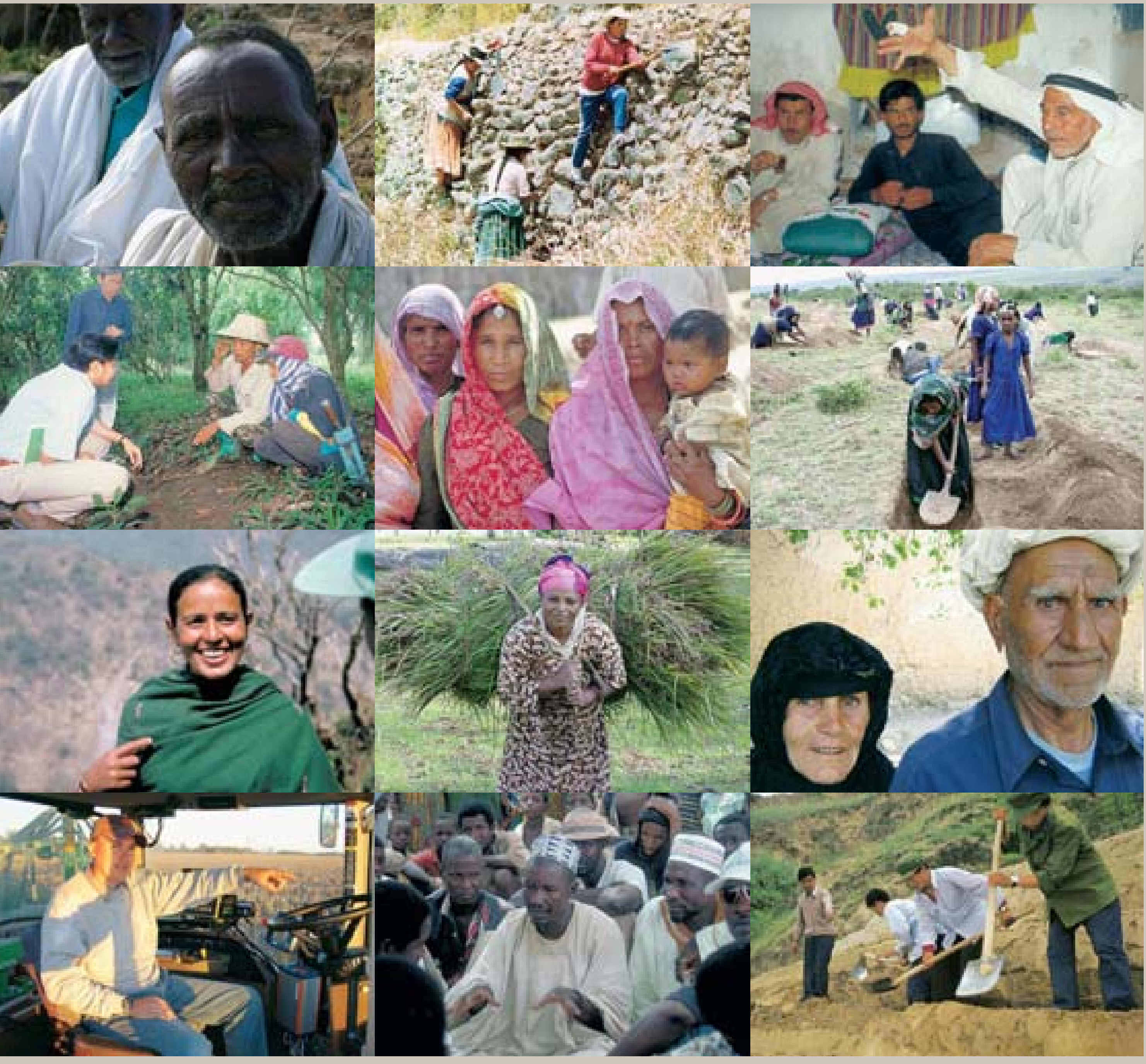
where the land is greener

case studies and analysis of soil and water conservation initiatives worldwide

WOCAT

World Overview of Conservation Approaches and Technologies



land users leading the way in making the land greener

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case studies and analysis of soil and water conservation initiatives worldwide

This book is dedicated to those women and men who take good care of the land – whose individual and collective efforts go, so often, unacknowledged.

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WOCAT – World Overview of Conservation Approaches and Technologies

CTA

UNEP

cde centre for development and environment

WOCAT 2007

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Cover photo ‘where the land is greener’ – a protected plot on a degraded hillside in the Varzob Valley, Tajikistan. (Hanspeter Liniger)

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The Technical Centre for Agricultural and Rural Cooperation (CTA) was established in 1983 under the Lomé Convention between the ACP (African, Caribbean and Pacific) Group of States and the European Union Member States. Since 2000, it has operated within the framework of the ACP-EC Cotonou Agreement. CTA’s tasks are to develop and provide services that improve access to information for agricultural and rural development, and to strengthen the capacity of ACP countries to produce, acquire, exchange and utilise information in this area. CTA’s programmes are designed to: provide a wide range of information products and services and enhance awareness of relevant information sources; promote the integrated use of appropriate communication channels and intensify contacts and information exchange (particularly intra-ACP); and develop ACP capacity to generate and manage agricultural information and to formulate ICM strategies, including those relevant to science and technology. CTA’s work incorporates new developments in methodologies and cross-cutting issues such as gender and social capital.

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Forewords

'where the land is greener' is a powerful title for a book on soil and water management. It conjures up images of where things are better – and the direction farming families want to go, literally or metaphorically. Those millions of people who make their living from soil and water, out of plants and animals, depend quite simply on vegetation. For them 'greener land' means better livelihoods; it means more food, more income – more of everything. These people need that security, since over 800 million of them are amongst the poorest on the globe.

Historically, migrating to greener land has been one of the fundamental survival strategies of farmers. However, while many may look for better land elsewhere – for 'greener pastures' – others go about 'greening' the land they already have. How do they achieve this? It is through an extraordinary deployment of physical, intellectual, social and cultural skills. They test new technologies – some invented, some copied from what they've observed elsewhere. Family traditions have been reshaped in the process. Women have talked their men into investing more time in land and less in leisure, and many women have become the intellectual masterminds of new ways to farm. These families are the true champions of sustainable, productive agricultural systems. Some have benefited from support of their governments, sometimes combined with international funding through projects. Yet the central and decisive element remains the continued effort of the families themselves.

'where the land is greener' is unique in depicting a broad range of important ways in which farming families have achieved these goals, and the contribution of support units to this process. While farmers may often be a cause of land degradation, this book deepens our understanding of how solutions cannot be arrived at without the full commitment – and creativity – of those same farmers. It helps us to understand the mechanics of this process. There is a detailed account of technologies used, the implications on family labour, soil and water use efficiency, and many other criteria. This information is crucial for professionals in their efforts to assist other farmers in 'making their land greener' and sustaining it in that condition. In an overpopulated world this may be the only realistic strategy for poor, rural families.

Martin Sommer, Head of Division Natural Resources and Environment **SDC,** Bern, Switzerland

Farming remains the dominant occupational sector in the global economy. Over one billion people are engaged in agriculture, and about 40% of the world's population – over 2.5 billion women, men and children – live in agricultural households. According to a recent international assessment, small-scale farming is the means of living for the majority of these people, and their livelihoods are intimately linked to the land they use for farming, livestock rearing and forestry. Sustainable management of the land, in economic, social and ecological terms, is thus a prerequisite for equity among those land users. This book ultimately addresses this group of land users, by providing a large sample of positive case studies from different contexts world-wide, and an analysis of why successes can be achieved by some land users, although unfortunately not by all.

'where the land is greener' is a stimulus to apply sustainable land management on all farmland, pastoral areas and forest land. It proposes appropriate technologies and approaches for areas where the land is not yet 'green enough'. But the task lies not just with the land users. A major share of food, feed, fibre and fuel is consumed by non-farming people. And what is more, this other sector of the world's population also has a major impact on natural resources. Fertile lands are being converted from agriculture to build houses, roads and factories. Biodiversity of natural and cultural plants and animals is greatly reduced by industrial development. Climate change and the degradation of the land's resources are mutually linked. 'where the land is greener' provides answers to some of these issues. Fertile soils have higher productivity and biodiversity, and better potential to absorb additional carbon. The global community at large profits from multiple agro-ecosystem services, and thus it is our responsibility to make sure that land users are empowered and enabled to invest more into their land.

WOCAT, the international programme behind the book, has been focusing on sustainable land management for many years. As chair of the World Association of Soil and Water Conservation (WASWC), I initiated WOCAT in 1992 as a new concept to link its members so that they could work together towards a common goal. Thanks to the continuous support and involvement by SDC, and many other institutions and individuals since its inception, the programme has developed and will hopefully continue to grow as a learning and sharing network that responds and adapts to evolving local and global needs.

Hans Hurni, Director **CDE,** University of Bern, Switzerland

The Land and Water Development Division of the Food and Agriculture Organization of the United Nations (FAO) has supported and collaborated with WOCAT for over ten years. Several joint efforts have contributed to the global dissemination of best practice in soil conservation. This book demonstrates that sustainable agricultural technologies are real options that contribute directly to food security and to improve living conditions of people in the rural areas.
Clemencia Licona Manzur, Soil Reclamation and Development Officer, Land and Plant Nutrition Management Service, **FAO,** Rome, Italy.

In 2006, the international community observed the International Year of Deserts and Desertification. This book follows that up, appropriately, by providing a menu of suitable technologies and approaches, that if scaled up, could generate global environmental benefits in terms of enhanced ecosystem functioning and services in drylands and other environments affected by land and water degradation.
Anna Tengberg, Senior Programme Officer Land Degradation, UNEP, Division of **GEF** Coordination, Nairobi, Kenya

This book is very timely in view of current environmental concerns. The successful technologies and approaches, collected from different ecological zones and landscapes around the world, hold potential for replication in other environments with similar characteristics. Most importantly, responding to the MDGs on poverty reduction and environmental protection, the analytical section sheds light on policy options for implementation.
Elizabeth Migongo-Bake, Environment Affairs Officer, **UNEP,** Nairobi, Kenya

WOCAT's mission is very important and we believe that this product is timely: by focusing on success stories and providing a summary of policy points this book will help us – and more broadly TerrAfrica – in our efforts to scale up sustainable land management practices throughout Sub-Saharan Africa.
Christophe Crepin, Africa Regional Coordinator, **World Bank,** Washington, USA

The 'Bright Spots' project shares common ground with WOCAT in its efforts to identify, and build on, successes in conservation of natural resources and sustainable land management. We welcome this book – which provides yet more evidence that there are ways and means of overcoming land degradation and simultaneously addressing poverty.
Deborah Bossio, Theme Leader and Principal Soil Scientist, Land, Water and Livelihoods, **IWMI** Colombo, Sri Lanka

It is a pleasure to welcome the book 'where the land is greener' which has been elaborated under a positive and stimulating approach. This volume represents an outstanding contribution towards combating land degradation. It has a global scope: sharing both scientific knowledge and invaluable practical references. The book shows how old and modern approaches could be used – with the common denominator of a more eco-efficient and more sensible use of the land.
José L. Rubio, President **ESSC,** Valencia, Spain

In agriculture, it is as important to conserve the knowledge of millions of farming families about soil and water management as it is to conserve natural resources. That is what makes WOCAT so important.
Willi Graf, Senior Advisor Natural Resources and Environment, **SDC,** Bern, Switzerland

Sustainable land management is an important prerequisite for meeting the Millennium Development Goals, and in particular those on hunger and environmental sustainability. Moreover, it is also important to mitigate climate change. We see this book as an important landmark in highlighting the possibilities of maintaining land in a productive state and making positive changes to degraded land. Denmark has actively supported WOCAT since 1999 and believes this publication is timely in giving a valuable contribution by presenting lessons learnt and making them readily available for all relevant actors.
Carsten Staur, Ambassador State Secretary, **Danida,** Ministry of Foreign Affairs, Copenhagen, Denmark

The pressure on landscapes to deliver a full range of ecosystem services to meet the growing demands of society makes the efficient sharing of knowledge and experience on better soil and water management ever more important and urgent. This is why we support WOCAT.
Andrew Bennett, Executive Director **Syngenta Foundation** for Sustainable Agriculture, Basel, Switzerland

Land degradation and related environmental catastrophes – essentially caused by man and worsened by climate change – are being felt more than ever. And now, the long awaited WOCAT global overview book is ready, documenting technologies and approaches that can help prevent or at least mitigate their effects. A timely coincidence indeed!
Samran Sombatpanit, Acting Director **WASWC,** Bangkok, Thailand

ISRIC has actively participated in the WOCAT programme since its initiation in 1992. This product is a testimony to the unique collection of SWC case studies compiled over these years. ISRIC is proud to have contributed to this important book - which helps demonstrate the importance of proper documentation and evaluation of lessons learned.
David Dent, Director **ISRIC,** Wageningen, The Netherlands

The Centre for International Cooperation of the Vrije Universiteit Amsterdam has an association with WOCAT that goes back over 10 years. This relationship fits well within our outreach mandate. And we are particularly happy to have been integral in the formulation of this book which promotes sustainable land management as a means to reduce poverty in developing countries – a goal we share.
Kees van Dongen, Director **CIS,** Vrije Universiteit Amsterdam, The Netherlands

Preface

'where the land is greener' had its origins around the turn of the new century. At that time WOCAT had been busy for just over five years with data collection and the creation of a digital database. But there was a promise in WOCAT brochures that there would be written products. It was surely time to collect and collate the 'best' case studies and analyse them – and then illustrate with some of the most striking photographs from that database. Work eventually started in 2002, but the one-year completion target finally stretched out to five. What were the reasons? Basically 'The Book', as it became familiarly known to us, developed into a sub-programme in itself. It evolved from the original proposal of compiling some 15 or so well documented and interesting technologies and approaches from the WOCAT database, to strategically seeking additional case studies to cover different conservation practices, geographical regions, land uses and production systems. The number of technologies ended up at 42. Throughout the preparation of the book, there has been a highly interactive process between the editing team and the contributors – who are scattered all over the world. There is trade–off between stakeholder consultation and timeliness.

This lengthy process, however, proved a blessing in disguise. Not only did it assist in making the book more comprehensive and ensuring quality, but it has helped WOCAT to focus on gaps in information – whether these were technologies (for example the spontaneous spread of *Grevillea robusta* trees in East Africa or 'Forest catchment treatment' in India) or geographical locations (for example Australia, Tajikistan and China). And has also allowed us to keep abreast of new developments: five years ago 'conservation agriculture' was a relatively little known concept outside of the Americas. Now it is spreading rapidly and we have captured examples from Australia, Kenya, Morocco, and the United Kingdom. And of course the international environmental conventions – those covering desertification, biodiversity and climate change in particular – have begun to have a marked impact on land management policy and practice. Furthermore the concepts of ecosystem services, fair trade production and 'agro-ecotourism' have grown in prominence. The Millennium Development Goals are now having an impact on development and related research. It has been possible to track these developments and integrate them into the analyses and the policy points.

It's been a long road, and there have been frustrations, but above all it has been rewarding. And, let's admit it, fun. Our editorial meetings – from Rome to Marrakech; from a chalet in the Swiss Alps to 'Room 119' in the University of Bern where it all finally came together – didn't just consist of arid soil and water conversations, but were enlivened by discovering all sorts of humorous mistakes and quirks of language: 'howlers' as we termed them. *'Toothless worms which produce flavourless manure'* was one, *'substance farmers'* another and – presumably in honour of the 2006 football World Cup – we had 'off-side impacts of SWC'. That last one nearly caused an own goal.

So many people have contributed that this is the result of a whole WOCAT community effort. Our privilege has been to coordinate and shape the final product: and we of course are ultimately responsible for any mistakes and errors. Finally, many thanks to all those who have put so much effort and time into a book we are proud of. Above all we hope that it will contribute to enlightened policy formulation, and thereby help to achieve WOCAT's goal of spreading the message of sustainable land management worldwide: a goal that we believe can, and must, be achieved.

Hanspeter Liniger and William Critchley

Acknowledgements

First of all we would like to thank the land users behind these case studies for sharing their most valuable experiences with a worldwide audience.

We are immensely grateful to the 93 contributors and contact persons of the case studies – listed on page XI – for their original descriptions and datasets, and for their tolerance in answering our multiple queries. Thanks also to the participants of the WOCAT workshops and steering meetings for reviewing the case studies.

We acknowledge the unwavering support of WOCAT's main funders – the Swiss Development Cooperation (SDC), who have confirmed their faith in WOCAT through continuous commitment that has lasted now for well over a decade. The Food and Agriculture Organisation of the United Nations (FAO) has encouraged and worked with WOCAT all along, not least in this production. Gratitude is due also to the United Nations Environment Programme (UNEP) for financial assistance and support – right at the beginning of this endeavour. DANIDA and Syngenta Foundation have also been long-term sponsors of WOCAT. World Soil Information (ISRIC) in The Netherlands is a long term partner. Thanks to all of these. A special mention should be made to Technical Centre for Agricultural and Rural Cooperation (CTA) for their very generous contribution towards printing and publication. Naturally we also thank our own institutions – the Centre for Development and Environment (CDE) of the University of Bern and the Centre for International Cooperation (CIS) of the Vrije Universiteit Amsterdam. And a special word of gratitude is due to all WOCAT's partner institutions – in particular those represented by the contributors.

