analyse global trends impacting biodiversity, in collaboration with data-rich organisations, and by catalysing academic research around key research questions and hypotheses. ICRAF in particular has expertise in Geographic Information Systems

application to heterogeneous landscape research and planning, and linkages with diverse international sources of geo-positioned land-use and biodiversity-related data.

We also suggest that several of the important research issues identified in Section 2 should not be priorities for the CIFOR-ICRAF joint initiative, due to the lack of comparative advantage in the CIFOR/ICRAF Partnership. Reasons for this are that:

- Their small size and situation make the two Centres poorly suited to provide backstopping services to implementing agencies on a general basis, or to have significant direct field impacts outside selected project areas.
- The Centres are not mandated to do basic research, long-term resource-intensive primary data collection, "maintenance" research, or taxonomy.
- Other international conservation organisations (e.g., IUCN, WWF, CI) are better-placed to undertake priority-setting for biodiversity action, although the joint initiative could provide some input to the strategic thinking behind these exercises.
- While analysis of the dynamics of landscape change is an important context for work on biodiversity, it is not recommended that this be a priority of the joint initiative (although other programs of CIFOR and ICRAF will continue to make significant contributions).
- CIFOR and ICRAF do not have the mandate or comparative advantage to address important questions of documenting and monitoring biodiversity, but can draw lessons from their research of relevance to monitoring.
- Other organisations seem better positioned to analyse the impacts of climate change on biodiversity and the poor.

Because of their mandate to promote poverty reduction, the CIFOR/ICRAF joint initiative would not have a comparative advantage to study the management of large-scale protected areas with relatively strict exclusion of human productive activities, or with low population density. Such research can better be done by conservation-focused organisations such as Conservation International, and by university-based ecologists and wildlife biologists.

We also suggest that while the ICRAF tree domestication section is a very good one doing innovative work, the Centres are too small to maintain expertise on tree genetic diversity for a very wide range of plant species. Biodiversity conservation work at genetic level should therefore be done only as it pertains to specific project areas, and the interactions between genetic aspects of economically useful tree species and wild species. IPGRI, on the other hand, would be very useful partners in a programme covering a wider range of plant species and are already doing work of forest tree genetics than extends to the landscape level. In addition, their work on crop plants and their wild relatives relates well to components of the broader landscape that are not well covered by CIFOR or ICRAF.

3.2 Proposed objectives and proposed focus of work

Taking into account global conservation concerns over the 15-20 years, current research needs and the goal in Section 3.0 we suggest that the CIFOR-ICRAF joint initiative should focus on **five objectives,** namely to:

(1) Provide better scientific information for biodiversity management in landscape mosaics;
(2) Develop improved incentive strategies for stakeholders, including rural people, to sustainably manage biodiversity in working landscape mosaics;
(3) Provide strategic support for pilot study sites promoting biodiversity conservation in working landscapes
(4) Develop individual and institutional capacity within partner countries and develop training and resource materials for biodiversity management and conservation at multiple-scales, and
(5) Influence global and national policies supporting biodiversity conservation in working landscapes

3.3 Matrix matters

We recommend that CIFOR and ICRAF focus primarily on understanding and managing biodiversity in the landscape matrices surrounding protected areas. As the goal of protected areas approaches has been to cover 10% of national land area (but varies from country to country), we refer to the matrix as "the other 90%" of terrestrial land area. What we mean by "matrix" is:

"*landscape areas that are not designated primarily for conservation of natural ecosystems, ecological processes and biodiversity, regardless of their current condition (ie : whether natural or developed*)" (Lindemayer & Franklin, 2002).

Multi-scaled approaches to biodiversity conservation across landscapes are being tested in landscapes with very different forest types across the world. Examples are work in:

- South-eastern Australia (the Tumut Fragmentation experiment and Central Victoria, *Eucalyptus* forests) (Lindemayer and Franklin, 2002);
- North-central Brazil (the Biological Dynamics of Forest Fragments Project (BDFFP), tropical lowland forest) (Bierregard *et.al*., 2001)
- Tierra del Fuego, southern Chile (*Nothofagus* forests, Rio Condor project, on land recently bought by TNC from the Trillium Corporation) (Arroyo *et.al*., 1996; N. Sizer pers. comm, 2002) and in
- Northern California (mainly *Tsuga, Pseudotsuga, Thuja* and *Picea* dominated forests) (Lindemayer and Franklin, 2002).

As far as we know, however, there are no international biodiversity research institutions presently focused on this topic, although many have small related projects. Diverse conservation organisations and public agencies around the world have begun to move decisively to improve biodiversity management in landscape mosaics, but they are doing so largely using a “trial and error” approach, based on existing, inadequate knowledge, with little research backstopping.

While some conservation organisations have much larger research resources than CIFOR and ICRAF, most are still focused on natural habitats. By clearly focusing their work on landscape issues, CIFOR and ICRAF will be in a position not only to support others’ research and conservation initiatives, but also indeed to take and develop a scientific leadership position in the field. By drawing from global information networks and working in partnership mode with diverse agricultural, community and conservation organisations, the CIFOR-ICRAF joint initiative can provide “state-of-the-art” synthesis for “best practice” in biodiversity management in working landscapes, help identify critical research questions and catalyse and implement research on those issues. The CIFOR-ICRAF initiative should form strategic links with individuals and organizations already working on this issue, particularly in Australia and South Africa, where expertise in systematic conservation planning at the landscape level is particularly strong. As CIFOR have expressed interest in a partnership with TNC, it is worth noting that TNC have recently bought the Rio Condor project land from the Trillium Corporation (N Sizer pers. comm, 2002) in Tierra del Fuego. This is one of the few examples of systematic planning across a landscape matrix and may offer an opportunity to learn from the Chilean university and government scientists involved (see Arroyo *et.al*, 1996). Other areas of interest to the CIFOR-ICRAF joint initiative are TNC's work in the cerrado (<1% protected), which is focussed on the Guaraqueçaba Environmental Protection Area in partnership with the Society for Wildlife Research and Environmental Education (SPVS) and Fundação O Botácario, creating private reserves of over 25,000 ha and on Grande Sertão Veredas National Park (savanna, forest, grasslands and well-preserved *veredas* - riparian palm communities). TNC are also launching a sustainable agriculture initiative in the cerrado, which is threatened by agricultural expansion (eg: soya production), which will start with a sustainable ranching and farming project in partnership with Fundação Emas, around Emas National Park. In Brazil's Atlantic forest, TNC and FUNATURA have established a 20-year endowment for management of Grande Sertão Veredas National Park through Brazil’s only debt-for-nature swap.

3.4 Geographic focus

Priority setting is critical where funding is increasingly scarce and problems are urgent. Well esigned field experiments can also be very costly. Some silvicultural experiments in the north-western US, for example, have a cumulative cost of over US$1 million per replication (Lindenmayer and Franklin, 2002). It is essential therefore, that a CIFOR/ICRAF joint initiative avoid over ambitious projects in too many sites with too many activities and goals. As we mentioned at the start of this report, it is far better, to do work well at fewer sites than less well at many sites. For this reason, a joint initiative must have a clearly defined geographic and thematic focus. It should also be implemented, where practical, with strategically selected partners who are also committed to testing multi-scaled approaches to biodiversity conservation across landscapes.

In the case of ICRAF and CIFOR, these need to be prioritised on the basis of five factors. Firstly, their biological distinctiveness and whether they have already been identified as global conservation priority sites ("hot spots" (Myers *et.al*, 2000), "ecoregions" (Olson *et.al*., 2000), "centres of plant diversity" (Davis, Heywood and Hamilton, 1994, 1996, 1998). Secondly, in terms of their location related to the CGIAR mandate of dealing with poverty. Thirdly, the feasibility of working in those sites. Feasibility of working at a particular site is affected by factors such as accessibility and remoteness or whether work at that location is affected by conflict or corruption. Fourthly, the need to choose research projects which will have a positive impact. In the past, CIFOR and ICRAF chose sites with:

- high potential for widespread application;
- substantial benefits to targeted clients, high adoption and minimum lag-time before adoption;
- high probability of success in both research and dissemination; activities commensurate with time, finances and resources available;
- potential to enhance the research capacity of partners; and potential to promote south-south co-operation.

This set of selection criteria for project impact should not change. The emphasis must be on comparative case studies to learn lessons. To achieve this, it is the choice of key research questions that should be the primary driver of the location of research.

For pragmatic reasons, however, it is important to consider how strategically current ICRAF and CIFOR research (and that of potential partners) is located in relation to the four factors mentioned above. The hypothetical graph in Figure 4 suggests that the optimum location of CIFOR's research occurs fairly early in the intensification stage of landscape change. To the extent that it can be shifted toward a higher level of forest cover, the cost of conservation should be minimized. However, the key is that the highest possible level of forest cover may not always lead to the highest economic return, so societies will have to negotiate about trade-offs regarding these two variables. ICRAF's work complements that of CIFOR in that ICRAF would probably focus on the rehabilitation and depleted stages (Figure 4).

