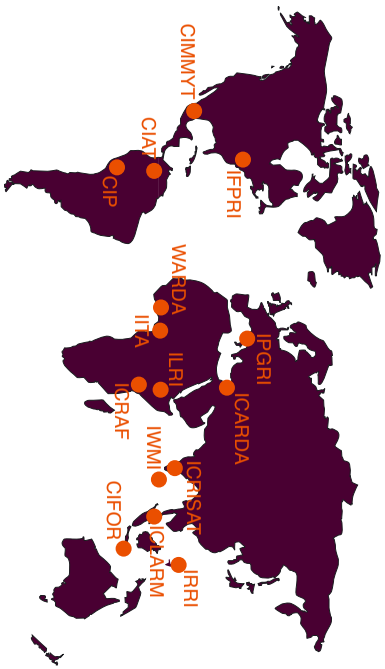

MORE

Method in Our Madness

Towards a toolbox for ecoregional research

The Ecoregional Fund

The Ecoregional Fund was launched in 1995 with a contribution from the Directorate General of International Cooperation (DGIS) of the Dutch Ministry of Foreign Affairs. In 1996 the Swiss Agency for Development Cooperation (SDC) became a second contributor. The Fund's purpose was to support the planning and implementation of ecoregional research in the developing world through the application of modelling tools and processes.

During its first phase, from 1996 to 2003, the Ecoregional Fund supported ten projects in Asia, sub-Saharan Africa and Latin America. In a consolidation phase launched in 2003, a further three projects were supported. The Fund was originally managed by the International Service for National Agricultural Research (ISNAR), but when this institute closed in early 2004 management passed to PricewaterhouseCoopers. An International Scientific Advisory Committee (ISAC) was responsible for vetting project proposals, monitoring the implementation of projects and evaluating their performance during the first phase. After ISAC was disbanded in late 2003, these functions passed to a Coordination Committee. The Fund completed its activities and held a final workshop to report its results in September 2005.

MORE Method in Our Madness

Towards a toolbox for ecoregional research

ISBN–10: 90–9020302–8
ISBN–13: 978–90–9020302–7

Correct citation:
Ecoregional Fund 2005. More Method in Our Madness: Towards a Toolbox for Ecoregional Research. c/o PricewaterhouseCoopers, The Hague, the Netherlands.

For more detailed information on the projects supported by the Ecological Fund, see the Fund's website at www.ecoregionalfund.com

'If this be madness, yet there is method in't' –
Hamlet Act II Scene 2

About this publication

This volume is the second in a two-part series describing the activities supported by the Ecoregional Fund. The first volume was published in 2004 by the International Service for National Agricultural Research (ISNAR), under the title *Method in Our Madness: Making Sense of Ecoregional Research with Modelling Tools and Processes*. In this second volume, as in the first, we have allowed our chosen writer, Simon Chater of Green Ink Ltd (UK), the freedom to express his own views of the Fund's activities. His first draft was circulated among project leaders and members of the Fund's Coordination Committee in order to detect any obvious errors of fact or interpretation, but aside from that the account is his, not ours.

Johan Bouma, Chair, Ecoregional Fund Coordination Committee

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Acknowledgements

On behalf of all the participants in the consolidation phase of the Ecoregional Fund, I would like to thank the Ministry of Foreign Affairs of the Netherlands, whose generosity made this phase possible. I am also grateful to the members of the Coordination Committee and to the project leaders, whose tireless efforts brought most of the Fund's activities to a successful conclusion. Lastly, special thanks go to Joep Meerman and Pauline Rauwerda of PricewaterhouseCoopers for their hard work to ensure efficient administration of the Fund's affairs, especially the organization of its final workshop.

Johan Bouma, Chair, Ecoregional Fund Coordination Committee

Like its predecessor, this second volume about the Ecoregional Fund's work owes its existence to Johan Bouma, who not only invited me to write it but gave me the freedom to write what I wished – an unusual privilege for writers of corporate publications. Johan's unique vision of the role of research, his commitment to the communication of its results and his astute comments on research activities have been an inspiration to me as, doubtless, to the many others with whom he has worked throughout his long career, now drawing to a close. I am sure all who have enjoyed his wisdom, humour and kindness over the years will join with me in wishing him well in his retirement. I'm also indebted to the Fund's Phase 2 project leaders – Jetse Stoorvogel, Roberto Quiroz and Steve Staal – who gave me much of their time, answered my many questions with clarity, enthusiasm, patience and good humour, and provided useful comments on my first draft. The projects' reviewers – Barry Dent, Charles Gachene, Tom Veldkamp and Ronald Mackay – have enriched my account with their many shrewd observations. Lastly, a big thank you to Joep Meerman and Pauline Rauwerda of PricewaterhouseCoopers for keeping me comfortable, well fed and refreshed (it wasn't always water) during the workshops whose logistics they so skilfully organized.

As in the first volume, I've done my best to correct any errors of fact or interpretation pointed out to me by those who read and commented on my first draft. I take full responsibility for any remaining imperfections.

Simon Chater, Green Ink Ltd, UK

Preface: The story continues

In 1995 the Dutch Government's Directorate General for Development Cooperation (DGIS) became the first donor agency in the international agricultural research system to allocate funds to the development of methods for ecoregional research.

It was a time when the system was struggling to come to terms with a new and very different research agenda. The old emphasis on increasing the productivity of staple food crops had given way to a more diverse set of concerns centred round poverty and the environment. Often, the interests of the different groups with a stake in research seemed to conflict rather than coincide. The search was on for the elusive win–win proposition – the intervention from which everyone could benefit. The new complexity of research called for new and more sophisticated analytical approaches. The concept of ecoregional research, then only 5 years old, seemed to meet this need. Yet early attempts to implement it had foundered on the rocks of inadequate methodology.

In launching the Ecoregional Fund, DGIS set out to tackle this problem by supporting the development of modelling tools. To provide expertise for this effort, it turned to the University of Wageningen, home to a group of researchers who were recognized internationally for their work on modelling. The new fund would enable this group to strengthen its links with similar groups around the world. The impetus given to the global research effort would lead to the generation of a new set of models better adapted to the challenges posed by ecoregional research.

Between 1996 and 2003, the Fund supported ten projects across the world's three major developing regions. The story of this first phase of the Fund's work is told in *Methods in Our Madness*, published in 2004 by the International Service for National Agricultural Research (ISNAR), the institute appointed by DGIS to oversee the projects' implementation. That publication also provides background information about ecoregional research and modelling, so readers needing such information should turn there first. This companion volume continues the story of the Fund's activities, focusing on the consolidation phase approved by DGIS in 2003.

The Fund chose some 'big issues' for this second phase – issues that present policy makers with difficult and dangerous choices. Difficult because the issues are complex, dangerous because the wrong decisions could lead to economic or environmental disaster. We believe this publication demonstrates the power of ecoregional research as a tool for analysing such issues. Dispassionate analysis, based on the tools and methods developed by the Ecoregional Fund and its partners, is needed now more than ever if the global community is to settle peacefully the many divisive issues that confront it.

Johan Bouma
Chair, Ecoregional Fund Coordination Committee

Setting the Scene

The world has not stood still since the Ecoregional Fund was established a decade ago. Both the international development agenda and the world of modelling have continued to change rapidly – with implications for the Fund's consolidation phase.

New challenges and opportunities

The most significant change in the international development agenda is the consensus that has emerged round the Millennium Development Goals (MDGs). This has led to bold political initiatives to speed up progress in tackling poverty and hunger, though it remains to be seen whether the world's leaders will deliver on their promises.

Set by the United Nations and repeatedly endorsed (despite American resistance) by the community of nations, the MDGs have raised the profile of development issues worldwide, refocused and re-energized the activities of many governments and donor agencies and, in some countries, caught the public imagination. In the UK, during the Gleneagles Summit of the G8 nations in the summer of 2005, millions marched to put pressure on the leaders of the world's richest countries to 'make poverty history'. At the summit itself, at the instigation of UK Prime Minister Tony Blair and Chancellor Gordon Brown, leaders pledged to double aid to Africa and cancel the debts of the poorest nations. And since the summit, USA President George Bush has indicated a new willingness to cut his country's agricultural subsidies, a major sticking point in global trade negotiations. The pressure is now on the European Union (EU) to follow suit.

Public campaigns to end poverty and hunger are putting pressure on the world's leaders

While the MDG process has improved the prospects for tackling world poverty, it has been less effective at instigating action on environmental issues. As the evidence of global warming grows daily more spectacular – meltdown in the Arctic, severe hurricanes in the Caribbean – public awareness of the problem has risen to the extent that, in the UK at least, the majority now perceive global warming to be a greater threat than global terrorism. But the political response has been disappointing. Neither at Gleneagles nor since have world leaders paid more than token attention to the issue – and Washington remains in denial altogether. The UK seems likely to fail to meet its Kyoto commitments to reduce carbon emissions.

While the politicians talked, the UN Millennium Project, under the leadership of well-known economist Jeffrey Sachs, convened a series of task forces to draw up detailed plans of action for achieving the MDGs. The task forces' consultations brought a new coherence to development thinking, enhancing our understanding of what needs to be done where, of the need for concerted action across sectors, and of the

synergies that can be achieved by combining and harmonizing interventions. Their analysis also drew attention to the very different rates of progress towards the MDGs achieved by different countries and regions, with the continuing plight of Africa emerging starkly (see box).

How can ecoregional research contribute to the global effort to reach the MDGs? The Annex to this publication lists the eight goals (see p. 67). The Fund's activities should, if they are successful, contribute directly to Goals 1 and 7 – eradicate extreme poverty and hunger and ensure environmental sustainability – and to Goal 8 – develop a global partnership for development. They may also contribute indirectly to such other goals as promote gender equality, reduce child mortality, improve maternal health and combat major diseases. Ecoregional research can also be used to explore the relationships among goals and the synergies among interventions.

'Our emphasis on improving land use and productivity is a logical starting point in efforts to reach the MDGs.' –

Johan Bouma, Chair, Ecoregional Fund Coordination Committee.

One welcome trend in development thinking that has accompanied the MDG process is the so-called 'rehabilitation of agriculture.' This sector had fallen out of fashion among investors during the 1990s, mainly because of the perception that agricultural projects, routinely derailed by mismanagment or corruption, did not pay off. A variety of factors, including the first signs of success in sub-Saharan Africa, have begun to change that perception. In some quarters at least, agriculture and agricultural research are once again seen as critical to broad-based economic development. Quite when the revisionists will become the guardians of a new orthodoxy remains to be seen, but this shift in thinking certainly has implications for the concept of ecoregional research, which some now find 'too environmentally loaded'. Perhaps the term 'agro-ecoregional research', ugly though it is, would better reflect the balance of objectives that has all along been pursued through this paradigm.

Africa: A region in retreat

Whereas most countries in Asia and Latin America are making progress towards the MDGs, those of sub-Saharan Africa are, with few exceptions, heading in the wrong direction. By 2004 the region had an estimated 204 million hungry people, 28 million of them pre-school children. The proportion of hungry children had risen to 26 per cent, up from 24 per cent in 1995.

Most hungry Africans live in rural areas. Ironically, many are small-scale farmers or farm labourers. That makes raising the productivity of agriculture a vital starting point in efforts to stem the region's rising tide of human misery. The Task Force on Hunger's recommendations to this end include tackling the problem of declining soil fertility, investing in water harvesting, improving access to improved seeds and other planting materials, diversifying into high-value products and reinvigorating the region's under-resourced extension services. The task force also stresses the importance of synergistic interventions such as school feeding programmes: by sourcing ingredients from local farming systems, these could raise rural incomes at the same time as delivering health and educational benefits.

UN Secretary General Kofi Annan has called for a 'uniquely African Green Revolution in the twenty-first century' to spearhead the region's fight against poverty and hunger.

Source: UN Millennium Project, 2005

'White peg' agronomy, symbol of a narrow focus on productivity at plot level, is no longer enough

As we saw in *Method in Our Madness* (which from now on we'll call Vol. 1), ecoregional research was originally the brainchild of the Technical Advisory Committee (TAC) of the Consultative Group on International Agricultural Research (CGIAR). The CGIAR centres had come under increasing pressure to integrate environmental and equity objectives into the research process, alongside the productivity objective that had been their traditional focus. It was this synthesis of objectives, together with the need to include a more diverse set of stakeholders, that TAC had sought to capture by inventing the term 'ecoregional', which emerged from a strategic re-think of the CGIAR system's research conducted in 1990. The re-think led to the reorganization of research at a number of centres and to the establishment of a new set of ecoregional programmes linking the work of different centres and other partners, often in regional consortia (see Annex, p. 65). It was these centres and programmes that became the main partners for the Ecoregional Fund's first-phase projects, when these were launched in the mid- to late 1990s.

In 2003, just as the Fund's consolidation phase was beginning, the CGIAR decided to replace TAC with a Science Council. Although this new entity is still flexing its muscles, early indications are that it will act vigorously to re-focus the CGIAR system on what it sees as the system's area of comparative advantage – strategic research that supports pro-poor development by producing international public goods. The Council has announced its intention to move the CGIAR away from pure development and away from applied research and other activities that benefit only one country. It has also proposed that, over a 3-year period, the centres should adapt their programmes so that 80 per cent of their funding goes to five priority areas (see box). Funds would be allocated through a new system-level mechanism that would work closely with donor agencies and the Science Council.

The CGIAR's five priority areas

The five priority areas identified by the CGIAR's Science Council are:

- Sustaining biodiversity for use by current and future generations
- Producing more and better food at lower cost through genetic improvement
- Reducing rural poverty through agricultural diversification and emerging opportunities for high-value commodities and products
- Poverty alleviation and sustainable management of water, land and forest resources
- Improving policies and facilitating innovation to support the sustainable reduction of poverty and hunger.

The fifth area – improving policies and facilitating innovation – is the one to which the Ecoregional Fund's activities most directly contribute. But in all areas ecoregional research can provide vital support by analysing the issues and informing decision making.

Source: CGIAR Science Council, 2005

This sharpened focus on a reduced number of priorities determined and funded at system level would replace the current centre- and partner-driven allocation of resources. Reactions to these changes have been mixed. While some have welcomed what they see as a return to core CGIAR values, others are critical, viewing the new process of resource allocation as a relapse into the discredited top-down ways of the past, and the new emphasis on research as opposed to development as driving a wedge between two activities that ought to be integrated – a throwback to the no less discredited 'linear approach' to technology development and transfer, discarded in the 1980s.

Another recent development in the CGIAR system is the launch of global challenge programmes. These are intended to tackle 'complex issues of overwhelming global and/or regional significance, requiring partnerships among a wide range of institutes', according to the CGIAR's website. So far, three programmes have been launched on a pilot basis – one on water and food, one on the development of new plant types and one on the reduction of micronutrient deficiencies. A further full programme to address the needs of sub-Saharan Africa has been approved in principle, but has had difficulty in coming up with a coherent set of priorities and suitable institutional arrangements for delivering its outputs.

'Researchers are at their best when ensuring effective communication between citizens and government.' – Johan Bouma

What do these developments imply for the future of ecoregional research? The new priorities document put out by the Science Council affords a continuing place in the system's portfolio to ecoregional programmes, which are expected to draw on research conducted under the five priorities to tackle issues specific to a given region. Examples are soil fertility in sub-Saharan Africa, the degradation of intensive production systems in South and East Asia, trade and market access in Latin America and the Caribbean, and water scarcity in West Asia – North Africa. (All of these issues except the last have been tackled by the Fund in either its first or its consolidation phase.) There is, however, concern that the new global challenge programmes will compete for turf and resources with the other 'regular' CGIAR programmes, including the ecoregional programmes.

Aside from this operational concern, the future of the paradigm itself seems assured, in substance if not in name. Ideas tend to have a short life-span in the faddish world of international development. If the concept of ecoregional research is now in its fifteenth year, that is because its basic principles – the balancing of research and development (R&D) objectives and the inclusion of stakeholders – are as valid today



The Fund has worked on most of the high-profile ecoregional themes mentioned in the CGIAR Science Council's priorities document

as when TAC first defined them in 1990. The enduring nature of these principles is reflected in the growing number of institutions and individuals that have adopted them, whether or not they call the resulting paradigm 'ecoregional research.' The UK's Department for International Development (DFID) is an example of a donor agency that has embraced the concept but dropped the term, apparently because of confusion over its meaning. The New Partnership for Africa's Development (NEPAD) and the CGIAR's Africa Challenge Programme have also endorsed the ecoregional approach.

One reason why ecoregional research is increasingly popular is that it speaks to the spirit of our post-modern age, in which no one has a monopoly on the truth. Johan Bouma, Chair of the Fund's Coordination Committee: 'In traditional research you define a problem, formulate a hypothesis or design technology to solve it, test and adapt the solution, then hand over the results to users. The strength of ecoregional research is that it deals with today's reality, in which we confront multiple viewpoints, interests and problems. So instead of designing a single "magic" solution, researchers must come up with options or storylines describing the future.'

Bouma (left): Ecoregional research deals with multiple viewpoints

Modelling: From development to application

The world of modelling has also changed since 1995 – in many cases directly as a result of the Fund's activities. Most of the changes reflect the demands placed on modellers by a broadening circle of users.

Phase 1 of the Fund's work saw most projects solve the scaling up issue that had dogged early attempts to extrapolate modelling results from the plot to the regional level. Looking back to 1990, Jetse Stoorvogel, Associate Professor of Soil Science at Wageningen University, is in no doubt about the progress made on this issue. 'Fifteen years ago, people tried simple linear calculations. Now they are aware that you just can't do that – that there are spatial issues you have to take into account.' Today's more sophisticated modellers conduct more studies than ever at the regional level – the level most relevant to policy makers.

In keeping with the ecoregional agenda, modelling has gone multidisciplinary – a trend that has accelerated rapidly over the past few years. A decade ago, modellers used to develop and apply biophysical and economic models separately. Today, they seek to integrate different disciplines and perspectives from the outset, in what is called 'bio-economic modelling'. The tradeoff analysis platform developed under Phase 1 is a good example of this new integrated approach (see Vol. 1, pp. 16–21).

Though more remains to be done, modellers have made steady progress in simulating natural processes and rainfed production systems, whose behaviour is less predictable and therefore harder to model than crop growth in irrigated systems. Several models have been developed or adapted to cope with livestock as a feature of mixed production systems. Others deal with soil fertility and erosion, hydrology, pesticide leaching – and so on. Most of these models have been linked to one another and to geographical information systems (GIS) to facilitate the processing and presentation of results. The outcome is what modellers are now calling a toolbox for ecoregional research.

'The search is on for a few key indicators that tell the whole story.' –

Jetse Stoorvogel, Associate Professor of Soil Science, Wageningen University.

A parallel trend is towards simplified versions of models. Conventional models of mixed systems and natural processes tend to be complex, requiring large amounts of data. 'Researchers often need to apply these models in data-scarce environments,' says Stoorvogel. 'Under these circumstances they face two options: either collect the data or use a simpler model. Because of time and cost constraints, simplifying the model is often the more attractive option.'

Opinions differ as to whether this will work. Stoorvogel is optimistic: 'Simpler models will often give you the same answers as more complex ones, using one-tenth of the data,' he claims. 'Complex models *look* more accurate, but often aren't because the data are defective or simply cannot be aggregated.' Other researchers are more cautious, allowing that simplified versions are acceptable when illustrating the uses of a modelling tool or training new users, but not when conducting a detailed analysis aiming at accurate results for policy makers. Perhaps the best solution is to mix and match approaches, using quick screening with few data to gain an overall impression of a problem, then following this up with a more detailed, data-rich study of selected hotspots. This is the approach used by Stoorvogel and his colleagues to apply tradeoff analysis to soil fertility issues in the Kenyan highlands (see p. 32).

Modelling to support precision farming is another growth area. Modellers conduct highly controlled experiments on a computer to gauge the best practices and the most efficient use of resources in response to specific natural conditions or weather events, then pass this information to the farming community for immediate action. Precision farming is a particularly attractive option in the developing world, because inputs here are relatively expensive and the risks of farming higher, especially in rainfed environments. A PhD student at Wageningen is testing this approach with local farmers in the university's backyard. Tomorrow could see its rapid extension to developing country settings. Some early moves in this direction were made during the Fund's consolidation phase, notably in Panama (see p. 11).

Modelling and participatory research make a powerful combination

Perhaps the most significant trend in recent years has been the integration of modelling with participatory research. 'This is the chief strength of the ecoregional approach and the main reason why it adds value over traditional research,' says Stoorvogel. 'Modelling is a critical ingredient because it supports the dialogue among different stakeholder groups, providing an objective basis for negotiations.' Reviewers of the Fund's Phase I projects identified a participatory approach as essential for success.

As modelling has moved closer to its users, the relationship between researchers and policy makers has come under scrutiny. According to Bouma, this relationship varied greatly during the Fund's first phase, from a one-off burst of interest that subsequently died down – the 'straw fire' type of relationship – to continuous or at least repeated interaction over a longer period. Understanding the policy process or cycle can help researchers improve the quality of their interaction with policy makers (see box).

The growing level of interaction with user groups marks the coming of age of modelling and another important shift: from the development of models to their adaptation and application in a broader range of settings. 'Modellers have got their heads up and are looking outwards, away from the computer screen

The policy cycle

The management literature identifies the following stages in the policy cycle:

- *Signalling*. This is the stage at which emerging problems or issues 'come onto the radar screen'. Signalling can come from any quarter – the scientific community, civil society, or policy makers themselves. Global warming is an example of a problem that has gone through a prolonged signalling phase, not yet over in some countries.
- *Design*. Once the problem has been recognized, policy makers must consult with stakeholders to draw up and analyse possible solutions. The more complex or intractable the problem, the longer the design stage tends to be. The outcome of this stage is, typically, a new policy document proposing various options.
- *Decision and implementation*. Policy makers select an option and put in place the policy measures required to implement it. Typical measures might include the deregulation of prices, the creation of a new regulatory body, the passing of a new land tenure law, and so on.
- *Review*. Policy analysts and/or researchers analyse the effects of policy measures to find out whether the outcomes are as anticipated. This is the stage at which 'second generation' problems become apparent, leading to a new policy cycle.

