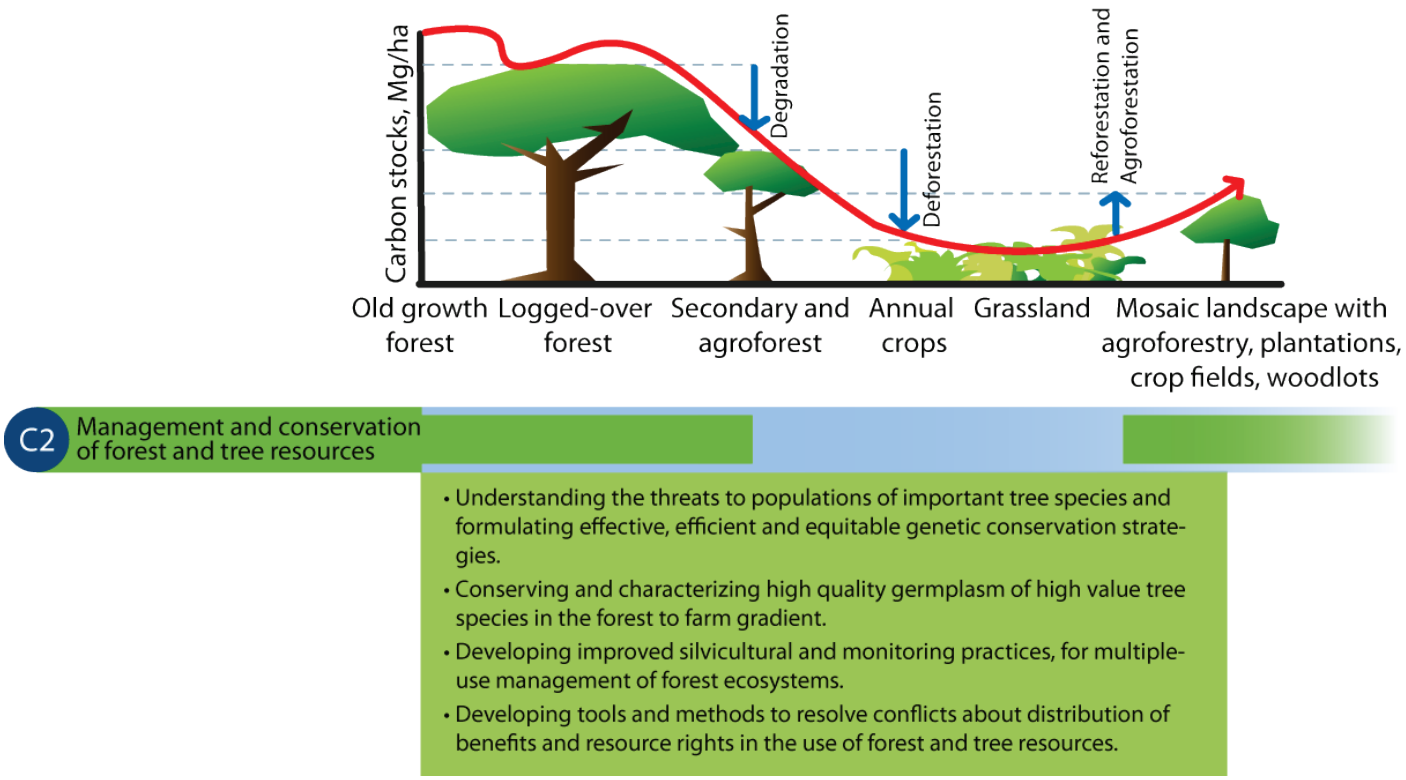
2.2 Component 2: Management and conservation of forest and tree resources



2.2.1 Introduction

Overexploitation of forest resources continues, even though sustainable forest management (SFM) principles have been acknowledged and accepted for decades. Forest biodiversity continues to decline rapidly[46] despite the fact that legally established protected areas cover an estimated 13% of the world's forests.[47] At the same time, in spite of substantial improvements in many countries, millions of people living in and around biodiversity-rich forests continue to suffer from poverty and reduced income from dwindling resources. A new approach to research is urgently needed to understand why accepted principles and practices do not produce expected outcomes when SFM is applied as well as the reasons for its non-implementation. Research is also needed to continue refining new management approaches at multiple scales to achieve sustainable production of resources from forests and trees that benefit the rural poor.

Persistent and increasingly urgent challenges require holistic research approaches premised on the need for multidisciplinary and multiscale studies. Complex problems involving human interactions with diminishing ecosystem resources—such as declining tree species that are used concurrently for fuel, timber, medicine and food—usually cannot be solved by addressing single factors in isolation from the system as a whole; social and biophysical approaches to problems must be merged and research must include multiple scales from landscapes to genes.

[46] Butchart, S.H.M. et al. 2010. Global biodiversity: indicators of recent declines. Science, 328: 1164–1168.
[47] FAO. 2010. Forest resource assessment. FAO, Rome.

One such challenge is the extent of degraded forestland—some 500 million hectares—found throughout the tropics. Some of the degraded forest requires interventions to regain productivity for the well-being of the rural poor and the restoration of essential environmental services. However, under some conditions, such degraded forest areas, including those that may have been deforested decades previously, can recover rapidly without any need for direct human intervention, even at large spatial scales.[48] Clarification is needed on how and when to invest both financial and human resources to actively rehabilitate degraded areas, and which species and seed sources within species are best adapted to particular ecological conditions. This is especially important in the context of recently agreed global commitments to rehabilitate degraded ecosystems within the next decade.[49]

A notable lack of decision support systems for directing forest rehabilitation efforts underlies the failure of projects in many countries to achieve their stated objectives.[50] Decision support systems can help managers who face complex problems to preferentially allocate their efforts to sites where ecosystems are sufficiently resilient, but where degradation or the landscape context is inhibiting natural recovery, as opposed to sites that are likely to recover with no or minimal intervention.[51] Such systems can also help managers choose species and genetically adapted seed sources that will increase the probability of survival and sustained rehabilitation of ecosystems. In the face of global climate change, it is essential to integrate good practices for all areas of management, from genes to trees and to rehabilitated forest management in maintaining connectivity while supplying key goods and services.

Another challenge is to enhance our understanding of the status of and threats to populations of priority tree species, as well as to identify best approaches for their conservation as a means of improving livelihoods in the context of SFM. Tree species are unlikely to be maintained in the absence of landscape management approaches. By the same token, forest landscapes will not be sustainable in the long term without consideration of the inter- and intraspecific diversity of trees[52] and the design of improved, low-impact silvicultural practices that maintain adequate levels of genetic diversity of harvested populations.[53] Many important but vulnerable tree species are not conserved in protected areas, and it is essential that viable populations be maintained in production forests. Furthermore, the integration of silvicultural and harvesting methods for timber that harmonize long-term productivity, and for coexisting non-timber forest products (NTFPs) whose productivity is vulnerable to loss of forest cover,[54] is a largely unexplored area—a shortfall that this component seeks to address.

---

[48] Lugo, A.E. and Helmer, E. 2004. Emerging forests on abandoned land: Puerto Rica's new forests. Forest Ecology and Management 190: 145–161.
[49] Convention on Biological Diversity, 2011–2020 strategic plan. http://www.cbd.int/decision/cop/?id=12268
[50] Holl, K.D. and Aide, T.M. 2010. When and where to actively restore ecosystems? Forest Ecology and Management doi:10.1016/j.foreco.2010.07.004
[51] Rodrigues, R.R. et al. 2010. Large-scale ecological restoration of high-diversity tropical forests in SE Brazil. Forest Ecology and Management doi:10.1016/j.foreco.2010.07.005
[52] Geburek, T. 2005. The role of biodiversity in forest ecosystems and for sustainability. In: Geburek, T. and Turok, J. (eds), Conservation and management of forest genetic resources in Europe, p. 435–458. Arbora Publishers, Zvolen, Slovakia.
[53] Jennings, S.B. et al. 2001. Ecology provides a pragmatic solution to the maintenance of genetic diversity in sustainably managed tropical forests. Forest Ecology and Management 154: 1–10.
[54] As is the case for the obligate out-crossing Brazil nut tree (*Bertholletia excelsa*) in Amazonia whose long-term productivity depends on non-managed populations of specific pollinators; see Garibaldi, L.A. et al. 2009. Pollinator shortage and global crop yield: looking at the whole spectrum of pollination dependency. Communicative and Integrative Biology 2: 37–39.

The genetic resources of wild and semi-domesticated tree species and their varieties are of utmost importance for human well-being as sources of fruits, medicines, fiber, resins, oil and bioenergy—all contributing to improved health, food during vulnerable periods, and income generation. These species are fundamental for future breeding and domestication, and help maintain future options. This diversity is seriously threatened along the forest-to-farm gradient; hence, coordinated *in situ*, *circa situ* and *ex situ* conservation efforts and sustainable management practices must be strengthened and initiated. There is also a need for effective long-term approaches to maintain genetic diversity and ecosystem functions of other useful tree species including wild relatives and cultivars of important tree crops, such as cacao, coconut and coffee. This will require research and careful attention to the maintenance of ecological functions within ecosystems, including the conservation of keystone species and processes, as well as biodiversity more generally.

Intraspecific variation constitutes the adaptive potential of a species in the short and medium term. This is vital to provide the raw genetic material for selecting or improving useful characteristics of trees and for responding to environmental change. Unfortunately, intraspecific diversity of trees is disappearing both on farms and from natural populations. The result is "silent extinctions" as mechanized agriculture displaces forests and traditional farmland, livestock grazing prevents regeneration, and overharvesting for fuel and other products continues. Forest regeneration and management decisions typically ignore genetic factors. As populations of trees are lost, accelerated by climate change, management options also are lost forever,[55] both for sustaining production in forests and for domestication. Such options include: countering effects of drought and salinity; enhancing resistance to pests and diseases through selection and breeding; developing new marketable commodities for poor farmers; and improving the quality and quantity of forest- or tree-sourced food.

