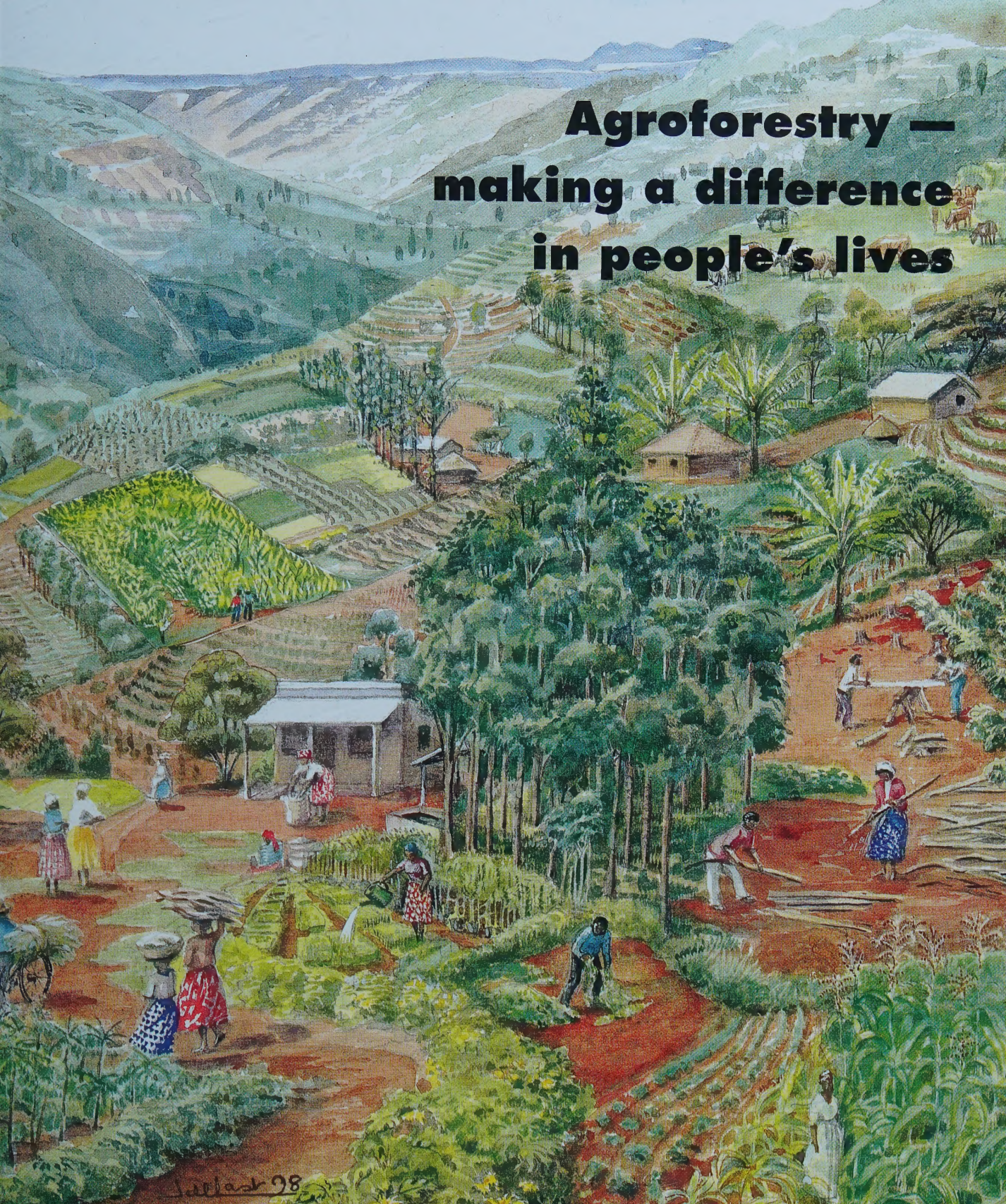
Agroforestry — making a difference in people's lives



INTERNATIONAL CENTRE FOR RESEARCH IN AGROFORESTRY

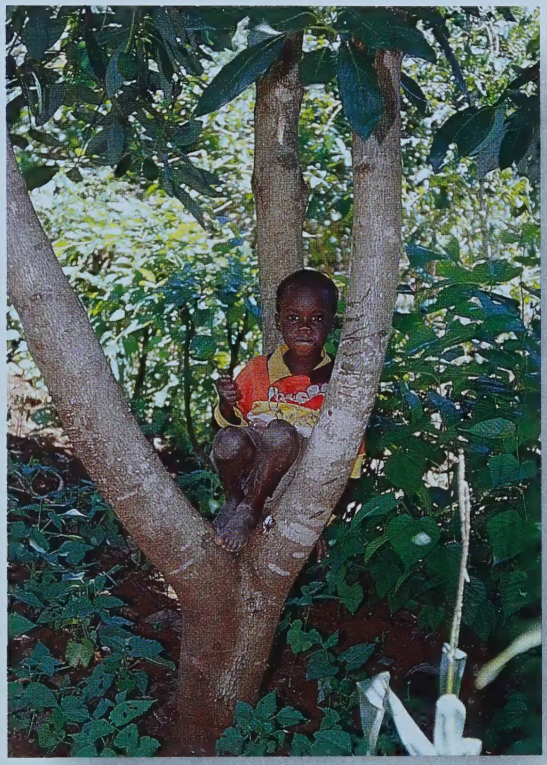
ICRAF

The International Centre for Research in Agroforestry (ICRAF), established in 1977, is an autonomous, non-profit international organization whose aim is to alleviate poverty, improve food and nutritional security and enhance environmental resilience in the tropics through improved agroforestry systems. ICRAF conducts strategic and applied research, in partnership with national institutions, aimed at developing appropriate agroforestry technology for more sustainable and productive land use. The centre strengthens national capacities to conduct agroforestry research and development by encouraging inter-institutional collaboration and promoting the spread of information through training, education, documentation and communication activities.

ICRAF is governed by a board of trustees, with representation from developed and developing countries. Financial support for ICRAF'S research and development activities is provided by many donors.

In 1997, they were (in alphabetical order) Asian Development Bank, Australia, Austria, Belgium, Ben Gurion University, Boehringer Ingelheim KG, Brazil, Canada, the Centre Technique de Coopération Agricole et Rurale (CTA), Denmark, the European Union, Finland, the Ford Foundation, France, Germany, the Interamerican Development Bank, International Development Research Centre, International Fund for Agricultural Development, Ireland, Japan, Mexico, Namur University, the Netherlands, Norway, the Philippines, Rockefeller Foundation, Spain, Sweden, Switzerland, the United Kingdom, United Nations Development Programme, the United States of America and the World Bank.

Agroforestry — making a difference in people's lives



Avocado is one of the trees in agroforestry systems that enhances food security for people in the tropics–like this child in Embu, Kenya.

International Centre for Research in Agroforestry

United Nations Avenue
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A proud farmer stands with her crop of maize, grown after a six-month sesbania fallow at Maseno, western Kenya.

Agroforestry — making a difference in people's lives

ICRAF may be a research centre but our scientists don't conduct research for its sake alone. Our work does not begin and end in a laboratory or behind a computer, or even at a field station. As our mission statement says, ICRAF aims to improve human welfare by alleviating poverty, improving food and nutritional security, and enhancing environmental resilience in the tropics.

Simply put, our goal is to make a positive impact on people's lives.

The *Concise Oxford Dictionary* defines 'impact' as 'an effect or influence, especially when strong'. It's a simple enough definition that seems to need no further explanation. But how do our scientists know whether their research is actually making a positive impact? In other words, how is impact measured?