All of us are indebted to Hans Hurni, who first came up with the concept of WOCAT and has been a constant source of support and inspiration over these years – not least during the compilation of this book.

Finally, we would like to acknowledge our review team by name: these are all people with a connection to WOCAT who gave us extremely valuable feedback on the analysis, conclusions and policy points in particular. So here's to Andrew Bennett, Charles Bielders, Malcolm Douglas, Markus Giger, Willi Graf, Karl Herweg, Udo Höggel, Hans Hurni, Clemencia Licona-Manzur, Godert van Lynden, Samran Sombatpanit, and Francis Turkelboom.

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Policy points – *guiding the process*

As a summary of the book's main messages we present a consolidated list of policy points. These are reproduced from chapter 4 where they are supported by conclusions. The conclusions in turn are drawn from analysis of the 42 worldwide case studies presented in this book – and further informed by WOCAT's broader database. Some of the policy points that follow are new; others reconfirm what is already known but deserves re-emphasising. These guidelines have clear implications for planners and decision-makers in governments and development agencies. Realigning soil and water conservation policy is crucial in addressing land degradation: this is a prerequisite for achieving sustainable land management and improving livelihoods.

Knowledge management –
the basis for decision support

- Concerted efforts to standardise documentation and evaluation of SWC technologies and approaches are needed and fully justified, especially in the light of the billions of dollars spent annually on implementation.
- To assure the quality and usefulness of information, scattered knowledge about SWC needs to be identified, documented and assessed through a thorough and interactive review process that involves the joint efforts of land users, technical specialists and researchers.
- Once documented, experiences with SWC need to be made widely available and accessible in a form that allows land users, advisors and planners to review a 'basket' of alternative options, setting out the advantages and disadvantages of each, thereby enabling them to make informed choices rather than following set prescriptions of 'what to do'.
- The implementation of new SWC efforts should build on existing knowledge from within a location itself or, alternatively, from similar conditions and environments elsewhere.
- There is need for a standardised methodology – like the WOCAT tools – to facilitate comprehensive data collection, knowledge management and dissemination.

Monitoring and evaluation – *a prerequisite to improve SWC and justify investments*

- Monitoring and evaluation in SWC projects/ programmes must be improved. It needs to do more than just monitor the timely delivery of project outputs; it should also evaluate whether the expected environmental and development benefits have been realised in a cost-effective manner.
- Rigorous impact assessment, involving the evaluation of strengths and how to sustain them, as well as evaluation of weaknesses and how to overcome them, is a must.
- Land users have to be involved as key actors in monitoring and evaluation activities: their judgement of the pros and cons of SWC interventions is crucial.
- There is a need to develop mechanisms to monitor and evaluate local conservation practices, land management innovations and traditional land use systems.
- More investment in training and capacity building is needed for objective and unbiased monitoring and evaluation, for impact assessment, and to improve skills in knowledge management including the dissemination and use of information.
- Mapping of conservation coverage is essential, in order to visualise the extent and effectiveness of human achievements.

left: Rainfed terraces in the Anti Atlas mountain range of Morocco. (Hanspeter Liniger)

right: An international group taking a keen interest in a Nepalese farmer who is enjoying explaining improvements she has made to her land. (Hanspeter Liniger)

Complexity and knowledge gaps –
the role of research

- There are no simple 'silver bullet' solutions to the complex problems of land degradation. It is therefore important to understand the ecological, social and economic causes of, and processes behind, degradation, to analyse what works and why, and how to modify and adapt particular technologies and approaches to locally specific circumstances and opportunities.

- Technologies and associated approaches need to be flexible and responsive to changing complex ecological and socio-economic environments.

- An urgent and specific area for further investigations and research is quantification and valuation of the ecological, social and economic impacts of SWC, both on-site and off-site, including the development of methods for the valuation of ecosystem services.

- SWC research should seek to incorporate land users, scientists from different disciplines and decision-makers. A continuous feedback mechanism is needed to ensure active participation of these stakeholders.

- Researchers need to take a more active role in further development of tools and methods for knowledge exchange and improved decision support.

Soil and water conservation technologies –
measures and their impacts

- Given limited financial and human resources, more attention should be focused on the prevention and mitigation of degradation before investing in areas that require costly rehabilitation, even though the achievements may not be so visible.

- Promotion of SWC technologies that lead to improved management of natural resources - soil, water and vegetation - has the potential not only to reduce land degradation but also to address simultaneously global concerns of water scarcity, land use conflicts, climate change (through carbon sequestration), biodiversity conservation, and poverty alleviation.

- Continued, sustained investments in optimising and adapting technologies to their specific environments as well as recognising innovative improvements are needed.

- In dry areas, investments in water harvesting and improved water use efficiency, combined with improved soil fertility management, should be emphasised to increase production, reduce the risk of crop failure, and lower the demand for irrigation water.

- In humid areas, long-term investments are required to maintain soil fertility and minimise on-site and off-site damage caused by soil erosion, as the impacts on production and conservation may only accrue in the medium and long term.

- Agronomic and vegetative measures should be given priority as they are cheaper than structures, often result in rapid increases in yield, and provide additional benefits such as soil cover, soil structure and soil fertility improvements.

- Structural measures should be promoted primarily for extra support where other measures are not sufficient on their own.

- Management measures are especially important on grazing land, where they should be considered as the initial intervention to achieve the major aim of SWC: namely to increase ground cover, and to improve species composition and productivity.

- Combined SWC measures – overlapping, or spaced over a catchment/ landscape, or over time - tend to be the most versatile and the most effective in difficult situations: they are worthy of more emphasis.

Land use types –
cropland, mixed land, grazing land and forest

- There is a need for continued SWC investments in cropland and mixed land, because of intensification and farming expanding into more marginal and vulnerable areas. Special attention needs to be given to rainfed farming, without neglecting irrigated cropland.

- Grazing land – and especially communally used areas in dry degradation-prone environments – is a priority for attention with regard to its neglected potential for increased production, and provision of on-site and off-site ecosystem services.

- Agroforestry and improved forest management need to be further recognised and promoted due to their multi-purpose functions, which go well beyond conservation – including biodiversity, provision of fuel/construction wood and other forest products.

Soil and water conservation approaches –
supporting and stimulating implementation

- More attention and support should be given to local innovation as well as to traditional systems, rather than focussing solely on project-based SWC implementation of standard technologies.

- Further efforts are needed to identify appropriate SWC technologies that assist small-scale and subsistence farmers to improve their livelihoods and escape from the poverty trap.

- Project/ programme interventions need to break out of the typical three-year project cycle and commit to a minimum of five years, and preferably ten or more. SWC requires long-term commitment from national and international implementation and research institutions. A clear strategy is needed to sustain results beyond the project life-time.

- Partnership alliances need to be developed between different agencies – with their various SWC initiatives and interventions – for synergy of efforts and cost-effectiveness.

Profitability and enabling environment –
motivating the land users

- SWC needs to be stimulated by further emphasising improved production (of plants and animals) and reduced costs, which are the primary interest of land users, and have direct consequences on livelihoods in small-scale subsistence farming.

- Accurate assessment of costs and benefits (in monetary and non-monetary terms) – using participatory and transdisciplinary methods – is urgently needed to evaluate SWC technologies in terms of their short- and long-term gains: without this, land users and development agencies cannot make informed decisions about which technologies and approaches are the most viable options.

- To help prevent off-site damage, further on-site investment in SWC is required: this is usually cheaper and more effective than dealing with the downstream consequences.

- An enabling environment should be nurtured for SWC to thrive best, building on people's and nature's capacity. Indirect measures such as credit, market opportunities or legislation to stimulate conservation activities must not be overlooked.

- Security of land use rights is important in conservation: policies to improve the rights of individual land users and/or rural communities to use their local land resources on a secure and long-term basis must be recognised as an important means of supporting SWC.

- Opportunities need to be seized that connect SWC with emerging environmental priorities – especially carbon sequestration (by increasing soil organic matter), biodiversity (above and below ground), water and ecosystem service provision. Ways of recognition and payment for these services need to be further explored to justify SWC investments.

- The benefits of improved land management for water quantity and quality must be further stressed and used as a motivation for SWC, especially in areas of water scarcity and water-related conflicts.

- Access to local and international markets has to be improved to enable producers to make SWC investments in their land. Fair prices, certification, and labelling schemes for products can further stimulate conservation.

Subsidising SWC –
the delicate issue of direct incentives

- SWC may require heavy investment costs that exceed the capacity of local land users and thus need to be covered by national and international initiatives. But direct material incentives should – in principle – only be considered where there is a need to overcome initial investment constraints and subsequent maintenance does not require continued support. This may be needed where the environmental improvements and social benefits are likely to be realised only in the long term.

left: Terraces in Machakos District, Kenya: significant soil and water conservation investment for crop production in a semi-arid area. (Hanspeter Liniger)

centre: Improving pasture and grazing management needs further attention as degradation rates remain high: marginal mountains areas, eg Tien Shan, Kyrgyzstan, not only secure livelihoods for people by directly providing resources, but also help protect the lowlands. (Hanspeter Liniger)

right: The value of agroforestry systems for production and protection of land needs to be further recognised. Here, together with local farmers, students are documenting an agroforestry technology developed during Soviet times in Central Asia – but recently modified and adapted by land users. (Peter Niederer)

- Before considering the use of direct incentives, alternative approaches should be explored, such as the adaptation of technologies, or the identification of cheaper technologies. The possibilities of removing some of the root causes of land degradation (related to, for example, land policy framework, land tenure security and market access) also need to be assessed.

- Rural areas may need and deserve compensation from urban/ industrial zones for the environmental and aesthetic/ recreational services they provide. And downstream beneficiaries of the environmental protection provided by upstream communities if possible should be prepared to pay compensation for these services.

- The value of the ecosystem services needs to be determined and agreed upon between users and providers. The establishment of compensation schemes may require support and guidance from policy level and external actors.

- Provision of microcredit at concessionary rates for better land management/ SWC requires serious consideration, as an alternative to handouts and payments, where farmers have financial constraints.

Extension, training and adoption –
building capacity and spreading the message

- On the basis of standardised tools and methods, training in proper documentation, evaluation and dissemination of SWC knowledge, as well as its use for and improved decision-making, needs to be strengthened.

- Investment in training and extension to support the capacity of land users and other local and national stakeholders must be a priority to adapt better to changing environmental, social and economic conditions, and to stimulate innovation.

- Local innovation and farmer-to-farmer extension should be promoted as effective and appropriate strategies.

Overall policy –
investing in soil and water conservation for ecosystems, society and the economy

- Investment in rural areas and SWC is a local concern, a national interest, and a global obligation. Thus it must be given priority:
  - at the local level: to increase income, improve food security, and sustain natural resources – thus helping to alleviate poverty in areas where the livelihoods of the majority depend on agricultural production;
  - at the global and national level: to safeguard natural resources and ecosystem services and in many cases to preserve cultural heritage.

- Investments in SWC must be carefully assessed and planned on the basis of properly documented experiences and evaluated impacts and benefits: concerted efforts are needed and sufficient resources must be mobilised to tap the wealth of knowledge and learn from SWC successes. These investments will give ‘value for money’ in economic, ecological and social terms.

left: Heavy storms without good soil protection can trigger landslides, as in the Varzob Valley of Tajikistan, blocking and damaging roads, and causing damage to houses. The impacts of such events are multiple, from on-site damage to the land, to destruction of public infrastructure, pollution of rivers and sedimentation of reservoirs. (Hanspeter Liniger)

centre: Enhancing the capacity for the documentation and evaluation of SWC knowledge during a training workshop in Tanzania: specialists are working with land users to enter knowledge into a database. The next step is to utilise this information for decision support. (Hanspeter Liniger)

right: Monitoring of land use change and the spread of soil and water conservation are rarely carried out efficiently: this is an exception from Bolivia. (Georg Heim)

Part 1

Grass emerging through crusted soil in Morocco – regreening is possible even in seemingly hopeless situations. (Hanspeter Liniger)

Analysis and policy implications

1 Introduction – *from hotspots to green spots*

Where the land is greener – *land users showing the way*

All over the world there are examples of winners in the struggle against land degradation. They are to be found on the gentle green hills of south-west Uganda and in the heat and aridity of Madhya Pradesh in India; they are present on the coastal sugar cane belt of far north Queensland, Australia and within the mountainous heights of Colca in Peru. Whether laying down 'trash lines' across the slope, digging water harvesting pits in dry stream beds, carpeting the ground with green cane mulch or rehabilitating thousand-year-old terraces, there is a common denominator: the land users leading the way in making the land greener. However, these positive soil and water conservation efforts – spontaneous or project-based – are hidden away and local achievements are not recorded, let alone documented and disseminated in a systematic way. There are lessons 'out there' that deserve recognition, and can help guide others to conserve or rehabilitate their land, raise production, and improve rural livelihoods. That is the rationale for the World Overview of Conservation Approaches and Technologies (WOCAT) at large – and this book in particular. 'where the land is greener' presents case studies, encompassing both technologies and their supporting approaches with analyses of these, and provides conclusions and associated policy points for action.

Land degradation and success stories – *the context of the book*

A word about land degradation is required to set the context for this book – and WOCAT in general. At the end of the 1980s the GLASOD (Global Assessment of Soil Degradation) map was produced depicting the extent of soil degradation worldwide (see box below). Based on 'expert opinion' it never claimed absolute accuracy, but what it achieved was to put the scale of the problem in the public arena. It was then used as evidence to support the creation of the UN

Global Assessment of Soil Degradation (GLASOD)

The GLASOD project set out to map global soil degradation. The assessment was based on 'expert opinion' – the perception of experts on the status of soil degradation in the country or region they were familiar with. Resultant statistics were based on continental trends and revealed that erosion by water is the most prominent degradation feature worldwide. Various forms of 'chemical deterioration', such as soil fertility decline and soil pollution, and 'physical deterioration', such as compaction and waterlogging, account for smaller areas. The GLASOD study was the first comprehensive soil degradation overview at the global scale. It raised awareness of various further needs, namely:

- the need for an assessment of measures to control degradation;
- the need for a more objective/quantitative approach (especially for more detailed scales);
- the need for data validation and updating.

Human-induced soil degradation in the world (million hectares)

Type	Light		Moderate		Strong		Extreme		Total	
Water erosion	343.2		526.7		217.2		6.6		1093.7	(55.6%)
Wind erosion	268.6		253.6		24.3		1.9		548.3	(27.9%)
Chemical deterioration	93.0		103.3		41.9		0.8		239.1	(12.2%)
Physical deterioration	44.2		26.8		12.3		–		83.3	(4.2%)
Totals	**749.0**	**(38%)**	**910.4**	**(46%)**	**295.7**	**(15%)**	**9.3**	**(1%)**	**1964.4**	**(100%)**

Source: (Oldeman et al, 1991)

left: A protected plot of land in the Varzob Valley, close to Dushanbe, Tajikistan, surrounded by degraded grazing land on an eroded hillside. This productive 'green spot' is planted with fruit trees and grass for haymaking. It went previously unnoticed and unappreciated until documented by WOCAT. (Hanspeter Liniger)

right: Another example of a 'green spot' from Colombia: an integrated agroforestry system where several soil and water conservation measures have been combined to rehabilitate formerly degraded land and bring it back into production. (Mats Gurtner)

WOCAT

The **W**orld **O**verview of **C**onservation **A**pproaches and **T**echnologies (WOCAT) is a **global network** of soil and water conservation specialists which was initiated in 1992. WOCAT is organised as a consortium of national and international institutions and operates in a decentralised manner, through initiatives at regional and national levels, with back-stopping from a management group.

WOCAT's **vision** is that existing knowledge of sustainable land management is shared and used globally to improve livelihoods and the environment.

WOCAT's **mission** is to support decision-making and innovation in sustainable land management by:
- connecting stakeholders
- enhancing capacity
- developing and applying standardised tools for the documentation, evaluation, monitoring and exchange of soil and water conservation knowledge

The **target group** comprises soil and water conservation (SWC) specialists, planners and decision-makers at the field and planning levels.

WOCAT's **tools** include three comprehensive questionnaires and a database system which cover all relevant aspects of SWC technologies and approaches, including area coverage.
WOCAT's **database** currently comprises datasets on 350 technologies and 225 approaches, of which a subset of 135 technologies and 75 approaches are quality assured. The WOCAT knowledge base is in the public domain. Results and outputs are accessible in digital form, either via the internet (www.wocat.net) or on CD-ROM. 'where the land is greener' is the first book compiled by WOCAT at the global level.

