# Agroforestry a global land use

World Agroforestry Centre
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# Agroforestry
# a global land use



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Writer: Charlie Pye-Smith

Coordination, compilation, editing/proofreading: Michael Hailu, Kate Langford,

Rebecca Selvarajah-Jaffery, Kris Vanhoutte

Design and Layout: Reagan Sirengo

Cover photo: Zhou Zhimei

Financial information: Francis Kinyanjui

Performance indicators: Elizabeth Mbele Kariuki

Publications: Jacinta Kimwaki

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*For a more comprehensive version of this report please visit www.worldagroforestry.org/ar2009*

Photo: Stevie Mann

# Contents



**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 our 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
- Mutual respect
- Creativity

**Our Focus** We pay particular emphasis to four areas in our work:

- Accelerating impact
- Enhancing science quality
- Strengthening partnerships
- Improving operational efficiency

# MESSAGE FROM THE CHAIR AND DIRECTOR GENERAL

**Lynn Haight**
**Chair of the Board of Trustees**

**Dennis Garrity, Director General**

This has been an extraordinary year for the World Agroforestry Centre. Most significantly, we hosted—along with the United Nations Environment Programme—the hugely successful 2nd World Congress of Agroforestry, which brought together close to 1200 participants from 96 countries.

During the four-day Congress in Nairobi, we had the unique opportunity to showcase recent advances in agroforestry research and raise the profile of agroforestry worldwide. The Congress helped to create stronger networks among researchers, policy makers and practitioners. There is no longer any doubt that agroforestry has come of age as a robust, science-based discipline, as well as a major land use at the global scale.

A new study, described in the following pages, provides definitive quantitative evidence of agroforestry's importance. Over 1 billion hectares of agricultural land – almost half of the world's farmland – are observed to have more than 10% tree cover, and 160 million of these hectares have more than 50% tree cover.

These new results, combined with the increasing density of trees on farms observed in many countries, show that farmers across the tropics are relying more on agroforestry to shape a better future for their families and for the environment. The evidence is clear: agroforestry can enhance food security and improve rural livelihoods, and it can increase soil fertility and crop yields. Indeed, trees on farms are now seen as one of the most promising means known to better adapt farming systems to climate change, and to absorb carbon dioxide in the battle to moderate global warming worldwide.

This was a particularly important year not just for us, but for the planet, with all eyes on the international climate-change negotiations, culminating in Copenhagen in December 2009.

Deforestation accounts for some 20% of greenhouse gas emissions, and it is now widely accepted that REDD – reducing emissions from deforestation and forest degradation – should be a key component of the climate change agreement that replaces the Kyoto Protocol. Our research strongly suggests that the agreement will only be successful, however, if it recognizes the critical role that smallholder farmers can play in reducing emissions, and in sequestering carbon by planting trees on farmland.

It is this message that the African Biocarbon Initiative, launched by

the Common Market for East and Southern Africa (COMESA) and the World Agroforestry Centre, is promoting in the lead up to the Copenhagen climate negotiations. If poor farmers are able to capture just a small fraction of the investment flow in projected carbon markets, agroforestry projects could dramatically reduce poverty, and at the same time remove billions of tonnes of carbon dioxide from the atmosphere.

This report highlights the breadth of our exciting agenda and achievements, from research on nitrogen-fixing trees that increase crop yields to the domestication of indigenous fruit trees; improving market access for smallholder farmers; providing evidence for crucial policy reforms; developing new ways of measuring soil health; and researching the best ways to disseminate information to farmers.

We made considerable progress during the year in implementing our new strategy. Our scientists have responded vigorously, with the number of peer-reviewed journal publications rising by over 43% in 2008. Our financial situation has remained healthy and stable. And we continue to wholeheartedly support and contribute to the CGIAR Change Management Initiative.

Building on this highly successful year of creating broad awareness about the role of agroforestry and about our own work in addressing global challenges, we are in a stronger position than ever before to continue providing science-based solutions that transform lives and landscapes.

We thank our many donors and partners for their strong and unrelenting support to these important joint efforts.

**This report highlights the breadth of our exciting agenda and achievements**

△ **Grafting superior varieties of citrus tree in a nursery in Malawi. (Stevie Mann)**

A bird's-eye view. More than half a billion people live on farmland with more than 10 per cent tree cover (World Agroforestry Centre photo archive).

# A MAJOR LAND USE – THE PROOF

Trees provide farmers with a range of goods and services, from fruit to livestock fodder, fuelwood to green fertilizers. But how much land is devoted to agroforestry? Until recently, we could only guess. However, a new study provides some solid figures – and a clear message about the importance of agroforestry.

A World Agroforestry Centre study used remote sensing data to analyse the extent of tree cover on agricultural land, and its relationship with population density and climate. Over 1 billion hectares of agricultural land – or 43% – have more than 10% tree cover, and these areas are home to almost a third of the 1.8 billion people who live on agricultural land. Some 0.6 billion hectares of agricultural land have more than 20% tree cover, and 160 million hectares more than 50%.

"Before we conducted the study, the only figures available were guesstimates," explains Richard Coe, co-author of *Trees on Farm: Analysis of Global Extent and Geographical Patterns of Agroforestry*. These varied wildly, with one as low as 50,000 hectares and another of over 307 million hectares, the latter figure being based on the assumption that 20% of agricultural land is covered with trees. "There are limitations to our study," continues Coe, "but it is a significant step in the right direction."

Agroforestry is a feature of agriculture landscapes throughout the world, but the extent to which it is practised varies from region to region. It is particularly significant in Central America; less so in East Asia. There is a strong positive correlation between tree cover and humidity, but the relationship between tree cover and population density is less clear. This is presumably because other factors, such as markets, government policies, development programmes and local history, also influence the level of tree cover on farmland.

The study has several limitations. For example, tree cover estimates are based on computer analysis of remote sensing of one kilometre square pixels. Fifty per cent tree cover in a square kilometer could mean one large block of trees – in other words, a small forest – or an even scattering across farmland. And the analysis provides no information about the nature and use of trees on farmland.

"Before we conducted the study, the only figures available were guesstimates."
**Richard Coe**

The global figures for tree cover are almost certainly conservative. There are large areas of agroforestry that are excluded from agricultural land, such as the jungle rubber systems in Indonesia and cocoa agroforestry in West Africa. In global land cover databases these areas are usually classified as forest, not as agricultural land.

*Trees on Farm* contains some important messages for politicians, climate-change negotiators, development specialists and others in a position to influence policy. It provides firm evidence that large areas of agricultural land contain significant tree cover; it also suggests that certain areas – for example, along the fringes of the Sahara desert – could support many more trees on farms than they currently do.

"What is needed now is a series of much more detailed analyses that provide a better understanding of where people plant trees, why they keep them and how they use them," says Coe. Recent research conducted by the World Agroforestry Centre in India (see box) and Indonesia is beginning to do precisely that.

Over **1 billion** hectares of agricultural land – almost half of the world's farmland – have more than **10%** tree cover; **160 million** hectares have more than **50%** tree cover.



## Focus on India

"If you know how many trees there are on agricultural land, that's useful," explains Pal Singh, the World Agroforestry Centre's Regional Coordinator for South Asia. "But it's much more useful if you know which species they are, and what they provide to farmers."

A recent study conducted by Pal Singh and AN Singh provides the most thorough analysis to date of the extent of agroforestry in India. The scientists looked at satellite imagery analysis carried out by the Forest Survey of India for 120 selected districts and the Punjab state. Detailed analysis was conducted for Yamuna Nagar district in Haryana, and a number of villages in Lucknow district of Uttar Pradesh. The scientists used different methods of sampling on remotely sensed data to analyse the nature and extent of linear plantations, such as avenues along canals and roads, block plantations and scattered trees, at different levels.

Countrywide, the most important agroforestry tree was mango, followed by neem and coconut. Not surprisingly, there was considerable variation between states, with just 0.3% tree cover on farmland in Sikkim to 13% in the Lakshadweep. In Punjab, almost half the trees on farms are eucalypts and poplars. In Kerala, mango, coconut and other fruit trees predominate.

But does this have any implications for policy makers? "Studies like this will provide important information to central government and the states," says Pal Singh, "and they will certainly be useful to the Greening India Programme." Under this programme, central government has stipulated that all states must have 33% tree cover by the year 2020. This, it is hoped, will encourage carbon sequestration and restore degraded lands.

Some states will be able to achieve their targets by planting more trees on state-owned forest land, but for those lacking forest land, the increase will have to come from planting trees on agricultural land – in other words, through agroforestry.

## Further reading

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The Congress provided solid proof that agroforestry has truly come of age (World Agroforestry Centre photo archive).

# ON THE WORLD STAGE

One of the clearest messages to come out of the 2nd World Congress of Agroforestry, held in Nairobi in August 2009, was that agroforestry has truly come of age. Over the last 30 years, it has been transformed from a vaguely defined concept to a robust, science-based discipline, and a land use which can address many of the world's most pressing problems.

Organized by the World Agroforestry Centre and the United Nations Environment Programme (UNEP), the Congress attracted close to 1200 participants from across the world, and was addressed by an impressive array of high-level speakers, including: Wangari Maathai, founder of Kenya's Green Belt Movement and Nobel prizewinner; Richard Leakey, the anthropologist and conservationist; MS Swaminathan, one of the fathers of the Green Revolution and now a champion of 'evergreen agriculture'; Namanga Ngongi, President of the Alliance for a Green Revolution in Africa (AGRA); and RK Pachauri, Chairman of the Intergovernmental Panel on Climate Change (IPCC). His Excellency Kalonzo Musyoka, the Vice President of Kenya, delivered the host country address on behalf of President Mwai Kibaki.

In his opening speech, Dennis Garrity, the Director General of the World Agroforestry Centre, conceded that the congress theme – 'Agroforestry – the future of global land use' – might seem far-fetched to some people. But he pointed out we now have plenty of evidence to show that agroforestry can deliver a wide range of benefits. It can enhance food security and improve rural livelihoods; increase soil fertility; absorb atmospheric carbon, a major greenhouse gas; and provide farmers with the technologies to restore degraded land.

