Agroforestry for **food security** and **healthy ecosystems**

WORLD AGROFORESTRY CENTRE
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World Agroforestry Centre
United Nations Avenue, Gigiri
P. O. Box 30677-00100
Nairobi, Kenya
Phone + (254) 20 722 4000
Fax + (254) 20 722 4001
Via USA phone (1-650) 833-6645
Via USA fax (1-650) 833-6646.
Email: icraf@cgiar.org
www.worldagroforestry.org

Writer: Charlie Pye-Smith
Coordination, compilation, editing/proofreading: Michael Hailu, Rebecca Selvarajah-Jaffery, Kris Vanhoutte
Design and Layout: Reagan Sirengo
Cover photo: Wendy Stone
Financial information: Francis Kinyanjui
Performance indicators: Elizabeth Mbele Kariuki
List of partners: Wahida Patwa Shah
Staff list: Beatrix Gacho, Stella Muasya, Faith Wambua
Publications: Humphrey Keah, Iddah Wandolo
Distribution: Naomi Kanyugo

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Our Vision, Mission and Values

Our Vision is a rural transformation in the developing world where smallholder households strategically increase their use of trees in agricultural landscapes to improve their food security, nutrition, income, health, shelter, energy resources and environmental sustainability.

Our Mission is to generate science-based knowledge about the diverse roles that trees play in agricultural landscapes and to use its research to advance policies and practices that benefit the poor and the environment.

Our Values. We strongly adhere to shared core values that guide our work and relationships with colleagues and partners:

- **Professionalism.** We aspire to achieve the highest standards of professionalism in our research, communications, fiduciary management and operations, transparency in our methods and approaches, and fairness in sharing credit.
- **Mutual respect.** We genuinely respect all those with whom we work, irrespective of nationality, gender, religion, age, profession or workplace seniority. We celebrate the achievements of our colleagues and partners. We support a work environment that fosters trust, teamwork and diversity. We commit ourselves to an environment of mutual respect and collaboration with partners, donors and colleagues.
- **Creativity.** We promote a culture of innovation, continuous learning, problem solving and independent thinking.

We believe that success in living and fostering these values is fundamental to maintaining a vibrant organization, contributing to science and achieving impact.

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Message from the Chair of the Board of Trustees and the Director General

The World Agroforestry Centre witnessed an exciting year as we developed a compelling **new strategy** to guide our research through to 2015. *Transforming Lives and Landscapes*[1] outlines the choices we have made, and how these choices will translate into action.

We are delighted that the CGIAR's Science Council strongly supported our new vision. "Overall this strategy provides a compelling case for ICRAF's activities for the next seven years," it noted.

Six **global research projects**, which are fundamental to agroforestry science form the basis of the strategy:

- Domestication, utilization and conservation of superior agroforestry germplasm
- Maximizing on-farm productivity of trees and agroforestry systems
- Improving tree product marketing for smallholders
- Reducing risks to land health and targeting agroforestry interventions to enhance land productivity and food availability
- Improving the ability of farmers, ecosystems and governments to cope with climate change
- Developing policies and incentives for multifunctional landscapes with trees that provide environmental services

1 Transforming Lives and Landscapes. The World Agroforestry Centre Strategy 2008-2015. World Agroforestry Centre, Nairobi, 2008.

As we look forward to the strategy's execution, we are committed to four pillars of excellence— further strengthening the quality of our scientific research; enhancing our strategic partnerships; accelerating the use and impact of our international public goods research; and improving our operational efficiency.

A major theme of this year's annual report is the way that agroforestry is helping to address the **global food crisis**. The research stories in the report, and the introductory essay, show how agroforestry science has been engaged in developing technical, institutional and policy innovations that are fundamental to achieving food security in the developing world, especially in Africa. The importance of agroforestry — not only for food security, but also as a way of improving rural incomes and nutrition, protecting biodiversity and environmental services, and helping the rural poor to adapt to climate change — is now widely recognized. For example, the International Assessment of Agricultural Science and Technology for Development challenged the world with a new vision of multifunctional agriculture. In its report,

completed in 2008, it concluded that agroforestry has a central role to play in achieving this vision, particularly in the developing world.

At the beginning of 2008, we welcomed a refreshed **senior leadership team** to assist the Director General. The team consists of the Deputy Director General, Tony Simons, the Director of Finance and Operations, Laksiri Abeysekera, and the Director of Communications, Michael Hailu. We believe that this team has the capacity to elevate the Centre to the new heights demanded by the strategy.

We were pleased to have exceeded a number of key **financial benchmarks** of the Consultative Group for International Agricultural Research (CGIAR) performance measurement system. The short-term solvency (liquidity) at the end of December 2007 was 182 days, against a benchmark of 90 to 120 days. The long-term financial stability (adequacy of reserves) for the same period was 126 days, against the CGIAR benchmark of 75 to 90 days.

We have been gratified to receive funds from new donors, some of them non-traditional donors to the CGIAR. However, stagnant core income and low overhead recovery levels on projects are a concern to us as well as other CGIAR centres. The senior leadership team will ensure that our excellent record of financial stability, often in the face of considerable external political and financial volatility, is sustained in the future.

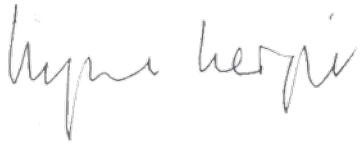
We are proud that during the past year, our scientists were recognized for their outstanding work. Most notably, several World Agroforestry Centre scientists have been active contributors to the Intergovernmental Panel on Climate Change—the recipient of the 2007 Nobel Peace Prize along with former US Vice President Al Gore. Three of our scientists were also recognized by their peers with 'best paper' **awards** for their publications while one was appointed as *Professor Extraordinaire* by Stellenbosch University in South Africa.

Our quarterly **Board** telephone meetings have enabled members to keep abreast of the Centre's activities, as well as the significant changes being undertaken by the CGIAR system. We are encouraged by the prospect of renewed energy and efficiency in the system, which will ultimately deliver better results for the benefit of the world's poor and hungry.

As we look ahead, we are excited to be partnering with the United Nations Environment Programme and other organizations as sponsors of the **2nd World Congress of Agroforestry**, to be held in Nairobi in August 2009. The Congress's theme is *Agroforestry: the Future of Global Land Use.* This timely topic will provoke serious debate. It will also provide an important forum to highlight our most important research and that of our sister CGIAR centres, national research organizations and NGO partners.

No report would be complete without acknowledging those who have helped the Centre in its many achievements this year. In particular, we would like to sincerely thank our donors and loyal partners in the journey of agroforestry research and development…and, of course, our indefatigable staff.

Lynn Haight
Chair of the Board of Trustees



Dennis Garrity
Director General

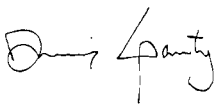


Photo: Charlie Pye-Smith

Perspective

Agroforestry and the global food crisis

During recent months, rising food prices have led to riots, protests and ever-lengthening food queues in countries as far afield as the Ivory Coast and Indonesia, Haiti and Thailand. Less visible, and seldom reported, has been the misery caused to tens of millions of families who can no longer afford to adequately feed themselves.

In September 2008, the UN's Food and Agriculture Organization (FAO) estimated that the global food crisis —prices had risen by over 80 per cent in 3 years—had added at least 75 million people to the 850 million already suffering from hunger and poverty. To avert disaster, FAO indicated that the world needed to mobilize US$30 billion a year. The aim: to double food production by 2050, when the population will be around 9 billion.[1]

A variety of factors have led to rising food prices, including dramatic increases in the price of oil and other fuels, a lack of investment in the agricultural sector, an increase in demand for meat and grain in growing economies like China, the expansion of the biofuel sector, and land degradation and declining soil fertility. Tackling the global food crisis will therefore require a range of vigorous activities and initiatives.

Our experience suggests that agroforestry science, and its application in development by smallholders throughout the tropics, must play an important role in achieving greater food security. The incorporation of a diverse variety of trees into agricultural systems can increase crop productivity, increase the incomes of smallholder farmers, and improve nutrition, especially among the rural poor. Here, briefly, is some of the evidence.

Increasing yields through agroforestry

In many parts of the developing world, and especially Africa, productive agricultural land is degrading in quality, and the fertility of soils continues to decline. This situation must be reversed. However, many farmers are unable to afford commercial fertilizers, lack sufficient animal manure, and cannot leave their land fallow to rebuild soil health. This means that soil organic

Declining soil fertility means that many farmers in Africa suffer from low crop yields. (Charlie Pye-Smith)

1 References used: the FAO facts and figures and UN press release: http://www.un.org/apps/news/story.asp?NewsID=28093&Cr=food&Cr1=crisis. World Bank estimated food price rise of 83% over 3 years up to Feb 2008: http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/AFRICAEXT0,,contentMDK:21727859~menuPK:258657~pagePK:2865106~piPK:2865128~theSitePK:258644,00.html

matter is declining and farmers are unable to replenish the nutrients that are removed from the soil with each harvest. As a result, they see their yields falling year after year. In Malawi, it is estimated that 80 per cent of smallholders now have insufficient food for four months a year. The same is true, to varying degrees, in many other countries.

Agroforestry research has shown conclusively that by applying integrated soil fertility management practices, farmers can reverse the trend of declining soil fertility and increase their crop yields substantially with minimal cash inputs. Decade-long trials in Malawi, in which maize was intercropped with a nitrogen-fixing tree, *Gliricidia sepium*, produced yields that averaged 3.7 tonnes a hectare – compared to just 1.1 tonne on plots without Gliricidia. Small additions of mineral fertilizer on plots with Gliricidia pushed yields above 5 tonnes. Similar results were observed in Zambia, Kenya, Tanzania, and other countries in southern and eastern Africa.

By around 2005, some 100,000 smallholders in Malawi were benefiting to some degree from the use of fertilizer trees. What was needed was a programme that would dramatically scale up the use of agroforestry technologies, and 2007 saw the launch of Malawi's Agroforestry Food Security Programme. Funded by Irish Aid and described on pages 28-30, this will enable around 1.3 million of the poorest people in Malawi to benefit from increased food production with a minimal investment of scarce cash. Programmes such as this should now be launched throughout the region.

Aaron Nahawa, a farmer in Kalimbuka village, Malawi, has significantly increased his maize yields by intercropping with Gliricidia. (Charlie Pye-Smith)

Several other stories in this year's annual report also highlight the important role that agroforestry can play in rehabilitating degraded soils. For example, the Utthan Centre for Sustainable Development and Poverty Alleviation promoted diversified agroforestry in rural India, drawing on the technical expertise of the World Agroforestry Centre. This work, which reclaimed some 85,000 hectares of degraded land, and directly benefited 90,000 families, was awarded the prestigious global Alcan Prize for Sustainability for 2007. Tree cover has increased. Soil fertility has improved. Crop yields have risen. (See pages 32-33)

Increasing incomes through agroforestry

Smallholder tree production can make a significant contribution to improving rural livelihoods and strengthening national economies, yet it is often ignored by policy-makers and politicians. In West Africa, the trees most highly valued by farmers are not, as one might expect, mahogany and other commercially important timber species. They are indigenous fruit trees, such as bush mango (*Irvingia gabonensis*), African plum (*Dacroydes edulis*) and the African nut (*Ricinodendron heudelotii*).

In the mid-1990s, our researchers recognized that if these species could be domesticated and commercialized, there would be tremendous benefits for the rural poor. This is precisely what has been done. There are now hundreds of farmer nurseries in the region, using propagation methods that we specifically adapted for rural conditions, who are mass-producing trees with the traits – large fruits, sweet taste and so forth – most valued by farmers and consumers.

Agroforestry research and development aims to reduce dependency on primary agricultural commodities and help to establish the production of added-valued products based on raw agricultural materials. If countries in Africa, or other parts of the developing world, are to compete successfully on the world market, their agricultural research and development institutions must develop new skills in both the domestication of indigenous species and in the processing and storage of fruits, nuts, resins and other tree products, as well as in market analysis and market linkages. The World Agroforestry Centre has long argued for a 'tree crops revolution' in the tropics, to increase the number of tree products and the range of species that are planted, processed and marketed. We are expanding our efforts with partners to domesticate more under-utilized fruit, fodder, timber and medicinal tree species. Major research and development experiences over the last 20 years are reviewed in a new book, *Indigenous Fruit Trees in the Tropics*. (See pages 9-12)

Agroforestry and better health

There are scores of definitions of food security, and the vast majority include references to good health. This is why fruit trees, a major source of vitamins, are so important. Expanding fruit tree cultivation can have a significant impact, particularly on the quality of child nutrition. Take, for example, Africa, where around 600,000 children die each year from diseases caused by vitamin A deficiency. World Agroforestry Centre scientists and partners have now identified portfolios of productive fruit trees for each ecoregion in Africa. By growing several species of indigenous and exotic vitamin-rich fruit trees around their homesteads, families can have access to fresh fruits year-round. This will go a long way to ensuring that their children have a healthy diet. The scaling-up of these 'household fruit tree portfolios' deserves much more attention by national and international development initiatives.

Medicinal plants — two-thirds of which are derived from trees — are vitally important for the health of poor people throughout the developing world. In Africa, for example, more than four-fifths of the population depend on medicinal plants. They also provide important ingredients for a large number of drugs used in Western medicine. Unfortunately, many trees are now seriously over-exploited, and some are even threatened with extinction. Our research on medicinal tree germplasm conservation and characterization, particularly work to develop herbal combination therapy for malaria treatment, has been increasing. Meeting the expanding demand for tree medicinals will only be assured, however, through much greater efforts to domesticate them, and promote their cultivation on farms. We are thus seeking more vigorous collaboration and support for these initiatives.

Advances in agroforestry can contribute significantly to the achievement of the Millennium Development Goals, and it is especially important as far as the first is concerned. This pledges to cut the number of hungry and desperately poor people by half by 2015. Unfortunately, the global food price crisis has meant that the chances of achieving this goal have been significantly reduced. This makes it all the more urgent that pro-poor efforts in agroforestry – and other aspects of agriculture – which can help to eradicate hunger, lift the rural poor out of poverty and improve nutrition should be vigorously promoted.

Smallholders can improve both their health and their incomes by growing fruit trees. Here, women in Malawi sell their fruit from roadside stalls. (Charlie Pye-Smith)

Photo: Jan Beniest

Research highlights

A hardy tree that adapts to a wide range of conditions, the guava (*Psidium guajava)* yields a tasty fruit packed with vitamins C and A. Eaten raw or canned, the fruit can be processed into syrup, puree, jams, jellies, juices and wines. (Charlie Pye-Smith)

From the forests to the farm

In 1996, scientists from the World Agroforestry Centre asked some 6000 farmers in Cameroon, Gabon, Ghana and Nigeria to name the trees they valued most highly. "I was shocked when we analysed the data," recalls Zac Tchoundjeu, principal tree scientist in Cameroon. "As a forester, I was expecting them to mention commercially important species like mahogany, but none of them did. What they valued most were indigenous fruit trees, about which we knew very little." Although there were some variations in preferences both within and between countries, a small number of fruit trees – especially Bush mango (*Irvingia gabonensis*), African Plum (*Dacroydes edulis*) and the African nut (*Ricinodendron heudelotii*) – were popular with all those questioned. If researchers, working with farmers, could domesticate and commercialize these species, then the welfare and incomes of some of the poorest people in Africa would improve.

With this in mind, Tchoundjeu and his colleagues launched a programme of participatory tree domestication. They analysed what traits were most appreciated by farmers – they wanted trees that produced large fruit at an early age with a sweet taste – and established nurseries where they began to develop new varieties. In 1996, there were just two farmers' tree nurseries; now there over 150, and some communities are making thousands of dollars a year selling improved varieties of indigenous fruit tree.

This is one of the many research programmes described in the book, *Indigenous Fruit Trees in the Tropics: Domestication, Utilization and Commercialization*. Although much of the book is devoted to research conducted by the World Agroforesty Centre and its partners in Eastern, Central, Southern and West Africa, it also provides an overview of the opportunities for domestication and commercialization in South America, Oceania and Southeast Asia.

Indigenous fruit trees have always been important to the rural poor. For example, in Malawi, Mozambique and Zambia, up to 80 per cent of rural households

lack access to adequate supplies of food for around a quarter of the year, and up to half of those interviewed in one survey said they relied on indigenous fruits to sustain them during this critical period. "Our research shows that the probability of households in Zimbabwe falling below the poverty line is 30 per cent less if they have access to indigenous fruit trees," explains Festus Akinnifesi, the senior author of the indigenous fruit tree book and the World Agroforestry Centre's Regional Coordinator for Southern Africa. "These species were largely ignored by researchers until recently, and local farmers lacked the understanding and skills to domesticate them and integrate them into their farming systems."

Domestication takes advantage of variations in the wild, which can be considerable. For example, a sample of 15 trees belonging to one nut-bearing species in Southern Africa, *Sclerocarya birrea*, found that the oil yield per nut ranged from 5 to 53 grams. The numbers of fruit of another species, *Ziziphus mauritania*, varies from less than 20 to more than 2000. (See box page 12: Getting the best out of ber.) The aim of domestication is to choose certain traits and use techniques such as grafting to create the most desirable varieties, which can then be propagated and distributed to farmers. A trial with grafted or marcotted *Uapaca kirkiana*, the most popular indigenous fruit tree in Southern Africa, produced more than 4000 fruits compared to less than a thousand in the wild, and fruited in 4 years as compared to more than 12 years in the wild.

What distinguishes the research conducted on indigenous fruit trees by the World Agroforestry Centre from traditional agricultural and silvicultural tree crop development is its strong emphasis on the development of participatory clonal propagation as a way of fast-tracking selection processes, rather than on conventional breeding, which requires a long period to develop true-to-type varieties. "From the outset, we recognized that it was essential to involve farmers at every stage," recalls Tchoundjeu. "Whatever experiments were conducted in our own nurseries, they were replicated in the farmers' fields. The fact is that when we began our research, the farmers knew more about these species than we did."