Definitions used by WOCAT

Sustainable Land Management (SLM): 'the use of land resources, including soils, water, animals and plants, for the production of goods to meet changing human needs, while simultaneously ensuring the long-term productive potential of these resources and ensuring their environmental functions'.
Soil and Water Conservation (SWC): 'activities at the local level which maintain or enhance the productive capacity of the land in areas affected by, or prone to, degradation'.
SWC Technologies: 'agronomic, vegetative, structural and/or management measures that prevent and control land degradation and enhance productivity in the field'.
SWC Approaches: 'ways and means of support that help introduce, implement, adapt and apply SWC technologies on the ground'.

Convention to Combat Desertification at the Rio Conference of 1992 – desertification being defined under that convention as land degradation in arid, semi-arid and dry subhumid areas. But simultaneously GLASOD lent support to the dominant environmental discourse – that of a downward spiral of land degradation which was perceived as being widespread and pervasive, particularly in the developing world.

WOCAT was originally conceived as an exercise to redress the balance towards achievements. A network was then established to document conservation efforts and to help spread the positive messages of how land can be managed sustainably. WOCAT is, furthermore, a tool to help in monitoring and evaluation of soil and water conservation efforts (see box WOCAT). With respect to new developments in monitoring land degradation, the Food and Agriculture Organisation of the United Nations (FAO), the United Nations Environment Programme (UNEP) and other partners – including WOCAT – are working towards a more comprehensive and scientifically based global assessment of land degradation through the Land Degradation Assessment in Drylands (LADA) project. LADA is funded by the Global Environment Facility (GEF). Among other objectives LADA aims to identify 'hot spots' (problem areas) and 'bright spots' (conservation successes). It is in the 'bright spots' context that WOCAT will feed into the LADA process. The WOCAT network, its database, CD-ROMs and now this book, provide multiple examples of these 'bright spots' or 'green spots'. WOCAT's next challenge is to produce a map which is, so to speak, a mirror image of GLASOD and a complement to the LADA project: in other words a global assessment of conservation and sustainable land management practices.

This book is based on case studies. But even the 42 presented here cannot give a comprehensive overview of SWC worldwide. Nevertheless, they do show a very wide variety of possibilities, complementing other documented success stories, amongst which the WOCAT database is unmatched elsewhere in the field of soil and water conservation. This book essentially presents a sample of that database. Table 1 (page 11) compares some other initiatives which have, similarly, collected success stories.

Compilation of case studies – *the methodology used*

'where the land is greener' represents the result of a process based on selection of case studies, documentation of these and a quality assurance procedure. First, criteria were

Table 1: Success stories and best practices: some recent examples

	Title/ Organisation	Date/ Duration	Region	Technical Focus	Database/ product	Number of cases	Comment
1	'Success Stories' UNEP	1994–02	Global	Success against desertification	'BSGN' database and book	24 (in book)	Based on submissions from the field
2	'Bright Spots' IWMI	2001–04	Global	Sustainable agriculture	Database/ book	286	Mainly secondary data + brief questionnaire
3	'Success Stories in Africa's Drylands' GM-CCD	2003	Africa	Agriculture/rural development in drylands	Documented in report	15	Analysis of projects and interventions from existing data
4	NRM Tracker/Frame USAid	1998–04	Africa	Community-based natural resource management	Database with documents and web resources	185	Based on NRM Tracker questionnaire, now included in FRAMEweb
5	'Building on Successes in African Agriculture' IFPRI	2003–04	Africa	Agricultural systems	Documented in report	08	Syntheses of detailed existing case studies
6	'Ecoagriculture' (McNeely & Scherr, 2003)	N/a	Global	Sustainable ecosystems	Case studies in book	36 (in book)	Analysis based on mainly secondary information
7	Global database of Conservation Approaches and Technologies WOCAT	1992 ongoing	Global	Soil and water conservation/ Sustainable land management	Internet database/ CD-ROM/ book	350 in database (135 quality controlled)	Detailed database from questionnaires at 3 different levels
8	'where the land is greener' WOCAT	2007	Global	Soil and water conservation/ Sustainable land management	Case studies and analysis in book	42 (with 28 associated approaches)	Selected from the overall WOCAT database

Note: see end of chapter for references

defined to select successes: examples of 'where the land is greener'. The intention was to collect case studies where:
- datasets were complete;
- cases were representative of main land use types;
- major degradation types were covered;
- a wide variety of soil and water conservation technologies could be shown;
- the geographical spread was broad; and
- project-based, traditional and spontaneous practices were all represented.

Data were collected by using the standardised WOCAT questionnaires, which were filled in by local contributors. A total of 92 women and men were involved in providing the data for the case studies. They are, for the most part, specialists in the field of soil and water conservation. Some are grassroots development workers/ field technicians (from non-governmental and government organisations alike); others are researchers. They are from both 'developing' and 'developed' countries. Typically these are the people with first-hand knowledge of a land management system, and people who want to 'tell their story'. When project personnel provide the information, they are in a privileged position with respect to data access, but inevitably there may be some 'wishful thinking' or a degree of self-interest involved in some of the answers given. An outsider describing a non-project related technology has a more difficult task, but s/he may be free of the bias that is sometimes associated with an 'inside job'.

The information compiled through the WOCAT questionnaires was put into an attractive four-page summary format. Quality was assured through a long review process: knowledge gaps, inconsistencies and contradictions were dealt with through an interactive process with the contributors to the book. This constituted a learning process for all involved and was an enriching and stimulating process. A final note on challenges faced when preparing the case studies is that,

left: Documenting information about terraces on the Loess Plateau, Gansu Province, PR China: a land user sharing his field expertise with specialists. (Hanspeter Liniger)

centre: Documentation of an agroforestry system in the field using WOCAT questionnaires: Two SWC specialists interview a Kyrgyz farmer. (Hanspeter Liniger)

right: Compiling and entering knowledge from the field into the database in Syria: quality is assured through querying data. (Hanspeter Liniger) in some cases, projects have proven to be 'moving targets', changing and developing so rapidly that information quickly became out-of-date. Thus many of the case studies bear two dates: the date of original data collection and an 'update' when final information was contributed.

Objectives and target groups – *defining the focus*

The main aim of the book is to highlight and analyse cases of sustainable land management from various parts of the world. It seeks to demonstrate that there *are* possibilities of maintaining land in a productive state, improving conditions where there has been degradation, and rehabilitating badly degraded land. Links are drawn to the Millennium Development Goals, to the various global environmental conventions – on desertification, climate change and biodiversity – and to the pervasive issue of poverty, and particularly rural poverty. It should be noted that the book is not intended to be a manual on SWC. The case studies are a collation of real-life examples from the field.

A secondary aim is to provide and promote a prototype for documentation of knowledge at national and regional levels. WOCAT has long supported and encouraged data collection, and attempted to stimulate interest in documentation, evaluation and dissemination of knowledge as a means for monitoring the success of land management practices. We hope that this book will encourage the compilation of national and regional soil and water conservation achievements and experiences, and the production of overviews. The four-page formats for the presentation of case studies, which are based on the WOCAT basic questionnaires, can act as a basis for further systematic compilation to maintain consistency and aid comparison. The consequent inventories and analyses will provide a reliable basis for decision-making – at local, national and regional levels.

The target audience of 'where the land is greener' comprises all those concerned with sustainable land management and rural development in general. The case studies are accessible to a very wide range of stakeholders: rural development and SWC specialists, field extension workers, and land users themselves. The analyses will be most relevant to academics, researchers and students as well as SWC specialists. The policy points are specifically formulated for planners and decision-makers in governments and development agencies.

Structure and content – *from case studies to policy points*

'where the land is greener' has resulted from the challenge of presenting the evidence in an accessible way. This evolved into the collation of representative, positive experiences in a standardised and attractive format – a four-page summary for each technology, and for each approach. Graphics and photographs are used to illustrate the cases. Before the presentation of the case studies in Part 2 of the book, an analysis brings out the main messages and is the basis for the conclusions and policy points.

Case studies

The case studies each describe a technical intervention in conjunction with a specific approach for a given situation, by an on-the-ground specialist. In total we present 42 technologies, and 28 of these are completed by corresponding approaches. Where a technology has been promoted under a project or programme, the approach has been relatively easy to describe. However, where the technology is a tradition or a local innovation that has spontaneously spread, the approach description is not straightforward. That is one of the reasons why some contributors have described a technology without its corresponding approach.

Six continents and twenty-three countries are represented. There are examples from arid plains as well as humid mountains; from poor and from rich areas. Technologies range from ancient and durable traditions to cutting-edge innovation. Furthermore, there is a span of degradation types such as soil erosion, desertification, compaction, fertility decline, water and vegetation degradation. The technologies to deal with them represent a wide array, encompassing agronomic, vegetative, structural and management measures. Some technologies are relatively well known and established, others little known and emerging.

Technologies – as explained in the analytical chapter – have been clustered into groups that are familiar to specialists and land users alike: 'Agroforestry', 'Conservation agriculture', 'Terraces', 'Manuring/ composting', 'Water harvesting', 'Vegetative strips/ cover', 'Gully rehabilitation', 'Grazing land management', and 'Other technologies'. These are described on page 20 and 21. On the other hand, each approach described is unique and we have therefore not attempted to group them. The examples range from top-down to participatory and spontaneous approaches.

Analysis

The analysis of the case studies has been divided into (a) technologies and (b) approaches. In each case the analysis follows (as far as possible) the sequence within the case studies. We have used charts and tables to illustrate several of the quantifiable indicators, and have interpreted the data to bring out important points. The analyses of the case studies have been enriched with knowledge of additional technologies and approaches worldwide – from the WOCAT database, and from that collected during WOCAT training workshops. It is important to stress that the case studies analysed do not represent a 'random sample' from which statistical significance can be drawn. What the analyses do provide, however, is an insight into common denominators of what are (for the great majority) successful and/or widespread examples of natural resource management. The intention was to avoid the temptation of merely presenting 'good-news narratives' in the form of case studies but to provide a balanced critique of these examples leading to solid conclusions and practical policy guidance. What is unique about such analyses of approaches and technologies is that they draw on a very wide range of examples, and are not restricted to one region of the world, to a single land use system – or just to projects that are dedicated exclusively to SWC. The analyses are as comprehensive as possible given the data available.

Conclusions and policy points

While the case studies form the foundation of the book and the analyses help in understanding the various parameters, the conclusions distil the most important issues. Not all of these conclusions are novel. Many are not surprising: some are merely reinforcements of what has been known for a long time. Others, however, are new. From the conclusions, and supported by them, emerge the policy points. We believe these associated policy points are worthy of urgent attention. After fifteen years of working with practitioners and specialists from all over the world, this is now an opportunity for WOCAT to offer pointers on better policy in the field of soil and water conservation – in order to help answer the question: *how best should money be spent to achieve sustainable land management and environmental protection – while improving the livelihoods of people in rural areas?*

References in Table 1

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Other References:

LADA: http://lada.virtualcentre.org
Oldeman LR, Hakkeling RTA and Sombroek WG (1991). *World Map of the Status of Human-Induced Soil Degradation.* An Explanatory Note. Global Assessment of Soil Degradation (GLASOD), October 1991. Second Revised Edition. Wageningen: International Soil Reference and Information Centre (ISRIC) und United Nations Environment Programme (UNEP)

left: Traditional stone bunds in the Anti Atlas mountains of Morocco: there are many lessons to be learned from traditions of soil and water conservation. (Hanspeter Liniger)

centre: Vineyards in Switzerland that are planted up and down the slope to facilitate access with machines: despite this the soil is well protected due to permanent green cover between the vines. (Hanspeter Liniger)

right: Hillside terraces in the Philippines are a 'living tradition'. Note that in the top left corner the terrace wall is being extended with stones carried up from the riverbed in the valley below. (William Critchley)

2 Analysis of technologies – *what works where, and why*

Introduction – *definitions and overview*

According to WOCAT, SWC technologies are defined as 'agronomic, vegetative, structural and/or management measures that prevent and control land degradation and enhance productivity in the field'. In this chapter, the technologies presented in the case studies are analysed and evaluated. It is important to reiterate that the 42 case studies are neither a random sample, nor strictly representative of SWC activities worldwide. Selection was based on other criteria, as explained in the introduction. The case studies span a broad range of successful experience representing different production systems, land use types, climatic conditions and geographical zones. Some of the technologies are widespread; others are innovative and isolated. While the overall WOCAT database has been used to support our arguments, the figures presented are constructed from the case study data alone.

The sequence adopted basically follows that used in the case studies. After an explanation of the grouping of technologies and their constituent measures through an overview table, we continue with sections on land use and forms of land degradation addressed. There is then a description of the main soil and water conservation technologies and measures involved, with their various functions and impacts. This is followed by a section on the environmental context – both natural and human – and concludes with an assessment of impacts, both economic and ecological.

Measures, Technologies, Case Studies and Groups (as defined by WOCAT)

SWC **measures** fall into 4 categories: agronomic (eg mulching), vegetative (eg contour grass strips), structural (eg check dams) or management measures (eg resting of land).

Measures are components of SWC **technologies.** For instance, a terracing system is a technology which typically comprises structural measures – the terrace riser, bed and a drainage ditch – combined with other measures, such as grass on the risers for stabilisation and fodder (a vegetative measure), or contour ploughing (an agronomic measure).

The 42 **case studies** in this book comprise technologies, the majority with related approaches. The technologies are built up from (in most cases – but not all) various measures.

For the purposes of the book: the technologies are clustered into nine **groups** – 'Water harvesting', 'Agroforestry' etc – which are common names, familiar to most SWC and rural development specialists.

The nine technology groups basically cover all the main types of soil and water conservation systems – though there are certain exceptions, such as shifting cultivation/ fallow systems which would form a group of their own but have not been described in our case studies. The 42 case studies are listed in Table 2, by group.

left: Traditional irrigated paddy rice terraces in Bali, Indonesia, make steep and vulnerable slopes productive – they are simultaneously a tourist attraction. (Hanspeter Liniger)

right: Sustainable land management: a productive and well conserved mixed farm growing tea, coffee, bananas, fodder, grass and grevillea trees in Embu District, Kenya. (William Critchley)

Table 2: Case studies/ technologies by group

Group Case study/ technology	Country	Climatic zone				Land use type						Degradation type						Conservation measure				Inter-vention type		
		arid	semi-arid	subhumid	humid	annual crops	perennial crops	grazing land	forest	mixed	other[1]	water erosion	wind erosion	chemical deterioration	physical deterioration	vegetation degrad.	water degradation	agronomic	vegetative	structural	management	prevention	mitigation	rehabilitation
1 Conservation agriculture																								
No-till technology	Morocco		■	■		■						■	□	□	■			■			■		■	
Conservation agriculture	UK			■		■						■		□				■					■	
Small-scale conservation tillage	Kenya		■			■						■			□		■	■	□				■	
No-till with controlled traffic	Australia	■	■			■						■	□		■			■					■	
Green cane trash blanket	Australia				■		■					■		■				■					■	
2 Manuring/ composting																								
Vermiculture	Nicaragua			■	■	■	■							■				■					■	
Composting/ planting pits	Burkina Faso		■							■		■		■	□		■	■					■	
Improved trash lines	Uganda			■		■						■		■			■	■					■	
3 Vegetative strips/ cover																								
Natural vegetative strips	Philippines				■	■						■		□				■	■				■	
Green cover in vineyards	Switzerland			■			■					■		□				■	■				■	
Vetiver grass lines	South Africa			■			■					■	□					□	■	□			■	
4 Agroforestry																								
Shelterbelts	P.R. China		■			■				□			■				■		■				■	
Grevillea agroforestry system	Kenya			■		■	■			□		■		□			■		■			■		
Poplar trees for bio-drainage	Kyrgyzstan		■			■				□	■			■	■			■	■					■
Multi-storey cropping	Philippines				■	■				□		■		■				■	■			■		
Intensive agroforestry system	Colombia			■						□	■	■	□	■				■	■	■			■	
Shade-grown coffee	Costa Rica				■					■		■		■				■	■	□		■		
Conversion of grazing land	Tajikistan			■				■		□		■			■	□		■	■	■	■			■
Orchard-based agroforestry	Tajikistan			■			■			□		■	□	□				■	■	■			■	
5 Water harvesting																								
Sunken streambed structure	India		■			■		■				■					■				■		■	
Planting pits and stone lines	Niger		■			□				■	■	■	■	□	□			□			■			■
Furrow-enhanced runoff harvesting	Syria		■				□	■		□		■	□	□			■	■			■			■
6 Gully rehabilitation																								
Check dams from stem cuttings	Nicaragua		■			■		■				■							■	■				■
Gully control and catchment protection	Bolivia		■	■		■		■				■				□			■	■				■
Landslip and stream bank stabilisation	Nepal			■						□	■	■		□					■	■				■
7 Terraces																								
Stone wall bench terraces	Syria		■				■					■					■			■		■		
Rehabilitation of ancient terraces	Peru		■			■		■				■		■			□	□	□	■				■
Traditional stone wall terraces	South Africa			■		■	■					■		■				□		■		■		
Fanya juu terraces	Kenya		■	■		■						■					■		□	■			■	
Small level bench terraces	Thailand				■	□	□		■			■		■			□		□	■			■	
Orchard terraces with bahia grass cover	PR China				■		□				■	■		□				■	■	■			■	
Zhuanglang loess terraces	PR China		■			■	■					■		■			□	□		■				■
Rainfed paddy rice terraces	Philippines				■	■						■		■					□	■		■		
Traditional irrigated rice terraces	Nepal				■	■						■						■	■	■		■		
8 Grazing land management																								
Ecograze	Australia		■					■				■			■	□			■		■		■	
Restoration of degraded rangeland	South Africa			■				■				□		■	□	■		■	■	■				■
Improved grazing land management	Ethiopia				■			■		□		■		■		□		■	■		■		■	
Area closure for rehabilitation	Ethiopia		■	■		■		■		□		■		■		■		■	■	□	■			■
9 Other technologies																								
Pepsee micro-irrigation system	India		■			■											■			■	■		■	
Sand dune stabilisation	Niger		■					■					■	□		□			■	■	■			■
Forest catchment treatment	India			■					■			■					■		■	■	■		■	
Strip mine rehabilitation	South Africa	■						□			■	■	□		■				■	■				■