Close to 1200 people attended the 2009 World Congress of Agroforestry. "Agroforestry has now come of age as an integrative science and practice. It is at the heart of the solution to so many of the challenges we face."
**Dennis Garrity**

The number of trees in forests may be decreasing, but the number on farms is steadily increasing.

The three main sub-themes of the Congress were food security, the conservation and rehabilitation of natural resources, and policies to enhance agroforestry. These were addressed at plenary sessions and explored in greater depth at over 30 technical sessions, at which scientists were able to deliver presentations and discuss their latest research. Much of this research will be published in peer-reviewed journals.

Such was the strength of the case made for agroforestry, and for increasing its practice worldwide, that Achim Steiner, Executive Director of UNEP, was moved to remark: "There are so many reasons why agroforestry should be practised everywhere. When something is so obvious, why isn't it catching on like wildfire?"

One reason, highlighted by several speakers, relates to the failure of agroforesters to communicate their findings in a compelling and intelligible way to policy makers, politicians and the public. "Agroforestry has a public relations problem, and we're often considered boring," suggested Roger Leakey of James Cook University, Australia. "It's time we learned how to talk more persuasively to communicators." Encouragingly, over 100 journalists attended a press briefing at the beginning of the Congress, and during the course of the week articles about agroforestry appeared in *Time* magazine, *New Scientist* and other international and national media.

The final day of the Congress was a time for reflection, with PK Nair chairing a symposium on the theme, 'The way forward - energizing the next wave of agroforestry science.' Meine van Noordwijk of the World Agroforestry Centre provided an overview of the highlights of the Congress, stressing the importance of linking science to policy. His colleague Frank Place provided insights into the discussions on the Agroforestry Policy Initiative, which the World Agroforestry Centre will be coordinating over the coming years. Finally, Dennis Garrity stressed the need to continue producing high–quality scientific research which has an impact on climate change decision-making, food security and much more.

## Making headlines

Agroforestry stories have featured strongly in the media, with the Congress inspiring coverage that stretched from China to Canada, India to Iceland. Among the newspapers and magazines which ran stories related to agroforestry were the Daily Telegraph, Le Monde, the Shanghai Daily, the Jakarta Post and the Hindustan Times. Stories related to the Congress featured on over 50 online sites, including those of El Pais, New Scientist and Time. Particular attention was given to the Trees on Farm study and the potential of a native African tree, *Faidherbia albida,* to provide natural fertilizers to improve crop yields. (See pages 13 to 15)

## Further reading

For Congress reports, summaries and presentations, visit the 2nd World Congress of Agroforestry website http://www.worldagroforestry.org/wca2009/

"Don't use resources as if you're the last generation and there is no other generation after you!"
**Wangari Maathai**

"We must take the best of the indigenous, traditional and farmers' knowledge, forged over centuries of trial and error, and submit it to empirical, scientific and rigorous evaluation."
**Achim Steiner**

"The loss of every species and gene limits options for the future."
**MS Swaminathan**

Agroforestry landscapes, such as this one in Senegal, can play an important role in the battle against global warming by sequestering and storing carbon. (World Agroforestry Centre photo archive).

# TACKLING CLIMATE CHANGE THROUGH AGROFORESTRY

During the year leading up to the United Nations Climate Change Conference in Copenhagen, in December 2009, research by the World Agroforestry Centre highlighted the role trees on farms could – and should – play in the battle against global warming. Our scientists also provided support for climate-change policy makers, especially in Africa and Indonesia, and are helping to develop new techniques to measure the quantities of carbon stored in agricultural landscapes.

At the 2007 Climate Change Conference, held in Bali, negotiators agreed that REDD – reducing emissions from deforestation and forest degradation – should be a key component of the agreement that will replace the Kyoto Protocol in 2012. Deforestation accounts for approximately 20% of greenhouse gas emissions and reducing the rate at which forests are cleared will cut emissions.

While fully supporting REDD, the Centre believes it needs to go further to consider agricultural landscapes beyond the forest boundaries. “During the past year, we have tried to move the agenda beyond REDD,” explains Frank Place, Head of the World Agroforestry Centre’s Impact Office. “The key focus of REDD is tackling emissions by planting or protecting forests, but it fails to recognize the role farmers can play in sequestering carbon dioxide from the atmosphere.”

## A whole landscape approach

The potential for extending REDD was highlighted by the World Agroforestry Centre when the 14th Conference of the Parties to the United Nations Framework Convention on

> “During the past year, we have tried to move the agenda beyond REDD.”
> **Frank Place**

Climate Change met in Poland in 2008. The Norwegian Government subsequently accepted World Agroforestry Centre scientist Meine van Noordwijk's proposal to develop the concept further. Instead of just reducing emissions from deforestation and degradation, he argues, we need to reduce emissions from all land uses – REALU, for short.

One of the difficulties with REDD relates to the definition of what is, and is not, forest, and this is largely determined by institutional arrangements rather than tree cover. Take, for example, Indonesia, the world's third largest emitter of greenhouse gases. According to van Noordwijk, you will find large areas of land classified as 'forest' without any trees, and large areas of 'non-forest' with significant tree cover. REDD would only apply to the land classified as 'forest', even though the 'non-forest' areas that actually have tree cover are highly significant when it comes to their greenhouse gas emissions, and could potentially play a major role in sequestering carbon.

At a rough estimate, REDD projects will only capture, at best, 60–70% of the emissions related to land-use change. "If we really want to reduce land-use emissions," says van Noordwijk, "we need to capture the other 30–40% as well, and much of that can be done by developing smallholder agroforestry on land which is not classified as forest land." In other words, we need REALU, which goes beyond REDD.

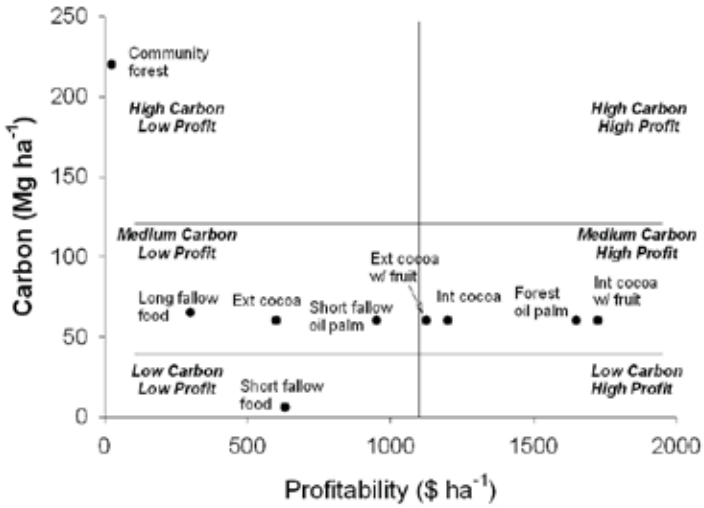
Most of the deforestation in Africa, and in many parts of Asia, is caused by agricultural expansion, largely by smallholder farmers. This means they can't be ignored in a future climate change agreement. "If millions of smallholders are denied access to the carbon market, then there'll be no incentive for them to change the way they behave," says Peter Minang, Global Coordinator of the ASB Partnership for the Tropical Forest Margins.

Drawing on over a decade of research on the complex relationship between forests and the adjacent landscapes, Minang and his colleagues believe that REDD is unlikely to achieve significant emission reductions unless it explicitly includes arrangements which encourage farmers to plant trees. "We should be encouraging carbon-rich agroforestry," says Minang. "It has the potential to increase farmers' income, sequester more carbon and benefit biodiversity." The ASB Policy Brief *REDD Strategies for High Carbon Rural Development* describes the benefits – both for climate mitigation and local livelihoods – of agroforestry.

## A new initiative for Africa

Research conducted by ASB found that in 80% of the areas investigated, the activities that caused a loss of carbon, such as converting forests to cropland, generated USD 5 or less in profits for every tonne of $CO_2$ equivalent released. This is considerably less than some

"The biocarbon initiative has created an African voice, and that's very important when it comes to international negotiations."
**Peter Minang**




**Agroforestry systems can store carbon and yield a good profit at the same time. (ASB Policy Brief 11).**

of the current prices being payed for carbon, for example when traded under the EU's Emission Trading System. This means that relatively modest payments could deter farmers from clearing forests and at the same time encourage them to plant tree crops.

This could be particularly important in Africa. Between 1900 and 2005, more than 9% of Africa's forests were lost, at a rate of 4 million hectares a year. If this continues, greenhouse gas emissions from African agriculture could increase by more than 60% by 2030.

Preventing this, and helping African smallholders benefit from the carbon trade, is a key objective of the Africa Biocarbon Initiative, established by the Common Market for East and Southern Africa (COMESA). The World Agroforestry Centre is providing scientific evidence to support the initiative. "The initiative is helping African governments engage in climate-change issues in a way they never did before," explains Minang. "It has created an African voice, and that's very important when it comes to international negotiations."

During the past year, the World Agroforestry Centre convened 11 COMESA workshops, bringing together policy makers, scientists and other interested parties from the 19 member countries. Together, they developed a clear idea of what they wanted from the Copenhagen climate meeting: an agreement that takes decisive action to reduce emissions and increase carbon stocks not just on forest land, but on land used for other purposes as well.

### Getting the sums right

One of the reasons why agricultural landscapes have been excluded from the EU's Emission Trading System relates to the difficulties in measuring carbon stocks. "The argument is that it's possible to measure the amount of carbon in a large, uniform tree plantation in, say, Moldova," explains Jonathan Hasket, principal scientist at the World Agroforestry Centre, "but we don't know how to measure carbon stocks in a landscape where there is a mosaic of different land uses, and trees are scattered in blocks of different sizes and species."