It's a complex issue, one that is the topic of debate in research institutions the world over. There is no one simple equation that works across all fields of science. But we believe one of the best ways to measure the impact of our research is to go directly to the people for whom we work — the farmers.

Our highlights this year feature four case studies — just a few of many — which demonstrate that our work is indeed making a positive difference in their lives. We take hope from these examples — and we believe you will too.

Protection through empowerment

They appear natural, but they aren't. Dominated by up to 20 tall-growing tree species, the mature agroforests of southern Sumatra are difficult to distinguish from the natural forest they have replaced. Tallest of all is the damar, a fine, straight-trunked timber species that produces a commercially valuable resin.

Until recently these world-famous agroforests were at risk owing to uncertainty over their tenure status. But in January 1998, Ir Djamaloedin Soeryohadikoesoemo, then Indonesia's Minister of Forestry, signed a historic decree safeguarding their future by officially placing them under community management.

A remarkable system

Standing on the mid-slopes of the inland massif that rises from Sumatra's southern coast, the damar agroforests were until recently relatively inaccessible. They are managed by the indigenous Krui people, who have evolved a complex multi-strata production system that is a model of sustainable productivity. The Krui first clear the vegetation by slashing and burning, then sow upland rice. The next year they plant coffee, pepper, fruit trees and timber trees, including damar. Fruit production starts at year five and after 15 to 20 years, the forest garden begins producing damar resin. Meanwhile, staple food supplies are assured from permanent irrigated rice paddies.

Damar agroforests in Krui, Lampung Province, Indonesia.

The Krui system differs crucially from a conventional slash-and-burn system in that burning occurs only once, as the first step of a process leading to permanent tree cover. Although fire is used to clear the land, it seldom gets out of control and causes little atmospheric pollution. Economically, the system is stabilized by the production of damar resin, for which there is a steadily growing international market. Used in the manufacture of paints and turpentine, the resin is harvested on a regular basis: individual trees are tapped from once a month to once every two weeks. A single villager can harvest 20 kg of resin a day, on average, which is then brought to the village and sold to traders. Resin sales represent a regular source of income for day-to-day expenses.

The construction of roads in the late 1980s opened the Krui lands up to increased trade, especially in fruits and timber. Villagers began to acquire chainsaws and to cut down trees. However, even this development has not so far led to unsustainable exploitation. Indeed, research has shown that the overall health of the forest has improved, since only older trees are harvested, replanting rates have increased and more attention is given to the pruning of timber species. Much of the timber processing is carried out on the forest floor, allowing the tree litter to replenish soil fertility and avoiding damage to other trees while taking out the trunks. Krui agroforesters have also developed some of the most careful and sophisticated tree-felling techniques found anywhere in the world.

A change of policy

For the past 25 years, large areas of the Krui agroforests have been considered by the government as state-controlled production and watershed forests. Beginning in 1992, the Department of Forestry took the bold step to delineate these forests on the ground, placing markers within the Krui agroforests that identify where the state forest begins. Subsequently, a right to manage this area was awarded to a forestry company, entitling it to harvest about three million commercially valuable trees planted by local people.

The response was dramatic. Many of the Krui chose not to plant trees in new damar agroforest plots until they could be sure of their rights to reap a harvest from their work. And from both within and beyond the Krui lands came a chorus of concern that a productive and sustainable agroforestry system might be lost forever.

The 1998 decree reverses the government's position, creating a distinctive forest use classification known as *Kawasan dengan Tujuan Istimewa* (KdTI — 'zone with distinct purpose') that legalizes management by the local community. For the first time in Indonesia, the

environmental and social benefits of an indigenous land-use system have been recognized, together with the role of local institutions in managing the system sustainably. At least 7000 Krui families will benefit directly from the recognition of their rights to harvest and market the produce of the trees they plant.

The decree is a direct response by former minister Djamaloedin to the human rights issues arising from land-use conflicts in the forest lands. In a seminar during a recent visit to ICRAF, he said that the opportunity to empower local people was the single most important factor in his decision to change the government's policy.

The government's action is a critical breakthrough in efforts to promote community-based natural resource management in Indonesia. If this prototype is successful, it could be applied in many other areas of the country, with benefits for hundreds of thousands of people through poverty alleviation, a healthier environment and reduced social conflict. Because it would reduce large-scale forest clearance by commercial companies, more widespread application would do much to prevent the problems of smoke pollution that have recently plagued Indonesia and its neighbours.

How it happened

A unique coalition between government officials, non-government organizations (NGOs) and research institutes paved the way for the ground-breaking decree. Starting in 1995, with the support of the Ford Foundation, the coalition worked with the Krui people to place their agroforestry system and its environmental, economic and social benefits on the policy makers' agenda. At the request of Minister Djamaloedin, ICRAF and NGO partners the Indonesian Institute for Tropical Nature (LATIN) and the Society of Nature Lovers (WATALA) worked closely with Forestry Department counterparts to identify and develop workable options for implementation of the Minister's KdTI concept in Krui.

The Krui system was first documented by a team of scientists from the French Institut français de recherche scientifique pour le développement en coopération (ORSTOM). 'ORSTOM's scientific input was critical in establishing the value of the system to Indonesia', says Thomas P Tomich, who heads ICRAF's policy research activities and is based in Southeast Asia. The ORSTOM team worked closely with ICRAF's researchers and also with those of the Centre for International Forestry Research. The leading national research partner was the University of Indonesia, which collaborated in socioeconomic studies.

The coalition's efforts culminated in the agreement of key government officials to visit the area and attend a two-day workshop at which the status of the Krui lands was discussed. A few months later, the path-breaking decree was signed.

Chances of success

According to Tomich, the chances of successful community management in the Krui area are relatively high. The crucial factor conducive to success is the congruence of environmental and economic interests. 'The value of damar resin, and the stability this confers on the system by providing a regular income, motivate the Krui to look after their trees, harvesting only those whose productive life is over.'

Another plus point is the existence of strong local institutions for forest management. 'Where new institutions have to be created from scratch, they often fail', Tomich says. 'The culture of the Krui people, in contrast, has evolved around forest management. That's a tremendous asset.'

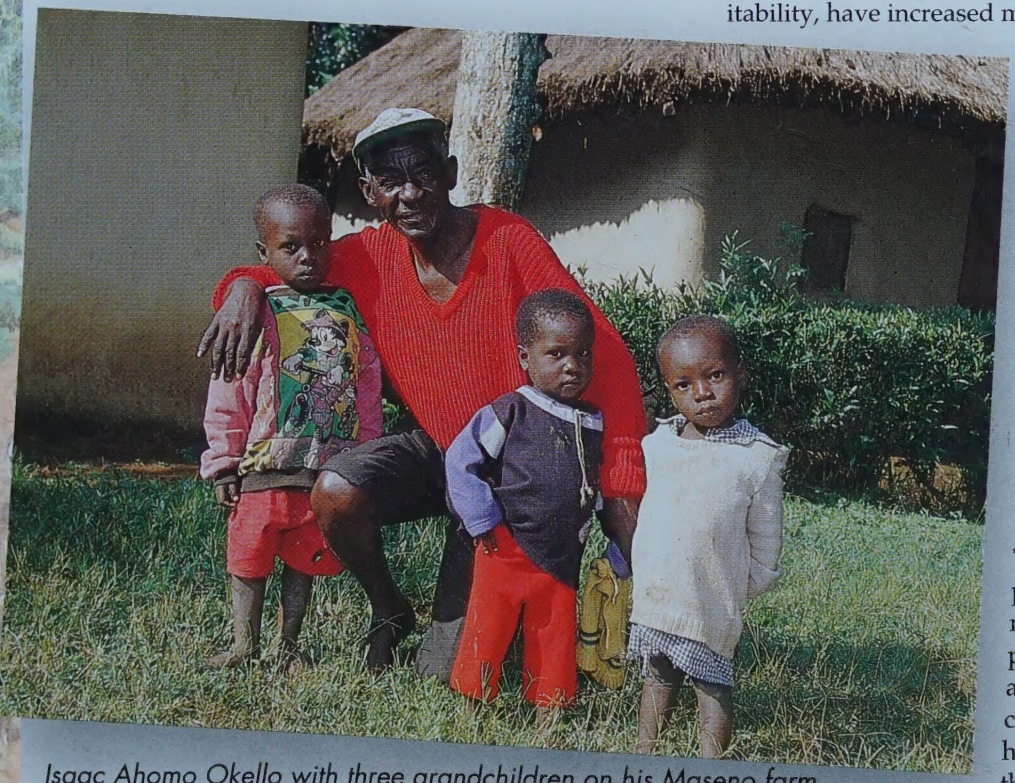
A watching world

ICRAF's involvement doesn't stop now that the new decree has been announced. 'Problems may arise during implementation, and we'll be on hand to help with those if we're needed', says Tomich. 'There will

