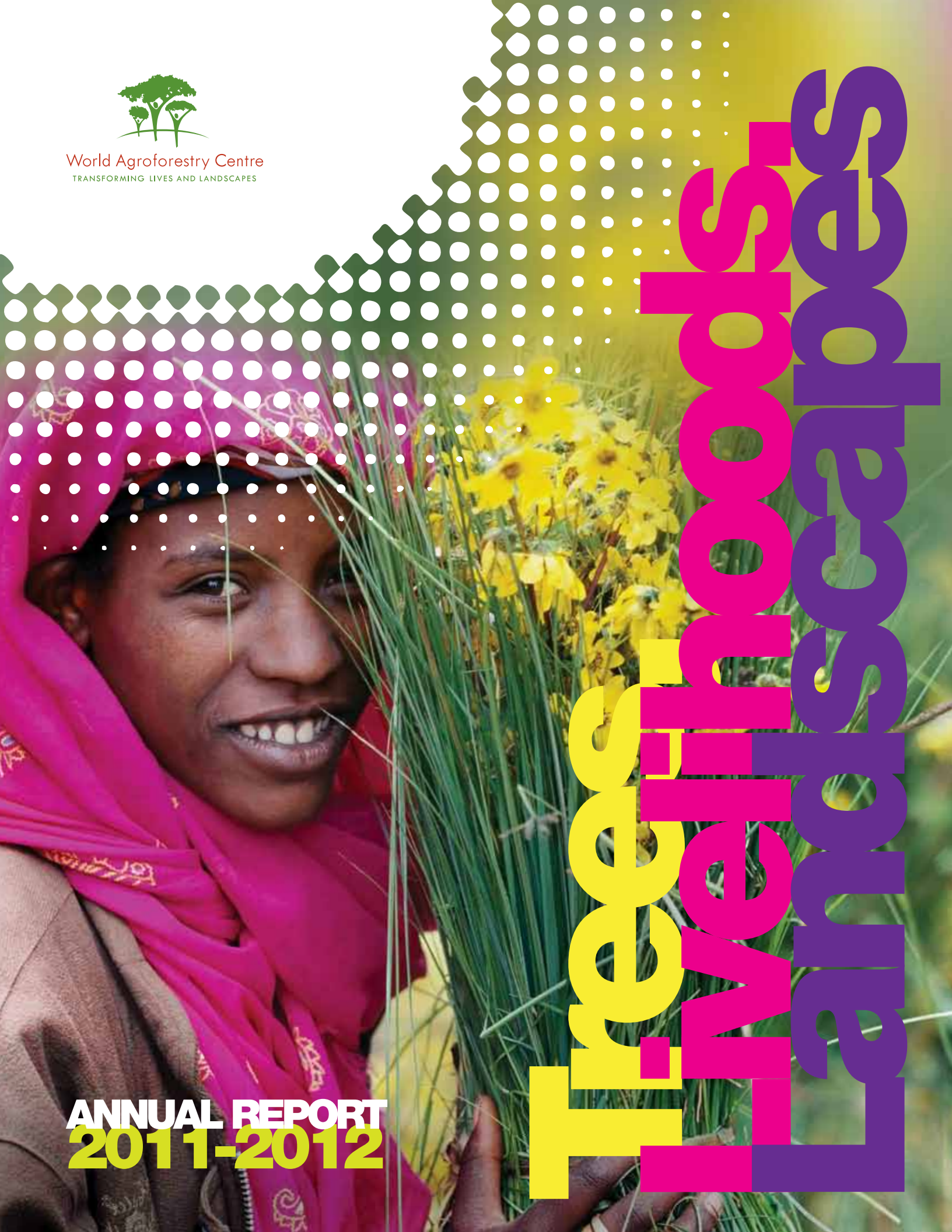
World Agroforestry Centre
TRANSFORMING LIVES AND LANDSCAPES

Trees in livelihoods landscapes



ANNUAL REPORT 2011-2012

Our Vision

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

To generate science-based knowledge about the diverse roles that trees play in agricultural landscapes, and 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
- Mutual respect
- Creativity

Our Focus

We put particular emphasis on four areas in our work:

- Accelerating impact
- Enhancing science quality
- Strengthening partnerships

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Message from the Chair

Agroforestry – growing trees on farms – can help nations and communities tackle some of the most pressing challenges we face, from climate change to food insecurity, from declining soil fertility to the need to provide a sustainable source of energy. Agroforestry's importance is now widely recognized, thanks in part to the pioneering research conducted by the World Agroforestry Centre.

During the course of 2011, the Centre experienced some notable changes in personnel. Tony Simons replaced Dennis Garrity as Director General in October. We established a new Senior Leadership Team, and recruited a new Deputy Director General of Research and Director of Administration. We also recruited a new board member from Peru.

From an institutional point of view, the Centre remains in excellent health. Our reserves, when expressed in operating days, are the highest of any centre operating within the CGIAR system and we closed the year with a surplus. The Board approved a new programme of work and a budget of US$54.2 million for 2012, almost US$3 million of which will be devoted to establishing new science positions. This will strengthen our research capacity.

We are proud of the great strides made by the Centre in its efforts to communicate its research findings, both within the world of science and beyond. In 2011, our scientists were responsible for 229 publications, over half of which appeared in peer-reviewed journals. An external review of our publications concluded that we are doing well, but could still do better.

I would also like to commend the communications team for the excellent use it has made of the World Wide Web. Over a two-year period, between April 2010 and April 2012, the number of web visits to our site increased more than fivefold. Only two other CGIAR centres are ranked ahead of us in terms of 'webometrics'.

During the course of the year, Tony Simons and his team embarked on a strategy refreshment exercise. Our four strategic goals remain the same. We seek to operate as efficiently as possible, produce high-quality science, foster partnerships with a wide range of organizations, and conduct research which has a strong impact.

Eric Tollens
Chair of the Board of Trustees

On the whole, our future is bright. The challenge now is to keep the momentum going, and strive to do even better along the research–development continuum. The growing worldwide interest in agroforestry makes the activities of the Centre all the more relevant and pertinent for the future of agriculture. In fact, we are now at the heart of the movement to promote 'climate-smart agriculture'. Our refreshed strategy, currently in the making, will reflect the new realities and help us to face new challenges and opportunities.

> "...we are now at the heart of the movement to promote 'climate-smart agriculture'."

Message from the DG

The only thing that is constant is change. A truism surely embodied in the exciting period of 2011-2012 for the World Agroforestry Centre. The start of 2011 marked the programmatic beginning of the much heralded CGIAR reforms. This was when the first of 15 CGIAR Research Programmes (CRPs) became operational and marked a new way of doing business for us and for all our sister CGIAR centres. The World Agroforestry Centre is actively engaged in seven of the 15 CRPs and most significantly within the Forest, Trees and Agroforestry CRP. Here it is partnering with the Centre for International Forestry Research (CIFOR) and others in an impactful collaboration to progress the science, promotion and value of woody landscapes. Although the early stages of the CGIAR reform were marked by high transaction costs, we are now starting to see the transaction benefits with substantially more inter-centre joint work. One of the most interesting manifestations of this is the sentinel landscapes with the prospect for co-located, long-term research and development across woody landscape transacts.

At the governance level of the CGIAR the appointment of a strong troika of Rachel Kyte (Chair of the Fund Council), Jonathan Wadsworth (Fund Office) and Frank Rijsberman (Consortium CEO) augurs well for greater profile, resources and impact.

Change at our Centre was punctuated by the appointment of myself as the fifth Director General taking over from Dennis Garrity's successful decade at the helm. Dennis' legacy was much celebrated by our Board and staff over a period of several months and fortunately is not complete as he graciously accepted a Senior Board Fellowship to write up his recent thinking and advance the

concept of Evergreen Agriculture. This was soon given an even more elevated platform when he was appointed as a United Nations Drylands Ambassador.

Leadership transitions can be tumultuous times for organizations but our Centre staff and Board of Trustees have rallied to ensure the wobbles are kept to a minimum whilst allowing latitude to adapt to new opportunities and directions. Supporting us in this transition has been the arrival of two new senior directors, namely: Ravi Prabhu (Deputy Director General, Research) and Stella Kiwango (Director of Administration).

The research and development outputs and outcomes reported in this year's report underlie our approach to science for development. In research there are two types of knowledge – things it would be nice to know and things you need to know. In this publication, our research teams have documented the way that the latter type is achieved. Specifically the exciting work around six areas of scaling up, water, climate adaptation, soil health, targeted tree interventions and value addition is portrayed. Read the stories covering each of these areas and see just how agroforestry is transforming lives and landscapes.