This is all set to change. Scientists from the World Agroforestry Centre, the Center for International Forestry Research (CIFOR), Michigan State University and World Wildlife Fund (WWF) are developing a new system to measure, monitor and manage carbon in a diverse range of landscapes. The research is being carried out under the Carbon Benefits Project, funded by the Global Environment Facility (GEF) and the United Nations Environment Programme. The project includes research sites in Kenya, Niger, Nigeria and China.

GEF was particularly keen to fund the research as it will provide the sort of guidance it needs to calculate the carbon benefits of the development projects it funds. "Although we're still developing the system for measuring carbon in complex landscapes, GEF is interested in applying the system across a wide range of land use projects in its portfolio," says Hasket. "This project is putting an end to the idea that you can't measure carbon beyond large blocks of forests."

Combining remote sensing, infrared spectroscopy (see page 17) and rigorous statistical analysis, the research could remove one of the major barriers which prevents smallholder farmers engaging in the carbon market.

"This project is putting an end to the idea that you can't measure carbon beyond large blocks of forests."
**Jonathan Hasket**

## Further reading

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The domestication of high-value indigenous fruit trees like the African plum (*Dacryodes edulis*) is helping to raise farm incomes in Cameroon. (Charlie Pye-Smith)

# FRUITS FOR A BETTER FUTURE

The World Agroforestry Centre is playing a leading role in the domestication of indigenous fruit trees, a process that has the potential to improve the welfare of millions of smallholder farmers. The research is already helping to increase incomes, improve nutrition and enhance biodiversity.

If you'd come here 10 years ago, says Thaddeus Salah, a smallholder in north-west Cameroon, you'd have seen real poverty. "In those times," he says, "we didn't have enough to eat." But it wasn't just food that his family lacked. They couldn't afford school fees, healthcare and many other things.

Thaddeus's fortunes began to change in 2000 when he learnt how to identify the best indigenous fruit trees in the wild, and the techniques to propagate them in a nursery. "Domesticating wild fruit trees has changed our lives," he says. He now earns five times more than he did in the past and he's been able to pay school fees and renovate his house.

Thaddeus is one of many farmers in West Africa who have benefited from the participatory domestication programmes launched by the World Agroforestry Centre in 1998. This ongoing programme involves communities in the selection, propagation and management of high-value indigenous fruit trees. In 1998, there were just two farmer-run nurseries. There are now several hundred. Many of these nurseries have been supported by a small network of 'rural resource centres'. Besides establishing nurseries and demonstration plots, the centres have provided training for thousands of farmers like Thaddeus in a range of agroforestry practices. (See story pages 21 to 23).

"If you come back to north-west Cameroon in 10 years' time, I hope you'll see improved varieties of indigenous fruit tree and medicinal plant on every smallholding."
**Zac Tchoundjeu**

## Seeds of hope

Partnership – and farmers' participation – has been at the heart of a programme to domesticate Allanblackia, an indigenous African tree whose seeds contain an oil with properties that make it highly attractive to companies manufacturing food spreads such as margarine.

The benefits of the emerging trade in Allanblackia oil, derived so far from harvesting in the wild, are already being felt by some 10,000 smallholder farmers. "With the money I've made," explains Wallace Kimweri, a farmer in Tanzania's East Usambara Mountains, "I've been able to buy things I could never afford before." Last year he bought a cow for 160,000 shillings (USD 120). The profits from Allanblackia have also paid for iron sheets to re-roof his house and his childrens' school fees.

But there's a problem: there aren't nearly enough trees to satisfy demand. The solution lies in turning Allanblackia into a crop that can be planted on farmers' fields, and its domestication is one of the key activities of the Novella Project, a public-private partnership involving the World Agroforestry Centre, Unilever, the World Conservation Union (IUCN) and the Netherlands Development Organisation (SNV).

"Within 10 years, we're hoping African farmers will be growing 25 million Allanblackia trees," explains Tony Simons, Deputy Director General of the World Agroforestry Centre. The project aims to double the income of those involved with Allanblackia cultivation by 2017.

In 1998, there were two farmers' nurseries in Cameroon. There are now over 300.

"Over 10,000 smallholder farmers in Africa are benefiting from the trade in Allanblackia oil. Before long, millions could be."

## The Science of Success

"As a general principle, it is important to maintain genetic variation in the trees farmers plant," explains Ian Dawson, a Research Fellow with the World Agroforestry Centre. "With many species of fruit trees, for example, different 'genotypes' need to cross with each other if they are to produce fruit."

Measuring fruit size, colour, taste and so on enables researchers and farmers to understand the variation in important traits, but these observations describe only a small portion of the underlying genetic diversity in trees. However, by using biotechnology, and particularly molecular markers, the genetic diversity of a species can be revealed in full.

Molecular markers provide detailed information about how genetic diversity is structured within and among different stands of trees. "They are like lamp posts on the genome," explains World Agroforestry Centre scientist Ramni Jamnadass, "and if we use them wisely they can help us to safeguard useful genetic variation within species."

Molecular markers could prove particularly useful for tree-crop domestication programmes. In Cameroon, for example, their use enables scientists to establish the degree of variation within the populations which are currently being cloned for planting in farmers' fields.

"We need to do this to ensure that farmers plant a genetically diverse range of trees," explains Zac Tchoundjeu, Regional Coordinator for West and Central Africa. "If we don't, then inbreeding is likely to lead to lower productivity, and a lack of genetic variation could also make the trees more prone to diseases and other problems."

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By planting nitrogen-fixing trees, farmers can significantly boost their crop yields—in certain situations. (Stevie Mann)

# A GREEN SALVATION FOR POOR FARMERS?

We know that farmers can boost their crop yields by planting legumes that fix nitrogen in the soil, but a key question remains: which 'green fertilizers' work best, and under what conditions? An analysis conducted by the World Agroforestry Centre provides some answers.

In sub-Saharan Africa, cereal yields average about one tonne per hectare, and have barely risen in the past 30 years. In many countries, the situation is desperate. In Zambia, for example, 69% of smallholders can't afford to buy mineral fertilizers, and around a third of the area planted with maize is abandoned each year. Declining soil fertility, coupled with the high price of mineral fertilizers, is largely to blame.

But there is a low-cost remedy, and increasing numbers of farmers are benefiting from it. By planting green fertilizers – leguminous plants which draw nitrogen from the air to produce compounds which enrich the soil – farmers can restore fertility and increase yields.

Take, for example, Nelson Mkwaila, who farms a small plot of land near Blantyre, Malawi. "Ten years ago, I was lucky if I got one tonne of maize a hectare and I struggled to feed my family," he recalls. "Now I get three times that much, thanks to these plants." Mr Mkwaila is dwarfed not just by his maize, but by the *Gliricidia* bushes which grow between each row, acting as a fertilizer factory in his fields. Every year, before he sows his maize, he cuts back the *Gliricidia;* the leaves are incorporated into the soil and the woody stems provide fuel for the kitchen.

"If farmers are to benefit from these technologies, it's important that we understand the conditions under which these plants work best."
**Gudeta Sileshi**

## Sifting the evidence

In Mr Mkwaila's case, the fertilizer trees undoubtedly work. However, there has been considerable debate during recent years about the precise impact of woody and herbaceous legumes on soil fertility. "There's been a lot of research on individual sites, but we needed to explain the variations in yield under different treatments," explains Gudeta Sileshi, an agroecologist with the World Agroforestry Centre and senior author of *Evidence for impact of green fertilizers on maize production in sub-Saharan Africa*. "If farmers are to benefit from these technologies, it's important that we understand the conditions under which these plants work best."

The meta-analysis conducted by Sileshi and his colleagues looked at the findings of 94 peer-reviewed studies. The increase in maize yields using green fertilizers was compared with the increase using mineral fertilizer, and with the yields of maize cropped continuously without fertilizer. "In broad terms, the use of green fertilizers increases yields," explains Sileshi. The mean yield increase was highest at 2.3 tonnes per hectare for fully fertilized maize and ranged between 0.8 and 1.6 tonnes per hectare with green fertilizers.

The meta-analysis found that the type of soil affects the degree to which green fertilizers increase yields, with the response being highest on nutrient-poor soils, and lowest on nutrient-rich soils. This means that green fertilizers offer the greatest benefits on land with low to medium potential, which is typically worked by poor farming families.

## Tree of Life?

*Creating an Evergreen Agriculture in Africa* describes two farming systems that are helping to restore exhausted soils and increase yields. One is maize agroforestry. The other is conservation agriculture with trees. This involves minimum tillage, crop rotation, retention of crop residues and the planting of *Faidherbia albida*, a nitrogen-fixing acacia tree.

*Creating an Evergreen Agriculture* suggests that these two systems, when combined with one another, could benefit millions of farmers.

*Faidherbia* has the remarkable habit of shedding its leaves during the rainy season and regrowing them during the dry season, which means that it does not compete with food crops for light, water or nutrients. Its chief virtue lies in its ability to make large quantities of nitrogen available to nearby crops, dramatically improving their performance during the growing season. Recent observations in Zambia found that unfertilized maize yields in the vicinity of *Faidherbia* trees averaged over 4 tonnes per hectare, compared to 1.3 tonnes beyond the tree canopy. In Niger, the tree is much favoured by farmers for its fertilizing qualities, and is now grown on almost 5 million hectares of crop land.

Nevertheless, we still have much to learn about *Faidherbia* and its suitability as a green fertilizer. We need to know more about its hydrological impact, and its influence on the water table. Are there certain situations where it would be imprudent to grow the tree? Could there be pests and diseases associated with *Faidherbia* which could threaten crop production? And what, exactly, is the potential to expand its use on African farms?

The vision of *Creating an Evergreen Agriculture in Africa* is attracting considerable interest, not just in Africa, but elsewhere. Festus Akinnifesi, the World Agroforestry Centre's Regional Coordinator for Southern Africa, spoke on the subject at a special side event at the United Nations General Assembly, held in New York in September 2009. The World Agroforestry Centre is supporting an initiative to promote conservation agriculture with trees across the African continent, launched by the New Partnership for Africa's Development (NEPAD).