Forest management systems in the tropics are still largely dominated by polycyclic silvicultural systems (selective logging). These systems, focusing exclusively on the extraction of a few valuable timber species, routinely disregard impacts on other forest resources and environmental services such as genetic diversity, bushmeat or NTFPs, which are used by communities that live in or use forest areas gazetted to timber producers, hydrological regulation and carbon sequestration. Efforts to minimize "conflicts of use" over species that provide both timber and non-timber benefits, or to incorporate cost-effective approaches to integrating timber and NTFP extraction are scarce.[56] Harvesting cycles for timber production usually span long periods of at least 30 years and limit the production of regular incomes for local populations. However, integrating the harvest of NTFPs between cutting cycles can ensure continuous revenue. Further, the development and implementation of more diversified silvicultural systems based on a range of tropical forest income options would stimulate the interest of multiple actors—indigenous and traditional populations and smallholder farmers—and offer alternative management options to logging companies. Such multipurpose forest management approaches need to incorporate current knowledge (both "scientific" and "traditional") on forest ecosystems. New integrated and holistic approaches for maintaining genetic diversity must be developed as an integral part of SFM. This includes strategic and effective *in situ* conservation, both in protected areas and in managed forests along the forest-to-farm gradient.

[55] Palmberg-Lerche, C. 2002. Thoughts on genetic conservation in forestry. Unasylva 209: 57–61.
[56] Guariguata, M.R. et al. 2010. Compatibility of timber and non-timber forest product management in tropical forests: perspectives, challenges and opportunities. Forest Ecology and Management 259: 237–245.

Component 2 will focus on developing and testing new forest and tree management paradigms, building on existing knowledge and practice, while considering the multiple uses and users of trees as well as the range of forest products that contribute to the well-being of rural people. We will also focus on the influence of dominant power structures, including the relative status of women and other marginalized actors in decision making. Our approach will be **transformative** and **innovative**, with direct participation by a wide spectrum of international and local stakeholders, and will involve, *inter alia*, the following.

Cross-sectoral, global comparative approach. Collaboration with private sector, research and civil society organizations, from timber producers to conservation and development NGOs, will foster the transfer of tested practices and experiences from settings where they are well established to those where they are not. This international- or regional-level exchange and knowledge sharing will help disseminate best practices and will strengthen regional platforms for promoting SFM and ensuring that diverse forest and tree resources will increasingly benefit the poor across the forest-to-farm spectrum. Sentinel landscapes (see below and Annex 4) will contribute to global comparative research, grounded in local realities but also addressing questions that are relevant across regions and continents and that require long time frames to answer.

Integration of local values and needs. Development of management approaches for production forests and for conservation of tree genetic resources across forest–farm landscape mosaics will include local communities' values and voices. We will seek ways to increase the participation of communities in decisions regarding production forest management, thereby increasing their bargaining power in the formal forest sector. In addition, communication of our research approaches and results will raise awareness among policymakers and concession holders of local values and provide them with tools to generate new ways of "doing business".

Gender. Participation in research from planning to implementation and sharing of benefits will involve all relevant user groups, including both men and women where possible, with an aim of giving all groups equitable opportunities to contribute knowledge and define priorities for improving the conservation and sustainable use of forests and trees. To date, this is a largely overlooked aspect in forest management research.

Technology. We will use, whenever needed, new and emerging technologies, such as the application of genomics and other molecular tools, to screen useful tree species for adaptive traits in resource management and for tracking illegally harvested timber, NTFPs and trade in wildlife products including bushmeat. We will also use modeling tools (e.g., multi-agent systems) to test proposed improved forest resource (timber, non-timber, bushmeat) management paradigms and the latest GIS applications to conduct spatial analyses of allelic and species richness and threats to priority species.

Strengthening local capacity. We will foster and guide the development of young scientists in priority countries by supporting a network of PhD student fellowships associated with research at sentinel landscapes. Students will be co-supervised by scientists at local universities and by scientists involved in the component and they will carry out research that will contribute to global comparative studies. We will also develop training materials intended for managers, students and practitioners, using relevant case studies organized in thematic modules. The training materials, to be produced in several languages, will be available for download from the Internet, complete with teachers' notes and electronic presentations.

2.2.2 Thematic focus

The research carried out in this component focuses on resources at the management unit level (e.g., forest–farm gradient, community forests or timber concessions) considering both biophysical (ecosystems, populations and species) and socioeconomic aspects.

This component has four integrated themes, which link management, conservation and sustainable use of forest and tree resources:

1. understanding the threats to populations of important tree species and formulating effective, efficient and equitable genetic conservation strategies;
2. conserving and characterizing high-quality germplasm of high-value tree species along the forest-to-farm gradient;
3. developing improved silvicultural and monitoring practices for multiple-use management of forest ecosystems; and
4. developing tools and methods to resolve conflicts over distribution of benefits and resource rights in the use of forest and tree resources.

Our research themes are linked with other CRP6 components and research themes. Some management units considered in Component 2 are equivalent to "landscapes" given their size and geographic variation, which implies the need for close exchange, input and feedback from/to Component 3 (particularly regarding sentinel landscapes). Understanding the status of genetic and ecological diversity, and designing more resilient management systems through multiple uses, will provide valuable information for mitigating and adapting to climate change (Component 4). Understanding patterns of diversity and threats to tree species of socioeconomic importance and characterizing important germplasm (e.g., tree crop cultivars) will inform the trees on farm and domestication aspects of Component 1. More specifically, Research Themes 3 and 4 will have a close link with Component 5 in terms of governance mechanisms and the translation of research findings into policy recommendations for improved forest management.

The extensive links between Component 2 and the other CRPs are set out and explained in Annex 3.

2.2.3 Objectives and expected outcomes (10 years)

The overarching objective of this component is to increase the likelihood that important forest and tree resources will be available for future generations while improving the well-being of the poor who are dependent on these resources for their livelihoods.

Expected outcomes

1. Status of and threats to at least 100 priority tree species, important to both men and women in Africa, Asia and Latin America, will be better understood and mitigation and conservation initiatives will be undertaken by national partners (government agencies, NGOs) and other stakeholders.
2. National agencies in at least five countries per region will have developed and be implementing strategies for the conservation and sustainable use of forest and tree resources including intraspecific tree genetic diversity.
3. Germplasm of wild relatives and cultivars of tree crops (e.g., cacao, coffee, coconut) and priority wild tree species with important traits will be conserved and characterized.

4. Production forests will be managed for multiple uses and improved multifunctionality by integrating management of timber and NTFPs in at least five priority countries.
5. Local communities will be better represented in decision making regarding the management of production forests, ensuring more equitable benefit sharing and reducing conflicts over land use and resource rights in at least five priority countries.

Through these outcomes, Component 2 will contribute to the following impacts targeted by CRP6: (1) conservation and increased use of forest and tree genetic resources; (2) increased social and economic benefits from forest and agroforestry goods and services; (3) enhanced access of women and other disadvantaged groups to benefits at all levels; and (4) reduced deforestation and degradation.

2.2.4 Geographic priorities

Priority regions and countries are characterized by a congruence of poverty and high biological diversity, and a strong need for improved forest and tree resource management due to the dependence of poor people on forests for livelihoods along with high levels of threats to these habitats. Several activities will be of global relevance (e.g., work with the Convention on Biological Diversity).

Geographic priorities within this component are also defined in part by the location of important genetic material in tree species identified as high priority by people living in high-poverty areas. In some cases, priorities will be clear only after preliminary studies indicate where high diversity, serious threats to priority species or forest ecosystems and/or the potential for multiple uses coincide with areas key to the well-being of poor people. For tree crops, priority locations would also include countries where collections are held (such as Côte d'Ivoire or Trinidad).

At the regional level, priorities are:

- in Latin America: Amazon Basin, Andes, dry forest areas and Mesoamerica.
- in Africa: Congo Basin, West Africa, Miombo and other Sudanian (Sahel) and Somalia-Masai dry forests.
- in Asia-Pacific: South, Southeast and Central Asia and Melanesia.

At the country level, priority countries where we expect to undertake research and demonstrate outcomes are:

- in Latin America: Argentina, Colombia, Brazil, Bolivia, Costa Rica, Peru.
- in Africa: Cameroon, Democratic Republic of Congo, Gabon, Ghana, Kenya, Liberia, Mali, Malawi, Mozambique, Niger, Nigeria, Tanzania, Uganda.
- in Asia-Pacific: China, India, Indonesia, Malaysia, Papua New Guinea, Philippines, Sri Lanka, Uzbekistan.

2.2.5 Research Theme 1: Understanding the threats to populations of important tree species and formulating effective, efficient and equitable genetic conservation strategies

Rationale

Erosion of genetic resources has been recognized generally as a serious threat to forest sustainability and human welfare, but the problem has received scant attention, especially in forested landscapes. Reasons for this inadequate attention include the dearth of readily available tools for measuring and monitoring change, and a perception that the problem is too complicated or not as important and immediate as other challenges. This situation is aggravated by the fact that loss of genetic variability is invisible. As a result, thousands of tree species or populations are under threat.[57]

Best practices for conservation of useful forest tree genetic resources across the forest transition curve, including production forests and agroforests, have not been developed for most species nor applied in many countries. National agencies need support to develop, document and synthesize findings through case studies, and to apply the findings in conservation and management plans. Research is needed to identify the best combination of approaches (*in situ*, *ex situ* and *circa situ*) for species that are important for livelihoods and subsistence in areas of high diversity and/or high poverty. CRP6 proponents and partners will analyze biological and other factors (including cost–benefit analysis) to determine which approaches, separately or in combination, are best suited to particular circumstances or to particular groups of species.