Ecoregional research can be called upon to inform the debate at any or, preferably, all of these stages. At each stage, too, modelling tools and processes can be harnessed to support the analysis.

'Effective interaction with policy makers consists of injecting the right knowledge or expertise into the debate at the right time.' – Johan Bouma.

'Modelling... promises to revolutionize understanding of processes affecting the management of natural resources. In the coming decade, one can expect the development of a more predictive approach to agriculture, the evolution of land and seascapes and the effects of climate, thus providing insights for the development of long-term agricultural policy.' – Priorities document, CGIAR Science Council.

and into the real world, where land users and policy makers face pressing issues on which they urgently need our support,' says Bouma. This shift is particularly evident in the projects and programme areas identified for the Fund's consolidation phase.

Consolidating the achievements

The ten projects implemented during the Fund's first phase (see Annex, p. 66) demonstrated that modelling tools and processes can add value to ecoregional research. However, external reviews revealed the need for further work to secure and extend the projects' achievements. Their findings formed the basis for a proposal to fund a second or consolidation phase, first submitted to DGIS in 2001.

In its original form this proposal outlined five programme areas and three projects. The five programmes would:

- Consolidate the frameworks and methods already developed. The aim here was a clearer exposition of the concept and process of ecoregional research, together with a more systematic presentation of the sequence of tools available for different analytical purposes – the toolbox, in fact.
- Test and apply ecoregional methods in regional case studies. Three studies were envisaged in which the toolbox would be applied to priority policy issues identified by stakeholders.
- Develop more user-friendly software for ecoregional analysis. This would involve further work to adapt and refine specific models and to integrate them so that they could be used together.
- Define strategies for institutionalizing ecoregional analysis. The aim here was to deal with one of the major challenges confronted during Phase I – the transfer of methods and tools to new institutions in such a way as to ensure their continued use once the Fund ceased operations.

- Communicate the results of the Fund's activities. The tools envisaged for this purpose included printed publications (including this one), training materials, websites and workshops.

The three projects would apply the toolbox to priority problems in specific ecoregions. The original proposal envisaged:

Trade is a key issue under research in the Americas

- A project in the Central and South American region, focusing on the selection and application of tools to the issue of free trade and its effects on small-scale farmers and the environment. The countries invited to participate were Panama, Bolivia and Peru. This project would be led by the Centro Internacional de la Papa (CIP), based in Lima, Peru.
- A project focusing on the factors that drive change in mixed crop–livestock systems. This project would analyse data from Kenya, India and Sri Lanka, with a view to predicting how these systems will evolve in response to different policy, technological and institutional interventions. It would be led by the International Livestock Research Institute (ILRI), based in Nairobi, Kenya.
- A project in highland sub-Saharan Africa, focusing on the identification of interventions to combat the key threat to the sustainability of agriculture in this region – declining soil fertility. This project would be led by Wageningen University, from its base in the Netherlands.

Circumstances conspired to delay the proposal's implementation. An extended review process within DGIS ended with a request to re-write and re-budget the proposal to fit a shorter time-span – 3 years instead of 4 – on the grounds that the Fund and its activities had 'been around for a while'. Without an agreed budget, DGIS was unable to release funds to allow work to start. And by the time the proposal had been revised, another problem had surfaced: there was no longer a management agent to oversee implementation. The International Service for National Agricultural Research (ISNAR), which had performed this role during the first phase, was to close, a victim of funding cuts in the CGIAR system. DGIS began a protracted search for a new management agent. This ended only in late 2003, when the advisory division of the international accountancy firm PricewaterhouseCoopers was appointed. This was a happy choice: the division's Joep Meerman and Pauline Rauwerda served the Fund well and took a lively interest in the projects under their care.

Meerman (left) with participants at the Fund's final conference

The delayed start, combined with the reduced time-frame and budget, squeezed the projects hard. To their credit, most of them nevertheless managed to complete most of their planned activities. However, lack of resources or the loss of national partners to other priorities forced two projects to alter their plans substantially: the Andean project had to be reformulated to focus solely on Panama (but was nevertheless able to take in a subproject in Tibet); and the project on crop–livestock systems had to restrict its activities to Kenya.

The Fund in Action

We will now take a tour of the Phase 2 projects, reviewing their achievements and limitations. We travel first to Panama, where researchers examined the likely effects of free trade on farmers and the environment in the run-up to an important policy decision in this area. Next we go to Tibet, where we take a glimpse at the contentious issues surrounding the plateau's water resources, under threat from a combination of overexploitation and global warming. Lastly we come to the highlands of Kenya, where we visit two projects – the first devoted to the issue that, above all others, will define the future of African agriculture, namely soil fertility; the second a study on how highland farming systems are likely to evolve over the next 20 years under different policy scenarios.

To sign or not to sign

'*Algo mas que leche*' runs Cooleche's strapline – 'more than just milk'. For western Panama's largest and most innovative dairy cooperative, the hunt is on for ways of adding value to its basic product. That hunt, however, is about more than diversifying into cheese and butter. It's a bid for survival.

Can Panama's dairy cooperatives diversify out of trouble?

The fact is that Panama, like several other Central American countries, is on the verge of signing up to a bilateral Free Trade Agreement (FTA) with the USA. The pessimistic view, widely held by non-government organizations (NGOs) and shared by some policy analysts, is that they would be fools to do so. After the failure of the Doha round of multilateral trade negotiations at Cancun, the USA is said to be 'picking off' smaller countries one by one – offering a few tantalizing come-ons in commodities in which it doesn't compete, in return for an opportunity to flood the markets of its weaker Southern neighbours with the surplus produce of its own intensive but heavily subsidized farm sector.

Though there are signs that this may be about to change, the USA and Europe have so far been reluctant to give up their own subsidies to producers despite preaching the virtues of free market capitalism to others – a gross hypocrisy that hasn't excited the outrage it should among developed-country consumers. Worse still, the USA's exacting food safety standards for imports, many put in place since 9/11, will continue to raise almost insuperable barriers for all but the largest developing-country exporters.

For Panama, this decidedly unlevel playing field creates a bleak outlook for crop after crop, according to agricultural journalist Blanca Gómez. Take the example of rice, a food staple grown largely by

smallholders. 'The USA subsidizes its producers to the tune of US$ 2 per quintal,' says Gómez. 'We don't have these subsidies. As a result our producers will be hard hit and rural jobs will be lost.' Potatoes, onions, oilseeds, pork and poultry look to be in similar trouble. And the market for liquid milk could be the worst hit of all.

'Our data on food security are shocking, especially in indigenous reservations.' – Blanca Gómez, agricultural journalist.

If there are benefits from an FTA, these are likely to accrue to medium-sized or larger farmers who can afford inputs and capture economies of scale, the pessimists argue. Many smaller or poorer farmers will go the wall and food security, already a problem in deprived rural and urban areas, will escalate. As if that were not enough, there could also be high environmental costs, as producers mine the resource base in the scramble to gain market share.

Producers will have to become more entrepreneurial, according to Salazar (seated)

Guillermo Salazar, Panama's official FTA negotiator, doesn't buy this downbeat assessment. 'There are opportunities out there,' he says, though he admits the country needs better technology and more entrepreneurial expertise if it is to grasp them. The essence of his case in favour of signing is that Panama's domestic market is too small to enable the country's agriculture to prosper in the long term. 'We have to build our exports,' he says. 'If we have to pay tariffs but others don't, then we won't be able to compete.' Other countries in the region are already signing, so Panama had better jump on the bandwagon before it's too late.

And there are other powerful arguments for signing. Even if the country's small-scale producers suffer, food prices should fall. This will be good for consumers, raising the purchasing power of the urban poor in particular. In addition, if the commercial export sector does take off in the wake of the agreement, that will create jobs, both on medium- to large-scale farms and in the input supply and processing sectors. As their farms are taken over, once-independent smallholders will find opportunities as farm labourers and service providers. According to this argument, the FTA will merely accelerate the concentration of farms that typifies the development of agriculture everywhere.

'Will we sink or swim? We have to find and use the tools that can help us analyse and improve our competitiveness' – Blanca Gómez.

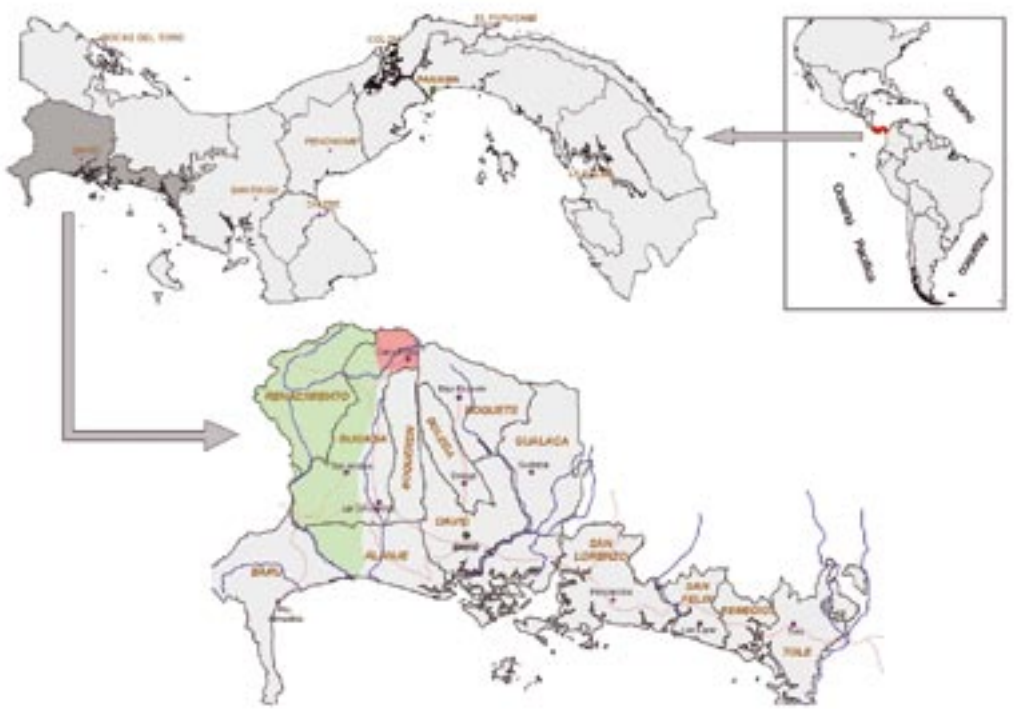
Both sides in the debate agree on one thing: the need for a set of analytical tools that will provide objective evidence of the pros and cons of signing. The tools should be used to conduct an integrated analysis of the FTA's likely effects, covering not only the actual and potential competitiveness of each commodity involved but also the probable impact on poverty and the environment, in each of the country's differently endowed agro-ecological zones. In short, Panama's FTA dilemma constitutes a classic challenge for ecoregional research.

An alliance for integrated analysis

Enter the Ecoregional Fund, which in 2001 put together a project proposal to apply the toolbox approach to ecoregional research in Panama, Peru and Bolivia. The research in Panama would be led by the country's premier public-sector agricultural research institute, the Instituto de Investigación Agropecuaria de

Panamá (IDIAP), but would involve a broad spectrum of partners drawn from government ministries, NGOs and the private sector, with technical support from CIP. It would be conducted mainly in Chiriquí Province, one of the country's most productive agricultural regions (see Figure 1).

Figure 1. Panama and Chiriquí Province.



Project partners:

- Instituto de Investigación Agropecuaria de Panamá (IDIAP)
- Ministries of Agriculture, Health and Environment
- Carinthia S.A. (a private-sector company)
- Cooleche (a dairy cooperative)
- Finca San Judas Tadeo (a banana plantation)
- Various NGOs and farmers' groups in Chiriquí Province
- Centro Internacional de la Papa (CIP)

'Chiriquí is the Brazil of Panama', says project leader Roberto Quiroz. 'Everyone tries to beat our baseball team.' Quiroz should know, since he was born and bred in the province, the son of a smallholder farmer on the slopes of Panama's highest mountain, the 3475-metre Volcan Barù. The mountain not only dominates the province physically but also determines its dual status as both the powerhouse of Panamanian agriculture and an important nature reserve. 'Our moderate climate and volcanic soils make it possible to grow almost anything here,' says Quiroz. The province produces the bulk of the national potato crop together with a host of other vegetables and fruits, and is home to a quarter of the country's cattle. Much of it is also a thickly forested and well watered national park, with nature trails and attractive small hotels. The province is gradually developing its tourist trade.

Chiriquí is one of Central America's finest nature reserves

'These are the kinds of situation we researchers have to deal with. Strategies and implementation plans should allow for such events.' –

Roberto Quiroz, project leader.

Officially, the project got off to a late start. The donor agency, DGIS, approved the release of funds only in April 2003, by which time the partners in Peru and Bolivia had other priorities. This meant that a sub-project in Tibet had to be substituted for their involvement (see p. 22). Then, in May 2004, Panama held general elections and a new government came to power. In September that year the government appointed a new director of IDIAP, who requested that the agreement to collaborate with CIP be renegotiated.

Only in January 2005, nearly 2 years after the proposed start date, was the project given the go-ahead. But these delays hadn't derailed activities at the local level, where a committed group of researchers had formed under the leadership of Melina Sánchez, former head of Chiriquí Province's Cerro Punta research station. Using the data collected by this group, Sánchez and Quiroz created a CD-ROM that they then sent to all project participants, a step that cemented existing partnerships and helped build a stronger alliance round the key challenge facing the research community at national level: to sign or not to sign.

Pause for thought

The project's delayed start meant that the analysis was still unfinished by the time the project's 'final' workshop was held, in May 2005. Nevertheless, the results presented should give Panama's negotiators pause for serious thought.

Milk producers will need to cut their production costs

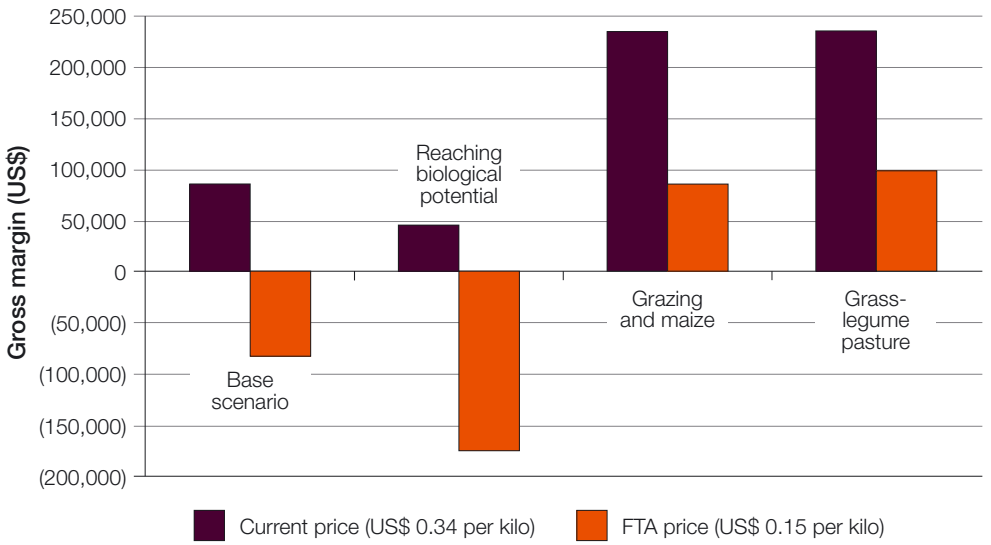
As expected, signing the FTA would subject the smallholder dairying sector to immense pressure. Back in the 1990s, the government introduced a milk pricing policy designed to encourage producers to borrow in order to install up-to-date milking parlours and upgrade their genetic stock. Dairy farmers currently receive up to US$ 0.31 per kilo of liquid milk, depending on their technical level and other factors. In contrast, prices in countries that have already signed an FTA, such as Chile, have fallen as low as US$ 0.15 per kilo.

The project's analysis suggests that producers in Panama's highlands could just survive under an FTA that drove prices down to this level, but to do so they would have to alter their management regime drastically – something they won't be able to achieve overnight (see Figure 2). 'High-yielding purebred dairy cows, fed on expensive concentrates, and state-of-the-art dairy parlours will no longer be affordable,' says Luis Hertentains, who conducted the research. 'Producers who have borrowed heavily to invest in this level of technology will be on their way out.' Instead, research will need to support a lower level of management, with increasing use of home-grown legumes sown in improved pastures.

Farms in the lowland plains appear even less viable, unable to compete below a price of US$ 0.20 per kilo of liquid milk. Many of these farms seem destined to go under, since it is difficult, once in dairying, to switch to other enterprises. One way of fighting back, energetically taken up by Cooleche, would be to diversify into cheese, yoghourt and butter – or perhaps Long Life milk for export.

In contrast, the prospects for beef look surprisingly good. If producers are to compete in the export market, they will need to drive prices down to around US$ 0.80 per kilo from their current level of US$ 1.30. 'We are well placed to do this', says Benjamin Name, IDIAP's Deputy Director General.

Figure 2. Economic viability of highland dairy farming under different technological assumptions.



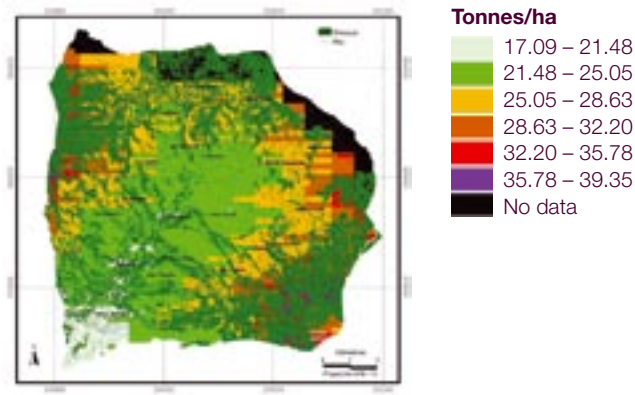
A breeding programme has raised the genetic quality of the country's beef cattle; past research on legumes and pasture grasses has met the challenge of feeding these higher grade animals; best of all, in the swamps and forests of its eastern Darien Province, Panama has a natural barrier against foot-and-mouth and other diseases that handicap its neighbours to the south. 'It all amounts to a solid foundation on which to build a competitive sector,' Name concludes. The only fly in the ointment is that the best place to produce beef is the lowland forest zone, where expansion could lead to deforestation.

The outlook for potato is at best uncertain, at worst decidedly gloomy. In Mexico, signing up to an FTA had a strong negative effect on potato production that hadn't been foreseen by negotiators. 'It was a warning light for us,' say Panama's researchers. According to Mexico's experience, costs need to be driven down to around US$ 0.10 per kilo if Chiriquí's farmers are to stay in the game once the FTA is signed.

To get there, they will need to raise yields to 40 tonnes per hectare, a tall order given today's average of only 26 tonnes per hectare (see Figure 3). Changing the variety grown from Granola, the popular choice since the 1970s, to new ones that are less susceptible to pests and diseases, would help, as also would the more widespread introduction of irrigation. If farmers can kick the chemical habit and instead adopt integrated pest management (IPM) practices, that would take them still nearer. 'But no matter what we do, we cannot come down to US$ 0.10 per kilo,' the researchers conclude. What, then, could save Chiriquí's producers? The domestic market for organic produce is still small, so the opportunities there are limited. As a last resort, the producers' association could perhaps launch a 'Buy Panamanian' campaign to raise consumer awareness – but who would fund such a campaign?

The struggle for competitiveness in potato and other horticultural crops highlights the importance of the natural resource management issues under research at the Cerro Punta station.

Figure 3. Potato yields achieved in Chiriquí using existing variety.



'We face the same chemical culture here as in Carchi Province of Ecuador.' – Melina Sánchez, former head of Cerro Punta research station.

Sánchez and her colleagues are measuring soil erosion, which could accelerate under the FTA

The first of these is IPM. 'The overuse of chemicals is common in Chiriquí,' says Sánchez. 'But bringing about change will be difficult.' Previous research has developed and tested an IPM package, but this has so far caught on with fewer than 10 per cent of farmers. As in Carchi Province of Ecuador (see Vol. 1, pp. 16–21), the challenge is to dislodge a well established 'chemical culture'. And, as also in Carchi, a combination of awareness raising in local communities, on-farm testing and extension of the package, and tradeoff analyis could just do the trick. Paradoxically, in this case the FTA may help, since farmers may be more inclined to cut back on chemicals as prices come under pressure.

Erosion is another major concern. Scientists at Cerro Punta say around 43 tonnes of soil per hectare are lost each year from the high basin of the Chiriquí river. And these losses could accelerate if farmers increase the area cultivated to export crops and persist in using poor cultivation practices. High on a slope overlooking the town, Sánchez and her colleagues are managing a set of experimental plots designed to measure soil loss under different crops and management regimes. Again, awareness raising will be a vital part of the effort to persuade farmers to change their ways. But, unlike in the IPM case, the FTA could make matters worse as farmers short-change their soils in a bid to remain competitive in the short term.