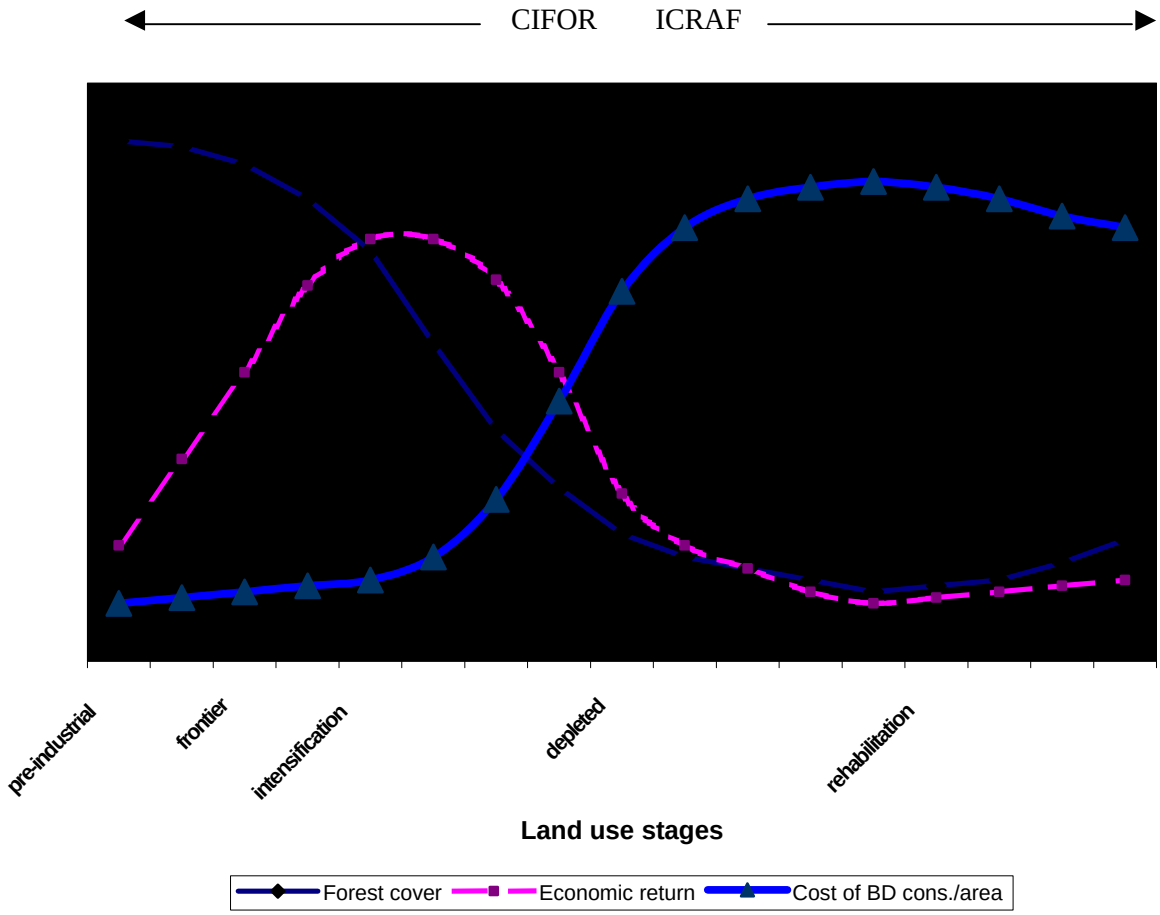

Figure 4. Relationships of forest cover, economic returns and conservation costs in relation to land use over different stages (from Byers and Nasi, 2002). Stages most appropriate to CIFOR would start at the pre-industrial stage and cover frontier forests and those under intensification, whereas ICRAF would focus more on the rehabilitation and depletion stages, perhaps linking components with CIFOR in the intensification stage.

Biophysical information on landscape management will be agroecosystem-specific. To ensure significant impact from a small group of scientists, research themes and topics must be carefully selected. We propose that the joint initiative focus its research on tropical ecosystems, particularly in the "megadiversity" countries, for the following reasons:

1. Existing institutional expertise, contacts and leadership role;
2. Relatively weaker institutional capacity for biodiversity research in tropical countries;
3. Importance of tropical ecosystems, in terms of biodiversity, human population, and poverty; and
4. Existing field sites across a spectrum of population density (low to high human population densities) and land use patterns (low arable to high potential).
5. Political interest in sustainable use by the "megadiversity" countries, and others with globally important ecosystems, as these have high potential for in-country replication and impact.

To complement the Rainforest Challenge Program it will be important that half or more of the research effort be directed at humid tropics in the lowlands and highlands. Sub-humid forest and woodland ecosystems should also be included. The focus should be on areas with moderate to high population densities, with high incidence of poverty.

4. Proposed Components

The CIFOR-ICRAF joint initiative should be pursued over a 10-year period, through five closely-linked components, as follows (a suggestive budget allocation is also indicated):

1) Ecological principles and practices for biodiversity management in tropical landscape matrix - comparative research and synthesis (30% resources);
2) Strategies to engage and benefit local people for biodiversity management in working landscapes - comparative research and synthesis (25%);
3) Strategic support for pilot studies at research and implementation sites promoting biodiversity conservation in working landscapes (20%); and
4) Capacity-building through information dissemination and training (10%);
5) Policy analysis and influence to promote biodiversity in working landscapes (15%).

4.1 Ecological principles and practices for biodiversity management in tropical landscape matrices

We suggest that the CIFOR-ICRAF joint initiative should undertake research which leads to principles that will guide the design of land-use in tropical forest and woodland ecosystems. It is widely recognised that this interface between ecological, economic, social and political factors is complex, so "principles" may often only apply to specific landscapes and species assemblages. In carrying out research and synthesis, the joint CIFOR-ICRAF joint initiative should aim at "generalization busting" and avoid creating inappropriate new generalizations. The CIFOR-ICRAF Unit should not shy away from expressing unpopular views based on sound research.

Research will be undertaken in 8 to 10 landscapes across the spectrum from tropical lowland forests (often more sparesely populated, <1-40 people/km^2) to montane forests (often more densely populated, sometimes >500 people/km^2). All research will be in regions of high biodiversity value (to be protected or rehabilitated), where conservation or rural development organisations have already established long-term landscape-scale projects with both biodiversity and poverty reduction objectives. Some of these sites will overlap with Rainforest Challenge Program sites; others where CIFOR or ICRAF already have strong or highly relevant site experience, including ICRAF's protected area buffer zone projects and RUPES projects.

In terms of the choice of 8-10 sites, the CIFOR-ICRAF initiative needs to take factors of poverty, high biodiversity, feasibility and the opportunities for maximum comparison and contrast into account. Most poor people live in South Asia, but the greatest proportion of poor in a regional population live in sub-Saharan Africa. In terms of mega-diversity sites, CIFOR and ICRAF are working in good locations already. Examples are:

- the Afromontane forests included within the African Highlands Initiative (AHI) area;
- watersheds within the Peruvian Amazon, South-east Asia and Lake Victoria region in East Africa;
- Madagascar, where ICRAF are active;
- lowland tropical forests of West Africa, the Congo and Amazon Basins, and Kalimantan, Indonesia.

These locations also offer a good opportunity for planning maximum comparison and contrast into projects in terms of human population densities and land-uses. In addition, CIFOR and ICRAF's current work in mono-dominant woodlands (miombo) could be expanded with further work in dry forests. While TNC are keen on a link with CIFOR in Melanesia (Papua New Guinea (PNG)), Papua and the Solomon islands), feasibility and logistics factors need to be carefully considered in relation to risk and return. New Guinea is the outstanding surviving forested region of the Asian tropics. The reasons for this are New Guinea's low human population densities, the prevalence of

malaria, difficult terrain and the high diversity of the forests (with consequently lower densities of commercial timber species than the dipterocarp forest of Sumatra and Kalimantan). With unsustainable rates of logging in lowland forests of Sumatra and Kalimantan, however, the forests of New Guinea will increasingly become the focus of major logging interests. The research, policy and partnership opportunities of working there need to be balanced out against periodic violent confrontations in Papua, growing lawlessness and violent crime in PNG and ongoing conflict in the Solomon islands.

Additional sites may be sought in the "megadiversity" countries, that represent additional major types of tropical land uses: smallholder rain-fed annual crops, tree crop plantations, ranching or dairy farming, community or farm production forestry, smallholder irrigated rice production, mixtures of small and large landholdings. Research will be driven by the priority management information needs for the site, and will include description and monitoring of the spatial and temproral patterns of biodiversity (*sensu* Noss, 1990) in relation to productive land management, and research to reduce the trade-offs through improved management practices.

Research will address both understanding biodiversity in landscape matrices (vulnerability and resilience thresholds, managing invasive species, spatial patterns and thresholds of vegetation needed to maintain key species, corridor design and management, biodiversity resources required to maintain ecosystem services). The research would also assess changes in the biodiversity values with changes in agricultural and forest components and management (ecoagriculture potential/performance, and costs/livelihood contributions).

The project will also evaluate and synthesise results from relevant past research (e.g., studies of forest fragmentation and biodiversity), and collaborate with colleagues in other sites interested to design comparative studies. From these, the project will develop "design principles" or "best practices" for different types of land use systems. Interactions among production forest, protection forest, forest remnants, annual crop fields, grazing lands, and perennial crop fields will be studied, to develop site specific"design principles" to enhance biodiversity, that can be used to guide community/landscape planning processes. Researchers will seek to identify critical ecological features needed to maintain biodiversity. Interventions in terms of plant components and management (in productive and conservation plots) will be monitored and evaluated.

The joint initiative could lead work on these issues within the Future Harvest Challenge Programs on the "Rainforest Challenge: Forests as Resources for the Poor" and "Agricultural Biodiversity for Sustainable Development" along with IPGRI, CIAT and CATIE, possibly with IUCN and the Future Harvest Foundation on ecoagriculture systems. CATIE, for example, are conducting landscape-scale approaches to ecosystem (forest) restoration in Central America and are also conducting a multi-country study funded by GEF that links livestock raising and biodiversity conservation in the lowland neotropics.

4.2 Strategies to engage and benefit local people in biodiversity management in working landscapes

In populated agroecosystems, forests and natural habitats will only be maintained if they can be managed to produce a reliable flow of products and income, including ecosystem services. The CIFOR-ICRAF joint initiative should aim to become a leading source of research and information on diverse strategies to engage local people in biodiversity conservation in rural working landscapes. We suggest that it would be useful to focus research activity on the following topics:

- Local perceptions of the importance of biodiversity;
- The role of biodiversity in managing livelihoods risks;
- Existing local mechanisms for biodiversity protection;
- How to integrate biodiversity into planning agriculture and production forestry at multiple scales;

- Mechanisms for compensating / rewarding biodiversity conservation
- The role of market in biodiversity conservation
- How to develop and manage multi-functions of forests for goods and services that are valued locally and to the wider community.