Having identified the species that mattered most to the farmers, Akinnifesi and his colleagues in Southern Africa relied on local people to show them trees in the wild that possessed the traits they considered most valuable. "We would follow them into the forest, mark the trees, catalogue and

Fatuma Kalipinde, manager of the World Agroforestry Centre's tree nursery at Makoka Research Station, Malawi, with *Vangueria infausta*, an indigenous fruit species undergoing domestication. (Charlie Pye-Smith)

name them – so that the farmers retained their property rights – and then take samples back to our nurseries for evaluation in clonal orchards," explains Akinnifesi.

The greatest progress was made by grafting scions from favoured mother trees on to nursery rootstock. *Indigenous Fruit Trees in the Tropics* describes the considerable research that went into developing the best vegetative propagation techniques and selection of elite trees from the wild. Initially, the scientists had only 10 per cent grafting success for species like *Uapaca kirkiana*; the success rate is now close to 80 per cent. Research has also helped to establish what conditions are required if domesticated fruit trees are to flourish on farmers' fields. It seems that the use of fertilizers and irrigation makes little difference, as most species are adapted to poor soils. This is greatly to the advantage of farmers, although they need to ensure they have the right sort of soil, as many indigenous fruit trees will only thrive in the presence of certain mycorrhizae.

Commercialization must go hand-in-hand with domestication if indigenous fruit trees are to improve the welfare of rural communities. So far, researchers have concentrated mostly on farmers' concerns, and paid little attention to those of consumers and marketers. More research needs to be carried out on developing products with an improved shelf life and higher nutritional value. In recent years scientists from the World Agroforestry Centre have provided inputs to training schemes that focus on the processing of fruits into juices, jams, sweets and wine. "We have been assessing the feasibility of these sort of enterprises, and results from enterprises in Malawi, Tanzania, Zambia and Zimbabwe showed that the profits could be quite high, especially for those processing indigenous fruits near city markets," says Akinnifesi.

Indigenous Fruit Trees in the Tropics is an essential source book for students, academics and practitioners, and it provides a solid foundation on which new science, partners and market opportunities can be developed in future. Indigenous fruit and nut trees in the tropics have long been described as 'Cinderella species' as their importance has been largely overlooked. This book should help to change that.

For more information, contact Festus Akinnifesi,
f.akinnifesi@cgiar.org

Domestication must go hand-in-hand with commercialization if indigenous fruits are to improve the welfare of rural communities. In Southern and Eastern African, the World Agroforestry Centre has supported training schemes that teach smallholders to process fruits into juices, jams, sweets and wine. (World Agroforestry Centre photo archive)

Frozen in time

The world's seed collections are vulnerable to civil wars, earthquakes, bad management, rising damp and poor ventilation. When disaster strikes, as it periodically does, it can threaten the survival of unique varieties of some of our most important crops. This is what inspired the Norwegian government, working in partnership with the Global Crop Diversity Trust, to establish the Svalbard Global Seed Vault midway between mainland Norway and the North Pole, on the island of Spitsbergen. The seed vault has been constructed deep below the permafrost, ensuring that the millions of seeds that will eventually be housed here will remain safely frozen, regardless of what happens outside.

The World Agroforestry Centre's Germplasm Resource Unit has contributed seeds from 300 agroforestry species. The first batch of 75,000 seeds, representing 150 African species with a range of uses – timber trees, fruit trees, fodder trees, medicinal trees – was dispatched in November 2007. The rest were sent before the vault was officially opened in February 2008. "We believe this is an important initiative to help safeguard against long-term risks to what are the largest and longest living organisms on Earth, the trees of the planet," explains Dennis Garrity, Director General of the World Agroforestry Centre.

Getting the best out of ber

One of the most highly favoured indigenous fruit trees in the Sahel is 'ber' – *Ziziphus mauritania*, locally known as '*jujubier*'. It is mainly used as a fruit pulp, which is consumed either fresh or dried, or as a juice. Either way, it fetches a good price in cities like Bamako, the capital of Mali. However, the indigenous variety of ber suffers from two defects: its fruit is very small and local trees produce on average just 7 kg of fruit a year. This compares unfavourably with varieties from India and Thailand, which are six times as productive and produce much larger fruit.

In 2005, the World Agroforestry Centre introduced germplasm from India and Thailand, and established a germ bank in Samanko, Mali, that now contains over 40 accessions, including those from the Sahel. The aim is to develop improved accessions that combine the heavy fruiting virtues of the Asian varieties with the pest-tolerant and locally adapted qualities of local ber. "Much of our research has focused on developing propagating techniques and selecting the best adapted and most productive accessions," explains Antoine Kalinganire, a World Agroforestry Centre tree scientist based at Samanko. "Selected plant materials, seeds and vegetative propagules are grown in the nursery and later planted in farmers' fields to assess their adaptability and fruit production potential."

A Thai variety of ber. In Samanko, Mali, the World Agroforestry Centre has introduced germplasm from India and Thailand to develop improved accessions.These combine the heavy-fruiting virtues of the Asian varieties with the pest-tolerant qualities of local ber. (Antoine Kalinganire)

Although this research is ongoing, it has already had a significant impact. Individual farmers and communities are now cultivating improved accessions, both for consumption and sale, and NGOs, schools and development agencies are actively promoting them. Increasingly large quantities of fruit from improved ber are on sale in the city markets. A report by the Global Environment Facility and the United Nations Development Programme described this as one of the most successful technologies contributing to better food security and income generation among rural communities in Mali. "I've talked to farmers who have told me: 'I've bought a motorbike with the profits from this fruit, and next year I'm going to acquire more land to plant more ber'," says Kalinganire with satisfaction. This is a clear case of research improving local livelihoods.

Further reading

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Pye-Smith C. 2008. *Farming Trees, Banishing Hunger. How an Agroforestry programme is helping smallholders in Malawi to grow more food and improve their livelihoods.* Nairobi: World Agroforestry Centre. http://www.worldagroforestry.org/library/listdetails.asp?id=50842

Forest converted to paddy in Sumatra. Deforestation and degradation of woody vegetation and peatlands account for approximately 20 per cent of all carbon emissions. (World Agroforestry Centre photo archive)

Making the most of forest carbon

Tropical forests lock up around 300 tonnes of carbon per hectare in above-ground biomass. Convert the forests to grassland or rice paddy, and this figure drops to 5 tonnes or less. The rest goes up in hot air and smoke or decomposes more slowly, adding to the amount of carbon dioxide in the atmosphere and thus contributing to global warming. At present, it makes economic sense to transform forests into cropland and tree crop plantations. Intact forests tend to generate little income for those who live there, while the land uses that generate the highest income are those that store low amounts of carbon.

However, a major study by a consortium of scientists led by the World Agroforestry Centre suggests that a carbon trade designed to tackle global warming could dramatically alter this. "If farmers were adequately rewarded for the carbon stored in trees and forests," explains Brent Swallow, the global Coordinator of the ASB Partnership for the Tropical Forest Margins and lead author of *Opportunities for Avoided Deforestation with Sustainable Benefits*, "vast areas of forest could be saved and carbon emissions greatly reduced." Compensating farmers for preserving carbon-rich landscapes could have the added benefit of alleviating poverty, although it is worth pointing out that where local people, governments and the private-sector contest the rights to use forests, the prospects of payments could also increase conflicts.

Deforestation and degradation of woody vegetation and peatlands account for around 20 per cent of all carbon emissions – more than the entire global transport sector. Although climate-change negotiators have been aware of this for more than a decade, they have failed to agree on how to provide incentives that would reward farmers and landowners for preserving forests and peatlands. Under the Clean Development Mechanism (CDM) of the Kyoto Protocol, companies in industrialized countries can offset some of their carbon emissions by funding afforestation and reforestation schemes in developing countries. But 'avoided deforestation', as it is known, has not been eligible for a number of reasons. While some of these reasons still apply, the urgent need to reduce emissions may encourage global negotiators to think again.

It is now almost certain that the United Nations Framework Convention on Climate Change (UNFCCC) will include measures to Reduce Emissions from Deforestation and Degradation (REDD) in the global climate-protection regime, which will replace the Kyoto Protocol in 2012. In the view of the influential Stern Report, published by the UK government, schemes that pay farmers to protect their forests could prove a cost-effective way of tackling global warming. However, others have disagreed, claiming that they are likely to be expensive, especially in Asia.

Until recently, the arguments on both sides have been largely based on desk studies. This is why the findings of *Opportunities for Avoided Deforestation with Sustainable Benefit*s, reflecting over a decade of field research, are so significant. "We are not dealing with hypotheses or speculation," explains Swallow. "The report provides empirical results with clear implications for schemes whose purpose is to reduce emissions from deforestation and degradation."

Building on past experience

The study was carried out by the ASB Partnership for the Tropical Forest Margins, which brings together five CGIAR centres and over 80 national partners. Since 1994, ASB – it was then known as the Alternatives to Slash and Burn project – has been investigating the causes and consequences of deforestation, and exploring the trade offs between development and conservation, at a range of sites in the humid tropics. The five sites selected for the *Opportunities* study represent a wide range of biophysical and socio-economic conditions under which forests are converted to agriculture. In Cameroon, the conversion of primary forest to cocoa farms has been the major land-use change. In East Kalimantan, one of the three sites chosen

Primary forest is cleared in Cameroon to make way for cocoa farms. (World Agroforestry Centre photo archive)

in Indonesia, logging and slash-and-burn farming have led to considerable forest loss, while in the Peruvian Amazon livestock farming and industrial logging have been the main drivers of change.

The title of the study is deliberately ambiguous, with the word 'opportunities' being used to denote three related concepts. The first is opportunity cost: in other words, the costs of keeping land in carbon-rich forest compared to the costs of converting to lower carbon land uses. The word opportunity is also used in a broader sense. What are the prospects of avoided deforestation becoming an important approach to tackling global warming? And to what extent can schemes that reward those who leave the forests intact benefit poor smallholder farmers?

The study found that deforestation invariably generated positive economic returns for land users in the five research sites. "It made sense for farmers to cut forests down and replace them with crops," explains Swallow. "However, in over 80 per cent of the areas we investigated, the activities that prompted the loss of carbon stocks generated US$5 or less in profits for every tonne of carbon dioxide equivalent that was released into the atmosphere."

The opportunity costs of carbon dioxide emissions varied from one site to another. In Peru, the majority of land-use changes generated less than US$5 per tonne of carbon dioxide equivalent (CO_2-eq). In Jambi, Indonesia, conversion of logged-over forest to oil palm on peat soils was associated with a similar opportunity cost, and in areas where forests were cleared over peat – which is rich in carbon – the opportunity costs were at times as low as US$0.10 a tonne.

In simple terms, this means that conversion would be economically irrational if farmers could sell the carbon locked up in their forests and trees for US$5 a tonne – way below the US$35 a tonne that some European buyers were paying at the time the study was published. However, it is worth pointing out that until now high transaction costs have had the effect of reducing the benefits carbon sellers have received. Under certain conditions, however, deforestation still makes economic sense, especially when converted to high-value crops such as coffee, cocoa or oil palm on mineral soils. For example, in Cameroon, each tonne of carbon dioxide emitted generated around US$11 in value, with the opportunity costs rising to around US$28 per tonne using certain social (rather than private) discount rates.

It won't be easy

The study concludes that there are cost-effective opportunities for large reductions in carbon dioxide emissions from avoided deforestation, provided the appropriate institutions and incentive systems are created.

"Carbon-payment schemes that reward farmers and landowners could be very effective if – and it's a big if – you can get the funds to the people who are actually making the choice to deforest," says Swallow.

However, if payments are channelled through governments and organizations who fail to pass them on to the people who wield the axes and the chainsaws, the latter will continue to do what makes economic sense to them, even if it has a high cost for the planet. The authors suggest that schemes to reduce emissions from deforestation and forest degradation should pay special attention to the carbon-rich, and much threatened, peat lands of Southeast Asia. (See box: Indonesia's burning problem.)

The research indicates that schemes to reduce emissions from deforestation and degradation could be used to encourage agroforestry. Research in Cameroon, to give just one example, revealed that cocoa plantations have aboveground carbon stocks of 141 tonnes per hectare. This compares with 250 tonnes for high forest, and just 4.5 tonnes for

Indonesia's burning problem

Travel to the peatlands of Kalimantan or Sumatra during the fire season, when forests are being cleared to make way for plantations and crops, and you may never see the sun. Airports are frequently forced to close and in the worst fire seasons so are many schools, as the smoke causes severe respiratory problems amongst children. But this isn't just an Indonesian problem. It is estimated that carbon dioxide emissions from the burning of peat lands in Southeast Asia, 90 per cent of which are found in Indonesia, amount to around 2 billion tonnes a year. This is equivalent to 8 per cent of global emissions from the burning of fossil fuels, and half the emissions caused by land-use change.

There may be some doubt about the precise figures, which have been contested by the Indonesian government, but there is no denying that the burning and conversion of peat is having a disastrous impact on the climate. Furthermore, the ASB study, *Opportunities for Avoided Deforestation with Sustainable Benefits,* provides solid proof that the profits to be made from the conversion of peatland forests are often meagre. "Our analysis shows that most of these conversions provide very small returns to farmers," explains Fahmuddin Agus of the Indonesian Soil Research Institute, and chair of ASB Indonesia. The study found that on peat soils, which may store ten times more carbon per unit area than the highest forest, conversion to agriculture often generated as little as 10¢ - 20¢ per tonne of carbon dioxide.

A series of studies conducted during 2007 by the Indonesian Forest Climate Alliance, whose members include the World Agroforestry Centre, argued that Indonesia's peatlands should be a high priority for future schemes designed to Reduce Emissions from Deforestation and Degradation (REDD). According to Daniel Murdiyarso of the Center for International Forestry Research, which was involved in ASB studies, this represents a serious business opportunity for Indonesia. In future REDD negotiations the country should be able to use its past emissions as a reference point for future reductions. "If it could control peat forest fires," explains Murdiyarso, "then Indonesia would have much 'hot air' to sell, for example to countries buying carbon credits to offset their own industrial emissions."

Carbon emissions from the burning of peatlands in South-east Asia account for approximately half of the global emissions caused by land-use change. (World Agroforestry Centre photo archive)

Opportunities for Avoided Deforestation with Sustainable Benefits highlights the dubious green credentials of biofuels, whose use has been heavily promoted in recent years as a way of reducing our dependence on fossil fuels. One study quoted in the report estimates that the production of one tonne of palm oil – a biofuel crop which has been widely planted on Indonesia's peatlands – results in an average emission of 20 tonnes of carbon dioxide from peat decomposition alone. Another study cited in the report suggests that avoided deforestation would sequester two to nine times more carbon over a 30-year period than the emissions avoided by the use of biofuels produced on the area in question.

short-fallow agriculture. Incentives that encourage farmers to establish multi-strata agroforests on degraded land could increase farmers' incomes *and* sequester carbon. For this to happen, however, a more comprehensive form of carbon accounting is needed than the one proposed in some of the REDD schemes currently on the negotiation table.

Opportunities for Avoided Deforestation with Sustainable Benefits was launched at UNFCCC's 13th session of the Conference of Parties – COP 13 – held in Bali, Indonesia, in December 2007. It received wide coverage in the international and local media and helped to inform discussions at 'Forest Day', an event organized by the Center for International Forestry Research and its partners in the Collaborative Partnership on Forests (which includes the World Agroforestry Centre). The Centre was a member of the Forest Day summary drafting team, which ensured that REDD remained high on the agenda throughout the conference.

A series of four research briefs – *Avoided Deforestation with Sustainable Benefits in Indonesia* – was also launched at the Bali conference. These explore the obstacles to creating an effective REDD mechanism, and look at the progress that has been made in Indonesia, the country with the highest land-use carbon dioxide emissions.

For more information, contact Brent Swallow,
b.swallow@cgiar.org

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When land rights are granted, farmers are much more likely to increase their efforts to adopt practices that conserve water – even if they aren't paid to do so. (World Agroforestry Centre photo archive)

Rewarding good behaviour

Some of the most violent land-use conflicts in Indonesia have occurred in Sumberjaya, a mountainous district in Sumatra. During the 1990s and the early years of this century, thousands of families migrated here to establish coffee gardens – illegally – in state-owned 'protection forest'. Convinced that their activities threatened the health of the watersheds, the authorities frequently evicted the squatters.

In recent years, peace has descended on Sumberjaya, thanks in part to the action research conducted by the RUPES programme – the acronym stands for Rewarding the Upland Poor for Environmental Services – coordinated by the World Agroforestry Centre. Research by the Centre's scientists established that multi-strata coffee gardens in Sumberjaya not only provide a livelihood for thousands of poor families, they help to control erosion in a similar way to natural forests. In short, when well managed, the coffee gardens pose no threat to the watershed. The RUPES Sumberjaya team convinced the Forestry Department that instead of evicting the squatters they should encourage them to adopt good management practices.

"Today is one of the most important days in my life," announced Mr Darmadi, the head of a local farmers' group, when he and 500 others were awarded community forestry permits in July 2006. "The process took more than two years, but with the assistance from the RUPES Sumberjaya team, I finally got permission to stay on the land I've been farming."

The permits granted land rights to the farmers for a five-year trial period, with a possibility of extending beyond 25 years. In return for secure tenure, the farmers agreed to certain management practices. When the RUPES team began working in Sumberjaya in 2004, community forestry permits covered just 7 per cent of the protection forest; by July 2006, they had been awarded to some 6400 farmers and covered 70 per cent of the area.

"Sumberjaya should start to see measurable improvements in watershed functions as a result of these agreements," explains Suyanto, the RUPES project site manager. "While these improvements have yet to be verified, the permits have already brought about tangible benefits for the farmers." They have doubled land

values, reduced corruption, increased income, promoted soil and water conservation measures, and given farmers good reasons for protecting the remaining natural forest. And all this has happened without the government – or downstream water users – having to make any cash payments. The permits themselves are the reward for good practice.