also be a role to play in drawing lessons from Indonesia's experience and helping others plan and implement similar schemes. The world will be watching to see how this experiment works out.'

The policy change has already attracted the attention of scientists working with the Alternatives to Slash-and-Burn (ASB) programme in Cameroon, a group of whom recently visited the Krui area. Forestry officials in Uganda have also expressed their interest.

On the technical side, the Krui people have asked ICRAF to help them improve damar production through selection and propagation of high-producing trees. They are also interested in ICRAF's ideas on how they can increase the profitability of their production system still further.



Isaac Ahomo Okello with three grandchildren on his Maseno farm.

Selling soil fertility

Every Tuesday and Friday during the season, Isaac Ahomo Okello harvests vegetables from the plots surrounding his homestead and takes them to his local village market in Luero, near Lake Victoria in western Kenya. 'The market is good right now', he says. 'Traders are also coming to my farm to buy vegetables. And I'm supplying local schools.'

It wasn't always so. Okello's produce, and its profitability, have increased markedly in the past year or so, thanks to new agroforestry technology introduced by ICRAF and its partners in local on-farm research and extension.

The technology consists of using the leaves and stalks of a prolific shrub, *Tithonia diversifolia*, the Mexican sunflower, as a green manure to restore fertility to soils exhausted by years of cropping without the addition of fertilizers or organic nutrient inputs. The tithonia biomass decomposes rapidly in the soil, releasing much needed supplies of nitrogen, phosphorus and potassium to growing crops. As well as increased harvests, Okello has noticed that he gets 'nicer green

leaves' when he applies tithonia. Traders too notice the difference, and offer higher prices for the better quality. With both the quantity and quality of his harvests up, Okello says his income has risen since he started using tithonia.

Tapping farmers' knowledge

To western Kenya's farmers, tithonia is not so much a new technique as an underused one. It's over 100 years since the shrub, a popular ornamental, first arrived in the region from southern Mexico. Now it flourishes widely as an attractive hedgerow species, marking field and compound boundaries with a mass of foliage and a splash of bright yellow flowers. The shrub also has medicinal value and is sometimes fed to livestock — but these uses are far from common.

Researchers from ICRAF and the Tropical Soil Biology and Fertility Programme first came across tithonia when they asked local farmers to identify potentially useful species for soil fertility. They hoped that, by tapping local knowledge, they could increase the range of options available to farmers for reversing the area's declining soil fertility. Western Kenya's ample rainfall makes it a high-potential area for agriculture, but centuries of rising human population and continuous cultivation have exhausted its once fertile soils.

The farmers came up with a list of over 10 species, of which tithonia was only one. But several farmers said that, when they cleared land on which tithonia had been present, their crops grew well there. The researchers picked up on this and began trials at the nearby Maseno station to investigate the potential of this species. They found that tithonia leaves contained 50% more phosphorus than legumes, and similar levels of nitrogen and potassium, even though tithonia is not a nitrogen-fixing plant. The trials showed that the farmers were right: tithonia-fertilized plots gave maize yield increases over non-fertilized and even conventionally fertilized control plots that surprised the researchers.

Money talks

The researchers lost no time in taking the technology to farmers. In 1995, they invited 60 farmers to test tithonia biomass on their maize crop. The farmers reported good responses, but complained about the labour required to cut the biomass from hedges, transport it to their fields and incorporate it into their soils. But still, farmers are rapidly adopting this technology throughout western Kenya.

The researchers concluded that the technology would be even more appropriate to high-value crops, because of the higher returns to labour. And indeed, six months later, they found farmers applying tithonia not to their maize crop but to their vegetables. The farmers said that on high-value crops such as tomato, kale and onion, the extra labour was well worth their while.

Word of the farmers' higher profits travelled fast. In a follow-up survey, the ICRAF team found that each of the 60 farmers had persuaded at least two of their friends to give tithonia a try. A further series of demonstration trials conducted by the local extension service boosted adoption still further. Now, an estimated 500 farmers are testing the technology.

Diversifying options for maize production

To Okello and to thousands like him, the price-tag attached to soil fertility is all-important. Standard recommendations for commercial fertilizer applications to maize in western Kenya are 60 kg N and 50 kg P_2O_5/ha a season, costing around Ksh 11 000 (US$185)/ha a year for the two rainy seasons. But more than 60% of farmers in the area earn less than Ksh 50 (US$0.85) a day from their land. That means that farmers are being advised to spend an unrealistically large part of their annual income on fertilizer.

The high price of commercial fertilizers heightens the urgency of the search for alternatives. Amadou

Niang, an agroforester with the KEFRI–KARI–ICRAF project, recognizes that lowering the costs of restoring soil fertility is vital to the future of agriculture in the region. But aside from the cost argument, there are other good reasons for diversifying farmers' soil fertility options. 'In a region like western Kenya, nutrient deficiencies are multiple. That means we need a cocktail of techniques in which synergies can occur', says Niang. 'On both counts, commercial fertilizers alone are clearly not the answer. Agroforestry technology has a big part to play in providing alternatives.'

In 1994, Niang and his colleagues began screening trials to identify promising tree and shrub species that would enrich the soil by adding nitrogen during fallow periods. Three species — *Sesbania sesban*, *Crotalaria grahamiana* and *Tephrosia vogelii* — showed particular promise, producing large amounts of leafy biomass that, when incorporated in the soil, led to a sizeable gain in the yield of subsequent maize crops. On-farm trials in 1996 showed that farmers were able to obtain similar responses.

Once again, word of the new method spread like wildfire. In less than two years, from a base of 35 farmers around Luero village, the on-farm research effort has expanded to cover more than 1000 farmers in 17 villages.

The improved fallows provide more than enough nitrogen for a following maize crop, but the yield increases could be still higher if another deficiency — phosphorus — could be overcome. Again, the imperative is to drive farmers' costs down. The recommended form of phosphorus application at present is triple superphosphate, whose price is the equivalent of Ksh 130 (US$2.20)/kg of phosphorus. Rock phosphate, in contrast, costs only the equivalent of Ksh 65–85 (US$1.10–1.44)/kg of phosphorus. The current source of rock phosphate is a mine at Minjingu near Arusha, Tanzania, which supplies a good soft rock that dissolves easily. The researchers are also looking at an alternative supplier in nearby Uganda, who may be able to supply a cheaper rock of similar quality.

Scaling up

The challenge now is to bring the benefits of the new options to as many farmers as possible. To speed up adoption, Niang and his colleagues are working with national partners, including extension services as well as non-government organizations. A pilot soil fertility replenishment project — supported by the European Union, Rockefeller Foundation, Royal Tropical Institute the Netherlands and World Bank — has been launched using a community-based, participatory approach to the testing and dissemination of all the options developed so far, with special emphasis on the combination of organic (for nitrogen and potassium) and inorganic (for phosphorus) sources of nutrient inputs.