The use of green fertilizers significantly reduces the level of risk for farmers. In areas with low and erratic rainfall, green fertilizers reduce the likelihood of crop failure, with woody legumes making scarce water resources available to the maize crop. In areas which experience high rainfall and are prone to water-logging, green fertilizers improve the soil's absorptive capacity and mop up some of the excess water.

"Our analysis suggests there are also important synergistic effects when mineral fertilizers and legumes are used together," says Sileshi. Maize yields increase by 25-30% when farmers use half the recommended dose of mineral fertilizers in tandem with green fertilizers. However, adding further quantities of fertilizer does little to improve yields further.

"This is a really substantial piece of work," says Fergus Sinclair, global project leader for the World Agroforestry Centre's research on increasing farm productivity. "It shows that fertilizer trees can lead to significant increases in yields under the right conditions."

The meta-analysis also opens up a new area of research. It is all very well showing that there is a mean increase in crop yields associated with the use of green fertilizers, but we now need to know what causes the variations around the mean. "Once we have the answers to that," says Sinclair, "we will be able to refine the recommendations to farmers, and suggest which are the right legumes to use under which conditions."



**Malawian farmer Nelson Mkwaila has improved his maize yields by planting fertilizer trees like Gliricidia. (Charlie Pye-Smith)**

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Degraded soils mean hunger and misery. A better understanding of soil conditions will help farmers to improve their land (World Agroforestry Centre photo archive).

# SOLVING AFRICA'S SOIL CRISIS

Over 230 million people in sub-Saharan Africa are chronically hungry. Soil degradation and meagre crop yields are partly to blame. Unfortunately, efforts to improve soils have been hampered by a serious lack of knowledge about soil conditions. A new project, launched in 2008, is tackling the problem.

The population of sub-Saharan Africa has more than doubled since 1970, and it may double again in the next 30 years. Land holdings have steadily shrunk in size and many farmers, unable to leave their land fallow, grow the same food crops, year after year, on the same plot of land. The vast majority cannot afford mineral fertilizers to replenish their soils and the result has been severe land degradation, declining yields and malnutrition.

The African Soil Information Service (AfSIS), funded by the Gates Foundation and the Alliance for a Green Revolution in Africa (AGRA), will revolutionize our understanding of Africa's soils. The World Agroforestry Centre, one of four international research organizations involved in the project, is responsible for analysing and evaluating soil properties.

"For us, this is very exciting," explains the lead soil scientist, Keith Shepherd. "We are using soil surveillance principles which we helped to develop in West Africa and elsewhere, and infrared spectroscopy techniques which we've refined over the years in our laboratories in Nairobi." The Centre recently extended these techniques to include new x-ray and laser technology, maintaining the theme of only using light to rapidly analyse soils.

During the four-year project, tens of thousands of soil samples will be taken from at least 60 randomly selected sites, each

"Soil management must be dramatically improved if we are to reduce poverty, feed growing populations and cope with the impact of climate change on agriculture."
**Nteranya Sanginga**

measuring 100 square kilometres. The data will then be statistically modelled and combined with data from satellite images and other geographic databases, and a process of extrapolation will enable the scientists to create high-resolution maps that provide a picture of soil health across the whole of sub-Saharan Africa.

The maps will provide detailed information about the main constraints to crop productivity, such as a lack of phosphorus or a susceptibility to erosion. "We will also be able to make comparisons between undisturbed land and cultivated land, and come up with various indices of soil health," explains Shepherd. The project will provide information about the impact of cultivation on soil carbon stocks, and the carbon storage potential of different soil types. This could be particularly useful for countries negotiating deals which will reward them for sequestering or storing carbon as a measure to reduce the level of greenhouse gases in the atmosphere (see also pages 8 to 10).

During recent years, scientists working in Africa have developed a new approach to improving soil health, known as integrated soil fertility management, which combines the use of organic and inorganic fertilizers. However, a lack of information about soil health has proved a barrier to its adoption on a large scale. The information gathered by AfSIS will not only hasten its spread, but provide farmers, extension workers, agricultural ministers and others with information which will enable them to improve soil management, and in doing so tackle one of Africa's most pressing problems: hunger.



About **500 million** hectares of sub-Saharan Africa's agricultural land is moderately or severely degraded.

"Helping smallholder farmers increase their yields and incomes is one of the most important things the world can do to alleviate hunger and poverty."
**Rajiv Shah**

## Cheap, quick, accurate

Scientists at the World Agroforestry Centre are using infrared, x-ray and laser spectroscopic techniques to analyse soils. These are cheap, accurate and easy to use. The new instruments provide accurate information that greatly increases the likelihood of agricultural and development projects achieving their goals.

When used by research and development programmes, the surveillance approach eliminates the guesswork involved in matching improved agricultural technologies to specific soil types. Although the World Agroforestry Centre adapted the new analytical techniques to increase agricultural productivity, they can also be used to plan and monitor environmental programmes. For example, in East Africa infrared spectroscopy has been used to identify the source of pollution that threatens Lake Victoria.

"We are confident that within 10 years, soil laboratories in developing countries will be using the new spectroscopic techniques, and traditional methods using chemical extractions will become obsolete," says Keith Shepherd.

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Helping farmers to develop their marketing skills can do much to improving incomes. Indigenous fruits on sale in a market in Cameroon. (Charlie Pye-Smith)

# CRACKING THE MARKET CONUNDRUM

For many farmers, the biggest challenge lies not in growing crops, but in getting good returns. Limited knowledge about the market, inadequate processing facilities, poor roads and selling at the wrong time of year can all depress the prices farmers receive for their crops. But it needn't be like that, as a project in Cameroon has shown.

If you'd visited members of the Association pour le Développement Intégral des Exploitants Agricoles du Centre (ADEAC) five years ago, they'd have complained about the meagre prices they were getting for their 'njansang'. This had nothing to do with lack of demand for these aromatic kernels, harvested from the tree *Ricinodendron heudelotii*: most households in Cameroon use njansang to prepare soups and other dishes.

Today, you'll hear a very different story from the ADEAC farmers involved in njansang production. They are now getting an average 31% more for the kernels, and because they're harvesting more, they have seen an 80% increase in their revenues.

This change in fortunes can be largely attributed to an innovative marketing approach pioneered by the World Agroforestry Centre and its local partners. The Farmer Enterprise Development initiative, launched in 2003, helped smallholder farmers develop marketing skills, increase their on-farm production and improve their processing capacity. Over 400 njansang producers have benefited, along with some 250 farmers who harvest and trade kola nuts, which are popular stimulants in West Africa.

According to Charly Facheux, an economist with the World Agroforestry Centre, three distinct processes have enabled njansang and kola nut sellers to get higher prices. First, they have acted collectively to improve their bargaining power

Farmers are now getting 31% more for their njansang kernels.

and gain a better understanding of the markets. Second, microfinance provided by the initiative during the first year meant that farmers were no longer forced to sell their crops when there was a glut and prices were low. By taking out small loans, they could meet their daily needs and wait until the market improved before selling their njansang and kola nuts.

Finally, the farmers benefited greatly from more efficient methods of processing. One of the problems with njansang is that the kernel is hard to crack, and it can take 10 women up to 25 days just to produce a 50kg bag. The introduction of a cracking machine, developed by engineer Moucha, working in collaboration with the Centre and with input from njansang farmers, has dramatically improved processing capacity. Now, it takes just two days to get a 50kg bag of njansang, and farmers from other parts of the region are coming to ADEAC to take advantage of the machine.

The stepwise approach pioneered by the Farmer Enterprise Development initiative is now being used for other agroforestry tree products elsewhere in the country. "With the right training, and access to microfinance and better processing facilities, farmers can dramatically increase their incomes from tree crops," says Facheux.

## Better prices, better lives

In Cameroon, the World Agroforestry Centre is probably best known for its work on participatory tree domestication, which has encouraged farmers to plant superior varieties of indigenous fruit trees like njansang, bush mango and African plum on their fields. During the past three years, the number of farmers taking part in domestication programmes has grown dramatically, thanks largely to the Agricultural and Tree Product Program managed by the Centre.

The programme has also focused on improving the marketing of tree crops and medicinal plants in the west and northwest regions. Like the Farmer Enterprise Development initiative, it has shown what a dramatic difference efficient processing can make to rural communities. Take, for example, the experience of a women's self-help group in Bafut.

It used to take the women 72 hours to process raw cassava into 'garri', a popular food which looks like a finely ground breakfast cereal. Among other things, this involved the laborious use of a hand grater. "We had so many problems," recalls Magdalene Sirri, the group's secretary. "Some of us would get backache, and we frequently cut our hands with the grater. It also took so much time."

"With the right training, and access to microfinance and better processing facilities, farmers can dramatically increase their incomes from tree crops."

**Charly Facheux**

△ **A cassava processing project has enabled these women in Bafut, Cameroon, to dramatically increase their incomes. (Charlie Pye-Smith)**

In 2008, the income-generating activity officer with the Agricultural and Tree Products Program suggested to the women that they could increase their incomes, and save themselves a lot of effort, if they used a machine to process the cassava. They agreed, and the 35 members contributed 5000 CFA francs (USD 10) each towards the running of a processing machine that was donated by the project. Besides using it for their own cassava, the women are now operating as a business, processing cassava for farmers in the area. It now takes one day, not three, to make garri.

The machine has transformed the women's lives. "I make more money in a shorter period of time," says one woman, "and that means I can spend more time with my family." Another says she can now buy better clothes and household goods, without having to ask her husband for money. One of the younger members no longer depends on her parents for pocket money. "Before, my family used to eat very simply," adds Magdalene Sirri. "But now our diet is much better. I buy vegetables in abundance as well as beef and fish, something we could never afford in the past."