A time to reflect

Since 2002, the RUPES programme has been conducting research at six sites in Asia – one in Nepal, three in Indonesia and two in the Philippines – on how the rural poor in upland areas can be rewarded for providing and protecting environmental services. The vast majority of communities living in the uplands suffer from poverty and a lack of investment, yet the land they occupy provides a range of services – clean and abundant water, biodiversity, carbon storage – that benefit the wider population. During recent years, there has been a growing interest in establishing market-based approaches to protecting environmental services by providing payments or non-financial rewards. The RUPES programme, largely supported by the International Fund for Agricultural Development (IFAD), has explored precisely how such schemes could be established, and the conditions necessary for their success, under a range of conditions.

Research conducted by RUPES scientists aims to establish conditions that favour market-based approaches to protecting environmental services. (Asep Nuranjani)

With the first phase of RUPES coming to an end, 2007 was a time to reflect on the lessons learned. In January, a workshop in Lombok, Indonesia, reviewed current knowledge about payments and rewards for environmental services. Many of the 150 scientists who attended the workshop had been closely involved with RUPES research projects, whose key findings were synthesized in two documents published during the year. The idea of developing a thematic issue of *Insight: Notes from the Field*, the biannual publication of Regional Community Forestry for Asia and the Pacific (RECOFTC), on payments for environmental services emerged during the Lombok workshop. The publication includes case studies from India, Indonesia, Nepal, the Philippines and Vietnam. A more detailed analysis of the criteria and indicators that can be used when establishing compensation and reward schemes is provided by the World Agroforestry Centre's Working Paper No. 37.

The ingredients for success

"Our research has found that if reward and payment schemes are to be effective, they must meet three main criteria," explains Meine van Noordwijk, Regional Coordinator for the Centre's Southeast Asia programme and co-author of Working Paper No. 37. "They need to be realistic, conditional and voluntary." In addition to these criteria, the RUPES researchers believe that reward schemes should ideally favour the poor.

Some schemes have faltered because they have failed to make a realistic assessment of the environmental and economic factors that are required to improve or maintain the provision of an environmental service. Van Noordwijk gives an example of a scheme in West Java which failed because there was no clear understanding of cause and effect. A hydropower company paid farmers in the watershed to plant trees as part of a scheme to ensure that it received reliable supplies of water. "But planting trees doesn't create more water," explains van Noordwijk, "and this meant

that the company was effectively paying farmers to do something that didn't deliver the services it anticipated." For schemes to work, they must also be realistic in the sense that payments or rewards are acceptable to all involved. They must cover the operational and opportunity costs of the providers and the transaction costs of intermediaries; and buyers must be willing to pay these costs, while still receiving a net benefit in terms of the environmental services provided.

There must also be clarity about precisely what the buyers and sellers are getting, with the payments or rewards being conditional on the delivery of an agreed service. If the providers fail to deliver, then the buyer should be able to withhold payments or rewards. One example of how this can work was provided by the RiverCare programme, established by RUPES in Sumberjaya. Local farmers pledged to undertake measures to reduce the amount of sediment reaching a hydro-power reservoir below their land, this being a major concern for the electricity company. Acting as a stand-in buyer, RUPES crafted an agreement that would reward RiverCare according to its success: the greater the reduction in sedimentation, the higher the payment. In short, payment for a service must be conditional on delivery.

By digging sedimentation pits, farmers in Sumberjaya helped to reduce the amount of sedimentation reaching a hydro-power reservoir below their land. (Asep Nuranjani)

To be effective, schemes that involve payments and rewards for environmental services should also be voluntary. The providers of environmental services should be party to the schemes by choice, not because they are compelled by regulations. The principles of free and prior informed consent should always apply, and individuals should be able to make their views known at all times. An experimental incentive scheme designed to reduce soil erosion in Sumberjaya— which involves farmers bidding to provide their services—emphasizes the virtues of voluntary participation. (See box: Asia's first reverse auction.)

But what about the poor?

The working paper and the *Insight* issue on payments for environmental services both look at how schemes could be designed to benefit the poor – and indeed, whether this should be one of their explicit purposes. The opportunities and risks for the poor seem to depend largely on the specific characteristics of the schemes and the context in which they take place. The type and location of the services being marketed, the transaction costs, the form of payments or rewards – all will have an influence in terms of their impact on the poor.

Some researchers have argued that if the focus is diverted away from environmental conservation towards poverty reduction, then the delivery of environmental services could suffer, encouraging buyers to pull out. However, even if we leave moral considerations aside, it makes sense to ensure, at the very least, that payment schemes do not make life tougher for the poor; ideally, they should make life better. In situations where existing barriers such as uncertain property rights, small land holdings, and weak political voice make it difficult for the poor to participate, positive efforts should be made to address these problems.

For more information, contact Meine van Noordwijk, m.vannoordwijk@cgiar.org

Asia's first reverse auction

Let's say a hydro-electric power company wants to pay farmers to adopt land-use practices that reduce erosion and sedimentation. How much should it pay? A novel way – tested for the first time in Asia by the RUPES programme – involves asking the farmers themselves what they are prepared to accept as a minimum payment for their services. The buyer – in this case, the RUPES team in Sumberjaya – decided how large a pot of money it had for the project, which would involve farmers digging sedimentation pits on the land, and how much it was prepared to pay each farmer. The farmers, who had no idea how much the buyer was prepared to pay, made their bids in sealed envelopes. Those who bid too high were excluded from the scheme; those who bid below joined the scheme.

"Reverse auction schemes like this are quite tough, but then that's how the market works," says Meine van Noordwijk. "If a farmer bids too high, he's out. But if he says he can do the job for US$10, and the buyer has already decided that the cut-off point is US$20, he still gets US$20. So this is an incentive for farmers to reveal the true value of the work and the service they are selling."

By asking farmers what they are prepared to accept as a minimum payment for their services, the RUPES programme is gaining fascinating insights into how farmers value the services they provide. (Rachman Pasha)

The experiment in Sumberjaya provided some fascinating insights into how farmers value the services they provide. For one thing, the farmers' bids amounted to less than the RUPES team's estimated cost of digging the sedimentation pits. This suggests that they thought that they too would share the benefits of these activities. Even more surprisingly, a number of people who bid too high, and were therefore excluded from the scheme, still decided to dig sedimentation pits. "We are looking at why this happened," explains van Noordwijk. "Social pressure? Possibly. What it does seem to prove is that people are not just *Homo economicus*, intent on maximizing their financial gains." There is, of course, another alternative: either RUPES or the farmers - or both - had failed to assess correctly the real costs and benefits.

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Africa's degraded soils are under pressure to yield crops to feed a population that has doubled in the last 30 years. (World Agroforestry Centre photo archive)

Can science save Africa's soils?

Crop yields in sub-Saharan Africa have barely risen over the past 30 years, yet the population has more than doubled. The result has been widespread malnutrition and persistent poverty, especially in rural areas. According to *Saving Africa's Soils: Science and Technology for Improved Soil Management in Africa*, the continent's degraded soils, and the lack of investments in adequate soil management, are undermining the ability of African farmers to increase crop yields and bring about an era of greater food security.

Commissioned by the secretariat of the New Partnership for Africa's Development (NEPAD), *Saving Africa's Soils* was compiled by the World Agroforestry Centre and the Tropical Soil Biology and Fertility Institute of the International Centre for Tropical Agriculture (CIAT). It draws on a series of sub-regional reports by soil scientists, based on interviews with professionals in East and Central Africa, Southern Africa, the West African humid tropics and the Sahel. The final report reflected the discussions at a Round Table of Experts, convened by the World Agroforestry Centre in Nairobi. The Round Table charted a way forward for soil science research in Africa, highlighting the main elements needed to support sustained agricultural production and environmental protection.

According to Keith Shepherd, co-author of the report and lead soil scientist at the World Agroforestry Centre, knowledge of Africa's soils is limited. "Basic soil surveys conducted in the 1950s and 1970s mapped broad boundaries for different soil types, but these were very crude, and the surveys failed to take into account the huge variability in soil types locally," he says. "The lack of good information, and the fact that there is no systematic data system monitoring soil health, has held back well-planned agricultural development."

However, there have been considerable technological advances in recent years, and these should enable scientists – and government agencies – to survey and assess soil health relatively quickly and

cheaply in future. *Saving Africa's Soils* identified problem diagnosis and impact assessment, using the latest technologies, as one of the four key areas of research that could make a major contribution to improving soil health and raising productivity. The report also stresses the importance of research on integrated soil fertility management, which combines the use of organic and inorganic fertilizers. Integrated soil fertility management recognizes that nutrients and water cycles are inextricably linked, and together determine a soil's ability to sustain crops and provide essential environmental services. Science has a key role to play in researching and promoting integrated soil fertility management, but the report recognizes that much more research needs to be done on how to increase the rate of adoption of good management practices.

Although sub-Saharan Africa is heavily reliant on agriculture for economic growth, public spending on farming amounts to just four per cent of total government spending. The lack of investment has meant that many soil laboratories have closed, admissions to soil science and agricultural university courses have fallen dramatically and many universities' soil science curricula are seriously out of date. Bucking these trends will be essential if Africa's soils are to be better managed.

The research agenda proposed by *Saving Africa's Soils* implies the reorientation of conventional approaches to soil science, with a much stronger emphasis on interdisciplinary thinking, and the updating of Africa's soil laboratories. All of this will require a significant increase in investment, both by national governments and donors. As the authors of the report point out, "The future livelihoods of the world's poorest people depend on the development and widespread adoption of practices aimed at restoring and sustaining the productivity and ecosystems service functions of Africa's soils."

The need to establish a diagnostic surveillance framework to improve the management of farmland is discussed in greater detail in a paper written by Keith Shepherd and Markus Walsh, and published in the *Journal of Near Infrared Spectroscopy*. Walsh and Shepherd have been developing the concept of 'soil health surveillance,' modelled on medical diagnosis approaches, for many years. The use of infrared spectroscopy, which provides a cheap and rapid means of

Integrated soil fertility management in Western Kenya keeps soils healthy and productive. (Laure Dutaur)

analysing the health of soils, plants, livestock and water resources, would be an integral part of such a system. "A soil health surveillance system would benefit a whole range of users, from agricultural extension workers and smallholder farmers to the fertilizer industry, regional development programmes and international donors," says Shepherd. The World Agroforestry Centre and the United Nations Environment Programme (UNEP) are using the soil health surveillance approach in West Africa to identify soil constraints to food production and opportunities for sequestrating carbon.

The New Partnership for Africa's Development (NEPAD) has just signed a cooperative agreement with the African Network for Soil Biology and Fertility (AFNET), the World Agroforestry Centre and CIAT's Tropical Soil Biology and Fertility Institute to jointly develop a programme to build African research and educational capacity in state-of-the-art concepts and methods in soil science. The emphasis will be on soil health surveillance and integrated soil fertility management through the establishment of virtual 'centres of excellence.' The group is also working with the Bill and Melinda Gates Foundation and the Alliance for a Green Revolution in Africa (AGRA) to help develop complimentary initiatives to save Africa's soils and boost agricultural productivity.

For more information, contact Keith Shepherd, k.shepherd@cgiar.org

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An erosion gulley in Kerio Valley (Kenya). Soil science research must focus on sustaining or enhancing agricultural production without damaging the environment. (Tor-Gunnar Vagen)

Soil carbon content is significantly higher in improved fallow systems where maize is intercropped with nitrogen-fixing legumes. (Laure Dutaur)

Making carbon markets work for Kenya's rural poor

Could the prospect of earning revenue from carbon markets encourage smallholder farmers in Africa to adopt more sustainable and productive land management practices? Louis Verchot, lead scientist for climate change at the World Agroforestry Centre, believes it could. His evidence is based, in part, on the findings of a long-term research project in Kenya.

"One of the key constraints preventing small farmers from taking advantage of emerging carbon markets has been the lack of knowledge about how to measure carbon stocks, especially in the soil," explains Verchot. "To address this, we have been putting together projects that are designed to measure carbon sequestration in agroforestry systems." One of these has focused on soil organic carbon – one of the major carbon pools in the global carbon cycle – at two sites in Western Kenya.

The experiment, which lasted six years, compared carbon storage in improved fallow systems – these involved the intercropping of maize and nitrogen-fixing legumes – with carbon storage in control plots of continuous maize and naturally regenerated fallow. The treatments were conducted on sandy soils at Teso and on silty-clay soils at Luero, under conditions of tillage and no tillage. "If you are going to establish a market for soil carbon," explains Laure Dutaur, a soil scientist at the World Agroforestry Centre, "it is important to know not only the quantities of carbon in the soil and where it comes from, but where it is in the soil and the extent to which it is protected from degradation."

The experiment found that the soil carbon content was significantly higher in the improved fallows than in the control plots. The increase in carbon in the top five centimetres was largely associated with the addition of above-ground inputs, notably the leaves and litter of the nitrogen-fixing species. These were incorporated into the soil prior to the sowing of each maize crop. "While most of the organic matter was found in the coarse fraction in both soil

types, the greatest concentrations of carbon were in the micro-aggregates," explains Dutaur. "This is important as the carbon in the micro-aggregates is less subject to degradation, and more stable, than carbon in the macro-aggregates." There was little difference between the till and no-till treatments, although Dutaur speculated that this might be because tillage was done with a hand hoe rather than large machinery, as would be the case on most commercial farms.

Research that makes a difference

The research has important implications both for the emerging carbon trade market, which is designed to tackle global warming (see also pages 13-17), and for small farmers. Under the European Union's Emission Trading Scheme, European companies can purchase carbon credits from industrial sources in developing countries to offset their own carbon emissions, but not from forestry, agricultural or agroforestry projects. One of the main reasons the EU has excluded these schemes is because methods for measuring carbon stored in soils are considered too unreliable. According to Verchot, this no longer holds true.

The prospect of earning some revenue from the carbon market could spur smallholder farmers to adopt more sustainable land-use practices. (Walter van Opzeeland)

Walter

The research in western Kenya can serve as a model of how to measure soil carbon accurately, and we now have a much better understanding of the processes by which soil carbon is sequestered. "Using agroforestry systems such as improved fallows is a good way of creating stable carbon stocks," explains Verchot. "The systems have the added attraction of improving soil fertility and increasing crop yields, and in that way they can help to reduce poverty."

The quantities of carbon sequestered in the soil are relatively modest, especially when compared with the potential of tree-planting schemes. However, this shouldn't preclude small farmers from pooling their carbon and making collective arrangements with companies seeking to buy carbon credits. "Incentives don't have to involve direct cash payments to individual farmers," says Verchot. "A group of farmers might sell their carbon in return for a better road, or books for the local school, or advice from the extension services that they would otherwise have to pay for."

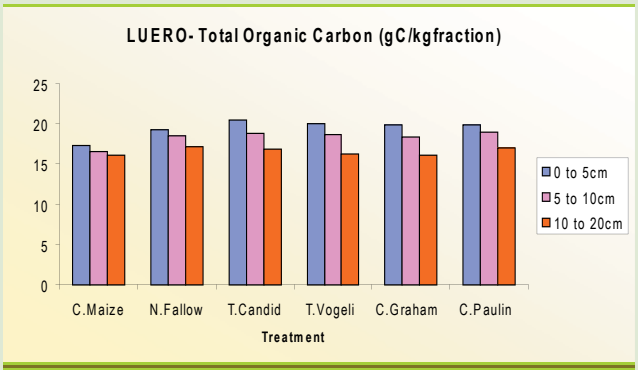
The research is providing a loose consortium of non-governmental organizations – the Carbon for Poverty Reduction Alliance – with some of the tools it needs to help small farmers participate in the carbon market. Members of the consortium are keen to make carbon markets work so that they favour sustainable land management, encourage rural development and conserve the environment. While the NGOs are responsible for liaising with farmers' organizations, the World Agroforestry Centre is providing technical support and helping to train the trainers.

For more information, contact Laure Dutaur,
l.dutaur@cgiar.org

Methane matters

Soils both produce and consume methane, with the net soil–atmosphere flux being the result of the balance between the two processes of microbial production and microbial consumption. Methane uptake by soils is relatively small, but any significant change in the soil methane sink could alter the atmospheric accumulation rate of this potent greenhouse gas, and the flux could be susceptible to changes in land use and climate.

Until recently, estimates of the global methane sink suffered from high margins of error. However, by analysing 120 studies and 318 data sets, representing a wide variety of ecosystems, climatic zones and soils, and by attributing some local variation to different conditions, Laure Dutaur and Louis Verchot of the World Agroforestry Centre have narrowed the figure for the global carbon sink from 36 ± 23 million tonnes a year to 22 ± 12 million tonnes per year.



TOC of the soil fractions and bulk with respect to treatment in Luero site

The scientists found that the consumption of methane is influenced more by ecosystem type than climate, with temperate forests being responsible for the greatest methane uptake, although there is a wide variation even within this particular ecosystem. There is a clear need for much further research on this important topic, not least because existing studies have tended to concentrate on certain ecosystems and climatic zones, with temperate forests being well researched and savannahs and grasslands in tropical and boreal regions largely ignored. The findings were reported in *Nature* magazine's 'Research highlights'

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The Centre's research is helping tens of thousands of rural households to improve their yields and escape from poverty. (Charlie Pye -Smith)

Farming trees, banishing hunger

Over a third of the people in Malawi are undernourished and life expectancy is just 46 years. As the size of land holdings continues to shrink, and soils become exhausted through continuous cropping, many families have seen the yields of the staple crop, maize, steadily decline. It is estimated that 80 per cent of smallholders, who constitute the majority of the population, lack food between November and February. They have eaten their last harvest and are waiting for their crops to produce the next. Were it not for food aid and fertilizer subsidies, levels of malnutrition would have been even higher during recent years. However, research by the World Agroforestry Centre is now helping tens of thousands of rural households to improve their yields and escape from poverty.

The experience of Mariko Majoni, a farmer who lives in the village of Jiya, near Blantyre, provides a window to the future. After retiring from the prison service in the mid-1990s, he used some of his pension to buy mineral fertilizers for his maize fields. But then his pension ran out and he could no longer afford to buy fertilizers. His annual yields declined. The maize was stunted; the soil exhausted. Fortunately, he lived near Makoka Research Station, where the World Agroforestry Centre had been conducting experiments showing that intercropping maize with a nitrogen-fixing tree, *Gliricidia sepium*, significantly increased yields.