Data and analyses will be generated from action research on diverse strategies in the core landscape projects, and from impact and management assessments by collaborators for existing field models in other sites. Good examples are the ICRAF project in Rewarding Upland Farmers for Ecosystem Services (RUPES); watershed payment field studies by the International Institute for Environment and Development (IIED). Studies will highlight local perceptions of important biodiversity, and the role of biodiversity in managing livelihood risks; existing local mechanisms for biodiversity protection; processes to integrate biodiversity into planning of agriculture and production forestry at farm and landscape scale; and mechanisms for compensating/rewarding local people for biodiversity conservation. Special attention will be paid to design of payments for ecosystem services, like watershed and carbon sequestration, including payments to indigenous forest communities. Other "quid-pro-quo" arrangements will also be explored, as well as the development of commercial timber and NTFP markets for local producers as an incentive for biodiversity conservation ("sustainable use" of forest resources used for habitat). Research will consider needed differences in approaches when working with rehabilitation of degraded landscapes, as contrasted with protecting well established habitat.

Key partners for CIFOR and ICRAF in the landscape sites are likely to include: national agricultural and conservation research institutions; farmer or forest users' organisations in study regions; and international conservation partners. Studies of other field experiences in the tropics can be promoted with Winrock International' Natural Resources and Ecosystem Services program; Forest Trends; The Katoomba Group; The Nature Conservancy; Conservation International; and WWF. Other potential partners are Weyerhaeuser, who are involved in work of this type in the Sierra Nevada and who have contact with CIFOR or possibly the Trillium Corporation, due to their experience in the Rio Condor project.

4.3 Strategic support for pilot studies at research and implementation sites promoting biodiversity conservation in working landscapes

The CIFOR-ICRAF initiative would provide strategic research support in developing selected initiatives for biodiversity conservation in working landscapes. It would be useful to select at least one of these sites on the basis of accessibility. This would enable the site to be a demonstration area to potential donors, some of whom have limited time. The watershed and national park in the Gunung Haliman area of Java, Indonesia, where ICRAF are working already is a good example of an accessible, strategically located site.

Probable partners in support at the pilot study level could be The Nature Conservancy and/or World Wildlife Fund, for whom pilot projects are designed to expand to multiple high-value biodiversity sites worldwide, or CARE International, who is partnering with WWF. CIFOR or ICRAF staff will be members of Advisory Groups for selected sites, and provide input into intervention strategies, as well as provide training to project staff (see Section 4.5 below). They will help to identify technical challenges and research needs, and work with the lead conservation organization (and other research support organizations) to find technical solutions, adapt research findings to local conditions, and design any necessary research. Those project sites close to or similar to existing CIFOR or ICRAF research sites will preferred. Where possible, some of the research for Components 1 and 2 will be implemented through or within partners' pilot projects.

Other potential partners are Winrock International planned landscape projects, IFAD natural resource management projects and the joint-biodiversity-livelihoods related projects of IUCN and SANREM. Additional collaborators could include: national agriculture and conservation research institutions; farmers' or forest owners/users' organisations in study regions. The Smithsonian

Tropical Research Institute, who have formed a network of permanent forest sites across tropical forests and are keen to work with CIFOR in Indonesia (Bulungan) and Gabon (Makouko). Although establishment of 50 ha plots is expensive, funding has been raised for CTFS sites in many parts of the world, including Cameroon (Korup). Other partners are Conservation International; the Millennium Ecosystem Assessment; Diversitas, who have proposed new program on biodiversity in working landscapes; university researchers with diverse expertise; IUCN, and possibly the UNESCO Biosphere Program, the Tropical Rainforest Collaborative Research Centre (Queensland, Australia), the Consortium for the Sustainable Development of the Andean Ecoregion (CONDESAN) and Tropenbos International.

4.4 Capacity-building through information and training

The Partnership will develop a set of training and resource modules on biodiversity conservation in working landscapes, that can be used by practitioners (including farmers and forest users) and researchers working with them. These will be tested with partners in the landscape projects. The United Nations University project on People, Land Management and the Environment (PLEC) (see http://www.unun.edu/env/plec) and the Tropical Soil Biology and Fertility (TSBF) programme (which has a close relationship with ICRAF) are interesting models to consider in this training process.

Once validated, a "train-the-trainer" workshop will be organized to assist organisations with established biodiversity- or rural development-related training programs to integrate this material into on-going leadership and training programs. Materials will include a Reader (and associated compact disc) based heavily on materials produced by other components, and will draw from these to identify basic training priorities and resources for design. Key resources will be translated into major languages. Work will begin in partnership with The Nature Conservancy' Conservation Training Center being developed in Bogor, and be closely linked with and promoted through ICRAF's already-strong training program. Training materials developed will also be shared with the International Institute for Rural Development and other "learning networks."

Annual, thematic two week regional training courses should be considered for CIFOR supported field stations in Bulungan (Kalimantan, Indonesia) and Makouko (Gabon). The annual field courses which the Smithsonian organises on Barro Colorado island are an extremely popular example of this type of course.

A special website will be developed, that links into websites of the Centres, Future Harvest Foundation, ecoagriculture, and major biodiversity organisations. It would be desirable to produce at least one short video describing the principles of biodiversity-conserving planning of working landscapes. The website will have downloadable papers available, and user-friendly guidelines and information for "best practices" in diverse tropical land use systems.

4.5 Policy analysis and influence for biodiversity conservation in working landscapes

The CIFOR-ICRAF initiative should seek to provide important strategic input to integrate biodiversity conservation and rural development into on-going policy dialogues and policy. The Partnership will assess the implications of available research results (from its own work and that of others around the world) for particular policy action, at landscape, municipal, national and international levels. This policy analysis component would effectively link the previous four components, namely the science elements (Sections 4.1 and 4.2), demonstrated in pilot project sites (Section 4.3) and capacity building (Section 4.4) to influencing the global agenda, including how policy relates to the funding agenda.

The Partnership will identify priority issues, audiences and policy processes, and tailor communication efforts for maximum impact. We suggest that the focus could be achieved through:

- Critical analysis of existing policy and their impacts of the "big players" (such as the World Bank and European Union);
- Lessons learn from successes and failures of the "big players";
- Identifying gaps and opportunity synthesis; and
- Packaging the result of CIFOR and ICRAF biodiversity research results in a timely and user friendly format tailored to specific audiences.

One of the conclusions drawn from analyses of Integrated Conservation and Development Projects (ICDPs), for example, is that many have performed poorly due to lack of attention to the broader policy environment. They failed to fully recognise the force and dynamics of the economic incentives driving land use change, and the local impacts of policy decisions taken far away about biodiversity conservation and rural development.

A separate series of Policy Briefs for Biodiversity in Rural Landscapes could be established, or such briefs may be integrated into the present series of ICRAF (e.g., ASB Briefs) and CIFOR (e.g., InfoBriefs); all would be translated into the main UN languages and some local languages (e.g., Bahasa Indonesia). CIFOR and ICRAF will co-ordinate to ensure appropriate representation at key meetings. Principal audiences could include: the Convention for Biodiversity, World Food Summit, the UN Forum on Forests, the Global Environment Facility, the Convention to Combat Desertification, the Clean Development Mechanism of the Kyoto Protocols on Climate Change, Rural Development Departments of the international development banks, NGO Coalitions for environment and rural development, international research priority-setting bodies, etc. The team will actively seek partners to co-author and co-sponsor policy messages (e.g., IUCN, World Conservation Monitoring Centre). Members of the Biodiversity team will participate in a limited number of key policy-related committees, as Members or Advisors. Outputs will also be fed into the highly valued POLEX e-mail service, and selected topics will be promoted in the international media with support from the Future Harvest Foundation.

5. Implementation

It is proposed that a CIFOR-ICRAF initiative be implemented through a re-allocation of existing senior research time and resources (which will call for replacing resources in the Unit that are depleted as current projects are completed). This could be done in two phases, with the overall goal of integrating CIFOR and ICRAF's work on biodiversity conservation (Figure 5). Phase 1 would be the formation of a Joint CIFOR-ICRAF Biodiversity Unit.

Merely because we have been asked to look forward 15-20 years into the future doesn't necessarily mean that the choice of sites needs to change radically, however. Many existing research sites are ideally located and work in these sites should be consolidated. Good examples are the African Highlands Initiative (AHI) and ICRAF's work in watersheds (the Peruvian Amazon and with upland farming communities in Indonesia, the Philippines, Laos, Vietnam and Thailand), the Lake Victoria Basin and African Highlands Initiative, all of which are located in the worlds "biodiversity hotspots" or WWF-US's Global 200 Ecoregions. Similarly, CIFORs work in tropical forests on the Brazilian Amazon, Mexico's Yucatan peninsula, Indonesia, Gabon and Cameroon and miombo woodlands of south-central Africa all coincide with internationally recognised priorities for biodiversity conservation.

In addition, ICRAF's focus on watersheds provides a useful landscape level focus which should be (and is being) built on (for example in ICRAF's more recent link to the Mekong and Salween watersheds in Yunnan, southwest China with a staff members based at CBIK in Kunming.

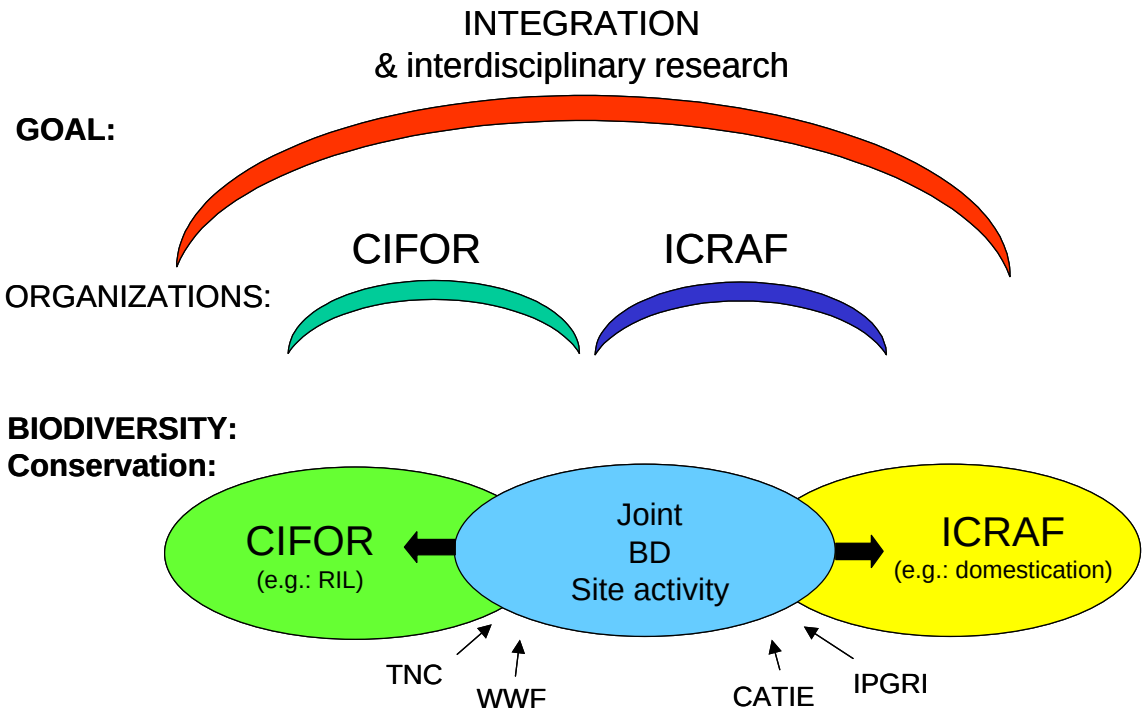

Figure 5 A conceptual diagram showing how a Joint Biodiversity Unit would be formed (Phase 1). If successful, the Unit then could expand "outwards" to more fully integrate and cut across each of the three CIFOR and ICRAF thematic programmes (Phase 2) (source: R Nasi, workshop, 29 July 2002).