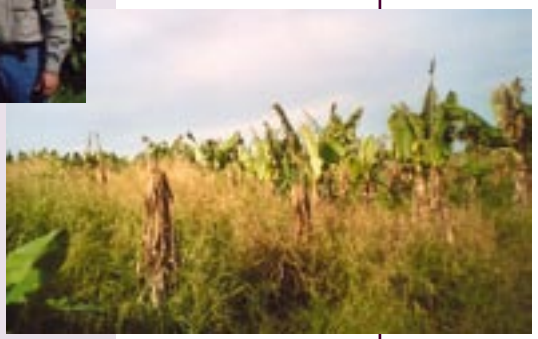
Unpacking the toolbox

Despite its short life, the project made use of an impressive range of tools to aid the ecoregional analysis. In most cases these uses have continued since the project ended.

Remote sensing is being used to assess land use, quantify the adoption of improved pasture, investigate the year-round availability of fodder, and evaluate the economic impact of major crop pests and diseases. Perhaps the most useful application so far has been the mapping of Black Sigatoka disease in banana plantations (see box and Figure 4).

Remote sensing versus Black Sigatoka

A desolate scene greets visitors on their way to the Finca San Judas Tadeo, an independent banana plantation owned and managed by Luis Arauz and his family. Weeds smother the once productive orchards; rusty and broken down harvesting equipment lines the potholed road; a packing plant rests idle, a last carton still on the table; and the houses of former plantation workers lie in ruins.



The culprit is Black Sigatoka, a deadly disease caused by the fungus *Mycosphaerella fijiensis*. There is no cure for this disease, which once established leads inevitably to the abandonment of infected areas, including whole plantations. Black Sigatoka can, however, be prevented, either by injecting plants with a cocktail of fungicides or, more often, by repeated aerial sprayings – up to 60 times a year. Besides polluting groundwater and soils, this cheaper treatment can devastate the health of plantation workers, who are reduced to standing under trees as the planes fly over. Ironically, the build-up of cupric acid in soils can be so severe that it rules out the cultivation of other crops once banana succumbs.

Thanks to frequent spraying, the Finca San Judas Tadeo remains a productive island in the midst of the devastation. Arauz is cheerful despite adversity, hoping to ride out the epidemic that has wiped out his neighbours' farms. If he can, prices should recover from their current depressed level, leading to better times.

Arauz's farm was the location of a research effort that should help him, and others like him, in the struggle to survive. It is here that the project's remote sensing was based. Project scientists produced satellite images showing the extent of infestation across the lowlands of Chiriquí Province. Such maps guide the targeting of interventions to prevent the disease from spreading still further.

The team at Cerro Punta is using tradeoff analysis to explore the relationships between crop production and the natural resource management issues it is already researching. The topics covered include soil erosion under different crops and cultivation practices, the leaching of soil nitrates into water supplies, and the pollution of soil and water with the toxic pesticide carbofuran. The adoption of the IPM package under different price and yield scenarios is also being assessed (see Figure 5).

One of the methodological advances under study is a minimum data (MD) version of tradeoff analysis. This is the creation of Montana State University's John Antle, a member of the team that developed the original concept. Antle worked on the MD version in 2004, after users had fed back the observation that the real McCoy was too demanding in terms of data collection. The MD version uses estimates based on a few empirical observations only.

Another tool proving useful on the natural resource management side is the Soil and Water Assessment Tool (SWAT). Water expert Juan Corella and his colleagues are using SWAT to assess the impact of soil

Figure 4. Banana plantations affected by Black Sigatoka disease in Chiriquí Province.

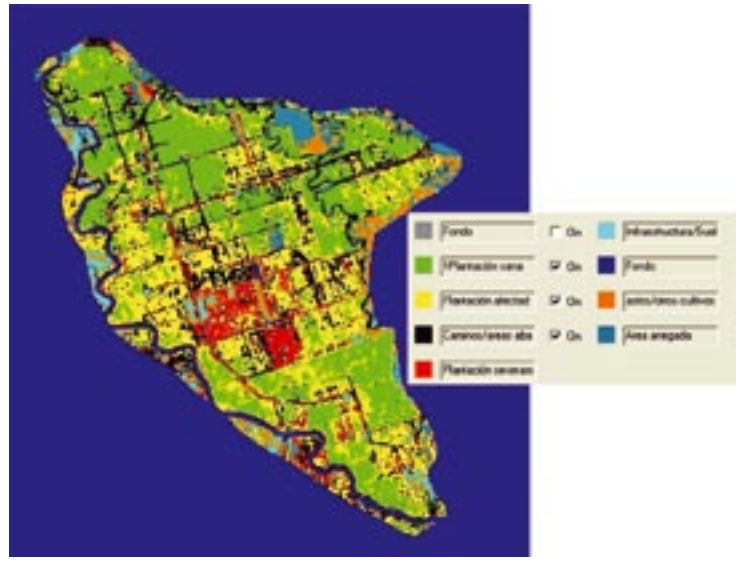
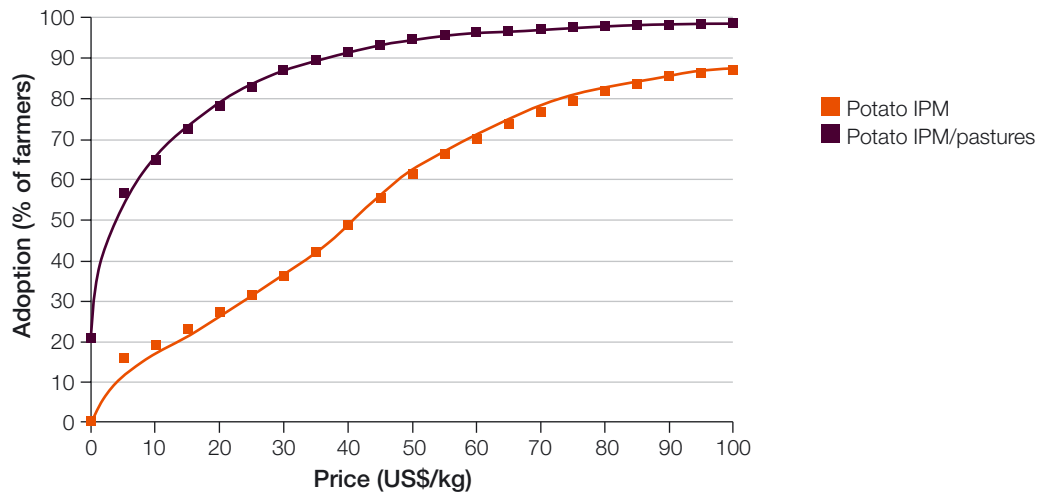


Figure 5. Adoption curve for IPM package at different product prices.



and crop management on water supplies and quality. 'Several of the export crops we might grow more of under the FTA demand higher pesticide applications and up to 30 per cent more water than food crops,' Corella says. 'Tools like SWAT can help us explore the "water tower" function of the Chiriquí watershed.' To improve the analysis of soil and water issues, scientists at CIP and Montana State University are working to integrate SWAT into the tradeoff analysis suite, using the MD version.

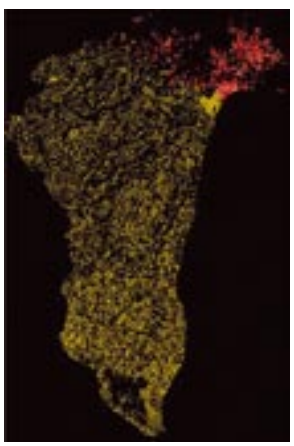
Animal scientists at IDIAP are working with producers and technicians at Cooleche to screen their research ideas with livestock models developed at CIP before implementing trials in the field. The models help to target experiments and decide on the treatments that are likely to make the biggest differences to productivity. The hope is that they will also help dairy and beef farmers make better management decisions in the difficult times that lie ahead. Researchers say that their computerized trials are able to forecast farmers' yields with 90 per cent accuracy.

The IDIAP team's economic analysis has been underpinned by a detailed study of the country's agro-ecological zones, using a variety of models linked to a GIS. At the outset of the project IDIAP already had a database of 100 000 soil samples from around the country. A subset of these, some 19 000 samples, was georeferenced – and interpolation and validation work was also done. The resulting soil maps were correlated with data on rainfall and vegetation. It is now possible to predict the economic viability and environmental sustainability of different commodities in different zones (Figure 6).

The project carried out plenty of training to support the national research effort. IDIAP staff were trained in the use of a CIP-developed potato model called Solanum, the LIFE-Sim livestock model also developed by CIP, the SWAT model, and tradeoff analysis. Cooleche and Ministry of Agriculture staff also received training in livestock models, GIS, remote sensing, tradeoff analysis and SWAT. The ministry's extension workers are now able to design alternative management regimes for individual dairy farms as a function of climate, soils and feed resources.

It is too early yet to tell whether the integrated ecoregional research approach fostered by the project will continue now that the project has ended. But there are promising signs that it will do so. The national partners involved in the project have pledged to continue working together for a further 5 years. The Minister of Agriculture has lent his full support, appointing a team of four IDIAP staff to implement the approach under the leadership of one of the institute's leading scientists. To raise funds for the work, IDIAP has submitted a concept note to the Regional Fund on Agricultural Technology (FONTAGRO); in response, Spain and other donor countries have expressed their interest in providing support.

Figure 6. Economic viability of dairy and beef production in different zones of Chiriquí Province.



What future for Chiriquí?

The analysis so far suggests that, if the FTA comes into force, many of the commodities traditionally produced in Panama will indeed face difficulties. So what new options will farmers be able to turn to? A few fruit crops such as pineapple, watermelon and papaya offer good opportunities. Sugar cane for fuel is another possibility. So too are orchids, over 500 species of which grow wild in the national park surrounding Cerro Punta. And there are other niche markets in organic and fair trade produce, notably specialty coffees (see box). 'But a niche is by definition small,' Gómez warns. 'Even if only a minority of farmers take up these options, the market could quickly become saturated.'

Coffee that smells of roses

La Florentina is the pride and joy of its producer, the private-sector company Carinthia S.A. Grown on the forested slopes of Panama's highest mountain, this controlled-origin specialty coffee is reaching a global market. Its buyer is Starbucks – once a single shop, now a multi-million business with a chain of upmarket and ethical coffee bars across three continents.

Starbucks is a demanding customer, requiring, in return for the premium prices it pays, an exclusive relationship in which Carinthia must meet exacting environmental, quality, food safety and fair trade standards. The multinational carries out twice-yearly inspections to check whether the standards are being met.

To fuel the coffee drying operation, Carinthia must not fell trees from the surrounding forest but may only clear fallen boughs. When it washes coffee, it is bound to keep stream water clear of all effluents. The pulp byproduct is composted with worms and returned to the soil. The company may spray its plantations, but must keep applications to the minimum needed for adequate control of the most harmful pests and diseases.

Labourers on the farm are paid 50 per cent more than the local going rate for similar work and enjoy social benefits such as free schooling for their children, free medical care and accident insurance. A doctor and dentist regularly visit the plantation.

Cradled by forested hills, Carinthia's farm has a happy, peaceful atmosphere, at one with its beautiful setting. Could others emulate this seemingly unique enterprise? Only with difficulty!

More radical alternatives for Chiriquí's future may need to be considered. For as long as agriculture remains the province's primary industry, its people will face difficult choices between environment and productivity. One alternative would be to encourage farmers to move into hydropower, which could generate export earnings and need not be environmentally destructive if carried out on a small scale. Another is to stimulate ecotourism – a course successfully pursued in neighbouring Costa Rica. If this sector were to take off, some of the profits could be re-invested in protecting and enhancing the national park. Panama has so far had little experience in ecotourism, but the case of the Panama Canal Basin shows what can be done when conservation is adequately funded (see box).

When conservation pays

Conservation can work when there's a strong economic rationale behind it, plus the money and other resources needed to implement it properly.

A case in point is the work of the Panama Canal Authority, whose job is to operate and safeguard what has become the country's most lucrative asset. After regaining control of the canal from the USA in the late 1970s, the government's first priority was to ensure an efficient and profitable shipping business – the original reason for establishing the Authority. In 1999, however, the Authority became responsible for guaranteeing freshwater supply and quality in the canal basin – and especially in the canal's raised central section, which depends on the streams and rivers that feed it from the forested hills on either side. The money needed to realize this objective comes from the shipping business, now thought to earn the country over US$ 800 million a year.

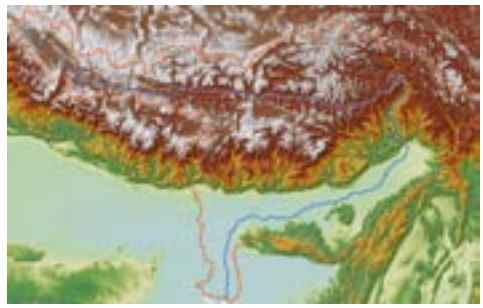
Today forest loss in the basin is estimated at less than 1 per cent a year. Strict controls cover all aspects of life in the basin, which retains a thick cloud cover and high rainfall for 10 months of the year. Biodiversity, and especially bird and insect life, has begun to recover after an earlier period of decline. To monitor soil, water and vegetation trends in the basin, the Authority has set up its own remote sensing unit.

Whatever the future holds for Chiriquí, the ecoregional analysis conducted by IDIAP and its partners will allow Panama to make a reasoned decision on whether or not to sign the FTA. On balance, the current evidence suggests that an immediate decision to go bilateral would be a wrong move and that it would be better to hold out for a regional or multilateral agreement, mediated through the World Trade Organization (WTO). In our brave new globalized world, free trade in one form or another is inevitable sooner or later. Whether it will also be fair is quite another question.

Whose flag on the water tower?

Seven of the mighty rivers that water eastern and southern Asia's lowlands spring from the Tibetan plateau. Among them is the Yarlung Tsampo, later the Brahmaputra, which describes a great question mark as it swings first east, then south, then west, then south again through India and Bangladesh to join the delta of the Ganges (see Figure 7).

Figure 7. Course of the Yarlung Tsampo/Brahmaputra river.



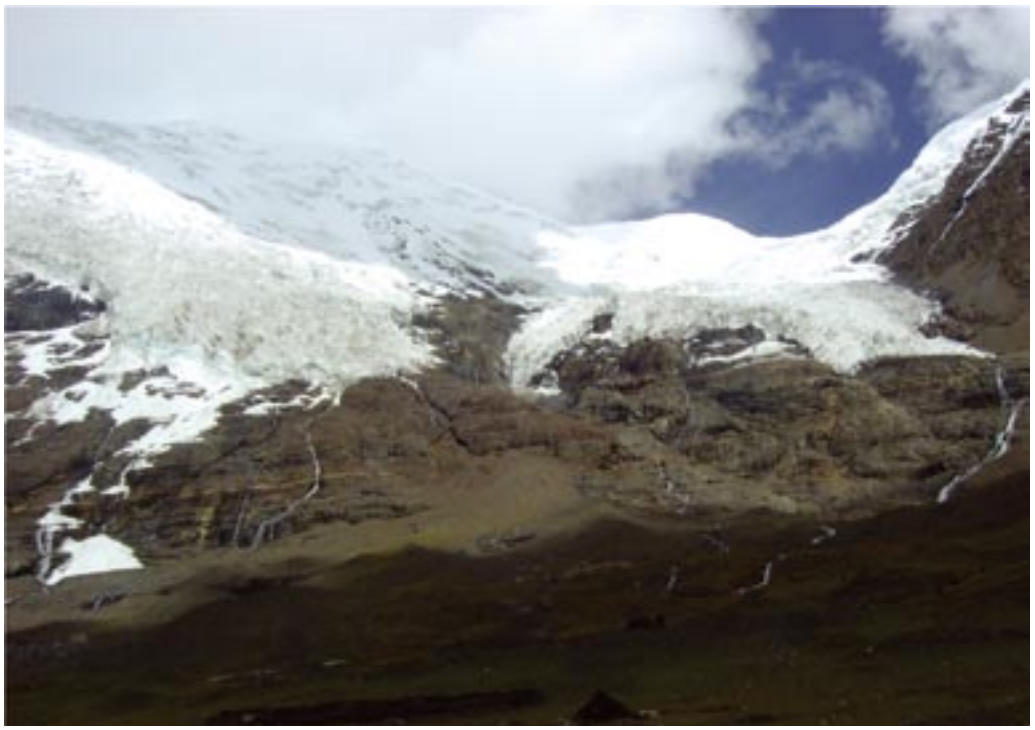
The question mark is apposite, since that is what hangs over the future of water resources, not just in the land that has been called the water tower of Asia but also in its lower lying neighbours. Tibet's rivers flow into some of the world's most densely populated regions, where millions depend on them for life and livelihoods. A total of ten countries use these resources, including Asia's two developing giants, China and India. Water has become a delicate issue in the region's geopolitics, with national governments unwilling to divulge their plans for the sector's development. Rumour has it that the Chinese intend to build the world's largest dam on the Yarlung Tsampo, a move that could put millions of downstream rice growers out of business.

Economic growth is bringing change to a highly traditional society

China is tightening its grip on the so-called autonomous region of Tibet, hoisting its flag over the water tower as it does so. The Chinese government subsidizes easterners to move to Lhasa and other cities to start businesses. Soon a railway will connect Lhasa with distant Beijing and the cities of the eastern seaboard. Tibet's once torpid economy has begun to grow.

Mounting pressures

Tibet's water is locked up in its glaciers – 43 000 square kilometres of them. Since rainfall is low, the glaciers effectively ration supplies, storing water in winter and releasing it in summer, freezing by night and melting by day.



Tibet's glaciers are retreating as global warming takes hold

Historically, Tibetans have used little of this water themselves, allowing most of it to flow downstream to users elsewhere. But, as the pace of development quickens, consumption on the plateau is set to rise, reducing what is left for others. Pressures are mounting throughout the basins of the rivers originating on the plateau, posing multiple threats to both the quantity and quality of water.

In Tibet itself, more than 300 000 people and 7 million animals face water shortages every year – figures that can only get worse as the population continues to rise. The most immediate need appears to be to increase the supply of irrigation water, which is essential for improving both crop productivity and the carrying capacity of rangeland (see box). However, irrigation greatly increases the amount of water that evaporates or is transpired by plants, drastically reducing downstream flows. It may also increase the already naturally high levels of soil salinity, threatening crop production in the longer term.

Tibet has great potential for hydropower to supply China's rapidly expanding cities. But the large dams and other infrastructure associated with hydropower schemes would inevitably stagnate rivers and fragment their reaches, preventing the movement of wildlife. Several species could become extinct.

Deforestation is increasing silt loads in rivers and is thought to exacerbate downstream flooding. Vulnerability to flooding has grown exponentially as the human population of lowland cities and plains has risen. Examples are the catastrophic floods of 1998 and 1999 in China and Bangladesh, which displaced millions.

Tibet's thirsty agriculture

Supply and demand for food in Tibet are increasingly at variance.

Rapid population growth, caused mainly by in-migration, is joining forces with rising incomes and urbanization to increase and alter demand. The staple food crop is barley, but diets are changing, with the demand for meat, milk and vegetables rising sharply.

Agriculture simply cannot keep up. Only 0.3 per cent of the plateau's land is cultivated – the rest consisting of degraded rangeland, barren wastelands, rocky cliffs or snowy peaks. In most areas only one crop a year can be cultivated, under rainfed conditions. Yields are curbed by a short growing season, cold nights and, above all, a shortage of water. Much of Tibet receives less than 600 millimetres of rainfall a year.

Irrigation seems an obvious way forward. The Chinese government plans to increase the plateau's irrigation infrastructure and encourage its farmers to use more water. The expansion of horticulture in greenhouses is a further growth area – one that will also increase the demand for water.

Sources of pollution are multiplying. Not least of these is the rising use of agrochemicals as agriculture intensifies. But industry and consumerism are also playing their part, as the plastic bottles and other debris that increasingly litter riverbanks in urban areas testify. Lhasa's once scrupulously clean riverine environment could quickly go the way of that in other major Chinese cities. Mining, one of the pillars of the economy recognized by the Chinese government, poses a further threat to water quality. Tailings from copper, gold, chromite and other mines produce sulphuric acid, cyanide and heavy metals, all of which are washed downstream and contaminate both soils and waters.

The greatest threat lies in global warming. The retreat of Tibet's glaciers is not a bogey dreamed up by scientists out to stifle America's economy; it is real, and has been measured and documented. The coverage of snow and ice in western China is predicted to decline by 27 per cent between now and 2050. At first the faster melt rate will swell streams and rivers, heightening the risk of flooding, but eventually there is likely to be a drastic decline, reducing flows to a trickle. Quite when is uncertain. 'Hydrologically speaking, mountain regions are a black box, in terms of both the data available and our understanding of the principles involved,' says Walter Immerzeel, the principal scientist responsible for the Fund's activities in Tibet. 'Decline could come faster if feedback mechanisms kick in, or more slowly if compensatory forces come into play.'

Will the water tower function of Tibet survive? No one knows how much other countries would have to pay China to persuade it not to build dams, expand the irrigation infrastructure and encourage greenhouse horticulture on the plateau. What is certain is that the Tibetan case presents a direct clash between development and conservation objectives. There is no easy win–win scenario in the short term. But it is

equally true that, in the longer term, all water users would be the losers if the seven mighty rivers of Tibet were to dry up.

Getting started

The purpose of the Fund's Tibetan subproject was to get an initial fix on these problems and to signal them to policy makers.

The original proposal envisaged collaboration with the Tibetan Academy for Agriculture and Animal Husbandry Sciences (TAAAS). This didn't materialize, largely because the project's sole contact person at this institute was promoted just as activities were starting and no longer had time to take part. Two other institutes, the Tibetan Bureau of Meteorology and the Tibetan Bureau of Hydrology, were invited to participate in TAAAS's place. Both assigned technicians to the project, though not a full-time scientist. The technicians were most helpful in planning and implementing field activities – and particularly in establishing links with farming communities.