Mr Majoni visited Makoka and returned home with some *Gliricidia* seeds. "People said I was studying to become a madman when they saw me planting trees in my fields," he recalls. For a couple of years, his yields remained stubbornly low, but then things began to change. Every year, he would cut back the regrown fertilizer trees to incorporate their leaves and twigs into the soil. Before long, his yields began to increase. Now he has enough maize to feed his family and plenty left over to sell. So impressed were many of his neighbours that they decided to adopt the same practice.

From research to development

The Centre and its partners in Malawi have been developing and disseminating agroforestry technologies to replenish the soil since 1987. Four related fertilizer tree options, including the most popular one using Gliricidia, have been tested at Makoka Research Station and on farmers' fields. Results from 10 years of continuous cultivation showed that the use of Gliricidia without fertilizer yielded an average of 3.7 tonnes per hectare at Makoka, compared to just 1.1 tonne on plots with neither mineral fertilizer nor Gliricidia. The judicious use of small amounts of fertilizer with Gliricidia pushed yields up to 5.5 tonnes.

By around 2005, an estimated 100,000 smallholders in Malawi were benefiting to some extent from the use of fertilizer trees. What was urgently needed was a programme to scale up the use of agroforestry technologies in a systematic way across the country. This is precisely what Malawi's Agroforestry Food Security Programme, launched in 2007 and funded by Irish Aid, is doing. By combining sound science with effective partnerships, the four-year programme will enable at least 200,000 families – or around 1.3 million of the poorest people in Malawi – to increase their food production and enhance their nutrition.

During 2007, the programme targeted over 42,000 farming households in eight districts. They were provided with training and tree-planting materials, including over 95,000 sachets of tree seeds. The programme established 344 on-farm demonstration plots, 123 roadside plots and eight 'farmer field schools' to showcase the agroforestry technologies available. The main emphasis during the first year was on increasing the use of fertilizer and fuelwood trees, but the programme also encouraged dairy farmers to plant fodder, trees and farmers everywhere to consider planting fruit trees in and around their fields and homesteads.

From a nutritional point of view, fruits have a vitally important role to play. "Every year, around 600,000 children in Africa die from diseases caused by vitamin A deficiency," explains Tony Simons, the Centre's Deputy Director General and the manager of the Agroforestry Food Security Programme. "There is also clear evidence that women who are deficient in vitamin A are more likely to pass HIV/AIDS on to their children through breast-feeding." Besides vitamins, fruits can provide water, energy, antioxidants and minerals, and for those who grow them in sufficient quantities they can provide an income. In 2007, 19,000 grafted fruit trees were delivered to farmers, and over 100,000 rootstocks were raised in preparation for the second year. The grafted trees tend to mature early, and produce large fruit with a good taste.

During 2007, the Malawi Agroforestry Food Security Programme worked with 42,000 farming households. Here, women tend seedlings in a community nursery. (Charlie Pye- Smith)

A new research phase

With the launch of the Agroforestry Food Security Programme, the Centre's research in Malawi entered a new phase. Scientists will continue to develop and test improved varieties of indigenous and exotic fruit trees on farms, but much of the research in Malawi will now focus on the dissemination of integrated agroforestry technologies. "Scaling up is both a practical matter and research issue," explains France Gondwe. "We are looking at what works and what doesn't work when it comes to scaling up. What are the best ways of demonstrating these technologies to farmers? What factors affect adoption dynamics and impact? Are there some areas where these technologies work better than others, and if there are, then why?"

According to Festus Akinnifesi, the Centre's Regional Coordinator for Southern Africa, the new partnerships formed to promote the programme have been vitally important. Approximately 60 per cent of all the funds go directly to seven national partners, including government departments, research agencies and smallholder farmers' associations. "One of the most gratifying things has been the way our partners have taken ownership of the project," explains Akinnifesi. "We have encouraged them to take the driver's seat, and that is exactly what they have done. Our role is mainly that of facilitator and knowledge provider."

Akinnifesi acknowledges the importance of the support from Irish Aid. "Before, we didn't have the means to scale up beyond a few pilot sites," he says. "Now we have the means and a unique opportunity to make a difference." With its strong emphasis on tackling hunger, improving nutrition and helping women – a third of the

Malawi's Agroforestry Food Security Programme envisions a countryside dramatically transformed by a wave of tree planting. (Charlie Pye-Smith)

families targeted are headed by women – Malawi's Agroforestry Food Security Programme is precisely the sort of venture the Irish are keen to support. Its aid to Africa as a share of the GDP is second only to that of Sweden, and much of this focuses on improving food security.

Tembo Chanyenga, principal forestry officer with the Forestry Research Institute of Malawi, one of the key partners involved with the programme, believes that in five to 10 years' time, the countryside could be dramatically transformed by the wave of planting – over 50 million trees will be planted by farmers – encouraged by the Agroforestry Food Security Programme. "The landscape will be much richer in trees than it is now and the soils more fertile," he says, "and I can foresee a time when farming families will be able to eat fruit every morning for breakfast."

For more information, contact Festus Akinnifesi,
f.akinnifesi@cgiar.org

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Former wasteland in India reclaimed with Jatropha, whose seeds are used to make carbon-neutral fuel. The World Agroforestry Centre provided technical advice for these agroforestry projects initiated by Utthan-Centre for Sustainable Development & Poverty Alleviation. (World Agroforestry Centre photo archive)

Rewarding excellence in India

In 2007, the Utthan Centre for Sustainable Development and Poverty Alleviation, one of the World Agroforestry Centre's key partners in India, was awarded the prestigious Alcan Prize for Sustainability, worth US$1 million. The prize recognized Utthan's remarkable achievements since it was founded in 1996. "The agroforestry and livelihoods projects initiated by Utthan have benefited at least 100,000 people, many of them among the poorest inhabitants of degraded tribal areas in North India," explains Pal Singh, the World Agroforestry Centre's Regional Coordinator for South Asia.

"Utthan has made remarkable strides on behalf of disadvantaged communities in India, and we are delighted to think that the Alcan prize might further advance the fine work this organization does."
Corey Copeland, Senior Vice-President, Rio Tinto Alcan

When announcing the award, Rio Tinto Alcan and the International Business Leaders Forum, managing partners of the Alcan Prize, cited two of Utthan's agroforestry projects among its major achievements. One has involved the widespread planting of *Jatropha curcas*, whose seeds are used to make carbon-neutral biofuels; the other has helped to reclaim large areas of degraded land. Utthan has also been involved in health and education. Its health programmes have led to the immunization of 600,000 children against six preventable diseases, and its literacy and adult education work has benefited around a million people in Uttar Pradesh, Chhattisgarh and Madhya Pradesh.

The World Agroforestry Centre provided technical advice for both agroforestry projects. In one of these, some 750 hectares of degraded land, belonging to 735 'scheduled caste' families, were reclaimed using superior varieties of Jatropha. The initial investment amounted to around US$650 per person. By the third year, the beneficiaries were earning US$1,200 from the sale of Jatropha seeds. "The project helped to improve the environment and lift the families out of poverty," says Singh, who helped to identify and source the 'super clones' of Jatropha and develop better agronomic techniques for early fruiting and higher nut and oil yields. As a result of this project, Jatropha has received widespread attention and Utthan believes that its cultivation on 30 million hectares of wasteland in

India could produce 60 million tonnes of biofuel a year, thus saving US$20 billion of oil imports.

The second of the two agroforestry projects has led to the reclamation of some 85,000 hectares of degraded land and directly benefited 90,000 families who have planted bamboo, 'babool', Jatropha and various medicinal plants. The project has dramatically increased tree cover, improved soil fertility and crop yields, and provided fodder for livestock and fuel for cooking. Once again, the World Agroforestry Centre provided technical advice and helped Utthan to source superior varieties of seeds.

Utthan will use the Alcan Prize to extend its agroforestry programmes, especially on degraded land in areas with high levels of poverty. "The funding and recognition is very significant for us," says Dr D.N.Tewari, President of the Utthan Centre and a member of the World Agroforestry Centre's Board of Trustees. "The money associated with the Alcan Prize will allow us to do so much more for disadvantaged communities. But, perhaps even more importantly, the recognition of our efforts on the international stage will lead to learning and partnerships that we might not have been able to access on our own."

For more information, contact V. P. Singh,
v.p.singh@cgiar.org

Receiving the prestigious Alcan Prize for Sustainability.
From left: Dr DKNG Pushpakumara (the Centre's Country Liaison Scientist in Sri Lanka), Laksiri Abeysekera (the Centre's Director of Finance and Operations), Mr. Adrian Hodges (Managing Director, International Business Leaders Forum), Mr Corey Copeland (Senior Vice President, Rio Tinto Alcan), Dr Kaushal Kumar (General Secretary, UTTHAN-Centre for Sustainable Development & Poverty Alleviation), Dr DN Tewari (President, UTTHAN-Centre for Sustainable Development & Poverty Alleviation, and a member of the World Agroforestry Centre Board of Trustees), Prof. HPM Gunasena (Senior Fellow, ICRAF), Dr Virendra Pal Singh (the Centre's Regional Representative for South Asia) and Dr J Coosji Hoogendoorn (Director General, International Centre for Bamboo and Rattan). (World Agroforestry Centre photo archive)

Under the LAMIL project, farmers are helping to promote new agricultural technologies. (Serge Ngendakumana)

An innovative approach to promoting agroforestry in Guinea

Introducing new agroforestry technologies, and encouraging farmers to use them, is never easy. However, research in Guinea suggests that when farmers themselves take a leading role in choosing and promoting the new technologies, the levels of uptake are likely to be significantly higher.

The Farmers' Initiative and Vision-Based Approach (FIVA) to disseminating agroforestry and agricultural innovations was piloted by the Landscape Management for Improved Livelihoods (LAMIL) project, which is jointly managed by the World Agroforestry Centre, the Center for International Forestry Research (CIFOR) and the United States Forestry Service. The LAMIL project seeks to reduce the pressure on the natural environment, and especially on forests rich in biodiversity, by improving the livelihoods of local villagers and raising their income.

The implementation of FIVA involves seven distinct steps. First, project staff and farmers meet to discuss and analyse the problems and challenges. A number of 'champion' farmers are then selected to promote new agroforestry and agricultural technologies. Community groups then establish a vision of how they would like the future to look. This is followed by capacity building of selected partners – including those working for government agencies – in natural resource management and the provision of services. Projects staff and the champion farmers then identify and promote selected agroforestry and agricultural technologies. The final step involves periodic evaluation of the project by the local communities.

In 2007, 920 farmers adopted a range of new agroforestry and agricultural technologies. Over 650 farmers planted improved varieties of groundnut, maize and cassava. The remainder transplanted

120,000 high-value tree seedlings as live fencing, fodder banks and to reforest degraded land. Most of the farmers significantly improved their incomes as a result of using these new technologies. For example, the 13 champion farmers involved in tree-seed production generated over US$12,000 of extra income in 2007.

According to Serge Ngendakumana of the World Agroforestry Centre, the farmer-based approach to disseminating new technologies had a tangible impact. Take, for example, the improved varieties of groundnut. "We found that there were significant differences in yield for two introduced varieties," he explains, "and these cannot be explained by variations in landscape or soil type. The difference in yield, we believe, can be attributed to FIVA. The communities that applied FIVA most rigorously had the higher yields."

According to a recent evaluation by USAID, who fund the project, and private consultants: "The LAMIL project has been one of the most integrated resource management initiatives the team visited, since it has succeeded in integrating biodiversity, governance and livelihood improvement." The plan now is to extend the project beyond Guinea into Sierra Leone, using similar approaches to improve livelihoods and protect the environment.

For more information, contact Serge Ngendakumana, s.ngendakumana@cgiar.org

Smallholder farmers in Guinea transport forage (*Pterocarpus sp*) for sale in the local market. (Serge Ngendakumana)

When farmers adopt technologies designed to improve soil fertility, they sometimes do so for reasons that have little to do with soil fertility. (World Agroforestry Centre photo archives)

Pseudo-adoption: new insights into an old but neglected problem

When farmers adopt a practice that has the potential to improve soil fertility, researchers naturally – and nearly always – assume they are doing so for the obvious reason: to improve soil fertility. But that's not always the case. For example, researchers in western Kenya recently found that farmers were planting *Tephrosia vogelii*, a shrub widely promoted to improve soil fertility, to control moles on their farms. Farmers may also adopt certain agroforestry practices because they expect to receive benefits that have little or nothing to do with improving productivity on their farms. These may include enhanced social status resulting from project officials visiting their farms, access to credit, and even the prospect of the project providing jobs for their children. This is the phenomenon of pseudo-adoption.

These are among the findings of a major study conducted in western Kenya by researchers from the Kenya Forestry Research Institute (KEFRI), the World Agroforestry Centre and Wageningen University, and published in the journal *Agricultural Systems*.

"Earlier studies from the area suggested that there had been good uptake of the improved tree fallow technologies designed to enhance soil fertility," explains Evelyne Kiptot of KEFRI, "so we were surprised to find that many farmers had actually abandoned the technology. Even more surprisingly, many of those who had used improved tree fallows were 'pseudo-adopters.'"

There has been a long history of agroforestry interventions in western Kenya, stretching back to the late 1980s. One of the main aims has been to introduce farmers to technologies that will restore soil fertility and thus increase yields and incomes. The first decade of research was patchy in terms of success. Although the technologies proved to be beneficial in experimental plots, transferring them to the farmers' fields proved difficult.

An alternative approach, based on greater community participation, began in 1997, when KEFRI, the World Agroforestry Centre and the Kenya Agricultural Research Institute (KARI) launched a pilot project in 17 villages in Siaya and Vihiga districts. This exposed all farmers in each village to agroforestry practices designed to improve soil fertility. The main practice was improved fallows; that is, the planting of fast-growing, nitrogen-fixing shrubs on a fallow plot. After four years of intensive dissemination, the pilot project came to an end. Another four-year project, whose purpose was to encourage farmers to diversify into high-value crops in order to feel the benefits of investing in soil improvement, began in 2001, with KEFRI and the Centre again playing a key role in promoting agroforestry.

The study by Kiptot and her colleagues focused on these last eight years. They found that the process of adoption was highly dynamic. There was a steady increase in the number of farmers using improved fallows after 1999, but the number declined dramatically in 2000 (See figure 1). There was an increase again in 2001 and 2002, followed by a further decline.

"Most of these trends were mainly influenced by factors unrelated to improving soil fertility," explains Kiptot. "Many of the farmers adopted the technologies because they provided them with access to credit, and many because they were able to sell tree seed back to the project, which then distributed it to other farmers." Other factors that encouraged farmers to adopt – or pseudo-adopt – agroforestry technologies included participation in seminars and a sense of prestige for those involved in the project.

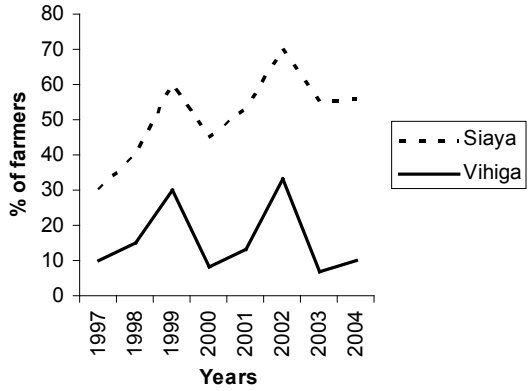

Figure 1. Proportion of farmers planting improved fallows who had received seed from projects, 1997-2004 (n=120).

Getting involved in an agroforestry project may give rural farmers and their families a heightened sense of visibility and prestige. (World Agroforestry Centre photo archive)

Despite the intense efforts to promote agroforestry, the researchers found that 91 per cent of farmers in Vihiga district and 53 per cent in Siaya district either stopped using improved fallows after initial experimentation, or never adopted them. The reasons why they stopped, or never started, included a lack of sufficient land, no noticeable increase in crop yield, a lack of a market for tree seeds after 2000, difficulties in obtaining credit, and having to forgo a season's crops for trees that did not provide edible products.

"In principle, using agroforestry technologies may be a good idea," says Kiptot, "but when you look at the situation on the ground, where over 60 per cent of farmers live below the poverty line on small landholdings with low soil fertility, it may be impractical. You can't ask farmers to forgo

a season's crops to grow trees that yield no tangible financial benefit. They simply can't afford to do that when they're so poor." Many farmers fallow their fields and it was thought that improved fallows would be an attractive venture for farmers. But it proved not to be, as farmers chose to allocate their time and scarce cash for other activities.

So were the researchers responsible for promoting agroforestry in western Kenya aware of the pseudo-adoption phenomenon highlighted by Kiptot and her colleagues? Co-author Stephen Franzel, principal agricultural economist at the World Agroforestry Centre, believes they were, at least towards the end of the project. "It's natural for researchers and extensionists to think that farmers are using a new practice because it's improving farm productivity, which is the reason it was introduced in the first place," he says. "But we all need to be more aware of the broader context in which farmers operate, and recognize that their reasons for testing or adopting a practice may have nothing to do with its intrinsic value."

During recent years, there has been an increase in research on the adoption by farmers of agroforestry technologies. The fact that most studies have failed to recognize the significance of pseudo-adoption can be attributed, in part, to their short-term nature: most studies have been based on a single snapshot in time and ignored the fact that agroforestry adoption is a dynamic process with a lengthy timescale. Furthermore, many adoption studies have failed to differentiate between different categories of users. They have also failed to consider the wider socio-economic, political and institutional settings in which farmers are embedded.

When farmers are obliged to forego a season's crop for the sake of improving soil fertility, they tend to favour tree species that yield timber, food, fodder or seeds to trees that only improve fertility. (World Agroforestry Centre photo archive)

The study by Kiptot and her colleagues focused on the adoption of a very narrow range of agroforestry technologies, which are now recognized as being less useful in western Kenya than originally thought. In no way does this detract from the fundamental importance of agroforestry as a means of improving soil fertility and livelihoods. However, the study does show that researchers and development practitioners need to be very aware of the many incentives for pseudo-adoption, and they should try to avoid projects that offer perverse and unsustainable incentives, particularly if they are trying to learn something about the attractions of particular agroforestry technologies for farmers.