"Now our diet is much better. I buy vegetables in abundance as well as beef and fish, something we could never afford in the past." **Magdalene Sirri**


△ **A LAMIL notice tells farmers how much they will get for their produce—maize, rice, peanuts—in different markets on any given day. (Charlie Pye-Smith)**

## Information matters

The Landscape Management for Improved Livelihoods (LAMIL) project in Guinea, jointly managed by the World Agroforestry Centre and the Center for International Forestry Research (CIFOR), has had a profound influence on the management of four forest areas and at the same time improved the welfare of local people. Among other things, LAMIL helped farmers to gain a better understanding of the market by providing information about crop prices. Here, in a village near Kindia, farmers can see how much they will get for their maize, rice and peanuts on any given day at three different markets.

To read more about the LAMIL project, download the booklet:

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The nurseries of excellence (NOEL) project helped farmers in Tsunami-hit Ache, Indonesia, to raise over half a million tree seedlings.(James M. Roshetko)

# SCALING UP

Introducing agroforestry practices which improve lives in a village or a valley is one thing. Scaling them up so that they benefit tens of thousands of people, or even millions, across large landscapes and whole countries is quite another. Three very different agroforestry projects provide insights into how it can be done.

## Cameroon's rural resource centres

Towards the end of the 1990s, the World Agroforestry Centre helped to train some 50 extension workers in Cameroon's Ministry of Agriculture and Rural Development in the techniques associated with the domestication of indigenous fruit trees (see page 11).

"The training went well," recalls Ebenezar Asaah, a tree scientist with the World Agroforestry Centre, "but the project ended in failure." This was because the vast majority of those trained moved within a short period of time to other ministries and departments where their new-found skills were of little or no use.

"So we came up with a new strategy," recalls Asaah. "We'd noticed that some farmers' groups were doing great things, and we decided to work with them to establish a new way of providing training. That paved the way for the creation of a network of rural resource centres."

One of the best developed is Twanoh Mixed Farming Common Initiative Group (MIFACIG) in Cameroon's northwest region. Prior to the World Agroforestry Centre's arrival on the scene in 1998, MIFACIG operated a small tree nursery and provided training in beekeeping and one or two other activities to local farmers. Since then, it has been transformed into a major training and plant-production enterprise.

"Our main purpose is to transmit knowledge to the surrounding communities," explains Emmanuel Kuh, MIFACIG's coordinator. "We have trained over 2500 farmers in a range of different activities and we now have 35 satellite nurseries run by community groups."

"Our main purpose is to transmit knowledge to the surrounding communities."

**Emmanuel Kuh**

Training programmes cover beekeeping, pig husbandry, propagation of indigenous fruit trees, marketing and much more. There is simple accommodation for 30 visitors and a large training hall. Sales of planting materials now bring in an income of around 10 million CFA francs (USD 20,000). Profits are reinvested in the centre, and help to pay for the eight-strong workforce.

A decade ago, the vast majority of farmers in the area earned most of their income from the sale of coffee, a cash crop whose price has fluctuated wildly. Thanks largely to the training provided by MIFACIG and the World Agroforestry Centre, many are now planting other crops, such as improved varieties of African plum and cola. They are no longer at the mercy of the coffee market, and many have increased their income.

By early 2009, there were six rural resource centres in the west and northwest, with four more in the process of being created. During recent years, the centres have benefited from their association with the Agricultural and Tree Products Program funded by the United States Department of Agriculture and managed by the World Agroforestry Centre. An independent mid-term evaluation found that the programme was transforming the lives of some 8000 farmers and entrepreneurs. The rural resource centres have been central to the programme's success.

## Farmers lead the way in East Africa

In August 2008, Sarah Kawere, a smallholder in the Ugandan village of Namulaba, was recruited as a voluntary 'farmer trainer' by Jane Kugonza, a dissemination facilitator with the World Agroforestry Centre. In just two months, Sarah, a widow with four children, trained 20 local farmers how to grow better fodder crops and improve the nutrition of their dairy cattle. By using a high-quality feed on her own farm, she also increased her milk production by two litres per cow per day.

Mrs Kawere is one of some 300 farmer trainers who are playing a crucial role in disseminating information which is helping smallholder farmers to improve their milk yields. "This is one of the really innovative aspects of our work with the East Africa Dairy Development Project," explains World Agroforestry Centre scientist Steve Franzel. Funded by the Gates Foundation, and managed by Heifer international, the project aims to transform the lives of around 179,000 families in Kenya, Uganda and Rwanda by doubling their dairy incomes over the next 10 years.

Among the problems facing the region's smallholders are a lack of knowledge about efficient farming practices and weak market institutions. The decline in agriculture extension services in recent years is partly to blame, and the World Agroforestry Centre and its partners recognized that a new approach to disseminating information was needed.

When the project began, seven dissemination facilitators were recruited in the three countries. Their task is to train trainers such as Mrs Kawere. They provide them with information about suitable fodder and feeding strategies, and the trainees are then in a position to offer advice to other farmers. "The trainees are chosen by their peers, not on

**179,000**
families in Kenya, Uganda and Rwanda will benefit from this project.

Sarah Kawere (in pink) training other farmers how to grow better fodder crops. (Charlie Pye-Smith)

A community tree nursery. (James M. Roshetko)

the basis of their expertise, but on their ability to communicate with their fellow farmers," explains Franzel. Around 40% of the farmer trainers are women.

A number of factors motivate the trainers. They learn about the best farming practices, and therefore increase their own chances of getting better milk yields and a better income. Trainers are provided with seeds and planting material they give free of charge to farmers in their group, but which they can sell to outsiders. And farmer trainers like Mrs Kawere have noticed that their role as teachers improves their social status.

Farmer trainers have been used before, but their impact has never been properly documented. The East Africa Dairy Development Project will not only improve the welfare of around a million people; it will shed new light on the best ways of disseminating research on a large scale.

### Aceh's triumph over adversity

On 26 December 2004, Indonesia was struck by a Tsunami which killed some 200,000 people and displaced half a million. The worst-affected province was Aceh, which had already suffered from many years of armed conflict. The immediate impact on the environment was devastating. But the long-term implications were also troubling: displaced people swelled the local population of some areas, posing a serious threat to forests and farmland.

The Canadian International Development Agency responded by providing the funds for an agroforestry programme whose main aim was to establish 'nurseries of excellence' (NOEL). Managed by the World Agroforestry Centre and Winrock International, the two-year programme came to an end in April 2009. "It is a measure of the programme's success that we achieved far more than we set out to do," says Team Leader and Tree and Market Specialist James Roshetko from Winrock International / World Agroforestry Centre.

Roshetko and his colleagues worked with local farmers' groups, Islamic groups and non-governmental organizations to identify the species most favoured by farmers and provide training in nursery management, vegetative propagation and other techniques. The NOEL approach also involved collective action by communities to identify land rehabilitation objectives, and the setting up of work plans to achieve these.

By April 2009, 54 nurseries had been established. Of these, 24 were spontaneously established – they are known locally as *susalan* – by farmers' groups which had observed the programme's activities and seen the advantages of establishing their own nurseries.

Over 5200 individuals were directly trained by the NOEL programme, and just under 2500 benefited indirectly through informal training. During the programme, the nurseries raised over 550,000 seedlings – rubber, cocoa, durian, rambutan and mango being the most favoured species – with a commercial value of 6.4 billion Indonesian Rupiah (USD 660,000). Over 60 farmers trained by the programme are now providing training to other farmers.

As far as the availability of high quality germplasm is concerned, the situation is better than it was before the Tsunami. Throughout the years of conflict, most farmers got their seedlings in the neighbouring province of North Sumatra. Besides being expensive, these were of variable genetic quality. "Thanks to the NOEL programme, there's now a network of nurseries producing excellent material at a price local people can afford," says Roshetko.



550,000
seedlings raised by nurseries.

"We achieved far more than we set out to do."
**James M. Roshetko**

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Vibrant partnerships lie at the heart of the Amazon Initiative. Partners in Peru collaborating on a research project. (Tito Marcos)

# THE POWER OF PARTNERSHIP

Partnerships enable research institutions such as the World Agroforestry Centre to achieve much more than they ever would on their own. “With so much to do, and a relatively small number of scientists, the only way we can deliver our agenda is through partnerships,” explains August Temu, who runs the Centre’s Partnership Office in Nairobi. One of the most ambitious partnerships is guiding research activities in Latin America.

“We have invested five years of work helping to create the Amazon Initiative Consortium,” explains Roberto Porro, the World Agroforestry Centre’s Regional Representative for Latin America, “and this is now the framework under which we conduct all of our research.”

The Amazon Initiative, established in 2003, brings together six national agricultural research systems, four centres belonging to the Consultative Group on International Agricultural Research (CGIAR), and a host of other research institutes, universities, non-government organizations and civil society groups.

In 2008, the CGIAR approved the Amazon Eco-Regional Programme, which is hosted by the International Center for Tropical Agriculture (CIAT) and includes a coordination unit in Belém, Brazil. This operates under the umbrella of the Amazon Initiative, and shares the

About 100 partnerships are covered by formal agreements

same research priorities: mitigation and adaptation to climate change; the adoption of sustainable land-use systems in deforested and degraded areas; enhancing benefits from forests for both livelihoods and the environment; and adding value to Amazonian forest products.

"Our main activities during 2008 and 2009 involved the creation of the Amazon Livelihoods and Environment Network," explains Porro. The network is analysing how forestry, agroforestry and agricultural activities contribute to the well-being of over 100 Amazonian communities, as well as to environmental conservation.

A series of 12 regional workshops, whose purpose was to strengthen partnerships among organizations working in agroforestry, were convened by the World Agroforestry Centre and its partners under the banner of 'Amazon Agroforestry Alliances.' Researchers and practitioners were able to share experiences about different agroforestry initiatives and develop work plans for future collaborative research.