[1] other land use types: eg wasteland, degraded land

Land use type	■ before SWC technology was implemented	□ after SWC technology was implemented
Degradation type	■ main degradation type addressed	□ minor degradation type addressed
Conservation measure	■ main conservation measure	□ supportive / optional SWC measure

Land use – *before and after*

Land use is often affected by soil and water conservation measures. Sometimes the technology itself has the effect of bringing land under a different use (eg terrace construction to create cropland on hillsides), and sometimes the SWC technology effectively defines a different land use (eg agroforestry = mixed land by definition). In the case of traditional systems that have long-established conservation/ land management practices, we have not assumed a land use change, even though one took place many centuries ago. About 60% of the case studies are on cropland, with little change after implementation of recent SWC (Figure 1). However mixed land demonstrates a dramatic, four-fold increase at the expense of grazing land, wasteland and mining land. The mixed land category implies a more intensive form of land use – after conversion into agroforestry systems in particular. This in itself is interesting: successful SWC often leads to more trees within the landscape, intensification of land use, and less pressure on surrounding natural ecosystems. Good forest management and agroforestry systems are often not perceived as SWC and are thus less frequently documented as such. Although the forest/woodland category has diminished as a result of conservation, this is because in two cases it has been transformed into agroforestry, and terraced cropland, respectively. This should not be seen negatively as 'deforestation' but as conversion to other productive uses under sound conservation practices. Even if SWC is applied only on a specific land use type, it is interrelated with other, adjacent land uses. For example, cropland management is affected by, and affects, grazing management: animals may destroy terraces or on the other hand, residues that are used for mulch or compost are then not available for animal feed. Land use needs to be seen in relation to degradation and conservation. Thus more detailed analysis is presented under 'degradation' and 'SWC measures'.

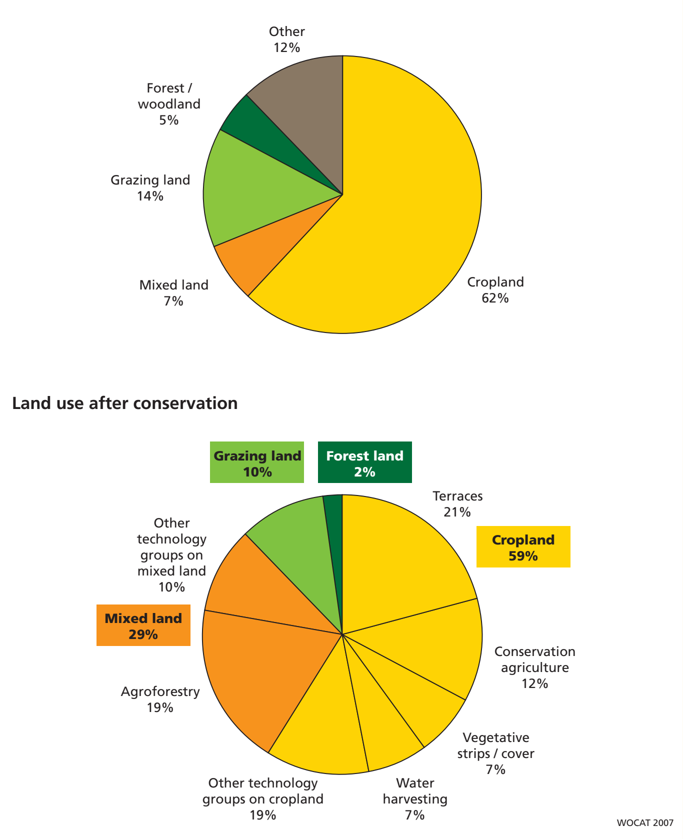


Figure 1: Land use types before (above) and after (below) implementation of SWC, showing dominant SWC groups within the land use types

Degradation – *facing the problem*

Types of degradation – *not just soil erosion*

In only three of the 42 analysed cases was it stated that a single type of land degradation was addressed. All the others gave combinations of at least two degradation types. Frequent combinations were: water erosion and fertility decline in 17 of the 42 cases (17/42); water erosion and water degradation (aridification) (8/42); water erosion and compaction (6/42).

Water erosion (ie soil erosion by water) was the predominant degradation factor mentioned (in almost all cases – 37/42). The few exceptions were those technologies specifically targeted at intensifying production through, for example, manuring/ composting and establishing agroforestry systems. In these cases erosion by water was not mentioned as a specific problem. There were 16 mentions of gully erosion and six of mass movement and offsite degradation (Figure 2).

Wind erosion (ie soil erosion by wind) – and specifically the problem of topsoil loss – was mentioned in over a quarter of the cases (10/42). Various conservation measures address, among others, wind erosion, with windbreaks being the most obvious example.

Rill erosion below a maize crop on a steep hillside in Mexico. Such slopes should not be cultivated without protection from erosive rainfall – through a combination of agronomic and vegetative measures. (William Critchley)

Land degradation

Degraded land is defined as land that, due to natural processes or human activity, is no longer able to sustain properly an economic function and/or the original ecological function. There are a number of interrelated land degradation components, all of which may contribute to a decline in agricultural production and other ecosystem services. The most important are:

Soil degradation – decline in the productive capacity of the soil as a result of soil erosion and changes in the hydrological, biological, chemical and physical functions of the soil. The major types include water erosion (such as inter-rill erosion, gully erosion, mass movement, off-site sedimentation), wind erosion, chemical deterioration (such as fertility decline, reduced organic matter, acidification, salinisation, soil pollution) and physical deterioration (such as soil compaction, surface sealing and crusting, waterlogging)

Vegetation degradation – decline in the quantity and/or quality (species composition, diversity, etc) of the natural biomass and decrease in the vegetative ground cover.

Water degradation – decline in the quantity and/or quality of both surface and groundwater resources (such as aridification and soil moisture problem).

Climate deterioration – changes in the micro- and macro-climatic conditions that increase the risk of crop failure.

Losses to urban/ industrial development – decline in the total area of land used, or with potential for agricultural production as a result of arable land being converted to urban, industrial and infrastructure uses. It needs to be stressed that there are many interactions and interdependencies between these components, and measures to combat land degradation and promote sustainable land management will commonly address more than one at a time.

Source: www.fao.org/ag/agl/agll/lada/seldefs.stm

Physical deterioration was mentioned in nine of the 42 cases. This mainly relates to deterioration of soil structure through compaction. Interestingly, surface sealing and crusting, which are commonly observed problems, were only mentioned once – in the case of ecograze from Australia.

Vegetation degradation was a feature of seven cases – several of these on grazing land, which included reduced cover, deterioration of species richness or proliferation of exotic/ invasive species. Off-site degradation was mentioned six times with respect to erosion by water – related to flooding, increased sediment loads and/or reduced dry season river flow – and once in connection with wind erosion, where cultivated land had been covered by sand.

Water degradation was mentioned in 13 of the 42 cases. These all relate to aridification and soil moisture problems. In dry areas, aridification resulting from the loss of water by evaporation and runoff is naturally a major concern.

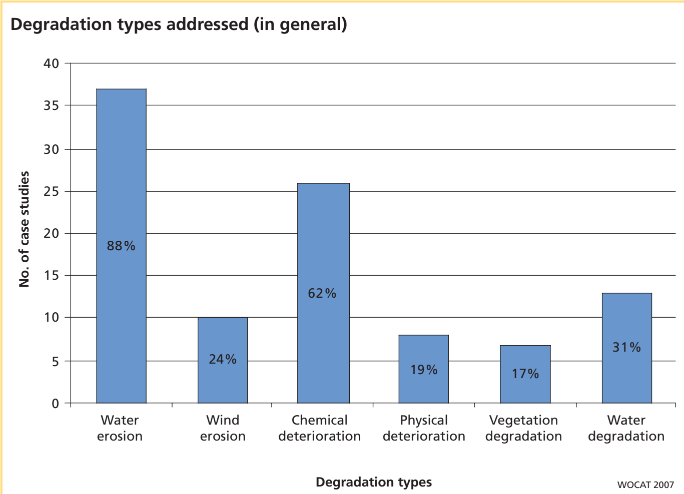


Figure 2: Land degradation types of the 42 case studies

Where **chemical deterioration** was noted, this was usually in relation to soil fertility and organic matter decline. There were 26 cases in which it was mentioned (62% of cases). It occurs over the full range of land use types and is also addressed by a variety of technologies – but especially by manuring/ composting and implementation of agroforestry systems. Only one case addressed salinity (biodrainage in Kyrgyzstan) and one mentioned soil pollution (vineyards in Switzerland).

Degradation by land use type – *deterioration before implementation*

Degradation on cropland (26 case studies): Topsoil erosion by water was the most commonly mentioned problem on cropland – in 20 of the 26 cases (77%), followed by gully erosion in 12 cases (46%), fertility decline in 14 cases (54%), water degradation (aridification) in 10 cases (38%), and compaction in three situations (12%) (note: more than one problem was cited in several cases). The main issues on crop-

land were inappropriate agricultural practices related to reduction of vegetation cover, removal of residues, destruction of soil structure (eg through ploughing), and exposure of topsoil to intensive rain and winds. These problems are commonly exacerbated by spill-over of populations into more and more marginal areas – onto increasingly steep slopes or into drier zones, or into areas characterised by unsuitable and vulnerable soils.

Degradation on mixed land (3 case studies): Of the three cases where degradation has taken place on mixed land, two of these are from the West African Sahel where the problem is attributed mainly to overgrazing and loss of vegetative cover. In the third case, there has been overuse of agroforestry resources in Costa Rica, leading again to loss of vegetation and resultant land degradation.

Degradation on grazing land (6 case studies): Worldwide, degradation problems are common and widespread on grazing land, especially in semi-arid areas. However, only six cases presented in this book deal with degradation on grazing land: this was despite deliberate efforts by the editors to encourage documentation of more grazing land examples. All cases on grazing land have multiple degradation types combined: most commonly vegetation degradation, erosion by water, and fertility decline. Compared to cropland, grazing zones are commonly located in the more marginal areas in terms of climate, soils, topography, fertility and accessibility. Another characteristic – of extensive grazing areas in particular – is the lack of clarity with respect to land use rights. Common property regimes encompass a very wide range of tenure systems, which are difficult to untangle or characterise. Due to periodic (or continuous) high grazing pressure, sparse cover and trampling, the soil is often bare, compacted and crusted. This accelerates water runoff and soil loss, and can initiate a vicious cycle of degradation.

Degradation on forest land (2 case studies): Only two of the case studies are associated with forest land, where topsoil erosion and water loss are the main issues cited. These cases focus on forest that has become degraded. Natural forest maintained in good condition confers excellent protection through its canopy and its 'floor' (ground cover). Where the canopy cover is reduced and the forest floor disturbed and impoverished, this can lead to serious soil erosion problems and loss of 'forest function' – especially in terms of hydrology and biodiversity.

Degradation on other land (5 case studies): Wasteland is often the result of pervasive erosion by water, leading to severe fertility decline. In each of the five cases documented here, SWC interventions had the effect of restoring biological functions in such wastelands, bringing them back into productive use: three of these were turned into agroforestry systems, one into cropland, and one into grazing land.

SWC measures – *what they are, and what they do*

The stage of intervention – *prophylaxis, therapy or 'rehab'?*

Depending on what stage of land degradation has been reached when SWC interventions are made, we can differentiate between prevention and mitigation of land degradation or rehabilitation of already degraded land.

Prevention implies employment of SWC measures that maintain natural resources and their environmental and productive function on land that may be prone to degradation. The implication is that good land management practice is already in place: it is effectively the antithesis of human-induced land degradation.

Mitigation is intervention intended to reduce ongoing degradation. This comes in at a stage when degradation has already begun. The main aim here is to halt further degradation and to start improving resources and their functions. Mitigation impacts tend to be noticeable in the short to medium term: this then provides a strong incentive for further efforts. The word 'mitigation' is also sometimes used to describe reducing the impacts of degradation.

Rehabilitation is required when the land is already degraded to such an extent that the original use is no longer possible, and land has become practically unproductive. Here longer-term and more costly investments are needed to show any impact.

Inputs and achievements depend very much on the stage of degradation at which SWC interventions are made. The best input-benefit ratio will normally be achieved through measures for prevention, followed by mitigation, and then rehabilitation. While the impacts of (and measures involved in) rehabilitation efforts can be highly visible, the related achievements need to be critically considered in terms of the cost and associated benefits. Of the 42 case studies analysed here, seven were classified as prevention of degradation (including the three traditional agroforestry systems of

left: Multiple forms of degradation in a single location in Niger: water erosion (gully), wind erosion, physical degradation (crusting and compaction) and chemical degradation (fertility loss). (Hanspeter Liniger)

centre: Salinisation in cotton fields due to a rising water table resulting from over-irrigation and inefficient drainage. This example from Tajikistan demonstrates a common problem that renders investment in irrigation useless. (Hanspeter Liniger)

right: the technology groups
1 Conservation agriculture in Switzerland: this is an example of no-till and direct seeding in a highly mechanised farming system. (Hanspeter Liniger)
2 Manuring/ composting improves soil fertility, soil structure, and infiltration, and helps to reduce soil and water loss. It is especially important in dry zones – as here in Orissa, India where both water availability and soil fertility need to be enhanced. (Hanspeter Liniger)

multi-storey cropping in the Philippines, shade-grown coffee in Costa Rica and grevillea in Kenya). Twenty-two were presented as mitigation of damage to the land (including all the cases of 'Conservation agriculture', 'Manuring/ composting', and 'Vegetative strips/ cover') and the remaining 13 were described as rehabilitation (including check dams in Nicaragua and conversion of grazing land in Tajikistan: see Figure 3).

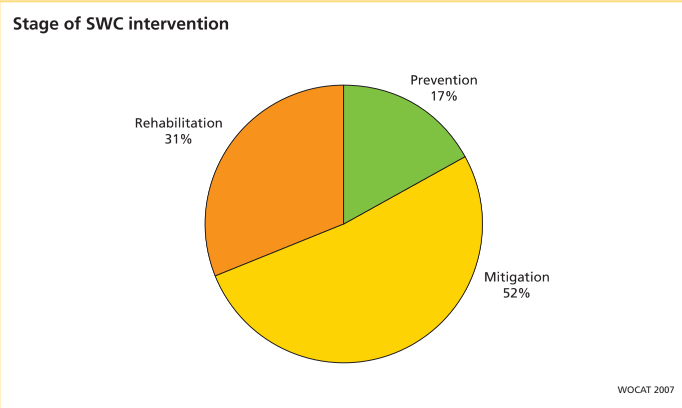


Figure 3: Prevention, mitigation or rehabilitation of land degradation

Ironically, the least spectacular yet most cost-effective category – preventing degradation – is often not perceived as a conservation achievement in itself. An analogy can be drawn to human health, where prophylaxis (preventing malaria, for example) often goes unnoticed, while therapy (curing a malarial fever) is dramatic. And thus in soil and water conservation, systems that maintain the soil and its fertility in place are commonly overlooked, and money instead poured into mitigating damage and rehabilitating badly degraded land. The fact that over 80% of the cases analysed here are mitigation or rehabilitation efforts gives some indication of where the money is going, and where the focus of attention is. Nevertheless, where land needs to be rehabilitated and this can be justified (eg for downstream protection), there may be no alternative. The overall message is: use limited funds to achieve their greatest impact.

Technology groups – *a typology*

The common groups, with familiar names, that have been used to cluster the technologies can be briefly described as follows:

Conservation agriculture (mainly agronomic measures; 5 case studies): this group is characterised by systems incorporating three basic principles: minimum soil disturbance, a degree of permanent soil cover, and crop rotation.

Manuring/ composting (mainly agronomic measures; 3 case studies): organic manures and composts are intended to improve soil fertility, and simultaneously enhance soil structure (against compaction and crusting) and improve water infiltration and percolation.