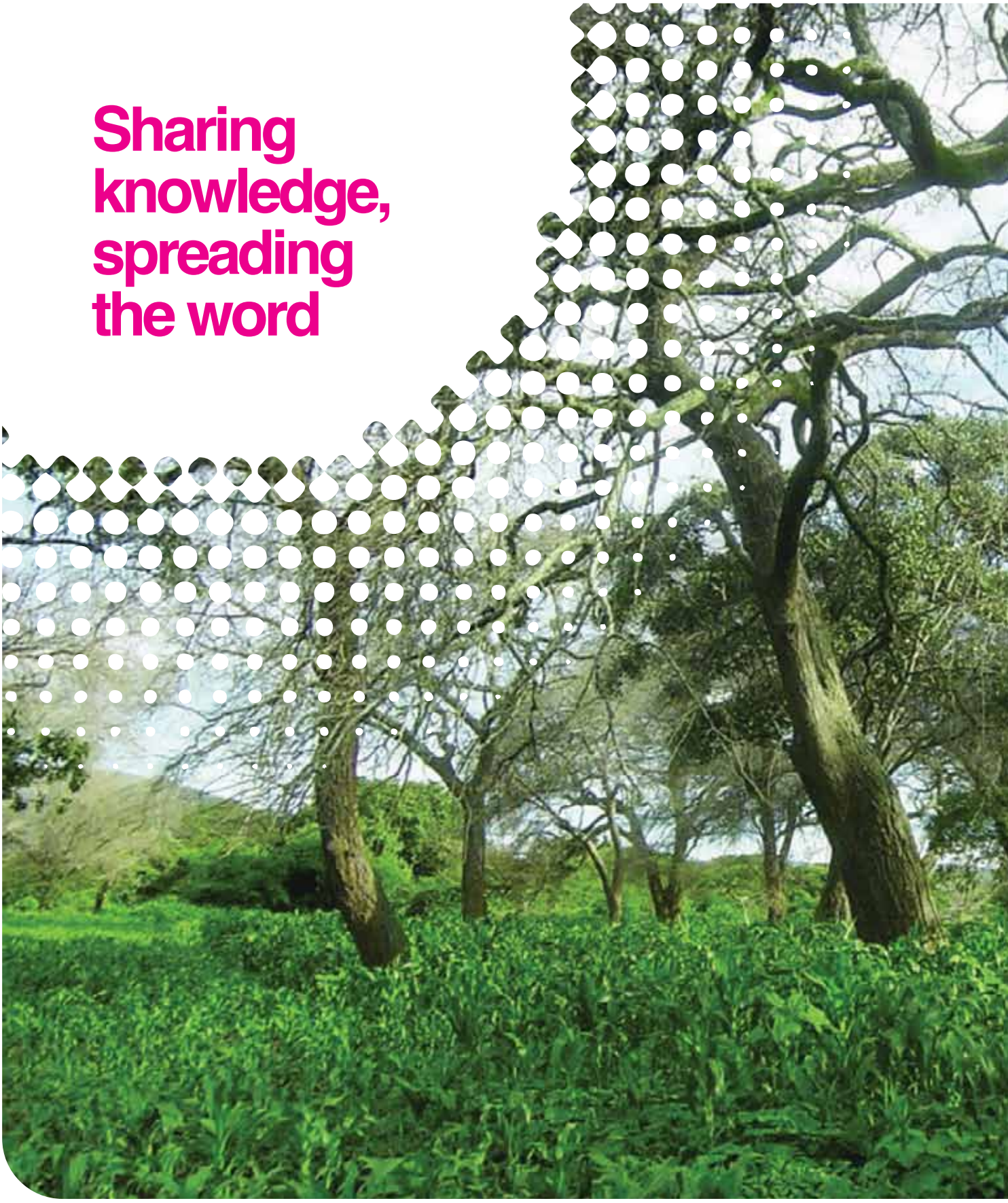
Tony Simons
Director General

With a changing CGIAR architecture, changing Centre leadership and a changing global context for our work, we have also decided to embark on refreshing our current strategy (2008-2015). Towards the end of this year we will produce a revitalized document primarily for our staff to align behind a strengthened focus on our Centre's strategic goals. Discussions with staff, investors and partners are underway to validate much of our existing work and highlight new areas for attention. This may include more work on tree genomics, landscape management, bioenergy, farmer institutions, proof of application, tree crop development and climate smart agriculture.

The decade ahead of us anticipates further change with post Rio +20 processes, multilateral successor to the Millennium Development Goals (MDGs) and initiatives to define measure and promote sustainable agricultural intensification.

The Board, management and staff of the World Agroforestry Centre are well positioned to contribute to producing international public goods, robust evidence, actionable knowledge, capacity development, proof of application and facilitating partnerships in support of these changes. We also count on your continued support.

Sharing knowledge, spreading the word



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TIME FOR AN EVERGREEN AGRICULTURE?

These are desperate times for farmers in many parts of Africa, where the yields of staple crops have barely risen over the past 30 years. However, two practices offer a significant ray of hope: agroforestry and conservation agriculture.

Research by the World Agroforestry Centre has demonstrated that agroforestry can improve livelihoods, restore degraded soils and raise crop productivity. Conservation agriculture, which involves disturbing the soil as little as possible, keeping the soil covered with organic matter and rotating crops, has also helped African farmers to increase their crop yields and incomes. Put agroforestry and conservation agriculture together and you get 'evergreen agriculture' – a practice which could transform the fortunes of millions across sub-Saharan Africa.

So what's preventing farmers from adopting evergreen agricultural practices? And how can they be encouraged to use the technologies associated with evergreen agriculture? These are among the questions which a major three-year research project, 'Towards an Evergreen Agriculture in Africa', seeks to answer. "For evergreen agriculture to be successful, we need to establish precisely what practices are required for a range of different agro-ecological zones and farming practices," says Dennis Garrity, former Director General of the World Agroforestry Centre and recently appointed United Nations Drylands Ambassador. By June 2011, scientists were able to reflect on progress made during the first year of the project.

Baseline studies at five sites in Kenya, Tanzania and Rwanda provided insight into everything from the sort of crops and livestock favoured by farmers to their access to extension services, their productivity and incomes, and their knowledge about agroforestry and conservation agriculture.

In some areas, such as Meru in Kenya, smallholders have planted large numbers of trees on their farms, with the majority being exotics such as *Grevillea* and eucalyptus. "We found that farmers considered indigenous species more useful when it came to improving crop productivity, but there were relatively few indigenous trees on their farms," says Jonathan Muriuki, the project coordinator. "The main reason was that they

had poor access to good-quality seeds and seedlings." Much the same was true of Machakos, another site in Kenya. At both sites, the researchers found that farmers' knowledge about conservation agriculture was poor or non-existent.

At one site in Tanzania, many farms had reasonable numbers of *Faidherbia albida,* a tree which possesses qualities of huge significance for evergreen agriculture. *Faidherbia* sheds its nitrogen-rich leaves during the rainy season, providing farmers with a free source of nutrients for their crops. Research suggests that by growing *Faidherbia* and practising conservation agriculture, farmers can increase their crop yields by a factor of three or more. However, although they realized the significance of these trees, Tanzanian farmers were doing little to ensure their regeneration.

"From our initial research, it was clear that farmers need much better access to good-quality seeds and seedlings, especially of indigenous species," says Muriuki. "It's also important to improve farmers' knowledge about how to use and manage indigenous trees and adopt technologies that promote evergreen agriculture."

The Centre and its partners have begun to establish the measures needed to improve access to good-quality seeds, based on the model of Rural Resource Centres, developed by the World Agroforestry Centre in Cameroon. The centres will be linked to a network of satellite nurseries, set up in local schools. During the next phase of the project, nursery owners and teachers will receive training on the benefits of evergreen agriculture, which they will be able to share with farmers. At the same time, the project will provide training to government extension agents.

The project aims to directly improve the livelihoods and incomes of 6000 smallholder farming households through the introduction of evergreen agriculture. Just as importantly, it will provide insights into the best way of disseminating information about evergreen agriculture, and a body of knowledge about which practices are most appropriate for different agro-ecological zones.

A man with a mission

Soon after Dennis Garrity retired from the World Agroforestry Centre, after serving 10 years as Director General, he was appointed UN Drylands Ambassador. The honour was in recognition of his achievements in raising the profile of agroforestry during a lifetime's work in Africa, southeast Asia and beyond. He has been a tireless promoter of 'evergreen agriculture,' and retirement has done nothing to diminish his energy, his breadth of vision, and his belief that agroforestry – and agroforestry research – has the potential to improve the welfare of smallholder farmers.

"It will be my duty to inform the wider community about the great successes in regenerating drylands around the world," said Garrity, who accepted the honour during the 10th session of the Conference of the Parties on the United Nations Convention to Combat Desertification (UNCCD), held in Korea in October 2011. "Most poor people can dramatically increase their food production through evergreen agriculture, agroforestry and farmer-managed natural regeneration."


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A NEW APPROACH TO AN OLD PROBLEM?

After more than a decade of engagement in the humid highlands of eastern Africa, the African Highlands Initiative commissioned a team of independent experts to assess its impact in the communities and institutions where innovations were designed and tested. Their findings were encouraging. The initiative, an eco-regional research programme of the Consultative Group for International Agricultural Research (CGIAR), had improved local livelihoods, increased crop yields, improved water quality and reduced conflict.

Convened by the World Agroforestry Centre (ICRAF) and the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA), the initiative was launched in 1995 to test a range of different practices to improve management in areas suffering from degradation and poverty. "There had been various attempts to introduce technologies to tackle problems such as soil erosion and low yields, but they'd largely failed as farmers had been reluctant to adopt them," says Jeremias Mowo, the World Agroforestry Centre's Regional Coordinator for Eastern Africa and co-editor of a new book, *Integrated Natural Resource Management in the Highlands of East Africa – From Concept to Practice.*[1]

In its later year, the initiative focused on six sites in Uganda, Tanzania, Ethiopia and Kenya. In these areas, rapid population growth and inheritance systems which led to progressively smaller landholdings had led to poor land management. Crop yields and incomes were declining; soil erosion and water pollution had become serious problems; and rising inequality had led to a proliferation of predominantly latent conflicts.

From the outset, the World Agroforestry Centre and its partners adopted a multidisciplinary approach to their research. Just as importantly, they promoted learning processes which encouraged everyone – scientists, farmers, extension agents, local government officials, NGOs – to work together to develop strategies to improve local livelihoods and management practices.

[1] *Integrated Natural Resource Management in the Highlands of East Africa – From Concept to Practice,* edited by Laura German, Jeremias Mowo, Tilahun Amede and Kenneth Masuki. Earthscan, 2012.

Making hard work worthwhile

"In addition to improving livelihoods and sustainable land management, one of our principal aims was to get farmers to use practices they had previously rejected, largely because they considered them too labour intensive," says Mowo. In some areas, farmers had also resisted certain technologies on cultural grounds. The colonial authorities had coerced their ancestors into carrying out soil conservation practices; little wonder they viewed them with suspicion now.

The researchers needed to find ways of making these practices more attractive, and they developed a number of approaches. One linked farmers' preferred enterprises with the activities or technologies they had previously resisted. For example, researchers convinced farmers who were keen to plant high-value crops that even the best varieties would only fulfil their potential when they improved their soil conservation practices. Farmers soon accepted that the hard work they put into building terraces and planting boundary hedges was worthwhile. As their crop yields increased, so did their incomes.

The researchers also looked for 'strategic entry points'. In Tanzania, for example, farmers wanted to get hold of improved germplasm for bananas, and in all the study areas farmers were keen to gain access to credit, something few had received in the past. The researchers agreed to make this possible, provided the farmers were willing to adopt better land management practices.

In subsequent phases of the project, innovations were introduced at the landscape, district and institutional levels. While solutions often required the participation of all households, some were more negatively affected by current land uses, or more likely to benefit from interventions, than others, creating a challenge for 'collective action.'

"By acknowledging that costs and benefits to different households vary, and fostering negotiations to identify solutions acceptable to all parties, site teams were able to solve previously intractable problems as diverse as inequitable technology access, crop destruction from pests and excess runoff, degradation of springs and waterways and boundary conflicts," says Laura German, one of the editors.

During the course of the project, the researchers published over 200 peer-reviewed journal papers, books and book chapters, policy briefs, methodology guides and programme reports. *Integrated Natural Resource Management in the Highlands of East Africa* brings the main findings together.

The African Highlands Initiative provides an excellent example of research institutions working closely together – precisely as envisaged under the new CGIAR Research Programmes – and doing so within a learning process involving farmers and others. The World Agroforestry Centre collaborated with six other CG centres, as well as scientists from a range of national agricultural research institutes in Ethiopia, Kenya, Madagascar, Rwanda, Tanzania and Uganda. "Without such close collaboration, and without a multidisciplinary approach to the research, we could never have achieved so much," says Mowo.