Around 85 scientists, most working for institutions that are members of the Amazon Initiative, contributed to a landmark study of agroforestry, edited by Roberto Porro. *Alternativa agroflorestal na Amazônia em transformação* – or 'The



"With so much to do, the only way we can deliver our agenda is through partnerships."
**August Temu**

## Breaking into the carbon market

Partnerships come in many shapes and sizes. Many of the most important involve scientists from the World Agroforestry Centre working with scientists from universities, national agricultural research institutes and forestry research institutes. However, our scientists also work with civil society groups and local communities. This is precisely what has happened with many of the projects which focus on Rewarding the Upland Poor for Environmental Services (RUPES).

A project in the Philippines, involving scientists and members of the Kalahan indigenous community, provides a good insight into the sort of partnerships established under RUPES. The main aim of the Philippines project has been to help communities develop small-scale agroforestry projects which will enable them to participate in carbon markets. The thinking is simple: in return for growing trees which sequester carbon, local communities could receive payments from companies that wish to offset their carbon emissions.

"We have provided assistance to the Kalahan in a number of ways," explains Rodel Lasco of the World Agroforestry Centre. "We have helped them to prepare the documentation required to gain access to the carbon market. We have linked them up with possible buyers of carbon, such as Mitsubishi. And we have provided guidance on how to measure carbon stocks." At present, the Kalahan are exploring ways of selling carbon both under voluntary agreements, and through the Clean Development Mechanism of the Kyoto Protocol.

But is this development or research? Both, says Lasco. On one hand, the Centre has provided practical guidance to the Kalahan. But there has also been a strong element of research, which has involved documenting the barriers which face community groups who are trying to gain access to carbon markets.

"At present, communities face a mountain of paperwork and bureaucracy and the transaction costs are prohibitively high," explains Lasco. Findings such as these, he says, should be taken into account when climate-change negotiators consider measures to Reduce Emissions from Deforestation and Degradation (REDD).
See page 8.

agroforestry alternative for an Amazon in transformation' – is a collection of peer-reviewed articles that illustrate current scientific knowledge about agroforestry and the opportunities and challenges for increasing agroforestry adoption in the region.

Another World Agroforestry Centre publication which was well received was 'A guide to carbon measurement for smallholders.' Aimed mainly at extension workers, the book provides practical guidance about how to measure carbon stocks and take advantage of the emerging carbon market.



**Partnerships with other institutions provide an excellent opportunity to make agroforestry science work for development. (World Agroforestry photo archive/Charlie Pye-Smith)**

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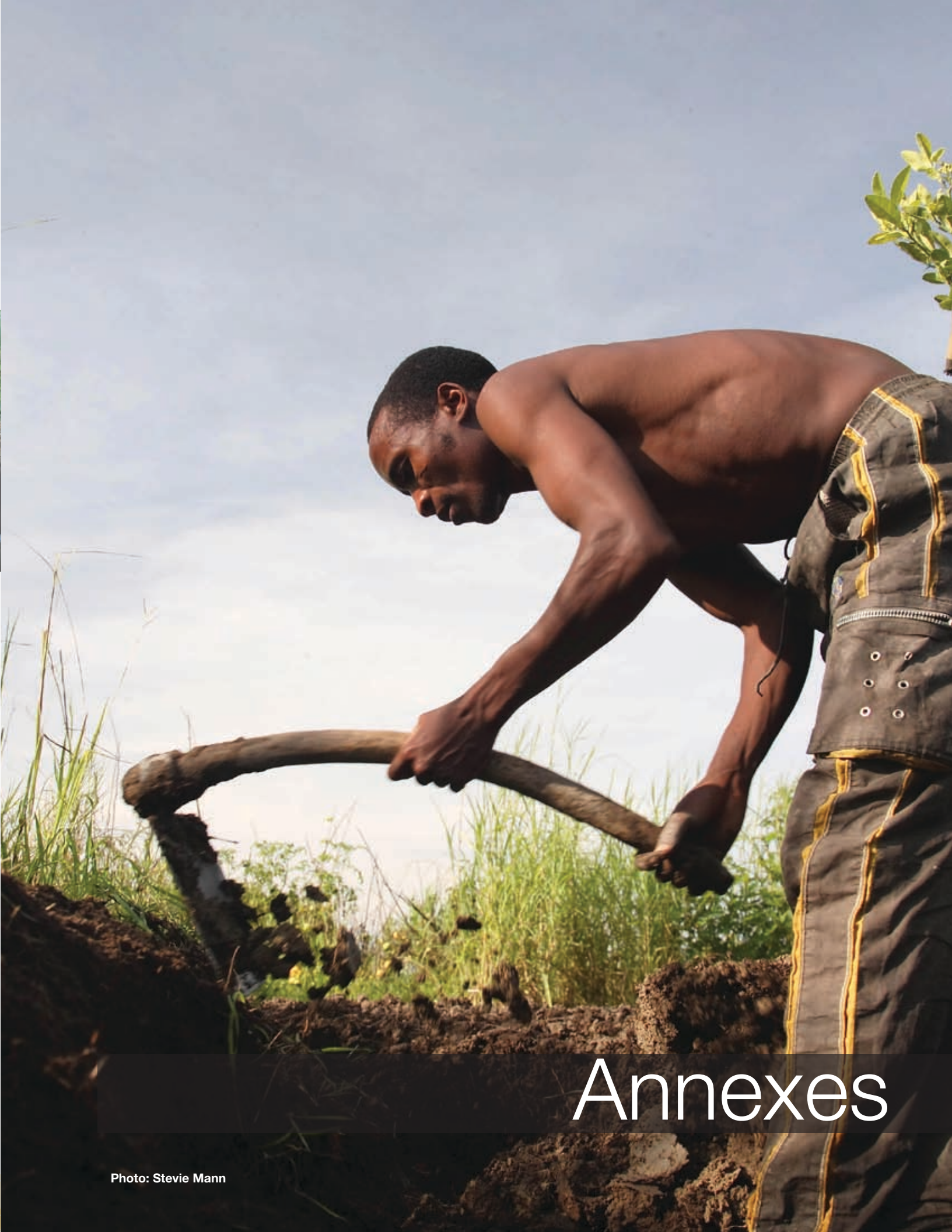

# Annexes

Photo: Stevie Mann

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World Bank *
European Union
Canada
Norway *
United Kingdom
Netherlands
Denmark
International Fund for Agricultural Development



ACDI/VOCA Rwanda
Africa Now
Africa Wildlife Foundation
AGEFO
Aid to Africa
Asia-Pacific Network for Global Change Research
Association for Strengthening Agriculture Research in Eastern and Central Africa
Australia
Australian Centre for International Agricultural Research
Austria
Belgium
Bill and Melinda Gates Foundation *
Bogor Institute of Agriculture
Brazil
CARE International
Centre for Biodiversity and Indigenous Knowledge
Centre for Cultural and Technical Interchange Between East and West, Inc
Centre for Mountain Ecosystem Studies
Centro International de la Papa
China
Comart Foundation
Conservation International Foundation
Cooperation of Common Fund for Commodities
Cornell University
Danish Centre for Forest, Landscape and Planning
Darwin Initiative
Dian Tama Foundation
Earth Institute - Columbia University
Finland
Food and Agriculture Organization of the United Nations
Ford Foundation
Forest Peoples Programme
Forum for Agricultural Research in Africa
Germany
Global Dimension Trust
Global Environment Facility
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Indonesia Palm Oil Board
Institute for Agricultural and Food Research and Technology (INIA) Spain
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International Plant Genetic Resources Institute
Internationale en Recherche Agronomique pour le Développement (CIRAD)
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Japan International Research Center for Agricultural Sciences
Katholic University Leuven
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Leibniz Centre for Agricultural Landscape Research
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Partnership for Governance Reforms in Indonesia
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SARCS Secretariat
Send A Cow Rwanda
South Africa
Spain
Sunshine Technology Group Limited
Swedish International Development Cooperation Agency
Swiss Development Corporation
Switzerland *
Syngenta *
Technical Centre for Agricultural and Rural Co-operation
Thailand
Tinker Foundation
Unilever
United Nations Development Programme
United Nations Environment Programme
United Nations Office at Nairobi
United States Department of Agriculture
University of Utrecht
Upland Development Programme in Southern Mindanao
World Conservation Union
World Food Programme
World Resources Institute
World Wildlife Fund

* Also contributes to CGIAR Gender and Diversity
* AWARD

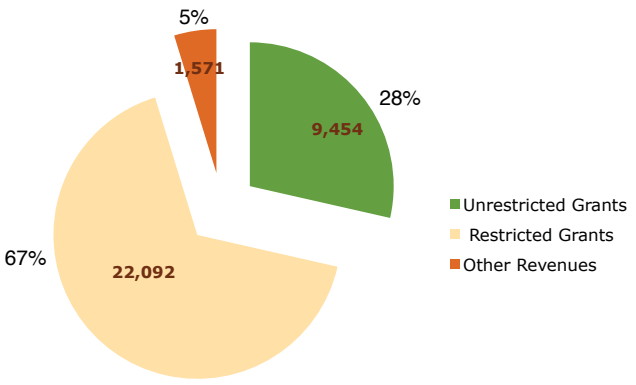
# Financial Highlights For the year ended 31 December 2008