As watersheds generally are clearly defined (apart from “sand catchments” along coasts such as the Mozambique coastal plain), they provide a useful starting point for land use and land cover assessments or socio-economic assessments for future conservation and watershed management planning. There is a need, however, for CIFOR to have improved Geographical Information System (GIS) capability. This will assist studies of land cover, fragmentation and habitat heterogeneity) over large geographical areas. ICRAF have a stronger GIS capability than CIFOR, and joining forces on a biodiversity research programme would enable wider use of high resolution satellite data as a powerful tool in understanding spatial patterns of biological diversity and fragmentation. Below are preliminary ideas regarding Unit organisation, staffing and funding.

5.1 Unit organisation

We considered diverse organisational models for a Biodiversity partnership, and concluded that a new Joint Unit is preferred, in addition to CIFOR’s 3 core programs (Governance, Livelihoods and Environmental Services) and ICRAF’s proposed 3 core programs. This will add another element to the organisational chart of the two Centres, but our reasoning is:

a) Though the Unit will share and draw from all the main programs of the two Centres, it does not logically fall under any of them, and would likely be marginalized if placed under them.
b) The five projects should be closely linked, which will be difficult to achieve if all are not under a single leadership, or if they are unable to work fluidly as a team. With primary institutional responsibility to the Biodiversity work, individual members may still be able to work effectively in components of the other Programs.
c) Although modest in size in either centre, the Joint Unit will represent a large share of both Institute’s work and require direct reporting to the Director-General and/or Directors of Research.

Under this option, the Joint Biodiversity Unit Director (also Leader of one of the five projects) might best be located at a CIFOR/ICRAF Biodiversity Unit office at CIFOR headquarters in Bogor. CIFOR could provide administrative support (at shared cost) for Unit planning and co-ordination activities. The proposed half-time Project Leader for Biodiversity Information and Training should also be in Bogor, to facilitate collaboration with the TNC Training Center, but should probably be linked to ICRAF's larger training program. At least one senior researcher (in projects 1 and/or 2) should probably be posted at a Latin American site. Posting of the other proposed 4.5 staff may be split between Bogor, Nairobi, or a Center located near another of the major field sites.

The Unit Director should play a regular Director's role in the Senior Management Team of CIFOR, and have some type of direct link with ICRAF's Senior Management Team. The Unit Director will be the principal supervisor of all staff dedicated to the Joint Biodiversity Unit, and submit evaluations to the appropriate Director of Research where those staff are employed. It is recommended that an Advisory Group of individuals with diverse expertise and perspective be established, to help review project proposals and outputs, and to facilitate processes of (2-way) networking and policy/science influence. These may include project partners. Some resources should be allocated for review activities, travel of Advisory Group members, etc.

5.2 Staffing

The proposed Unit would provide resources for 6 full-time equivalent senior staff and associated costs.

A Director of the Joint Unit would be selected together by CIFOR and ICRAF, and jointly appointed. The Director will work full-time on the Unit to lead the program, co-ordinating the five projects, and also leading at least one of the projects. The research components 1, 2 and 3 will employ 4-5 ICRAF and CIFOR staff, and directly finance much of the field research of collaborators.

The Policy Project will employ 0.5 persons to organise and manage staff and consultant input, and participation in major meetings; a half-time communications specialist will support the policy project. The information and training project will require 0.5 staff.

Each senior researcher will have a full-time research assistant. Much of the expertise for developing synthesis papers, strategic support, etc. will be drawn from short-term consultants and collaborators. A high proportion of the research and synthesis work will be done by and with local, national and international collaborators at the major field project sites, with CIFOR/ICRAF staff playing a major catalytic, co-ordination and synthesis roles. Both Centres should aggressively seek doctoral and post-doctoral students to participate in field research.

Partners for the strategic research support should be chosen from among the institutions that have strongly committed to the landscape/ecosystem approach for conservation (e.g., TNC, WWF, CI, WRI) and from rural development institutions that have strongly committed to a conservation component. University partners are important in the countries where ICRAF and CIFOR are working; local governments and NGOs need to be involved for actual delivery. More generally, it is essential to involve more of the social constituency regarding forest-based communities.

5.3 Planning and co-ordination

In-depth planning and Unit evaluation should be done by the entire team, plus the Director of Research of CIFOR and of ICRAF, probably the Directors of CIFOR's Program 1 on Environmental Services and ICRAF's Program 3 on Ecosystem Rehabilitation, plus possibly a small number of other core partners or Advisory Group members from outside the two institutes. These would define general and specific Unit objectives, define projects and final products

expected from those projects (and how they would contribute to objectives), component projects, and project budget allocation. The entire team should meet at least yearly to share progress, evaluate findings and modify work plans. Otherwise, the Unit director will monitor progress through regular consultation with the project.

Projects should be implemented by project teams that have substantial autonomy of action and budget allocation, so long as they remain the objectives and promised products. Synthesis of findings from different project components, co-ordinated by the Unit director, drawing on the products of different projects.

Members of the Biodiversity Team may be designated as a liaison with a key international organisations (e.g., Agrobiodiversity Challenge Program, Rainforest Global Challenge Program, Smithsonian Institution, DIVERSITAS, SANREM, Conservation International, The Nature Conservancy), and a modest budget provided to ensure participation in one or two meetings/workshop with these groups each year.

A simple e-mail based information networking service may be set up to facilitate information-sharing among the different projects and partners, overseen by the Unit director. It is advisable to set up individual computer video capability, to facilitate regular team meetings.

5.4 Funding sources and strategies

This Unit will require a budget of US$12 million over five years--$10 million for Unit activities ($2 million/year) and $2 million (20%) for overhead costs. The cost would be roughly allocated among the five projects as indicated above. Of this cost, $4.2 million (35%) will be covered by core Center resources, including all of the project on Strategic Influence. An additional $8.5 million will need to be sought from other sources, with several options:

(1) An estimated $1 million will be funded from allocations to CIFOR and ICRAF from its participation in the CG Global Challenge programs on Rainforests and Agrobiodiversity. Separate funding for the other 3 projects can be sought from diverse donors. It is recommended to approach the following donors: MacArthur Foundation, Ford Foundation, DFID, IFAD, Global Environment Facility.
(2) Prepare an umbrella project on Biodiversity in Landscape Matrices to be funded by one or two large Foundation donors. We suggest exploring this possibility early on.

- In the case of the Moore Foundation, an established partnership with The Nature Conservancy regional office based in Bogor (particularly its Conservation Leadership program) could be beneficial. TNC has a large joint Moore-funded project with World Resources Institute. Moore is also funding Conservation International. TNC, CI, and WRI could potentially be partners under various projects.
- Counterpart funding from partners must be negotiated to cover full personnel and resources for implementing the field projects and training.
- USAID's Global Development Alliance might also be a useful source, if counterpart funding from the private sector can be organized - a key strategy for at least one of the sites with an international commercial agriculture or forestry component.
- European Union, by linking with rural landscape projects in European countries.

(3) Prepare an umbrella project on Biodiversity in Landscape Matrices for the Global Environment Facility (GEF). These are generally more problematic, and with high transaction costs - could require 2 years before funding, if successful. The Unit should begin planning to submit at GEF proposal within a few years.

Although one reviewer of an early draft of this report commented that the budget seemed like the CG system in the 1970's (when funds were easier to raise), the suggested budget needs to be seen in perspective. Not only is biodiversity conservation an area of CIFOR and ICRAF's work which needed to be strengthened, but the total budget suggested over 10 years in less that the cost of the recent, 1-day Commonwealth Games opening ceremony (US$18 million). It also pales into insignificance when compared against the current annual budget of the Nature Conservancy (US$800 million/yr). We have no doubt that if packaged well, the above budget can be raised.

6. Glossary

Agroforestry: "a dynamic and ecological approach to land use that integrates trees into the landscape" (from Leakey, 1996 in Agroforestry Today, Jan-March 1997).

Agroecosystems: a biological and natural resource system managed by humans for the primary purpose of producing food as well as other socially valuable nonfood goods and environmental services" (Wood, Sebastian & Scherr, 2000)

Alpha diversity: species diversity at the plot level.

Beta diversity: species diversity across a broader spatial (landscape) scales.

Biodiversity: comprising "genes, individuals, demes, metapopulations, populations, species, communities, ecosystems and the interactions between these entities" (Lindemayer & Franklin, 2002).

Depleted forest stage: when forests are depleted because of prior intense and rapid forest exploitation and intensification of land use. Primary forest cover is very low and total forest cover stabilises with reduced large-scale exploitation, and increased protection and better management. Population pressures on the land and the natural resource base raise concerns about meeting local livelihood needs for fuelwood and other forest products. Low forest cover and environmental deterioration raise concerns for watershed protection, biodiversity conservation, and soil protection among other environmental values. There is also increased concern for future timber supplies. Continued demand for forest products are met by imports and product substitution, but resource imports, substitute products, and intensified agriculture or plantation development are generally not available to poorer sections of society. This condition exists today, for example, in Vietnam, most of India, Nepal, tropical China, Peninsular Malaysia and Afromontane forests of East and West Africa.