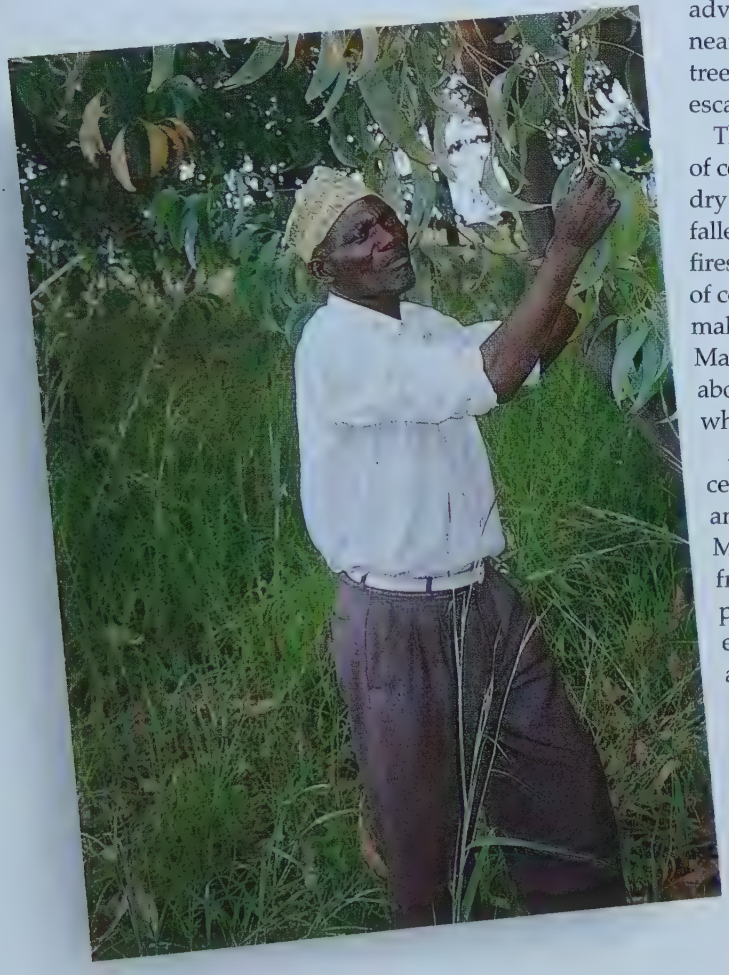
One innovative feature being tested during the scaling up process is the use of village committees to achieve a multiplier effect. The ratio of extension agents to farmers is far too low to allow large numbers of farmers to be reached directly. But social organization in densely populated western Kenya is already complex, and most farmers are members of at least one local institution, be it a church group or a women's group. In the village committee model, each group elects a member to a village committee, which is then trained by the extension service. The delegates return to their groups to pass the training on to others.

The main areas in which farmers need training are in seedling production and tree management. On these and other subjects, the researchers have organized workshops and field days, and have written and produced leaflets and posters in local languages.

As the experience with tithonia has shown, not all the options developed will be suitable for all farmers. To keep a handle on the adoption process, the researchers are using a geographical information system to characterize farms according to both biophysical and socioeconomic characteristics, including soil type and fertility status, wealth classification and ethnic group. The aim is to target each technology to specific groups of users.

Demand pull

Behind the speedy transition from research to development lies a simple fact: farmers find the technology on offer attractive. The experience in western Kenya shows that farmers are willing to nurture the fertility of their soils, provided it pays to do so. Success lies in providing them with a range of options that lower costs while raising productivity. For as long as these vital conditions are met, selling farmers the message on soil fertility shouldn't be a problem.



Hussein Maganga with Acacia crassicarpa *in his woodlot in the Tabora region, Tanzania.*

Tanzania's woodlot cure

Hussein Maganga wasn't around when the fire bore down on his woodlot. But his children were, and they knew what to do. They ran through the smoke-filled air until they reached the advancing line of flames, tore branches from the nearby trees and used them to beat out the fire. A few trees on the edge of the stand were scorched, but most escaped unharmed.

The scene is Isikizya, a village in the Tabora district of central Tanzania. The month is September, late in the dry season, when skies darken but no rain has yet fallen and a dusty wind blows. At this time of year, fires started by farmers to clear land can easily get out of control. As no crops are in the ground, there is normally little of value that is at risk from such fires. But Maganga's children had often heard their parents talk about the importance of the family woodlot. That's why they sprang so valiantly to its defence.

At present, the possession of a woodlot is the exception rather than the rule in Isikizya. But more and more farmers in the area are following Maganga's example. In so doing they are benefiting from new technology introduced by ICRAF and its partners — technology that is restoring a degraded environment at the same time as raising incomes and creating new jobs.

Threatened livelihoods

Around Isikizya village lies a gently undulating, largely treeless plain, crossed only by a few deeply rutted tracks. It's a poor area, with sandy soils and low and unreliable rainfall, in which growing tobacco is one of the few ways to earn a cash income. Yet many farmers cannot get into the tobacco-growing business, as they lack the start-up capital needed to invest in the enterprise's single most expensive input — fuelwood.

Having harvested their tobacco crop, farmers must cure the leaf before selling it to the tobacco companies. Curing is done with a traditional clay furnace, lodged in a barn wall. These furnaces consume very large quantities of wood. Farmers need about 37 t of fuelwood (equivalent to 1.16 ha of miombo woodland) every year to cure the average harvest from a hectare of tobacco. That means the Tabora district, where an estimated 7460 ha of tobacco is grown annually, is getting through some 8670 ha of fuelwood a year, just to feed its tobacco industry.

This village in central Tanzania has long exhausted its principal source of fuelwood supplies, natural miombo woodland. Instead, farmers must order their wood from traders, who deliver it by the truckload from miombo areas many kilometres away. As the radius of deforestation grows, so the price rises inexorably.

Agroforestry solutions

In January 1994, Maganga planted about half a hectare of his land with tree seedlings provided by ICRAF. He and a few other farmers were the first participants in a new project to combat the growing scarcity of fuelwood. The National Agroforestry Research Project, a collaborative effort between Tanzania's Ministry of Agriculture, the Forestry Division of the Ministry of Natural Resources and Tourism, and ICRAF, now operates at several pilot sites in the Tabora and neighbouring Shinyanga regions.

The species planted by Maganga was *Acacia crassicarpa*, one of several Australian acacias introduced to Africa under the project. Maganga's woodlot is now providing cooking fuel for his large family as well as meeting some of his tobacco curing needs. 'My only regret is that I didn't plant a lot more of it', he says.

Maganga's wives have also become firm supporters of the woodlot. In the third year, the trees came into flower for the first time and produced seed. Enclosed by a hard pod which opens when dry, the minute seeds have to be teased free by hand — a delicate task that takes many hours. The work is done in the afternoons under the shade of the woodlot, by the women — who keep the cash they earn by selling the seeds to neighbours keen to plant their own woodlots. A kilo of seeds — numbering around 25 000 — earns them US$5.50. Such is the demand for seed that in one season they sold all they could collect.

The leguminous trees are also helping to restore fertility to Maganga's soils by fixing atmospheric nitrogen and transferring it into the soil by shedding a generous leaf litter. Last year, Maganga noticed a large fungus growing at the foot of one of the trees. 'That's something we normally see only on our rubbish heap', he said. For him, it was proof that the trees were having a beneficial effect on his soils.