Establishing criteria for developing national, subnational or regional lists of priority species and populations, and the drivers of threats to them, is the first step in defining strategies to ensure the future availability of socioeconomically important species. Identifying impediments to policy implementation in cases where countries already have conservation strategies is also important. The process of defining criteria will ensure the inclusion of tree species and traits that are valued by women, as well as those valued by men. This represents a significant change—and a challenge—to the way important genetic resources have been identified in most countries; however, it is clear that the different user groups will have different priorities at the community level (see Section 3.1 on gender).

Wild and semi-domesticated fruit and other tree species with different uses and wild relatives of tree crops are increasingly threatened in their natural ranges.[58] Germplasm of these species is valuable, and conserving it through use may improve its chances of survival. Several tools will be applied to understand diversity in wild and semi-domesticated fruit species (e.g., molecular analysis combined with basic morphological studies), to evaluate nutritional/biochemical qualities (starch properties, oil compositions and beta-carotenes), and to strengthen capacity for management and use of diversity by farmers, communities and national agencies. Methods and best practices that have proven effective for conservation elsewhere will be adapted and tested for target species. Documentation of users' knowledge and practices of *in situ*, *circa situ* and *ex situ* conservation and management will be enhanced. The research will improve our

[57] IUCN. 2010. IUCN Red list of threatened species. Version 2010.2. http://www.iucnredlist.org.
[58] Dawson, I.K. et al. 2009. Managing genetic variation in tropical trees: linking knowledge with action in agroforestry ecosystems for improved conservation and enhanced livelihoods. Biodiversity and Conservation. 18: 969–986.

understanding and account for differences in knowledge, priorities and roles of men and women in managing and conserving diversity of these resources.

Methods and research approach

Determining priority species for conservation action is complicated by the high diversity and many uses of tree species in tropical forests. For example, in Cameroon alone, just one small country in Africa, at least 74 tree species produce edible fruit[59] that people consume during times of food shortage. Some of the species are widespread, others are narrowly distributed, some have conservation designations, a few are partially domesticated and others are still completely wild and almost unknown to science. The situation is similar in many tropical countries.

The approach for developing criteria to define cost-effective species and conservation priorities will include creating and testing decision support tools in collaboration with local people, including women and disadvantaged groups. Factors that must be considered in developing such tools are the species' importance in meeting the subsistence needs of local people, income generation potential and provision of ecological services, perceived threats, costs of conservation, and opportunities for increasing use and conservation. Improved econometric tools will be developed and applied.

Understanding the status and threats to genetic resources of priority tree species with distributions that extend along forest–farm gradients and across national borders requires close collaboration with partners, for example through networks such as the Latin American Forest Genetic Resources Network (LAFORGEN), to share information, material for genetic analyses and data between institutions. As tools for genetic analysis improve and become more affordable, genetic diversity data have become more available, and it is feasible to carry out studies to obtain data that were not available in the past. A factor in choosing species for genetic analysis is their potential as models, yielding insights and lessons that could be applied to other species with similar reproductive biology and ecological characteristics. Where data are lacking, ecological proxies will be identified, tested and used to identify areas of probable high genetic diversity. Because of the small number of recorded occurrences for many species of interest, distribution will be predicted using available presence points to create descriptors of "ecological niches" for particular species.

In situ, circa situ and *ex situ* conservation status, estimated using available protected area and gene bank data as well as expert knowledge, will be combined with threat and opportunity maps. Threat maps will be developed by mapping threat factors, including predicted climate change impacts across the species distribution. Opportunity mapping will relate to market access and requirements. Combining these factors with known or predicted genetic diversity hotspots will result in genetic resource status and threat assessments for priority species. Using our research and practitioner networks, this information will be shared with managers and policymakers at national and subnational levels to define conservation targets and will be incorporated into strategies for sustainable management and conservation.

[59] Eyog Matig, O. et al. (eds). 2006. Les fruitiers forestiers comestibles du Cameroun. International Plant Genetic Resources Institute (IPGRI) Regional Office for West and Central Africa, Cotonou, Benin.

Research Questions

Broad research questions (Component 2, Theme 1)	Gender-specific aspects of the research question	Examples of science outputs
What are the most important criteria for identifying priority tree species and populations for conservation action at subnational, national and regional levels?	How could the different priorities of men and women be considered more equally when defining common priorities? How can understanding the different gender roles help refine priorities?	Criteria for prioritizing useful diversity from local to country level developed and tested together with local and national partners
What are the status, trends threats and major drivers of loss of intra- and interspecific forest and tree biodiversity of socioeconomic importance? Considering that most countries have policies for biodiversity conservation, what impedes implementation?	Do men and women value species and traits differently and play different roles in and/or experience different effects from the drivers of diversity loss? Who loses, relatively and quantitatively when different types of diversity are lost?	Genetic diversity, useful traits, conservation status and threats assessed for priority species groups Methods for threat analysis and understanding of *in situ* conservation status, along with identification of viable solutions
What are the most effective and practical indicators of genetic diversity (including ecological proxies) across landscapes (including semi-natural, managed and planted forests)?		Practical, applicable, interpretable indicators of genetic resources for use across the landscape gradient Methodology for rapid *in situ* evaluation of diversity of useful traits of wild and semi-domesticated fruit tree species
What is the best combination of *in situ*, *ex situ* and/or *circa situ* (on-farm) conservation approaches and how can challenges to their implementation be overcome for priority tree species (including fruit trees and tree crops across the forest-to-farm spectrum?)	How can one encourage equitable participation in strategy development and outcomes? How do conservation strategies affect men and women and their access to resources? What kinds of checks should be included in tools to address gender impacts? Women are important processers and quality controllers of many fruits. How can their role be recognized?	Methods, guidelines and decision support tools developed and disseminated for complementary *in situ*, *ex situ* and *circa situ* conservation strategies for priority tree species and populations that facilitate their use in improvement and development activities Systems and procedures established for effectively conserving genetic diversity of tree crops
Which elements must be included in guidelines or strategies for conservation of genetic resources for uptake and adoption in high-poverty areas and by different user groups, including women and men?	How can equitable participation and influence in the strategy development processes, by different user groups, be encouraged?	Genetic diversity conservation strategies developed for socioeconomically important tree species, for high-poverty areas Methodologies and incentive mechanisms identified for *in situ* and on-farm conservation of tree crop genetic resources

Research partners

Type of research partner	Organization	Research partner contributions
Participating CGIAR Center	Bioversity	Develops and guides projects, carries out research
	World Agroforestry Centre	Develops and guides projects, carries out research
	CIAT	Collaborates in fruit tree research
	CIFOR	Collaborates in the development of guides and undertakes research on the ecology, dynamics of important species
International level	CAMCORE	Provides data, participates in specific parts of research
	CIRAD	Participates in research, contributes expertise, data and sites
Regional level	LAFORGEN, SAFORGEN, APFORGEN, EUFORGEN	Members (government and university scientists in Latin America, Africa, Asia Pacific, and Europe) carry out parts of research projects, participate in sampling, provide data and expert information, and facilitate access to policymakers
Country or site level	FRIM (Malaysia); IRAD (Cameroon); Silo National de Graines Forestières (Madagascar); INERA (Burkina Faso); FORIG (Ghana); KEFRI (Kenya); Amani Nature Reserve (Tanzania); Université de Parakou (Bénin); various East African Universities; INTA (Argentina); EMBRAPA (Brazil)	Collaborate in specific parts of research projects
	BFW, BOKU (Austria)	Provide high-tech facilities for genetic analysis, participate in design, execution and interpretation of specific research projects in Africa

2.2.6 Research Theme 2: Conserving and characterizing high-quality germplasm of high-value tree species in the forest-to-farm gradient

Rationale

Under some circumstances, genetic resources can best be conserved through use. This is particularly true of many fruit tree species and tree crops. Research is needed to understand how to maintain genetic diversity of wild and semi-domesticated fruit species along the forest-to-farm continuum, and what kinds of incentives are needed for managers and farmers to use (and thus conserve) diverse cultivars of tree crop species. Different approaches and incentives may be needed to involve men and women in the use and conservation of diversity, depending on their access to knowledge and resources. Knowledge of genetic aspects of reproductive materials is weak for many useful tree species, and characterization and documentation are lacking on

variation in important traits. Research is needed to address these constraints to increase knowledge of high-quality adapted germplasm.[60]

This research theme builds on Theme 1 and complements Component 1 of this CRP by focusing on characterizing and using advanced genomic methods, and documenting and conserving germplasm of priority species and varieties. Wild and semi-domesticated varieties of fruit tree species and their wild relatives are important for present and future food production, nutrition, income and resilience in the face of climatic uncertainties. Research is needed to develop participatory methods to characterize and document useful diversity across the forest-to-farm spectrum and to involve relevant user groups.

For important tree crops such as cacao, coffee and coconut, research will be carried out to characterize and evaluate germplasm material to facilitate its use in breeding or domestication (c.f. Component 1). Where appropriate, users will be included as participants in the research through activities to identify priorities and desired traits, and to provide expert opinion on local conditions. Again, it is important to involve both men and women to benefit from their differential knowledge and ensure that research results are broadly useful and accessible. National research systems, to be supported, will play an important role by incorporating the development of improved material at the regional or global level, and by facilitating local research.

Methods and research approach

Research will involve the characterization of populations of important species by traditional and novel approaches. Traditional methods will involve phenotypic observations in natural stands and in nursery, on-station and on-farm field trials, with approaches to characterization designed by scientists, farmers and forest-harvesting communities. Field trials will be undertaken across environmental gradients in order to understand the roles of plasticity and adaptation in tree-site matching. This is a key factor in determining recommendation zones for conservation and use in forest and farmland in the light of global challenges (such as climate change, which may result in mismatching between current tree species and population distributions and prevalent environmental conditions). Field trials of a few select species will also identify material for incorporation into formal breeding programs. Novel approaches to characterization will involve laboratory studies based on molecular markers and genomic techniques. Data from the field and laboratories will be combined with spatial data using modern statistical methods applied in association with genetic studies in model systems that take into account stochastic variation, which can create spurious positive linkages between the “phenome” and the genome.