Ecoagriculture: Land use systems designed to produce both food and ecosystem services, including biodiversity conservation.

Ecologically sustainable forest management: perpetuates ecosystem integrity while continuing to provide wood and non-wood values; where ecosystem integrity means the maintenance of forest structure, species composition, and the rate of ecological processes and functions with the bounds of normal disturbance regimes".

Frontier stage of forests: the arrival of industrial use of natural resources (logging for timber, mining for mineral resources) in a pre-industrial stage forest area. Rapid forest exploitation encroaches into regions with remaining primary forest. Because logging in these frontier forests necessitates building important infrastructure (especially roads) and heavy equipment (to harvest large trees), it is an activity carried out by large, often trans-national, companies. It generally results in the selective logging of the most valuable timber species, the ones that “pay” for the opening of the frontier. Because logging is selective, forest cover remains relatively undisturbed except where the concentration of high-value timber is very high. However, industrial logging activities tend to be largely exploitative with limited concern for long-term sustainability.

Habitat: the range of environments in which a species can occur. *Note*: **Suitable habitat** is: "where a species occurs at a rate high enough to maintain long-term positive population growth" (Lindenmayer & Franklin, 2002).

Intensification stage of forests: characterized by an intense and rapid exploitation of forests: more species are harvested, new settlers move into the area searching for agricultural land and better road access allows increased trade in forest products. Primary forest cover declines rapidly, and

conflicting uses by multiple actors result in land scarcity and dispute. The big players of the frontier stage are often still operating but there is emergence of smaller players (local logging companies, small saw-mills, etc.). As the resource base decreases and the forestry sector becomes more and more fragmented it becomes difficult to maintain suitable land use options. Environmental deterioration sets in and includes loss of forest cover and biodiversity, watershed destruction, soil erosion, land degradation, siltation, flooding and landslides.

Landscape: this can be an area ranging from 100's of ha to many 10 000 ha units which comprises many sets of stands.

Matrix: comprises landscape areas that are not designated primarily for conservation of natural ecosystems, ecological processes, and biodiversity regardless of their current condition (ie : whether natural or developed) (Lindemayer & Franklin, 2002).

Pre-industrial stage of forest use: simple technologies and relatively low population densities put minimal pressure on forest resources, as was common throughout pre-colonial tropical countries. In this stage, primary forest cover undergoes a slow decline with the general trends of rising population and expansion of agriculture. Indigenous groups inhabiting the forested regions practice long-fallow swidden agriculture and extraction of forest products. Households limit forest clearing to what can be managed for cultivation, because labour is scarce. Forests and forest products play an integral role in local livelihoods. Most products extracted are for subsistence, while selected products are traded making use of animal and river transport. Home gardens and enriched fallows managed receiving low-intensity management already are common, but may be intensified in areas of greater market access. Capital and technological inputs are low both in agriculture and forest resource use. Traditional institutions regulate land use, and government intervention is very limited.

Rehabilitation stage of forest use: forested land previously cleared for agriculture or other purposes which has been abandoned and left to recover, or is actively managed to increase the restoration of forest cover. If adequate ecological conditions are in place, these lands can return to a forested state that may or may not be similar to the original one. This is currently happening in North America, parts of Europe because of agricultural policy (eg: France, where hardwood forest cover is increasing because agricultural land is being abandoned) and in some tropical countries (e.g. Gabon, Congo) where anthropogenic savannas are allowed to return to a forest state.

Working landscape: a landscape used by people, for production purposes as well as for cultural, social and utilitarian values. This term is broader than that of "managed landscapes" and is used preferentially here, as not all landscapes are "managed" - many are mismanaged for short-term gain or despoiled without understanding of the long-term consequences of this: a situation which can be changed.

7. Selected References

Anon. 1999. *World Population Prospects: the 1998 Revisio*n, United Nations Dept of Economic and Social Affairs

Anon. 2001. Mineral for cell phones aggravates Congo War. Drillbits & Tailings 6(3): March 31, 2001

Arnold, J.E.M. 1999. Conservation of diversity in managed landscapes: Review of a concept note proposing a new research initiative in this subject area. Oxford, United Kingdom.

Arnold, J.E.M. 2001 Forestry, poverty and aid, CIFOR Occasional Paper No 33, Center for International Forestry Research, Bogor, Indonesia.

Arroyo, M T K *et.al*. 1996. *Toward an ecologically sustainable forestry project: concepts, analysis and recommendations. Protecting biodiversity and ecosystem processes in the Rio Condor project, Tierra del Fuego.* Departmento Investigacion y Desarollo, Universidade de Chile, Santiago [cited in Lindemayer and Franklin, 2002]

Balmford, Andrew, J.L. Moore, T. Brooks, N. Burgess, L.A. Hansen, P. Williams, C. Rahbek. March 2001. Conservation conflicts across Africa. *Science* 291: 2616-2619.

Bass, S; Dubois, O; Moura Costa, P; Pinard, M; Tipper, R and Wilson, C. 2000. Rural livelihood and carbon management. IIED Natural Resources Issues Paper No 1, IIED, London.

Barrett, C.B., K. Brandon, C. Gibson, H. Gjertsen. June 2001. Conserving tropical biodiversity amid weak institutions. *BioScience* 51(6): 497- 502.

Barr, C. 2001. Banking on sustainability : structural adjustment and forestry reform in post-Suharto Indonesia. Macroeconomics for Sustainable Development Program office, CIFOR.

Bierregard, R O, C Gascon, T E Lovejoy and R Misquita. 2001. Lessons from Amazonia : the ecology and conservation of a fragmented forest. Yale University Press, New Haven.

Bond W.J. 1994. Do mutualisms matter? Assessing the impact of pollinator/disperser disruption on plant extinction's. *Phil. Trans. Roy. Soc. B* 344:83-90

Bond W.J. & Midgley J.J. 2001. The importance of the persistence niche. *Tree* 16:45-51.

Burslem, D F R P., N C Garwood and S C Thomas. 2001. Tropical forest diversity – the plot thickens. *Science* 291: 606- 607.

Brooks, Thomas, A. Balmford, N. Burgess, J. Fjeldså, L.A. Hansen, J. Moore, C. Rahbek, P. Williams. August 2001. Toward a blueprint for conservation in Africa. *BioScience*, 51(4): 613-624

Bruner, A.G., R.E. Gullison, R.E. Rice, G.A.B. da Fonesca. August 10, 2001. The effectiveness of parks. *Science*, 293: 1007a.

Bruner, A.G. *et. al.* 2001. Effectiveness of parks in protecting tropical biodiversity. *Science* 291: 125- 128.

Buck, L.E., C.C. Geisler, J. Schelhas, E. Wollenberg (Eds.) 2001. Biological Diversity: Balancing Interests Through Adaptive Collaborative Management. CRC Press. Boca Raton, Florida.

Byers, B and R Nasi. 2002. *Creating an Enabling Environment for Biodiversity Conservation Across the Landscape.* Workshop on "Actions to be supported by GEF to create an enabling environment for achieving sustained biodiversity conservation across the landscape, using forests as an example". CIFOR Headquarters, Bogor, 16-20 April 2001, unpublished draft report, 17 July 2002.

Campbell, B (1996) The Miombo in transition: Woodlands and welfare in Africa, Center for International Forestry Research (CIFOR), Bogor, Indonesia

Center for Applied Biodiversity Science. 2002. Designing Sustainable Landscapes: The Brazilian Atlantic Forest. Conservation International. Washington, D.C.

CIFOR, *et. al. 2002*. The rainforest challenge: Meeting poor people's needs while conserving biodiversity. CIFOR, Bogor, Indonesia.

Cincotta, R P and R Engleman. 2000. Nature's place: human population and the future of biological diversity. Population Action Internationbal, Washington DC.

Cochrane, M.A. and Laurance, W.F. Fire as a large-scale edge effect in Amazonian forests. J. Trop. Ecol. (in press), cited in Laurance *et.al*., (2002)

Cochrane, M.A. *et.al*. (1999) Positive feedbacks in the fire dynamics of closed canopy tropical forests. Science 284, 1832–1835

Collier, P. 2000. Economic causes of civil conflict and their implications. World Bank, Washington DC. (cited by Dudley *et.al*., 2002)

Collier, P and A Hoeffler. 1998. On the economic causes of civil war. Oxford economic papers 50:563-573.

Condit R., Pitman N., Chave J., Leigh Jr E.G., Terborgh J., Foster R.B., Valencia R., Villa G. Losos E., Muller-Landau H. and Hubbell S.P., 2002, Beta-diversity in tropical forest trees. *Science* 288(5470): 1414-1418

Constanza, R, L Wainger, C Folke and K-G Maler. 1993. Modeling complex ecological economic systems. *BioScience* 43: 545 - 555.

Dietrich, C. 2000. Inventory of formal diamond mining in Angola pp. 141-172 in Cilliers, J and C Dietrich (eds). Angola's war economy: the role of oil and diamonds. Institute for Security Studies, South Africa.

Dobson, A.P., J.P. Rodriguez, W.M. Roberts. 2001. Synoptic Tinkering: Integrating strategies for large-scale conservation. *Ecological Applications* 11(4): 1019-1026.

Dudley, J P, J P Ginsberg, A J Plumptre, J A Hart and L C Campos. 2002. Effects of war and civil strife on wildlife and wildlife habitats. *Conservation Biology* 16: 319 - 329.

Ellis, S. 1999. The mask of anarchy: the destruction of Liberia and the religious dimension of an African Civil War. New York University Press, New York.