Vegetative strips/ cover (mainly vegetative measures; 3 case studies): in this group, grasses or trees are used in various ways. In the case of strips, these often lead to the formation of bunds and terraces due to 'tillage erosion' – the downslope movement of soil during cultivation. In the other cases, the effect of dispersed vegetation cover is multiple, including increasing ground cover, improving soil structure, and infiltration, as well as decreasing erosion by water and wind.

Agroforestry (mainly vegetative, combined with agronomic; 8 case studies): agroforestry describes land use systems where trees are grown in association with agricultural crops, pastures or livestock – and there are usually both ecological and economic interactions between components of the system. There is a wide range covered here: from shelterbelts, to trees with coffee, to multi-storey cropping.

Water harvesting (structural, but also combined; 3 case studies): water harvesting is the collection and concentration of rainfall runoff for crop production – or for improving the performance of grass and trees – in dry areas where moisture deficit is the primary limiting factor.

Gully control (structural combined with vegetative; 3 case studies): gully control encompasses a set of measures that address this specific and severe type of erosion, where land rehabilitation is required. There is a whole range of different and complementary measures, though structural barriers dominate – often stabilised with permanent vegetation. Commonly, such technologies are applied over a whole catchment.

Terraces (structural, but often combined with vegetative and agronomic measures; 9 case studies): this is perhaps the best-known and most spectacular group of SWC technologies. There is a wide variety of different terrace types, from forward-sloping terraces to level or backward-sloping bench terraces, with or without drainage systems. Irrigated ter-

races (usually for paddy rice) are a special case in terms of water management and its implications for terrace design.

Grazing land management (management practices with associated vegetative and agronomic measures; 4 case studies): improved management of grazing land relates to changing control and regulation of grazing pressure. It is associated with an initial reduction of the grazing intensity through fencing, followed either by rotational grazing, or 'cut-and-carry' of fodder, and vegetation improvement and management change.

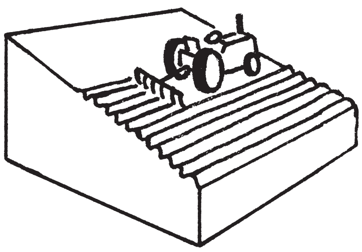
Other technologies (various; 4 case studies): this group embraces a mixed bag of case study technologies, namely the use of drip irrigation to increase water use efficiency, sand dune stabilisation, forest treatment, and the rehabilitation of mining lands.

Conservation measures – *constituents of technologies*

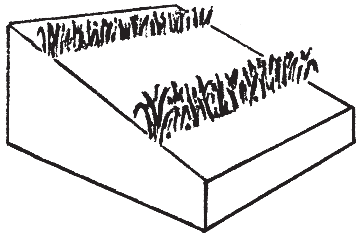
Each case study comprises a technology, made up of management, agronomic, vegetative, or structural measures or, very commonly, combinations of these. Not surprisingly, the technologies within a particular group all have similar compositions in terms of their component measures. WOCAT disaggregates technologies into specific measures in order to help understand how these technologies function.

Agronomic measures are related to soil management, soil cover, and crop mixtures and rotations. Typically, they are relatively cheap, requiring low inputs, can be very effective, and are often related to fertility management such as compost/ manuring and thus to productivity. They are usually integrated into farming activities and often not considered as SWC by the land users or specialists: these measures achieve conservation as a side-effect of good land management. Agronomic measures have, in recent years, received much more attention. Perhaps the most notable example is 'Conservation agriculture', represented here by five case studies. Conservation agriculture rose to prominence when it was recognised by land users, rather than specialists, that with reduced tillage and lower costs erosion could be minimised, water used much more efficiently, and soil organic matter and biodiversity enhanced. The other group here that is agronomic in nature is 'Manuring/ composting'.

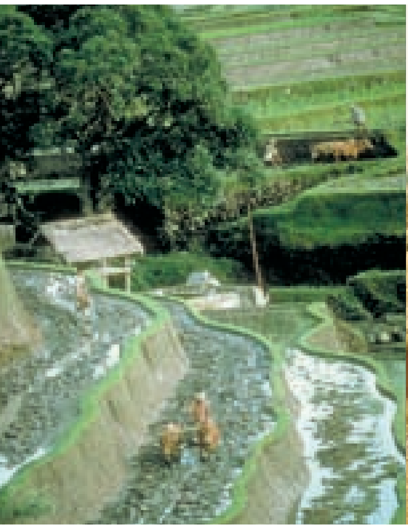
Vegetative measures: The most common and widespread types of vegetative measures amongst our cases are the 'Vegetative strips/ cover' group and the 'Agroforestry' systems. Agroforestry (comprising mainly vegetative measures, but with some agronomic components) is particularly common in humid, tropical conditions where, often, no structural measures are needed due to the ground protection provided by the vegetation – except on the steepest slopes. In drier conditions where wind erosion increases water stress, vegetative measures also have very positive impacts through reducing wind speed – for example the shelterbelts described in China. Vegetative measures can compete with crops for moisture – especially in drier areas – and special management is required to reduce this competition. Thus



Agronomic measures such as conservation agriculture, manuring/ composting, mixed cropping, contour cultivation, mulching, etc
- are usually associated with annual crops
- are repeated routinely each season or in a rotational sequence
- are of short duration and not permanent
- are often not zoned
- do not lead to changes in slope profile
- are normally independent of slope



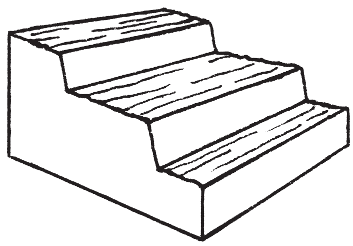
Vegetative measures such as grass strips, hedge barriers, windbreaks, or agroforestry, etc
- involve the use of perennial grasses, shrubs or trees
- are of long duration
- often lead to a change in slope profile
- are often aligned along the contour or against the wind
- are often spaced according to slope



from left to right: the technology groups (continued)
3 Vegetative strips/ cover: fodder grass combined with grevillea trees in Kenya. Terraces form over time. (Hanspeter Liniger)
4 Agroforestry: here a highly productive and protective system from Papua New Guinea, based on vanilla vines growing up palm and gliricidia trees. (William Critchley)
5 Water harvesting through *demi-lune* ('half moon') microcatchments in an arid zone of Niger, collecting water and nutrients from an unproductive area. (Hanspeter Liniger)
6 Gully control through stone check dams showing its effect in slowing down water flow and trapping sediments – in southern Ethiopia. (Hanspeter Liniger)
7 Terraces for traditional cultivation of paddy rice under extreme conditions in Bali: very steep slopes and high rainfall intensities. (Hanspeter Liniger)
8 Grazing land management through regulating grazing pressure on sand dunes in Niger: the impact (right) after 3 years. (Hanspeter Liniger)

negative and positive impacts need to be assessed and weighed against each other. Vegetative measures are often overlooked in regard to their SWC function, especially under traditional land use systems where erosion has been prevented.

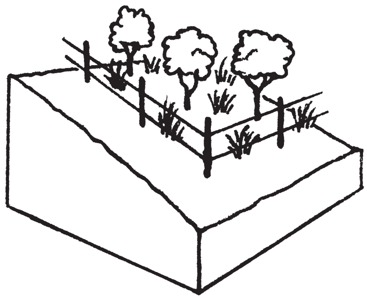
Structural measures are usually considered to be the centerpiece of SWC: in the recent past, most SWC campaigns have been based on the implementation of physical barriers to prevent movement of eroded soil. Amongst our groups, terraces stand out clearly as being structural, though they are often combined with other supplementary measures, such as grasses to stabilise risers. There are many traditional and even ancient terrace systems, which are still in use today: some of the older structures now require rehabilitation. Other technologies presented here that are basically structural include water harvesting systems, palisades against wind erosion, and check dams in gullies.



Structural measures such as terraces, banks, bunds, constructions, palisades, etc

- often lead to a change in slope profile
- are of long duration or permanent
- are carried out primarily to control runoff, wind velocity and erosion
- often require substantial inputs of labour or money when first installed
- are often aligned along the contour or against the wind
- are often spaced according to slope
- involve major earth movements and/or construction with wood, stone, concrete, etc

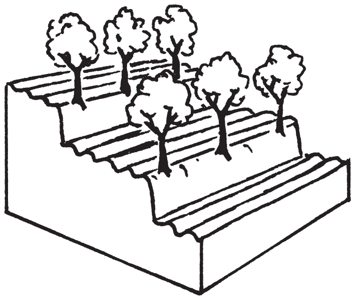
Management measures are often applied to grazing land in situations where uncontrolled use has led to degradation and where other measures simply do not work without a fundamental change in land management. Examples presented here are systems involving enclosures – thus protection from grazing – to allow regeneration of vegetation cover. Such measures are often essential for the rehabilitation of badly degraded areas where technical measures and other interventions are not adequate on their own (but can act in a supplementary way). But there are also examples of intensification of grazing land use where fodder crops are planted and used for cut-and-carry feeding of livestock. One of the major advantages of management measures is that they often do not involve very high investments of money or labour. On the other hand, taking land out of use can lead to increased pressure on neighbouring land – which may also be in poor condition and vulnerable to further degradation. Another disadvantage is that management measures are often not clear-cut; they require great flexibility and responsiveness, not only initially, but over the years that follow. However, there are often implications for land tenure that can complicate decision-making and may sour relationships between neighbours.



Management measures such as land use change, area closure, rotational grazing, etc

- involve a fundamental change in land use
- involve no agronomic and structural measures
- often result in improved vegetative cover
- often reduce the intensity of use

Combinations: Frequently, measures have been implemented together, combining different functions and creating synergies. Amongst the nine groups of technologies described in this book, 'Agroforestry', 'Terraces' and 'Grazing land management' are each made up of various measures: they are not simply vegetative (agroforestry) or structural (terraces) or management (grazing land). Additional measures involved play a supplementary, but crucial role in conserving the soil and water.



Combinations in conditions where different measures are complementary and thus enhance each other's effectiveness.
Any combination of the above measures is possible, eg:
- **structural:** terrace
- **vegetative:** grass and trees
- **agronomic:** mulching
- **management:** fencing off

To take specific examples, at first glance, check dams built from wooden stakes in Nicaragua appeared to be structural measures. However, not just dead branches are used, but green stakes are planted – which then 'strike' and begin to grow. This constitutes a vegetative measure. In fact, this living component is more effective (and more durable) in controlling rapid water flow in a gully. In the case of the traditional stonewall terracing in South Africa, contour ploughing was also applied; in the vetiver grass example, also from South Africa, mulching and minimum tillage are crucial to its functioning. Combinations of measures within a technology are much more common and important than had first been thought when WOCAT was designed. Overall, 23 of the 42 cases represent combinations (see Table 2). These are either (a) superimposed on the same plot of land, or (b) dispersed over a catchment (eg cut-off drains and afforestation in the upper catchment and check dams in gullies), or (c) phased over time (eg through a rotation system). Combinations support each other and often address multiple degradation types.

Various technologies are spaced in different locations within a catchment depending on the situation and degradation processes. They address specific on-site conditions but they also depend on upstream, and interact with downstream, SWC technologies. Thus their function is not just local but they also play a role in the whole catchment or landscape. Impacts as well as costs and benefits need to be seen at both levels: at the local, as well as at the catchment/ landscape scale. Several examples illustrate this: eg the case from Bolivia; 'Forest catchment treatment' in India; 'Area closure for rehabilitation' in Ethiopia. In the example of the terraces on the loess plateau in China, a landscape approach is followed: here the ridge tops are protected usually by afforestation, the terraces (described in the case study) conserve the slopes and various gully control and water harvesting technologies (eg small dams) are applied in the valleys.

Looking at the SWC technology groups, in respect to the terrace cases, for example, only three of the nine examples are purely structural; all the other cases are combinations with agronomic and vegetative measures. On the other hand, only one of the five conservation agriculture cases combines measures: the other four are purely agronomic. Agroforestry systems, however, typically combine measures: only two of the eight are purely vegetative (see Table 2). This illustrates the complexity of the case study examples, making it difficult to disentangle the various measures and their functioning within the technologies. This, however, is attempted in the following section.

Technical functions and impacts of SWC – *what is targeted, what is achieved*

Figure 4 shows the technical functions/ impacts of the SWC technologies in combating different forms of land degradation, as presented in the case studies. It is clear from Figure 4 that combinations of different functions and impacts are very common.

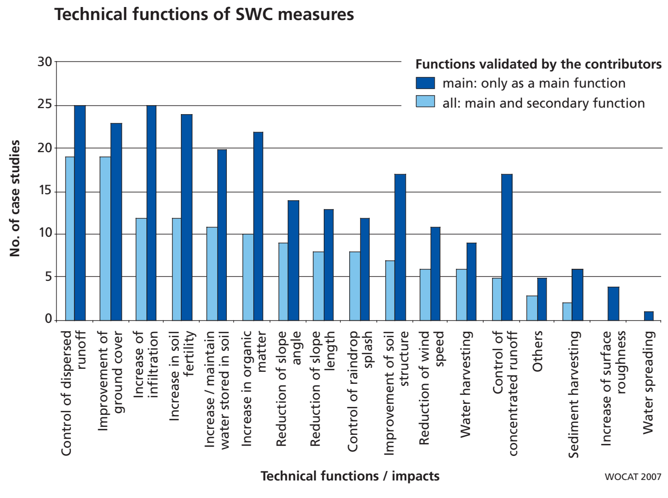


Figure 4: Technical functions/ impacts of the SWC technologies in combating different forms of land degradation

from left to right: Categorisation of SWC measures
Agronomic measures: conservation agriculture in Australia comprising no-till combined with direct seeding – replacing centuries of farming with the plough. (Hanspeter Liniger)

Vegetative measures: grass strips planted on the contour, leading to terrace development over time in Kenya. Hedges around cropland/ agroforestry system constitute another vegetative measure – as seen in upper right part of the photo. (Hanspeter Liniger)

Structural measures: terraces on the Loess Plateau in China cover 80,000km^2 and are one of the world's wonders – most of them have been built manually. (Hanspeter Liniger)

Soil erosion by water is the most frequently addressed degradation type, and the following conservation principles can be differentiated:
- diverting/ draining runoff and run-on;
- impeding runoff;
- retaining runoff/ preventing runoff; and
- collecting and trapping runoff (harvest runoff/ run-on).

Soil erosion is most commonly a water-related problem and the solution lies in better management of rainwater, whether through infiltration into the soil or other ways of managing surface runoff. Although in the case studies SWC specialists have indicated how the different measures function, the lack of supporting data shows that the efficiency, effectiveness and impacts are inadequately monitored or evaluated.

Taking the groups of SWC technologies:
- The first two groups, 'Conservation agriculture' and 'Manuring/ composting' have similar functions. These are mostly related to improvement of soil structure, and increase of organic matter and soil fertility. There is an increase in infiltration and water stored, and as a result of all these functions, runoff is also controlled – as is mentioned in around half of the cases. In conservation agriculture, ground cover improvement is an additional major factor that underlies its functioning.
- 'Vegetative strips/ cover' and 'Agroforestry' work in relation to controlling runoff and increasing ground cover, infiltration, organic matter, soil fertility, and water storage in the soil.
- 'Water harvesting' systems function through the collection of runoff from a catchment area, and the concentration and increase of water stored in the soil where production is located. While there is reduced infiltration in the area from which the runoff is harvested, this is compensated by enhanced infiltration where the water is accumulated and stored.
- 'Gully rehabilitaion' mainly addresses the problem of concentrated runoff; 'Terracing' deals with dispersed runoff down a hillside. Otherwise, what these two groups have in common is the reduction of the slope angle and slope length. Terraces often aim more for increased water storage in the soil (while providing for drainage in areas of rainfall excess), whereas gully control works through ground cover improvement and infiltration increase brought about by this vegetation, and through the physical effect of check dams.
- Technologies on grazing land function through control of dispersed runoff, improvement of ground cover, and improving soil fertility. In about two-thirds of the cases, control of concentrated runoff, increase of infiltration, and improvement of soil structure are indicated as the main ways these systems function.