In the first two years, farmers are able to intercrop the trees with annual crops, such as maize, tobacco and sunflower. These grow normally and do not seem adversely affected by competition from the trees, despite the rapid establishment of the latter. By the third year the trees form a dense canopy, so annual cropping has to be suspended until after the trees have been felled. But a farmer planting 0.22 ha each year will have enough wood for domestic use and curing. As farm size averages five hectares, with 20% uncultivated, farmers can have woodlots with-

out reducing their area under annual crops, especially since they can intercrop during the first two years.

Also under experimentation by the project is an improved furnace. Designed in Africa and made from locally available materials, the Malakis furnace uses one fifth the amount of fuelwood consumed by the traditional furnace, reducing the amount of improved acacia woodlot required to cure 1 ha of tobacco from 0.20 ha/year to only 0.04 ha. Maganga says he will rebuild his barn to accommodate the new model.

Woodlots clearly have tremendous potential in central Tanzania. And it's not just the researchers who think so. The demand for seedlings has rocketed as word of the new technology has spread in the farming community. Farmers, researchers, extension workers, representatives from non-government organizations (NGOs) and others are networking to speed up dissemination. Seed orchards are being launched, and training is being provided in nursery and tree management.

Policy push

In March 1998, the project hosted a regional policy workshop on the future of woodlots in central Tanzania. Present were government officials, local members of parliament, extension workers, scientists, NGO workers and representatives of the tobacco companies.

At the meeting, the companies agreed to fund dissemination of the woodlot technology and other relevant agroforestry interventions, such as improved fallows. An environmental action group, formed in 1997 and active at the regional level, will manage the funds and coordinate the dissemination process. The Forest Research and Management Programme of Tanzania's Forestry Department will be an active participant, as will several NGOs. Tobacco company extension agents will help train villagers in the production of tree seedlings.

The coalition of interest groups now behind the promotion of agroforestry in central Tanzania promises accelerated progress in reversing the region's environmental degradation. The involvement of the tobacco companies, long urged to take more responsibility for the environmental consequences of their business, is particularly encouraging.

Enhancing local talent

They call her 'Mama miti', Ki-swahili for 'mother of the trees'. Mbiki Mumba, agricultural research officer with Tanzania's Ministry of Agriculture, is a popular figure with farmers in the Shinyanga Region, to whom she began dispensing seedlings and advice for the project when she was posted there in 1994.

'I didn't want to go there at first', says Mumba. 'Now I can't wait to get back. The farmers are so nice. If I miss visiting them, they stop me the next day on the road and say "Why didn't you come? I have this and this problem. I'll be waiting for you today ... and, please, bring me more seedlings." '

Under sponsorship from the project, Mumba is now nearing completion of a master's degree in agricultural economics at New Mexico State University, in the USA. On return to Shinyanga she will carry out her fieldwork for the degree, studying farmers' adoption problems and assessing the impact of the project in the pilot areas. 'I'm confident the training will help me in my work', she says. 'I particularly appreciated the course in statistics, which will aid me in designing experiments and analysing the results.'

Mumba identifies strongly with the project. 'In Shinyanga we are really successful, with almost 1000 farmers adopting', she says with pride. But she's also aware of potential adoption problems. Many farmers own livestock, which are allowed to graze freely once the annual crop harvest is in. Under a by-law, farmers can be fined if their animals damage other people's plants. 'Some of those farmers don't want trees and don't want others to have them either, because it

means they'll have to supervise their animals more closely', she says.

Another constraint is the shortage of water in the area. Most farmers don't have wells and so cannot water their young trees during the long dry season. Mumba is keen to emulate the experience in neighbouring Tabora, where nurseries have been started in depressions where there are ponds or dams.

Committed to her job, keen to make an impact yet keeping an eagle eye out for trouble, Mbiki Mumba is the kind of person ICRAF likes to train. People like her are vital to the future of agroforestry in her country.

Tea for two . . . million

Purity Wanjiku Njagi lives near Embu, in the mid-altitude coffee-growing zone on the slopes of Mount Kenya. She buys her tea and sugar from a store in town, but her milk comes from the three cows she keeps on her smallholding. Besides meeting the family's needs, the cows provide a surplus for sale locally and are an important source of income.

Recently, Purity has been able to increase the profitability of her dairy enterprise. Like most smallholder dairy farmers, she has long grown a field of *Pennisetum purpureum* or napier grass to provide her cows with a basic maintenance diet. But to keep the cows productive, she has had to supplement

Purity Wanjiku Njagi in her shamba (field) in Embu District, Kenya, surrounded by calliandra, napier grass and maize.

this by buying an expensive high-protein dairy meal, fetched from the local market. Now she is growing her own high-protein feed instead, in the form of a hedgerow shrub called *Calliandra calothyrsus*. The switch has saved her an estimated US$150 per cow per year — a substantial proportion of her total income.

A food staple

Milk is a staple part of the diet in Kenya's central highlands, where over 80% of smallholder farmers own at least one dairy cow. Most of the milk produced is consumed on the farm, with small surpluses being sold in nearby medium-sized towns such as Meru, Kerugoya and Embu. The main buyers are the district's many small cafes and restaurants. Some is also sold to private-sector companies or to Kenya Cooperative Creameries, which has a bulking plant in the area.

With population rising rapidly, the demand for milk is growing fast and prices have risen in recent years. But smallholder dairying in Embu District has not yet intensified to the levels typical of the peri-urban systems found around capital cities. In the short term at least, the impact of increasing the supply of milk in Embu would thus be to improve the food security of many thousands of smallholder farm families.

A successful partnership

Purity was first introduced to calliandra by the National Dairy Development Project (NDDP), a Dutch-funded bilateral project with the Ministry of Agriculture, Livestock Development and Marketing. She now participates in that project's successor, the National Agroforestry Research Project (NAFRP), which provided her with the bulk of her seedlings.

Launched in 1991, NAFRP is a collaborative project between the Kenya Agriculture Research Institute (KARI), the Kenya Forestry Research Institute and ICRAF. Under KARI's leadership, the three institutes have worked closely with each other and with the local extension services to build on the start made by NDDP. The NAFRP team quickly settled on research to improve fodder supplies as its highest priority, reflecting the findings of an earlier diagnostic survey that had identified the shortage of high-protein feed as dairy farmers' most serious constraint. NDDP had already introduced a few farmers to three new fodder species — *Leucaena leucocephala, Sesbania sesban* and *Calliandra calothyrsus*.

An initial survey by NAFRP scientists revealed that many more farmers were interested in the new species. In response, the scientists launched on-station and on-farm trials to check the adaptability of the species and introduce them to more farmers.

Finding the niches

Most farms in the coffee zone of Kenya's high-potential highlands are small, typically 1.5 ha. They are also highly diverse, growing a wide range of crop and tree species besides coffee. The challenge facing the researchers was to find ways of introducing new fodder species without obliging farmers to give up growing something else.

Most farmers were already growing napier grass, either in small fodder gardens or as strips along the contour. And most bordered their fields and their farm boundaries with a row of straight-trunked, tall-growing grevillea trees raised for fuelwood and timber. The researchers introduced the three lower-storey fodder species beneath the canopy of the grevillea, with additional rows grown in the open napier grass. All three species established well in both niches. As most farmers practise stall feeding, the young trees needed no protection from grazing livestock.

The trials revealed that sesbania did not withstand intensive cutting and died back after the first year of

utilization, necessitating replanting. Then, in 1992, during the second year of testing, leucaena was attacked by the psyllid *Heteropsylla cubana*, a devastating insect pest that reached Africa from Southeast Asia, where it had already all but wiped out the tree. That left calliandra as the species in which farmers had the most confidence. A second survey carried out in 1995 showed that virtually all the farmers participating in the trials were now using calliandra alone and had extended its use within their own holdings. Many were producing their own seed to expand their plantings or to sell to interested neighbours.