Project partners:

- **Tibetan Bureaux of Meteorology and Hydrology**
- **International Centre for Integrated Mountain Development (ICIMOD)**
- **Centro Internacional de la Papa (CIP)**
- **Future Water (a Netherlands-based company)**

The subproject operated at two scales. Immerzeel first used remotely sensed data to study land use on the Tibetan plateau as a whole. Next, he focused on a specific watershed, building a hydrological model as a basis for quantifying how changes in land use, and specifically the intensification of agriculture, would affect water resources downstream. The site of this research was a small valley in Duilondeqing County, around 40 kilometres northwest of Lhasa. Streams here drain into the strategically important Yarlung Tsampo river.

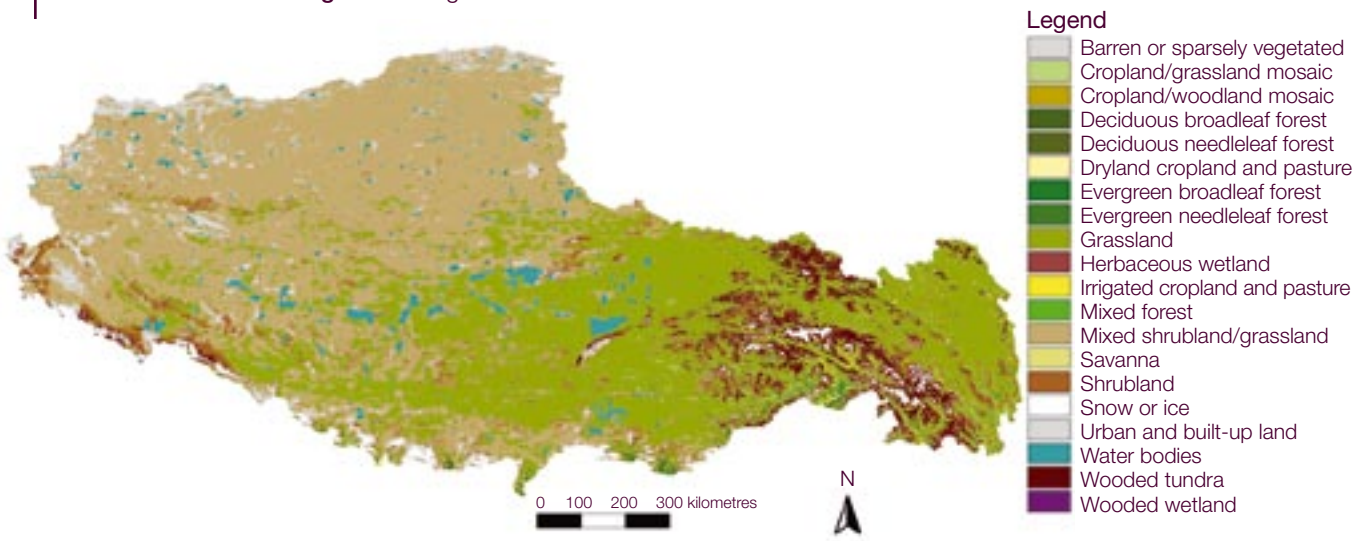
In theory, remote sensing is ideal for understanding the agro-ecologies of areas such as the Tibetan plateau. Conditions here can be highly varied, yet data on soils, vegetation, rainfall and temperature tend

Gathering data in Tibet can be an awesome experience

to be scarce. Obtaining such data requires lengthy and hazardous forays into terrain that is often tough going if not downright inaccessible. In practice the use of remote sensing alone carries some risk of inaccuracy, since in mountainous areas of this kind cloud cover can compound the problems caused by such factors as satellite wobble. Nevertheless, this tool provides at least an initial assessment of land use – quite adequate for the signalling stage of the policy cycle.

Immerzeel was able to use remotely sensed data to quantify the relationship between rainfall and vegetation cover (see Figure 8). This provided a basis for identifying areas that might have scope for increasing food production. It also confirmed the astonishingly small area that is cultivated at present: only about 230 000 hectares, mostly along river valleys in the Shigatse, Changdu and Lhasa Prefectures.

Figure 8. Vegetation cover in Tibet.



A powerful aid

'It makes you gasp when you first see it,' says Immerzeel. No, he's not referring to the view from the Tibetan plateau, though the altitude up there certainly did take his breath away. Immerzeel is talking about SWAT, the model he used for his work at the watershed level. 'It's very comprehensive, representing all the relevant processes. As such it's an incredibly powerful tool for attracting user interest.'

The Soil and Water Assessment Tool (SWAT) embodies a systems approach to hydrology modelling. Developed by the United States Department of Agriculture (USDA) and Texas A&M University, it was designed to predict the impact of different land management practices on water quality and quantity over long periods in large and complex watersheds with highly variable conditions. As such it takes into account the whole range of variables affecting outcomes, including rainfall, temperature, soils, slopes,

land use and crop management. The model's outputs include land-based processes (such as evaporation, transpiration, runoff and groundwater flows), channel-based processes (such as stream flow, sediment transport and chemical loads), and agronomic processes (such as crop growth, nutrient cycling and salinization).

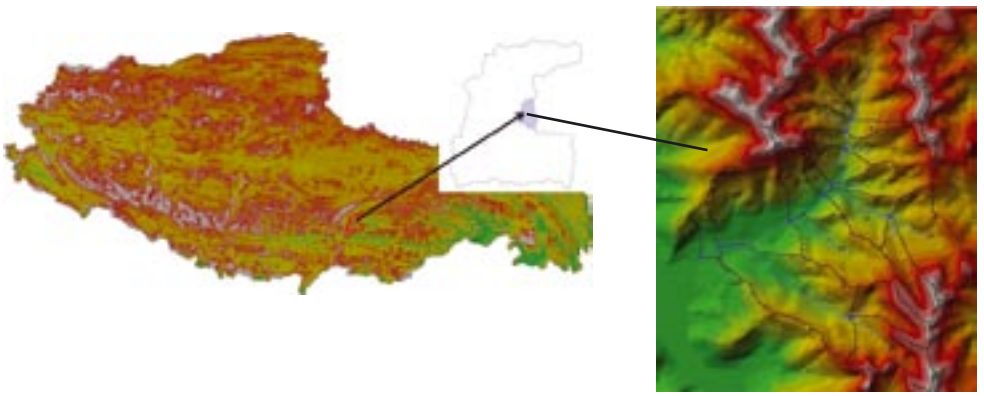
Another advantage of SWAT is its flexibility. It can serve to generate discussion and interest through a 'quick and dirty' assessment that uses estimates or low-quality data. Or it can handle detailed, accurate assessments that take much longer and have much higher data requirements.

But for all its sophistication, SWAT also has its limitations. Like most models describing natural processes, it can all too easily give misleading results. Water and soils are particularly unpredictable in their behaviour, so considerable efforts are needed in both data collection and calibration if a detailed study aiming at accuracy is to be made. In the case of this Tibetan study, there simply wasn't the time or the money for such efforts. Resources were spread too thinly.

Irrigation isn't always the priority

Immerzeel began his field research by calibrating SWAT as best he could for local conditions. He defined the watershed, deliberately keeping it small so as to minimize the risk of error (see Figure 9). Next, he used aerial photos to ascertain land use and soil conditions, then fed in weather data from a station 40 kilometres away, guessing suitable adaptations of these data to account for differences in altitude. He then interviewed farmers to determine their cropping practices.

Figure 9. Defining the watershed.

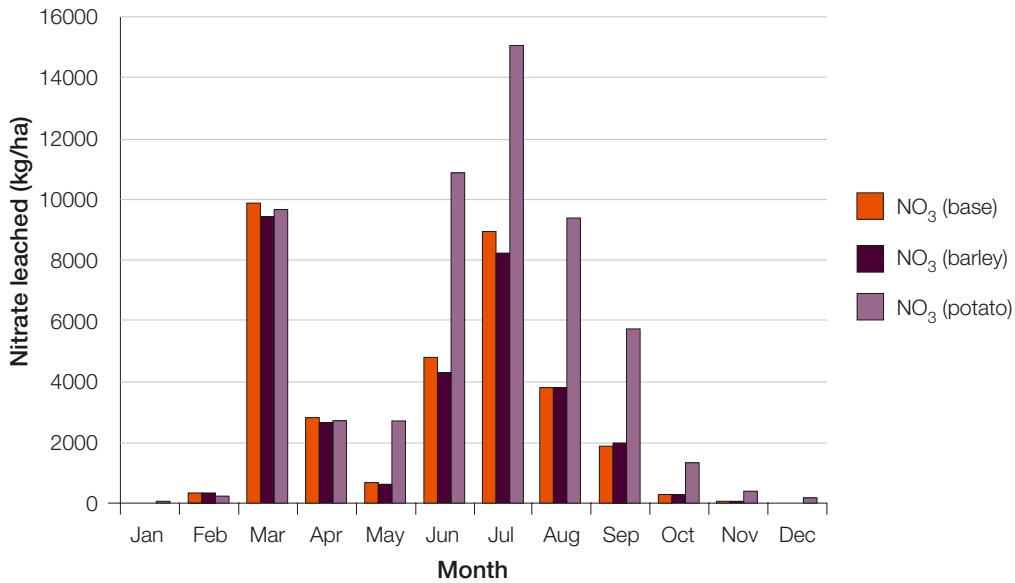


The watershed turned out to be a difficult place to farm. The steeply sloping valley sides consist largely of rangeland grazed by livestock and only the valley floor is cultivated. Farmers said they were able to grow only a single crop per year, mainly barley but rotated with wheat and black beans. Only a small area was irrigated and low levels of such inputs as manure, urea and pesticides were used.

Immerzeel then used SWAT to simulate crop yields and stream flow out of the watershed over a period of 4 years, contrasting a baseline situation with scenarios involving changes in either the crops grown or the way the crops were managed.

The results of this exercise suggested that switching from barley to potato would not make a great deal of difference to stream flow and sediment loads in this watershed. Potato would need higher applications of nitrogen fertilizer, so water quality might suffer owing to the increased risk of nitrate leaching (see Figure 10). The most important finding, however, was that irrigation would improve the yields of both crops only slightly.

Figure 10. Nitrate leaching under different cropping assumptions.



What accounts for the small difference made by irrigation? 'The fact is that much of the extra water would simply run off,' Immerzeel explains. 'This watershed's steep slopes and shallow soils do not allow water to be retained in the root zone of growing crops. Here, as in the many watersheds that resemble this one, irrigation wouldn't deliver the returns needed to justify the investment. These returns would improve only if measures to conserve soil and water, such as terracing, strip cropping and contour tillage, were first introduced.'

This finding has intriguing implications. Clearly, watershed characteristics strongly determine whether or not irrigation will be effective. This means that the overall potential for irrigation throughout Tibet may be lower than planners and developers think.

The study also highlighted the negative effect of evaporation on water availability at high altitudes. Evaporation puts this watershed under severe drought stress for much of the year, even during the rainy season

when crops are grown. This would greatly reduce the effectiveness of irrigation. For at least 2 months of the year the streambed dries out altogether, making irrigation impossible.

Traditional livestock production: A hard living, but a sustainable one

Throughout much of the plateau the most sustainable form of land use is the traditional one: livestock production with low stocking densities. Only in a few high-potential areas will investment in irrigation for cropping pay dividends. The potential of both crop and livestock production should be explored through further research, with a view to quantifying their value. Putting a figure on this will provide the basis for a regional dialogue on how both sets of users – pastoralists and farmers – can be rewarded for the sacrifices they will have to make if downstream users are to continue to enjoy plentiful supplies of clean water.

Limited achievements

Mainly because of lack of resources, this Tibetan case study had its limitations. Two merit discussion here.

First, the site selected for field research turned out to have been chosen more for its accessibility from the capital city than for its representativeness. Tibet's most productive agriculture lies not to the northwest of Lhasa but well to its west, on the plains near the plateau's two other major cities, Shigatse and Gyantse. Soils here are deep and relatively fertile, so the potential for irrigation is much higher. 'Now we have shown how to apply the tools successfully, future efforts should focus on these areas,' says Immerzeel.

Future research needs to focus on Tibet's high-potential areas

A second, and related, limitation was that the study did not succeed in meeting its major aim of attracting policy makers' attention. 'This is partly because the location is not recognized as strategically important,' notes Immerzeel. But there are also cultural and political factors at work here. Issue-driven applied science is not yet valued highly as a basis for decision making in China, whose politicians tend to be guided more by ideology than by pragmatism. Central government targets tend to get more attention than local circumstances. Further complicating factors are Tibet's status as an outlying region, remote from the centre of power, and its limited capacity for local research. Local scientists who are well educated and proficient in English tend to climb the career ladder quickly, escaping the relative tranquillity of Lhasa for a more challenging position elsewhere. 'We saw this time and time again,' says Immerzeel.

There could also be a deeper reason why policy makers showed so little interest in the study. Like other countries dealing with water resources that cross national frontiers, China is intent on harnessing these resources for its own use and might not welcome a reminder that they should be shared with other countries – or that environmental concerns should curb its headlong rush for development. China's flag should not be the only one on Asia's water tower, but its government may be reluctant to acknowledge this.

Despite these limitations, the Tibet study successfully demonstrated the potential of modelling tools to 'open windows' onto prospects not previously viewed by policy makers. The future of Tibet's water resources is a new issue on which almost no research has yet been done. Though this subproject did not draw an immediate response from policy makers, it afforded a glimpse of a problem that is bound to clamour for increased attention in years to come. In short, it was good signalling, even if no one is yet heeding the signals.

Soils and smallholders

When experts on the UN Millennium Project's Task Force on Hunger sat down to think about how to halve world hunger by 2015, their number one recommendation for agriculture was to improve soil health.

Nowhere is this recommendation more relevant than in the highlands of sub-Saharan Africa, whose smallholders have for centuries mined their soils by taking crops out but failing to put anything much back in.

Kenya's highland smallholders are mining their soils

From 1960 to 1990 annual mineral fertilizer use in Africa rose only fractionally, from 5 to 8 kilogrammes per hectare, whereas in China over the same period it soared from 10 to 240 kilogrammes per hectare. In 1990, scientists estimated the net drain of major nutrients from farmers' fields in Kenya to be 22 kilogrammes of nitrogen, 2.5 kilogrammes of phosphorus and 15 kilogrammes of potassium per hectare per year – staggeringly high rates of loss that, if they continue unchecked, will eventually lead to the collapse of smallholder agriculture. The biggest drain on nutrients was maize, which most farmers crop continuously without using inputs (see Table 1).

These nutrient losses are strongly associated with poverty: people farming at or below subsistence level on the tiny patches of land that characterize Africa's crowded highlands simply do not have the cash to buy

Table 1. Nutrient balances for farming systems near Embu, in the Kenyan highlands.

	Nutrient balance		
	N	P	K
Tea	16	144	–19.3
Vegetables	–78	–2	–37
Maize/beans	–104	–6	–43
Napier grass	224	12	554

fertilizers. But more than that, the losses also deepen poverty, since crop yields decline steadily over time, reducing still further the cash available for re-investing in the farm. The result is worsening soil degradation and an accelerating slide into hunger and deprivation.

There is no shortage of ideas on what to do about declining soil fertility in Africa (see box). Indeed, the solutions are as plentiful as they are well known. The challenge, for policy makers and development workers, is to combine these solutions synergically, so as to enhance their impact, and to target them

What can be done?

Ideas on how to reverse soil degradation in highland sub-Saharan Africa include:

- Reintroducing subsidies on mineral fertilizers. These would be targeted to the areas and farmers most in need.
- Re-packaging mineral fertilizers in smaller amounts to make them more affordable.
- Establishing networks of small-scale agro-dealers in rural areas, so as to make inputs more accessible.
- Increasing and improving the use of animal manure, for example by encouraging small-scale dairying and the practice of zero grazing.
- Combining organic and mineral fertilizers. This is known to give the best response in crops.
- Introducing nitrogen-fixing legumes. These provide human food and/or animal feed at the same time as they replenish the soil.
- Harnessing Africa's deposits of rock phosphate. In many areas, phosphorus is the most limiting nutrient.
- Encouraging farmers to make compost. This is labour-intensive, but can be highly effective.
- Encouraging farmers to switch from subsistence to cash crops (such as coffee and horticultural crops). These demand better management but provide a higher income, making such management feasible.
- Promoting water harvesting, to facilitate the switch to higher-value crops.
- Improving access to markets by building roads. Again, better market access will facilitate the switch to cash crops and dairying.
- Diversifying end product use, so as to sustain incomes once surpluses are created.

Source: UN Millennium Project, 2005.

accurately, so that resources are not wasted. Intervention is now needed on such a vast scale that it will be very costly. All the more important, then, to make sure that it is both effective and efficient.

The right tool for the job

Rural agro-dealers: Critical for increasing farmers' access to inputs

'That's where tradeoff analysis comes in,' says Jetse Stoorvogel. 'With its ability to provide a clear picture of the returns to different courses of action, this tool should prove ideal for sorting out what interventions fit where.' Stoorvogel is part-time Professor of Land Use Analysis at Montana State University in the USA, as well as Associate Professor of Soil Science at Wageningen University. Both universities were partners in the consortium that developed the tool.

Put simply, tradeoff analysis is a participatory research and modelling process designed to help people take difficult decisions about the management of natural resources. Its end product is a simple yet persuasive graph that shows the nature of the tradeoff between two variables – an economic indicator, such as farmers' incomes, and an environmental one, such as water quality. The idea is to compare the situation under current practices with what would happen if policies or technologies were to change, then to use the comparison to forge a consensus for action.

Scientists first developed and tested tradeoff analysis in Carchi Province of Ecuador, where they used it to demonstrate the terrible effects of pesticides on human health (see Vol. 1, pp. 16–21). They also used the tool to support decision making on the introduction of terracing to protect steep slopes against erosion in Cajamarca Province of Peru. Both experiences suggested that the tool might prove more widely applicable. The Fund's consolidation phase provided the opportunity to find out whether this was so – and to transfer the tool to a new region, Africa. By electing to focus on soil fertility, the Fund would be applying tradeoff analysis to what is arguably the single greatest challenge facing the future of African agriculture.

The proposal that Stoorvogel and his colleagues submitted to the Fund was designed to complement the support already provided by one of the partners in the tool's original development, the Soil Management Collaborative Research Support Program (SM-CRSP) of the United States Agency for International Development (USAID). The joint project would focus on Kenya and Uganda, while SM-CRSP activities also covered Senegal and Panama. Whereas the Fund's involvement would be limited to 3 years, the CRSP project had a longer time-span that would allow continuing support for activities in Kenya and Uganda after the Fund had ceased.

The project's first challenge was one of methodology. If researchers were to use tradeoff analysis to tackle the issue of soil fertility, the tradeoff analysis platform – already host to a suite of models covering economic analysis, crop growth and various natural processes – would have to support an additional tool that was fit for this new purpose. The obvious choice for the job was NUTMON (see box).

The project was skilfully designed to ensure it would quickly meet its key objectives of transferring tradeoff analysis to a new region, applying it to a new problem, and securing its adoption by new users. The strategy adopted by Stoorvogel and his colleagues was to choose a site at which NUTMON had already

Nuts about nutrients

The NUTMON or Nutrient Monitoring tool was developed by scientists at Wageningen University, who had already tested it widely in Africa by the time the Kenyan tradeoff analysis project began.

NUTMON is designed to support farmers and scientists in a participatory assessment of the environmental and economic implications of farmers' soil management practices. Techniques such as resource flow mapping, matrix ranking and trend analysis are used to capture farmers' perspectives. This qualitative analysis is complemented by a quantitative one that generates indicators such as nutrient flows and balances, cash flows and net farm income. Some users have criticized the name NUTMON as 'too nutrient-fixated', since the model in fact deals with a wider range of subjects.

Many applications of NUTMON had shown nutrient mining to be a serious threat in East Africa. But NUTMON's purely diagnostic nature meant that these applications had not provided guidance on the technology and policy changes needed to improve matters. Integrating NUTMON with tradeoff analysis would overcome this problem, allowing users to recommend specific interventions.

been applied and to use the data it had generated to run the tradeoff analysis model. This would allow the team to develop the necessary interface between the two. It would also give rise to a case study that would demonstrate the relevance of tradeoff analysis to national research groups, enlisting their interest and support. And it would provide an opportunity for further work on an MD version of the model, a concept initially developed and tested in Panama (see p. 19). 'Large data requirements are one of the drawbacks of many models and tradeoff analysis is no exception,' Stoorvogel comments. 'An MD version would be ideal for training purposes, facilitating the tool's introduction to national user groups.'

Skilful design was followed by efficient implementation. Like the other projects in the consolidation phase, this one got off to a late start owing to the delayed release of funds by DGIS. However, as the project's reviewers noted, tight programming allowed most of the planned activities to be completed in half the time originally envisaged – a year and a half instead of 3 years.

Maize, manure and Machakos

The best NUTMON data set available in Kenya when the project began was for the Machakos District, a highland enclave just southeast of Nairobi (see box and Figure 11). Project staff selected five representative villages on which to concentrate their analysis (see Figure 12).