Environment – *the natural and human setting*

Natural environment – *how nature influences the technologies*

Climatic zones: With respect to climate there is a reasonable balance between the 42 technologies documented, with 19 in arid to semi-arid and 23 in subhumid to humid zones (Figure 5). Looking now at the groups, some differentiation can be noted regarding their location. The 'Vegetative strips / cover' examples from our 42 case studies are all from the sub-humid/ humid areas, where vegetation prospers and there is relatively little competition for water compared with drier areas. Six agroforestry systems out of eight reported here are in subhumid/ humid areas, while all of the 'Water harvesting' technologies – not surprisingly – are located in semi-arid conditions. We need to differentiate between two basic types of terraces: (a) rainfed terraces of which about half are in semi-arid and subhumid areas; and (b) irrigated terraces (mainly paddy rice terraces), which in the case studies are all from subhumid or humid zones. The grazing land cases are mainly located in subhumid environments (three-quarters), with the remainder from semi-arid regions. This is perhaps a surprising selection, as semi-arid

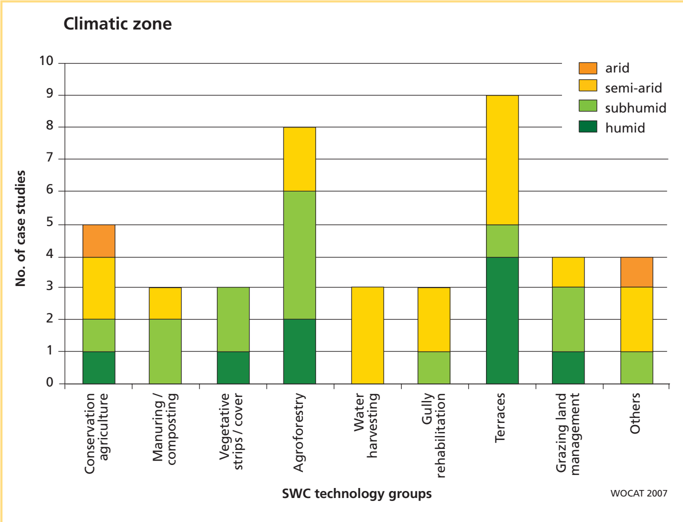


Figure 5: Climatic zones in relation to the SWC technology groups

grazing lands often have the most pronounced and widespread degradation problems. One would have expected more examples from these regions. The examples from the subhumid areas, however, illustrate that the success rate can be high, as the land can produce good fodder for 'cut-and-carry' systems (for example in Ethiopia). More rapid and sustained processes of rehabilitation based on vegetative recovery can, naturally, occur in the more humid areas.

Elevation: Two main elevation zones cover the 42 case studies. These are (a) below 500 m and (b) between 1,000 and 2,000 m. In the tropics and subtropics, the zone between 1,000 and 2,000 m often has favourable conditions for agriculture: it tends not to be too hot and benefits from favourable rainfall. Nevertheless, this is an area where SWC is a priority, and both agronomic and vegetative measures can work well through combining conservation with production. The agroforestry and also manuring/ composting cases are mainly drawn from this zone. Above 2,000 m conditions become more marginal for agriculture, and at this altitude only gully, terraces and grazing land management cases are represented here. With increasing elevation, the potential effects of land degradation on downstream areas increase, and SWC can have considerable off-site/ downstream impacts.

Slope: Terraces are (naturally) found on sloping land: a third of those in this book are on slopes steeper than 30%. On these slopes, production is difficult without terraces and their beds that effectively provide cultivation platforms. On the contrary, agroforestry systems are more or less independent of slope; there are examples here from the gentlest to (almost) the steepest. Vegetative strips/ cover tend to be located on sloping land between 8 and 30%: these have emerged as a cheaper alternative to terrace construction in this situation. Conservation agriculture is mainly implemented on gentle slopes – below 8% (see Figure 6).

Soil fertility and organic matter: None of the case studies are characterised by soils with very high fertility (before intervention with SWC). Around half, however, are located on very low, to low fertility soils and the other half on soils with medium (including two on 'high') fertility. This shows the concentration of efforts on soils where degradation (and also nutrient mining) has probably already reduced soil fertility.

Soil organic matter (SOM) is closely related to soil fertility and has an impact on physical, chemical and biological properties. Not surprisingly, we see that in around half of the cases the SOM was initially low, while almost all the remainder are on soils with medium levels of SOM (see Figure 7). Because most soils where SWC has been applied contain a rather low level of SOM, they correspondingly have the potential to increase that proportion and by doing so, to increase nutrient holding capacity and simultaneously sequester carbon in the degraded soil. This is an important characteristic of conservation agriculture systems, and here

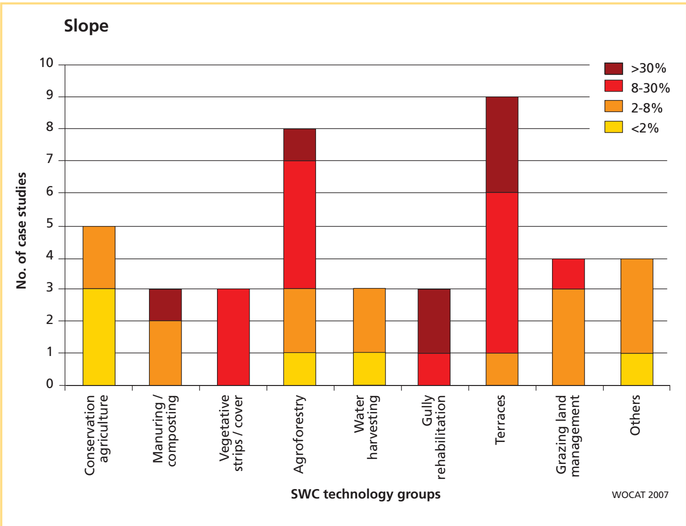


Figure 6: Slope categories in relation to the SWC technology groups

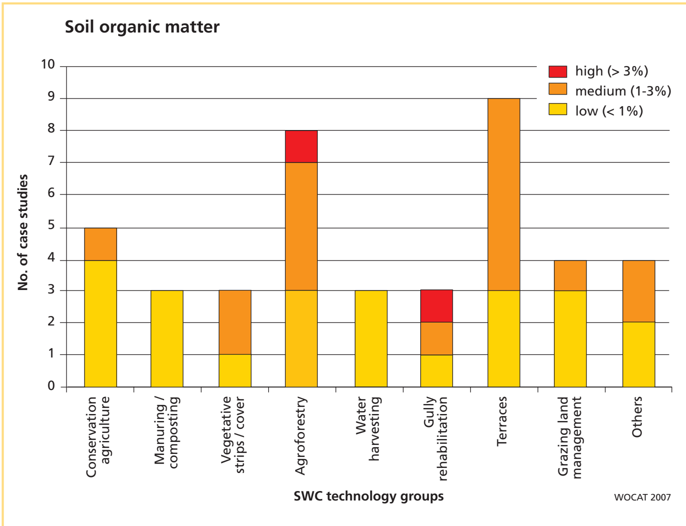


Figure 7: Level of soil organic matter in relation to the SWC technology groups

from left to right: Categorisation of SWC measures (continued)
Management measures: improved management can lead to better conservation and increased output, for example by turning open access grazing into cut-and-carry fodder production systems (Iran). (William Critchley)

Combinations of measures: in this case from Nepal, terraces (structural) with molasses grass *(Melinis minutiflora)* on their risers for fodder and stability (vegetative) and manure to enrich the soil (agronomic) for sesame production. (Hanspeter Liniger)

Combinations of measures: a 'landscape approach' in the Uluguru Mountains, Tanzania, where various measures interact both within, and between plots. This includes terracing for irrigation (foreground), intercropping of annual and perennial crops, and agroforestry systems (background). (Hanspeter Liniger) lies a potential for vast amounts of carbon to be fixed. In the global debate about climate change, the potential for carbon sequestration in the soil is crucial. Given the extensive areas of degraded land and the potential of SWC to increase soil organic matter in the topsoil, SWC offers a substantial and potentially long-lasting sink for carbon. And this is a win-win/ local-global benefit combination. However, once soils are rehabilitated and have reached their climax in terms of SOM, no additional carbon can be sequestered.

Human environment – *livelihood conditions*

Production orientation: With respect to the type of production orientation (from subsistence to commercial), the cases presented are relatively well distributed: subsistence accounts for 31% (13/42), mixed (subsistence and commercial) for 40% (17/42), and purely commercial represent the remaining 29% (12/42) (see Figure 8). Looking at some of the technology groups, 'Gully rehabilitation' is only reported under subsistence conditions. This supports the common observation that gullies are a major problem in poorer areas and on common land. Investments are needed to stop this degradation. While under our case studies three-quarters of the agroforestry and terrace systems occurred under mixed or commercial systems, they can also be found in subsistence farming situations. Under 'Terraces, market orientation is well represented, indicating that the high investments made (both in maintenance and establishment) must be affordable – and can be paid for – through farming on terraced hillsides. None of the 'Manuring/ composting' or 'Water harvesting' systems examples fall under commercial farming regimes. These cases are drawn from either the drier or poorer areas or both.

Size of land holding: The range of land sizes across different case studies is very considerable (see Figure 9). 'Terrace systems', 'Manuring/ composting' systems, and 'Gully rehabilitation' are all implemented in the context of smallholder farms with less than two hectares per farmer. Water harvesting is found on farms up to five hectares in size. It is only when we look at agroforestry systems that the plot sizes increase towards 15 hectares. 'Conservation agriculture' has a very wide distribution, covering a broad range from less than one hectare to over 1,000 ha. 'Grazing land management' also varies enormously: from small 'cut-and-carry' fodder-based plots (Ethiopia) to very large holdings of land (Australia). However, what is striking is that two-thirds of the case studies focus on land holdings of less than two hectares in size on average. This helps to support the theory that there is a significant and underestimated investment, worldwide, in conservation within the smallholder farming sector.

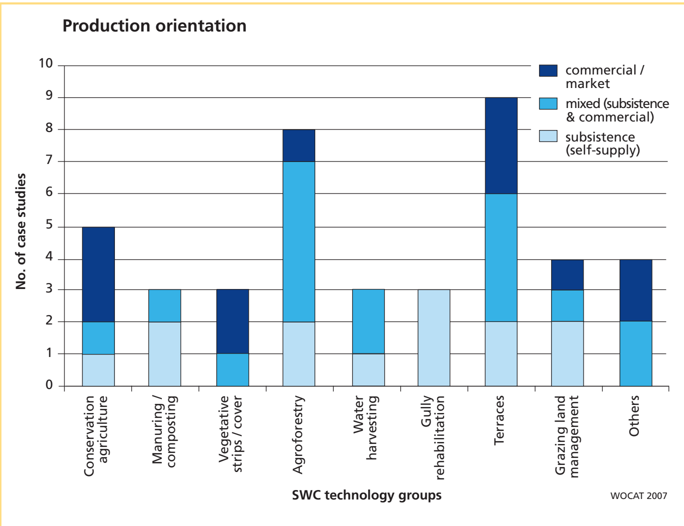


Figure 8: Production orientation in relation to the SWC technology groups

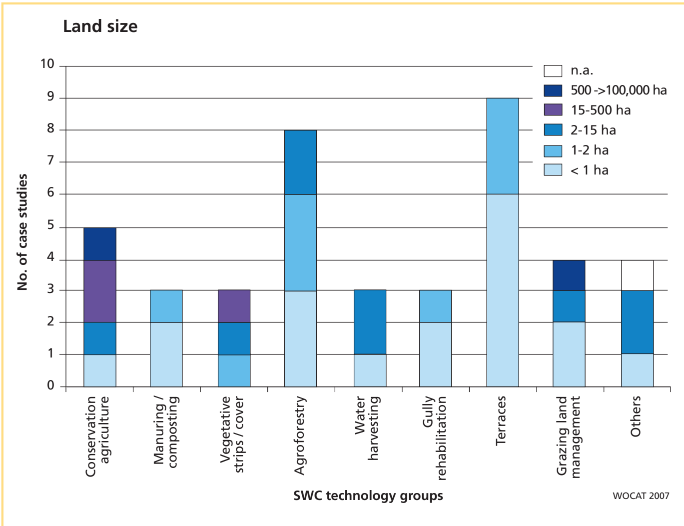


Figure 9: Land size in relation to the SWC technology groups

Socio-economic impacts – *weighing the costs and benefits*

Costs and investments – *crucial inputs*

In compiling the cost of a technology, it is often difficult to separate normal agricultural inputs from additional expenses for the technology. In some cases (for example, conservation agriculture) the costs are actually less than for the normal or conventional practice. Thus it is relatively difficult to determine the incremental (or alternative) costs (and benefits) for SWC. This is especially the case when the production system changes, for example in agroforestry systems (eg shade-grown coffee in Costa Rica), in conservation agriculture, or when changing a grazing land management system. An additional difficulty occurs if there are multipurpose uses of the system. The question here is how relevant it is to weigh and compare financial advantages of one system over another, when there may be various other economic benefits that are not so easy to quantify. It is still a considerable challenge to account for costs and benefits – ecological and social gains – that cannot simply be expressed in monetary terms. Increased investment costs are rarely accounted for in terms of improved ecosystem services – for example raised groundwater levels, maintained biodiversity or reduced off-site/ downstream damage. There are also other considerations to be taken into account, such as social status, and emotional, aesthetic, ideological, and cultural values.

All costs are country- and site-specific. In order to analyse the differences among the case studies, it is important not to forget the different situations regarding daily wages. There is a huge difference between the costs of labour in 'developing' and 'developed' countries.

Establishment costs are defined as those specific one-off, initial costs which are incurred during the setting up of a SWC technology. These investments are made over a period that generally lasts from a few weeks to two or three years. Typically included are extra labour, hire of machinery, purchase of equipment such as tools, fencing materials, and tree seedlings. There is generally no establishment phase involved in agronomic measures. However, in the group of case studies on conservation agriculture – which is based on agronomic measures – whereas in four out of five cases there are almost no extra costs recorded for the establishment phase, there has to be a change to new machinery at some stage. These costs, however, may be 'hidden' as part of general farm investments in equipment.

The highest establishment costs were associated with terrace construction (Figure 10). Only two of them were below US$ 500/ha (the '*Fanya juu* terraces' from Kenya, and 'Small level bench terraces' in Thailand). Five of them recorded figures of US$ 500 to 2,000/ha and the remaining two were both above US$ 2,000/ha. These two were the traditional Nepal and Philippine paddy rice terraces, estimated on the basis of 'if constructed today'. 'Agroforestry' also shows a wide range of investment costs, depending much on the cost of trees and labour required to plant them. Establishment costs for the agroforestry systems presented ranged from US$ 160 to 2,700/ha. As most of the grazing land examples are from the subhumid areas with quite good production potential, considerable investments were made, ranging from a few hundred to slightly over a thousand dollars per hectare. Establishment of vegetative strips and cover is generally also cheap, except for the Swiss case study where labour costs are very high – compared with the Philippines, for example.

There are a number of cases where input is needed to lift ancient systems out of current deterioration, and revitalise them and bring them back into productivity. These include the Roman terraces in Syria, and those of the Inca terraces in Peru. Investments required now to restore such systems to a functional level are too high to be met by the land users in the short term. Thus, in these cases support to the land users may be justified, as a one-off investment by governments and/or international donors. However, once these investments are made, the recurrent maintenance costs should be low enough to be covered by the local land users with minimal additional support. Otherwise, there is a danger once again of degradation. The relevant case studies here are too recent to provide information about the post-reconstruction period.