The study also found that if the soil fertility potential of leguminous species, such as those used in western Kenya, is to be fully realized, they must yield tangible and immediate benefits for the farmers, thus compensating for the fact that they are obliged to forgo a season's crop. Farmers are much more likely to look kindly upon tree species which yield timber, food, fodder or seeds that can be sold in the market, than ones that don't. "One of the key lessons from our study," says Kiptot, "is that researchers need to be fully aware of the needs and priorities of farmers, and target their research accordingly."

For more information, contact Steve Franzel, s.franzel@cgiar.org

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Photo: Sheila Rao

How we work

The blended learning course makes for more competent researchers, who can then make the most of their time at a CG centre. (Jan Beniest)

Encouraging students to think scientifically

Every year, large numbers of university students join CGIAR research centres to gain practical experience and gather data for their Masters and PhD theses. However, many come with little or no idea how to conduct proper scientific research. "Their knowledge of the subject matter may be fine," explains Ric Coe, head of the Research Methods Group established by the World Agroforestry Centre and the International Livestock Research Institute (ILRI), "but when students arrive they often know little about the fundamentals of research, such as how to formulate a hypothesis, or set up a scientific study." Many are also poorly versed in the ethics of research and think, for example, that it is acceptable to plagiarize other people's work.

Part of the fault lies with universities, which frequently fail to provide students with a good grounding on how to conduct scientific research. In theory, the scientists at the CG centres who are responsible for supervising and mentoring the students should help to make up for this, but all too often that doesn't happen. "Some scientists look on the students as cheap labour," explains Jan Beniest, head of the World Agroforestry Centre's Training Unit in Nairobi. "The students might spend a lot of time measuring tree growth and doing other donkey work, but they don't always get the bigger picture about what good research entails."

To counter these problems, the Training Unit and the ILRI-World Agroforestry Centre Research Methods Group ran an induction course for postgraduate students in Nairobi in 2006. Attended by 37 students attached to CG centres in the region, the one-week course addressed the gaps in university training and introduced students to the principles, concepts, methods and approaches used to conduct high-quality

research for development in agriculture and natural resource management. It proved such a success that some students suggested future courses should be attended by supervisors, both from the CG centres and universities.

This sort of intensive learning experience, gathering a large number of people in one place for a length of time, is too expensive to repeat on a regular basis, so Coe and Beniest decided to replicate the course using a 'blended learning' approach, involving e-learning and a face-to-face, problem-solving workshop. The long-term aim is to establish purely e-learning courses, but a face-to-face component was included on this occasion to identify the gaps in the course that would need filling.

Prospective students submitted their research proposals, which were evaluated by the Research Methods Group. These were used as a basis for choosing the course participants and as a benchmark for assessing their progress. A one-week online preparatory course was followed by six weeks of online learning on 'Research Methods: Thinking Scientifically.' This was managed by two professional online facilitators and the subject-matter specialists – one being Coe – responsible for five modules. These were:

- Science and how it works – critical thinking and innovation
- Scientists – who they are and how they work
- Controversies and issues related to research and development
- Your research proposal – a toolbox to develop quality research
- Connecting knowledge to action – completing the loop

The expectation was that students would spend half a day a week on the online course, but many spent longer. Their progress was monitored by

Researchers at an earlier learning event on a field trip in the highlands of Guinea. (Jan Beniest)

the facilitators, who e-mailed students if they were getting behind and alerted the subject-matter specialists when particular issues arose that required their immediate attention. After the online course the students gathered for a one-week workshop in Nairobi. This gave them the chance to directly interact with one another and with the subject-matter specialists.

Although people in Africa often cite access problems as a major constraint to e-learning, none were seriously inconvenienced on this course. Some participants felt that the group was too large – there were 36 students, most from Africa – and heterogenous, with the result that online discussions could sometimes be disjointed. Overall, however, the students considered this an excellent learning process and many said it helped them to improve their research proposals and the quality of their research work.

As far as the subject-matter specialists were concerned, they felt that the blended learning event enabled them to get to know the participants much better than they would have done in a single, one-week meeting. This meant that they were better able to prepare their interventions at the problem-solving workshop. In their view, research supervisors, especially those from universities, should be more involved in the blending learning process, and it would also be helpful if the course was offered to university lecturers, so that they could teach it themselves.

The experience gained will enable CG centres to offer a multitude of other blended or purely e-learning events during future years, and thus meet the ever-increasing demand for agricultural and natural resource management learning. "We'd like to see every graduate researcher who comes to join a CG centre undergoing a course like this," says Coe. "The blended learning experience has shown that they will become more competent researchers, and they will get much more out of the time they spend at a CG research centre."

For more information, contact Jan Beniest,
j.beniest@cgiar.org

Further reading

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Participants at the first global workshop on forestry education. A key output was a Policy Brief that sets out recommendations to improve forestry education. (August Temu)

A renaissance in forestry education?

The first global workshop on forestry education was held at the headquarters of the World Agroforestry Centre in Nairobi in September 2007. Eighty-five participants from 29 countries reflected on the declining standards in forestry education and agreed on measures to improve it. The key findings from the workshop are described in a policy brief, *Future Forestry Education – Responding to Expanding Societal Needs*.

"There has been serious degradation of forestry education around the world, especially in developing countries," explains August Temu, Partnerships Coordinator at the World Agroforestry Centre and one of the organizers of the workshop, "and this is having a damaging impact on rural development." According to the World Bank's 2008 *World Development Report*[1], growth in the agricultural sector in Africa – and this includes forestry and agroforestry – is four times more effective in overcoming poverty than growth in other sectors. This means that investing in education and training in agriculture and related fields provides an attractive way of strengthening Africa's economies, while at the same time addressing poverty.

1 Online reference for World Development Report 2008 (forestry story) http://siteresources.worldbank.org/INTWDR2008/Resources/2795087-1192111580172/WDROver2008-ENG.pdf

The policy brief points out that in recent years forestry education has largely failed to respond to the dynamics in forestry practice, the demands of the job market and the challenges of new global forestry paradigms. Many curricula are outdated and they have failed to align forestry education with related disciplines, such as agriculture, soil science and biodiversity conservation. Many schools of forestry have failed to recognize that over recent decades the forester's job has been transformed from that of just managing forests to applying a wide range of skills to respond to the needs of many different stakeholders. At the same time, there has been a significant decline in investment in forestry education (See figure 1 in box).

The policy brief sets out a series of recommendations to improve forestry education. These include:

- increasing investment in forestry capacity;
- improving co-ordination mechanisms to reinforce the quality and content of forestry education and training;
- enhancing the harmonization of forestry with other related sectors;
- establishing and sustaining regional and global mechanisms for collaboration in forestry education, for example through the International Partnership for Forestry Education, which was launched in 2006.

"The policy brief is a major wake-up call for governments and donors, alerting them to the urgent need to improve forestry education worldwide," says Temu. He believes the workshop and the policy brief have already begun to influence the policies of donors such as the World Bank, and he expects to see an increase in investment in forestry education in the near future.

For more information, contact August Temu, a.temu@cgiar.org

ANAFE comes of age

Since it was established in 1993, ANAFE – the acronym now stands for the African Network for Agriculture, Agroforestry and Natural Resources Education – has had a profound influence on institutions of higher learning throughout sub-Saharan Africa. Funded by the Swedish International Development Agency (Sida) and facilitated by the World Agroforestry Centre, ANAFE grew rapidly in both size and influence. It began with a membership of 29 colleges and universities; now it has over 128, in four regional chapters, working together to improve the quality, relevance and application of agriculture education in Africa.

According to Aissetou Yaye, Executive Secretary of ANAFE, one of its greatest achievements has been to encourage and improve connectivity between different disciplines. "In the past, agroforestry used to fall between the cracks," she explains. "Agriculture departments thought it was the responsibility of forestry departments, and vice-versa, so it was often ignored." As a result of ANAFE's activities, and the scientific training and products supplied by the World Agroforestry Centre, agroforestry is now firmly on the curricula of many universities and colleges in Africa.

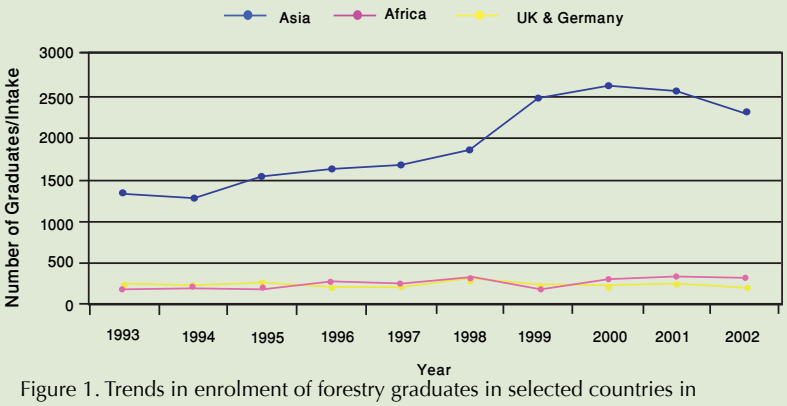

Figure 1. Trends in enrolment of forestry graduates in selected countries in Africa, Asia and Europe.

In 2007, ANAFE became an independent international NGO, recognized as such by the Government of Kenya, with its own Executive Secretary, Dr Aissetou Drame Yaye. Its head office remains in Nairobi at the World Agroforestry Centre, with whom it will continue to work closely in future.

Since the1990s, there has been a 30 per cent decline in the number of graduates from forestry education and training programmes. Many forestry technician schools have closed down or significantly reduced their enrolment.

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The seven billion tree campaign

Director General, Dennis Garrity and Nobel Laureate Prof Wangari Maathai look through the *Tree Seeds for Farmers Toolkit* (a World Agroforestry Centre reference manual) at the launch of the Billion Tree Campaign. The Centre provides technical support to the Campaign. (William Oeri)

When the United Nations Environment Programme (UNEP) and the World Agroforestry Centre launched the Billion Tree Campaign at the Climate Convention meeting in Nairobi in 2006, some wondered whether the target was too ambitious. They needn't have worried. Within 18 months, the campaign had encouraged the planting of over 2 billion trees.

"Having exceeded every target that has been set for the campaign," says Achim Steiner, UNEP Executive Director, "we are now calling on individuals, communities, business and industry, civil society organizations and governments to evolve this initiative onto a new and even higher level." The aim now is to plant 7 billion trees – more than one for every person alive – before the crucial climate change conference in Copenhagen in 2009.

Planting trees is one of the most cost-effective ways of addressing climate change, as trees and forests can absorb carbon dioxide, one of the key greenhouse gases leading to global warming. However, trees are also important for other reasons, as Dennis Garrity, the World Agroforestry Centre's Director General, points out. "The Billion Tree Campaign has not only helped to mobilize millions of people to respond to the challenges of climate change," he says, "it has also opened the door, especially for the rural poor, to benefit from the valuable products and services that trees provide."

The campaign, whose patrons are Nobel Peace Prize Laureate Wangari Maathai, the founder of Kenya's Green Belt Movement, and Prince Albert II of Monaco, has stimulated tree-planting in over 150 countries. Heads of state, big business, local authorities, aid agencies, community and faith groups – all have lent their support in one way or another. Besides helping to tackle global warming, the campaign has generated significant interest in places recovering from conflict and disasters, including Afghanistan, Iraq, Liberia and Somalia. As Wangari Maathai puts it, "when we plant trees, we plant the seeds of peace and the seeds of hope."

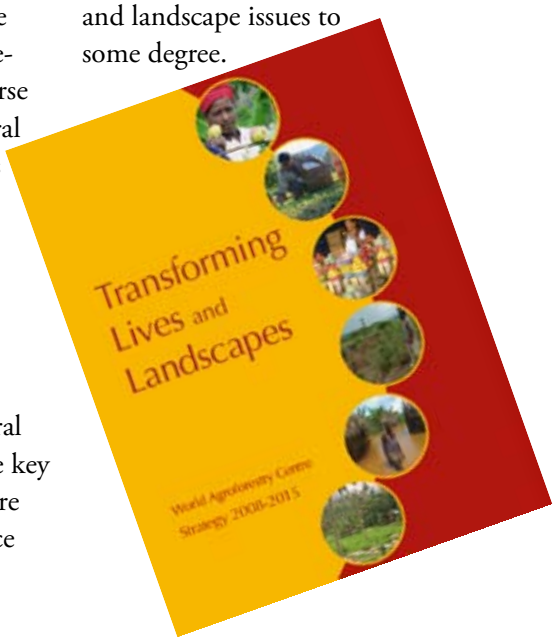
Our new strategy

In 2008, the World Agroforestry Centre unveiled a new strategy to guide its research through to 2015, *Transforming Lives and Landscapes*. The strategy was triggered by the Centre's third External Programme and Management Review, which made significant recommendations about how the Centre could improve its operational and organizational framework.

The Centre's vision is a rural transformation in the developing world as smallholder households massively increase the use of trees in agricultural landscapes to improve, among other things, their food security and income. The Centre will continue to generate science-based knowledge about the diverse roles that trees play in agricultural landscapes, and advance policies and practices that benefit the poor and the environment.

"The strategy is a clear guide to the choices we have made and how those choices translate into action," explains Director General Dennis Garrity. "It identifies the key milestones that we have set before ourselves, major obstacles we face and how we intend to overcome them."

The new strategy was formulated after extensive consultations with a broad range of stakeholders from both the South and the North. In drawing up the six new Global Research Projects (GRPs), four criteria were used in the selection process: relevance to global problems of rural poverty and environmental degradation (salience), the Centre's capability to deliver results (credibility), its comparative advantage (legitimacy) and fundability. Each of the new GRPs addresses both livelihoods and landscape issues to some degree.



GRP 1: Domestication, utilization and conservation of superior agroforestry germplasm

GRP 2: Maximizing on-farm productivity of trees and agroforestry systems

GRP 3: Improving tree product marketing for smallholders

GRP 4: Reducing risks to land health and targeting agroforestry interventions to enhance land productivity and food availability

GRP 5: Improving the ability of farmers, ecosystems and governments to cope with climate change

GRP 6: Developing policies and incentives for multi-functional landscapes with trees that provide environmental services

The World Agroforestry Centre will continue to conduct its research in six ecoregions across sub-Saharan Africa, South and South-east Asia and Latin America. These regions share the interconnected problems of poverty, hunger and environmental degradation to varying degrees and offer opportunities for agroforestry interventions. The Centre's strategy is aligned to the predominant development needs of each region. To ensure the effective implementation of the new strategy, the Centre is taking steps to enhance the quality of its science, to accelerate the use and impact of its research, to build stronger and more effective partnerships and to improve its operational efficiency.

In its commentary on the World Agroforestry Centre strategy, CGIAR's Science Council noted that "the mission and goals are clear and the Center's contribution to the broader goals of the CGIAR system are well articulated; the set of priorities are, in general, relevant for and consistent with the vision, goals and priorities of the CGIAR".

Further reading

World Agroforestry Centre. 2008. *Transforming Lives and Landscapes. Strategy 2008-2015*. Nairobi: World Agroforestry Centre.
http://worldagroforestry.org/af1/downloads/publications/PDFs/B15732/pdf

Photo: Tom Vandenbosch

Annexes

Board of Trustees

Ms Lynn Haight, Chair	Canada
Dr Eugene Terry, former Chair	Sierra Leone (Left in April 2007)
Prof Samir Barua	India (Joined in April 2007)
Dr M. Hosny El-Lakany	Egypt (Joined in June 2008)
Dr Seyfu Ketema	Ethiopia (Left in April 2007)
Dr Romano Kiome	Kenya
Prof Ragnhild Lund	Norway (Left in April 2008)
Dr Juan Mayr	Colombia
Dr Cristian Samper	USA (Left in June 2008)
Dr Sara Scherr	USA (Left in April 2008)
Dr Paco Sereme	Burkina Faso (Joined in November 2007)
Dr Kiyoshi Tanaka	Japan
Dr Dina Nath Tewari	India
Prof Eric Tollens	Belgium
Dr Barbara Wells	USA
Dr Linxiu Zhang	China
Dr Dennis Garrity	USA

Michael Hailu
Board Secretary

Investor support

For the year ended 31 December 2007 (in '000 USD)

Donor	Unrestricted	Restricted	Total
United States of America (USAID)	779	3,168	3,947
European Union	-	3,495	3,495
Ireland	1,412	1,144	2,556
World Bank	1,800	396	2,196
United Kingdom (DFID)	1,286	572	1,858
Canada (CIDA)	782	927	1,708
Netherlands	617	930	1,548
Swedish International Development Cooperation Agency	507	754	1,260
Association for Strengthening Agriculture Research in Eastern and Central Africa		1,032	1,032
Norway	721	307	1,028
International Fund for Agricultural Development	-	949	949
Cooperation of Common Fund for Commodities	-	882	882
Finland	513	160	674
Switzerland	443	211	653
Flemish Office for Development Cooperation and Technical Assistance		599	599
International Development Research Centre	-	597	597
Other donors	-	470	470
United Nations Environmental Programme	-	456	456
Royal Swedish Academy of Agriculture and Forestry- KSLA	-	441	441
Ford Foundation	-	361	361
Germany	354	-	354
International Food Policy Research Institute	-	243	243
Global Environment Facility	-	237	237
Australia	188	317	505
Deutsche Gessellschaft fur Technische Zusammenarbeit (GTZ)	-	216	216
ACDI/VOCA Rwanda	-	181	181
Italy	-	181	181
Katholic University, Leuven, Belgium	-	176	176
Government of Rwanda	-	174	174
World Conservation Union	-	145	145
Austria	-	132	132
Earth Institute - Columbia University	-	131	131
Internationale en Recherche Agronomique pour le Développement		130	130
Spain	-	120	120
Conservation International Foundation	-	116	116
Rockefeller Foundation	-	112	112
Africa Wildlife Foundation	-	99	99
United Nations Development Programme	-	93	93
Rural Sector Support Project (Rwanda)	-	84	84
Global Mountain Programme	-	83	83
Centre for International Forestry Research	-	81	81
Food and Agriculture Organization of the United Nations	-	80	80
Unilever	-	75	75
Bill and Melinda Gates Foundation	-	59	59
International Rice Research Institute	-	59	59
World Wildlife Foundation	-	54	54
Brazil	-	50	50
Centro Internacional de Agricultural Tropical, Colombia	-	46	46
North Carolina State University	-	45	45
CARE International	-	42	42
Peru	-	37	37
Harvard University	-	36	36
Mars Inc	-	35	35