The results of different phenotypic characterization strategies for female and male farmers and forest harvesters that identify how these actors recognize and value variation will be compared with the underlying variations revealed within populations based on other methods. This will reveal which phenotypic approaches are likely to result in the largest gains for initial production and the greatest long-term benefits for sustainable provision of products and services, which may be inversely related. Proxies for selecting material for different purposes will be identified. Trade-offs between short- and long-term benefits will be tested through cost–benefit analysis to find an optimum for given conditions, leading to the development of a generic model. Approaches developed for management will be tested along the forest-to-farm continuum to

[60] Koskela, J. et al. 2009. The use and movement of forest genetic resources for food and agriculture. Background Study Paper No. 44. The Commission on Genetic Resources for Food and Agriculture, FAO, Rome.

assess short- and long-term benefits for use and conservation. A cost–benefit analysis of different methods for domestication of important species—based on centralized and decentralized strategies and combinations of the two—will be undertaken.

Box 2.2 Developing a global strategy for the conservation and use of cocoa genetic resources

The future of the world cocoa economy depends on the conservation and sustainable use of a broad genetic base to adapt to biotic and abiotic stresses and changing environments. Effective and coordinated conservation efforts are needed, to safeguard and have access to the diversity existing in forests as well as within farmers' fields and in *ex situ* gene banks. With this in mind, CacaoNet was launched in 2006 under the leadership of Bioversity International as a global network to optimize and coordinate the conservation and use of cacao genetic resources. One of the first internationally agreed priorities for CacaoNet was the development of a global strategy for the conservation and use of cacao germplasm.

An expert working group was created to draft the strategy based on broad consultation. Members of the expert group divided up responsibilities along different components, i.e., *in situ* conservation, *ex situ* conservation (including "virtual" strategic global base and active collections), germplasm characterization (morphological and molecular), germplasm collection and acquisition, germplasm exchange (legal aspects and safe movement), information management at different levels, and facilitation of the use of cacao germplasm.

A central component of this strategy is the proposed creation of a Global Strategic Base Collection (GSBC), providing a rational and cost-effective basis for the long-term conservation of cacao genetic resources. Composition of the GSBC will be based on an innovative selection process, strongly based on molecular genetics and designed to ensure that the known genetic diversity is comprehensively represented without bias. Selected accessions will be conserved as a virtual collection in their countries of origin and duplicated for safety purposes in one of the international collections, including the use of cryopreservation. Furthermore, a Global Strategic Active Collection (GSAC) will be created as a dynamic and dispersed collection composed of accessions that are in the public domain and with combinations of characteristics of immediate value to breeders.

Any distribution of this germplasm, whether it is intracountry, intercountry or interregional, requires that safe movement procedures and methods are in place, in order to minimize the risk of spreading pests and diseases. A specific component of the strategy will cover the organizational, managerial and policy considerations relevant to germplasm dissemination. The strategy will also consider ways to improve communication about the importance of safe germplasm movement to the cacao community.

An essential prerequisite for the efficient conservation and effective use of germplasm is the management of relevant information, and the development of CacaoNet's information management system (IMS) as another key component of the strategy. Central to the development of the IMS is CANGIS (CacaoNet Germplasm Information System), a web-based inventory of passport, morphological characterization and evaluation data for CacaoNet accessions. Additional data are accessible through links to existing databases. A germplasm ordering system will also be established for easy access and monitoring of exchanges. The widely dispersed nature of accessions also means that a particularly important aspect of the strategy will be the successful integration of local and diverse gene bank information management systems.

The development of the CacaoNet Strategy is a highly participative process, taking into account the views of as many cacao genetic resources specialists and other stakeholders as possible. This has allowed the global cocoa genetic resources community to focus on a common strategy governed through the CacaoNet platform (www.cacaonet.org).

Research questions

Broad research questions (Component 2, Theme 2)	Gender-specific aspects of the research question	Examples of science outputs
How can key genetic traits in wild and local populations be quickly identified such that high-quality germplasm of socioeconomically important tree species can be conserved?	What traits are important for men and women, taking into account their different roles and resources? What knowledge do they each have and how do they identify valuable traits?	Assessment of feasibility of using genomic tools to find sources of variation in important adaptive and useful traits Methodologies/standards for phenotypic and genetic characterization of genetic resources developed and agreed
What are the most cost-effective ways of conserving desired traits in wild and local populations?	What role can women and men play in conserving valuable local and wild populations that they have access to and use?	System and procedures established for effectively conserving important genetic diversity
How can users (e.g., researchers, breeders, farmers) get rapid access to desired genetic resources and local germplasm?	Are the primary users of genetic resources seeking priority traits identified by women and men for their different roles and resources?	Information systems and databases on genetic resources established or strengthened Systems and procedures established for making important genetic diversity of tree crops available to breeders
What institutional frameworks are effective and cost efficient to ensure genetic resources conservation, access and use of trees and tree crops?	How do we ensure that gender-specific aspects are built into a sustainable institutional framework?	Global partnership frameworks for the evaluation and conservation of and access to tree crop germplasm for important traits established

Research partners

Type of research partner	Organization	Research partner contributions
Participating CGIAR Center	Bioversity International	Provides expertise in genetic resources and information management, manages tree crop genetic resources networks (CacaoNet and Cogent)
	World Agroforestry Centre	Provides research expertise in agroforestry tree genetic resources and information management
	IITA; CIAT	Provide expertise in genetic resources
International level	IUCN	Collaborate in developing best strategies for *in situ* management of genetic resources of key agroforestry species
	FLD	Provides input into establishment of field trials and strategies for conservation through establishment of breeding seed orchards for key agroforestry species
	SCRI	Collaborates in development of genomic libraries using cutting-edge technologies; conducts genotyping and sequencing of priority species to evaluate genetic diversity of adaptive and other traits along the forest–farm gradient
	CIRAD; IRD; United States Department of Agriculture	Provides expertise on conservation methods and approaches,

Type of research partner	Organization	Research partner contributions
		characterization, information management, breeding
	Mars Inc	Provides expertise on characterization and breeding
	Unilever	Analyzes oil diversity and helps identify best varieties of *Allanblackia*
Regional level	CATIE (Costa Rica)	Manages international cocoa collections, expertise in genetic resources and breeding
	Secretariat of the Pacific Community (SPC, Fiji)	Provides expertise in genetic resources
Country or site level	KEFRI (Kenya); KARI (Kenya); NARO; TAFORI; FORIG (Ghana); Amani Nature Reserve (Tanzania)	Analyze phenotypic variation along forest–tree gradients in landscape; facilitates
	Kunming Institute of Botany (China)	Provides biodiversity of tree genetic resources and its management in SW China
	National universities in most partner countries	Collaborates with lecturers to train postgraduate students who will be undertaking the project work
	Cocoa Research Unit (Trinidad and Tobago); Centre National De Recherche Agronomique (Côte d'Ivoire); Cocoa Research Institute of Ghana; CEPLAC (Brazil); INIAP (Ecuador); INIA (Venezuela); MCB (Malaysia); ICECRD (Indonesia); ICCRI (Indonesia); CRI (Sri Lanka); PCA (Philippines); Central Plantation Crops Research Institute (India); CICY (Mexico); Mikocheni Agricultural Research Institute (Tanzania); ICHORD (Indonesia); EMBRAPA (Brazil); CCI (PNG); VARTC (Vanuatu)	Manage tree-crop collections and breeding
	Production Centre Ornamental Gardening and Forestry (Uzbekistan); National Institute of Deserts, Flora and Fauna (Turkmenistan); Institute of Forestry (Kyrgyzstan); Institute of Forestry (Tajikistan)	Participate in specific aspects of research projects
	Academy of Agricultural Sciences, Almaty, Kazakhstan	Coordinate activities among stakeholder groups
	University of Reading (UK); University of Queensland (Australia); Rural Development Administration (Korea)	Provide expertise on conservation methods and approaches, characterization, information management

2.2.7 Research Theme 3: Developing improved silvicultural and monitoring practices for multiple-use management of forest ecosystems

Rationale

Despite the global community's collective efforts to promote SFM, tropical forests are under increasing pressure with increasing population and demands for new agricultural land, forest products and environmental services. Past efforts have resulted in an increase in production forests under improved management. Their number, still low,[61] is expected to increase in the near future and CRP6.2 can contribute significantly to this expansion.

At the same time, in many tropical forested countries, the basic tenets of forest management have not changed substantively over the past decades. Reduced impact logging (RIL) guidelines and forest management units (FMUs) are commonly advocated as a positive change in management, but the overall tenets are still largely based on European models "exported" to the tropics in the 1950s. This is despite growing evidence of the potential contribution of forest-dwelling people by way of their traditional management systems,[62] and the wide availability of powerful new tools for managers, such as GIS and remote-sensing imagery. Consequently, existing management plans in the tropics are frequently based on unrealistic technical prescriptions that hinder implementation by many operators.

Furthermore, in the tropics, most existing management models appear to be viable only for large concessions in unlogged forests, whereas there is an increasing number of small- to medium-scale enterprises (some directly managed by local communities) working in secondary or previously logged forests. The latter such enterprises require adapted models that encompass multiple goods and services. Research is therefore needed to reevaluate existing management approaches for tropical production forests to facilitate the design of more socially and environmentally friendly management rules.[63]

Timber-dominated management models are increasingly being challenged to explicitly include other goods and services. Although the elements for implementing multiple-use forest management have been known theoretically for decades, integrated approaches remain rare. However, there is emerging evidence[64] that different types of community-managed forests for multiple goods can be equally—if not more—effective in maintaining forest cover vis-à-vis nearby protected areas.