Ehrlich, P.R. *et.al*. (1995) *The Stork and the Plo*w, Yale University Press

FAO (2001) Forestry outlook study for Africa : a regional overview of opportunities and challenges towards 2020. African Forestry and Wildlife Commission and Near East Forestry Commission, FAO, Rome. Online at: http://www.fao.org/forestry/fosa

Fearnside, P.M. (2000) Global warming and tropical land-use change: greenhouse gas emissions from biomass burning, decomposition and soils in forest conversion, shifting cultivation and secondary vegetation. *Climatic Change* 46: 115–158

Fjeldsa, J and C Rahbek. 1998. Continent-wide conservation priorities and diversification processes. Pp. 139-160 in ; G M Mace, A Balmford and J R Ginsberg (eds) Conservation in a changing world. Conservation Biology series 1, Cambridge University Press, Cambridge.

Forman, D., J Davis, D Johns, R Noss and M Soule. 1992. The wildlands project mission statement. Wild Earth (Special Issue); 3-4.

Forman, R.T.T. 1995. Land Mosaics: The Ecology of Landscapes and Regions. Cambridge University Press. Cambridge.

Gascon, C., G.B. Williamson, G.A.B. da Fonesca. May 2000. Receding Forest Edges and Vanishing Reserves. *Science* 288: 1356-1358.

Gedney, N. and Valdes, P.J. (2000) The effect of Amazonian deforestation on the Northern Hemisphere circulation and climate. Geophysical. *Research Letters* 27, 3053–3056

GEF Study team. 2001. Second Overall Performace Study (OPS2) – Final Draft, 11 November 2001. GEF, Washington, cited in: Baastel. 2001. Second review of the effectiveness of the financial mechanism[s] for the United Nations Convention of Biological diversity: Analysis of findings: Financial resources and mechanism[s] (Article[s] 20 and 21), Le Groupe-conseil Baastel Ltee, Quebec for UNEP/CBD/COP/6/INF.4, 14 January 2002.

Havens K.E. & Aumen N.G., 2000 - Hypothesis-driven experimental research is necessary for natural resource management. *Environmental management* 25 (1): 1-7.

Hubbell, S. 2001. The Unified Neutral Theory of Biodiversity and Biogeography. Princeton University Press.

Jackson, D.L. and L.L Jackson. 2002. The Farm as Natural Habitat : Reconnecting Food Systems with Ecosystems. Island Press. Washington, D.C.

Johnson, B.R., J. Silbnernagel, M. Hostetler, A. Mills, F. Ndubisi, E. Fife, M.R. Hunter. 2002. The nature of dialogue and the dialogue of nature : Designers and ecologists in collaboration. In : Johnson, B.R. and K. Hill (Eds.) Ecology and Design: Frameworks for Learning. Island Press. Washington D.C. Pp. 305-356.

Klare, M T. 2001. Resource wars. Henry Holt, New York. 277pp.

Le Billon, P. 2000. The political economy of resource wars. pp. 21-42 in : J Cilliers & C Dietrich (eds) Angola's war economy : the role of oil and diamonds. Institute of Strategic Studies, Pretoria with support from the Government of Finland.

Laurance, W.F. (1998) A crisis in the making: responses of Amazonian forests to land use and climate change. *Trends Ecol. Evol.* 13, 411–415

Laurance, W.F. and Williamson, G.B. (2001) Positive feedbacks among forest fragmentation, drought, and climate change in the Amazon. *Conservation. Biology* 15: 1529–1535

Laurance, W F., G Powell and L Hansen.2002. A precarious future for Amazonia. *Trends in Ecology & Evolution* Vol.17 No.6 June 2002 p. 254-255

Lavorel S., McIntyre S Landsberg J & Forbes T.D.A. 1997. Plant functional classifications: from general groups to specific groups based on response to disturbance. *Tree* 12 (12): 475-7

Lindenmayer D.B., Margules C.R. & Botkin D.B. 2000 - Indicators of biodiversity for ecologically sustainable forest management. *Conservation Biology* 14 (4): 941-950

Lindenmayer, D B and J Franklin. 2002. Conserving forest biodiversity : a comprehensive, multi-scaled approach. Island Press, Washington.

Lutz, E. and J. Caldecott (Eds.) 1996. Decentralization and Biodiversity Conservation. The World Bank. Washington D.C.

MacArthur, R H and E O Wilson. 1967. *The theory of island biogeography*. Princeton Univ. Press, NJ.

Maddison, A. 1995. *Monitoring the World Economy, 1820–199*2, Organisation for Economic Cooperation and Development

Marc-Olivier, H., B. Delen and P. Vermaerke. 2002. Supporting the war economy in the DRC : European companies and the coltan trade. IPIS, Antwerp, Belgium.

Margules, C R, T D Redhead, M F Hutchinson and D P Faith. 1995. BioRap : Guidelines for using the BioRap methodology and tools. Canberra, Australia. CSIRO Publishing.

Margules, C and Pressey, R L. 2000. Systematic conservation planning. *Nature* 405: 243 - 253.

McIntyre, S and R Hobbs. 1999. A framework for conceptualizing human effects on landscapes and its relevance to management and research models. *Conservation Biology* 13: 1282-1292.

Mac Nally, R. and G.P. Quinn. 1998. Symposium introduction: The importance of scale in ecology. *Australian Journal of Ecology* 23: 1-7.

McCann, K.S. May 2000. The diversity-stability debate. *Nature* 405: 228-233.

Miller, J R and R J Hobbs. 2002. Conservation where people live and work. *Conservation Biology* 16: 330-337

Myers, N., RA Mittermeier, C G Mittermeier, GB da Fonesca and J Kent. 2000. Biodiversity hotspots for conservation priorities. *Nature* 403: 853-858.

National Research Council. 1999. *Our Common Journey: a Transition Toward Sustainability*, National Academy Press

Nix. H. 1997. Management of parks and reserves for the conservation of biological diversity. Pp. 11-36 in*: National Parks and protected areas: selection, delimitation and management.* JJ Pigram and R C Sundell (eds) University fo New Englad, Armidale, NSW, Australia).

Olson, DM, E Dinerstein, R Abell, T Allnutt, C Carpenter, L McClenachan, J D'Amico, P Hurley, K Kassem, H Strand, M Taye, and M Thieme. 2000. The Global 200: A representation approach to conserving the Earth's distinctive ecoregions. Conservation Science Program, World Wildlife Fund-US 1250 24th Street, NW, Washington, DC, 20037 USA

Pimm, S.L., M. Ayres, A. Balmford, G. Branch, K. Brandon, T. Brooks, R. Bustamante, R. Costanza, R. Cowling, L.M. Curran, A. Dobson, S. Farber, G.A.B. da Fonesca, C. Gascon, R. Kitching, J. McNeely, T. Lovejoy, R.A. Mittermeier, N. Myers, J.A. Patz, B. Raffle, D. Rapport, P. Raven, C. Roberts, J.P. Rodríguez, A.B. Rylands, C. Tucker, C. Safina, C. Samper, M.L.J. Stiassny, J. Supriatna, D.H. Wall, D. Wilcove. May 2001. Can we defy nature's end? *Science* 293: 2207-2208.

Pressey, R L. 1995. Conservation reserves in New South Wales. Crown jewels or leftovers? *Australasian Science* 26:47-51.

Pressey, R L. *et.al*. 1993. Beyond opportunism: key principles for systematic reserve selection. *Trends in Ecology & Evolution* 8: 124-128.

Pulliam, H.R. and B.R. Johnson. 2002. Ecology's new paradigm: What does it offer designers and planners? In: Johnson, B.R. and K. Hill (Eds.) Ecology and Design: Frameworks for Learning. Island Press. Washington, D.C. Pp. 51-84.

Pullin A.S. & Knight T.M., 2001 - Effectiveness in conservation practice: pointers from medicine and public health. *Conservation Biology* 15: 50-54.

Puth, L.M. and K.A. Wilson. February 2001. Boundaries and corridors as a continuum of ecological flow control: Lessons from rivers and streams. *Conservation Biology* 15 (1): 21-30.

Rhoades, R.E. and J. Stallings (Eds.) 2001. Integrated Conservation and Development in Tropical America: Experiences and Lessons in Linking Communities, Projects, and Policies. SANREM CRSP and CARE-SUBIR. Athens, Georgia.

Richards, P. 1996. Fighting for the rain forest: war, youth and resources in Sierra Leone. James Currey, London.

Riitters, K., J. Wickham, R. O'Neill, B. Jones, and E. Smith. 2000. Global-scale patterns of forest fragmentation. Conservation Ecology 4(2): 3. [online] URL: http://www.consecol.org/vol4/iss2/art3

Scherr, S.J. and J.A. McNeely, 2002. Reconciling agriculture and biodiversity: Policy and research challenges of 'ecoagriculture'. Opinion. World Summit on Sustainable Development. International Institute for Environment and Development, London.

Scott, J.M., T.H. Tear, F.W. Davis. 1996. Gap analysis: A landscape approach to biodiversity planning. American Society for Photogrammetry and Remote Sensing. Bethesda, Maryland.

Skole, D. and Tucker, C.J. (1993) Tropical deforestation and habitat fragmentation in the Amazon: satellite data from 1978 to 1988. *Science* 260, 1905–1910

Singh, S and C Volunte. 2001. Biodiversity Program Study, Global Environment Facility, Monitoring and Evaluation Unit, Washington (p. 3 and p. 6) cited in: CDB. 2002. Financial resurces and mechanism (Article 20 and 21), UNEP/CBD/COP/6/INF/4, 14 January 2002.

Sithole, B.P Frost and T S Veeman. 2002. Searching for synthesis: integrating economic perspectives with those from other disciplines. Pp. 198 – 227 in: B M Campbell and M K Luckert (eds) Uncovering the hidden harvest: valuation methods for woodland & forest resources. Earthscan, London.

Smith T.M., Shugart H.H. & Woodward F.I. 1997. (eds) Plant Functional Types I.G.B. P. Vol 1. Cambridge University Press.

Soule, J.D. and J.K. Piper. 1992. Farming in Nature's Image: An Ecological Approach to Agriculture. Island Press. Washington, D.C.

Spilsbury, M. J., and D. Kaimowitz. 2000. The influence of research and publications on conventional wisdom and policies affecting forests. *Unasylva* 51(4): 3–10.

TAC Secretariat, 2000. Review of system-wide programmes with an ecoregional approach. Unpublished report, TAC SECRETARIAT, FAO. June 2000.