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LAND OF MILK AND MONEY

Some two decades ago, the World Agroforestry Centre and its partners began research on fodder trees in East Africa. They identified species that farmers could grow as a source of protein for their dairy animals, and conducted research on how to grow them and where they grew best. By 2006, the use of protein-rich fodder trees and the introduction of improved breeds had enabled some 200,000 smallholder farmers – most with just one or two cows and perhaps a few goats – to increase their milk yields and incomes. Dairy farming was proving to be one of the best pathways out of poverty for hill farmers with modest holdings.

Since 2008, the World Agroforestry Centre has been in charge of the feed and feeding system component of the East Africa Dairy Development (EADD) project, which is managed by Heifer International and funded by the Gates Foundation. The project aims to double the income of 179,000 small-scale dairy farmers in Kenya, Uganda and Rwanda over a ten-year period.

“We’ve been using an approach which we developed during our long-term research on fodder shrubs, which involves disseminating knowledge and technologies by using farmer trainers,” explains Josephine Kirui.

There’s nothing unusual about the use of farmer trainers, but most agricultural extension programmes select farmers on the basis of their technical expertise. The EADD project has taken a different approach. “Our research shows that about 40% of farmers who have technical expertise are not good disseminators – that is, they are not effective networkers and communicators,” explains Steven Franzel, an agricultural economist with the World Agroforestry Centre. “We therefore seek farmers who have both sets of skills.” Under the EADD project, suitable candidates are identified by the local Dairy Farmers Business Associations (DFBAs) – cooperatives with up to 10,000 members – and the World Agroforestry Centre.

The number of farmer trainers has risen steadily, from 262 in 2008 to 2520 by December 2011. Just under 40% are women. The trainers establish demonstration plots where they can show visiting farmers a range of practices – the use of fodder shrubs, methods of making silage, how to mix feeds and so forth – which will improve the diet of dairy animals and raise milk yields. By the end of 2011, EADD had provided information and training about feeds to 159,000 farmers. “As a result, many dairy farmers have significantly increased their milk yields and incomes,” says Kirui (See box: Philemon’s story).

The project has also helped 18 DFBAs to develop plans which will enable their members to improve their feeding strategies and increase the supply of milk to DFBA chilling plants. This has been done through collaboration between the World Agroforestry Centre and the International Livestock Research Institute (ILRI), using software known as FEAST, the Feed Assessment Tool. During 2011, the project also helped DFBAs to improve their capacity to stock high-quality fodder seeds and distribute them to farmers.

Farmers after a training on the use of fodder.

Philemon's story

Before the East Africa Dairy Development (EADD) project came into his life, Philemon Bomett, a farmer in Kenya's Rift Valley, used to get around five litres of milk a day from each of his four cows. Now, they yield up to 29 litres a day. This dramatic increase can be attributed to his new feeding strategy, adopted after he received training from the EADD project. He has established four acres of Rhodes grass and two acres of Columbus grass. He also makes hay and silage for dry-season feeding, and has set up an enterprise which sells Columbus grass seed.

Profits from the dairy enterprise and the sale of grass seeds have enabled Philemon to pay university fees for one of his children and establish a 900-layer poultry unit. He was recently elected by his local Dairy Management Group to represent them as the area director for Tanyikina Dairy Ltd. In short, the EADD project has changed his life.

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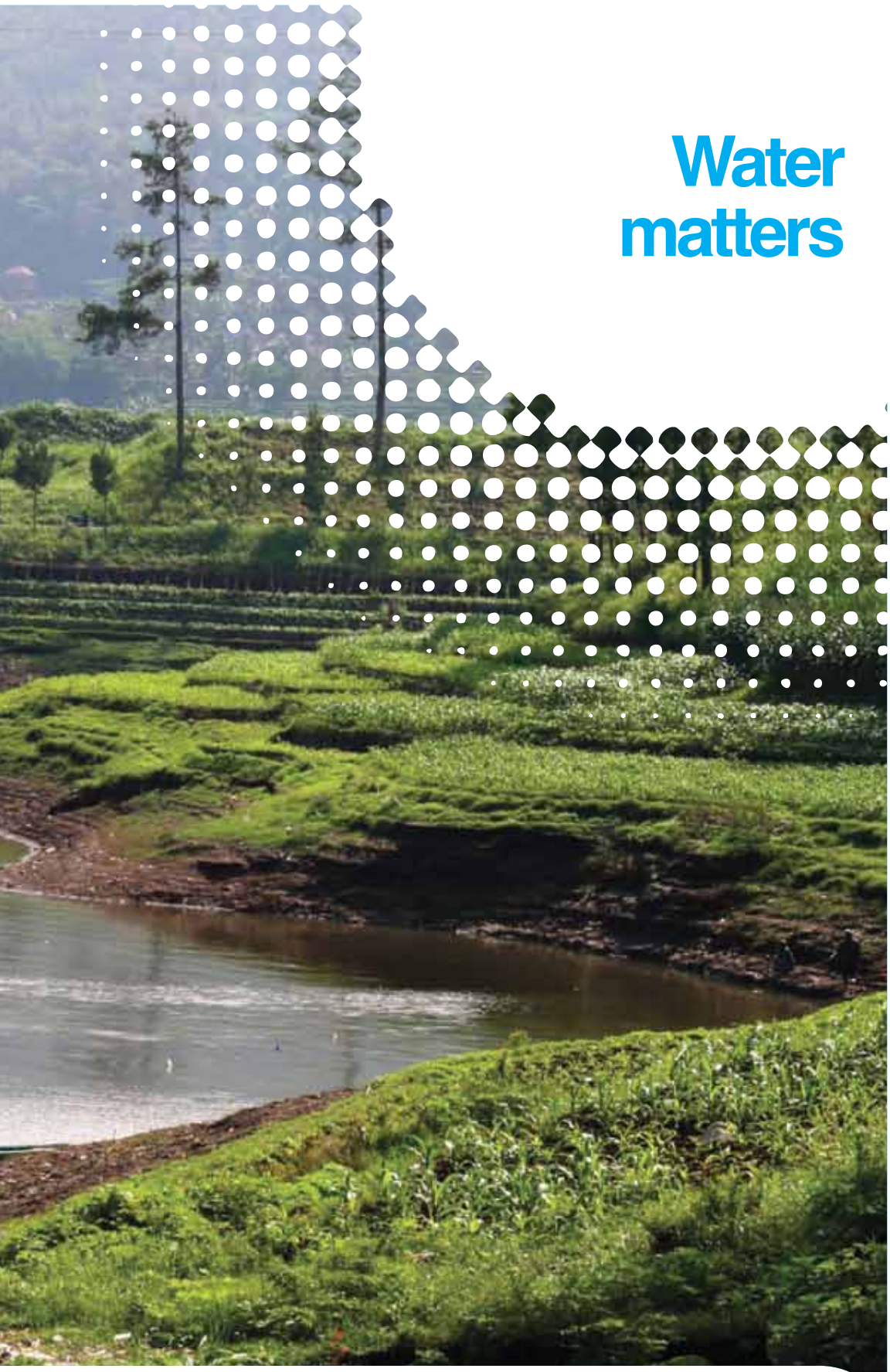
Water matters



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DAMMED IF YOU DO; DAMMED IF YOU DON'T

During recent years, the World Agroforestry Centre has expanded its portfolio of research activities in China; scientists in the China office have also begun to develop major research projects beyond the country's borders. In recognition of this, the Centre established the 'China and East Asian Node' in 2011. This will serve as a base for research programmes throughout the region, from North Korea west to Pakistan, from Outer Mongolia south to the Mekong Delta.

In 2011, scientists from the Centre conducted a range of research projects along the length of the Mekong River, one of the world's last large rivers to remain largely undammed. "What we're trying to do is think in terms of the health of the entire river basin," says Jianchu Xu, the Centre's coordinator for the China and East Asian Node.

Few issues prove more controversial than the building of major dams, especially in China and East Asia. It came as little surprise, then, that there was considerable outcry when the Lao People's Democratic Republic petitioned the Mekong River Commission (MRC) to begin the formal process of approving the first of 11 proposed dams across the Lower Mekong.

In a series of high-profile policy papers, published in *Science and Frontiers in Ecology and the Environment,* Jianchu and Edward Grumbine, a Chinese Academy of Sciences senior research fellow at the Kunming Institute of Botany, provided a detailed overview of the impacts the dams could have.

At present, the Lower Mekong flows through an area which suffers from high levels of poverty and meagre economic development. Hydropower development could generate significant quantities of power and the means to foster economic growth and reduce poverty. The 11 dams could also generate some US$3.7 billion a year in revenue, much of which would go to the dam operators and investors.

However, the dams would also have significant impacts. Among other things, they would lead to the reduction of inland fisheries, flood riverside gardens, and significantly reduce the flow of nutrient-rich sediment onto the agricultural floodplain. "This would damage the livelihoods of hundreds of thousands of people in Cambodia and Laos," says Jianchu. "In our papers, we have sought to argue that it is important to consider


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the negative impact of dam construction, as well as the advantages."

Jianchu and Grumbine put forward a number of proposals to improve river-basin planning. These include strengthening the Mekong River Commission as a regional forum for discussing transboundary issues; improving the sharing of knowledge between countries and institutions; and enhancing transparency and the participation of local people in decision-making processes.

This is a story which still has a long way to run. However, the paper in *Science* undoubtedly had an impact. The decision on whether to give the go-ahead for the 11 dams was deferred, and the article contributed important information to ongoing ministry-level dialogues between the Lower Mekong countries.

There are problems upstream too

Scientists from the World Agroforestry Centre have continued their research on the impact of monocultural rubber plantations in south-west China's Yunnan Province, in the middle reaches of the Mekong River. According to Jianchu, the expansion of rubber could be every bit as devastating for the environment as the hydropower dams planned for the Lower Mekong. The conversion of natural forests to rubber threatens biodiversity, and may lead to a reduction in the forests' carbon biomass. Rubber expansion could also have serious consequences on the region's hydrology.

The Mekong River rises on the Tibetan plateau and flows through Yunnan, parts of which have seen substantial tree-planting activity during recent years. This is the source of considerable pride for the Chinese Government, which has pledged to increase the country's total area of forest by 40 million ha over the next decade. "This sounds impressive, but we risk failing to see the wood for the trees," says Jianchu.

He points out that most of the planting comes from an increase in tree crops such as fruit, rubber and eucalyptus – not from the regeneration of natural forest. Furthermore, the government has established massive tree plantations, including some on the Tibetan Plateau in areas where forests never previously grew.

"When it comes to protecting the topsoil in these areas, perennial grasses with their extensive root systems are far more effective than the new plantations, many of which are filled with exotic species," says Jianchu. Maintaining these plantations also requires considerable resources, with irrigation water being brought long distances by tractors. "It all comes down to planting the right trees in the right place," says Jianchu. His analysis of China's tree-planting efforts was published as an opinion piece in *Nature.*

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REVIVING THE ANCIENT PRACTICE OF HARVESTING WATER

Fly over certain drought-prone districts in Rwanda and you will see scores of small dams, their water glinting in the sun. These are part of a new wave of development which is helping farmers increase their agricultural production and incomes. Small-scale rainwater harvesting is now firmly on the agenda in a growing number of countries, thanks in part to research and advocacy programmes conducted by the World Agroforestry Centre and its partners.