Another outcome of the agronomic trials was confirmation that calliandra is a useful plant for soil conservation. When grown along the contour, it forms a thick hedge to hold back soil and water, forming natural terraces. It can also be grown along embankments as a means of stabilizing them.

Feed value

The project quickly progressed to feeding trials, again conducted both on station and on farm. The results showed that calliandra foliage could replace dairy meal without reducing milk yields or quality. The foliage had to be fed fresh, as tannins quickly bind up the nutrients if it is left to dry, decreasing its digestibility. Farmers said that their animals loved the fresh, juicy leaves.

Calliandra fodder — fed within three hours of being picked for best digestibility.

To feed a dairy cow its normal daily supplement, about 6 kg of fresh matter (equivalent to 2 kg of dairy meal) is needed. To produce this amount of fodder daily, farmers would need to grow around 500 trees on their land. Using only the two niches tested in the on-farm trials, most have room for twice this number.

Dissemination

Having established the feasibility of the technology, NAFRP scientists worked closely with the national extension services and with the farmers themselves to promote it as widely as possible. Farmers were trained in how to raise seedlings, and several have now started their own

nurseries. Larger group nurseries launched in several villages have also proved successful. Calliandra is relatively easy to propagate, with 1 kg of seeds producing up to 10 000 seedlings. Plastic bags, which increase farmers' costs, need not be used.

Word of the new fodder species spread rapidly, and more and more farmers queued up to join the project. By the end of 1997, more than 410 farmers had successfully planted some 95 500 seedlings. About half these seedlings have been planted as a soil conservation measure as well as to increase fodder supplies. In 1998, an estimated 1000 farmers will try out the tree. And the numbers look set to rise even more rapidly in the years to come as the project places greater emphasis on dissemination through the International Livestock Research Institute's System-wide Livestock Programme, which is funding a special project with ICRAF and KARI based at Embu.

Search for alternatives

Although delighted with the success of calliandra, the scientists are conscious of the narrow genetic base on which Embu's increased fodder supplies currently depend. The psyllid epidemic of 1992 showed how vulnerable the smallholder dairy sector would be if calliandra were to fall prey to an insect pest or a disease.

To guard against future catastrophes, the scientists are searching for alternative provenances, species and genera. In addition to *Calliandra calothyrsus, C. juzepczukii, C. houstoniana* and *Acacia angustissima* are among those being screened, using germplasm obtained from the UK's Oxford Forestry Institute. The most promising find so far is that of *A. angustissima,* which gives spectacular yields of biomass, but more research needs to be done on its feed value before it can be recommended to farmers. A number of indigenous species, also identified as potential replacements for calliandra, are currently being tested.

Ingredients of success

Several factors explain NAFRP's success. First, farmers in Embu already have a tree-planting culture and understand the importance of feeding their cows well. That made the project's task in persuading farmers to try new fodder species relatively easy.

A second factor is the strength of the national research and extension services in Embu. KARI has had a presence in the district since the 1950s, enabling it to win farmers' confidence with a steady stream of new technology (especially improved maize varieties). Both the provincial and the district branches of the extension services are also based in Embu, allowing more intensive interaction with the farming community than in other areas. Over the years, strong links have developed between research and extension.

Third, and most important, the technology cuts costs and increases farmers' profitability. It is also useful in conserving soils, but that's a happy side-effect rather than a real incentive to adopt. The bottom line, as always, is the impact on farmers' livelihoods.

Potential

Replacing dairy meal with calliandra would bring impressive economic benefits. Kenya's highlands are home to around 400 000 smallholder dairy farmers, each of whom typically owns one or two cows (the average is 1.7). If every farmer making the switch saves US$150 per cow per year, the sector as a whole could save an extra US$102 million annually.

That figure, of course, refers only to Kenya's smallholder sector. Calliandra also has potential in large-scale dairying, which supplies 30% of the country's milk. And there are several other eastern and southern African countries with highland areas where calliandra could make a similar difference. Indeed, the species is currently being tested in Ethiopia, Uganda, Tanzania and Zimbabwe.

Tackling a thorny methodological issue

Each year ICRAF hosts a major international conference or workshop. Past meetings have had a technological theme and have focused firmly on agroforestry, covering such subjects as tree domestication or the use of improved fallows. This year we decided to broaden the focus and to tackle a particularly thorny methodological issue — how to measure the impact of research on the management of natural resources.

The workshop, entitled Assessing the Impact of Research in Natural Resource Management and held 27–29 April 1998 at ICRAF's headquarters, was the first of its kind to be organized in the research system of the Consultative Group on International Agricultural Research (CGIAR), to which ICRAF belongs. Participants came from most of the CGIAR research centres, national institutes, non-government organizations and the donor community. 'The ease with which we were able to find funding testifies to the importance of this issue to donors', says ICRAF's director of research Anne-Marie Izac, who organized the workshop.

The rationale for the workshop was simple: while methods for assessing the impact of commodity research are relatively well understood and easily applied, the equivalent methods for natural resource management research are not. The impact of such research is often delayed — trees, for example, may take a decade or more to grow and produce their full range of products — and is often felt outside the area in which project interventions are made. For example, planting trees in the upper reaches of a watershed may reduce the silt loads carried down rivers and so prolong the life of downstream irrigation schemes. Factors such as these mean that assessments must span a large range of temporal and spatial scales. In addition, natural resource management research covers multiple products and services and each natural resource management project is different, so the indicators of impact that can be used are many and variable.

None of this means that impact assessment in natural resource management research doesn't take place, according to Izac. 'We've all done it', she says, 'but in bits and pieces rather than comprehensively'. Nor is it true to say that there are no methods. 'Methods have been developed and we use them. But what we lack is an overall set of principles and a conceptual framework.' The aim of the workshop was thus to compare experiences, identify the knowledge gaps and develop a plan of action to tackle them, rather than to start creating a methodology out of nothing.

So what came out of the workshop? 'We made progress', Izac says, 'but we still haven't put together a definitive set of principles and a conceptual framework. We'll have a shot at doing that in the synthesis paper.' At the workshop itself there was consensus on several important points:

- Impact assessment has to be planned at the outset of the research process, not added on afterwards as an afterthought
- The criteria for assessment should reflect the objectives of the research. Careful definition of these objectives is therefore essential at the outset of the research process
- Appropriate stakeholders in the process, including land users, must be involved in both the selection of objectives and the definition of impact indicators. Stakeholders who are left out often won't buy the assessment's findings.

Several difficult issues remained unresolved. One of them is how to integrate the conflicting objectives of different stakeholders in the assessment of overall impact. For instance, if an intervention increases the environmental benefits of a production system without increasing yields and incomes, that may constitute a positive impact in the eyes of society, but the farmer will probably not see it that way. In a sense the question is academic, since in such situations the farmer rarely adopts the intervention unless under duress. But it becomes relevant again if policy changes to encourage adoption are being considered.

Another question is deciding how far to extend the time-frame of impact assessment. Especially where policy reform is concerned, the impact may come decades after the end of the research project. In a recent case, a government reached for a row of reports gathering dust on the bookshelf, liked what it read and implemented two of the recommendations in them. The reports were 15 years old! Periods this long carry high costs if impact assessment is carried out repeatedly as a formal exercise. Yet if the cut-off date is too early, some kinds of impact will be exaggerated while others will escape detection altogether.

And what of win-win type interventions? As befits a director of research, Izac strikes a note of caution. 'True win-win situations are rare', she says. 'There's more likely to be a trade-off between environmental and economic gains. At the workshop, we mostly discussed trade-offs.' What is clear is that workshops like this are critical in providing a framework for assessing the impacts of adoption of trees in agricultural landscapes.

Produce from some Latin American trees — fruits like these are the subject of research on the management of natural resources.