Donor	Unrestricted	Restricted	Total
Oregon State University	-	35	35
Consultative Group on International Agricultural Research	-	34	34
Centre for Cultural and Technical Interchange Between East and West, Inc		34	34
Kenya	-	33	33
Technical Centre for Agricultural and Rural Co-operation	-	32	32
Sunshine Technology Group Limited	-	31	31
INIA-Spain	-	30	30
Plan International	-	28	28
Centro International de la Papa (CIP)	-	27	27
Soil Fertility Consortium for Southern Africa	-	22	22
United Nations Office at Nairobi	-	20	20
China	20	-	20
Bioversity International	-	19	19
Japan	7	10	17
IFAR Wilfred Thalwitz Scholarship	-	16	16
World Resources Institute	-	15	15
Institute of International Education Inc	-	13	13
International Livestock Research Institute	-	13	13
University of Edinburgh	-	12	12
Tigray Food Security Office - Ethiopia	-	11	11
Philippines	11	-	11
Third World Organization for Women in Science	-	10	10
Thailand	10	-	10
SAFE	-	10	10
Centre for Natural Resources and Development	-	10	10
Syngenta Foundation	-	9	9
Institute for Law and Environmental Governance	-	9	9
Darwin Inititiative	-	8	8
Asia-Pacific Network for Global Change Research	-	7	7
Upland Development Programme in Southern Mindanao	-	6	6
International Foundation for Sciences	-	6	6
National Science Foundation	-	6	6
Centre for Development Research	-	5	5
Bogor Institute of Agriculture	-	5	5
Aid to Africa	5	-	5
Japan International Research Center For Agricultural Sciences	-	5	5
Laguna Lake Development Authority	-	5	5
Cornell University	-	5	5
Oxford Forestry Institute	-	4	4
Biodiversity Transect Monitoring Analysis in Africa	-	4	4
Tropical Soil Biology and Fertility Programme	-	4	4
Centre for the Development of Enterprise (CDE)	-	4	4
Forum for Agricultural Research in Africa	-	3	3
International Institute of Environment and Development	-	3	3
Western Midanao Community Initiatives Project	-	3	3
University of Utrecht	-	3	3
The Royal Swedish Academy of Agriculture and Forestry	-	2	2
COIN	-	2	2
Forest Action Network	-	2	2
National Agricultural Research Organization - UGANDA	-	1	1
Centre for Biodiversity and Indigenous Knowledge	-	1	1
International Water Management Institute	-	1	1
START Secretariat	-	1	1
Uganda Forest Sector Co-ordination Secretariat	-	0.480	0.480
Development Bank of South Africa	-	0.446	0.446
Dian Tama Foundation	-	0.089	0.089
Total	**9,454**	**22,092**	**31,546**

Financial highlights for 2007

STATEMENT OF FINANCIAL POSITION as at 31st December 2007 and 2006 (In US Dollars '000)

	2007	2006
ASSETS		
Current Assets		
Cash and cash equivalent	18,851	13,268
Accounts receivables		
Donor	7,487	6,884
Employees	74	94
Other CGIAR Centers	576	875
Other	2,251	2,228
Inventories - net	91	88
Prepaid expenses	35	33
Total current assets	29,365	23,469
Non-Current Assets		
Property, Plant and Equipment - net	5,444	5,993
Total Non-current assets	5,444	5,993
TOTAL ASSETS	**34,809**	**29,462**
LIABILITIES AND NET ASSETS		
Current Liabilities		
Accounts payable		
Donor	8,943	6,588
Employees	967	1,143
Other CGIAR Centers	177	140
Other	1,304	1,795
Accruals	3,669	2,424
Total current liabilities	15,060	12,090
Non-Current Liabilities		
Accounts payable		
Employees	4,020	4,369
Total Non-current liabilities	4,020	4,369
TOTAL LIABILITIES	**19,080**	**16,459**
NET ASSETS		
Unrestricted		
Designated	9,168	9,168
Undesignated	6,561	3,835
	15,729	13,003
TOTAL LIABILITIES AND NET ASSETS	**34,809**	**29,462**

STATEMENT OF ACTIVITIES for the year ended 31st December 2007 and 2006 (In US Dollars '000)

	2007				2006
	Unrestricted	Restricted			
		Temporarily	Challenge Programs	Total	Total
Revenue, Gains and other Support					
Grant revenue	9,454	22,046	46	31,546	30,284
Other revenue and gains	1,571	-	-	1,571	1,190
Total revenue and gains	11,025	22,046	46	33,117	31,474
Expenses and Losses					
Program related expenses	6,373	20,423	46	26,842	28,853
Management and general expenses	4,196	48		4,244	4,716
CGIAR Gender and Diversity program		1,575		1,575	1,071
Sub Total expenses and losses	10,569	22,046	46	32,661	34,640
Overhead cost recovery	(2,270)			(2,270)	(2,313)
Total expenses and losses	8,299	22,046	46	30,391	32,327
Net Surplus / (Deficit)	2,726			2,726	(853)

Board statement on risk management

The Board of Trustees and Management of the World Agroforestry Centre have reviewed the implementation of the risk management framework during 2007 and the Board is satisfied with the progress made.

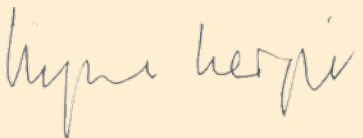
The Board of Trustees has responsibility for ensuring that an appropriate risk management process is in place to identify and manage current and emerging significant risks to the achievement of the Centre's business objectives, and to ensure alignment with CGIAR principles and guidelines as adopted by all CGIAR Centres. These risks include operational, financial and reputation risks that are inherent in the nature, *modus operandi* and locations of the Centre's activities. They are dynamic owing to the environment in which the Centre operates. There is potential for loss resulting from inadequate or failed internal processes or systems, human factors or external events. Risks include:

- low impact science (and therefore irrelevance);
- misallocation of scientific efforts away from agreed priorities;
- loss of reputation for scientific excellence and integrity;
- business disruption and information system failure;
- liquidity problems;
- transaction processing failures;
- loss of assets, including information assets;
- failures to recruit, retain and effectively utilize qualified and experienced staff;
- failures in staff health and safety systems;
- failures in the execution of legal, fiduciary and Centre responsibilities and;
- subsidization of the cost of projects funded from restricted grants and/or partial non-delivery of promised outputs, due to inadequate costing of restricted projects.

The Board has adopted a risk management policy – communicated to all staff – that includes a framework by which the Centre's management identifies, evaluates and prioritizes risks and opportunities across the organization; develops risk mitigation strategies which balance benefits with costs; monitors the implementation of these strategies; and periodically reports to the Board on results. This process draws upon risk assessments and analysis prepared by staff of the Centre's business unit, internal auditors, Centre-commissioned external reviewers and the external auditors. The risk assessments also incorporate the results of collaborative risk assessments with other CGIAR Centres, System Office components, and other entities in relation to shared risks arising from jointly managed activities. The risk management framework seeks to draw upon best practices, as promoted in codes and standards promulgated in a number of CGIAR member countries. It is subject to ongoing review as part of the Centre's continuous improvement efforts.

Risk mitigation strategies include the implementation of systems of internal controls, which, by their nature, are designed to manage rather than eliminate risk. The Centre endeavours to manage risk by ensuring that the appropriate infrastructure, controls, systems and people are in place throughout the organization. Key practices employed in managing risks and opportunities include business environmental scans, clear policies and accountabilities, transaction approval frameworks, financial and management reporting, and the monitoring of metrics designed to highlight positive or negative performance of individuals and business processes across a broad range of key performance areas. The design and effectiveness of the risk management system and internal controls is subject to ongoing review by the Centre's internal audit service, which is independent of the business units, and which reports on the results of its audits directly to the Director General and to the Board through its Audit Committee.

The Board also remains very alive to the impact of external events over which the Centre has no control other than to monitor and, as the occasion arises, to provide mitigation.



Lynn Haight
Chair, Board of Trustees
World Agroforestry Centre
April 2008

Performance indicators

1. Outputs — 92% of output targets achieved.*

2. Outcomes — scored 6.4 on a scale of 10.

3. Impact

3A. SC/SPIA rating of Commitment to documenting impacts and building impact assessment culture – 5.2 on a scale of 10.
3B. SC/SPIA rating of two Centre impact studies carried out in the period 2003-05 for rigour – 6.8 on a scale of 10.

4. Quality and relevance of current research:

4A. Number of peer-reviewed publications per scientist in 2007 (excluding articles that are published in journals that are listed in the Thompson Scientific/ISI 2007 — 2.22
4B. Number of peer-reviewed publications per scientist in 2007 that are published in journals listed in Thomson Scientific/ISI 2007 — 0.94.
4C. Percentage of scientific papers that are published with developing country partners in refereed journals, conference and workshop proceedings in 2007 — 39.50.

5. Institutional Health

Governance
5A. Checklist on Centre governance — can be availed upon request.
5B: Assessment of Board statements — scored 7.5 on a scale of 8.

Culture of learning and change
5C. Checklist on culture of learning and change — can be availed upon request.

Diversity
5D. Gender diversity goals — the Centre has Board-approved gender diversity goals.
5E. Percent of management positions occupied by women — 25%.
5F. IRS nationality concentration — the two most prevalent nationalities represented on the IRS staff are USA (14%) and Belgium (9%).
5G. Diversity in recency of PhDs (% of scientists receiving their PhD in the last five years (2003–2007) — scored 11%.

6. Financial Health

6A. Short term solvency (liquidity) — 178 days where 90–120 days is the recommended acceptable range.
6B. Long-term financial stability (adequacy of reserves) — 128 days, where 75–90 days is the recommended acceptable range.
6C. Efficiency of Operations (indirect cost ratio) — 22% on Direct Cost.
6D. Cash Management on Restricted Operations — 0.75, where 1.0 is the upper threshold.
6E. Audit Opinion – Unqualified.

Stakeholder Perceptions
The results of the CGIAR's 2006 Stakeholder Perceptions Survey can be availed upon request. They include:
(1) Key findings and implications
(2) Full Report on the CGIAR Overall and
(3) Full Centre Report

*As a result of a Science Council and CGIAR Secreteriat review of Centre submitted output targets outlined in the Centre's 2007 to 2009 Medium Term Plan.

Our partners

African Academy of Sciences (AAS)

African Forest Forum (AFF)

African Forestry Research Network (AFORNET)

African Virtual University Project (AVU)

African Network for Agriculture Agroforestry and Natural Resources Education (ANAFE)

Agricultural Open Curriculum and Learning Initiative (AGROCURI)

Amazon Initiative

Asia-Pacific Association of Agricultural Research Institutions (APAARI)

Association for Strengthening Agriculture Research in Eastern and Central Africa (ASARECA)

Australian Tree Seed Centre

Bioversity International

Bogor Agricultural University, Indonesia

Bruker Optics, Germany

Bunda College, Malawi

Bureau of Soils and Water Management, Philippines

CAB International

CARE International

Center for International Earth Science Information Networks at Columbia Earth Institute (CIESIN)

Centre de cooperation internationale en recherche agronomique pour le développement (CIRAD)

Centre de Recherche Agronomique de Foulaya (IRAG), Guinea

Centre for Environment Research, Education and Development (CERED), Vietnam

Centre for International Forestry Research (CIFOR)

Centro Agronómico Tropical de Investigación y Enseñanza (CATIE)

Coffee Agroforestry Network (CAFNET)

Comité Permanent Inter-Etats de Lutte Contre la Sécheresse au Sahel (CILSS)

Commercial Products from the Wild, Department of Forest and Wood Science, University of Stellenbosch

Commission des Forêts d'Afrique Centrale (COMIFAC)

Common Market for Eastern and Southern Africa (COMESA)

Commonwealth of Learning

Commonwealth Scientific and Industrial Research Organisation (CSIRO)

Comprehensive African Agriculture Development Plan (CAADP)

Conseil Ouest et Centre Africain pour la Recherche et le Développement Agricole (CORAF/WECARD)

Cornell University, USA

Council for Agriculture Research Policy (CARP), Sri Lanka

Danish Forest Seed Centre

Department of Environment and Natural Resources, the Philippines

Department of Agricultural Research and Extension, Ministry of Agriculture, Tanzania

Department of Agricultural Research and Extension, Ministry of Agriculture, Zambia

Diversitas - International Programme of Biodiversity Science

Earth Institute – Columbia University

East and Central African Programme for Agricultural Policy Analysis (ECAPAPA)

Egerton University, Kenya

European Forestry Institute

Food Agriculture and Natural Resources Policy Analysis Network (FARNPAN)

Food and Agriculture Organization of the United Nations (FAO)

Forestry Research Network for sub-Saharan Africa (FORNESSA)

Forum for Agricultural Research in Africa (FARA)

Foundation for Advanced Studies in International Development (FASID), Japan

Foundation for Ecological Security, India

Ghent University, Belgium

Govind Ballabh Pant University of Agriculture and Technology (GBPUAT), India

Harvard University

Hohenheim University, Germany

Indian Council for Agricultural Research

Indonesian Research Institute for Estate Crops (LRPI)

Indonesian Soil Research Institute

Institute d'Economie Rurale (IER), Mali

Institute Perrtanian Bogor, Indonesia

International Livestock Research Institute (ILRI)

International Centre for Research in the Semi-Arid Tropics (ICRISAT)

International Centre for Underutilised Crops

International Food Policy Research Institute (IFPRI)

International Institute of Tropical Agriculture (IITA)

International Society for Horticultural Science

International Water Management Institute (IWMI)

Institut de l'Environnement et de Recherches Agricoles (INERA), Burkina Faso

Institut de recherche scientifique et technique appliquée, ISRA, Senegal

Institut National de la Recherche Agronomique du Niger (INRAN), Niger

Jomo Kenyatta University for Agriculture and Technology, Kenya

Kennedy School of Environment

Landcare Foundation of the Philippines

Makerere University, Uganda

Michigan State University

Ministry of Natural Resources and Environment (MONRE), Vietnam

Mozambique National Institute of Agronomic Research (IIAM)

National Center for Agriculture Policy Research (India)

National Farmer Association of Malawi (NASFAM)

National University of Laos, Lao PDR

New Partnership for Africa's Development (NEPAD)

Norwegian Institute for Agricultural and Environmental Research (BioForsk), Norway

OASIS Challenge Program

ProAmbiente Programme, Brazil

Regional Universities Forum for Capacity Building in Agriculture (RUFORUM)

Scottish Crop Research Institute

South African Development Community (SADC) - Tree Seed Centre Network

Southeast Asian Regional Centre for Graduate Study (SEARCA)

Sub-Saharan Africa Challenge Programme (SSA-CP)

Swedish VI Programme in Lake Victoria

Tegemeo Institute of Egerton University, Kenya

Trees on Farm Network (TOFNET)

Tropical Soil Biology and Fertility Institute-CIAT

United Nations Development Programme (UNDP)

United Nations Environment Programme (UNEP)

United Nations Framework Convention on Climate Change (UNFCCC)

University of California at Berkeley, USA

University of California, Davis, USA

University of Copenhagen, Denmark

University of Florida, USA

University of Laval, Montreal, Canada

University of Leuven, Belgium

University of Nairobi, Kenya

University of Peradeniya, Sri Lanka

University of the Philippines

Winrock International

World Bank

World Vision

Staff list
as at 30 June 2008

(Where no duty station is mentioned, the staff member is based at the global headquarters, Nairobi, Kenya)

Office of the Director General
Dennis Garrity, Director General
Mohamed Bakarr, Director of Strategic Initiatives *(left December 2007)*
Claudette Disii, Snr Administrative Assistant *(left October 2007)*
Sheila Keino, Executive Assistant
Samuel Kiunga, Assistant Internal Auditor
Lucy Mbugua, Project Development Officer
Alison Ng'eny, Internal Auditor
Wahida Patwa Shah, Research Assistant

Consultants
Edward Sulzberger
Jean-Yves Maillat

Office of the Deputy Director General
Anthony Simons, Deputy Director General
Jan Laarman, Deputy Director General *(left January 2008)*
Wim Buysse, VVOB Training Associate (*left December 2007*)
Richard Coe Principal Scientist, Head Research Methods Group
David Karari, Senior Administrative Assistant
Elizabeth Mbele Kariuki, Programme Administrative Officer
Peter Muraya, Data Management Specialist
Stella Muasya, Projects Officer
Frank Place, Senior Scientist

Consultants
Allan Rodgers
Justine Wangila

Office of the Director of Communications
Michael Hailu, Director of Communications
Sammy Asura - ICT Database Specialist
Jan Beniest, Head of the Training Unit
Harrison Gatumu - ICT Network specialist
James Indimuli - ICT Infrastructure Manager
Nyawira Kailemia - ICT Administrative officer
Rosemary Kande, ICT Customer service specialist
Naomi Kanyugo, Senior Administrative Assistant
Sarah Katuu - ICT Customer service technician/Helpdesk
Humphrey Keah, Information Specialist
Margaret Kiarie, Senior IT Assistant (*left December 2007*)
David Kimwaki - ICT Telecommunications Officer
Jacinta Kimwaki, Head Librarian
Juma Lumumba, ICT Customer Services Manager
Caroline Mbogo, Administrative Assistant
Ian Moore, IT Manager
Patrick Nabiswa, IT Assistant - Telecommunications (*left December 2007*)
Frank Namunaba, Senior IT Technician-Software (*left December 2007*)
Lawrence Nguri, IT Site Manager (*left December 2007*)
Patrick Njuguna, Web Coordinator
George Obanyi, Publications Officer
Hellen Ochieng, Training Officer
Peter Ochieng, Senior IT Technician - Hardware, (*left December 2007*)
George Ogoti - ICT Server specialist
Robert Okal - ICT Infrastructure specialist
Rebecca Selvarajah-Jaffery, Information Officer
Joshua Shivo - ICT Applications Manager
Tom Vandenbosch, Coordinator, Farmers of the Future
Lucy Wanjau, Senior Communication Clerk (*left December 2007*)
Hilary Wanyiri - ICT Customer service technician/Helpdesk