At the same time, Stoorvogel and his colleagues began discussions with national research groups at the Kenya Agricultural Research Institute (KARI) and Egerton University in Kenya, and at Makerere University in Uganda. The aim was to establish local research teams that could apply tradeoff analysis in their own projects – with support from Wageningen during the Fund's project and from the continuing CRSP project

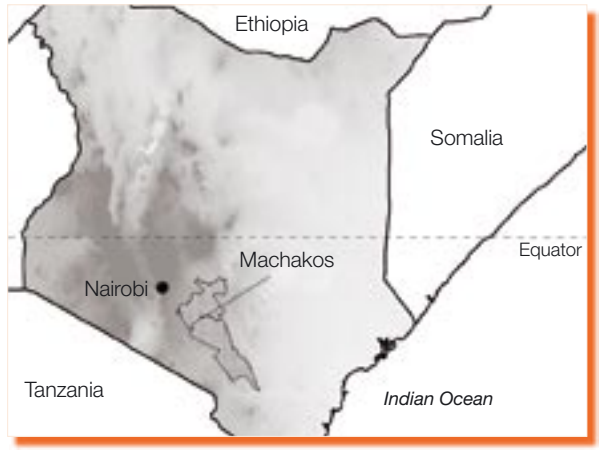
Machakos: Epitome of the soil fertility challenge

Machakos District is an area well trodden by researchers in the past. On Nairobi's doorstep, it is relatively easy of access and is also of interest to policy makers because of its potential to supply Kenya's largest urban market. When project scientists conducted a literature search on soil fertility in the district, they found over 100 references.

The district is one of contrasts: parts of it are high-potential, with a diverse array of enterprises, but there are also lower-lying areas where farmers' choices are fewer; soils vary greatly, in accordance with a host of factors including parent rocks, climate, land use and vulnerability to erosion; some areas enjoy good access to markets while others do not. The unifying factors are maize, which is almost universally grown as the major food crop, and declining farm size, caused by population growth. Commercial enterprises include small-scale dairying and horticultural crops, but these are possible only in high-potential areas with good access to markets in addition to fertile soils and good water supplies.

Soil fertility is declining. Data from across the district show that, almost everywhere, nutrient balances in farmers' fields are negative. As is typical throughout the Kenyan highlands, the worst problems occur in fields where maize is grown continuously without inputs. Manure and fertilizer are, however, applied to cash crops.

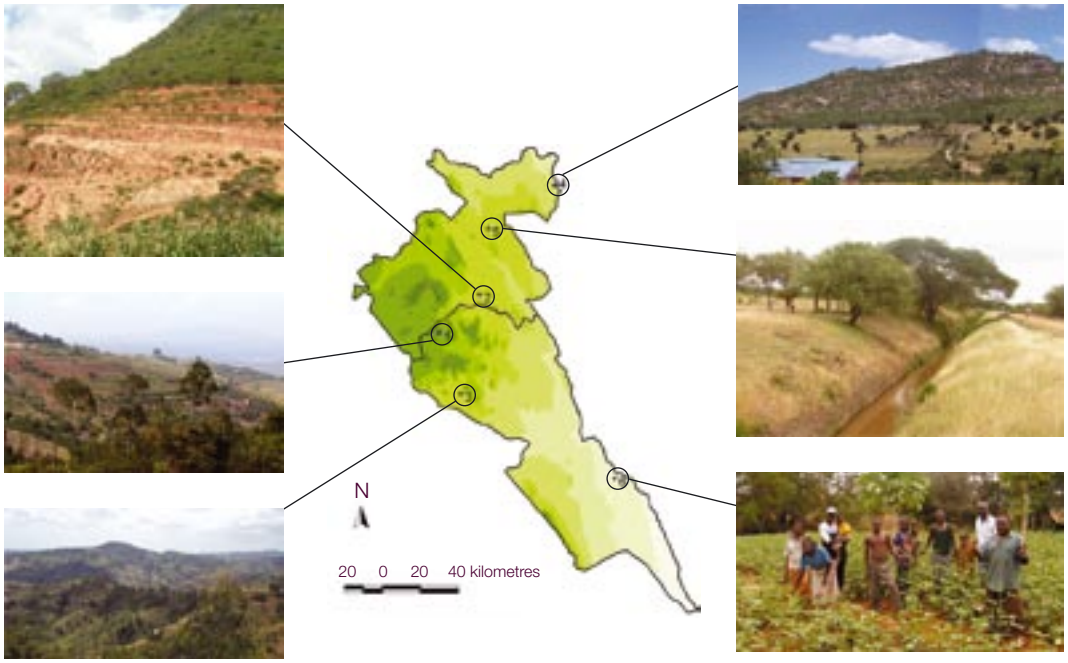
Figure 11. Kenya and Machakos District.



thereafter. A condition of participation was that partner organizations must constitute dedicated research teams for tradeoff analysis – a first, and major, step towards institutionalizing the approach.

The project supported these embryonic user groups through the provision of training and the development of training materials. A workshop was held for each newly formed national team, whose members performed hands-on exercises to familiarize them with the tradeoff methodology. This was followed by a workshop held

Figure 12. Locations and landscapes: the five study villages.



at ILRI that brought together all the national groups for further intensive training and the exchange of initial experiences with the tool. A manual was written and is now available either as hard copy or on the tradeoff analysis programme's website (www.tradeoffs.nl). The website also provides access to an on-line course. Users have contributed actively to the development of both the website and the training materials.

The work in Machakos covered a wide range of crops but focused in detail on beans and maize – the two crops for which crop growth models were available and were already supported by the tradeoff analysis platform. These models were calibrated using data on responses to fertilizer from the Kenya Fertilizer Use Recommendation Program (FURP).

For both crops, project scientists analysed a variety of scenarios dealing with technical and/or policy interventions. These included the effects of a rise in maize prices and of increased manure application on the distribution of nutrient depletion and poverty (see Figures 13 and 14).

One counterintuitive finding thrown up by the analysis is that, in some areas, applying more manure could worsen rather than improve nutrient balances. According to the scientists, this is because farmers with more manure available would allocate less of their land to beans and more to maize – a crop that takes more out of the soil. More manure also spells more weeds, which act as a further drain on nutrients. This finding highlights the dangers of the low-external-input approach to farming, whose proponents often actively discourage farmers from accessing inputs from outside the system. Only by combining manure with bought-in mineral fertilizers can farmers begin to replenish their soils (see Figure 15).

Project partners:

- **Kenya Agricultural Research Institute (KARI)**
- **Egerton University, Kenya**
- **Makerere University, Uganda**
- **World Agroforestry Centre (ICRAF)**
- **Montana State University, USA**
- **Wageningen University, the Netherlands**
- **Centro Internacional de la Papa (CIP)**

Figure 13. Soil nutrient depletion under different maize price and manure production scenarios.

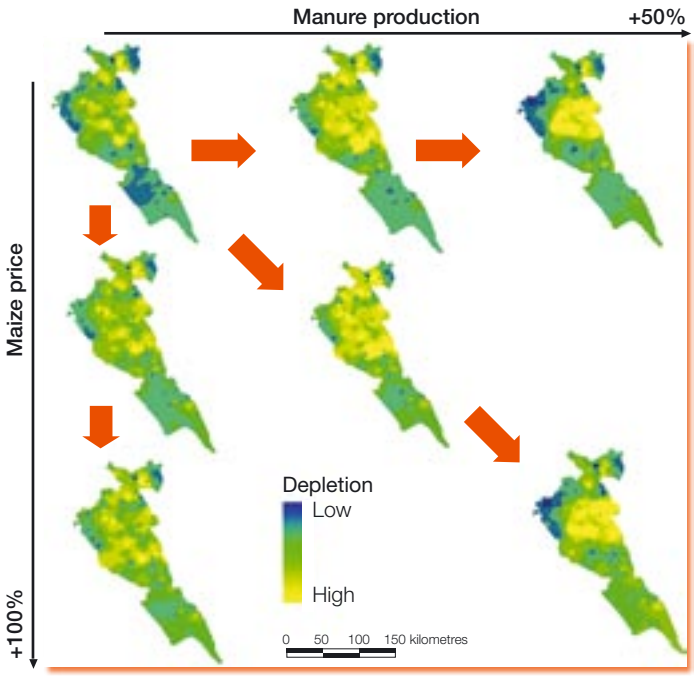


Figure 14. Poverty incidence under different maize price and manure production scenarios.

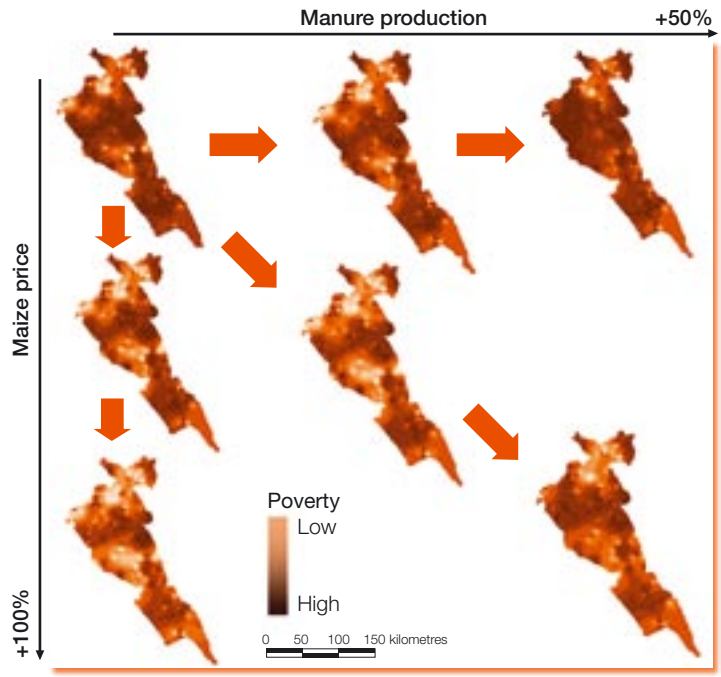
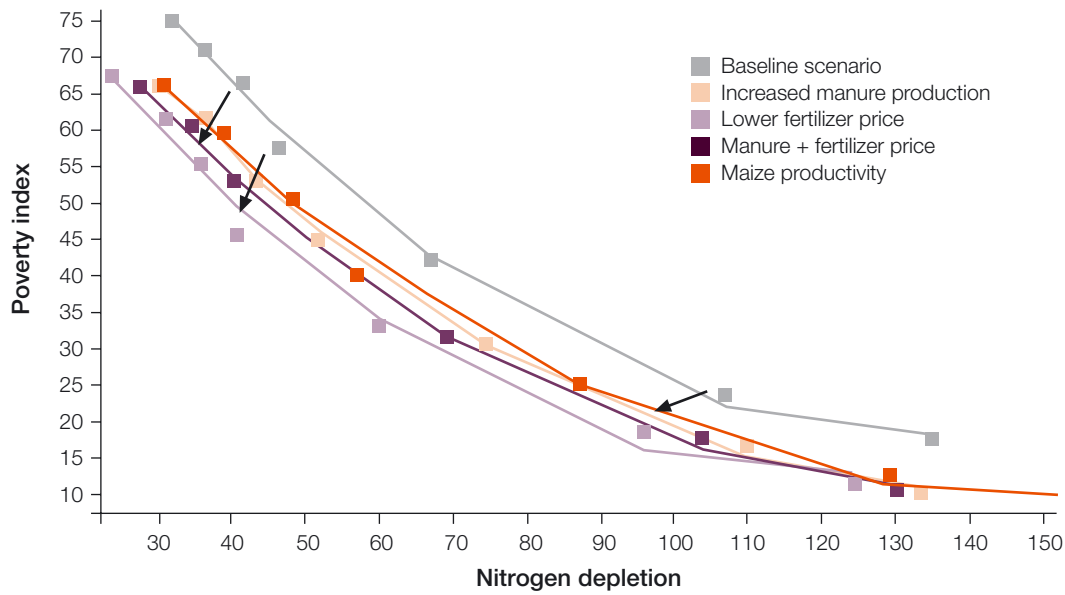


Figure 15. Tradeoff curves for poverty incidence and nutrient depletion under different policy and technology scenarios.



Besides the link with NUTMON, applying tradeoff analysis to the 'new' problem of soil fertility drove several other methodological advances. Foremost among these was a radical overhaul to make the model work at the whole farm level rather than the level of individual fields, which had been the focus of the Latin American applications. Dairy farmers in Machakos increasingly raise their animals in a zero-grazing system, keeping them in stalls close to the homestead and feeding them a mix of home-grown feeds and bought-in concentrates. The animals contribute manure to the fields and milk to the family's income and nutrition. This management system, together with its inputs and outputs, doesn't show up at the field level and can only be accounted for when looking at the whole farm (see Figure 16).

Figure 16. Integrated analysis of nutrient flows at the whole farm level.

The project also made progress in developing the MD version of tradeoff analysis. This was the work of Wageningen MSc student Reinier Ellenkamp (see box overleaf).

Rapid national uptake

Wageningen PhD student Alejandra Mora-Vallejo remembers being badly shaken up on the road to Palissa. The group she was travelling with had set off by car from Kampala at noon – too late to complete the journey by sunset. 'We lurched from pothole to pothole in pitch darkness, as lorries driving without their lights bore down on us,' she says. 'We were all scared we'd have an accident.'

Mora-Vallejo had experienced at first hand one of the factors that keeps Uganda's Palissa District what it is – one of the poorest areas in the country. Lying a short distance north of the main road that links Mbale to Jinja and so to Kampala, the district ought in theory to have good access to markets. But a crucial all-weather feeder road remains half built, leaving the district cut off for much of the rainy season – just when farmers need inputs and harvested crops have to be taken to market.

'Living and working in Kenya among local people changed my view of the world.' –

Reinier Ellenkamp, MSc student, Wageningen University.

Soil mapping goes digital

Traditional soil mapping is costly and time-consuming and usually still leaves large blank areas for which there's little or no information. This is especially the case in developing countries, where a lack of roads into remote areas compounds the shortage of technical expertise. Digital soil mapping (DSM), a technique developed only in 2003, is a low-cost but apparently effective alternative.

To make a digital soil map of Machakos, Ellenkamp turned first to work done in the 1940s to develop what is called the soil forming factors equation. This states that the kind of soil you will find at a given spot is the combined effect of climate, soil organisms, relief, parent material and weathering over time.

Next, Ellenkamp used various sources to capture the spatial variation of these factors. A combined geology and landform map served to screen out non-agricultural areas and to subdivide the agricultural area into intensive agriculture, found in hilly terraced areas, and extensive agriculture and pastoralism, found in the lower and drier areas. Information on relief allowed the identification of areas where soils were stable, prone to erosion or undergoing deposition. This work led to the determination of 14 landscape units at different points on the slope, from mountain crest down to alluvial fan (see Figure 17). The effects of climate were built in by interpolating data from the district's two weather stations.

Ellenkamp complemented these secondary data with 170 soil samples taken in the field. He correlated the results of chemical analyses of the samples with the factors determining soil formation, then used the correlations to predict soil properties at specific locations.

This elaborate piece of detective work proved remarkably effective: when the predictions were validated in the field, they proved more accurate than the existing soil map of the district. The predictions were then used as the basis for a digital soil map made using ArcView software on a GIS.

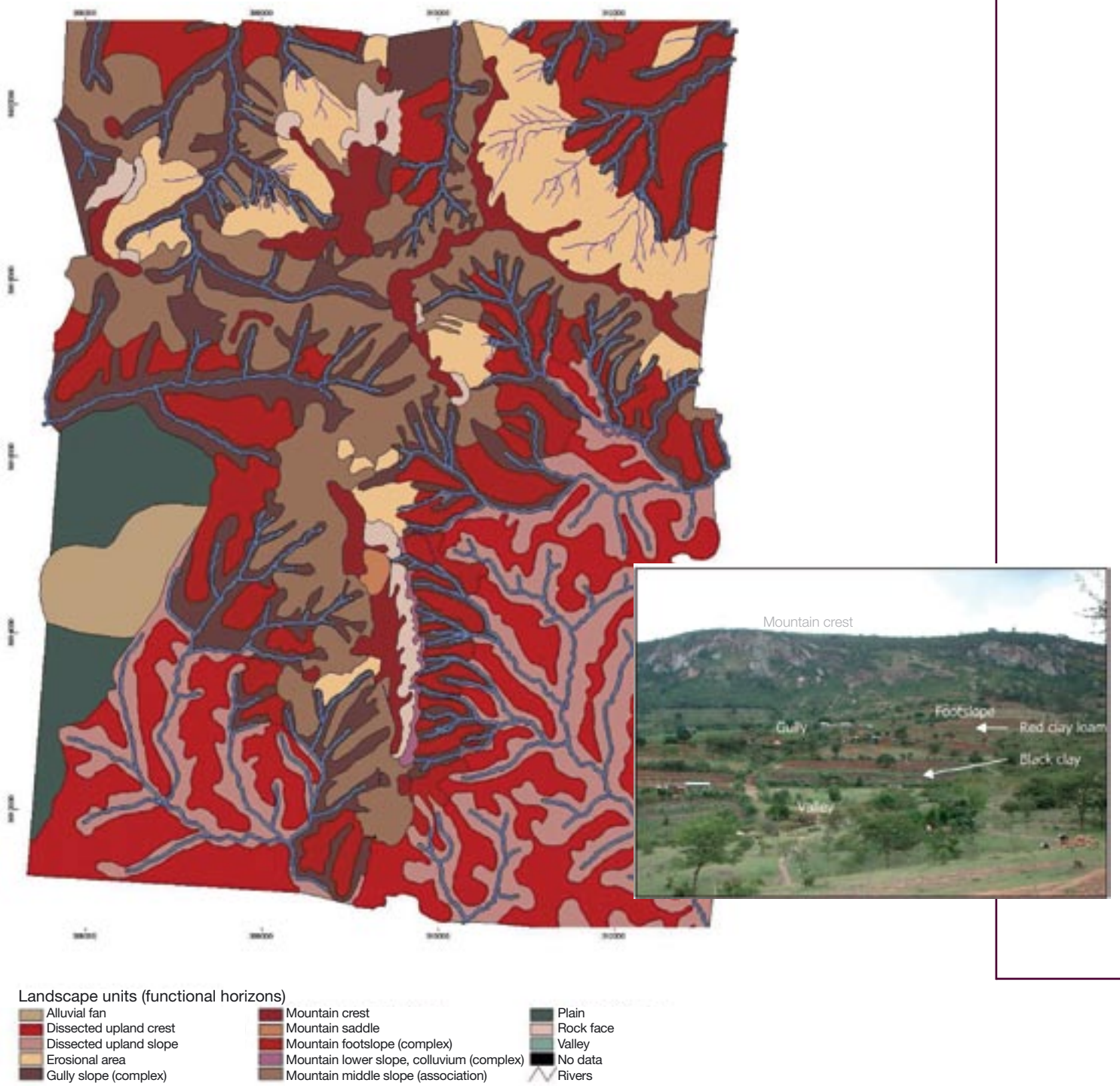
Source: Ellenkamp, 2004.

Erosion is a serious problem in Palissa District

A gently sloping plateau dissected by steep-sided valleys, Palissa suffers from just about every ill that can beset Africa's rural areas. It is densely populated and farm size is shrinking with each successive generation. The shortage of good land is exacerbated by erosion and declining soil fertility, as the rains wash both soil and nutrients down gullies, ravines and valleys. Yields of staple food crops such as maize have fallen to an all-time low. The only growth sector is rainfed rice production, which is expanding in seasonally flooded valley bottoms traditionally used for grazing. This shift in land use is the occasion of violent clashes between farmers and pastoralists. To make matters worse, cattle rustling by pastoralists from further north has become so common that people are giving up one of their few remaining sources of income, the keeping of a family dairy cow. 'Even if I put my cow in the kitchen overnight, the thieves will still break in,' says one farmer.

Palissa is one of three areas of East Africa where the work started by the project is being enthusiastically taken forward by national research groups. Like Machakos, it has already been the subject of considerable research on soil fertility, including a diagnostic study using NUTMON. Now the district's farmers are participating in tradeoff analysis, in an attempt to identify feasible interventions. In 2004, Imelda Nalukenge, the agricultural economist at Makerere University responsible for the study, went to Wageningen for a week to process the NUTMON data on the district. From there she went on to Montana State University

Figure 17. Landscape units in Machakos District.



Source: Ellenkamp, 2004.

in the USA, to work with Antle on adapting the economic simulation models to reflect the district's farming systems. Nalukenge is grateful for the support and training she has received. 'The combination of a participatory approach and the tradeoff model is a new and exciting way forward,' she says. 'In an area where all else has failed, it might just work.'

A similar study is under way in an area close to Egerton University, in Kenya's western highlands. This study, supported by various CRSPs, is focusing on livestock and fishponds in addition to soil management. The plan is to use tradeoff analysis to integrate the analysis. Like Makerere, Egerton University welcomes the introduction of a new tool that will help its scientists sharpen their focus on the farming systems in their own backyard. Both universities are keen to integrate tradeoff analysis into their curricula.

Finally, KARI and the World Agroforestry Centre (ICRAF) plan to make tradeoff analysis a central component in a large-scale project on land degradation and carbon sequestration in the Lake Victoria Basin. This project, funded by the Global Environment Facility (GEF), will use data from Vihiga, one of the sites of a previous project implemented under the Fund's Phase I (see Vol. I, pp. 21–25).

Progress – but still some way to go

This project's major achievement is the successful transfer of tradeoff analysis to three national research groups in East Africa. While it is still too early to boast permanent institutionalization, all three groups have shown considerable interest and expressed their intention to continue the work. The support available from CRSP over the next few years will help realize this intention.

Reviewers hailed the project's achievements in transferring tradeoff analysis to national research groups

Another area of success has been the development of training materials and a website, with the participation of users. The website will enable the three national groups to continue working together, forming a regional community of users. There are also signs that the website is stimulating the development of a global users' group.