“Rainwater harvesting is an ancient practice, but until recently most governments in Africa largely ignored these initiatives and focused their attention on creating large, centralized water-supply systems,” explains Malesu Maimbo of the World Agroforestry Centre. These have benefited urban populations and industry, but done little to improve the welfare and productivity of rural communities.

Between 2002 and 2007, a World Agroforestry Centre programme funded by the Dutch government helped to establish large numbers of rainwater harvesting schemes in sub-Saharan Africa, and created considerable awareness about their potential. However, it failed to bring about any significant change in thinking among governments and policymakers. A second phase of the programme – ‘Improved Capacity in Rainwater Management for Sustainable Development’ – was launched in 2008.

“Our objective was to provide the evidence needed to show governments and others why rainwater harvesting is so important,” says Maimbo.

The programme, which was jointly managed by the World Agroforestry Centre and the Delhi-based Centre for Science and Environment, focused on Ethiopia, Kenya, Rwanda, Malawi, Zambia and India. Three new ‘best-practice scaling-up sites’ were established and support was providing for two existing ones. These acted as a stimulus for wider investment in rainwater harvesting by governments, the private sector, NGOs and local communities.

The programme also targeted policymakers, the media and others by presenting case studies at workshops,

conferences and international forums. The result: more governments are now funding rainwater harvesting schemes either from their own budgets or with loans from the Africa Water Facility, a fund established by the African Ministers' Council on Water (AMCOW).

Progress has been particularly impressive in Rwanda, where Maimbo and his colleagues helped the Ministry of Agriculture and Animal Resources to research and draft the Irrigation Master Plan. This recognizes the importance of small-scale rainwater harvesting. With technical support from the Centre and funding from the ministry, 85 farm ponds were established across 10 districts in drought-prone regions. Since then, over 1500 more have been created. These have helped farmers irrigate their crops during the dry season and increase crop yields.

"This is not an isolated success story," says Maimbo. "Increasing numbers of countries now recognize that small-scale rainwater harvesting projects represent not only the best way of utilizing scarce resources, but one of the best ways of improving food security." Small dams and farm ponds can also play a key role in helping farmers to establish agroforestry ventures.

Small-scale rainwater harvesting is firmly on the agenda of a growing number of countries.

Coping with the climate

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TAKING THE HEAT OUT OF FARMING

Until recently, farmers have found it almost impossible to take advantage of the carbon market, which is based on organizations or individuals selling the carbon they capture – for example, through planting trees – to countries or companies which wish to offset their own carbon emissions.

According to Pal Singh, the World Agroforestry Centre's Regional Coordinator for South Asia, there are a number of obstacles preventing smallholders from taking advantage of the carbon market. "They can't produce the minimum volume required to enter the market," he says. "Their landholdings are small and scattered, and they conduct all sorts of diverse activities to feed themselves and make a living, and that makes measuring carbon stocks a complicated business." Furthermore, the costs of registering projects, drawing up contracts and monitoring stocks are prohibitively high for smallholders acting alone or in small groups.

To get round these problems the World Agroforestry Centre devised a project – 'Enabling smallholders to improve their livelihoods and benefit from carbon finance' – which was launched in 2009. A mid-term evaluation of the project was carried out by the World Bank and India's National Agricultural Innovation Project (NAIP) in 2011. According to the evaluation, the project is well on the way to becoming one of the largest and most successful schemes of its kind.

With field sites in Andhra Pradesh, Orissa, Rajasthan and Uttrakhand, the carbon project has encouraged large groups of smallholders to adopt activities which are helping farmers to improve their yields and incomes – and, at the same time, either reduce their emissions or sequester carbon. By mid-2011, over 5000 farming households were adopting a range of measures that fell into three main categories: planting trees to sequester carbon; switching to agricultural practices that reduce emissions, such as ploughing crop residues back into the soil rather than burning them; and reducing energy consumption by using fuel-efficient stoves and energy-saving compact fluorescent light (CFL) bulbs.

"At the household scale, these measures may sound trivial," says Singh. "But when you add together the activities of many thousands of farming families, they become highly significant, both for the environment and the farmers."

In Andhra Pradesh, for example, it is estimated that farmers could save the equivalent of 11,500 Certified Emission Reductions (CERs) per year. Assuming a value of US$5, households within the grid would receive over US$55,000 a year – a huge sum of money in a remote tribal area. But even if they don't, all the farmers interviewed for a 'Trees for Change' booklet which tells the story of the project – Taking the heat out of farming – said they would continue to adopt measures that reduce their carbon footprint because they make financial, as well as environmental, sense.

One of the strengths of the project is that nothing other than technical advice has been given free of charge. Farmers who receive fuel-efficient stoves or CFL bulbs or tree seedlings pay a share of the costs, generally around 50%. Money raised this way is placed in the bank accounts of organizations, run by villagers, which have been established to handle all the financial aspects of carbon management.

The mid-term review found that the project was well on the way to achieving its key objectives. These included testing and validating the SMART-CDM protocol, designed to ensure that projects can take advantage of the Kyoto Protocol's Clean Development Mechanism (CDM); establishing pilot sites in different ecological zones; and creating a skilled pool of scientists and technicians trained in all matters related to the carbon market.

A number of companies – including Danone, the Ambuja Cement Foundation and Sony have expressed an interest in buying carbon credits from the project. International donors have also been impressed and the German agency GIZ recently commissioned a similar scheme, to be managed by the World Agroforestry Centre, in a heavily degraded, drought-prone part of Rajasthan.

"The way the carbon project works, taking a grid of the thousand hectares or more with 700 or 800 households, makes a lot of sense to us," says Sanjay Tomar of GIZ. "If you focus intensively on one area, you can have a real impact, and that's what we're hoping will happen in Rajasthan."

Financing carbon schemes for Kenya's smallholders

2011 saw the launch of a major, long-term project which seeks to address growing food insecurity and land degradation in the Nyando River catchment in western Kenya. The project will explore how carbon finance can be used to enhance farm productivity and help small farmers to become more resilient to climate change. Conservation agriculture and agroforestry are among the measures which could help farmers take advantage of the carbon market.

The first phase of the project, which was launched by CARE Kenya and the Climate Change, Agriculture and Food Security (CCAFS) programme of the CGIAR, is focusing on developing a methodology, using action research with 1000 farmers. The second four-year phase will expand activities to more than 10,000 households, and the third phase should reach 100,000 households, with carbon finance covering a substantial part of the cost of sustaining and expanding the project. The World Agroforestry Centre is providing technical advice.

COPING WITH CLIMATE CHANGE

If farmers are to adapt to climate change, they will need to know what crops they should plant in future. Climate change is likely to lead to increases in temperature, changing patterns of rainfall and more extreme droughts and floods. This, in turn, could lead to dramatic changes in patterns of land use. While some farmers are likely to benefit – for example, from longer growing seasons – there will be large numbers of losers too.

Research conducted by the World Agroforestry Centre on the impact of climate change on crop production in two counties on the shores of Lake Victoria, Kenya, provides some intriguing insights about possible options for farmers over the coming century.

Predicting change is never easy, but it was all the more difficult in this case by the lack of quantitative data – a familiar problem throughout sub-Saharan Africa, according to the World Agroforestry Centre's modelling expert Eike Luedeling. There were no long-term weather records for Busia and Homa Bay counties; climate-change predictions for the region were scarce. There was also very little information about soil quality, the crops grown locally and how they are managed. This meant that Luedeling had to use a series of 'best-bet proxy datasets'. From these he developed a data-processing framework to predict crop yields for specific places and specific times under a range of different climatic scenarios.

"I had to make a number of assumptions, not just about the way the climate will change, but also about soil quality and crop management," says Luedeling. "However, I believe that the results still provide some useful pointers for decision-makers and farmers about the sort of crops that could be grown – and should be grown – in these parts of Kenya in the future."

The main climatic factor responsible for predicted yield losses of certain annual crops was an increase in temperature, rather than any changes in rainfall. Temperature is the climate parameter that is most predictable, with all models agreeing that it will rise substantially over the next century throughout the study region. According to Luedeling, the most promising strategy for reducing crop vulnerability involves breeding for heat tolerance and introducing drought-tolerant crops and varieties. This could be particularly important for maize, the staple food crop.


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The research also suggests that establishing multi-layer agroforestry systems could be a promising option, as temperatures under an open tree canopy can be several degrees cooler than under full sunlight. “As long as competition between trees and crops for water and nutrients can be controlled, these systems, which are already to be found in the study area, could be highly beneficial for future generations of farmers,” says Luedeling. In short, agroforestry could play a key role in helping farmers adapt to climate change, and at the same time sequester significant quantities of carbon dioxide, the main gases responsible for global warming.

According to Luedeling’s projections, changes in the climate could increase the suitability of much of the study area for the growing of mango, pineapple, banana and several other perennial crops. So the picture is far from bleak.


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The best strategy for reducing crop vulnerability involves introducing drought-tolerant crops and varieties.

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SEEING THE WOOD FOR THE TREES

Deforestation accounts for approximately 15% of greenhouse gas emissions, so reducing the rate at which forests are cleared will help to cut emissions which contribute to global warming. Hence the current focus on reducing emissions from deforestation and forest degradation – or REDD+.

Several years ago, scientists from the ASB Partnership for the Tropical Forest Margins at the World Agroforestry Centre pointed out that in many countries it would make greater sense to reduce emissions from all land uses (REALU). This is because forest-related emissions often occur outside areas which are institutionally defined as forests, and are therefore unlikely to be accounted for under current national REDD policies.

"We have consistently argued that an approach to reduce emissions from all land uses would be much more effective than one that only focuses on areas defined as forest," says Peter Minang, who leads the ASB Partnership, a consortium of over 90 international and national organizations focusing on the forest/agriculture margins in the humid tropics.

Scientists from the ASB Partnership began to make the case for REALU at the 14th Conference of the Parties to United Nations Framework Convention on Climate Change (UNFCCC) in Poland in 2008. "Since then, the debate has moved on, and it's now widely accepted that REDD mechanisms are only likely to work if we take the landscape approach that we've been advocating," says Minang. Indeed, during Forest Day 5, a side event co-organized by the World Agroforestry Centre during the United Nations Climate Change Conference held in Durban in 2011, there were two sessions devoted entirely to the subject. This suggests that REALU has now become part of mainstream thinking.