Consultants
Samuel Kairu - Web Developer
Charlie Pye-Smith – Science Writer

Office of the Director of Finance & Operations
Laksiri Abeysekera, Director of Finance & Operations
Beatrice Achuti, Assistant Accountant
Pauline Ahero, Accountant
John Ayodi, Senior Office Attendant
Leonard Chira, Assistant Accountant (*left February 2008*)
Ernest Gatoru, Budget and Corporate Finance Manager
Ruth Gicho, Procurement Assistant - International
John Gitau, Senior Registry Clerk
Hannah Gitere, Accounts Clerk
Mahmouda Hamoud, Travel Manager
Linus Kabutha, Manager, Financial Information Systems
Jennifer Kariithi, Front Office Assistant
Lillian Kemunto, Assistant Operations Officer
Jimmy Kiio, Operations Manager
Francis Kinyanjui, Finance Officer
Abel Magana, Storekeeper
Samuel Maina, Audio/Visual Technician
Evelyn Matara-Tayari, Accountant
Anthony Mathenge, Accountant
George Mbiriri, Protocol Officer
Jane Moraa, Senior Secretary
Ezra Muna, Assistant Accountant (*left March 2008*)
Nzioka Muoki, Manager - Corporate Accounting
Cecilia Mutinda, Front Office Assistant
Daniel Mwangangi, Procurement Assistant - Local
Lucy Mwangi, Senior Administrative Assistant
Betsy Ngugi, Assistant Accountant
Jacqueline Nyaboga, Accountant-Payroll
Stephen Obondo, Technician
Joanes Ojiambo Okumu, Security Officer
Charles Otieno, Technician
Rose Thuo, Senior Administrative Assistant (*Deceased September 2008*)

Partnerships Office
August Temu, Partnerships Coordinator
Rita Mulinge, Administrative Assistant

Human Resources Unit
Nancy Ntinu, Human Resources Manager
Margaret De Souza, Human Resources Officer *(left July 2007)*
Beatrix Gacho, Human Resources Coordinator
Bernice Getata, Assistant Human Resource Officer- Recruitment *(left July 2007)*
Faith Makumi, HRIS Assistant *(left July 2007)*
Hulda Mogaka, Assistant Human Resource Officer- Staff Welfare *(left July 2007)*
George Mutyauvyu, Human Resources Coordinator
Faith Wambua, Human Resources Assistant
Esther Wamoto, Human Resources Assistant

GRP1[1]: Domestication, Utilization and Conservation of Superior Agroforestry Germplasm
Ramni Jamnadass, GRP Leader
Dickens Alubaka, Senior Laboratory Assistant
Edith Anyango, Laboratory Attendant
Sammy Carsan, Agroforester
Robin Chacha, Laboratory Attendant
Valentine Karari, Technician
Roeland Kindt, Ecologist/Vegetation Mapping Specialist
Vincent Mainga, Laboratory Technician *(left May 2008)*

1 GRP – Global Research Project

Sallyannie Muhoro, Administrative Assistant
Moses Munjuga, ICT Specialist
Jonathan Muriuki, Agroforester
Josephine Muteti, Assistant Laboratory Attendant
Jane Ndirangu, Laboratory Attendant
Mercy Nyambura, Senior Laboratory Technician
Alexious Nzisa, Database Clerk
Caleb Obonyo Orwa, Database Assistant
Parnwell Simitu, Research Assistant
Margaret Thiong'o, Laboratory Technician
Elvis Weullow, Senior Laboratory Technician

Consultants
Anne Mbora
Lucy Muchoki
Alice Muchugi
Lucy Mwaura

GRP 2: Improving on-farm productivity of trees and agroforestry systems
Antoine Kalinganire, GRP Leader, Tree Production Systems and Economics, Bamako, Mali

GRP3: Improving Tree Product Marketing for Smallholders
Steven Franzel, GRP Leader, Markets and Value Chains for Tree Products
Josina Kimotho, Administrative Assistant
Charles Wambugu, Dissemination Extension Specialist (*left March 2008*)

Consultants
Eliot Masters

GRP4: Reducing Land Health Risks
Keith Shepherd GRP Leader, Land Rehabilitation
Andrew Sila, Data Analyst
Thomas Terhoeven-Urselmans, Post-doc Fellow
Tor -Gunnar Vagen, Seconded Researcher

Consultants
Thomas Gumbricht

GRP5: Improving the Ability of Farmers, Ecosystems, and Governments to cope with Climate Change
Louis Verchot GRP Leader - Climate Change
Laure Dutaur, Post Doctoral Fellow
Pamela Akinyi, Administrative Assistant
Jonathan Haskett, Principal Scientist
Meshack Nyabenge, GIS Unit Manager
Jane Wanjara, GIS Technician

GRP6: Developing Policies and Incentives for Multi-functional Landscapes
Brent Swallow GRP Leader - Environmental Policies and Provisioning
Jean-Marc Boffa, Tree Domestication and Biodiversity Scientist
Catherine Kimengu, Administrative Assistant
Miika Makela, Associate Scientist
Martha Mathenge, Research Assistant *(left August 2007)*
Salla Rantala, Associate Expert
Thomas Yatich, Research Analyst in Environmental Policy

Eastern Africa Regional Programme
Henning Baur, Regional Coordinator
Walter Adongo, Driver/Field attendant
Anand Aithal, Associate Enterprise and Entrepreneurship in Agroforestry
Luka Anjeho, Senior Field Technician
Johannes Dietz, Landscape Ecologist
Zeleke Gete, Research Fellow- Rural Urban Linkage Program
Miyuki Iiyama, Post Doctoral Fellow
David Kagoro, Liaison Officer/Dissemination Facilitator
Daniel Kaloki, Assistant Accountant
Esther Karanja, Dissemination Facilitator
Ernest Koroso, Finance and Administrative Assistant *(left October 2007)*
Isaac Learamo, Technician
Maimbo Malesu, Programme Coordinator – Water Management
Joash Mango, Technician
Claire Momoh, Programme Administrator
Martin Ngendo, Project Field Officer
Johnson Nkuusi, Assistant Dissemination Facilitator
Daniel Nyamai, TOFNET Co-ordinator *(left September 2007)*
Thomas Ochinga, Field Attendant
Donald Odhiambo, Driver
Nashon Odieny, Office Assistant/Caretaker/Gardener
Alex Oduor, Programme Officer - Information
Peter Okoth, Driver
Fabrice Pinard, Plant Pathologist
Claude Ruganirwa, Dissemination Technician
Grace Uwimana, Assistant Accountant
Elidad Uwiringiyimana, Field Assistant
Susan Yiapan, Administrative Assistant
Robert Zomer, Landscape Ecologist (*left March 2008*)

Latin America Regional Programme
Roberto Porro, Regional Coordinator, Belem, Brazil
Silvia Dupuy, Accounts/Office Assistant, Pucallpa, Peru
Majorie Lima, Administrative Assistant, Pucallpa, Peru
Abel Meza, Agroforestry Specialist, Pucallpa, Peru
Marcos Rugnitz, Climate Change Specialist, Belem, Brazil
Julio Ugarte, Tree Domestication Specialist, Pucallpa, Peru

Consultants
Hohnwald Maren
Tito Marcos Rugnitz

South Asia Regional Programme
Virendra Pal Singh, Regional Representative, New Delhi, India
Tara Dhoundiyal, Office Assistant, New Delhi, India
HPM Gunasena, Emeritus Scientist, Colombo, Sri Lanka
Giashuddin Mohamed Miah, Country Liaison Scientist, Dhaka, Bangladesh
Jamal Pervez Noor, Regional Finance & Administrative Officer, New Delhi, India
DKNG Pushpakumara, Country Liaison Scientist, Colombo, Sri Lanka
Vinod Kumar Singh, Driver, New Delhi, India
Ram Kathin Singh, Senior Fellow, New Delhi, India

Southeast Asia Regional Programme
Meine Van Noordwijk, Regional Coordinator and GRP6 Co-Leader, Bogor, Indonesia
Dudy Adi, GIS/RS Assistant, Bogor, Indonesia
Ratna Akiefnawati, Field Manager, Jambi, Indonesia
Denta Anggakusuma, Statistician, Lantapan, Philippines
Voni Ardiani, Accountant, Bogor, Indonesia
Sad Ardiharti, Finance Officer, Bogor, Indonesia
Josef Arinto, Desktop Publisher, Assistant Bogor, Indonesia
Armansyah, Office Service Assistant, Bogor, Indonesia
Degi Asmara, Computer Modeler, Bogor, Indonesia
Tonni Asmawan, Landscape Hydrologist, Bogor, Indonesia
Tikah Atikah, Desktop Publisher, Bogor, Indonesia
Suseno Budidarsono, Research Officer, Bogor, Indonesia
Rosemarie Caballero, Accountant, Los Banos, Philippines
Nurka Cahyaningsih, West Lampung, NSS Coordinator, Lampung, Indonesia
Delia Catacutan, Natural Resource Management Researcher, Lantapan, Philippines
Saipim Channuan, Secretary, Chiang Mai, Thailand
Lia Dahlia, Functional Unit Assistant, Bogor, Indonesia
Sonya Dewi, Spatial Analyst, Bogor, Indonesia
Chen Dong, Program Assistant/HR, Beijing, China
Caroline Duque, NRM Research Assistant, Lantapan, Philippines
Andree Putra, Remote Sensing Specialist, Bogor, Indonesia
Aniq Fadhillah, Functional Unit Assistant, Bogor, Indonesia
Aunul Fauzi, Program Assistant, RUPES Bogor, Indonesia
Jesus Fernandez, Capacity Building Specialist, Bogor, Indonesia
Melinda Firds, Publication Assistant, Bogor, Indonesia
Hernane Franje, Field Assistant/Driver, Claveria, Philippines
Minh Ha, ICRAF Vietnam coordinator, Hanoi, Vietnam
Fitri Heryani, Library Assistant, Bogor, Indonesia
Haris Hidayat, Nursery Specialist, Aceh, Indonesia

Chen Huafang, GIS Technician, Kunming, China
Nazar Idris, Deputy Team Leader, Aceh, Indonesia
Rika Irawati, Program Assistant SEANAFE, Bogor, Indonesia
Vinny Iskandar, Administrative Officer, Bogor, Indonesia
Abi Ismarrahman, Research Assistant in Agricultural Economics, Bogor, Indonesia
Jasnari, Field Facilitator, Jambi, Indonesia
Xu Jianchu, ICRAF China Country Representative, Beijing, China
Feri Johana, Spatial Planning Officer, Aceh, Indonesia
Laxman Joshi, INRM Scientist, Bogor, Indonesia
He Jun, Project Manager, Kunming, China
Pramualpis Kanthatham, Country Administrative Officer, Chiang Mai, Thailand
Ni'matul Khasanah, Agroforestry Modeler, Bogor, Indonesia
Noviana Khususiyah, Assistant Officer, Bogor, Indonesia
Amang Kisworo, Nursery Specialist, Calang Aceh, Indonesia
Iwan Kurniawan, Marketing Specialist, Bogor, Indonesia
Rodel Lasco, ICRAF-Philippines Coordinator, Los Banos, Philippines
Beria Leimona, RUPES Program Officer, Bogor, Indonesia
Flordeliza Lopez, Account Assistant, Los Banos, Philippines
Anna Luntungan, Accountant, Bogor, Indonesia
Betha Lusiana, Agroforestry Modeler (on Study Leave), Bogor, Indonesia
Mahyuddin, Nursery Specialist, Pidie Bogor, Indonesia
Gerhard Sebastian Manurung, Agroforestry Tree Specialist, (on study leave) Bogor, Indonesia
Endri Martini, Agroforestry Tree Specialist, Bogor, Indonesia
Jati Martopranoto, Finance Services Leader, Bogor, Indonesia
Marzuki, Administrative Assistant, Aceh, Indonesia
Yan Mei, Project Assistant Kunming, China
Agustin Mercado, Jr, Associate Research Officer, Claveria, Philippines
Usman Muchlish, IT Officer, Bogor, Indonesia
Rahmat Mulia, Landscape Modele,r Bogor, Indonesia
Mutia Muliasih, Accountant, Bogor, Indonesia
Elok Mulyoutami, Local Ecological Knowledge Analyst, Bogor, Indonesia
Sonat Natee, Field Researcher, Chiang Mai, Thailand
Quan Nguyen, Research Staff, Hanoi, Vietnam
Ery Nugraha, Agroforestry Livelihood Specialist, Aceh, Indonesia
Rachman Pasha, Research Assistant, Lampung, Indonesia
Gamal Pasya, Policy Specialist Bogor, Indonesia
Andi Prahmono, Nursery Specialist-Meulaboh, Aceh, Indonesia
Wahyu Priono, Human Resources Officer, Bogor, Indonesia
Hemalina Purba, Project Administrator, Bogor, Indonesia
Maria Luisa Quintos, Senior Secretary, Los Banos, Philippines
Maria Rafiñan, Administrative Assistant, Los Banos, Philippines
Subekti Rahayu, Database Manager, Bogor, Indonesia
Arif Rahmanulloh, Research Assistant in Socio Economics, Bogor, Indonesia
Anantika Ratnamhin, GIS Research Assistant, Chiang Mai, Thailand
James Roshetko, Tree and Market Specialist, Bogor, Indonesia
Gamma Galudra Triana Rusvi, Social Forestry Specialist, Bogor, Indonesia
Niken Sakuntaladewi, Liaison Officer, Bogor, Indonesia
Atang Senjaya, Office Service Assistant, Bogor, Indonesia
Sunthorn Sepan, Senior Field Research Assistant, Chiang Mai, Thailand (*left June 2009)*
Anang Setiawan, Nursery Specialist-Meulaboh, Aceh, Indonesia
Erik Setiawan, Research Assistant, Lampung, Indonesia
Retno Setyowati, Regional Office Secretary, Bogor, Indonesia
Pratiknyo Sidhi, District Coordinator, Aceh, Indonesia
Martua Sirait, Policy Analyst (On Study Leave), Bogor, Indonesia
Endri Subagyo, Field Facilitator, Bogor, Indonesia
Rachmat Sujadi, Office Driver, Bogor, Indonesia
Supardi Suparman, Office Driver, Bogor, Indonesia
Mulus Surgana K, Nursery Specialist, Aceh, Indonesia
Sutarja, Office Driver, Bogor, Indonesia
Desi Suyamto, Landscape Modeler, Bogor, Indonesia
Suyanto, Environment Economist, Bogor, Indonesia
Suyitno, Field Facilitator, Aceh, Indonesia
Syaifullah, Research Assistant, Lampung, Indonesia
Yosi Tapjani, Accountant, Bogor, Indonesia
Jusupta Tarigan, District Coordinator, Bogor, Indonesia
Ahmad Taufik, Computer Programmer, Bogor, Indonesia
Pham Thanh, Finance Officer, Hanoi, Vietnam
David Thomas, Senior Policy Analyst, Chiang Mai, Thailand
Pham Thu Thuy, Ph.D candidate (study leave), Hanoi, Vietnam
Tennigkeit Timm, Carbon Specialist (CIM Senior Expert), Kunming, China
Retno Utaira, Management Service Leader, Bogor, Indonesia
Grace Villamor, Researcher, ICRAF-RUPES Project, Los Banos, Philippines
Atiek Widayati, Spatial Analyst (On Study Leave), Bogor, Indonesia
Diah Wulandari, Program Support Assistant, Bogor, Indonesia
Hu Xinping, Project Assistant, Kunming, China
Liang Xue, Admin Assistant and Accountant, Kunming, China
Arerut Yarnvudhi, Accountant, Chiang Mai, Thailand (*left June 2008*)
Mai Yen, Program Officer Hanoi, Vietnam
Zhang Yifei, Accountant, Kunming, China
Su Yufang, Project Manager, Kunming, China
Li Zhengli, Project Assistant, Kunming, China
Mu Zhilin, Driver, Kunming, China
T. Zulfadhli, District Coordinator, Aceh, Indonesia

Consultants
Lai Chun, Senior Building Capacity Specialist

Southern Africa Regional Programme
Festus Akinnifesi, Regional Coordinator/ Principal Tree Scientist, Lilongwe, Malawi
Oluyede Ajayi, Senior Agricultural Economist, Lilongwe, Malawi
Ester Bhebhe, Research Technician, Harare, Zimbabwe
Sebastian Chakeredza, Associate Scientist, Lilongwe, Malawi
Ernest Chetse, Regional Human Resources & Administration Manager, Harare, Zimbabwe (*left August 2007*)
Thomson Chilanga, Horticulturist/Germplasm Specialist Makoka, Malawi (*left January 2008*)
Richard Chintu, Technical Agroforestry Researcher/Country Liason Chipata, Zambia (*left January 2008*)
Onward Chirmuzhengeni, Senior Driver, Harare, Zimbabwe
Fannie Gondwe, Regional Finance & Administration Officer, Lilongwe, Malawi
France Gondwe, Scaling-Up Officer, Lilongwe, Malawi
Lorraine Itaye, Administrative Secretary, Chitedze, Malawi
Irene Kadzere, Horticulturalist & Country Representative, Harare, Zimbabwe (*left September 2007*)
Christopher Katema, Scaling Up Assistant, Lilongwe, Malawi
Aichi Kitalyi, Country Representative/ Scientist Livestock & Farming, Dar es Salaam,Tanzania
Livai Matarirano, Development Facilitator Harare, Zimbabwe
Arnela Mausse, Country Liaison Officer/Scientist Forester, Maputo, Mozambique
Konisaga B Y Mwafongo, Field Assistant, Chitedze, Malawi
Monica Nyakuwa, Assistant Administrator, Harare, Zimbabwe
Sileshi Weldesemayat, Agro-Ecologist, Lilongwe, Malawi
Clever Zinaka, Finance & Administartive Officer, Harare, Zimbabwe