And there are plenty of other, less spectacular achievements. For example, the work to link NUTMON and the tradeoff analysis model has opened up opportunities for applications elsewhere in East Africa where NUTMON has been used. In addition, the work on digital soil mapping has made a valuable contribution to the development of an MD version of tradeoff analysis.

The project fell short of its objectives in terms of introducing tradeoff analysis to user groups other than researchers. In Kenya as in Tibet, it proved difficult to attract the attention of policy makers and analysts. In the other participating countries, the project ran out of time to establish links with the policy community.

All in all, this project took important steps forward in providing Africa with a new tool for deciding what to do about the region's gathering soil fertility crisis. But there is some way to go before the tool can be widely used to convey the urgency of the problem, and the options for tackling it, to those with the power to act.

Highland futures

Steve Staal makes no apology for crystal ball gazing. 'We all like to know the future,' he says. A livestock economist at ILRI, Staal was leader of a project that set out to do just that.

Livestock: Can small-scale farmers cash in?

The project used different sets of assumptions, or scenarios, to predict how land use in the Kenyan highlands will change over the period 2005 to 2025. 'Forecasts like this are useful to policy makers facing decisions on the allocation of resources and the targeting of policies and technologies,' says Staal. This is especially the case in Kenya, whose new government is coming to grips with the formidable challenges facing the country as it seeks to recover from the corruption and misrule of the past. The government has outlined an ambitious way forward in its Economic Recovery Strategy (ERS), which envisages broad-based investment to improve the lot of the poor.

The forecasting exercise undertaken by Staal and his colleagues was especially relevant for Kenya's livestock sector. In Kenya as elsewhere in highland Africa, meat and milk production are rising rapidly in response to what ILRI and other agencies have dubbed the Livestock Revolution – the surge in demand for these products associated with rising incomes, urbanization and population growth (see box). The question is: can small-scale farmers cash in

The Livestock Revolution: Unique opportunity for poverty eradication

If current trends continue, over half the world's meat and milk will be produced and consumed in the developing countries by 2020. Millions of small-scale farmers in these countries stand to benefit, provided the right mix of policies, technologies and institutions is put in place.

Livestock are a relatively easy market for poor people to enter. Many poor people keep animals already and can use feed and other resources present in their local environments as inputs to an improved livestock enterprise. In highland areas, new technologies such as crossbred cows and legumes can improve the productivity of the whole farm, raising incomes at the same time as improving the family's food security and health. Switching from food crops to livestock is a good way of raising the productivity and income that can be derived from small areas of land. And poor farmers can raise their incomes still further if they can add value to their produce by, for example, joining a cooperative that processes raw milk into cheese, butter and yoghurt.

So far, the production and consumption of milk and meat have grown much more rapidly in Asia and Latin America than in sub-Saharan Africa. It is in this latter region that an equity-oriented Livestock Revolution is most needed.

Source: ILRI, 2000.

on the opportunity to produce for this new market, or will most of the benefits pass to larger producers who can more easily gear up for commercial production? That question begs two further ones for governments: should they try to tilt the playing field in the small producer's favour and, if so, what are the best ways of doing this?

Staal: We need to know what drives change in mixed crop–livestock systems

'Accurate information on the factors that drive change in livestock systems is vital as policy makers grapple with these questions,' says Staal. The Kenyan project was part of a broader transregional analysis that aimed to provide such information by analysing data from contrasting production systems across Asia, Africa and Latin America. The data came from an earlier survey of 3000 households in the country's highlands, conducted by the CGIAR's Systemwide Livestock Programme (SLP). Originally, the Kenyan study was to be twinned with a similar one in India's Gujarat State, but this had to be postponed, due mainly to shortages of time and staff but also to methodological complications.

Staal and his colleagues took steps at the start of the project to engage with the national research and policy groups that might use their approach and results. A key step was the formation of an expert panel to guide project activities. A larger stakeholders' meeting was also organized.

Tell us a story

Project partners

- **Kenya Agricultural Research Institute (KARI)**
- **Ministries of Agriculture and Livestock Development, Kenya**
- **Wageningen University, the Netherlands**
- **International Livestock Research Institute (ILRI)**

Together with national partners, the project team created four different 'storylines' or scenarios describing Kenya's development over the next 20 years.

The first or baseline scenario is a pessimistic one in which the country's policy environment fails to change for the better. The economy grows only slowly or not at all, stifling the growth of employment outside the farming sector. The result is further land fragmentation as farms continue to be divided among the sons of each successive generation. Barriers to trade remain firmly in place, limiting farmers' opportunities to diversify into cash crops. The public institutions that are supposed to support agriculture suffer from underinvestment and so don't work properly, leading to a dearth of new technology, extension advice and credit for small-scale farmers. Continued subsistence cropping with little or no use of inputs spells declining crop yields and reduced food security, leading to a further decline in the productivity of labour. Poverty, hunger and environmental degradation tighten their grip.

Under the second scenario, labeled 'equitable growth', the future looks much brighter. The key assumption here is that the government successfully implements the ERS. This translates into stronger institutions that support agriculture, the building of more roads in rural areas, the removal of trade barriers, and the provision of free primary education throughout the rural areas. The outcome is a more entrepreneurial farming community, willing and able to switch to new enterprises and technologies. Yields rise and markets expand, raising farmers' incomes. There is some consolidation of land as farmers migrate to take up employment opportunities elsewhere.

In contrast, the third scenario depicts inequitable growth. Here the institutions that support agriculture, if they work at all, are biased in favour of large-scale producers. The few roads that are built serve high-potential areas only. In these areas, technology adoption and export-led agriculture take off as the barriers to trade come down. But the majority of small-scale producers remain mired in poverty and hunger.

The fourth and last scenario makes the same basic assumptions as the equitable growth scenario but superimposes the effects of climate change, as modelled by climate experts.

All four scenarios were revised and adapted in the light of comments from stakeholders and the panel of experts. An early proposal by the panel was to build in the effects of HIV/AIDS, which could severely depress agricultural productivity in the medium to longer term. The team was able to respond to this proposal by factoring in the disease's likely effects on population growth rates and rural–urban migration.

Methodological challenges

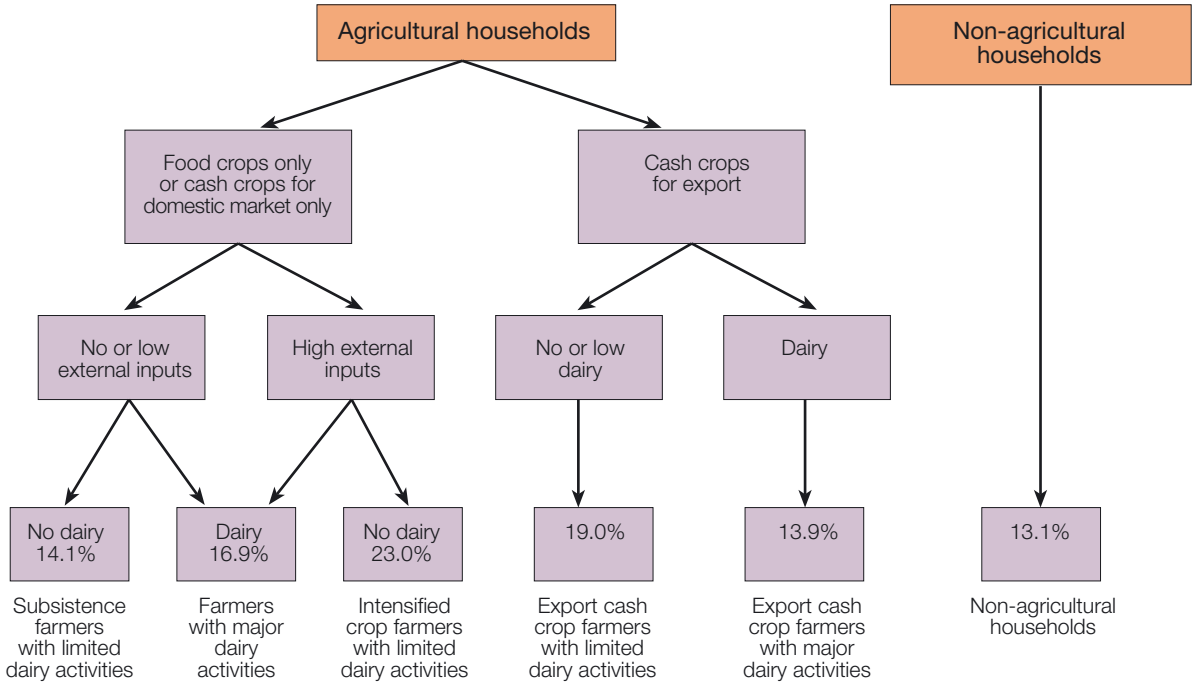
In its analysis of the outcomes of these scenarios, the project broke new ground – applying tools and processes that had only recently been developed. Inevitably, it confronted difficult methodological challenges as it did so.

The first challenge was to get a conceptual handle on the highlands' complex farming systems, which had to be classified as a basis for the forecasting exercise. The conventional classification methods of statistics, such as clustering and principal component analysis, gave results that had high levels of intrinsic variability and couldn't be depicted spatially, so these methods were jettisoned in favour of expert opinion. Eventually the scientists settled on a logical classification 'tree' that distinguished households first in terms of whether or not they had adopted export crops and secondly in terms of their involvement in dairy production. This gave five farm types and a sixth category, non-agricultural households (see Figure 18). This classification wasn't ideal, but was considered a reasonable working model for the time being. It could also be mapped – a prequisite if the modelling tools lined up for the project were to do their job.

Cash crops such as tea are a major determinant of farm income and hence a good criterion for classifying rural households

The analysis relied on the combined use of two models at two different levels. The Integrated Modelling Platform for Mixed Crop–Animal Systems (IMPACT) was first applied at the household level to find out how each farm type could be expected to change under the different scenarios over the next 20 years (see box overleaf). The Conversion of Land Use and its Effects (CLUE) model was then used to map these changes at the regional level. But getting the two models to work well together proved difficult. The CLUE model had to be adapted to 'recognize' changes in farming systems overall rather than just in land use. This was necessary because of the presence of livestock, which have effects that are not necessarily reflected in vegetation cover (see p. 35). Further adaptation was needed to allow the model to be used at a higher resolution than in

Figure 18. Categories of household in the Kenyan highlands.



previous applications. Lastly, integration of the two was dogged by the same problem of system heterogeneity that had thwarted the classification of farm types.

Combined with the project's short time-span and limited resources, these methodological issues meant that the project fell short of its original objective of providing a definitive analysis of the future of Kenyan highland farming. With that caveat in mind, we'll now look at its principal findings.

How will farming change?

Surprisingly, even under the pessimistic baseline scenario, highland agriculture looks set to change substantially over the next 20 years, with about 20 per cent of the total farmed area undergoing a shift in production of some kind (see Figure 19). This is because factors such as population growth and rising urban incomes exert pressure whatever the political climate, forcing farmers out of subsistence agriculture and into the market economy. Large numbers of farmers shift into export crops and dairy farming, especially round major urban markets such as Nairobi.

Changes under the equitable growth scenario are not qualitatively different to those under the baseline scenario, but they are more pronounced and far more widespread. Change occurs on around 25 per cent of the farmed area and the shift into export crops and dairying is accelerated (see box overleaf and

A powerful tool for understanding farmers' decisions

Originally developed by a consortium of partners and then refined by Mario Herero and colleagues at ILRI under the Fund's first phase, IMPACT allows users to 'manage' a farm according to stated objectives such as maximizing net profit or minimizing soil nutrient losses. The user 'achieves' a given objective by mixing different activities such as producing certain commodities, selling some of the produce, and buying inputs such as seeds, fertilizer or livestock feed – all within the limits imposed by constraints such as level of indebtedness or availability of labour. External policies and development interventions, such as the building of a new road, can ease or tighten these constraints.

IMPACT is an imaginative creation, typical of the new generation of interactive models that allow users to step into others' shoes. For policy analysts, it can provide real insights into what it means to be a small-scale farmer. The down side is the model's data requirements, which are substantial: calibrating IMPACT for use in this project required three or four visits to each of the 18 farms selected to represent the different farm types.

Figure 19. Distribution of farming systems in 2004 and 2024, baseline scenario.

a) 2004

b) 2024

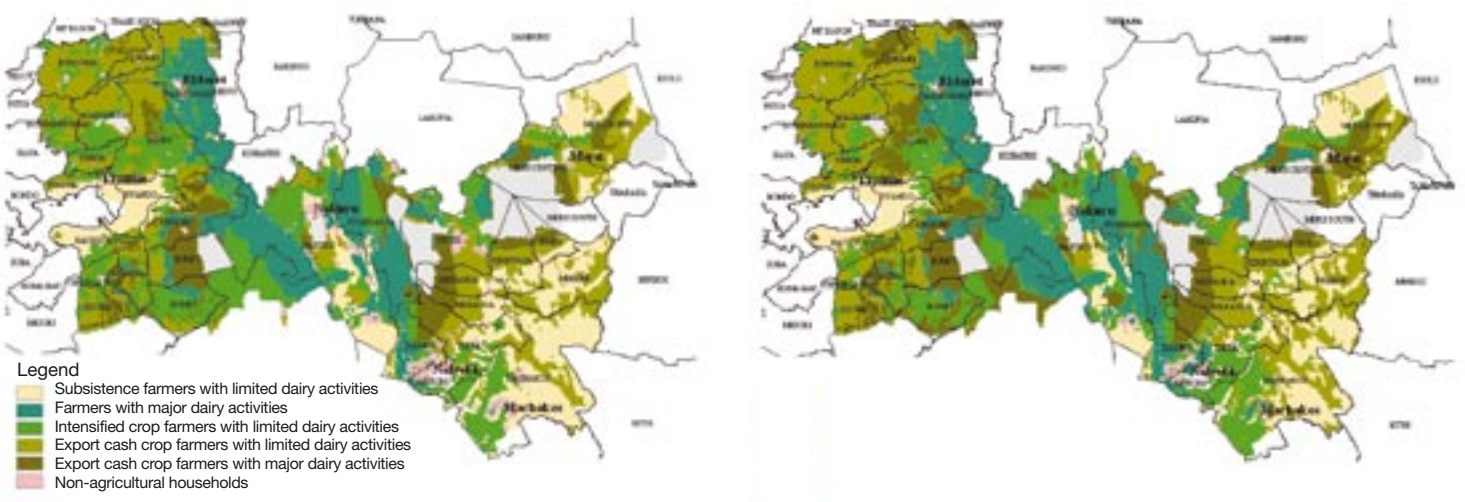


Figure 20a). Larger numbers of farmers are able to 'cross the gap' from subsistence farming to market-oriented enterprises. And broad-based growth in the economy as a whole enables more farmers to leave agriculture altogether to earn their living in other ways.

The most controversial picture of highland agriculture in 2025 emerges under the inequitable growth scenario (see Figure 20b). For this part of the analysis the scientists divided the highlands into well endowed (and politically favoured) areas, with a high potential for large-scale commercial farming, and poorly

The equity effect: How agriculture will change if the government implements the ERS

The major shifts in production under the equitable development scenario are:

- From subsistence farming to export cash cropping with limited dairy activities
- From export cash cropping with limited dairy activities to export cash cropping with major dairy activities
- From intensified farming with limited dairy activities to export cash cropping with limited dairy activities
- From intensified farming with limited dairy activities to export cash cropping with major dairy activities.

Compared with the baseline scenario, the equitable development scenario allows many more farmers to shift into cash cropping and dairying. These shifts are more widely scattered across the highlands, instead of being concentrated around Nairobi. There is also a more pronounced movement out of farming, as farmers take up jobs in other sectors.

Figure 20. Distribution of farming systems in 2024, equitable and inequitable growth scenarios.

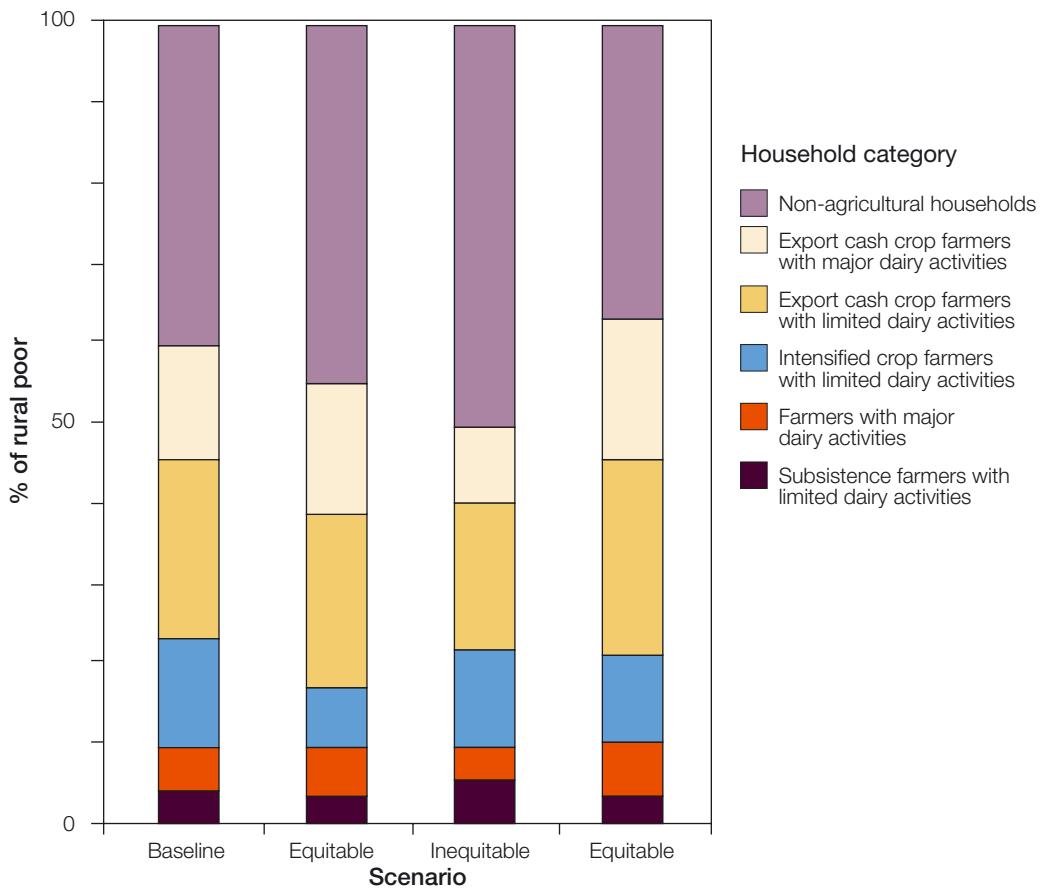
endowed areas, with little or no such potential. Under this scenario, a much lower proportion of the farmed area is likely to change – only 15 per cent. While the well endowed areas change rapidly, in terms of the infrastructure and services available to farmers, other rural areas are likely to miss out, experiencing a stagnant economy and high levels of unemployment. But it's not all bad news: poorly endowed areas that border on well endowed ones are likely to see an increase in the opportunities for hired labour in the adjacent commercial farming sector. And, in the areas with large farms, employment opportunities outside agriculture should increase markedly.

The climate change scenario does not greatly alter the outcomes obtained under the equitable development scenario. This is because current models of climate change predict only slight changes in temperature and

rainfall in the Kenyan highlands over the next 20 years. This is not to say that the pace of change will not accelerate after this time, nor to claim that these models are infallible. Indeed, anecdotal evidence suggests that change may be happening more rapidly than scientists think.

What do the different scenarios imply for poverty eradication in Kenya? Unsurprisingly, the equitable scenario is the one associated with the largest decline in the proportion of poor people – from 45 per cent of the population today to 17 per cent in 2025, compared with 38 per cent under the baseline scenario. The equitable growth scenario is also the only one associated with an absolute decline in the number of poor people. This decline is marked in the subsistence farming sector, from which many are able to escape to a better life elsewhere (see Figure 21). Intriguingly, poverty declines proportionately faster under the inequitable development scenario than under the baseline, falling to 25 per cent of the population. This is due to the classic 'trickle-down' phenomenon associated with rapid but unequal economic growth. But investment in the well endowed areas only would almost certainly be accompanied by an absolute increase in the number of subsistence farmers in the less favoured areas. The outlook for these farmers, crowded into areas less and less able to support them, would be bleak indeed.

Figure 21. Proportion of poor people in different household categories in 2024.



Engaging the policy community

In June 2005 the project presented its results to policy analysts and makers at a second stakeholders' meeting, held at downtown Nairobi's Intercontinental Hotel.

Ocheng: The project's results are relevant to our work

The meeting positively teemed with men in dark suits – mainly officials from the Ministry of Planning but also staff from other government bodies and ministries. Doubtless this was partly because of its easily accessible location. But the high level of attendance, together with the ensuing lively debate, also reflected the new climate of awareness of poverty issues in Kenya following the country's change of government. Now is certainly an opportune moment to attract policy makers' attention and open up discussion of the options available to them.

Peter Ocheng, who attended the meeting in his capacity as head of the Central Planning Unit at the Ministry of Livestock, sees the methods used by the project as directly relevant to his own work. Ocheng's chief interest lies in promoting Kenya's beef exports, mainly to the EU. 'For this we need to be disease-free,' he notes. 'These mapping approaches can tell us more about the risks and sources of infection in different areas and what we need to do to prevent outbreaks.' A further issue is the real value of this market to Kenya: exporting more beef could come at the expense of the country's wildlife, whose tourism value may be higher. Ocheng and his colleagues are keen to use modelling tools and approaches to explore this issue.