A double celebration

Happy birthday, ICRAF!' Thus ICRAF's director general, Dr Pedro Sanchez, launched a day of celebrations at the Centre's Nairobi headquarters on 23 April 1998. We were celebrating the opening of ICRAF's new research building, and the completion in 1997 of 20 years of work by ICRAF.

The day's first formal event was a seminar given by Dr Ismail Serageldin, chairman of the Consultative Group on International Agricultural Research (CGIAR), whom ICRAF was delighted to welcome as one of several guests of honour at the occasion. To an appreciative audience in the Lundgren auditorium of the original building, Dr Serageldin gave a stimulating account of the work of the CGIAR and of ICRAF's contribution to it. ICRAF, he said, played a leading part in the 'contextualization' of agricultural research — its adaptation to users' needs, its links with other sectors and its accommodation of natural resource management concerns. Dr Serageldin went on to paint his vision of the coming revolution in biotechnology which, he said, would transform research and agriculture in the next 25 years.

After a lunch for the guests, at which many old friends were welcomed back to ICRAF, the focus of activity switched to ICRAF's new research building, where guests and staff gathered for the second of our two causes for celebration, the building's inauguration. The research building is designed by the same architects as the original building. Offices and laboratories are grouped around two spacious courtyards

The Honourable Andrew Kiptoon, Kenya's Minister for Research and Technical Training, cuts the ceremonial ribbon for the new building at ICRAF Nairobi campus.

Pictured (left to right) are ICRAF Board members Moise Mensah and Uraivan Tan-Kim-Yong, KARI director Cyrus Ndiritu, CGIAR chairman Ismail Serageldin, ICRAF Board chairman Yemi Katerere, Mayor of Nairobi Samuel Mbugua, the Hon Andrew Kiptoon, former ICRAF director general Bjorn Lundgren, Tamara Scott, ICRAF director general Pedro Sanchez, former Board chairman George Holmes, former Indonesian Minister of Forestry Djamaloedin Soeryohadikoesoemo, and ICRAF staff member Lucille Teemba.

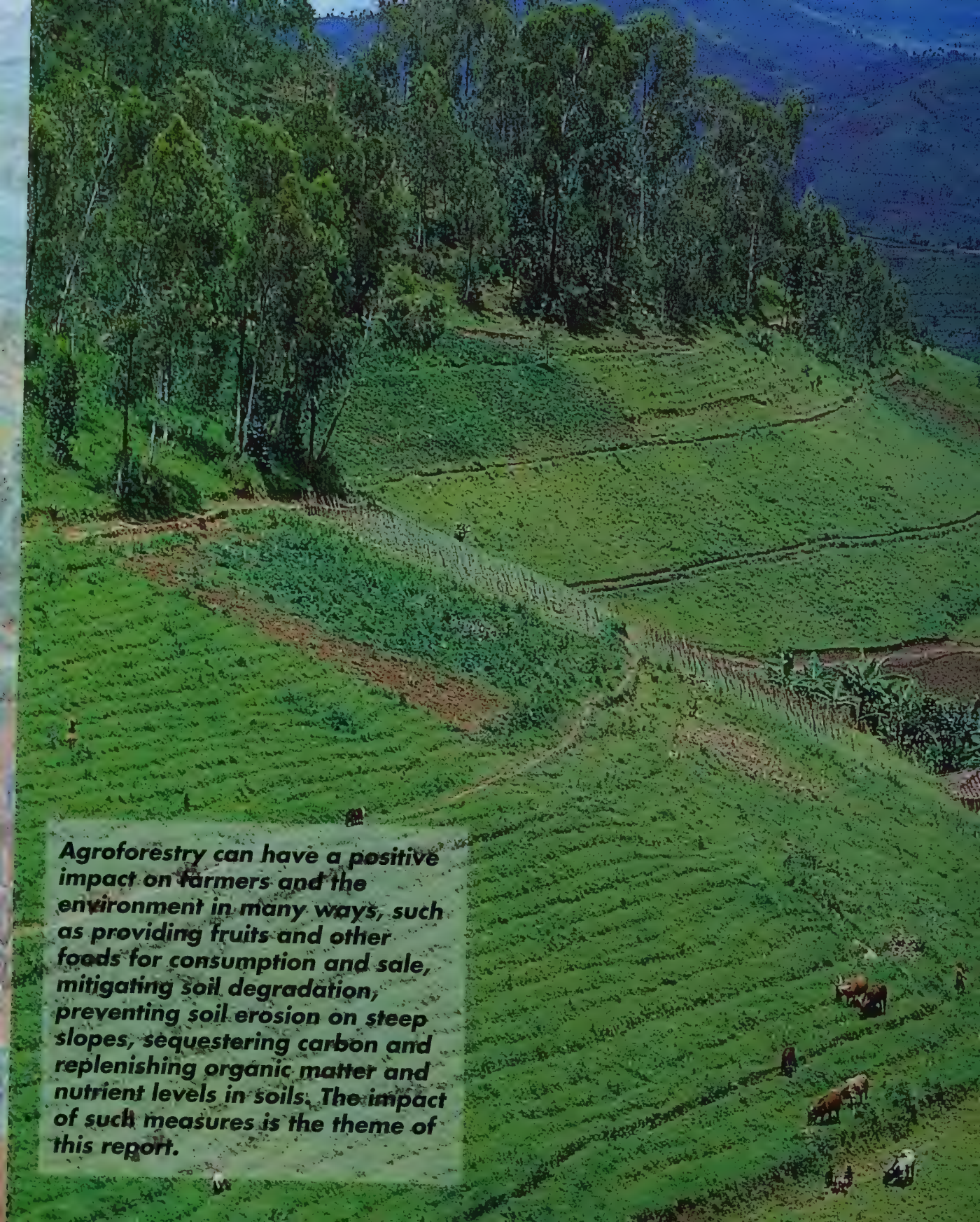
separated by a central auditorium. A mark of ICRAF's transition from council to research centre, the laboratories provide much-needed room for work vital to the Centre's future agenda, including tree domestication research, germplasm resources, soils and plant analysis and geographical information systems. The new building also houses ICRAF's research division and hosts a number of other institutions — CAB International, GTZ Integration of Tree Crops into Farming Systems Project, International Crops Research Institute for the Semi-Arid Tropics, International Plant Genetic Resources Institute, Centro Internacional de Mejoramiento de Maiz y Trigo, and Regional Land Management Unit — as well as the laboratories of the Tropical Soil Biology and Fertility Programme. The proximity of these institutions is a boost to the logistics of regional collaboration.

Presiding over the inauguration was an old friend of ICRAF, the Hon. Andrew Kiptoon, Kenya's Minister for Research and Technical Training. Proceedings began with prayers led by the Very Rev. George Wanjau, of St Andrew's Church Nairobi, in which he asked for God's blessing on ICRAF's endeavours. Next came a welcome address by Dr Sanchez, who sketched ICRAF's evolution from council to research centre. Dr Katerere, chairman of ICRAF's Board of Trustees, thanked donors for their support of ICRAF and also called upon the staff of ICRAF to stand for a round of applause in appreciation of their work.

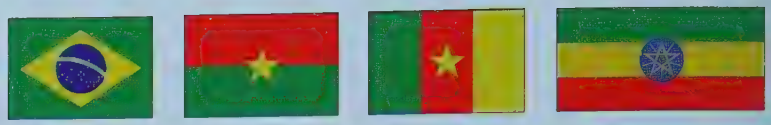
Dr Serageldin then gave his second speech of the day, a stirring reminder of the mission of the CGIAR to alleviate poverty, protect the environment and improve food security. 'We are guests of farmers on this planet', he said, 'yet they are poor and marginalized. It is our duty to be their allies.' Finally, the Hon. Andrew Kiptoon reaffirmed Kenya's commitment to the CGIAR and called upon scientists to provide leadership in solving the problems of sustainable development. He then declared the building open on behalf of President Daniel arap Moi.