Tilman, D. *et.al.* (2001) Forecasting agriculturally driven global environmental change. *Science* 292, 281–284

Timmerman,A. *et.al*. (1999) Increased El Niño frequency in a climate model forced by future greenhouse warming. *Nature* 398, 694–697

United Nations Development Programme, United Nations Environment Programme, World Bank, World Resources Institute. 2000. World Resources 2000-2001. World Resources Institute. Canada.

Van Noordwijk, M, T P Tomich, H de Foresta and G Minchon. 1997. To segregate - or to integrate? *Agroforestry Today*, Jan-March 1997: 6-9.

Van Noordwijk, M., T P Tomich and B Verbist. 2001. Negotiation support models for integrated natural resource management in tropical forest margins. Conservation Ecology 5(2): 21 (on-line at : http://www.consecol.org/iss2/art21)

Van Schaik, C.P. and M. van Noordwijk. June 2002. In S.M. Sitompul and S.R. Utami (Eds.) Akar Pertanian Sehat. Proc. Seminar. Brawijaya University, Malang. Pp 147-156.

Verweij, P. 2002. Innovative financing mechanisms for conservation and sustainable management of tropical forests: Issues and perspectives. International Seminar `Forest Valuation & Innovative Financing Mechanisms for conservation and sustainable management of tropical forests', The Hague, 20-21 March 2002. http://www.tropenbos.nl/docs/draftpaperpita.pdf.

Vitousek, P. *et.al.* (1986) Human appropriation of the products of photosynthesis. *BioScience* 36, 368–373

Westoby M. 1998 A leaf-height-seed (LHS) plant ecology strategy scheme. *Plant and Soil* 199:213-227

Wilson J.B. 1999. Guilds, functional types and ecological groups. *Oikos* 86:507-522

Woodward F.I. & Cramer W. 1996. Plant functional types and climatic changes: introduction. *J. Veg. Sci* 7:306-308

8. Annexes

8.1 Terms of reference

The main goal was to produce a report which ICRAF and CIFOR could use as a starting point in their internal discussions on their respective research agendas and potential collaboration on biodiversity/agrobiodiversity issues. Partnerships with other centres within the Consultative Group on International Agricultural Research (CGIAR), such as IPGRI and CIAT, as well as other global institutions and networks were also taken into account, but detailed organisational analysis was not required.

As a basis for this review, we carried out interviews with key staff of CIFOR, ICRAF and IPGRI in addition to non-CGIAR institutions renowned for their research work on biodiversity and agrobiodiversity (Appendix 2). These were supplemented by a review of relevant internal reports and published papers. The following four questions provided the focus of these interviews and of our task :

- What are the major challenges related to management and use of biological resources in forested landscapes and landscape mosaics over the next 15-20 years and what main questions should the international research community seek to address?
- Given these challenges, what are the key research questions which the international scientific community needs to address?
- From this set of questions, current scientific understanding of available options and the research activities of other players in the field, what is the smaller set of research questions that two international institutions mandated to work on forestry and agroforestry issues must address?
- What other partners would be essential in such work and would increase chances for impacts on the actual resolution of biodiversity-development challenges in target countries?

In our terms of reference, we were expecting to provide the most detail on question 3 (above) and to highlight the expected benefits of working on the set of research questions identified in question 3. In addition, we also needed to provide answers to two additional questions within a total set of six questions specified in our terms of reference :

- What sources of funding would allow CIFOR and ICRAF to actually pursue this agenda?
- What will be the most effective ways of CIFOR and ICRAF collaborating to ensure that our work will indeed address and develop solutions for the big issues lying ahead?

In total, our time allocations for this review process and to produce this report, including all travel, were : Tony Cunningham (TC, 30 days), Sari Scherr (SJS, 12 days) and Jeff McNeely (JM, 5 days). This time allocation, which was exceeded in order to produce this report, had to include visits by each of us to Bogor, Indonesia (TC, twice), JM and TC to the Hague and TC to the UK, USA and Kenya. SJS conducted meetings in Washington and elsewhere in the US by telephone (April, May, June). TC then travelled to WWF-International, meeting with Jeff Sayer (former CIFOR DG), to IPGRI (HQ in Rome and to their offices in Kenya), to the UK (Oxford, SCB meeting & NR International/DFID) and to Nairobi (ICRAF HQ).

8.2 Sources of information for this report

This review is based on four main sources of information. The first and principal source was a series of 55 interviews ranging from internationally respected scientists to representatives of funding organisations. Secondly, from a review of recent literature. This included published studies with which we were familiar plus recent ones recommended to us during the course of interviews (eg: Bierregard *et.al.*, 2001; Condit *et.al*., 2002; Roling and Wagemakers, 2000) and assessments of what topics have been the focus of research in conservation biology (With, 1997), restoration ecology (Young, 2000) or which published studies have had greatest influence (Kaimowitz and Spilsbury, 2000). The recent CIFOR workshop report on "*Actions to be supported by GEF to create an enabling environment for achieving sustained biodiversity conservation across the landscape, using forests as an example"* (Byers and Nasi, 2002) was also extremely useful. Thirdly, from our attending policy and professional meetings during the course of this review (Annex 8.4). At the Conference of the Parties (COP) of the Convention on Biological Diversity (April 2002), JM and TC spoke with selected delegates and seek their views on research priorities in forests and biodiversity. Interviews also took place at the Society for Conservation Biology (SCB) meeting (14-18 July), which TC attended with two CIFOR staff (Luca Tacconi and Doug Sheil). Fourthly, we drew on information from reports on key meetings that had taken place in the past year, which similarly dealt with the question of major problems and challenges facing conservation of biodiversity. One of the largest of these was the recent "*The Challenges of a Changing Earth: Global Change Open Science Conference*" held in Amsterdam, The Netherlands, from 10 to 13 July 2001. Attended by scientists from 100 countries, including more than 400 scientists from developing countries, it was the biggest and most internationally attended event in global change science that has taken place.. Reports on smaller thematic meetings on topical questions also provided useful results. Examples of these over the past few months are "*The Future of the Amazon:Impacts of Deforestation and Climate Change*" held in Panamá from 29 to 31 January 2002 (with a report by Laurance, W F., G Powell and L Hansen (2002); and the International Seminar on "*Forest Valuation & Innovative Financing Mechanisms for conservation and sustainable management of tropical forests*" held in The Hague, 20-21 March 2002 and the subsequent report prepared for Tropenbos by Verweij (2002). SJS also drew information from her participation in the World Resources Institute-led study on "Securing Protected Areas and Ecosystem Services in the Face of Global Change".

In Bogor, ICRAF and CIFOR staff participated in a 2-day workshop which identified the strengths and weaknesses of the two organisations in terms of biodiversity research and helped set research priorities (April 2002). The first day of this workshop was facilitated by JM and the second by SJS. The final workshop was held in Bogor on 29 July 2002, led by TC and facilitated by Bruce Campbell.

Individuals (by country), plus Future Harvest Centre staff interviewed

AUSTRALIA : Prof. Roger Leakey; CHINA : Prof. Xu Jianchu; FRANCE : Dr Robert Nasi; Peter Bridgewater, Director, UNESCO, Division of Ecological Sciences; INDONESIA : Dr Pipin Permadi; Dede Rohadi (FORDA), Nigel Sizer (Director, Forests Programme, The Nature Conservancy); Dr Setijati Sastrapradja, Director, Indonesia Biodiversity Foundation (former head, Indonesia National Herbarium); KENYA : Dr Geoff Howard, IUCN; Agi Kiss, World Bank, Nairobi (brief discussion with Luca Tacconi); MALAWI : Dr James Seyani, former Director, National Botanical Gardens, noew Commonwealth Science Council, London, UK; MEXICO : Dr Javier Cabellero Nieto, Jardin Botanico Exterior, Instituto de Biologia, UNAM; Jorge Soberon, Head, National Biodiversity Institute of Mexico (CONABIO); NETHERLANDS : Clara van der Hammen, Dr Hans de Iongh and Dr Erik van Bueren, Tropenbos, Dr Flip van Helden, Staff Officer Biodiversity, Depr of Nature Management, Ministry of Agriculture, Nature Management and Fisheries (interviewed by Luca Tacconi) and Dr Piet Wit, Chair, Forest Working Group of the IUCN Commission on Ecosystem Management; SOUTH AFRICA : Brian Huntley, Director of the

Botanical Research Institute; SWITZERLAND : Dr Stewart McGinnis, IUCN; Dr Tom McShane, WWF International and Dr Jeff Sayer, WWF International; UK : John Palmer, NR International, Programme Manager, DFID Forestry Research programme, Dr Gill Shepherd (ODI), Anna Lawrence, University of Oxford, Dr Alan Hamilton, WWF International Plants Conservation Unit, WWF-UK; Mark Collins, Director of the UNEP World Conservation Monitoring Centre; Hannah Jaenicke, Deputy Porgramme manager, DFID Forestry research Programme; Robert Barrington, Director, Earth Watch-Europe; Dr J.E.M. Arnold, Oxford University, Dr Will Hawthorne, Oxford Forestry Institute, University of Oxford; USA : Dr Paul Ferraro, Georgia State University (interviewed by Luca Tacconi, feedback to TC); Dr John Hough, Principal Technical Advisor, Biodiversity, Global Environment Facility, ESDG/BDP, UNDP; Dr Judy Oglethorpe, Director, Conservation Strategies, Bob Charles, Consultant on Social Forestry; WWF-US; Dr Nick Menzies, Visiting Scholar (formerly Ford Foundation in China then in East Africa dealing with natural resources management), University of California, Berkeley; Dr Elizabeth Losos, Director, Centre for Tropical Forest Science, Dr Christian Samper and Dr Leonard Hirsch all at the Smithsonian Institution, Washington DC; Dr Janice Alcorn, World Resources Institute (WRI), Washington; Dr Richard Rice, Chief Economist, Center for Applied Biodiversity Science, Conservation International (interviewed by Luca Tacconi, feedback to TC), Dr Frances Seymour, World Resources Institute (WRI), Washington, Dr Jan Salick, Missouri Botanical Garden, St. Louis, Dr Christine Paddock, Institute of Economic Botany, The New York Botanical Garden, Dr Cynthia Gill, USAID, Biodiversity Program; DR Russell Mittermeier, President, Dr Gustavo Fonseca, VicePresident for Biodiversity Science and Dr Carlye Vynne, Center fo Biodiversity Science, Conservation International; Dr Eric Dinerstein and Dr Kate Newman, WWF-US, Washington; Dr Katherine Warner, Winrock International (Formerly FAO Community Forestry; Dr Mary Melnyk, Senior Advisor, Natural resources Management, US-AID; Dr Kathy MacKinnon, World Bank Environment Department; Kenton R. Miller, Vice-President, World Resources Institute; Walter Reid, Executive Secretary, Millenium Ecosystem Assessment and Gretchen Daily, Stanford University