[61] Nasi, R. et al. (eds). 2006. Exploitation et gestion durable des forêts d'Afrique Centrale: la quête de la durabilité. ITTO, CIFOR, CIRAD, L'Harmattan, Paris.
[62] Parrotta, J.A. et al. 2008. Sustainable forest management and poverty alleviation: roles of traditional forest-related knowledge. IUFRO World Series Vol. 21. International Union of Forest Research Organizations, Vienna.
[63] Nasi, R. and Frost, P.G.H. 2009. Sustainable forest management in the tropics: is everything in order but the patient still dying? Ecology and Society 14(2): 40. [online]: http://www.ecologyandsociety.org/vol14/iss2/art40/
[64] Hayes, T. and Ostrom, E. 2005. Conserving the world's forests: are protected areas the only way? Paper presented at the Indiana Law Review's Symposium on The Law and Economics of Development and Environment at the Indiana University School of Law. Indianapolis, IN, USA. 22 January 2005; Ellis, E.A. and Porter-Bolland, L. 2008. Is community-based forest management more effective than protected areas? A comparison of land use/land cover change in two neighboring study areas of the Central Yucatan Peninsula, Mexico. Forest Ecology and Management 256: 1971–1983.

Methods and research approach

This research theme will identify bottlenecks to minimize trade-offs in both the design and the implementation of multiple-use forestry systems. It will include timber harvesting as a primary economic output at the industrial scale or in community managed forests, but will also focus on NTFPs and environmental services as secondary outputs.

Research will take place at various scales, as follows.

- First, at the level of the FMU, where the most acute trade-offs are to be found, we will analyze regulatory frameworks, certification, knowledge capacity and silvicultural approaches, as there are scant data on how the trade-offs operate in the context of multiple-use forest management for different stakeholders, and the appropriate management interventions to ameliorate these.
- Second, we will work at the landscape scale (with links to Component 3 of CRP6), because, in some circumstances, multiple use is assumed to be more feasible there than at the stand level.

At both scales, different tools will be applied for promoting multi-stakeholder dialogue and consensus building, in order to enhance forest multifunctionality. Multi-criteria decision analysis will be carried out to assess the minimum set of institutional, organizational and policy conditions required to promote multiple-use forest management and to minimize trade-offs. Further, research will involve the development and validation of commercially viable yet locally accepted silvicultural systems through participatory approaches that harmonize Western and traditional knowledge into harvesting practices for more than one forest product. This includes minimizing conflict over use of timber species that have other values. Spatial analysis will be used to optimize management outcomes at landscape scales when segregation of uses is a preferred approach.

We will apply a combination of top-down and locally based monitoring approaches to assess the effectiveness of management outcomes in promoting multiple-use management. We will conduct diachronic analyses of time-series data using both remote sensing tools (e.g., to monitor resource availability or regeneration trends following intervention) and field methods such as permanent sample plots (e.g., to monitor biodiversity change or forest integrity changes before and after intervention). We will also adopt synchronic approaches using snapshot censuses of various diversity components, floristic and vegetation structure in impacted and non-impacted sites presenting similar conditions (e.g., comparing certified and non-certified forests for biodiversity outcomes).

Research questions

Broad research questions (Component 2, Theme 3)	Gender-specific aspects of the research question	Examples of science outputs
What forest management policies and practices can provide sustainable incomes and incentives for maintaining environmental services, while protecting the natural resource base, and under what conditions?	What factors affect distribution of incomes from different approaches? How are nonmonetary benefits (e.g., domestic use) affected? Who do incentives target; what factors influence targeting? What are the constraints on women benefiting?	Development of tools, methods and guidelines for better monitoring and management of tropical production forests for multiple uses and beneficiaries
How can we go "beyond timber"? What management interventions are needed to maximize the total array of benefits (environmental, social, economic) from forests?	How can men and women share responsibility as resource managers, users and knowledge holders? How can forest managers be sensitized and their capacities to identify and consider gendered roles, preferences and knowledge be enhanced? What processes and accountabilities are required to ensure that the analysis of forest products takes into account postharvest processing possibilities and constraints by men and women for different products?	New silvicultural tools, harvesting guidelines and approaches that avoid local extinction of commercial timber species and attempt to integrate biodiversity considerations (including bushmeat) and other environmental or cultural services into management plans
Does forest certification contribute to the achievement of SFM in tropical production forests or is it simply adding cost and complexity without sufficient corresponding commercial advantage?	Who participates and what are the conditions for participation in the development of standards? What alternative processes and strategies can be adopted to broaden participation? Who benefits in terms of resource conservation and increased incomes and why? How can market-based mechanisms on a global level address and ensure distributional equity and outcomes at the site of production? What innovative solutions and institutions (responsibilities and accountabilities) can be crafted at different governance levels (local, national, global) to facilitate equitable outcomes?	Identification of stand-level trade-offs in multiple-use management systems as they relate to regulatory frameworks, certification and knowledge capacity and silvicultural approaches
What is the minimum set of criteria to include for allocating efforts to rehabilitate degraded ecosystems for the provision of multiple goods and services at the stand and landscape levels?	Differential gender appropriation of the provision of forest goods and services from rehabilitated forests and gender-specific traditional knowledge as an input of silvicultural practice	Decision support systems, best practice guidelines including genetic, ecological and silvicultural approaches
How can agreements be facilitated in existing large and complex stakeholder networks around tropical production forests?	Analysis and recognition of power relations (including influencing factors) in order to design procedures and strategies for increasing the bargaining power of marginalized actors. What resources are irreplaceable for each gender and should thus be addressed as a priority?	Guidelines and mechanisms developed for use of government agencies, certification bodies, private enterprises and communities

Research partners

Type of research partner	Organization	Research partner contributions
Participating CGIAR Center	CIFOR	Provides scientific expertise on multiple-use systems in tropical forests with emphasis on silviculture, management planning, certification, monitoring
International level	CIRAD	Provides scientific expertise on tropical forest management; provides access to network of PSPs; participates in research at most sites
	Tropenbos International	Participates in research at specific sites
	Joint Research Center of the European Commission	Provides scientific expertise in remote sensing, database management; participates in development of observatories and in sentinel landscapes
	Tropical Forest Foundation	Provides scientific expertise in silviculture, RIL; participates in research at specific sites
Regional level	CATIE (esp. Central and South America)	Provides scientific expertise on tropical forest management; provides access to International Model Forest Network; engages in capacity building; participates in research
Country or site level	SPDA (Peru)	Provides expertise in design and implementation of multi-stakeholder platforms for improving forest management; provides expertise in influencing forest policy
	IRAD (Cameroon); IRET (Gabon); University of Kisangani (DRC); Forest Research Institute of Papua New Guinea (PNG FRI); Iwokrama International Center (Guyana)	Participate in research at specific sites and co-supervise MSc/PhD students
	Université Catholique de Louvain (Belgium); Université Libre de Bruxelles (Belgium); University of Florida (USA)	Participate in research at specific sites and co-supervise MSc/PhD students

2.2.8 Research Theme 4: Developing tools and methods to resolve conflicts about distribution of benefits and resource rights in the use of forest and tree resources

It is widely acknowledged that local men and women have forest management strategies that are potentially valuable to the development of new silvicultural systems. Many stakeholders are involved in the formal and "informal" (including customary) management of forests designated for production. Some, such as indigenous communities, migrants, timber companies, frontline forestry officials and local NGOs, are involved directly. Others, such as international NGOs, national governments, end consumers and companies that trade wood or carbon credits, may be involved in less direct ways. Different groups often have conflicting or overlapping rights and responsibilities. Companies, for example, may be allocated usage rights in areas inhabited by local forest dwellers and/or used by forest-adjacent communities. However, there may be unrealized scope for synergies in production forest management.

The devolution of forestry governance, a global trend over the past two decades, offers great promise. Decentralized systems are anticipated to provide opportunities for better incorporating

local values, knowledge and aspirations into forest resource management.[65] At this stage, however, the extent to which such governance reforms have achieved (or are achieving) anticipated policy objectives is unclear.[66] Forest decentralization has occurred against the backdrop of an extended history and practice of industrial forestry concessions in many parts of the world. Most of these concessions arose as a consequence of direct allocation by governments to forestry sector investors (such as in the Congo Basin). Community concessions are on the rise (e.g., in Latin America), and agreements and arrangements between industrial concessions and local authorities/communities (global) are forming a new trend, increasingly pursued as a means for due consideration of local economic, social and cultural needs. In addition, recent rigorous analytical research[67] demonstrates the central role of women in forest management, although the potential contribution of women to sustainable production forest management remains a neglected aspect of production forestry.

Overall, there is a general lack of empirically grounded analysis with systematic data collection on the interactions between communities and timber concession holders. The World Bank,[68] for example, has collected data from experts, with the aim of identifying the most important attributes of successful partnerships, while other researchers[69] have established the motivations for and impacts of different community–company arrangements, although their methodological aspects beg further clarity. Other studies have collected field data to address issues related to, but not congruent with, the interactions between timber concession holders and local communities.[70] There has been little data collection on the interactions between communities and concession holders; most existing studies lack a community perspective.