Ir Djamaloedin Soeryohadikoesoemo, Indonesia's former Minister for Forestry, concluded the day's formal proceedings by giving a seminar on his government's recent policy initiative — a decree placing some 29 000 ha of Sumatra's Krui agroforests under community management. The Minister said that the opportunity to empower local people had been the single most important factor behind his decision to issue the decree.

ICRAF's new research building at our headquarters in Nairobi, Kenya.



Agroforestry can have a positive impact on farmers and the environment in many ways, such as providing fruits and other foods for consumption and sale, mitigating soil degradation, preventing soil erosion on steep slopes, sequestering carbon and replenishing organic matter and nutrient levels in soils. The impact of such measures is the theme of this report.



ICRAF in the tropics

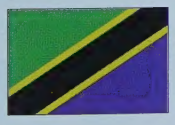
ICRAF activities are carried out by programme and project. We carry out these activities with our partners at sites and stations in 22 countries—locations chosen within our six ecoregions: the humid tropics of Latin America and of Southeast Asia, the humid lowlands of west Africa, the highlands of eastern and central Africa, the subhumid plateau of southern Africa, and the semi-arid lowlands of west Africa. These sites represent a range of biophysical, environmental and socioeconomic conditions broad enough to provide us with the global perspective we need to produce international public goods from agroforestry research. ICRAF has only one research station of its own, located at Machakos in Kenya. Therefore, our on-station experimental work is done almost entirely in the research stations of national agricultural research systems (NARS). As a result, collaboration with NARS provides a critical link between ICRAF and farmers, especially in assisting with the adaptation of research results for a wider clientele.







The designations employed and the presentation of material in this publication and in its maps do not imply the expression of any opinion whatsoever on the part of ICRAF or the CGIAR concerning the legal status of any country, territory or area or its authorities or concerning the delimitation of its frontiers or boundaries.






TAKING STOCK

ICRAF's work continues to have positive influence at different levels. First, we have successfully developed and tested models and methods which have increased our predictive understanding of agroforestry systems and of the role such systems can play in agricultural intensification. These include a decision support system for predicting deforestation risk in humid forest margins, and a spatially dynamic soil erosion model which takes account of trees. Such advances benefit the global scientific community, as do our publications, such as the new *Tree seed suppliers directory* and *Replenishing soil fertility in Africa.*

Second, some of our results and approaches have now been taken up by influential international institutions such as the World Bank (our work on soil fertility replenishment and its associated paradigm have been recognised as priorities by the bank, FAO and other donors in sub-Saharan Africa) and the Global Environmental Facility (which recognises as valuable our natural resource management approach to the management of slash-and-burn agriculture in forest margins).

Third, ICRAF has affected regional and national policy-making, in particular in Southeast Asia. The new decree to which ICRAF and our partners contributed has a major positive effect on the welfare of thousands of indigenous farmers at the forest margins of Sumatra. Similar work on the management of fires should start bearing fruit in the next few years.

Fourth, our training and capacity building activities, which have a substantial impact on regional and national institutions, continues to spread in Africa and started to gather momentum in Southeast Asia.

Fifth, ICRAF has started to have a direct impact on farmers. In southern Africa, about 4000 farmers have started to adopt improved fallows, which increase their maize yields by 200–400%. In western Kenya, more than 1500 farmers are experimenting with ways of increasing soil fertility through synergies between organic (tree-based) and inorganic nutrient sources. These options increase their crop yields by 300–400% and increase profitability when farmers shift from food crops to high-value crops. In the Philippines, ICRAF has helped farmers create a land care association, with more than 1000 farmer members, spreading conservation farming methods to other farmers. We are fully aware that impact on this specific category of stakeholders — farmers — is only just beginning. We therefore decided to create a new Development Division in 1998, and we look forward to expanding our ability to significantly improve the livelihood of large numbers of farmers in the tropics while protecting the environment.

OUR INVESTORS

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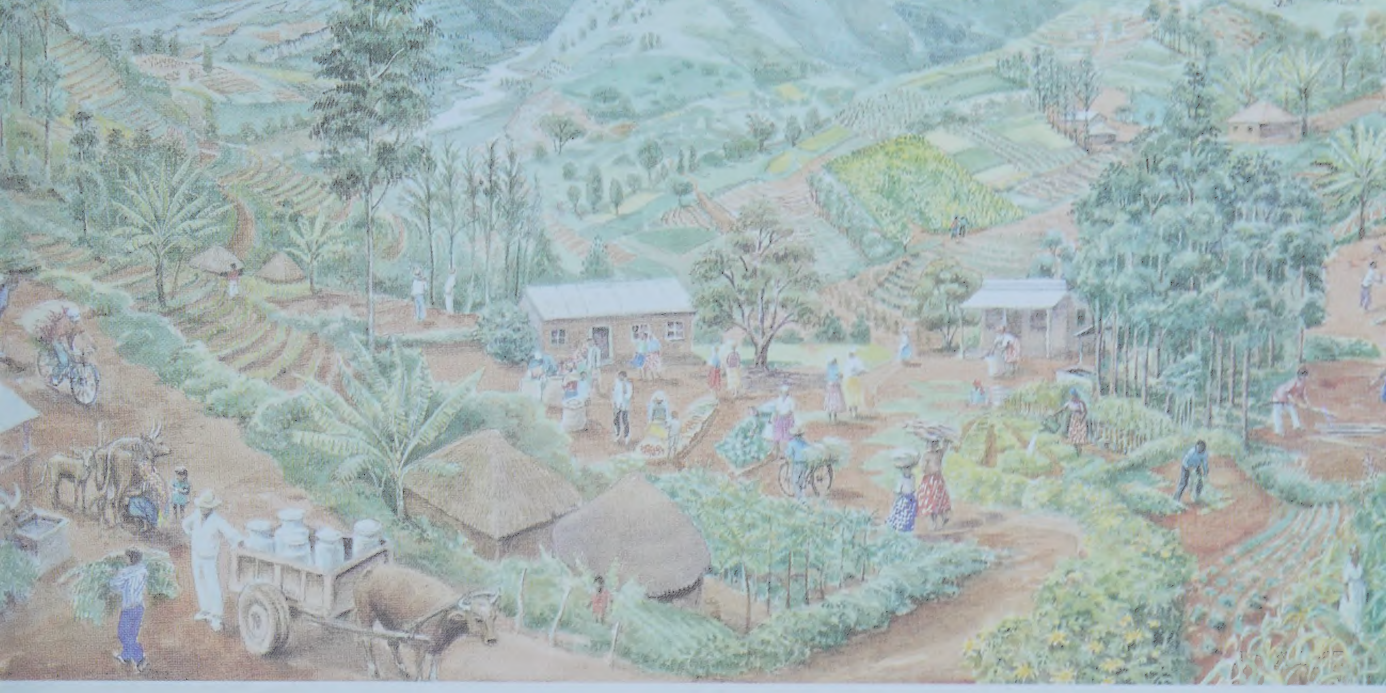

In the east African highlands, farmers use agroforestry practices depicted on the cover of this report to replenish soil fertility and boost crop and livestock yields. They grow *Calliandra calothyrsus*, a leguminous fodder plant, in local nurseries, feeding dairy cattle with it to improve milk production. Improved fallows of another legume, the shrub *Sesbania sesban*, help restore soil fertility. Biomass from the common shrub tithonia increases vegetable and maize yields. Woodlots of trees including *Alnus acuminata* and *Grevillea robusta* yield fuelwood, timber and other products.

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