Maintenance (recurrent) costs are those that relate to keeping a system functional. They are incurred regularly – and costed on an annual basis. They are generally made up of labour, equipment, and agricultural inputs. In the current analysis, there were very low maintenance costs for a number of the technologies under the nine groups: for 'Manuring/ composting', for 'Water harvesting', for 'Gully rehabilitation', and also for 'Vegetative strips/ cover' (except for the Swiss example, where labour costs are very high). In contrast, the (absolute) maintenance costs for 'Conservation agriculture' are, surprisingly, quite high (Figure 10). But this can partially be explained by the fact that, of the five examples, two are from commercial farming systems in Australia and one from the United Kingdom. In fact, when the main-

left: Land use and land use change: left – large-scale conservation farming of barley with contour bunds; right – small-scale encroachment into previously forested zone of Mount Kenya where farmers are starting to conserve land with grass strips. (Hanspeter Liniger)
centre left: Manual construction of terraces: heavy labour inputs and financial investments are sometimes needed to bring degraded land into productivity as on China's Loess Plateau.
(Ministry of Agriculture, PR China)
centre right: Unterraced, steep slopes in the Uluguru Mountains, Tanzania – yet no sign of degradation due to good soil cover management, combinations of measures in the same fields and low erodibility of the soil. This combines low cost with high benefits– and is attractive to the eye as well. (Hanspeter Liniger)
right: A steep hillside in Kabale, Uganda, being cleared for cultivation: an erosion hazard in this area with its erodible soils. A solution here is to lay trash lines across the contour and allow grass to grow through them, providing strips of protection after three or four years. (William Critchley)

Table 3: A comparison of inputs involved in terrace establishment and maintenance

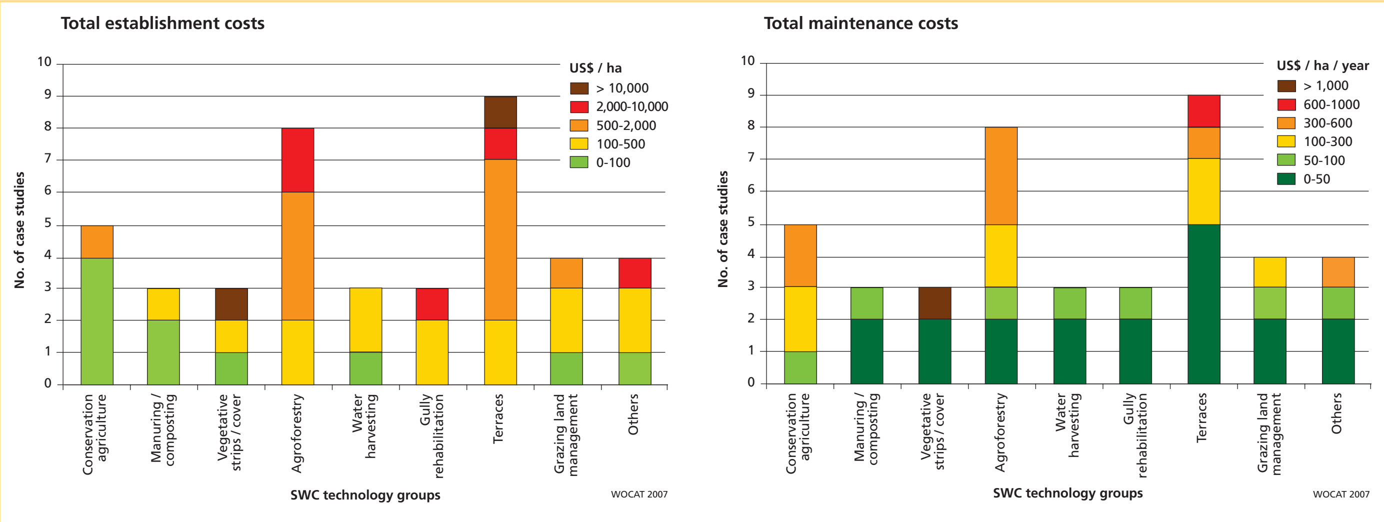
Technology	Country	Slope	Rainfed/ irrigated	Establishment			Maintenance		
				Person-days/ha	Total costs/ha US $	% met by land users	Person-days/ ha/year	Total costs/ha/ year US $	% met by land users
Orchard terraces with bahia grass cover	China	16–30%	Rainfed	350	1,840	70	60	376	100
Loess plateau terraces	China	16–30%	Rainfed	600	1,200	95	12	25	95
Fanya juu terraces	Kenya	5–8%	Rainfed	90	320	100	10	38	100
Rainfed paddy rice terraces	Philipp.	30–60%	Rainfed	800	2,700	100	10	40	100
Traditional stone wall terraces	Syria	16–30%	Rainfed	375	1,270	100	50	160	100
Small level bench terraces	Thailand	8–16%	Rainfed	125	275	100	20	45	100
Stone wall bench terraces	S. Africa	16–30%	Rainfed	420	1,460	100	5	20	100
Traditional irrigated rice terraces[1]	Nepal	30–60%	Irrigated	unknown	unknown	100	125	840	100
Rehabilitation of ancient terraces[2]	Peru	30–60%	Irrigated	130	1,400	35	6	126	100

[1] no information on labour input in contraction of these ancient terraces

[2] refers to rehabilitation of ancient systems, not original establishment

tenance activities of the conservation agriculture systems are compared with the conventional cultivation activities, the costs of the former are lower. The implication is that by changing to conservation agriculture there are cost savings in terms of annual field operations, even though there might be new inputs needed – especially herbicides. The reduced recurrent costs are one of the attractive aspects of the system to farmers.

Table 3 compares and contrasts the labour input and costs involved in construction and maintenance of the terrace systems described in the case studies. Generally speaking terraces are labour-intensive and expensive options for SWC. There are two exceptions though: (a) the *fanja juu* system from Kenya, where only the bund is constructed and the terrace bed levels out over time, and (b) the small step terraces from Thailand. Significantly, also, these are both located on moderate slopes. A general rule in terracing is that the steeper the slope the more soil needs to be moved and the higher the cost. This is confirmed here. With the exception of the orchard terraces from China, the major cost in all cases is associated with labour. However, the relationship



Figures 10: Establishment and maintenance costs in relation to the SWC technology groups

between person-days and costs is complicated because of the different rates calculated for daily labour, the cost of labour itself varies among countries. Allowance has been made for the historical change in costs; labour and other inputs have been calculated on the basis of 'what it would have cost in 2006'.

Costs and benefits (on-site) – *profitability of SWC*

The most convincing argument for land users to invest in SWC is an increase in land productivity and the associated economic returns. However, compiling relevant and reliable information for a rigorous cost-benefit analysis presents a major challenge to land users and soil and water conservation specialists alike. This analysis of the 42 case studies reveals that there are marked differences in land productivity and in economic returns between the various technologies. The whole basket of investments made, and the benefits accruing, need to be considered together in order to make informed decisions on selection and combination of measures.

Cost and benefits are extremely difficult to assess, but are obviously a crucial factor in justifying SWC interventions. The basic problem is the lack of hard and reliable data. In the absence of such data, WOCAT has had to rely on 'perceived benefits'. This, however, is not just a poor substitute for data – it is intrinsically important in itself: without a positive perception of benefits, land users (or outside donors) are unlikely to invest. Figure 11 shows the perceived benefits of the SWC technologies with respect to establishment (investments needed during the first three years) and maintenance (costs that are incurred annually). These were assessed by asking the land users to rank the benefits on a scale ranging from 'very negative' to 'very positive'. Three caveats are required here. First, it should be noted that these ratings are rarely supported by hard data – but based on experience and perceptions. Second, the assessment of the returns and benefits might give a too rosy picture due to contributors 'talking-up' their cases. Thirdly, the answers are derived from those land users active on-site. Thus benefits perceived by those off-site (or global benefits, for that matter) are not reflected.

Establishment cost and benefits over the short-term: With the exception of 'Terraces', there are examples in each group of cases where there are positive returns within a short period of time. Terraces are a case in point: in only three of the nine cases were 'neutral to slightly positive' benefits recorded in the short term; the other five were classed as 'slightly negative' (two) or 'very negative' (three). This reflects high investment costs and, probably, some initial reduction of the production level due to exposure and disturbance of subsoil during terrace bed levelling, or surface area loss due to the space taken up by terrace structures. In some cases the initially unproductive establishment phase of fruit trees means some years without any significant returns. However, the irrigated paddy rice terraces, as well as the newly established terraces in Tajikistan and on the Loess Plateau of China, pay back after a few years, since in these cases terracing leads to much higher, sustained productivity. In the latter case badly degraded hillsides have been converted into good farmland.

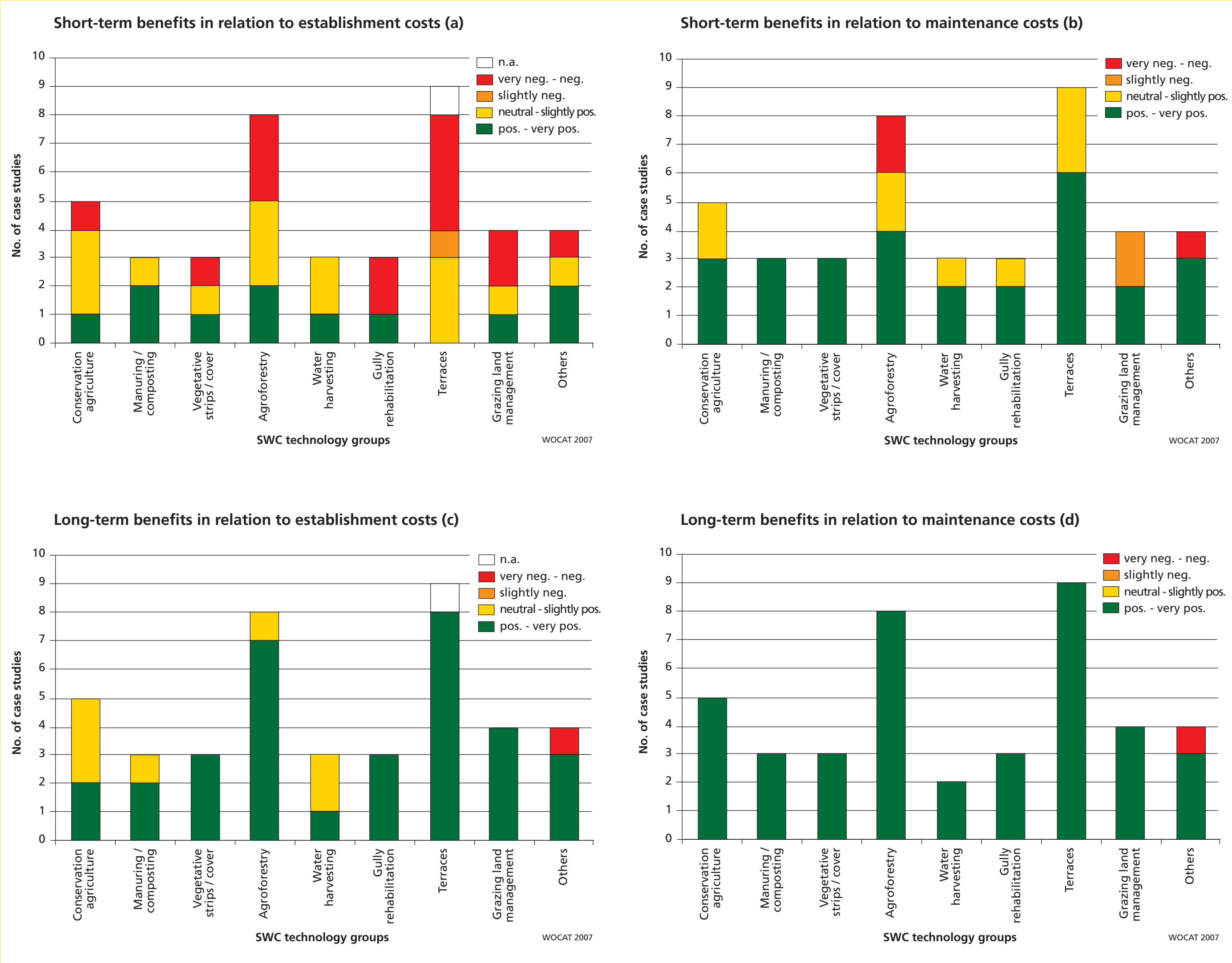
Establishment cost and benefits over the long-term: Thirty three cases (of the 35 where establishment costs were incurred) indicate that establishment costs were not only covered but gave a 'positive to very positive' return, except for one example – the stabilisation of the sand dunes in Niger. Here, compared to the high investment costs, the on-site benefits were low. However, the assessment does not take the possible off-site benefits into account: it is more difficult to assess what it would mean in terms of benefits if dunes threaten a village or an oasis with associated irrigated land.

Maintenance cost and benefits over the short term and the long term: Regarding maintenance, the extra benefits compared with returns to recurrent annual costs within the first years were already perceived to be 'positive' in around two-thirds of the cases. Only in the agroforestry examples, where new systems were established and degraded land was upgraded to agroforestry, did short-term maintenance fail to pay back quickly. Examples were in Costa Rica with shade-grown coffee, and the conversion from degraded rangeland to fruit orchards in Tajikistan. In the long term, the maintenance inputs gave positive returns in all case studies except for, once again, the fixation of the sand dunes in Niger (Figure 11d).

left: A mulched vegetable plot in the Solomon Islands of the South Pacific – demonstrating a low external input, simple technology that conserves the land and leads directly to productive impact. (William Critchley)

centre: The initial costs of this high technology conservation agriculture system from Queensland, Australia are considerable – including equipment for precision, satellite guided direct seeding/ fertilizing. But over time this proves cheaper than regular conventional tillage, and furthermore fertilizer requirement is reduced substantially making wheat production economic under dryland conditions. (Hanspeter Liniger)

right: Bringing home the harvest of fodder: this productive cut-and-carry system in Colombia protects the land from being overgrazed. (Mats Gurtner)



Figures 11: Perceived benefits of SWC technologies: short-term benefits in relation (a) to establishment costs and (b) to maintenance costs, and long-term benefits in relation (c) to establishment costs and (d) to maintenance costs

Establishment and maintenance cost and benefits over the short-term: Another look at the short-term costs and benefits is illustrated in Figure 12. Those cases that have rapid pay-back are worthwhile for every land user to invest in, as the increased returns are immediate. Those with short-term negative returns in relation to establishment, but positive returns in relation to maintenance, often require some support by projects, by the government, or the communities for a 'kick-start'. However, those with negative returns both from investment and maintenance (six examples) are unlikely to be taken up by small-scale subsistence farmers, unless they are awarded incentives. These technologies would inevitably require long-term external support if they are to be promoted – and could only be justified for other reasons, such as off-site benefits.

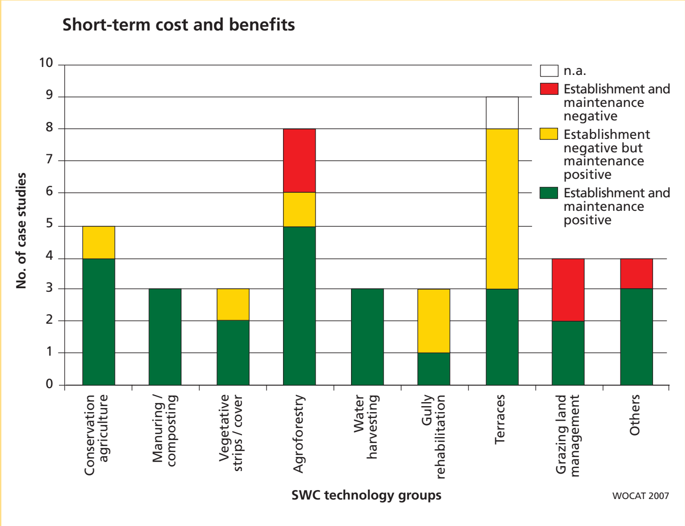
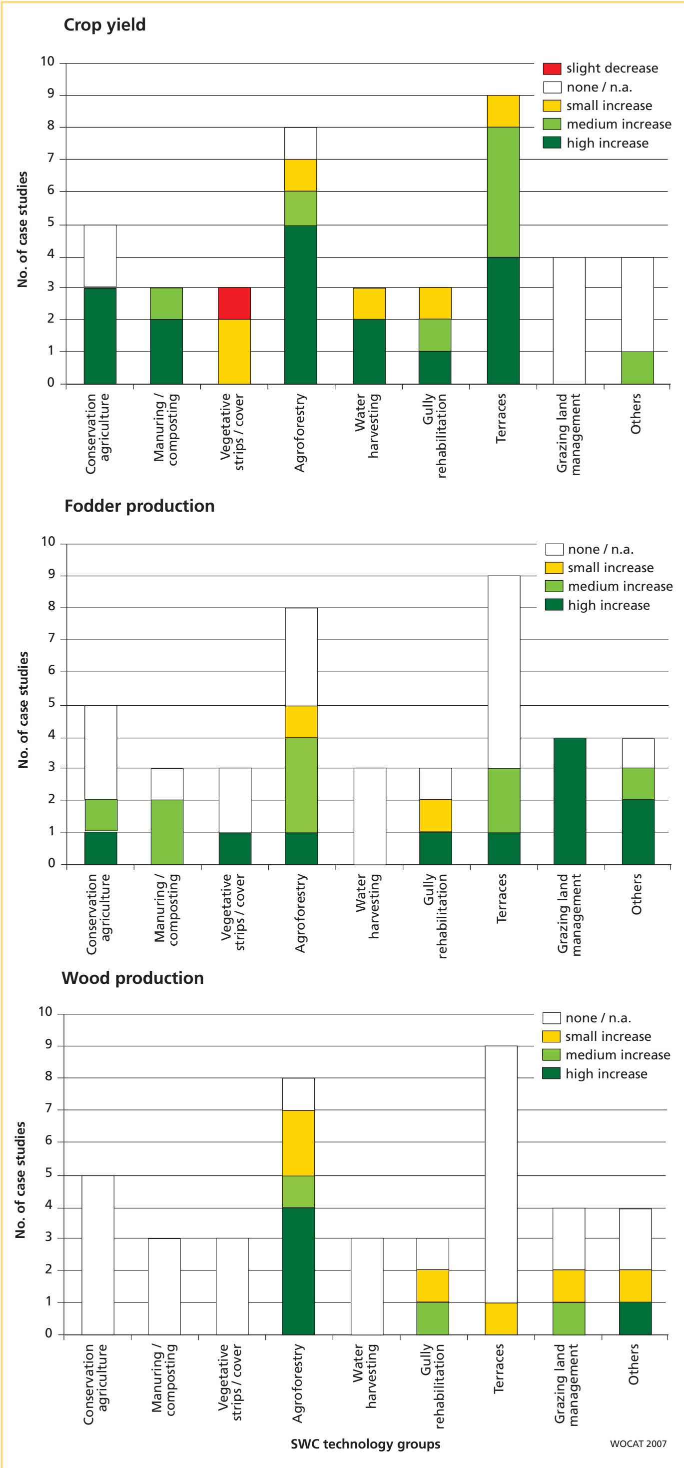


Figure 12: Establishment and maintenance cost and benefits over the short-term

Improving livelihoods and production – *more output for better lives*

Livelihoods: For each technology, the land users' judgment and perceptions were used with respect to the benefits of the technology – in both the short and the long term. SWC technologies with low investment and maintenance costs and rapid, as well as long-term benefits, help all farmers, and are especially useful in assisting small-scale subsistence land users to climb out of poverty. Several technologies – mainly those based on agronomic and vegetative measures – fulfil these criteria. Increase in farm income generated from improved land use through SWC was recorded in two-thirds of the cases.