Without methodological clarity or the inclusion of the perspectives of a critical actor (e.g., local communities), it is difficult to assess what aspects of concession management are working (or not); hence, it is difficult to propose policies, practices and strategies that are likely to deliver the broad goals of equity, efficiency and effectiveness in production forestry management. In an analysis of the impacts of forest concession management on customary tenure systems in Central Africa, researchers found that the concession yields insignificant benefits to local communities. In post-1996 Bolivia,[71] where, unlike in East Kalimantan,[72] community rights are

[65] Agrawal, A. and Ostrom, E. 2001. Collective action, property rights and decentralization in resource use in India and Nepal. Politics and Society 29: 485–514.
[66] Andersson, K.P. et al. In press. Unpacking decentralization: a case study of Uganda's forestry reforms. CAPRi Working Paper. IFPRI, Washington, DC.
[67] Agarwal, B. 2000. Conceptualizing environmental collective action: why gender matters. Cambridge Journal of Economics 24(3): 283–310; Agarwal, B. 2009. Rule making in community forestry institutions: the difference women make. Ecological Economics 68: 2296–2308; Agarwal, B. 2010. Does women's proportional strength affect their participation? Governing local forests in South Asia. World Development 38(1): 98–112.
[68] World Bank. 2009. Rethinking forest partnerships and benefit sharing: insights on factors and context that make collaborative arrangements work for communities and landowners. Report No. 51575-GLB. Agriculture and Rural Development Department, World Bank, Washington, DC.
[69] Nawir, A.A. et al. 2003. Towards mutually beneficial company–community partnerships in timber plantations: Lessons learnt from Indonesia. Working Paper no. 26. CIFOR, Bogor, Indonesia.
[70] Mendoza, G. and Prabhu, R. 2000. Multiple criteria decision making approaches to assessing forest sustainability using criteria and indicators: a case study. Forest Ecology and Management 131(1–3): 107–126; Donovan, D. and Puri, R. 2004. Learning from traditional knowledge of non-timber forest products: Penan Benalui and the autecology of Aquilaria in Indonesian Borneo. Ecology and Society 9(3): 3 [online] http://www.ecologyandsociety.org/vol9/iss3/art3/; Becker, C. and Ghimire, K. 2003. Synergy between traditional ecological knowledge and conservation science supports forest preservation in Ecuador. Ecology and Society 8(1): 1 [online] http://www.ecologyandsociety.org/vol8/iss1/art1/.
[71] Larson, A.M. et al. 2010. New rights for forest-based communities? Understanding processes of forest tenure reform. International Forestry Review 12(1): 78–96.

legally recognized, local communities can directly manage concessions or even lease/sell management rights to external commercial actors. Local communities with land rights have the first option rights to apply for management rights. Because logging concessions in East Kalimantan overlap with customary/*adat*-held forests, conflicts over access and use are prevalent, unlike in Bolivia. Such cross-country comparisons are valuable, although scarce. Their policy relevance and validity can be greatly enhanced both through a broader, systematic comparison of contrasting models and property regimes and by including an analysis of the actual practice of rights as opposed to rights-in-law alone.

Methods and research approach

We will focus on generating knowledge of the relative ability of different production forestry models/approaches to contribute to the enhancement of the benefits, skills and knowledge of forest-adjacent and forest-dwelling communities. A broad range of approaches are currently practiced in different parts of the world: lease–lease back arrangements in Papua New Guinea; community concessions and company–community agreements in different parts of Latin America; formal benefit-sharing agreements in Africa, Asia and Latin America; and outgrower forestry schemes and voluntary systems (such as certification, eco-forestry and corporate social responsibility) in all three continents. A careful research design that is grounded in comparative methods will be employed to isolate the factors that condition successful community–company interactions. We anticipate that property rights/tenure security (for communities/ groups and for individuals within communities) will prove a fundamental incentive for the capture of benefits of management and for engendering sustainable management.

Research will explore the values, knowledge and perceptions of local men and women in relation to production forests. The potential contribution of women to sustainable production forest management, a much-neglected aspect of production forestry, will be assessed; measures for enhancing their participation in relevant aspects of the enterprise will be identified. This research output will also generate knowledge on the relative ability of different production forestry models/approaches (e.g., outgrower schemes, community concessions) to contribute to the enhancement of the benefits, skills and knowledge of forest-adjacent and forest-dwelling communities. It will examine the factors that determine how forests are managed and benefits distributed among relevant stakeholders under each production model, including the responsibilities, accountabilities and coordination mechanisms of communities, private companies, government agents and other relevant actors. In particular, it will seek to understand and identify incentive mechanisms and procedures for enhancing the benefits of production forestry for women under the different models.

Analyses will reveal the range of property rights regimes that exist at the company concession–community interface in diverse contextual settings and will help determine how such regimes create, allocate and enforce entitlements and responsibilities among actors. The analyses will identify rights allocation regimes that have the potential to resolve existing conflicts, and governance processes and practices that are inclusive and have the potential to enhance equitable access and benefit distribution from production forests. Many forest-adjacent communities, including those residing close to production forests, are among the poorest and sit at the lower end of a power continuum compared with governments and private companies. We will seek to understand how communities can build cooperation and synergies both internally

[72] Palmer, C. 2004. The role of collective action in determining the benefits from IPPK logging concessions: a case study from Sekatak, East Kalimantan. CIFOR Working Paper No. 28. CIFOR, Bogor, Indonesia.

and with external actors. Factors that strengthen or undermine collective action for sustainable use and/or securing rights to production forests will be assessed, as will the extent to which communities are aware of their rights and responsibilities. We will assess institutional channels through which claims to land and forest resources can be or are contested, including mechanisms for resolving disputes and their effectiveness.

A comparative research design will be used to identify and select cases with contrasting institutional characteristics, not only with regard to specific community–company benefit-sharing arrangements, but also with respect to broader institutional arrangements such as levels of interaction with government actors or the existence (or not) of statutory recognition of community rights to forest resources. Such a research design will enable the testing of hypotheses, for example, that legal recognition and enforcement of community rights result in greater benefits to communities and more favorable community–company relationships. Further, hypotheses will be crafted to test whether intra-community distribution of benefits is conditioned by company–community relationships or company policies/strategies, among possible variables.

A broad range of tools and methods spanning multiple disciplines are relevant. Household surveys will be used to collect data on: socioeconomic attributes; production forest dependency; access to and share of flow of forestry benefits; inequalities; values and beliefs; and local community perceptions of forest timber concession operations. Where possible, intra-household surveys will be used to differentiate within-household preferences, values and benefits of concession use and management. Focus group discussions among differentiated resource users (including women, youth, ethnic minorities/indigenous people) will be used to collect group-level data on: local forest use, preferences, values and beliefs; local/customary rules governing forest resource, access, use and management; historical dimensions of forest access and use; local systems of accountability and enforcement; community–company relationships; community–local/central government relationships; forest-related conflicts; and resolution mechanisms.

On the company side, where possible, key informants will provide information on company policies and strategies with respect to local communities, including benefit-sharing programs, dispute-resolution mechanisms and their implementation. Similar interviews will be conducted with other actors in government and civil society organizations. Behavioral experiments of various kinds (economic experimental games, role-playing games) will be conducted with representative samples of community members to elicit data on individuals' preferences, resource use and decision making, in order to isolate the factors that influence these parameters within the context of forestry concessions. Thus, both qualitative and quantitative data will be collected, allowing the use of multiple data analysis techniques, including in-depth interpretation and classification of institutional dimensions, as well as regression analysis.

Research questions

Broad research questions (Component 2, Theme 4)	Gender-specific aspects of the research question	Examples of science outputs
What do local people (men, women, old, young, dominant and marginalized ethnic groups) value about the production forests in which (or near which) they live?	How do differential roles in the community explain and affect valuations among multiple interests and to what extent are people able to express their views and influence decisions on forest management?	Guidelines/uses developed for forest resources that incorporate and recognize local values
What strategies exist and can be developed for bringing together the ideas of formal production forest managers and local community members (including women and other marginalized groups)?	How have existing strategies performed and how can they be structured and improved to better meet objectives? How do groups' and individuals' power relationships help to explain their attitudes and their actions? How would recognition of sensitization and capacity-building needs help to achieve common understanding?	Guidelines and mechanisms for forest resource use developed that reconcile/resolve trade-offs and build common understanding between forest managers and communities
How can agreements be facilitated in existing large and complex stakeholder networks around tropical production forests?	Analysis and recognition of power relations. What resources are irreplaceable for each gender and should thus be addressed as a priority?	Guidelines and mechanisms developed for use of government agencies, certification bodies, private enterprises and communities

Research partners

Type of research partner	Organization	Research partner contributions
Participating CGIAR Center	CIFOR	Leads research; oversees and coordinates methodological development and implementation of research project
International level	FAO	Links to policy at national, regional and global level
	PROFOR	Analyzes benefit-sharing arrangements; links to policy at national, regional and global level
	ICRW	Conducts gender analysis and methodology development
	IUCN	Links to policy and advocacy and national, regional and global levels
	IFRI (International Forestry Research & Institutions research program)	Shares multi-country, extended-period (15 years) data sets on institutional, socioeconomic and biophysical aspects of forests and forest management
	ITTO	Links to policy at national, regional and global levels
Country or site level	FORDA, Indonesia	Engages in national- and regional-level policy development
	Forest Research Institute of Papua New Guinea	Engages in research and policy development at national and subnational levels
	University of Kisangani (Cameroon)	Engages in research and policy development at national and subnational levels
	Universidad de Sao Paolo (Brazil)	Engages in research and policy development at national and subnational levels
	WOCAN	Engages in gender advocacy at national and subnational levels
	WEDO	Engages in gender and advocacy at national and subnational levels
	Ministries/departments of gender and development	Engages in policy advocacy at national and subnational levels

2.2.9 Sentinel landscapes

Component 2 would use sentinel landscapes to gather baseline data and monitor changes in people, institutions, forests, trees and genetic resources. These landscapes would cover a gradient of socio-ecological conditions and would include networks of study sites that would be remeasured at regular intervals. The factors that threaten forests, trees and genetic resources and/or their response to experimental treatments and current management activities would be tracked. Long-term monitoring (including remote sensing) would allow us to establish and test the factors that condition success or failure of interventions aimed at enhancing the capture and distribution of benefits of production forests between local men and women.

Ideally, sentinel landscapes would allow us, through a mix of diachronic (permanent plots, repeated censuses) and synchronic (large scale inventories, screenings) approaches, to understand the effects of the main social and environmental factors on the structure, diversity, dynamics, C-storage capacity and resilience of forests, trees and genetic resources and to test the effects of management options. This knowledge base would then be used to design improved conservation strategies and multiple-use management systems for trees and forest ecosystems that also take into account the values, needs and priorities of different resource users, and minimize conflicts among them.