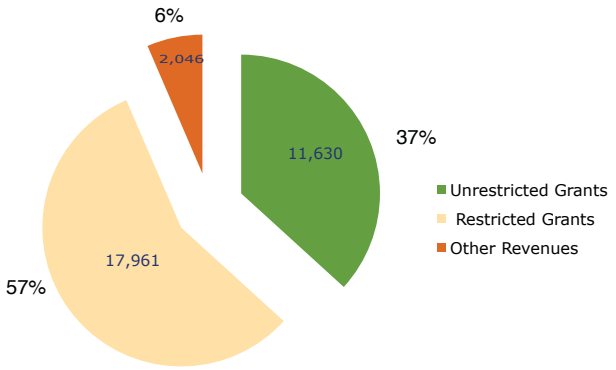
STATEMENT OF FINANCIAL POSITION (In US Dollars '000)

| | 2008 | 2007 |
|---|---|---|
| **ASSETS** | | |
| **Current Assets** | | |
| Cash and cash equivalents | 21,175 | 18,851 |
| Accounts receivable | | |
| Donor | 6,936 | 7,487 |
| Employees | 123 | 74 |
| Other CGIAR Centres | 476 | 576 |
| Other | 1,828 | 2,251 |
| Inventories - net | 103 | 91 |
| Prepaid expenses | 332 | 35 |
| Total current assets | 30,973 | 29,365 |
| **Non-Current Assets** | | |
| Property and equipment - net | 5,285 | 5,444 |
| **Total Non-Current Assets** | **5,285** | **5,444** |
| **TOTAL ASSETS** | **36,258** | **34,809** |
| **LIABILITIES AND NET ASSETS** | | |
| **Current Liabilities** | | |
| Accounts payable | | |
| Donor | 7,742 | 8,943 |
| Employees | 719 | 967 |
| Other CGIAR Centres | 302 | 177 |
| Other | 1,399 | 1,304 |
| Accruals | 3,471 | 3,669 |
| **Total Current Liabilities** | **13,633** | **15,060** |
| **Non-Current Liabilities** | | |
| Accounts payable | | |
| Employees | 3,862 | 4,020 |
| **Total Non-Current Liabilities** | **3,862** | **4,020** |
| **TOTAL LIABILITIES** | **17,495** | **19,080** |
| **NET ASSETS** | | |
| Unrestricted | | |
| Designated | 12,168 | 9,168 |
| Undesignated | 6,595 | 6,561 |
| | 18,763 | 15,729 |
| **TOTAL LIABILITIES AND NET ASSETS** | **36,258** | **34,809** |

## Income 2007 (USD)




## Income 2008 (USD)




STATEMENT OF ACTIVITIES (In US Dollars '000)

| | 2008 | | | | 2007 |
|---|---|---|---|---|---|
| | Unrestricted | Restricted | | | |
| | | Temporarily | Challenge Programmes | Total | Total |
| **Revenue, Gains and other Support** | | | | | |
| Grant revenue | 11,630 | 17,949 | 12 | 29,591 | 31,546 |
| Other revenue and gains | 2,046 | - | - | 2,046 | 1,571 |
| Total revenue and gains | 13,676 | 17,949 | 12 | 31,637 | 33,117 |
| **Expenses and Losses** | | | | | |
| Programme related expenses | 8,186 | 15,116 | 12 | 23,314 | 26,842 |
| Management and general expenses | 4,406 | 82 | - | 4,488 | 4,244 |
| CGIAR Gender and Diversity programme | - | 2,751 | | 2,751 | 1,575 |
| Sub total expenses and losses | 12,592 | 17,949 | 12 | 30,553 | 32,661 |
| Overhead cost recovery | (1,950) | - | - | (1,950) | (2,270) |
| Total expenses and losses | 10,642 | 17,949 | 12 | 28,603 | 30,391 |
| **Surplus for the year** | 3,034 | - | - | 3,034 | 2,726 |
| **Expenses by Natural Classification** | | | | | |
| Personnel cost | 6,662 | 5,170 | 7 | 11,839 | 12,441 |
| Supplies and services | 1,918 | 7,041 | 5 | 8,964 | 9,063 |
| Collaborators/partnerships | 552 | 2,811 | - | 3,363 | 4,206 |
| Operational travel | 912 | 2,559 | - | 3,471 | 3,636 |
| Depreciation | 598 | 368 | - | 966 | 1,045 |
| **Total** | **10,642** | **17,949** | **12** | **28,603** | **30,391** |

# Board Statement on Risk Management

The Board of Trustees and Management of World Agroforestry reviewed implementation of the risk management framework during 2008 and the Board is satisfied with the progress that has been made.

The Board of Trustees is responsible for ensuring appropriate risk management processes are in place to identify and manage significant current and emerging 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. Such risks include operational, financial and reputation risks inherent in the nature, *modus operandi* and locations of the Centre's activities. These risks 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:

- 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;
- failure 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;
- withdrawal or reduction of funding by donors due to the global financial crisis;
- potential negative impact of the CGIAR change management process in terms of funding or non-prioritization of agroforestry; 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 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 on risk assessments and analysis prepared by staff of the Centre's business unit, internal auditors, Centre-commissioned external reviewers and 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 is aiming for best practice, as documented in the codes and standards of a number of CGIAR member countries. The framework is subject to ongoing review as part of the Centre's continuous improvement efforts.

Risk mitigation strategies include 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 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 framework 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 to the Director General and the Board through its Audit Committee.

The Board also remains very much aware of 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

# Performance Indicators



**1.** Composite measure of Centre research publications: 6.5

**1A:** Number of externally peer-reviewed publications per scientist in 2008 that are published in journals listed in Thomson Scientific/ ISI: 2.13

**1B:** Number of externally peer-reviewed publications per scientist in 2008 (excluding articles published in journals listed in the Thomson Scientific/ ISI): 2.0

**1C:** Relative rating of Centre's best publications regarding journal impact factor: 2.37

**2.** Percentage of scientific papers that are published with developing country partners in refereed journals, conference and workshop proceedings in 2008: 45.67

**3:** SC assessment of Centre Outcome reports: 6.7

**4:** Composite Indicator on Centre Impact Assessment Culture: 72.0

## Institutional Health

**Governance**

**5A:** Summary score on governance checklist: 93.5

**5B**: Assessment of Board statements: 3.5

**Culture of learning and change**

**5C:** Summary score on culture of learning and change checklist: 65.2

**Diversity**

**5D:** Percentage of women in management: 33

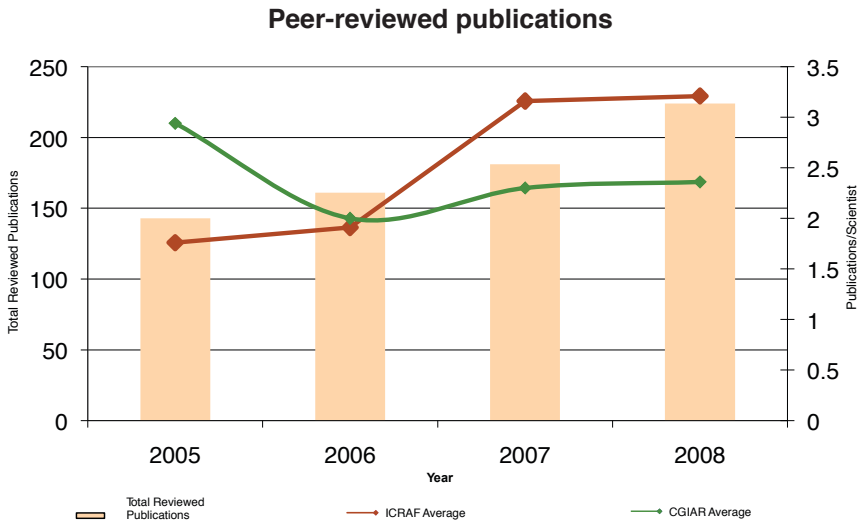
**5E:** IRS Nationality Concentration: First most prevalent nationality – UK, 5; Second most prevalent nationality, Belgium, Germany, USA, 4 each.

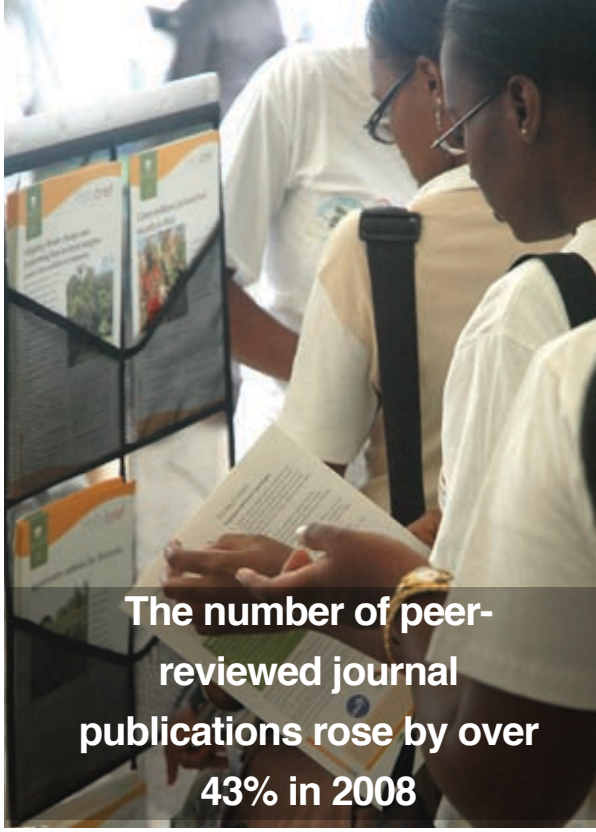
**Financial Health**

**6A:** Long-term financial stability (adequacy of reserves): 178 days where the minimum benchmark is 75 days.

**6B:** Cash Management on Restricted Operations: 0.7 where the benchmark is less than 1.0.

# Publications




# Selected Publications

### Occasional Papers

Sileshi G, Akinnifesi FK, Ajayi OC, Place F. 2009. *Evidence for impact of green fertilizers on maize production in sub-Saharan Africa: a meta-analysis.* Nairobi, Kenya: World Agroforestry Centre.

van Noordwijk M, Mulyoutami E, Sakuntaladewi N, Agus F. 2008. *Swiddens in transition: shifted perceptions on shifting cultivators in Indonesia.* Bogor, Indonesia: World Agroforestry Centre.

### Trees for Change

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.* Trees for Change no. 1. Nairobi, Kenya: World Agroforestry Centre.