FUTURE HARVEST CENTER STAFF: ICRAF: Dr Dennis Garrity, Dr Lou Verchot, Dr Keith Shepard, Will Frost, Joyce Kasyoki, Dr Tom Tomich, Dr Diane Russell, Roland Kindt, Dr Meine van Noordwijk, Dr Chip Fay. CIFOR STAFF: Dr David Kaimowitz, Dr Robert Nasi, Dr Doug Sheil, Dr John Poulsen, Dr Bruce Campbell, Dr Ken MacDicken, Dr Laura Snook, Dr Trish Shanley (Note: Additional ICRAF and CIFOR staff participated in the workshops held in Bogor in April and July 2002). IPGRI STAFF: Dr Pablo Eyzaguirre, Dr Coosje Hoogendoorn (Deputy Director General, IPGRI), Dr Jan Engels, Dr Toby Hodgkin, Dr Kwesi Atta-Krah, Regional Director (sub-Saharan Africa), Dr Eshan Dulloo, Scientist, Conservation and Management of Germplasm.

8.3 Programmes of the Future Harvest Centers

Planning and programme formulation within the CGIAR system itself is undergoing major change as this report is being written, with uncertainty over whether Ecoregional programmes will be replaced by “Challenge Programmes”. These events will certainly affect the mechanism through which a joint ICRAF/CIFOR bidiversity research programme will be implemented. The CGIAR supported the establishment of ecoregional programmes since the early 1990s. These typically were consortia, involving national agricultural research systems (NARS), international agricultural research centers (IARCs), advanced research institutes, nongovernmental organisations (NGOs), and local and national government agencies that aimed at resolving major development problems related to the sustainable use of natural resources within an ecoregion. There currently are eight ecoregional programmes within Future Harvest, namely the:

- Desert margins programme for sub-Saharan Africa (DMI).
- Programme for the warm humid and sub-humid tropics of sub-Saharan Africa (EPHTA).
- Programme for the humid and sub-humid tropics of Asia (Ecor(I)Asia).
- On-farm water husbandry programme for West Asia and North Africa (OFWH).

- Programme for rice/wheat based cropping systems in the Indo-Gangetic plain (RWC).
- Programme for enhancing agricultural research effectiveness in Tropical America (CIAT's).
- Alternatives to slash and burn agriculture programme (ASB).
- Sustainable mountain agricultural development programme - now Global Mountain
- Programme (GMP).

More recently, however, "Challnege programmes (CPs)" have been developed, with the CGIAR Interim Science Council (ISC) recommending 13 CP concept notes to the ExCo for pre-proposal development. These are:

- Development of sustainable agricultural production systems in Central Asia & the Caucasus
- Reducing poverty by removing market barriers caused by animal diseases
- Securing livestock genetic resources for present and future food security
- Increasing productivity in the coastal zone
- Beating the heat: Climate change and rural prosperity
- Harnessing global IPM initiatives
- Urban harvest: A challenge programme on urban and peri-urban agriculture
- Agriculture, poverty and combating desertification
- Improving livelihoods and natural resources management in Sub-Saharan Africa
- The rainforest challenge: Forests as resources for the poor
- Agricultural biodiversity for sustainable development
- Biological nitrogen fixation
- Sustainable mountain development

8.4 CIFOR and ICRAF's current programmes and initiatives

Both ICRAF and CIFOR are autonomous, non-profit research organisations which are part of and supported by the CGIAR. Consistent with the CGIAR goals, both ICRAF and CIFORs research programmes are strongly linked to poverty alleviation, food security and environmental sustainability. Interestingly, a significant number of people we spoke to during this review of aware that both CIFOR and ICRAF have to link their research to poverty and peoples livelihoods. Several people were also unaware of CIFOR's modest size (50 research staff) and the limits this consequently places on how may issues it can tackle and still remain effective. CIFOR in particular was seen as a well resourced international organisation with a large staff and a far greater capability that currently exists.

Both organisations are currently restructuring their thematic research programmes, reducing the number of three themes each. In CIFORs case, the three thematic groups will be:

- Environmental services and sustainable use of forests;
- Forest governance;
- Forests and livelihoods

This represents a reduction from the six earlier thematic programmes, namely: Policies, Technologies and Global Changes; Adaptive Co-management; Sustainable Forest Management; Biodiversity and Genetic Resources and the Forest Products and People programme. RAF currently has five research and development themes. These are: (I) diversification and intensification of land use through domestication of agroforestry trees; (2) soil fertility replenishment in nutrient-depleted lands with agroforestry and other nutrient inputs; (3) socio-economic and policy research to allow policies that will benefit smallholder farmers; (4) acceleration of impact on farm by ensuring that research results are used; and (5) capacity and institutional strengthening through training and the dissemination of information. Although the

consolidation of these themes from the current five into three themes is still to be decided, these are likely to be:

- environmental management.
- production; and
- human welfare.

8.5 Partnership opportunities

EarthWatch, as an organisation that provides thousands of non-specialists to field research projects, would welcome cooperation with CIFOR and ICRAF in appropriate projects. They have recently become much more successful, and have more of the non-specialist researchers than they are able to place in research projects. They are able to make long-term commitments, sending teams of 10-12 non-specialists to work as field assistants for lead investigators; this requires careful research design, but for the right kinds of projects, considerable field support can be provided for up to two weeks at a time, several times per year over several years. The organisation also provides substantial financial support in addition to the non-specialist labour. However, EarthWatch would not be very suitable for conducting social research in developing countries.

CONABIO works primarily through inventory and remote sensing, in hopes that this will lead to improved management. They hope that CIFOR and ICRAF will work in a largely temperate country such as Mexico, and would be happy to collaborate.

The **Smithsonian Institution**, and its Tropical Research Institute (STRI) have established a series of long-term research plots in various parts of the tropics, suitable for additional kinds of research (see Burslem *et.al*, 2001). These research plots are highly appropriate for comparative studies. They would like to establish associated experimental plots as well, using the sample plots as controls (such as at Bulungan and in Gabon). They would like such research to contribute to advice in support of multiple uses of forest ecosystems. STRI would be very glad to do more work with CIFOR and ICRAF, especially using their network of sample plots. Smithsonian is especially interested in using new approaches to data analysis to synthesise available information, looking at old data sets to ask new questions, such as the impact of El Niño on flowering and fruiting. They would also welcome collaboration on their Biodiversity Forest Fragments project, where forest regeneration outside of the 'forest fragments" experimental sites also offers a great opportunity for studies on restoration ecology.

The **Consortium for the Sustainable Development of the Andean Ecoregion (CONDESAN)** consists of more than 75 research institutions, universities, NGOs, businesses, producer groups, and government agencies. Angie Laura Sarria (CONDESAN), c/o Centro Internacional de la Papa, Av. La Molian 1895, Lima 12, Perú, Tel.: (51-1) 349-5313 (dir.) (51-1) 349-6017 ext.3021; fax: (51-1) 349-5326 e-mail: a.laura@cgiar.org

South Africa's National Botanical Institute (which has numerous research sites throughout the country) would be glad to work with ICRAF and CIFOR.

UNESCO has a global network of Biosphere Reserves that are designed at least partly as research sites, enabling exchange of scientific information. UNESCO would be very glad for CIFOR and ICRAF to do more research in biosphere reserves, and would be willing to advise and broker on which biosphere reserves might be most appropriate. The system in Brazil seems especially promising. One issue of particular importance is monitoring of change over time, and UNESCO would welcome CIFOR/ICRAF support on designing appropriate monitoring protocols and doing some of the demonstration research. Another important biosphere reserve is the tri-national "W" Biosphere Reserve in Africa. It may also be possible to encourage governments to establish as

biosphere reserves some of the research sites where CIFOR and ICRAF have been doing significant research.

The part of **World Resources Institute** that would be most relevant to collaborate with CIFOR and ICRAF is Global Forest Watch, which is headed by Dirk Bryant. This might be part of a systematic monitoring programme to which CIFOR and ICRAF might wish to contribute.

The Millennium Ecosystem Assessment would be very glad to work with CIFOR and ICRAF, and indeed the Alternatives to Shifting Cultivation project is explicitly part of the MEA. Mobilising existing research would also be extremely useful, and indeed this is what the Millennium Ecosystem Assessment is doing.

The **Tropical Rainforest Collaborative Research Centre** in Queensland, Australia seeks to support the sustainable use, management and conservation of tropical forests through world-class research, training and technology transfer. It is carrying out multi-disciplinary research on: environmental planning and management in rainforest regions; evaluating ecosystem goods and services in a dynamic landscape; rainforest visitation, business, interpretation and presentation; managing and monitoring impacts arising from rainforest access; rehabilitation and restoration, including riparian; conservation principles and management; and aboriginal and collaborative management. It also oversees operations of the Canopy Crane Company, with a canopy crane that spans over one hectare of lowland tropical rainforest in the Daintree. It includes comfortable on-site accommodation and a laboratory located nearby the crane. Research projects include: photosynthesis and water use; ecology of arboreal ants and beetles; climate and microclimate in the canopy; tree metabolism; and pollination in the rainforest canopy.

Tropenbos International (TBI) has initiated a wide range of biodiversity research in its site programmes in Colombia, Guyana, Cameroon, Indonesia, and Côte d'Ivoire, and is planning new research in Vietnam, Ghana and Suriname. It has issued over 60 scientific publications on forest-related biodiversity issues, including seed dispersal, impact of forest fires, biological indicators, non-timber forest products, and biodiversity monitoring by indigenous people. Tropenbos would be glad to work with CIFOR and ICRAF on this research, building on past collaboration.