2.2.10 Impact pathways

The research team for Component 2 will be accountable for the successful delivery of the outputs related to the conservation and use of forest and tree resources; it will also engage and share responsibility with key partners for the dissemination and adoption of the project's outputs to achieve the expected outcomes. The indicators, methods and best practices developed will provide the scientific and practical foundations for enhancing certification schemes to include appropriate attention to conserving genetic diversity and promoting equity in the distribution of benefits. Capacity will be enhanced in project countries to carry out the processes of identification and development, dissemination and adoption of best practices in conservation, management and use of forests and tree genetic resources. The adoption of these practices will lead to an increased level of conservation of important forest and tree resources for future generations; the availability and use of a broader range of trees and their products will improve the well-being and food security of people living in areas of high poverty, as well as ecosystem resilience.

Stakeholder analysis will enable the project team to integrate target groups into the research process to ensure the relevance and uptake of research findings. In addition to engaging with the national and regional forestry research community (NARS), this will involve extension services, farmers or NTFP-collector groups (including both men and women), forest enterprises (including small-scale, NTFP-focused enterprises) and national and international NGOs. Local people will participate in the research and be the ultimate beneficiaries through enhanced management capacities, reduced levels of local conflict and greater inclusion in decision-making processes governing production forests.

Research outputs will be used at multiple levels as illustrated in the following examples.

- Practical indicators of genetic resources will be useful for policy partners (e.g., ITTO), managers and certification schemes (e.g., FSC) to take into account genetic diversity in management plans or standards.

- Methodology for a rapid *in situ* evaluation of diversity of useful traits of wild and semi-domesticated fruit tree species will be useful for producer organizations, managers and breeders.
- New silvicultural tools, harvesting guidelines and approaches for multiple-use management, integrating NTFPs (including bushmeat) and other services into management plans will be of interest to international policy/practice partners (e.g., FAO, ITTO), the World Bank and other development banks, government agencies and training institutions.
- The identification of stand-level trade-offs in multiple-use management systems as they relate to regulatory frameworks or certification will help in the design of better adapted certification standards and more favorable policies at the national level. This output will be of considerable use to certification schemes (e.g., FSC standards for Small and Low Intensity Forest Management (SLIMF)) and government agencies in charge of production forests.
- Integrating NTFPs (including wildlife and bushmeat) into multiple-resource forest management will conserve important environmental services and safety nets for the poor, as well as building local confidence and capacity in management of both timber and non-timber products. We will collaborate with international organizations (e.g., CPF, ITTO, FAO), national and local governments, industry and national and international NGOs in the development and dissemination of improved silvicultural and monitoring practices for conservation and sustainable management of production forests, to reach end users more effectively.
- A more holistic approach to forest management will also have indirect benefits (see Box 2.3), such as reducing conflicts between companies and local people through attention to NTFPs, many of which are collected by women. At national and local levels, research will empower **development and knowledge-sharing** partners to provide tools and knowledge to governments, companies and communities for the development and adoption of sound policies, standards and management arrangements.

The adoption of these practices is expected to contribute to the following impacts: (1) conservation and increased use of forest and tree genetic resources; (2) increased social and economic benefits from forest and agroforestry goods and services; (3) enhanced access of women and other disadvantaged groups to benefits and decision making at all levels; and (4) reduced deforestation and degradation (see Figure 2.3 and Section 3.1 for gender-specific impact pathways).

Box 2.3 The benefits of better managed production forests

Better managed production forests suffer less unnecessary damage during harvesting, thus ensuring a better living environment for local communities (e.g., less pollution, maintenance of water quality and conservation of important local resources); this results in greater ecological and economic value of the remaining forest stands, less forest degradation and more CO_2 stocks in the logged-over forests.

Carbon: The potential global contribution of improved tropical forest management to carbon retention is substantial. With a total area of about 350 million hectares of tropical moist forests designated for production, research[1] shows that improved timber harvesting practices would retain at least 0.16 gigatons of carbon per year (Gt CO_2 yr^{-1}), amounting to about 10% of the total emissions linked to deforestation.

Degradation, biodiversity: Production forests sustainably managed for multiple uses[2] allow combined economic benefits—mixing short-term returns from NTFPs or wildlife and long-term returns from timber—with as much as 30% less damage to the residual stand. This is potentially applicable to more than 100 million hectares of timber concessions in Central Africa, Amazonia and Southeast Asia.

Economics: Improved management practices (including RIL) increase the efficiency of the timber sector, allowing an optimal use of equipment (20% lower heavy machinery needs) and less waste (up to 20% of logs are forgotten in conventional logging operations). This ensures generally a better financial return on a hectare basis and the need to use a smaller forest area for the same production level.[3]

Given the rate of adoption of management[4] and certification in the tropics,[5] we can expect our research to contribute to the adoption of ecologically and socially sustainable production and management practices for 9.3–27.8 million hectares of production forests. This may result in secondary benefits of between 0.01 and 0.03 Gt CO_2 yr^{-1} of averted emissions, as well as in a significant decrease in biodiversity loss due to forest degradation, with 3–9 million hectares of more productive forests not unnecessarily degraded by harvesting activities.

References:

[1] Putz, F.E. et al. 2008. Reduced-impact logging: challenges and opportunities. Forest Ecology and Management 256: 1427–1433.
[2] Guariguata, M.R. et al. 2010. Compatibility of timber and non-timber forest product management in tropical forests: perspectives, challenges and opportunities. Forest Ecology and Management 259(3): 237–245.
[3] Putz, F.E. et al. 2008.
[4] ITTO. 2006. Status of tropical forest management 2005. ITTO Technical Series no. 24, ITTO, Yokohama, Japan.
[5] Auld et al. 2008. Certification schemes and the impacts on forests and forestry. Annual Review of Environmental Resources 33:187–211.