Another Kenyan who sees a bright future for the project's outputs is Michael Waithaka, formerly on the team of the prototyping project completed under Phase I (see Vol. 1, pp. 21–25) and now with the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA). 'The Agricultural Policy Analysis and Research Network coordinated by ASARECA should find the methods used by this project particularly useful,' he says.

Besides engaging directly with the policy community, the project has helped strengthen national research capacity. Stella Makokha, a KARI researcher and Nairobi University PhD student posted at ILRI, who presented the project's methodology at the meeting, feels she has gained hugely from her involvement. That is evident not only in the confidence with which she now makes presentations – she was once shy of public speaking, she confesses – but also from her future career prospects. After her spell at ILRI she plans to return to KARI, where she will work on marketing issues. 'I plan to apply the approaches and tools I have learned about on this project,' she says.

Alongside those presenting results at the meeting were national collaborators from three institutions – KARI, Egerton University and the Ministry of Planning – who presented proposals for continuing various aspects of the project's work, including application of the tools to the semi-arid zone and improvement of the country's stock of electronic data sets for future analysis. Training workshops had earlier been held for staff from these and other national institutions.

The project's results have been published in a series of ILRI policy briefs. All the project's data sets, tools and models are available on its website (www.trajectories.org) and can also be obtained on CD-ROM. As in the case of the tradeoff analysis project, the website has become a lively medium for the exchange of ideas, information and training materials.

Unfinished business

Partly because of the large amount of time taken up in tackling methodological issues, this project ended with plenty still on its 'to do' list.

The most urgent priority is a disaggregated analysis of the factors that drive change in farming systems. Policy makers need to know which, out of the many forms of investment needed, are likely to yield the highest dividends for rural development. This is no abstract question: Kenya has already committed itself to the provision of universal primary education; could a similarly large-scale investment in rural roads deliver similar benefits? According to ILRI research, a single kilometre of bad road between a farm and a market is sufficient to reduce the producer price of milk by 2 per cent. The average African country today has less tarmac per square kilometre of land than India had in 1950.

'Continued persistence by the team could achieve some real take-up by Kenyan institutions.' –

Barry Dent and Charles Gachene, project reviewers.

Could investing in roads pay equal dividends to investing in education?

Another urgent need is a detailed analysis of the 'hotspots' of change revealed by the study – particularly the areas where farmers are likely to become poorer. Understanding the combinations of factors that are likely to lead to such negative outcomes will help policy makers identify the measures needed to avoid them.

Participants at the second stakeholders' meeting suggested adding a 'pro-poor' scenario to the four existing ones. This would go further than the equitable development scenario in targeting investments to the more backward rural areas. The idea is to demonstrate the potential for lifting larger numbers of Kenyans out of poverty altogether, in line with MDG targets.

The longest list of outstanding tasks lies on the methodological side. Work needs to be done to develop a better understanding of patterns of change in farming systems – the likelihood that specific farm types will evolve into specific other types. Progress here will make it easier to integrate IMPACT and CLUE – a technical obstacle that needs to be overcome if future applications are to be less time-consuming while providing more accurate results. Progress could also be made by 'triangulating' – using the CLUE, IMPACT and tradeoff models together to get a better fix on the dynamics of change in complex production systems. Running the IMPACT model requires a great deal of information that is costly to gather and process. Could an MD version be developed, along the lines attempted for tradeoff analysis? Having been successfully applied in the data-rich environment of the Kenyan highlands, both models should now be tested for their robustness in a data-scarce environment such as Gujarat State in India.

'We feel the team has established a valuable process with which to study change in farming systems.' –

Barry Dent and Charles Gachene.

Only when these challenges have been met will the novel approach developed by this project come fully into its own. Despite these limitations, this project's reviewers felt it had developed what could turn out to be a key set of tools and methods for informing future policy debates. The reviewers recommended that these be further refined and applied in other settings.

Final Curtain

The Ecoregional Fund held its final conference in Nairobi in September 2005. The participants were a select group of 30 or so policy makers and research managers from around the world. The conclusions and recommendations formulated after 2 days of stimulating presentations and discussions are reproduced in the Annex (see p. 68).

The conference's title posed an intriguing question: 'Ecoregional Research and Policy Making: Living Happily Ever After?' In other words, had the Fund helped build a strong and lasting relationship – a marriage, if you will – between the two groups whose work is most vital to the quest for sustainable development yet who so often seem to make uneasy partners in that quest – researchers and policy makers? This question begs two others. Did the Fund meet its objective of supporting such a relationship by creating a toolbox for ecoregional analysis? And will the toolbox continue to be used by others once the Fund is no longer active?

Chairing the conference was James Nyoro (second from right), Director of the Tegemeo Institute of Egerton University, Kenya's premier policy think-tank

Her Excellency Tanya van Gool, the Ambassador of the Netherlands to Kenya, opened the conference by challenging the participants to demonstrate the use of ecoregional research to tackle conflicts over natural resources

Achievements and limitations

In this closing chapter on the Fund's activities we'll try to sum up the Phase 2 projects' achievements and limitations, beginning with the three questions outlined above, then moving on to other issues and lessons. We'll end by identifying what we believe to be the key ingredients of successful ecoregional research.

Links with policy makers

Efforts to engage with the policy community met with varying degrees of success in the projects undertaken during the consolidation phase.

As in the first phase, selecting an urgent problem on which to work emerged as a prerequisite for attracting and retaining policy makers' attention. The clearest example of this was the Panama project, where the trigger for government interest in ecoregional analysis was an impending decision on whether or not to

sign an FTA. As negotiations advanced and national debate on the issue intensified, policy makers placed increasing pressure on the national research system to assess the country's ability to compete in different commodities. National researchers responded with energy and commitment, enthusiastically adopting an array of modelling tools in order to come up with answers. It will be interesting to see whether the same level of activity is sustained once the government has decided whether or not to sign.

In the Panama case, then, policy makers engaged with the research community, rather than the other way round. But it remains to be seen whether a strong 'demand pull' of this kind is the key to a lasting relationship.

The Panama project formed an intriguing contrast with the project on soil fertility in Kenya. Although it has serious long-term implications, the soil fertility issue does not appear urgent in the short term, since the slow loss of productivity year by year is relatively undramatic. In addition, this issue does not confront policy makers with a 'yes or no' decision to make in the short term but rather with a 'how to' problem implying a longer time-frame in which to develop solutions. The 'demand pull' from the policy community can therefore be expected to be weaker at the outset, though it might prove to have more staying power once it gets going. Experiences confirmed this expectation: the soil fertility project forged good links with national research groups but did not attract much attention from policy makers in the short period for which it was operational.

The future of Kenya's highlands attracted strong interest from policy makers

The highland futures project also took place in Kenya, yet was much more successful in involving policy makers. Several characteristics explain this success. A critical institutional innovation was the formation of a panel of experts drawn from both the research and the policy communities. This created strong national ownership, since the experts were able to influence the project's storylines. Holding a stakeholder workshop early in the research process was another good move, further building ownership. The 'crystal ball gazing' character of the project attracted curiosity; and the presentation of results in the form of easily understandable maps and short policy briefs were further plus points. Lastly, the 'ILRI effect' may have had something to do with it: this international centre is hosted by Kenya, where its policy-oriented research has a strong reputation for relevance in the national policy community.

Least successful in attracting policy makers' attention was the subproject in Tibet, where researchers' unfamiliarity with the geography, culture and language of the host country compounded the difficulties caused by inherent political and institutional factors. This project revealed the special challenges posed by the signalling stage of the policy cycle, when the issues under research may be unfamiliar to the policy community, which affords them low priority as a result. Investing in public awareness and consensus building may be just as important at this stage as conducting research to build the body of evidence.

One necessary, though not sufficient, condition for attracting policy makers' attention is a good communication strategy. This takes time and money to plan and implement – and it has to cover all the bases. The Tibetan subproject failed to get itself noticed in Lhasa despite producing an attractive final report and using powerful imagery, such as the 'water tower', to get its message across. One possible reason is that there was no provision for an end-of-project seminar.

The Tibetan subproject, in contrast, failed to engage with the policy community

One issue that arose across the projects is how partisan researchers should be when presenting alternative scenarios to policy makers. Even if they have strong personal feelings about what would be right, researchers often prefer to put on the mask of impartiality, refusing to put policy makers under pressure to act in a specific way – perhaps for fear this might backfire. Yet experience worldwide suggests the opposite: that changes in policy most often occur when researchers turn advocates, making common cause with public opinion or with NGOs to argue the case for change. Public-sector researchers are not stepping out of line when they do this: they have a mandate to speak up for the poor and marginalized. Often, they may need to resist the temptation to cosy up to the policy community, instead adopting a more confrontational stance. If researchers find themselves working in a country where they are not free to speak their minds to policy makers, they should ask themselves whether it is right to be there at all.

Creating the toolbox

The projects made valuable contributions to the adaptation and application of individual modelling tools – especially those designed to analyse natural resource management issues in complex rainfed production systems.

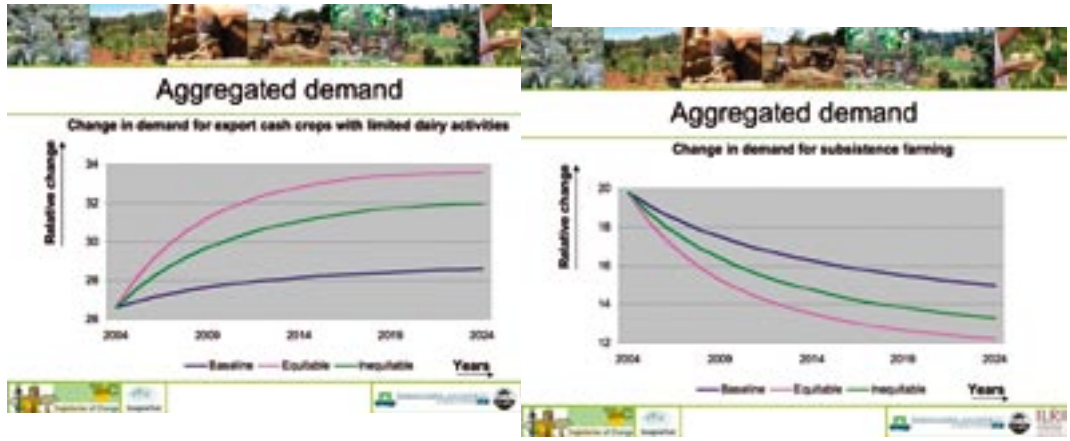
As regards adaptation, the integration of NUTMON into the tradeoff analysis platform was a useful step forward, turning a hitherto diagnostic tool into a prescriptive one. Researchers are now better equipped to support decision making on interventions in the soil fertility area, which is critical for the future of smallholder agriculture in Africa and elsewhere. Similarly, the adaptation of the CLUE and tradeoff models to cope with livestock and whole-farm analyses lays the foundations for a better understanding of the dynamics of mixed farming systems – vital if the Livestock Revolution is to be steered in directions that will benefit smallholders. The only adaptive task that couldn't be completed as intended was linking the CLUE and IMPACT models. The setback here may slow down the extrapolation of household data to the

regional level when this combination of tools is used, but in fact there are other tools that can achieve the same purpose.

In terms of application, the major achievement of Phase 2 was to demonstrate that the tradeoff analysis tool, originally developed in response to specific problems in Latin America, can be transferred to Africa, where it now appears suitable for tackling a broader set of issues. The soil fertility project showed the tool to be genuinely versatile – able to answer 'how to' questions as well 'what if' ones, and suitable for targeting interventions as well as filling knowledge gaps.

With its simple and striking graphic outputs, the tradeoff tool lends itself to persuasive communication with decision makers. But a note of caution should be sounded here: it is important not to use these outputs to arouse misleading expectations as to what can be achieved through specific interventions. The contrasting curves that provide such a clear indication of expected impact are, to quote one project reviewer, 'a bit of a conjuring trick.' In the real world the effects of new policies or technologies would materialize only slowly, leading to a gradual transition from one state to another rather than an overnight transformation. And other factors would doubtless intervene during the transition to muddy the waters still further. This is really a problem of interpretation rather than of the curves themselves – but it is worth bearing in mind when presenting to policy makers.

The development of MD versions of the tradeoff model, begun in Panama and continued in Kenya, could prove critical to making this valuable tool more user-friendly. MD versions certainly ease the tool's introduction to national research groups, as the experience of the soil fertility project showed. What is not yet clear is whether these versions can be used for detailed analysis in support of decision making. At present that appears doubtful – but it's worth continuing work in this area, to find out if 'tell-tale' indicators can be identified for a range of applications. One problem is that, although MD versions are user-friendly once you have them, developing them in the first place is almost as resource-intensive as conducting a full analysis, since a lot of methodological work is needed to create them and a great deal of data are needed to check whether or not they work. They may turn out to be too location-specific to be cost-effective.



Tradeoff analysis curves: A persuasive tool, but beware of misinterpretations

Application of the toolbox as a whole was best exemplified by the Panama project. Here researchers were encouraged to select their own tools from the range available, which included tools developed without the support of the Fund. The project leader deliberately avoided 'pushing' any specific tool over others. This more liberal approach to the discovery and adoption of tools forms an interesting counterpoint to projects designed to introduce a single tool – such as the soil fertility project, with its focus on tradeoff analysis. Both approaches have their advantages, but the one used in Panama appears better adapted to relatively strong national research systems, where the ability to self-start and to experiment with a range of tools is likely to be better developed.

Other contributions to the use of models occurred through the provision of training and the development of training materials. All the projects performed well in these areas, demonstrating particular strength in the development of websites to support emerging regional or global communities of practice.

The institutionalization challenge

'Our friends from the Netherlands are going to leave us, for sure,' –

Kenyan national researcher.

Phase 1 showed that the most difficult challenge facing the Fund was to secure lasting adoption of modelling tools and processes by national research groups. The consolidation phase confirmed this experience, but threw light on a few ingredients that can lead to success.

One of the keys to successful institutionalization identified in Phase 1 was the 'nesting' of modelling in a set of complementary approaches geared to a single objective pursued by different groups across the national research system. This can take time to achieve – a decade in the case of the tradeoff analysis project in Ecuador. For the most part the Phase 2 projects were implemented over too short a time-span for these vital links with other activities to materialize on the ground. There were, however, signs of this starting to happen in Panama, where, besides IDIAP, a range of institutions including NGOs and a private-sector company joined a national research effort reinvigorated by its sharpened focus on a single question – whether or not to sign the FTA.

Institutionalization can take place from the bottom up, when national scientists spontaneously adopt and apply tools, or it can be led from the top down, when senior management strongly endorses a given approach and allocates resources to it. The process is most likely to succeed when both occur. In Panama, spontaneous adoption spread among scientists in several institutions across the national system; this was followed by ministerial endorsement and the designation of a core team at IDIAP to lead the effort after the project ended.

Participation is vital to successful institutionalization, which is more likely to happen when national researchers are involved throughout the research process rather than merely at certain stages of it. It is particularly important to secure national inputs into project design. The highland futures project convened an expert panel that successfully combined inputs from national researchers and policy makers in this way, helping to bring the two communities together. This project also appointed a national researcher to

develop its methodology, thereby ensuring transfer of this methodology to the national research institute to which she returned when the project was over.

Requiring national researchers to form a dedicated team as a pre-condition for participating in a project was another useful innovation. This was one of the steps taken by the soil fertility project, which adopted a more pro-active approach to institutionalization than the one used in the course of tool development during Phase 1 (see box).

Institutionalization gets easier once the development phase is over

In Ecuador and Peru, where the tradeoff model and process were under development over a relatively long period, national user groups got rather fed up with waiting for the results.

In Kenya and Uganda, in contrast, an MD version of the model proved of immediate interest to national research groups, who were able to start using it straight away. Project staff visited these groups at the outset in order to gauge their interest. If they confirmed their interest by forming a tradeoff analysis team, the team received training at an in-depth workshop tailored to its needs. After the workshop, the team was asked to prepare its own project, together with a plan for its implementation. Then, in 2004, a further workshop for both the national teams was held at ILRI, with a view to consolidating the experiences so far and forging a users' community in the region.

These contrasting experiences of institutionalization in the tool development and tool application phases suggest that institutionalization is easier in the latter phase, when it can become a conscious objective reflected in the project's design and activities.

When the issues explored through ecoregional research are controversial, a platform or forum may be needed to bring together competing stakeholder groups. This institution wasn't evident in any of the Phase 2 projects – but it may well be needed in the Tibet case if a regional dialogue on transboundary water issues is to be established and acceptable compromises reached in the longer term. The Global Water Partnership (GWP) is the organization best placed to broker the establishment of such an institution.

'Institutionalization is especially difficult when the institute is dependent on external funding. You end up transferring to another project, but not to the institute itself.' – Jetse Stoorvogel.

Some of the models used in the consolidation phase are still too difficult to pass on to user groups other than researchers. A case in point is IMPACT, which would require a huge input into training if extensionists were to use it in its current form. Herero and his colleagues at ILRI are trying to simplify the model's diagnostic tools, while acknowledging that the household component is always likely to remain too complex for all but the diehard enthusiast. Other tools, such as decision trees, can sometimes come to the rescue in these circumstances.

Weaker national systems face special difficulties in institutionalizing new research tools. Such systems are typically characterized by a plethora of special projects with short life-spans, such that tools are continually passed from one project to another without ever being integrated with the institute's own programmes. This is one symptom of the need for donor agencies to re-think the project cycle with a view to committing funds for longer periods than the standard 3 years (see below).

Now that the toolbox is available, the next step will be to invest in capacity building to secure its widespread adoption and effective use. A substantial investment is needed in this area, especially if weaker national systems are to benefit.

Contributions to science

The Fund's Phase 2 projects made some strategic contributions to the knowledge base that supports modelling.

Quiroz and his colleagues continued their work on fractal analysis, begun during Phase 1. Fractal analysis is a set of mathematical techniques for understanding the variable distribution of phenomena on different scales. These techniques have been applied to a wide range of phenomena, including natural ones, such as the size of soil particles, and man-made ones, such as the behaviour of the money markets. A major obstacle to their use in ecoregional research has been the absence of readily accessible, user-friendly software for this purpose. During Phase 2 Quiroz responded to this lack by developing CIP-FRACTLAB, a dedicated software package that can be downloaded free-of-charge from CIP's website. In the Panama project, Quiroz used CIP-FRACTLAB to derive information on rainfall patterns from remotely sensed imagery (see box).

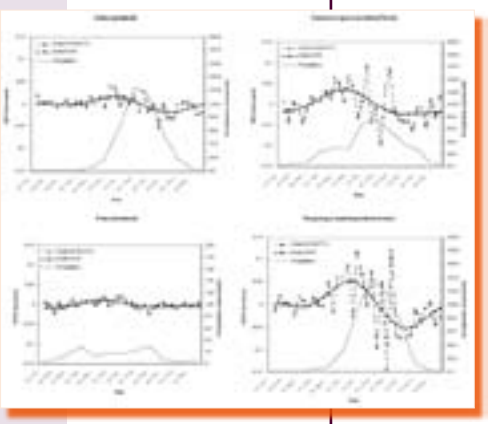
'Tools must be simple and user-friendly if local professionals are to apply them.' – Roberto Quiroz, project leader.

Noises off: Fractal analysis aids rainfall prediction

Rainfall varies greatly in highland environments, according to such factors as altitude and rain shadow in addition to season. These environments are typically data-scarce, so rainfall for specific locations often has to be interpolated from distant weather stations. Such interpolations can be highly inaccurate.

To estimate the rainfall for project locations in the Chiriquí watershed, Quiroz started with the 'noise' – the peaks and troughs in a graph – for a nearby location at which rainfall had actually been measured. He compared this with what is called the Normalized Distribution Vegetation Index (NDVI) for that location. NDVI is a measure of the greenness of vegetation at specified time intervals (usually 10 days) throughout the year. Quiroz then used satellite imagery to establish the NDVI at the project locations, working backward from these to derive the noise and hence the graph for rainfall at each location.

NDVI alone has been successfully used to predict rainfall. However, experts in remote sensing maintain that this is possible only in arid and semi-arid areas, where greenness peaks early in the rainy season, then fluctuates sharply according to rainfall events. Through his work in Panama, Quiroz has shown that noise can be used to improve this method and extend it to humid areas. Validated against actual rainfall data, the use of noise explained 80 per cent of the variation in rainfall at different locations in the Chiriquí watershed, compared with only 72 per cent using NDVI alone.



Other projects too had useful spinoffs. For example, researchers at ILRI who worked on the highland futures project have submitted a proposal to the Gatsby Charitable Foundation to fine-tune the analysis and make policy recommendations. Another proposal, submitted to the EU by Alterra and Wageningen University, includes an ILRI-led case study on the effects of EU subsidies on dairy farming in the Kenyan

The effects of EU subsidies on Kenyan dairy producers will be studied in a forthcoming ILRI project

highlands. And a concept note has been prepared for a KARI-led initiative to model changes in farming systems in poverty and soil fertility hotspots, also in the Kenyan highlands.

The journal articles published as a result of the projects' contributions to science are listed in the Annex (see p. 67).

Things that can happen

A loud clunk had awoken the slumbering passengers and, a kilometre or so further down the road, the coach had come to an abrupt halt on the deserted forecourt of a closed petrol station. In the darkness and silence of the rural Panamanian night, the disembarked passengers stood around glumly, staring at the stream of petrol haemorrhaging from the coach's wounded underbelly.

It was an example of what Spanish speakers euphemistically call *'las cosas que pueden pasar'* – 'things that can happen'. The coachload of workshop participants had left Panama City late in the afternoon, after a full day of presentations and discussions, to undertake the 6-hour drive to the western town of David, capital of Chiriquí Province, where they were to go on a field trip the next day.