Minang concedes that the landscape approach to reducing emissions is not without difficulties. For example, it is harder to measure carbon stocks in a mosaic of different habitats – forests, fields, orchards, marshland, scrub – than in forests alone. However, the advantages of the landscape approach outweigh the disadvantages, and the case is persuasively made in *ASB Policy Brief 26: Agroforestry in REDD+: Opportunities and Challenges.*

Many of the activities which lead to deforestation relate to activities, or resource needs, beyond the forest margin, such as mining, farming and the demand for fuelwood and building timber. Addressing these 'drivers of change' should be part of any emission-reduction strategy. At the same time, it is clear that agroforestry has the potential to reduce emissions from forest degradation by increasing the production of on-farm timber and fuelwood, especially where there is restricted access to forests or a limited supply.

However, planting trees, or preventing trees from being felled, is not enough on its own. "It's important that countries introduce policy reforms which include incentives that encourage tree-based enterprises that can enhance the role of trees outside areas which are strictly defined as forests," says Minang. The ASB approach is already finding favour in Indonesia, where the government has introduced a comprehensive strategy to reduce emissions from land-use activities. The World Agroforestry Centre is working closely with local government departments to design emission-reduction strategies which will help the country to fulfil its commitments.

Trade matters

During recent years, countries such as China, Vietnam and Costa Rica, have significantly increased the proportion of land under forest. A cause for celebration, you might think, as an increase in forest cover implies a reduction in carbon emissions related to land-use change. But there's a catch: these countries have all increased their imports of timber, thus leading to an increase in emissions in other countries. Research by the ASB Partnership found that more than 50% of the reduction in CO_2 emissions attributable to reforestation in the last five years is cancelled out by the increase in overseas trade to meet demand for forest products.

The implications of international emission displacement through trade in food, forests and wood products are explored in *ASB Policy Brief 17: Emissions Embodied in Trade and Land Use in Tropical Forest Margins.* "The failure to recognize the significance of these emissions in future discussions related to REDD+ could encourage emission displacement through trade, which would be counter-productive to reducing global greenhouse gas emissions," says Minang.

The policy brief, which was the subject of the European Commission's fourth most downloaded news alert on 'Science for Environment Policy', suggests that market demand for greener commodities could be one of the best ways of encouraging land-use strategies to reduce emissions. For example, the public outcry over the destruction of forests on peat swamps by palm-oil plantation companies in Indonesia led to consumer boycotts which forced the industry to rethink its strategy. Contracts were cancelled, and companies were obliged to adopt a greener approach. Not only has this been good for biodiversity, it has helped reduce the industry's carbon footprint.

Eco-labelling schemes designed to calculate emissions related to supply chains are emerging in France, the USA and elsewhere. However, they use a diverse set of accounting rules and this is proving problematic. "We believe that there is an urgent need for globally acceptable rules and methods for carbon footprint accounting," says Minang. This will help to make certification schemes more credible both nationally and internationally.

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ASB Policy Brief 17: Emissions Embodied in Trade and Land Use in Tropical Forest Margins. http://www.asb.cgiar.org/PDFwebdocs/PB17_final.pdf

ASB Policy Brief 26: Agroforestry in REDD+: Opportunities and Challenges. http://www.asb.cgiar.org/PDFwebdocs/ASB_PB26.pdf

GATHERING EVIDENCE FOR CLIMATE-SMART AGRICULTURE

Over the coming decades, global warming is likely to change the face of farming in many parts of the world. To give just one example, it is estimated that higher temperatures could reduce crop yields by 10-20% in sub-Saharan Africa by 2050. However, agriculture is not just a victim of climate change, but a significant cause, being responsible for 10-12% of human-generated greenhouse gas emissions each year, and much more if you take into account the clearance of forests to make way for crops and livestock.

“Climate-smart agriculture is now being discussed at all levels, including the highest policy circles, but it is an ambiguous term and there is a lack of hard scientific evidence to back up the claims made for it,” says Todd Rosenstock, an agro-ecologist at the World Agroforestry Centre.

In 2011, the UN Food and Agriculture Organization (FAO) launched a major research programme – Mitigation of Climate Change in Agriculture (MICCA) – which will measure the performance of different agricultural systems in terms of food production, reducing greenhouse gas emissions and helping farmers adapt to climate change. The World Agroforestry Centre is managing the research in two different farming systems in East Africa.

In Kenya, Rosenstock is working with the East Africa Dairy Development project (see page 14) to analyse the social and economic benefits and global-warming potential for different types of smallholder dairy production systems, ranging from intensive zero-grazed systems, where animals are stall fed, to open grazing, where the animals graze on pasture.

In Tanzania, the research focuses on a remote region in the Uluguru Mountains, where CARE International is encouraging farmers to adopt conservation agriculture, typically on steep hillsides. Conservation agriculture involves three key practices: zero or minimum tillage, the rotation of crops, and keeping the soil permanently under some form of cover.

"One of the problems in this area is that farmers tend to pick and choose just one or two of these practices," says Rosenstock. "Yet research suggests that unless you do all three, neither you nor the environment will reap the benefits – in terms of increased yields, soil moisture conservation, erosion control, and soil carbon sequestration – that are sometimes associated with conservation agriculture." Rosenstock is assessing the climate-smart properties of different intensity conservation agriculture systems, as well as a control area using conventional farming practices.

One of the key outputs of the MICCA project will be a protocol that forms the scientific basis for estimating the mitigation potential of smallholder systems to reduce their climate footprint while achieving food security goals. Measurements comparing production systems in terms of climate-smartness will be coupled with the quantification of soil health using the Land Degradation Surveillance Framework described on pages 36 . The framework will help identify constraints to productivity and enable local and national extension agencies to determine where to target climate-smart interventions over large areas.

Measuring grassland carbon

Andreas Wilkes of the World Agroforestry Centre's China and East Asian Node collaborated with several national and international organizations to establish the first Methodology for Sustainable Grassland Management under the Verified Carbon Standard, a quality assurance scheme for the voluntary carbon offset industry. The methodology was based on a project in China that introduced better grassland management practices. These included improving the rotation of grazing animals between summer and winter pastures, limiting the timing and number of grazing animals on degraded pastures, and restoring severely degraded land by replanting with perennial glasses. This was the culmination of many years of work on carbon storage in China's rangelands.

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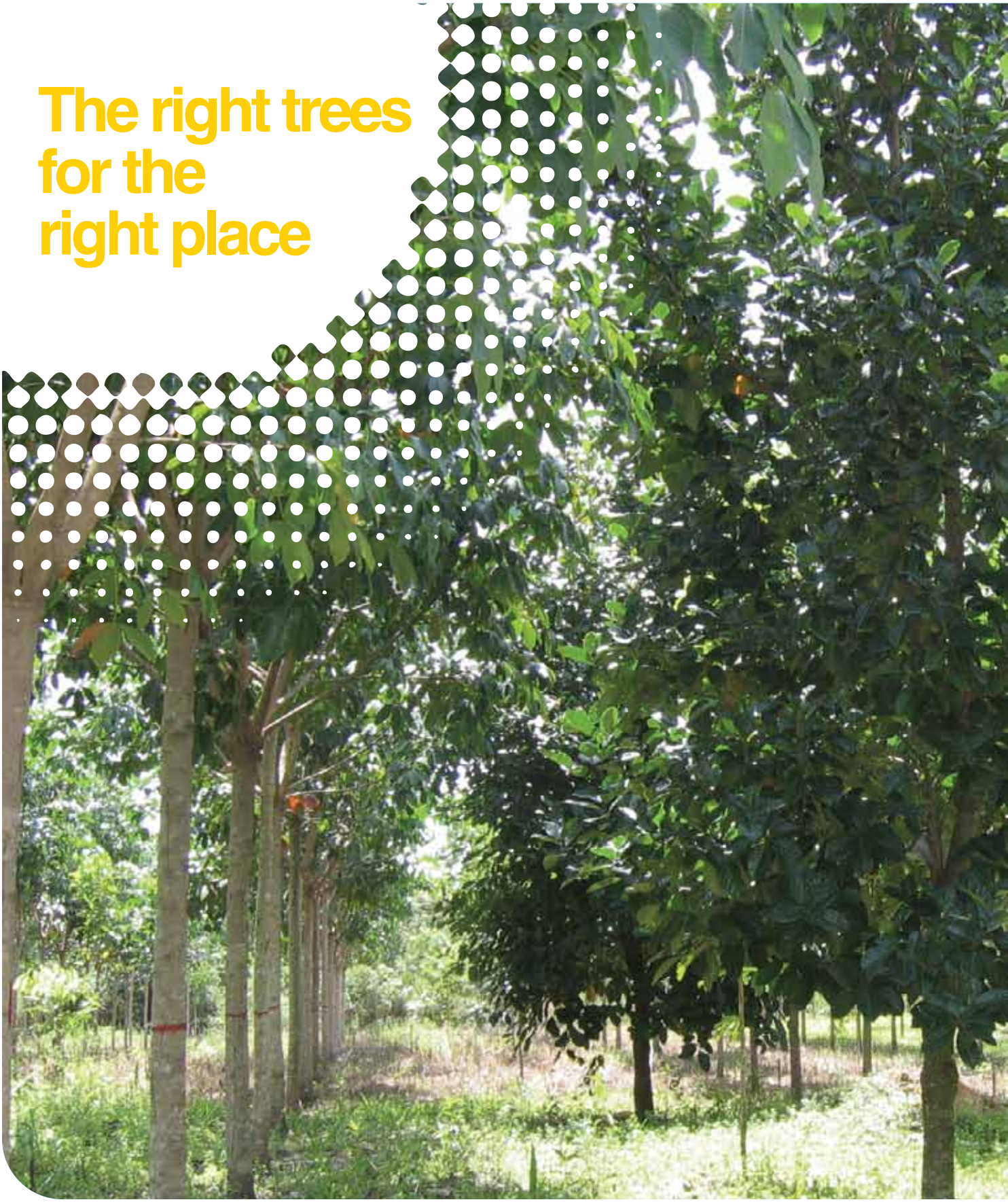
The right trees for the right place



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FRUIT ON FARMS – A RECIPE FOR GOOD HEALTH

Around a third of the population in sub-Saharan Africa are undernourished. Besides suffering from a lack of proteins and calories, the most obvious cause of hunger, their health is greatly weakened by their meagre consumption of essential vitamins and minerals.

Vitamin A deficiency – to give one telling example – compromises the immune systems of 40% of children under the age of five in developing countries, and approximately 1 million children die each year of preventable diseases caused by Vitamin A deficiency. One solution lies not in dishing out pills or potions, but in providing children with adequate quantities of fresh fruit.

A major review by scientists from the World Agroforestry Centre, published in the *International Forestry Review*, makes the case for increasing the cultivation of high-quality indigenous and exotic fruit trees on smallholders' farms in sub-Saharan Africa.[1] This would yield significant benefits for both nutrition and farmers' livelihoods.

"In East Africa, the average daily intake of fruit is 35 g per person, way below the World Health Organization (WHO) recommendations," says Ramni Jamnadass, head of the Centre's research programme on domestication and co-author of the review. "Agroforestry with trees that produce good-quality fruit is already showing great promise for improving people's physical and financial health."