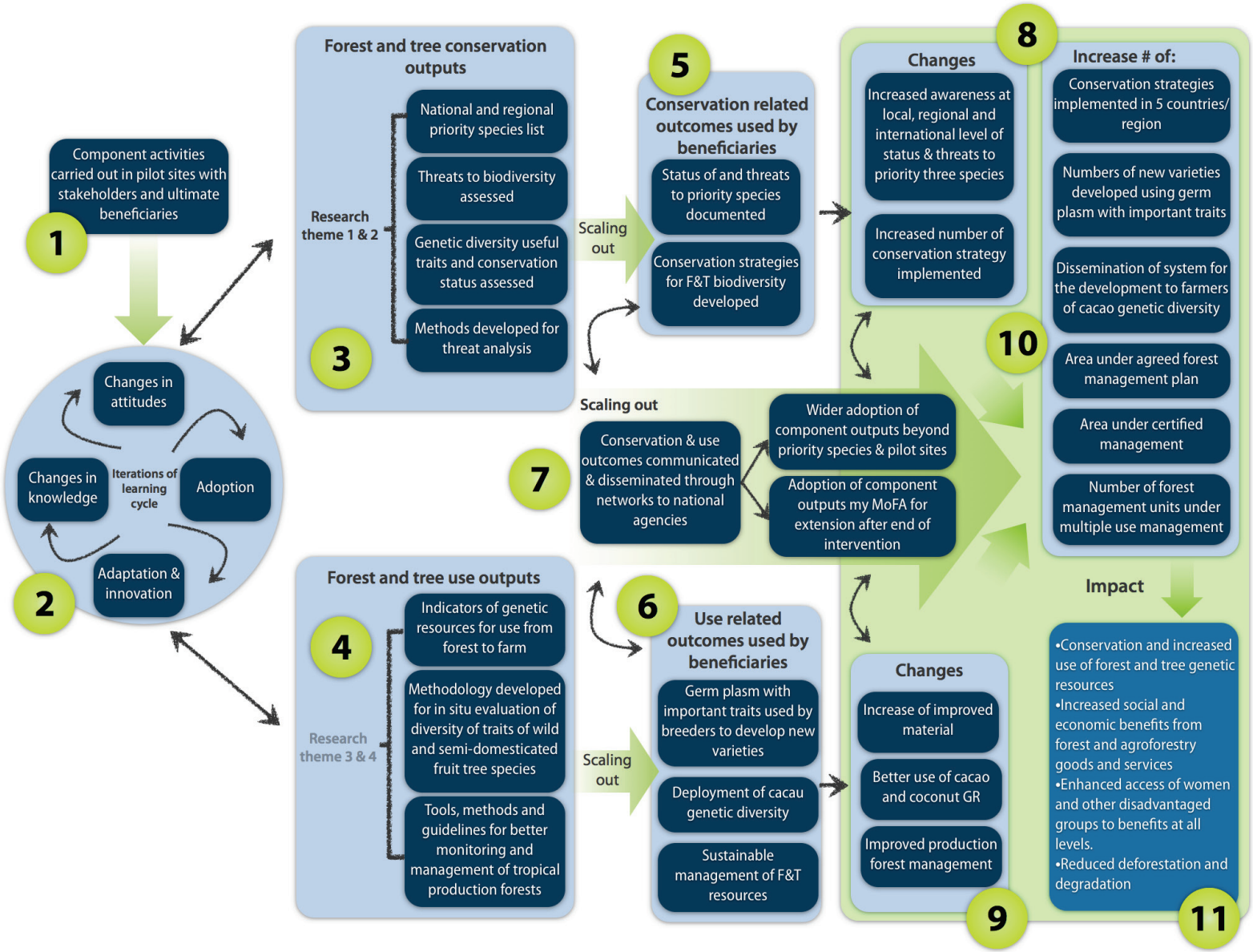


Figure 2.3 Impact pathways for Component 2

2.2.11 Milestones

Years	Research Theme 1	Research Theme 2	Research Theme 3	Research Theme 4
1–2	Existing partnerships reinforced and new partnerships established, memoranda of understanding and subcontracts in place with research partners in relevant countries. Roles and responsibilities agreed for each stage, capacity-strengthening elements established for PhD and postdoctoral fellows (including women) from national institutes. Priority sites, species, populations identified and standardized methodologies to be used across sites agreed upon with partners ideally associated with sentinel landscapes. Data-sharing agreements developed. Monitoring and evaluation systems developed and agreed (in collaboration with other component teams). Continuation of ongoing relevant projects. Joint fundraising to develop new projects or expand existing projects to new countries.			
2–4	Sampling carried out, lab analysis conducted, data assembled from diverse sources, baseline data collected in pilot sites using participatory methods, genetic status of first group of priority species evaluated. Threat analysis, evaluation of genetic variability in traits for first-level priority species, data analysis, journal publications.	Phenotypic observation carried out, field trials across environmental gradients to understand plasticity and adaptation established for key species; sampling carried out, genomic libraries developed and genotyping/sequence analysis undertaken; spatial data assembled; students trained; genetic status of first group of priority species evaluated, results obtained.	Literature reviews and scoping assessments on past experiences and lessons learned on several dimensions of multiple-use forests carried out. Multi-stakeholder dialogue platforms established. Bottlenecks identified and opportunities for targeted interventions discussed with partners and proposed. Continuation of ongoing relevant projects	Research conducted in selected priority country sites. Institutional factors and conflicts mapped for each site. Community value and community–company conflict profiles developed. Community-level monitoring indicators developed. Various manuals and guidelines developed (coordination between government, companies and communities, approaches for lowering company–community conflicts, improved benefit sharing)
	Completion of most preexisting projects and start of new portfolio of relevant projects. Joint fundraising to develop new projects or expand existing projects to new countries.			
4–6	Guidelines and strategies drafted; community training carried out at pilot sites.	Data (field, traditional knowledge and laboratory) combined with spatial data to link phenomes with genomes; field trials of a select few species for incorporation into breeding programs established.	Interim research outputs synthesized to further guide changes in policy and develop best practices for designing multiple-use systems and monitoring their outcomes.	
	Case studies developed for modular training materials on forest genetic resources, multiple forest use (including non-timber forest products), resource conflict resolution. New major round of fundraising. Research outputs placed in peer-reviewed journals and peer-reviewed reports and disseminated through various vehicles to national and global scientific and policy arenas (e.g., policy briefs, community feedback sessions, national policy roundtables, exchange meetings between communities, practitioners and policymakers).			

Years	Research Theme 1	Research Theme 2	Research Theme 3	Research Theme 4
7–8	*In situ* protection strengthened, *ex situ* collections established (live gene banks, seed bank collections), extension material	Evaluation of genetic variability in traits for first-level priority species, contribute to Theme 1 in prioritizing geographic areas for conservation and use in forest and farmland in the light of global challenges	Uptake by relevant certification agencies, NGOs and the private sector	Guidelines, strategies, policy briefs disseminated. Use of manuals, practitioner guides and policy briefs by NGOs, local government and companies in their community work.
	National and subnational policies changed to reflect guidelines, strategies implemented. Changes observed in conservation and management practices at local level, i.e., increased number of tree species retained in farmers' fields, increased implementation of actions to conserve priority tree species and populations by national management agencies and international forest management (such as FSC) and conservation organizations, more planting of vulnerable species.		National organizations adopt the recommendations derived from the research and are embodied in regulations and local norms. National project advisory committees play central roles in encouraging use, application and revision of manuals, guides, policy briefs and tools.	
9–10	Reduced threats and greater use of intra- and interspecific diversity, as indicated by monitoring of pilot sites; greater recognition by development organizations of the importance of tree species for food and other needs.	Evaluation field trials; impact of research taken so far assessed; contribute to the component's strategy for management and conservation of the genetic resources of priority species.	Conversion of multiple-use managed forests into other land uses is reduced with respect to mono-dominant uses and forest protected areas	Resource and recourse diagrams and community monitoring tools applied for monitoring. External impact assessments of research encouraged. Reduced conflicts between local communities and companies.
	Long-term, effective management and conservation of forest and trees and their genetic resources in three regions is in place.			
	Rights allocation regimes and alternative resource access options are understood (and put into practice) by multiple-resource users. Improved distribution of benefits to the poor (including to women and ethnic minorities) such as enhanced resource access options, increased employment opportunities and incomes, improved capacities and opportunities to sustainably manage production forests. Capacity of local communities to engage in collective action strengthened.			

2.2.12 Role of partners

Most of our work will be carried out under some form of partnership. Relevant partners belong to all three categories defined in Section 3.2.

We will develop and carry out research activities with our research partners (presented in the research partner tables for each component). At international and regional levels, collaboration with advanced research institutes (ARIs), regional centers and universities will ensure the scientific relevance of our work while at the same time covering a wider range of scientific fields. These partners will bring their own strengths and fields of expertise into our joint research. The association between Component 2 and ARI teams will constitute the core

team at the global level to develop and implement research project proposals to develop international public goods (IPGs).

The global or regional networks developed for the conservation of genetic resources of crop trees (CacaoNet, COGENT) and other important tree species (APFORGEN, SAFORGEN and LAFORGEN) will contribute to Themes 1 and 2 by increasing our overall capacity in assessing genetic diversity and pre-breeding activities. National research partners will be an integral part of the research design and implementation at the country level. They will play an essential role in grounding our research in local realities, bring their knowledge of local conditions to the partnership and, in return, benefit from technology transfer and capacity building from the international partner teams. They are also important vectors for the inclusion of our joint research findings into new curricula.

Our policy and practitioner partners enter the picture to improve impact. These development-oriented organizations are the immediate and intermediate clients for research results in our impact pathway. For example, the Component 2 teams will work upstream with the UN CBD Secretariat to bring the most up-to-date scientific knowledge into the documents prepared for the Subsidiary Body for Scientific, Technical and Technological Advice (SBSTTA) and UNFCCC Conferences of the Parties. At the national level, our close engagement and partnerships with the managers (logging companies, communities, major consulting firms such as SGS) and the administrations in charge of forests keep our agenda relevant to local needs (while addressing the global IPG demand) and influence the policy decisions about the management of forests and tree resources. We will work to establish new partnerships with development organizations, such as WFP, Oxfam, CARE and others, and environmental NGOs, such as WWF, to increase the likelihood of our research results being applied at the grassroots level. We will convene periodic meetings with these organizations to foster understanding and information exchange.

The knowledge-sharing partners facilitate the communication of our findings to key target audiences, as well as to students, the media and the general public. International research networks (e.g., IUFRO), conservation organizations (e.g., IUCN) and development agencies (e.g., the World Bank) can all mobilize their networks to reach key policy and practitioner communities. Others, such as RECOFTC, can ensure that research results are incorporated into training curricula for forest-related practitioner communities. Still others, such as CATIE and the University of British Columbia, can incorporate relevant perspectives and experiences into graduate training in forest-related disciplines. At national and local levels, knowledge-sharing partners will assist in disseminating research results in the formats and languages most accessible to local users.

A non-exhaustive list of key policy/practitioners and knowledge-sharing partners at various levels is provided in Table 2.2.

Table 2.2 Illustrative list of policy and knowledge-sharing partners for Component 2

Levels/types	Policy and practitioner partners*	Roles/ contributions	Knowledge-sharing partners	Roles/ contributions
International level	CBD	Adoption of research results and translation into policy decision	CBD	Distribution of research information; development of guidelines, policy guidance documents
	FAO**	Synthesis of information for best practice guidance at global levels	FAO**	Distribution of research information; development of guidelines, policy guidance documents
	FSC	Translation of research results into standards and guidelines for producers		
	ITTO	Promotion of including multiple-use forest into SFM guidelines	ITTO	Distribution of research information; development of guidelines, policy guidance documents
	Environmental and social NGOs	Testing and use of methods or guidelines developed by research	Environmental and social NGOs	Distribution of research information; development of guidelines, policy guidance documents
	Forestry consulting firms (SGS, FRM…)	Testing and use of methods or guidelines developed by research		
	IFAD, International Development Banks	Mainstream research results in development projects		
			Panos	Use of content in training journalists
Regional level	COMIFAC	Translation of research results into policy guidance for Congo Basin governments		
	OTCA	Translation of research results into policy guidance in Amazon basin countries		
			RECOFTC	Use of content in training courses
			CATIE	Use of content in graduate curriculum

Levels/types	Policy and practitioner partners*	Roles/ contributions	Knowledge-sharing partners	Roles/ contributions
Country or site level	Ministries in charge of forests, forest resources and environment	Adoption of research results and production of relevant improved policies		
	Ministries, agencies in charge of gender and community development	Adoption of research results and production of relevant improved policies		
	Technical and extension agencies	Testing of new methods developed by research	Technical and extension agencies	Dissemination of new methods to practitioners
	Certified and managed timber companies	Field sites and resources to develop / test new management		
	Environmental and social NGOs	Testing and use of methods or guidelines developed by research	Environmental and social NGOs	Distribution of research information; development of guidelines, policy guidance documents
			Local media organizations	Use of content in training journalists and local people

* See the list of abbreviations at the beginning of this proposal.

** Partner with substantial gender-relevant programs

2.2.13 Prioritization

Achieving the expected outcomes and contributing to the above-mentioned impacts will require detailed understanding of many different issues and stakeholders. Therefore, it will not be possible to reduce effort in a given study site without compromising the quality of research outputs. We will respond to fluctuations in the available budget by increasing or decreasing the number of cases/study sites. Priority will be given to those countries/sites/species that offer the best learning opportunities, partnerships, baseline data and potential for impacts. Other prioritization criteria would be possible synergies with other components (in the context of sentinel landscapes) or CRPs, representativeness of the entire portfolio of research and potential to generate IPGs.