Consultants
Simon Mng'omba
Isaac Nyoka

West & Central Africa Regional Programme
Harold Roy-Macauley , Regional Coordinator, Bamako, Mali
Zachary Tchoundjeu, Representative Humid Tropics Node/GRP1 Co-Leader, Yaounde, Cameroon
Antoine Kalinganire, GRP Leader - Tree Production Systems and Economics Bamako, Mali
Tchouala M, Operational/Administrative Officer, Bamenda, Cameroon
Claude Adandedjan, Strengthening Institutions, Bamako, Mali
Ebenezar Asaah, Tree Scientist & Project Manager, Bamenda, Cameroon
Diallo Assamou, Driver, Bamako, Mali
Innocent Bekolo, Income Generating Activities Officer, Bamenda, Cameroon
Guindo Boubacar, Administrative Clerk, Bamako, Mali

Philomène Mbosso Charlie, Farmer Group Facilitator, Yaounde, Cameroon
Louis Chin, Field Assistant, Bamenda, Cameroon
Ann Marie Degrande, Socio Economist, Yaounde, Cameroon
Gustave Ebengue, Field Attendant, Yaounde, Cameroon
Charly Facheux, Marketing Specialist, Yaounde, Cameroon
Mbene Faye, Agro-Economist IFAD Project, Bamako, Mali
Baba Gaspard, Field Attendant, Bamenda, Cameroon
Ibrahim Gatta, Administration & HR Officer, Bamako, Mali
Sangaré Ibrahim, Driver/Observator, Bamako, Mali
Kwembe Jean, Driver, Kinshasa, DRC
Andre Kamga, Administrator Yaounde, Cameroon (*left October 2007*)
Lyliane Kani, Office Assistant, Yaounde, Cameroon
Brehima Kone, Scientific Officer, Bamako, Mali
James Kongnyui, Capacity Building Officer, Bamenda, Cameroon
Nya Landry, Driver/Mechanic, Yaounde, Cameroon
Maurice Lenou, Driver/Mechanic, Bamenda, Cameroon
Epongolo Mpassi Leon, Agronomist, Kinshasa, DRC
John Mafolo, National Coordinator, Kinshasa, DRC
Sidibe Malick, Scientific Officer, Samanko, Mali
Dia Mamadou, Driver/Field Attendant, Bamako, Mali
Waigalo Mariam, Account Assistant, Bamako, Mali
Etienne Mbatchou, Office Security, Yaounde, Cameroon
Peter Mbile, Integrated Natural Resources Management, Yaounde, Cameroon
Ahmadou Mbouombouo, Field Assistant, Yaounde, Cameroon
Doumbia Modibo, Nursery Attendant, Bamako, Mali
Catherine Momha, Communications Officer, Yaounde, Cameroon (*left May 2008*)
Diallo Rokia Moulaye, Administrative Secretary, Bamako, Mali
Modeste Ndzana, Field attendant, Yaounde, Cameroon
Andrew Nebaso, Driver/Mechanic, Yaounde, Cameroon
Crose Ngondjou, Office Assistant, Yaounde, Cameroon
Jacqueline Azor, Office Attendant, Yaounde, Cameroon
Francis Numfor, Office Assistant, Bamenda, Cameroon
Hilda Nyanga, Office Attendant, Bamenda, Cameroon
Justin Omengle, Field attendant, Yaounde, Cameroon
Traore Oumar, Associate Scientist, Samanko, Mali
Anegbeh Paul, Research Associate/Tree Scientist, Benin City, Nigeria
Diallo Roliatou, Administration & Finance Officer, Segou, Mali
Thadee Sado, Research Assistant, Yaounde, Cameroon
Festus Shu, Driver/Mechanic, Yaounde, Cameroon
Keita Souleymane, Scientific Officer, Samanko, Mali
Edith Souop, Office Assistant, Yaounde, Cameroon
Honore Tabuna, Marketing and Entrepreneurial Development Specialist, Yaounde, Cameroon
Olutosine Tada, Office Attendant, Yaounde, Cameroon
Anselme Takoutsin, Agricultural Production Officer, Bamenda, Cameroon
Landry Tankam, IT Technician, Yaounde, Cameroon
Tchiama Tchiama, Secretary/Accountant, Kinshasa, DRC
Ibrahim Toure, ICT Specialist, Bamako, Mali
Alain Tsobeng, Plan Biotechnologist, Yaounde, Cameroon
John Weber, IFAD Project Coordinator Bamako, Mali

Consultants
Claude Adandedjan, Policies, learning tools and institutional capacity
Serge Ngendakumana, Scalling up Expert for LAMIL project Guinea
John Weber, Tree Domestication

African Highlands Initiative
Jeremias Gasper Mowo, Regional Coordinator AHI, Kampala, Uganda
Vincent Epodoi, Driver, Kampala, Uganda (*left March 2008*)
Rick Kamugisha, Research Assistant/Community Facilitator, Kampala, Uganda
Edidah Kanyunya, Office Assistant, Kampala, Uganda
Jane Kugonza, Technician, Kampala, Uganda
Kenneth Masuki, ACACIA Project Leader, Kampala, Uganda
Noreen Nabwami, Administrative Officer, Kampala, Uganda
Sarah Nakabugo, Finance and Administrative Officer, Kampala, Uganda (*left December 2007*)
Chris Opondo, Research Fellow, Kampala, Uganda (*left May 2008*)
Charles Ssonko, Driver, Kampala, Uganda
Joseph Tanui, Landcare Coordinator, Kampala, Uganda
Joy Tukahirwa, NRM Specialist, Kampala, Uganda
Ronald Wabwire, Dissemination Facilitator, Kampala, Uganda

Consultants
Nabwami Noreen, Administrative Support

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or contact Jacinta Kimwaki, j.kimwaki@cgiar.org

Awards

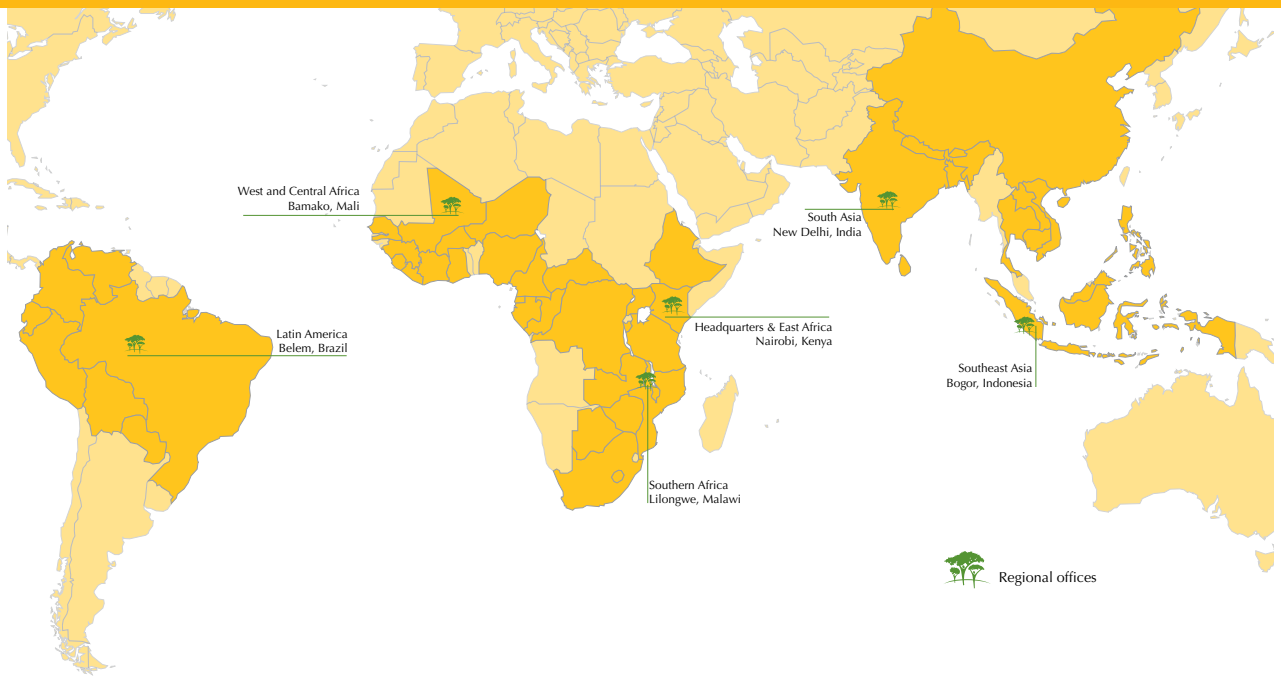
- In May 2008, Dr Festus Akinnifesi was appointed Professor Extraordinaire of Stellenbosch University, South Africa.

- *The Challenges of Inclusive Cross-Scale Collective Action in Watersheds* by Brent Swallow (World Agroforestry Centre), Nancy Johnson, Ruth Meinzen-Dick, and Anna Knox, was awarded the Best Paper published in *Water International* in 2006.

- *Bylaws and their critical role in natural resource management: Insights from African experience* by Helen Markelova and Brent Swallow (World Agroforestry Centre) won the 'Best Paper Award' at the biannual meeting of the International Association for the Study of the Commons that was held in Cheltenham, England, from July 14-18, 2008.

- Keith Shepherd and Markus Walsh published the lead article in the 2007 Journal of Near Infrared Spectroscopy (see citation on page 62).

Our regional presence



HEADQUARTERS
World Agroforestry Centre
United Nations Avenue, Gigiri
PO Box 30677
Nairobi, 00100, Kenya
Telephone: +254 20 7224000
Via USA +1 650833 6645
Fax: +254 20 7224001
Via USA +1 650833 6646
Email: icraf@cgiar.org
www.worldagroforestry.org

EASTERN AFRICA REGIONAL PROGRAMME
United Nations Avenue, Gigiri
PO Box 30677, Nairobi, 00100, Kenya
Telephone: +254 20 7224000
Via USA: +1 650833 6645
Fax: +254 20 7224401
Via USA: +1 650833 6646 Kenya
Email: h.baur@cgiar.org
www.worldagroforestry.org/ea/newstyle/index.asp

Kisumu Office
PO Box 25199, Kisumu, Kenya
Telephone: +254 57 2021918/3191
Email: icraf-kisumu@cgiar.org

Meru Office
Off Meru-Makutano Road, Kaaga Area
PO Box 3208-60200
Meru, Kenya
Telephone: +254 64 31267
Cell: +254 720554927 or
+254 735615902
Email: icraf-meru@cgiar.org

SOUTH ASIA REGIONAL PROGRAMME
1st Floor National Agricultural Science Complex (NASC)
Dev Prakash Shastri Marg
Pusa, New Delhi, India 110012
Telephone: +91 11 25609800/25847885/6
Fax: +91 11 25847884
Email: v.p.singh@cgiar.org
www.worldagroforestry.org/af1/index.php?id=27

Sri Lanka
Dr. D.K.N.G. Pushpakumara
Country Liaison Scientist for Sri Lanka
C/o Faculty of Agriculture
University of Peradeniya
Peradeniya, Sri Lanka
Cell: +94 714933591
Email: ngpkumara@pdn.ac.lk

Bangladesh
Dr. Giashuddin Miah
Country Liaison Scientist for Bangladesh
C/o Bangbandhu Sheikh Mujibur Rehman
University of Agriculture
Gazipur - 1706, Bangladesh
Email: giashbd@hotmail.com

SOUTHEAST ASIA REGIONAL PROGRAMME
JL, CIFOR, Situ Gede
Sindang Barang, Bogor 16115
PO Box 161, Bogor 16001
Indonesia
Telephone: +62 251625415
Via USA: +1 6508336665
Fax: +62 251625416
Via USA: +1 650 833 6666
Email: u.p.pradhan@cgiar.org
www.worldagroforestry.org/sea/

Philippines Country Office
Khush Hall, International Rice Research Institute
Los Baños, Laguna, Philippines
PO Box 35024, UPLB, College, Laguna 4031, Philippines
Telephone: +63 2 845 0563/70/75
Telefax: +63 49 536 2925
Email: r.lasco@cgiar.org
www.worldagroforestry.org/sea/ph/05_cntct.htm

Vietnam Country Office
Hoang Minh Ha
ICRAF-CIFOR Vietnam representative
17T5 Trung Hoa - Nhan Chinh
Apartment 302, Hanoi, Vietnam
Tel/Fax: +84 4 2510830
Email: ICRAFVN@gmail.com;
minh-ha.fagerstrom@mv.slu.se

Thailand Country Office
Faculty of Agriculture
5th Floor, Chiang Mai, University
PO Box 267, CMU Post Office,
Chiang Mai 50202,Thailand
Telephone: +66 53 357906-7
Fax: +66 53 357908
Email: dthomas@cgiar.org
www.worldagroforestry.org/sea/th/

China
Beijing Office
#12 Zhongguancun Nan Dajie
CAAS Mailbox 100081
PR China
Telephone: +86 10 62119430
Fax: +86 10 62119431
Email: cmes@mail.kib.ac.cn
http://cmes.kib.ac.cn/CorpsData/icrafc3e35ca1-8beb-48ab-b7fa-82837dae4ca8/index.aspx

Kunming Office
Centre for Mountain Ecosystem Studies
C/o Kunming Institute of Botany,
3/F, Library Building
Heilongtan, Kunming, 650204
PR China
Telephone: +86 871 5223014
Fax: +86 871 5216350
Email: cmes@mail.kib.ac.cn

SOUTHERN AFRICA REGIONAL PROGRAMME

World Agroforestry Centre (SADCICRAF)
Chitedze Research Station
ICRISAT buildings
PO Box 30798
Lilongwe 3, Malawi
Tel: +265 1 707 332/ 319
Fax: +265 1 707 319
Email: f.akinnifesi@cgiar.org
http://worldagroforestry.org/af1/index.php?id=29

Mozambique
ICRAF-Mozambique,
Caixa Postal 1884
Av. das FPLM 3698, Mavalane
Maputo, Mozambique
Telephone: +258 21 461775
Email: arnela.mausse@intra.com

Tanzania
ICRAF - Tanzania
ARI-Mikocheni Campus
Mwenge Coca Cola Road
PO Box 6226 Dar es Salaam.
Telephone: +255 22 2700660
Fax: +255 22 2700090
Email: ICRAF-DAR@cgiar.org

Uganda
African Highlands Initiative
Eco-regional Programme
PO Box 26416
Kampala, Uganda
Telephone: +256 41 220607/2
Fax: +256 41 223242
Email: ahi@cgiar.org

Zambia
Zambia-ICRAF Agroforestry Project
c/o Provincial Agriculture Office
(Eastern Province)
Msekera Agriculture Research
PO Box 510046, Chipata, Zambia
Telephone: +260 62 21404
Fax: +260 62 21725
Email: drsmartlungu@yahoo.com

WEST AND CENTRAL AFRICA REGIONAL PROGRAMME

c/o: ICRISAT
BP 320, Bamako, Mali
Telephone: +223 223375/7707
Fax: +223 228683
Email: h.roy-macauley@cgiar.org
http://worldagroforestry.org/af1/index.php?id=28

Cameroon
Humid Tropics Node
P.O Box 16317 Yaounde, Cameroon
(Main Office in Bastos)
Telephone: +237 22 21 50 84
Fax: +237 22 21 50 89
Email: icraf-aht@cgiar.org

Nkolbisson Office
PO Box: 16 317 Yaounde,Cameroon
Tel: +237 22 23 75 60
Fax: +237 22 23 74 40

Bamenda Office
P.O Box 950 Bamenda, Cameroon
Telephone: +237 33 36 28 90
Fax: +237 33 36 20 12
Email: icraf-ffp2006@cgiar.org

Democratic Republic of Congo ICRAF
Country Office
c/o INERA
Avenue des cliniques No 15
Commune de la Gombe
Kinshasa/RDC
Telephone: +243 818996083
Fax: +243 990592200
Email: j.mafolo@cgiar.org

Guinea
Lamil Node - Guinea
DNEF/ICRAF/CIFOR/USAID
PO Box 5841 Conakry, Guinea Conakry
Telephone: +224 64 051775/60570746
Email: mohamadoubella@yahoo.fr

Labé, Guinea Conakry
PO Box 26, Labe, Guinea Conakry
Telephone: +224 60520393/64603492
Email: mbalinga@cgiar.org

Nigeria
Country Office
Agricultural Development Programme
Airport Road, Benin City, Edo State,
Nigeria
Telephone: +234 8065046434
Email: p.anegbeh@cgiar.org

LATIN AMERICA
Inter-Centre Amazon Initiative and Regional Office - Belem (PA) - Brazil
EMBRAPA AMAZONIA ORIENTAL
Travessa Dr Eneas Pinheiro s/n
66095-100 - Belem, Para - Brazil
Telephone: +55 91 4009-2664
Email: r.porro@cgiar.org
http://www.icraf-peru.org/

LA, National Office Lima, Peru
Peru Country Office
CIP-ICRAF
PO Box 1558 Lima 12, Peru
Telephone: +51 1 349-6017
Fax: +51 1 317-5326
Email: j.ugarte@cgiar.org

LA, Local Office
Pucallpa - Ucayali - Peru
ICRAF (Ex-CENFOR)
Carretera Federico Basadre Km 4.2
Pucallpa, Ucayali - Peru
Telephone: +51 61 579078
Fax: + 51 61 579222
Email: icraf-admpucallpa@cgiar.org

www.worldagroforestry.org

World Agroforestry Centre

TRANSFORMING LIVES AND LANDSCAPES

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