During the past two decades, scientists at the World Agroforestry Centre have successfully launched a number of domestication programmes which have led to farmers planting superior varieties of indigenous fruit and nut tree species, including African plum, bush mango and kola nut in Central Africa. But much more needs to be done. Research by Jamnadass and her colleagues has identified a number of other indigenous species worthy of domestication, including baobab, whose vitamin C-rich fruit is used as a drink and in soups, and marula fruit, which is made into conserves and alcoholic drinks.

[1] Improving livelihoods and nutrition in sub-Saharan Africa through the promotion of indigenous and exotic fruit production in smallholders' agroforestry systems: a review. Jamnadass, R.H et al. International Forestry Review Vol 13 (3), 2011.

However, if smallholders are to increase the production of indigenous and exotic fruits, a number of obstacles need to be addressed. Poor access to good-quality planting material is a major constraint (See box: Falling by the Wayside). Furthermore, international legislation restricts the exchange of domesticated fruit trees, and this means that African farmers are unable to import more productive cultivars – for example of guava, tamarind and custard apple – from other continents.

Poor management practices, inadequate post-harvest storage and transport, and weak marketing systems are also limiting the widespread uptake of high-quality fruit trees.

The authors of the review propose eight key measures which would make high-quality indigenous and exotic fruit more widely available to both farmers and consumers in Africa.

Falling by the wayside

Agroforestry can only achieve its full potential if farmers have access to high-quality tree seeds and seedlings. The fact that so many haven't amounts to a great scandal – one which has been largely ignored by governments and policymakers. Every year, tens of millions of farmers in the developing world plant tree seeds and seedlings of poor and variable quality. It may take up to a decade before they realize that they have devoted space and energy to nurturing trees which will fail to produce the yields, income and other benefits they anticipated.

This subject is explored in a *Trees for Change* booklet, published in early 2012.[2] Drawing on two decades of research on tree seeds and seedlings supply systems around the world by the World Agroforestry Centre and Forest & Landscape Denmark (FLD), the booklet explores the problems and challenges through the eyes of scientists, nursery managers and farmers.

Based on their experience, the Centre and FLD have devised solutions which could significantly improve the quality of planting material and the livelihoods of many millions of farmers. These include the introduction of quality assurance systems appropriate to developing countries. "We also believe it is time to rethink the role of National Tree Seed Centres and introduce measures that enable the private sector to play a more prominent role in the sale and distribution of seeds and seedlings," write Tony Simons, Director General of the World Agroforestry Centre, and Lars Graudal, head of research at FLD, in the foreword to the booklet.

[2] Falling by the wayside: improving the availability of high-quality tree seeds and seedlings would benefit hundreds of millions of small-scale farmers. World Agroforestry Centre, 2012.

ADAPTING TO CHANGE IN THE SAHEL

For pastoralists and farmers living in the West African Sahel, two native trees are of particular importance. *Prosopis africana* and *Balanites aegyptiaca* provide a range of products, including poles for construction, wood to make handles for farm implements, and firewood and charcoal. The wood of both species is durable and easy to work and has relatively high calorific value, burning without any unpleasant smoke or sparks. This is particularly important in a region where the vast majority of people use fuelwood for cooking.

During recent decades, these and other tree species have come under threat from over-exploitation and, quite possibly, from a shift to a hotter and drier climate. This means that if local people are to have adequate timber and fuelwood in future, there is an urgent need for tree domestication and conservation programmes. These will only succeed if we have a thorough knowledge of the distribution of genetic variation in growth and wood properties – the former determining potential volume; the latter providing an indicator of wood density and calorific value – and the heritability of particular traits.

Scientists from the World Agroforestry Centre have recently published a stream of papers describing research on the genetic variation among provenances – that is, different natural populations with their own genetic variations – of *P. africana* and *B. aegyptiaca* in Burkina Faso and Mali. These include the first published reports of genetic variation in wood density and calorific value and their correlations with tree growth for native African hardwood species. The research was conducted under a programme funded by the International Fund for Agricultural Development (IFAD), 'Parkland trees and livelihoods: adapting to climate change in the West African Sahel'.

"We believe our studies have important practical implications for the management of these species in the West African Sahel," explains John C. Weber, who is based in the Centre's Sahel office in Bamako, Mali. "In particular, the research suggests that it would be prudent for tree domestication and conservation programmes to conserve and collect germplasm from the drier parts of the region, for planting throughout the region."

For both species, provenances from drier zones in the Sahel were found to grow more rapidly than those from more humid zones. Provenances of *P. africana* from drier zones also had denser wood and higher survival rates

than those from the more humid zones. The researchers found that faster-growing trees of both species tended to have denser wood and higher calorific value – in other words, they would make the best fuelwood.

The research provides insight into how domestication and conservation programmes could help these trees adapt to a changing climate, although it is still uncertain precisely how the climate is likely to change. If it becomes progressively drier and hotter, as most Global Circulation Models predict, then it would make sense to use provenances that are best adapted to such a future, says Weber, these being those from hotter, drier regions. However, if changes in weather patterns are going to be unpredictable, it would make sense to plant a mixture of provenances from a range of different environmental conditions and allow natural selection to take its course.

Growing crops under trees in the Sahelian parklands

Parklands in the Sahel support a range of different trees and shrubs. Some produce fruits and nuts; others condiments, fats and oils. At the same time, parklands are also used to grow stable crops, such as millet, sorghum and taro. In short, parklands are vital for the survival and livelihoods of hundreds of thousands of families, which is why their loss and degradation is becoming such a concern.

World Agroforestry Centre scientist Jules Bayala has been assessing the performance of different crops under shade in parklands in Burkina Faso. His research has shown that certain crops thrive under shade; others fare less well. For example, millet performs better under baobab *(Adansonia digitata)* than in full sun and the yields of taro and chilli pepper are higher under a canopy of néré *(Parkia biglobosa)* than in the open.

"If we can get a better understanding about which crops perform well when grown under different tree species, then farmers could benefit from higher yields and they would have a good reason to maintain a diverse range of trees in their fields, preventing further degradation of the parklands," says Bayala. "We concluded that parklands productivity could be enhanced by matching crop ecological niche requirements with appropriate tree species, such as cropping taro, a shade-tolerant crop, under the heavy shade of néré."

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Save our soils

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THE ANSWER LIES IN THE SOIL

Over the past decade, scientists from the World Agroforestry Centre have devised a framework for measuring and monitoring soil characteristics which has transformed our ability to assess land health. “Five years ago, we simply couldn’t measure land health on the scale, or with the accuracy, that we can now,” says soil scientist Keith Shepherd. By combining the use of infrared spectroscopy to analyse soil properties – such as mineral deficiencies, salinity and carbon content – with satellite imagery, scientists can now analyse the state of the soils in considerable detail over large areas.

Tor-Gunnar Vågen is leading the soil health mapping component of the Africa Soil Information Service (AfSIS) project, which is evaluating soil health at 60 sites in 21 countries in Africa. He and his colleagues are now using the framework to assess land health for a range of clients. Among those who benefited during 2011 were a private conservation organization, Wajibu, and the pastoralist communities with which it works in North Laikipia, Kenya.

For a variety of reasons, some pastoral communities in North Laikipia no longer move their cattle around, as their forebears used to, although many pastoralists still do, and this has led to overgrazing, soil erosion and the loss of vegetation. “To tackle the problem, the pastoralists are experimenting with improved management systems that mimic how wild herbivores move across the land grazing it, without damaging the vegetation and soil,” explains Tor-Gunnar Vågen.

To help them work out where to target their interventions, the World Agroforestry Centre has helped to develop detailed maps of vegetation, bare soil and soil carbon, and identify the hotspots of degradation where pastoralists could introduce activities – including better grazing management – to restore soil health. Much of the research on the ground was carried out by members of the local community, trained by a member of the Wajibu staff who had learned his skills with the AfSIS sampling team in Tanzania in 2010.

By the end of 2011, the project had mapped soil carbon for some 50,000 ha. As a general rule, the lower the soil carbon content, the more degraded the land. The maps will prove useful in two ways. First, if the pastoralists ever decide to take advantage of the carbon market by introducing practices which sequester carbon and improve land health, they will provide the necessary carbon baselines.

More importantly, says Vågen, the maps enable the local community to plan activities which will improve the health of soil and vegetation. For example, they might decide to target areas of low soil carbon and poor fertility for 'kraaling'. This involves retaining their cattle with a stockade so that their manuring improves fertility and the production of grass. In other areas, cattle might be excluded, or trees planted, to improve the health of the land.

A practice that works

Vågen believes that the work carried out in Laikipia has helped to provide what he describes as 'proof of concept' for the land degradation surveillance framework (LDSF) applied in the AfSIS project. "It shows that it is an effective and efficient way of assessing land health in arid and semi-arid lands, such as you find in northern Kenya," he says.

It is also an approach which the World Agroforestry Centre is using to evaluate land health in a range of other projects which were launched in 2011. Research carried out under the Mitigation of Climate Change in Agriculture (MICCA) project is described on the next page. The LDSF will also help the World Agroforestry Centre to make significant contributions to a number of other major projects.

In early 2012, the Gates Foundation announced a US$10 million grant to Conservation International for the creation of the Africa Monitoring System. This will involve a vast exercise of data collection from the household to the regional scale to monitor agricultural productivity and the health of both people and the environment. Information will be loaded onto an open access online dashboard which policymakers will be able to use to improve decisions related to food security and environmental health.

The Centre will also be analysing soil health for the agricultural component of the World Bank's Living Standards Measurement Study. Rather than gathering data at randomized sentinel sites, as scientists have done for the AfSIS project, the focus will be on individual fields. "This should help us to get a much better idea about soil fertility and soil health at the farm level in the two pilot countries where we will be working," says Shepherd. In one way or another, all of these projects will ultimately help to improve soil management and the livelihoods of rural communities.

THE VIEW FROM THE MOUNTAINS

When Emilie Smith, a scientist at the World Agroforestry Centre, first made the arduous journey high up into the remote mountains in Kivu District, in the Democratic Republic of Congo (DRC), the villagers were astonished to see her. “They hadn’t seen a white person, or an educated Congolese, since 1953,” she says. “They were so happy to see us, to find that somebody was interested in what was happening to them.”

During a six-week period, between December 2010 in January 2011, Smith and Deodatus Kilola, a young anthropologist, explored the changes that had taken place to the landscape in this remote – and, until recently, war-ravaged – region to the west of Lake Tanganyika. Their research has made a significant contribution to a project designed to improve the management of the lake catchment. During recent decades, a range of activities have led to a dramatic increase in soil erosion and sedimentation. This poses a significant threat to biodiversity and the livelihoods of the farmers and fisherfolk who live along the lake shore.