Pye-Smith C. 2009. *Seeds of hope: a public-private partnership to domesticate a native tree, Allanblackia, is transforming lives in rural Africa.* Trees for Change no. 2. Nairobi, Kenya: World Agroforestry Centre.

Pye-Smith C. 2009. *Restoring lives and landscapes: how a partnership between local communities and the state is saving forests and improving livelihoods in Guinea.* Trees for Change no. 3. Nairobi, Kenya: World Agroforestry Centre.

### Books

Catacutan D, Neely C, Johnson M, Poussard H. Youl R. (eds). 2009. *Landcare: local action - global progress.* Nairobi, Kenya: World Agroforestry Centre.

Porro R. 2009. *Alternativa agroflorestal na Amazônia em transformação*. Brasília, DF: Embrapa Informação Tecnológica.

Holden ST, Otsuka K, Place FM. (eds). 2008. *The emergence of land markets in Africa: impacts on poverty, equity, and efficiency.* Washington, D.C. USA: Resources for the Future, Environment for Development.

Munjuga M, Ofori D, Sawe C, Asaah E, Anegbeh P, Peprah T, Mpanda M, Mwaura L, Mtui E, Sirito C, Atangana A, Henneh S, Tchoundjeu Z, Jamnadass R, Simons AJ. 2008. *Allanblackia propagation protocol.* Nairobi, Kenya: World Agroforestry Centre.

Snelder DJ, Lasco RD (eds). 2008. *Smallholder tree growing for rural development and environmental services: lessons from Asia.* Dordrecht, The Netherlands: Springer Science + Business Media B.V.

Temu A, Chamshama SAO, Kung'u J, Kaboggoza JRS, Chikamai B, Kiwia AM (eds). 2008. *New perspectives in forestry education.* Nairobi, Kenya: World Agroforestry Centre/ANAFE.

Thomas DE, Ekasingh B, Ekasingh M, Lebel L, Hoang MH, Ediger L, Thongmanivong S, Xu J, Sangchyoswat C, Nyberg Y. 2008. *Comparative assessment of resource and market access of the poor in upland zones of the Greater Mekong Region.* Chiang Mai, Thailand: World Agroforestry Centre.

### Film

World Agroforestry Centre (ICRAF). 2009. *Trees for Life.* (DVD).

### Policy Briefs

Mitigating climate change and transforming lives in forest margins: lessons from swiddens in Indonesia. World Agroforestry Centre Policy brief no. 1. http://www.worldagroforestry.org/af/publications/publicationsdetails?node=52041

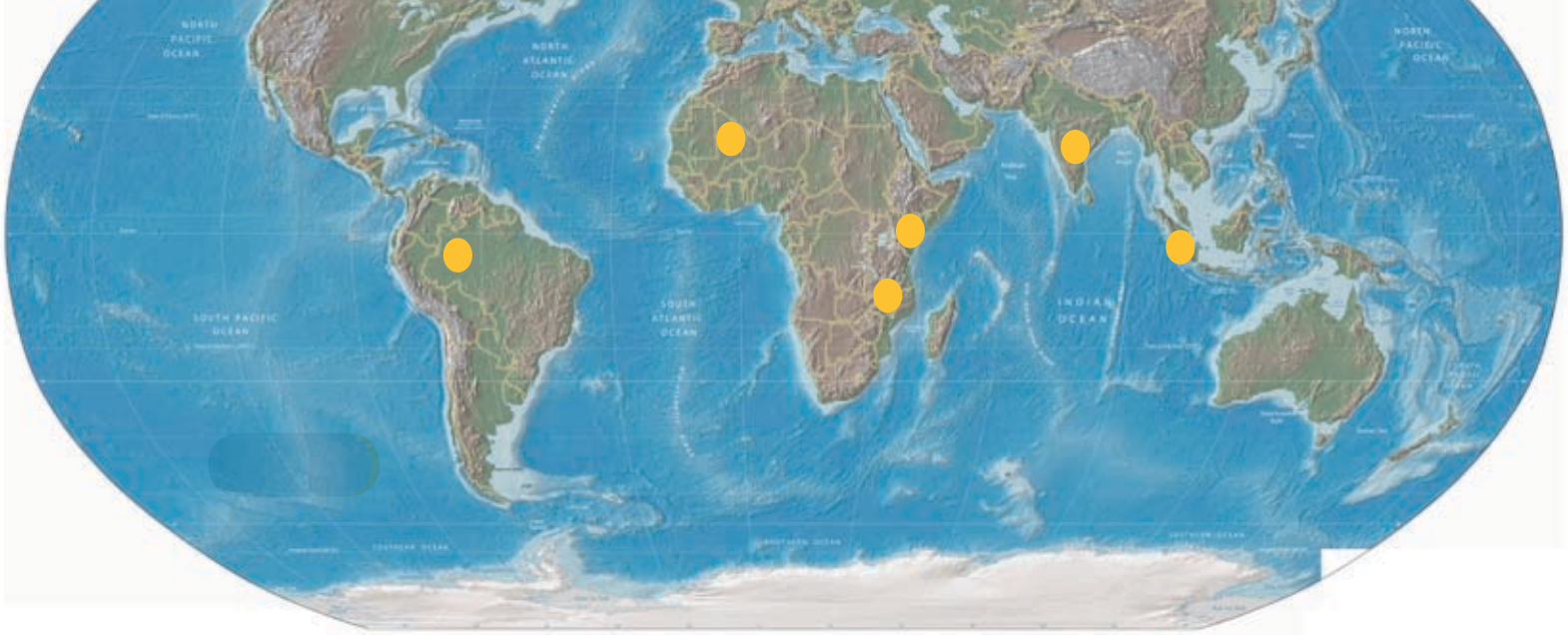
Green fertilizers can boost food security in Africa. World Agroforestry Centre Policy brief no. 2. http://www.worldagroforestry.org/af/publications/publicationsdetails?node=52039

Agroforestry options for Tanzania. World Agroforestry Centre Policy brief no. 3. http://www.worldagroforestry.org/af/publications/publicationsdetails?node=51936

The case for investing in Africa's biocarbon potential. World Agroforestry Centre Policy brief no. 4. http://www.worldagroforestry.org/af/publications/publicationsdetails?node=52023

Africa's biocarbon interests - perspectives for a new climate change deal. World Agroforestry Centre Policy brief no. 5. http://www.worldagroforestry.org/af/publications/publicationsdetails?node=52024

*For a comprehensive list of publications, visit our publications page: www.worldagroforestry.org/af/publications*



# Our Offices


**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: j.mowo@cgiar.org

**Kisumu Office**
PO Box 25199, Kisumu, Kenya
Telephone: +254 57 2021234
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: s.muhuro@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

**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: +62 251 8625415
Via USA: +1 6508336665
Fax: +62 251 8625416
Via USA: +1 650 833 6666
Email: u.p.pradhan@cgiar.org

**Philippines Country Office**
2nd Fl., Khush Hall Bldg.
International Rice Research Institute
Los Baños, Laguna, Philippines
PO Box 35024, UPLB, College,
Laguna 4031
Philippines
Telephone: +63 2 845 0563/70/75
ext. 2544/2657/2860
Telefax: +63 49 536 2925
Email: icrafphi@cgiar.org / r.lasco@cgiar.org

**Vietnam Country Office**
Dr. Hoang Thi Minh Ha
ICRAF-CIFOR Vietnam representative
17T5 Trung Hoa - Nhan Chinh
Apartment 302, Hanoi, Vietnam
Tel/Fax: +84 4 62510830
Email: m.h.hoang@cgiar.org
icraf-vietnam@cgiar.org

**Thailand Country Office**
Faculty of Social Sciences
5th Floor, Chiang Mai University
PO Box 267, CMU Post Office
Chiang Mai 50202
Thailand
Phone: +66 5335 7906 or 5335 7907
Fax: +66 5335 7908
Email: dthomas@cgiar.org

**China**
**Beijing Office**
#12 Zhongguancun Nan Da Jie
CAAS Mailbox 195
Beijing 100081 China
Telephone: +86 10 82105693
Fax: +86 10 82105694
Email: J.C.Xu@cgiar.org
cmes-icraf@mail.kib.ac.cn

**Kunming Office**
Centre for Mountain Ecosystem Studies
C/o Kunming Institute of Botany,
3/F, Library Building
Heilongtan, Kunming, 650204
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
Telephone: +265 1 707 332/ 319
Fax: +265 1 707 319
Email: f.akinnifesi@cgiar.org

**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
Mobile +255 718533661
Fax: +255 22 2700090
Email: a.kitalyi@cgiar.org

**Uganda**
African Highlands Initiative
Kawanda Agricultural Research Institute
(KARI) Campus
P.O Box 26416, Kampala - Uganda
Tel. +256 414 220 602
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: z.tchoundjeu@cgiar.org

**Cameroon**
Humid Tropics Node
P.O. Box 16317, Yaounde, Cameroon
Telephone: (+237) 22 21 50 84
Bamenda: (+237) 33 36 28 90
Fax: (+237) 22 21 50 89
Email: icraf-aht@cgiar.org

**Upper Guinea Node**
BP 5841, Conakry, Guinea
Telephone: (+224) 6219 3326 / 6405 1775
Email: icraf-wca@cgiar.org

**Sahel Node**
BP E5118, Bamako, Mali
Tel: (+223) 2023 5000 / 2022 3375
Fax: (+223) 2022 8683
Email: icraf-wca@cgiar.org

**Democratic Republic of Congo**
**ICRAF**
**Country Office**
c/o INERA
Avenue des cliniques No 13,
Commune de la Gombe
Kinshasa/RDC
Telephone: +243 817762807
/897943806
Email: a.biloso@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**
C/o Rubber Research Institute of
Nigeria (RRIN) Iyanomo, P. M. B. 1049
Benin City, Edo State, Nigeria
Telephone: +234-8033197241 / +234-8054047996
Email: richgilnd@yahoo.com

**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

**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

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