The course of agricultural research in developing countries seldom runs smooth. The further a project from the capital city, with its relatively well developed infrastructure and services, the more such incidents are likely to occur – and the higher the costs of dealing with them. In this case, the disruption was kept to a minimum: the participants took taxis into David, which turned out to be only a few kilometres down the

road, and, thanks to strenuous efforts by the driver and a garage mechanic, the coach was repaired in time to take them on their field trip the next morning. But it could all have been a lot worse.

Yet despite the risks and costs associated with its remoteness, Quiroz had chosen the right location for his project – a high-potential area of strategic importance to the country's agriculture and hence to its policy makers. As the Tibetan subproject showed, using ease of access alone as the criterion for selecting a location can render a project more or less invisible to the national policy community. Sometimes the interests of relevance and logistics coincide more happily, however: the Machakos District of Kenya, chosen for detailed analysis by the soil fertility project, was both easy to reach and of interest to policy makers.

Projects must be located in areas of interest to policy makers

The bottom line is that a project location must be the focus of policy attention, however hard or easy it is to get to. If it is not, then the project is likely to have little impact.

Choice of partners

The Fund's projects worked with partners at the international and national levels. The two experiences differed markedly.

At the international level, the Fund was originally established to support the ecoregional research of the CGIAR's centres and programmes. In the consolidation phase, two centres, CIP and ILRI, showed themselves to be active partners whose commitment to ecoregional research seems likely to outlive the Fund, while others, such as ICRAF, look set to take up at least some of the tools and methods developed. However, the CGIAR's multi-partner ecoregional programmes often played only a minor part in the Fund's projects and were absent altogether from Phase 2. This is regrettable, since the criticisms commonly levelled against these programmes – their lack of focus on priority problems and fragmentation of efforts – provided the rationale for the Fund's establishment. The CGIAR's new global challenge programmes also had little to do with the Fund's activities. For example, no representative from the Africa Challenge Programme attended the Fund's final conference. Again, this is regrettable, since this programme too has had difficulty in setting priorities and could have benefited from an ecocregional approach to this task.

In contrast, the partnership record at the national level looks much better. The projects in Panama and Kenya, in particular, built successful relationships with research groups at national institutes and universities. In the case of the Kenya-based projects, these partnerships began spreading to neighbouring countries, particularly Uganda. Regional or international users' groups, or communities of practice, seem likely to form, using the Internet as their principal means of communication.

Partnerships were more vibrant at the national than at the international level

The inescapable conclusion is that national research groups make more willing partners than programmes at the international level, which are often too overburdened by political and administrative constraints to be able to respond positively to invitations to participate.

Modelling: Vital ingredient or optional extra?

Modellers must learn to resist the temptation to open the toolbox when it's not needed. In some situations modelling is superfluous because the priority development interventions are obvious. A case in point is the Palissa District of Uganda. Why not dispense with tradeoff analysis here and instead put energy and resources into getting the road completed?

A well stocked store is an obvious starting point

Barry Dent, who reviewed two of the Fund's Phase 2 projects, believes that some of the more localized modelling applications undertaken by the projects could have been replaced by good diagnostic research, which is cheaper and quicker to do. A participatory rural appraisal, undertaken by a few dedicated researchers and some expert local informants, can reveal most of the innovations typically needed by rural communities. Most of these are common sense anyway – roads, schools, clinics and a well stocked local inputs store being obvious starting points. 'All you need is good empathy and an ability to listen,' says Dent. Arguably, modelling in these situations is an unnecessary luxury, a bolt-on to projects that reflects researchers' interests rather than real needs.

A related point is that models need not always be computer-based. The mental 'model' of a production system in the mind of a farmer or extension worker may be less mathematically accurate than a computer-based model, but it can sometimes be intuitively superior. And the tacit knowledge or folk wisdom of local people can be just as good a guide to action.

'A farm is like a baby. If you want it to grow well, you must provide for it.' – Kenyan woman farmer.

The only advantage of computer-based modelling in such settings is that it can tell local people more about how to meet their implicit needs – their unarticulated demand for technologies of whose existence they are unaware. For instance, if farmers complain that their potatoes are killed by frost, a scientist armed with a good computerized crop growth model can tell them about new frost-tolerant varieties and the yields that can be expected from such varieties under their specific conditions.

Towards greater donor efficiency

The projects' experiences yield two lessons for donor agencies that may help them to operate more efficiently in future.

First, it would be in the interests of everyone to try to shorten the time between the submission of a project proposal and the release of funds. The delays incurred in launching the Phase 2 projects had severe knock-on effects, ranging from wholesale redesign and the selection of new partners and countries to the curtailment or cancellation of specific activities. Of course, DGIS has to operate according to the rulebook governing the disbursement of taxpayers' money. It could not, therefore, short-cut its proper procedures, including project review, budgetary approval and the appointment of a management agency. But it is ironic to note that the very checks and balances that are supposed to ensure the efficient use of public money can end up achieving the precise opposite. Some of the circumstances that prevented efficiency

in this case could not be helped, but the protracted review process at the outset could perhaps have been avoided. DGIS needs to find ways of streamlining this process.

Secondly, for ecoregional research as for many other R&D activities, the conventional 3-year project span is too short to deliver lasting outcomes. DGIS's decision to shorten the consolidation phase from the requested 4 years to only 3 meant that most projects fell short of their stated objectives. It is particularly difficult to institutionalize new research tools and methods in such a short period. As recommended by the UN Millennium Project's Task Force on Hunger, DGIS should join other donor agencies in a radical re-think of its institutional arrangements for the provision of grant aid.

Bowing out

The Ecoregional Fund ceases to exist on 31 December 2005. This will not spell the end of methodology development to support ecoregional research. This paradigm's abiding popularity will ensure that others will take up where the Fund leaves off.

There will be a continuing need to develop and refine models that deal with mixed production systems and natural processes. Uncertainties over the 'results' achieved by such models still cloud too many researchers' presentations. When the audience consists of policy makers, it is especially important that researchers should be sure of their ground. That said, it will never be possible to achieve perfection in modelling. A pragmatic approach, using the best available tool for the job but explaining its limitations clearly to stakeholders, will continue to be the best way forward.

'You seem to have had more confidence in the model at the start of the project than you have now.' –
Barry Dent.

'With modeling, we are still in the early days of the motor car.' –
Steve Staal.

'If you wait for the perfect match, you will never get married.' –
Roberto Quiroz.

Golden rules

What can we learn from the Fund's experiences? We can sum up the most important lessons in the form of ten golden rules for ecoregional research:

- Choose an issue and a geographical area of importance to policy makers. Don't select areas solely for their ease of access.
- Ask if modelling is really necessary. If the priority development interventions are obvious, don't waste taxpayers' money on a modelling exercise driven more by your research interests than by real needs.
- If there is a researchable issue that genuinely calls for a modelling solution, select the right tool for the job. Where appropriate, select a combination or sequence of tools that can be applied to different tasks or at different stages in the research process.
- Involve stakeholders, especially national research groups and policy makers, early in the research process. Make sure they have an input into the design of your project, as well as its implementation. In the case of controversial issues, you may need to launch a new discussion forum or platform that is seen as neutral.

- Be clear about the objectives of your project. Decide whether you are using a model to stimulate the interest of new users or to conduct a detailed study for policy makers. If the former, use an MD version of the model, if this exists.
- Consider your data requirements carefully, taking special care to identify key indicators. If working in a data-scarce environment, there is no alternative but to collect data on these indicators yourself, engaging national partners to assist in the effort.
- Invest in building the capacity to use modelling tools sensibly. There is no substitute for thorough hands-on training. Remember that the returns to training can be multiplied by developing manuals, case studies and other materials, together with a website to support them. Work towards the development of a community of practice at the national, regional and international levels.
- Be honest about the limitations of the model you are using and take care not to demand too much of a model. Remember, modelling is an aid to decision making, not a substitute for it. If possible, 'triangulate' the modelling exercise by using other sources of information, including other models, to verify your results.
- Work out a comprehensive communications strategy for conveying your results to the policy community. Key tools are policy briefs, workshops and field days. Make sure you are confident of your results and clear about what you are advocating before you present at workshops. Present with feeling!
- To maximize your chances of impact, nest the modelling exercise in a set of other complementary activities, including advocacy and awareness building. Make common cause with NGOs and the public in pursuit of change.

Bowing out: Johan Bouma presents on behalf of the Fund for the last time

One final piece of advice: remember, the job of researchers is to challenge, not to reassure; resist the temptation to cosy up to policy makers, telling them only what they want to hear; the marriage between ecoregional researchers and policy makers should occasionally be one of inconvenience.

Concluding remarks

It is clear that the Ecoregional Fund has made major contributions to the development of a toolbox for ecoregional research. There is no longer any reason why this approach should lack focus and coherence, as it did in its early days. The tools and processes are now in place to conduct analyses that balance different development objectives and the interests of different stakeholder groups. The Fund's crowning achievement is probably the development of tradeoff analysis – a tool and a process that look set to take their rightful place at the heart of ecoregional research in the years to come.

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Annex

1. The research system of the Consultative Group on International Agricultural Research

CIAT	Centro Internacional de Agricultura Tropical, Cali, Colombia
CIFOR	Center for International Forestry Research, Bogor, Indonesia
CIMMYT	Centro Internacional de Mejoramiento de Maíz y Trigo, El Batan, Mexico
CIP	Centro Internacional de la Papa, Lima, Peru
ICARDA	International Center for Agricultural Research in the Dry Areas, Aleppo, Syria
ICLARM	WorldFish Center (International Center for Living Aquatic Resources Management), Penang, Malaysia
ICRAF	World Agroforestry Centre (International Centre for Research in Agroforestry), Nairobi, Kenya
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics, Patancheru, India
IFPRI	International Food Policy Research Institute, Washington DC, USA
IITA	International Institute of Tropical Agriculture, Ibadan, Nigeria
ILRI	International Livestock Research Institute, Addis Ababa, Ethiopia/Nairobi, Kenya
IPGRI	International Plant Genetic Resources Institute, Rome, Italy
IRRI	International Rice Research Institute, Los Baños, the Philippines
IWMI	International Water Management Institute, Colombo, Sri Lanka
WARDA	Africa Rice Center (West Africa Rice Development Association), Cotonou, Benin (temporary headquarters)

Ecoregional programmes

- African Highlands Initiative (AHI), led by ICRAF
- Collaborative Research Program for Sustainable Agricultural Development in Central Asia and the Caucasus (CAC), led by ICARDA

- Consortium for the Sustainable Development of the Andean Ecoregion (CONDESAN), led by CIP
- Desert Margins Program, led by ICRISAT
- Rice–Wheat Consortium (RWC) for the Indo-Gangetic Plains, led by CIMMYT
- Consortium for the Sustainable Use of Inland Valley Agro-ecosystems in Sub-Saharan Africa (IVC), led by WARDA

Since Phase 1 the Alternatives to Slash and Burn (ASB) Programme, led by ICRAF, and the Global Mountain Program, led by CIP, have been reclassified as inter-centre initiatives.

2. The Coordination Committee

Chair:

Dr J. Bouma (the Netherlands)

Members:

Dr J. Stoorvogel (the Netherlands)
Dr R. Quiroz (Panama)
Dr S. Staal (USA)

Ex-officio members:

J. Meerman, PricewaterhouseCoopers
P. Rauwerda, PricewaterhouseCoopers

3. The ten Phase 1 projects

During its first phase the Ecoregional Fund supported ten projects with the following objectives:

1. To develop and apply a decision-support system for assessing the tradeoffs between agricultural production, human health and the environment. Lead agency: the International Potato Center (CIP), based in Lima, Peru. Started: October 1996.
2. To integrate remote sensing, GIS and modelling for the purpose of monitoring land use in the arid and semi-arid Andes. Lead agency: CIP. Started: October 1996.
3. To develop and apply methods for the regional analysis of trends and options in land use in South and Southeast Asia. Lead agency: the International Rice Research Institute (IRRI), based in Los Baños, the Philippines. Started: October 1996.
4. To develop and document methodologies for integrating data across geographic scales. Lead agency: the Centro Internacional de Agricultura Tropical (CIAT), based in Cali, Colombia. Started: January 1997.
5. To optimize the use of resources at village and district levels in the desert margins of West Africa. Lead agency: the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), based in Patancheru, India. Started: August 1997.

6. To use systems analysis to promote the sustainability of maize production in the Highveld of South Africa. Lead agency: the Agricultural Research Council – Grain Crop Institute (ARC–GCI), Potchefstroom, South Africa. Started: January 1999.
7. To assess sustainable agricultural systems in the Hindu Kush–Himalayas region. Lead agency: the International Centre for Integrated Mountain Development (ICIMOD), based in Kathmandu, Nepal. Started: February 1999.
8. To promote the adoption and diffusion of a systems approach to the improvement of soil fertility and agricultural productivity in West Africa. Lead agency: the Africa programme of the International Fertilizer Development Center (IFDC), based in Lomé, Togo. Started: September 1999.
9. To assess alternative production systems for mixed smallholder crop–livestock farms in high-potential areas of East Africa. Lead agency: Wageningen University, the Netherlands. Started: March 2000.
10. To improve the methods for planning and implementing soil and water conservation at the watershed level in the East Africa highlands. Lead agency: Alterra, Wageningen, the Netherlands. Started: January 2000.

4. The Millennium Development Goals

Goal 1 Eradicate extreme poverty and hunger

Goal 2 Achieve universal primary education

Goal 3 Promote gender equality and empower women

Goal 4 Reduce child mortality

Goal 5 Improve maternal health

Goal 6 Combat HIV/AIDS, malaria, and other diseases

Goal 7 Ensure environmental sustainability

Goal 8 Develop a global partnership for development

5. Refereed publications

Participants in the Ecoregional Fund's activities have published, or intend to publish, the following papers in refereed journals:

Immerzeel, W., Quiroz, R. and de Jong, S. 2005. Understanding precipitation patterns and land use interaction in Tibet using harmonic analysis of SPOT VGT-S10 NDVI time series. *International Journal of Remote Sensing* 26 (11): 2281–2296.

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6. Conclusions and recommendations

At its closing workshop, held in Nairobi 21–22 September 2005, the Fund's Coordinating Committee formulated the following Conclusions and Recommendations, which were discussed and agreed by participants in the final plenary session:

New ways of doing research

- Ecoregional studies of land use systems should be based on a comprehensive systems analysis geared towards an integrated assessment, using a sequence of computer simulation models applied at different spatial scales. The Panama and Kenya case studies presented at the workshop demonstrated the validity of this approach. Further case studies in other countries or regions are needed to refine the methodology and test its generic character. This task has already been addressed for the CLUE and tradeoff applications, which have been successfully transferred from Latin America to Africa.
- Ecoregional research should cover the entire policy cycle, from signalling the problem to be studied, through characterizing current conditions, designing options for future land use and deciding which option to implement, to assessing the impact of implementation and drawing out the lessons, so that these can be fed into future policy design. If this cycle is followed, the design process will be realistic and implementation should meet with success.
- Ecoregional research requires effective interaction of scientists with both policy makers and land users. Rather than working separately with either group, scientists should promote interaction between the two by contributing knowledge and by facilitating and mediating a joint learning process in which they act as honest brokers. Capacity building and backstopping are effective tools for achieving high-quality interaction.

- The ecoregional research process is most effective when the problems to be studied are clearly defined and are a national or regional priority. This was the case in Panama, where the issues raised by a new Free Trade Agreement (FTA) resulted in a highly effective interactive research process. Particular attention should be paid to the signalling stage of the policy cycle, since at this stage the urgency of the problem under study may not yet be widely apparent.
- Policy-oriented ecoregional research can be reactive or proactive, either covering the analysis of existing policy instruments and documents or supporting the development of new ones. Both kinds of research are needed.

New ways of presenting results

- Geographic information systems (GIS) are an effective medium for presenting the results of land use studies in spatial and temporal terms. Interactive GIS are particularly effective for stimulating dialogue with policy makers and land users. They need to be further developed and tested, as they are crucial tools for bridging the gap between scientists, policy makers and land users. The use of GIS for gaming approaches is an attractive possibility to be explored in future applications.
- The classic output of tradeoff analysis – a curve showing the relationship between an environmental and an economic variable under current conditions and if a change in policy or technology were adopted – is a highly persuasive way of making recommendations to policy makers or researchers. It does, however, oversimplify, since the adoption of a new policy or technology will not result in a sudden transformation but rather a gradual transition from the current to the desired curve. In addition, factors other than those modelled may intervene, further blurring the transition. It is important, then, to make sure that such curves are not misinterpreted when presenting results to stakeholders.
- When presenting the results of model applications, it is important to state clearly whether the application is for illustrative purposes, to arouse interest in the tool and demonstrate how it can be used, or for analytical or predictive purposes – which require a more rigorous process of data collection and model calibration.

New messages to policy makers and land users

- Scientists should strive for lasting partnerships with policy makers and land users. These partnerships should be based on joint learning in a functional 'community of practice' with well defined responsibilities, covering the entire policy cycle. Communities of practice should be inclusive of all major stakeholder groups. In the Fund's case studies in Panama, Kenya and Ecuador, these communities included NGOs and private-sector companies in addition to farmers.

Acronyms

ARC–GCI	Agricultural Research Council – Grain Crop Institute (South Africa)
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa
CGIAR	Consultative Group on International Agricultural Research
CIP	Centro Internacional de la Papa
CLUE	Conversion of Land Use and its Effects
DFID	Department for International Development (UK)
DGIS	Directorate General of International Cooperation (the Netherlands)
DSM	digital soil mapping
ERS	Economic Recovery Strategy (Kenya)
EU	European Union
FONTAGRO	Regional Fund on Agricultural Technology (Latin America)
FTA	Free Trade Agreement
FURP	Fertilizer Use Recommendation Program (Kenya)
GEF	Global Environment Facility
GIS	geographical information system
GWP	Global Water Partnership
ICIMOD	International Centre for Integrated Mountain Development
ICRAF	World Agroforestry Centre
IDIAP	Instituto de Investigación Agropecuaria de Panamá
IFDC	International Fertilizer Development Center
ILRI	International Livestock Research Institute
IMPACT	Integrated Modelling Platform for Mixed Crop–Animal Systems
IPM	integrated pest management
ISAC	International Scientific Advisory Committee
ISNAR	International Service for National Agricultural Research
KARI	Kenya Agricultural Research Institute
MD	minimum data
MDG	Millennium Development Goal
NDVI	Normalized Distribution Vegetation Index
NEPAD	New Partnership for Africa's Development
NGO	non-government organization
NUTMON	Nutrient Monitoring
R&D	research and development
SDC	Swiss Agency for Development Cooperation
SM-CRSP	Soil Management Collaborative Research Support Program (USA)
SLP	Systemwide Livestock Programme (CGIAR)

SWAT	Soil and Water Assessment Tool
TAAAS	Tibetan Academy for Agriculture and Animal Husbandry Sciences
TAC	Technical Advisory Committee (CGIAR)
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
WTO	World Trade Organization

Credits

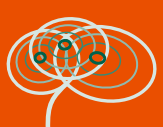
Figures
Christel Blank/Green Ink: cover and p. 65 (map); Reinier Ellenkamp/Wageningen University: p. 39 (Figure 17); Walter Immerzeel/Future Water: p. 22 (Figure 7), p. 26 (Figure 8), p. 27 (Figure 9), p. 28 (Figure 10); Roberto Quiroz/CIP: p. 13 (Figure 1), p. 15 (Figure 2), p. 16 (Figure 3), p. 18 (Figures 4 and 5), p. 19 (Figure 6); Steve Staal/ILRI: p. 44 (Figure 18), p. 45 (Figure 19), p. 46 (Figure 20), p. 47 (Figure 21); Jetse Stoorvogel/Wageningen University: p. 31 (Table 1), p. 34 (Figure 11), p. 35 (Figure 12), p. 36 (Figures 13, 14 and 15), p. 37 (Figure 16)

Photos/cover (clockwise from top left)
Walter Immerzeel/Future Water; Simon Chater/Green Ink; Pauline Rauwerda/PricewaterhouseCoopers; Simon Chater/Green Ink; Simon Chater/Green Ink; Walter Immerzeel/Future Water; Simon Chater/Green Ink; Dieter Telemans/Panos Pictures

Photos/text
Isabelle Baltenweck/ILRI: p. 48; Christel Blank/Green Ink: p. 4, p. 11, p. 45; Simon Chater/Green Ink: p. 5 (above and below), p. 6 (right), p. 7, p. 12, p. 13 (above and below), p. 14, p. 16, p. 17 (above and below), p. 20 (above and below left and right), p. 21, p. 31, p. 32 (below), p. 40, p. 42, p. 51 (below), p. 59 (above), p. 60; Walter Immerzeel/Future Water: p. 22 (above and below), p. 23, p. 24 (above and below), p. 25, p. 29 (above and below), p. 53 (above and below); Roberto Quiroz/CIP: p. 10 (above); Pauline Rauwerda/PricewaterhouseCoopers: p. 10 (below), p. 51 (above), p. 59 (below); Steve Staal/ILRI: p. 6 (left and middle), p. 8, p. 43, p. 52, p. 58; Jetse Stoorvogel/Wageningen University: p. 30, p. 32 (above), p. 34 (above and below), p. 35 (all), p. 38, p. 41, p. 49, p. 54; Andrew Testa/Panos Pictures: p. 3

Writing, editing, design and layout
Simon Chater and Christel Blank/Green Ink, UK (www.greenink.co.uk)

Printing
Pragati Offset Pvt. Ltd, India (www.pragati.com)



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PricewaterhouseCoopers is the management agent of the Ecoregional Fund