The trans-boundary project, which is funded by the United Nations Development Programme’s Global Environment Facility, aims to reduce sedimentation and improve local livelihoods by controlling erosion and improving land-use practices. In Tanzania and Zambia, the project is managed by government departments. In DRC, the lack of a strong government presence meant that the task was put out to tender. The World Wildlife Fund (WWF) East Africa, the current project manager in DRC, sought technical advice from the World Agroforestry Centre.

When Smith arrived at what she describes as ‘le boulevard des ONGs’ – a strip of shoreline settled numerous humanitarian organizations – WWF didn’t even have a desk. At the time, it had few concrete plans, though there was talk of establishing woodlots of exotic species such as eucalyptus.

Instead of hanging around the lowlands, Smith decided to head for the mountains. With the help of the villagers, she identified the ‘hotspots of degradation’ and the reasons behind the environmental damage she witnessed. An area once rich in forests was now almost treeless. “There was scarcely a monkey to be seen and nearly all the fruit trees had been felled to make charcoal,” she recalls. Poor agricultural practices and charcoal burning – charcoal provided a major source of

income for the armed groups who flowed through the area, and sometimes stayed, during the 1990s – were among the activities which had caused significant soil erosion.

The villagers had had little contact with agricultural extension workers, whose knowledge was largely confined to farming practices in the lowlands. The extension workers, according to Smith, had a reasonable theoretical knowledge of exotic trees, but knew little or nothing about the native species which grew at high altitudes. This was hardly surprising, as the last tree survey in the area had been done by botanists during the colonial era. The villagers, in contrast, had a great deal of knowledge about native tree species and had even developed some of their own innovations to regenerate degraded land.

After the field work, a three-day workshop enabled scientists, farmers and extension workers to discuss the findings of Smith's research and identify the activities that could improve land management and reduce erosion. These included soil and water conservation practices, focusing in particular on landslide-prone areas, such as riverbanks and pathways. Instead of planting exotic species, it was agreed that the project should encourage the planting of native species and fruit trees to provide a source of food and income for local farmers. It was also clear that there needed to be a much better system of communicating knowledge – not just to farmers, but to the extension workers involved in improving local land management.

This is a work in progress, and the research in DRC represents one part of a much bigger project, but Smith believes that it confirms the importance of working with local farmers as research partners and learning from their experience and knowledge. Here, and in others areas round Lake Tanganyika, there has been a history of unsuccessful reforestation initiatives. That's partly because they have focused on introducing exotic eucalyptus in the lower catchment and failed to address the problems in the more remote upper catchments.

Sharing knowledge for better land management

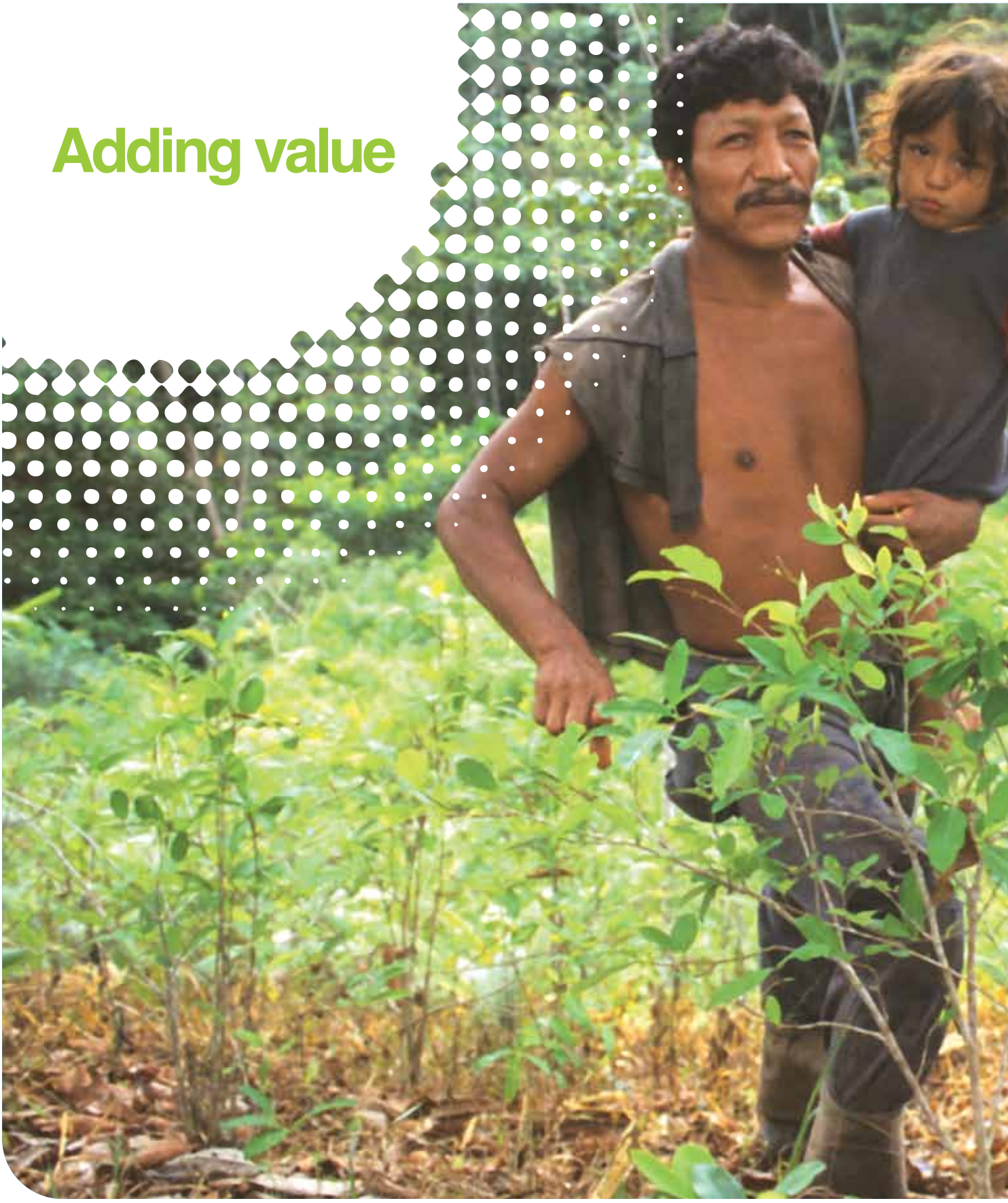
There was a time when scientists paid little or no attention to the great wealth of understanding and know-how which can be found among most people living on the land. That's beginning to change. In 2011, the World Agroforestry Centre, the International Centre for Tropical Agriculture (CIAT) and the Brazilian agricultural research organization, Embrapa published a methodological guide which will help researchers and others to blend local and scientific knowledge so that they can monitor and improve soil quality.

"It is our hope that the guide will become a useful tool to facilitate bottom-up approaches that integrate local knowledge into the soil management decision-making processes," says lead author, Edmundo Barrios of the World Agroforestry Centre.

The Integraçao Participativa de Conhecimentos sobre Indicadores de Qualidade do Solo (InPaC-S) guide recognizes that local knowledge, when combined with the latest scientific thinking, can help to improve decision-making. This is particularly important when devising early-warning indicators to monitor changes of soil quality in agricultural landscapes.

The guide will be used during 2012 in Mozambique in a capacity-building exercise for staff from the National Institute of Agronomic Research (IIAM), national extension services, universities and non-governmental organizations. The aim is to promote effective communication between scientists, development workers and farmers so that they can develop a consensus about which problem should be tackled first, as well as the best land management options.

Adding value



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ADDING VALUE IN LATIN AMERICA

In 2011, the World Agroforestry Centre and the Tropical Agricultural Research and Higher Education Centre (CATIE) published a tool which can be used to understand how value-chain development affects farming households and the enterprises which they do business with. *5Captials: A tool for assessing the poverty impacts of value chain development* – published in both Spanish and English – was the culmination of several years of collaboration between the Centre, CATIE, the Ford Foundation and various other research and development organizations.

It has long been assumed that value-chain development is an inherently good thing, benefiting both farmers and the buyers of agricultural and forest products. But does this necessarily help to reduce poverty and benefit small business?

It has been difficult to tell, not least because there are limited tools for assessing the impact of value-chain development on poverty. Most of those in existence tend to focus on single interventions and assess short-term changes in income and employment. “Without innovation and assessment tools, those promoting value-chain development often don’t know whether their approach is contributing to poverty reduction, or what they need to do to achieve greater and more lasting results,” says Jason Donovan, a marketing specialist based in the World Agroforestry Centre’s new Latin American headquarters in Lima, Peru.

Most efforts to develop value chains assume smallholders have sufficient resources to participate, but this isn’t necessarily the case. “Equally disconcerting is the fact that impact assessment of value-chain development tends to be simplistic,” explains Dietmar Stoian, a senior economist at CATIE. “They tend to focus on the generation of employment and income, rather than broader changes in terms of livelihoods and assets.”

During the course of the project, which began in 2008, Donovan and Stoian collaborated with over 20 research and develop and organizations to devise a new tool to assess the impact of value-chain development. The initial methodology was tested with 12 case studies before being refined and put to the test with a further 11 case studies from Latin America, Africa, Asia and the United States. These included analyses of coffee in Colombia, dairy products in Bolivia, and vegetables

in Kenya and Uganda, each involving different development or research-based organizations.

A case-study companion to *5Capitals* presents results from the implementation of the tool in Nicaragua, Colombia, Afghanistan, the United States and India.

5Captials and its case-study companion will be available on the ICRAF and CATIE websites in mid-2012. The tool has contributed significantly to the design of a three-year research programme that will investigate the potential for developing value chains around underutilized fruits in Cameroon, Kenya and Peru.

Expanding research activities in Latin America

In 2011, the World Agroforestry Centre shifted its headquarters in Latin America from Belém, Brazil, to the Peruvian capital of Lima. The Lima office, which is based at the headquarters of the International Potato Centre, expanded rapidly, with the arrival of Jonathan Cornelius, the new regional coordinator, marketing specialist Jason Donovan and Claudia Silva, who will coordinate research on REALU (Reducing Emissions from All Land Uses). During the year, the centre also established a new office in Costa Rica, posting researcher Jenny Ordoñez to the headquarters of the Tropical Agricultural Research and Higher Education Centre (CATIE), with the aim of developing closer linkages with CATIE and expanding research in Central America.

Promoting agroforestry in Colombia

Colombia is one of South America's most climatically and topographically varied countries. Its five natural regions – the Amazon, Andes, Caribbean, Orinoco and Pacific – offer unexplored opportunities for agroforestry development in support of rural livelihoods and environmental sustainability. In 2011 The World Agroforestry Centre and the Center for Research and Higher Education in Tropical Agronomy (CATIE) were asked by the Colombian Corporation for Agricultural and Livestock Research (CORPOICA) to carry out a review of its agroforestry programme.

A multidisciplinary mission from both centres, found a rich tradition of agroforestry research and development dating back more than two decades: from silvopastoral systems in the wide expanses of the Orinoco to cocoa and rubber systems in the Amazon. Nevertheless, adoption by farmers of research-based agroforestry remains low, and research itself has been affected by problems that have been common in other locations. These include a short-term, project-based funding model that impedes strategic direction; lack of emphasis on socioeconomic and marketing aspects; lack of peer-reviewed publications, and uneven coordination among the many excellent researchers operating in different themes or regions.

The way forward for Colombia's agroforestry research, as proposed in the report –'Enhancing the effectiveness of agroforestry research in Colombia' – is an inspiring one: towards a strategic national framework, taking advantage of cutting-edge technology such as the Centre's land health surveillance methods, and focused on understanding which agroforestry options, and which socio-economic and ecological conditions, offer the greatest benefits. Such an approach is the key to maximizing the contribution of Colombia's agroforestry research expertise to meeting the needs of farmers and the wider community.

The World Agroforestry Centre is currently holding discussions with CORPOICA on the implementation of these exciting plans.

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A HARD NUT TO CRACK

One of the World Agroforestry Centre's great successes in West and Central Africa has been a collaborative effort with local farmers. A programme of participatory tree domestication, where farmers and scientists work side-by-side, has developed superior varieties of several wild species, including African plum, bush mango, kola nut and njansang. As a result, many thousands of families have improved their incomes.

In recent years, the World Agroforestry Centre has turned its attention to improving the processing and marketing of njansang (*Riconodendron heudelottii*), whose spicy nuts are rich in essential oils and widely consumed across most of West and Central Africa. Njansang's economic importance has long been recognized, but the processing of its hard nuts is a time-consuming and sometimes dangerous business. However, that's beginning to change, thanks to the recent development of a cracking machine.

"We are all very happy today because many people in our village are now processing njansang," says Bridgitte Biloa, president of the women's group in Epkwassong village in Cameroon. "Thanks to the income we generate, we're now able to pay for our children's school fees." The village was one of the first to be involved in participatory tree domestication; now, it has benefited from the introduction of one of the World Agroforestry Centre's new cracking machines, developed under a Belgian-sponsored project, 'Agroforestry Tree Products for Africa'.

In the traditional system of production fruits are collected from the wild and their pulp is allowed to decompose, prior to being washed and boiled. The kernels are then extracted from the nuts using sharpened nails. This is a risky and time-consuming exercise. Manual extraction of 1 kg of kernels takes approximately 60 minutes. The use of a cracking machine, in contrast, dramatically reduces processing time. It takes just over 2 minutes to crack the nuts and a further 39 minutes to sort the kernels from the shells. This represents a saving of around 20 minutes for each kilogram of kernels.

So far, the World Agroforestry Centre has provided six njansang cracking machines in Cameroon. "The handing over of the machines is one of the crowning achievements of our relationship with local populations," says Zac Tchoundjeu, regional coordinator for West and Central Africa. "Originally, the villagers were only producing njansang for local consumption, but the machines are helping them tap into the large urban market."

The Centre has also encouraged producers to act collectively and negotiate as a team with njansang buyers. This has increased their profits. In the past, most villagers used to get around CFA 700 (US$1.40) per kg; now, group sales have helped to push prices up to CFA 1000–1800 (US$2–3.60). The cracking machines and group sales have saved time, raised incomes and reduced injuries.

The Njansang cracking machine.

Annexes

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For a full staff list, please see the comprehensive version of this report at www.worldagroforestry.org/ar2012

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World Bank
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Financial Highlights

STATEMENT OF FINANCIAL POSITION

AS AT 31 DECEMBER 2011 (*In US Dollars '000'*)

	Note	2011	2010
ASSETS			
Current assets			
Cash and cash equivalent	5	20,873	16,940
Short term investments	6	13,450	10,368
Accounts receivables			
Donor	7	7,241	9,345
Employees	8	94	96
Other CGIAR Centres	9	297	186
Other	10	3,462	2,596
Inventories - net	11	84	88
Prepaid expenses	12	742	839
Total current assets		46,243	40,458
Non-current assets			
Property and Equipment	13	5,350	5,429
Long term investments	14	3,020	5,044
Total non-current assets		8,370	10,473
TOTAL ASSETS		**54,613**	**50,931**
LIABILITIES AND NET ASSETS			
Current liabilities			
Accounts payable			
Donor	15	12,389	12,241
Employees	16	871	1,012
Other CGIAR Centres	17	436	428
Other	18	2,609	1,805
Accruals	19	6,292	4,483
Total current liabilities		**22,597**	**19,969**
Non-current liabilities			
Accounts payable			
Employees	20	5,263	5,410
Total Non-current liabilities		**5,263**	**5,410**
TOTAL LIABILITIES		**27,860**	**25,379**
NET ASSETS			
Unrestricted			
Designated	21	16,847	15,939
Undesignated	21	9,906	9,613
		26,753	25,552
TOTAL LIABILITIES AND NET ASSETS		**54,613**	**50,931**

The financial statements were approved by the Board of Trustees on 3 May 2012

STATEMENT OF ACTIVITIES

FOR THE YEAR ENDED 31 DECEMBER 2011 (In US Dollars '000')

	Note	2011			2010
		Unrestricted	Restricted temporarily	Total	Total
Revenue, Gains and other Support					
Grant revenue	22	5,721	36,175	41,896	40,931
Other revenue and gains	23	1,196	-	1,196	2,123
Total revenue and gains		6,917	36,175	43,092	43,054
Expenses and losses					
Program related expenses	24	6,497	30,685	37,182	30,827
Management and general expenses	25	3,451	668	4,119	4,360
CGIAR Gender and Diversity Program	26		4,822	4,822	5,501
Sub total expenses and losses		**9,948**	**36,175**	**46,123**	**40,688**
Overhead cost recovery	27	(4,232)	-	(4,232)	(2,822)
Total expenses and losses		5,716	36,175	41,891	37,866
Net Surplus		1,201	-	1,201	5,188
Expenses by natural classification					
Personnel cost		6,018	11,225	17,243	15,854
Supplies and services		2,294	13,851	16,145	14,402
Collaborators/partnerships		18	5,234	5,252	4,180
Operational travel		1,183	4,583	5,766	5,292
Depreciation		435	1,282	1,717	960
Overhead cost recovery		**(4,232)**	**-**	**(4,232)**	**(2,822)**
Total		**5,716**	**36,175**	**41,891**	**37,866**

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 2011 and the Board is satisfied with the progress made.

The Board of Trustees has the responsibility of 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:

1. Misallocation of scientific efforts away from agreed priorities
2. Loss of reputation for scientific excellence and integrity
3. Business disruption and information system failure
4. Liquidity problems
5. Transaction processing failures
6. Loss of assets, including information assets
7. Failure to recruit, retain and effectively utilize qualified and experienced staff
8. Failure in staff health and safety systems
9. Failure in the execution of legal, fiduciary and Centre responsibilities
10. Withdrawal or reduction of funding by donors due to the financial crisis
11. Lack of funding to, or non-prioritization of agroforestry in the mega programmes due to the CGIAR change management process
12. 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 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, office system 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 Finance and 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.

Eric Tollens
Chair
Board of Trustees
World Agroforestry Centre
3rd May 2012

Performance Indicators

The Performance Measurement (PM) system of the Consultative Group on International Agricultural Research (CGIAR) measures the performance of the Centres it supports in terms of their results and potential to perform.

The PM system provides the Centres with a method to better understand their own performance and demonstrate accountability. Due to the ongoing changes in the CGIAR consortium, the Performance Measurement exercise was not conducted centre-wide this year. However, the World Agroforestry Centre did collect some information for its own internal use. These are presented below.

Results for the World Agroforestry Centre

Publications

1. Composite measure of Centre research publications:

   Number of peer-reviewed publications per scientist in 2011 that are published in journals listed in Thomson Scientific/ISI: 1.92

   Number of externally peer-reviewed publications in 2011: 213

2. Percentage of scientific papers published with developing country partners in refereed journals, conference and workshop proceedings in 2011: 20.8%

Institutional health

5D: Percentage of women in management: 33%

Financial health

6A: Long-term financial stability (adequacy of reserves): 194 days where the minimum benchmark is 90 days

6B: Cash management on restricted operations: 0.61 where the benchmark is less than 1.00

Selected Publications

Books

Barrios E, Coutinho HLC, Medeiros CAB. 2011. InPaC-S: integração participativa de conhecimentos sobre indicadores de qualidade do solo – guia metodológico. 183p. Nairobi: World Agroforestry Centre, Embrapa & CIAT.

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Kiptot E, Franzel S. 2011. Gender and agroforestry in Africa: are women participating? Occasional paper no. 13. Nairobi: World Agroforestry Centre.

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Pye-Smith C. 2011. Rich rewards for rubber? Research in Indonesia is exploring how smallholders can increase rubber production, retain biodiversity and provide additional environmental benefits. Trees for change no. 8. Nairobi: World Agroforestry Centre.

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List of Abbreviations

AfSIS	Africa Soil Information Service
AHI	African Highlands Initiative
ALLREDI	Accountability and Local Level Initiative to Reduce Emissions from Deforestation and Degradation
AMCOW	African Ministers' Council on Water
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa
CATIE	Tropical Agricultural Research and Higher Education Centre
CCAFS	Climate Change, Agriculture and Food Security
CDM	Clean Development Mechanism
CER	Certified Emission Reduction
CFL	Compact Fluorescent Light
CGIAR	Consultative Group on International Agricultural Research
CIAT	International Centre for Tropical Agriculture
COP	Conference of the Parties
Corpoica	Corporación Colombiana de Investigación Agropecuaria
DFBA	Dairy Farmers Business Association
DRC	Democratic Republic of Congo
EADD	East African Dairy Development
FEAST	Feed Assessment Tool
FLD	Forest and Landscape Denmark
GIZ	Gesellschaft für Internationale Zusammenarbeit
ICRAF	World Agroforestry Centre
IFAD	International Fund for Agricultural Development
IIAM	National Institute of Agronomic Research
ILRI	International Livestock Research Institute
IMP	Irrigation Master Plan
InPaC-S	Integração Participativa de Conhecimentos sobre Indicadores de Qualidade do Solo
LDSF	Land Degradation Surveillance Framework
MICCA	Mitigation of Climate Change in Agriculture
MRC	Mekong River Commission
NAIP	National Agricultural Innovation Project
NGO	Non-governmental Organization
REALU	Reducing Emissions From All Land Uses
REDD	Reducing Emissions from Deforestation and Forest Degradation
UN	United Nations
UNCCD	United Nations Convention to Combat Desertification
UNFCCC	United Nations Framework Convention on Climate Change
US$	United States Dollar
USA	United States of America
WHO	World Health Organization
WWF	World Wide Fund for Nature

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