Production: Figure 13 demonstrates how increases in production – across the nine groups – are often high (or at least medium) for crops, fodder and/or wood production. The first and most important point here is that SWC technologies increase primary production. This may be directly connected to the agronomic and vegetative components of many technologies, and associated with increases in soil fertility, or improved availability of water in the drier areas. Under 'Conservation agriculture', for example, crop yield increase is high in three of the five cases, and this is basically related



Figures 13: Increase/ decrease in crops, fodder and/or wood production across the SWC technology groups

left: Forward-sloping terraces in Uganda demonstrating a water and nutrient 'gradient': relatively higher yields behind the barrier due to an accumulation of sediment and moisture. (William Critchley)

centre: In the highlands of Eritrea huge investment is needed for the establishment of hillside terraces/ microbasins associated with tree planting on a very large scale – but it takes time to pay back: how can that gap be bridged? (Mats Gurtner)

right: Maize production under conventional ploughing in dryland areas, such as here in Kenya, carries a high risk of crop failure (left): but in this case the neighbour (right) – with his conservation agriculture system – had a harvest and furthermore, at reduced cost. (Hanspeter Liniger) to improved water conservation. 'Agroforestry' systems are, not surprisingly, reported as providing consistent production increases (generally medium and high) in terms of crops, fodder and wood. 'Terraces' also generally provide medium to high production increases for crops. An important by-product is increased fodder production from grass planted on the risers. A word of caution is required: as yields and impacts are seldom measured, they have generally been estimated by the contributors and land users, and thus there may have been a temptation to overstate the benefits.

The 'island effect': a word of caution

The 'island effect' refers to a specific (and relatively rare) situation under SWC interventions where benefits accrue to an isolated individual/ activity precisely because of that isolation. The case study from Kyrgyzstan illustrates the point. The planting of poplar trees provides locally beneficial 'bio-drainage' and simultaneously supplies wood for a hungry market. An expansion of the system, however, could lower the water table excessively – and flood the market with wood at the same time. The broader lesson here is that calculations of benefits, based on extrapolation from local success, should be done with caution, and that planning by local institutions to avoid oversupply of the market, and accordingly adapt technologies to local conditions, is crucial.

Ecological impacts – *improving ecosystem functions*

Water and the land

By definition, all SWC technologies function in relation to water – usually in relation to control of runoff and increase of infiltration, and as a result, an increase in water stored in the soil. Even control of wind erosion improves soil moisture. Some technologies are more explicitly related to drainage, and some specifically harvest water. Nearly all (88%) of the SWC technology cases indicated an increase in soil moisture (Figure 14). In 71% of all cases, improvement was rated as 'medium' or 'high'. A second water-related issue is that in one-third of the cases drainage was said to have improved. Reduced water loss through runoff and increased water infiltration and storage in the soil were strongly perceived as leading to greater water availability. Cases from dryland areas report seasonal water loss in the order of 15–20% due to surface runoff. Additionally, the potential of reducing evaporation from the soil, especially in drier environments, where 40–70% of the rainfall can be lost, has been described clearly in examples of conservation agriculture. The combined water loss through runoff and evaporation often leaves less than half of the rainfall – or irrigated water – available for crops or other vegetation. This clearly demonstrates the need for, and potential of, SWC. Terraces, rainfed as well as irrigated, also have a profound impact on water. Rainfed terraces generally provide for storage of rainfall through a raised 'lip' and are often designed to discharge excess runoff through a drainage system. Examples of this are the 'Rainfed paddy rice terraces' in the Philippines and the 'Zhuanglang loess terraces' in China.

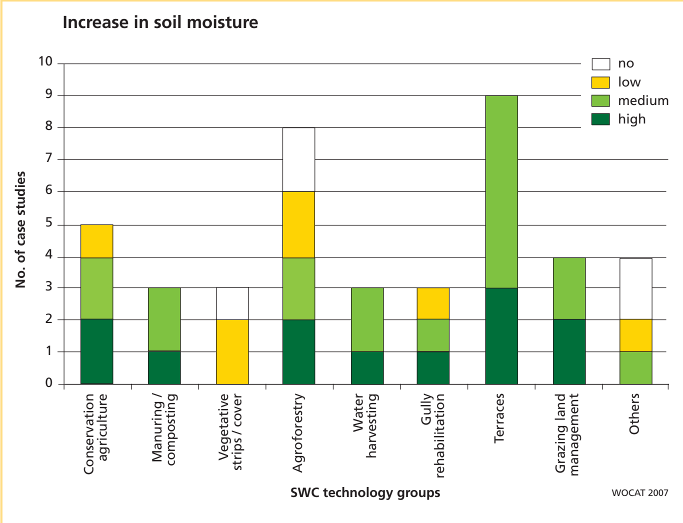


Figure 14: Increase of soil moisture within the SWC technology groups

Improved soil resources – *where roots can thrive*

Soil loss reduction: Generally all the groups of technologies are reported to have achieved a 'high' soil loss reduction – especially 'Terraces' (8 out of 9), 'Agroforestry' (5 out of 8), 'Conservation agriculture' (4 out of 5) and all 'Gully rehabilitation' and 'Vegetative strips/ cover'. The exceptions are 'Manuring/ composting' and 'Water harvesting' where the technologies are more concerned with fertility improvement and increasing water availability, respectively (Figure 15).

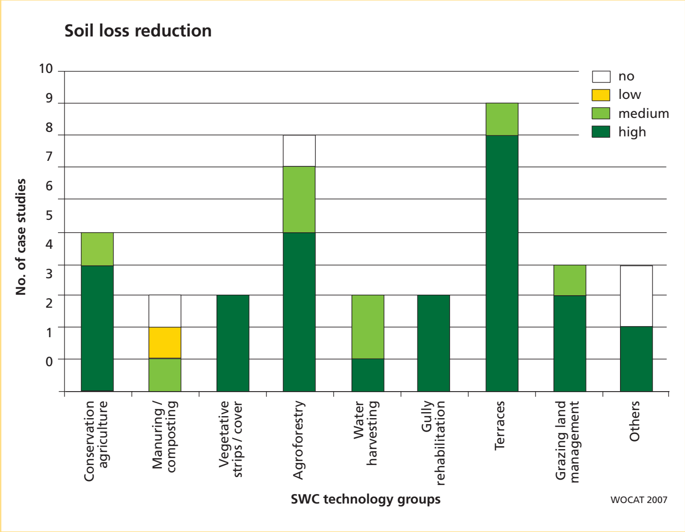


Figure 15: Soil loss reduction within the SWC technology groups

Soil cover improvement: The major achievers in terms of cover improvement are the cases under 'Grazing land management' (more grass; increased tree canopies), 'Conservation agriculture' (mulch) and 'Agroforestry' (multi-storey canopies and improved undercover) (Figure 16). Terraces score poorly in this respect: most are still cultivated through inversion tillage (ploughs drawn by tractors or by oxen/ donkeys, tillage by hand hoes) and kept weed-free.

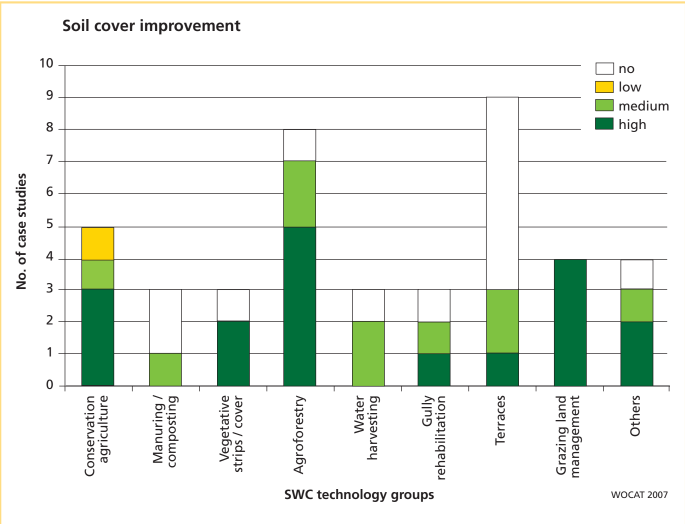


Figure 16: Soil cover improvement within the SWC technology groups

Manure and composts are usually incorporated into the soil rather than being used as mulch. Where water harvesting is practised, the catchment areas need to be kept relatively bare of cover to encourage runoff. This then comprises a system with a built-in self-contradiction: runoff and (to a lesser extent) surface erosion are actively encouraged in parts of the system to feed other parts.

Increase in soil fertility: The greatest increase in soil fertility recorded amongst the case study groups, not surprisingly, was under 'Manuring/ composting', as this was the primary objective of this group (see Figure 17). Nevertheless, 'Agroforestry' also scores well; two of the cases noting a 'high' increase and the remaining six all recording 'medium'. The 'Gully rehabilitation' and 'Water harvesting' cases are not primarily concerned with soil fertility management – though this may be achieved as a spin-off from sediment (and organic matter) harvesting behind physical barriers. Indeed more than half of the technologies (22 of 42) led to increased soil organic matter.

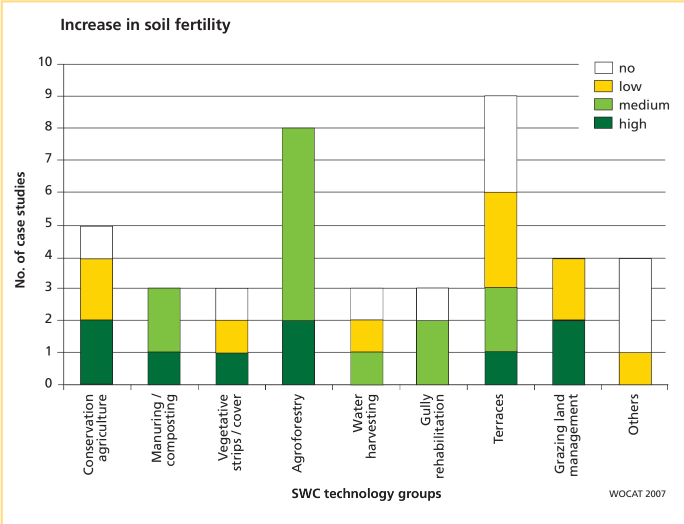
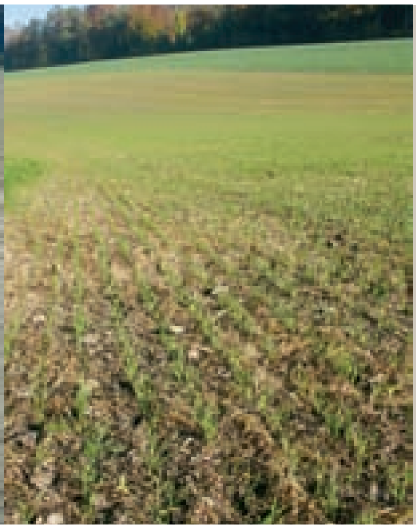


Figure 17: Increase in soil fertility within the SWC technology groups

On-site disadvantages – *drawbacks to in-field conservation*

Disadvantages mentioned by the contributors were presented as either 'high' 'medium' or 'low' in terms of their severity. The most commonly cited disadvantages were increased labour constraints (mentioned in around half the case studies for establishment; just less than half for maintenance),



left and centre left: Given declining availability of water for irrigation and domestic supplies, as well as growing incidence of water conflicts, the impact of SWC on river flow is crucial. This river in the Varzob valley of Tajikistan drains a degraded catchment: before heavy rain (left) and afterwards. (Hanspeter Liniger)

centre right: In Switzerland, with no conservation there can be serious on-site erosion, and consequent off-site impacts: roads covered with soil; drainage systems clogged. (Hanspeter Liniger)

right: In contrast, the neighbouring field with good soil cover and direct seeding – no damage at all after the same rainfall event. (Hanspeter Liniger)

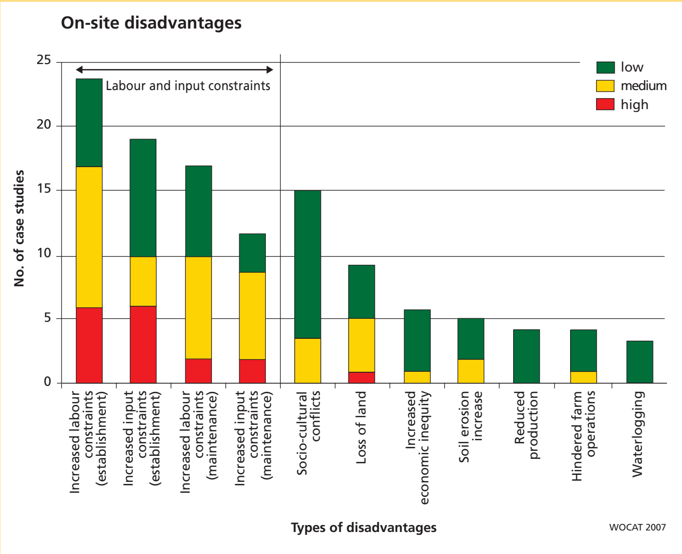


Figure 18: Perceived on-site disadvantages

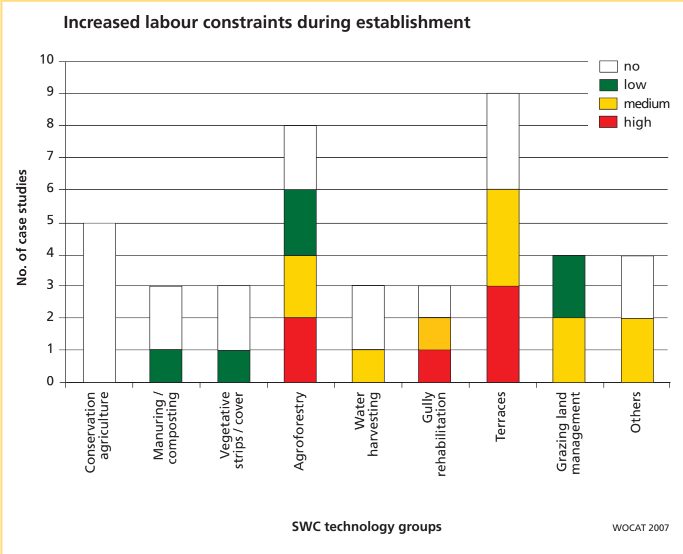


Figure 19: Perceived labour constraints during the initial phase of implementation in relation to SWC technology groups

and increased input costs (Figure 18). The only other two significant categories are loss of land (a common problem under terrace construction where land is 'lost' to the bunds and risers) and 'socio-economic conflicts,' which is a mixed bag of problems including, for example, the conversion of grazing areas to cropland, and thus some conflict between pastoralists and agriculturalists.

Additional disadvantages mentioned include a few cases where those who invest in SWC do not receive the benefits, which instead accrue to others – typically downstream – creating inequity. In other cases, erosion initially increases and production is also reduced before the measures begin to have impact. Others mention an alteration in the division of labour between men and women, and a change of values and norms regarding land use practices. All these factors need studied attention as they affect the acceptance, spread and adoption of SWC. It also needs pointing out that perceptions can change fast, and what was believed to be unlikely or even impossible, can sometimes, suddenly become accepted norms and practices.

Figure 19 demonstrates that the most frequently mentioned labour constraints are clearly related to those SWC groups that require the largest inputs. These are terraces and gully control, which comprise structural measures. Agroforestry also requires initial investment for the establishment of the tree component. Interestingly, water harvesting which generally depends on structural measures was not perceived as a burden in the case studies: this is probably due to the immediate improvement in plant production from water harvested in dry areas. Increased labour constraints were not noted in association with conservation agriculture, nor the adoption of manure/ compost, nor systems involving vegetative strip and cover.

Off-site impacts – *the great unknown*

Figure 20 presents a summary of the perceived off-site (generally 'downstream') advantages and disadvantages of the technologies described in the case studies. The most striking water-related off-site benefit is the reduced downstream flooding and siltation reported in three-quarters of the case studies. Around half indicated a high to medium impact. Just less than half (43%) indicated reduced river pollution, and about one-third noted increased river/ stream flow in the dry season. However, the information – derived from SWC specialists working with land users – has seldom been quantified. One exception is the case of Australia's 'Green cane trash blanket', where research is currently assessing impacts on rivers and on the Barrier Reef. In the absence of such impact assessments, the question arises whether this high rating of off-site impacts is more wishful thinking than proven fact. However, there are also a few off-site disadvantages mentioned; reduced overall river flow was reported in four cases, though the impact was assessed as 'low' in three

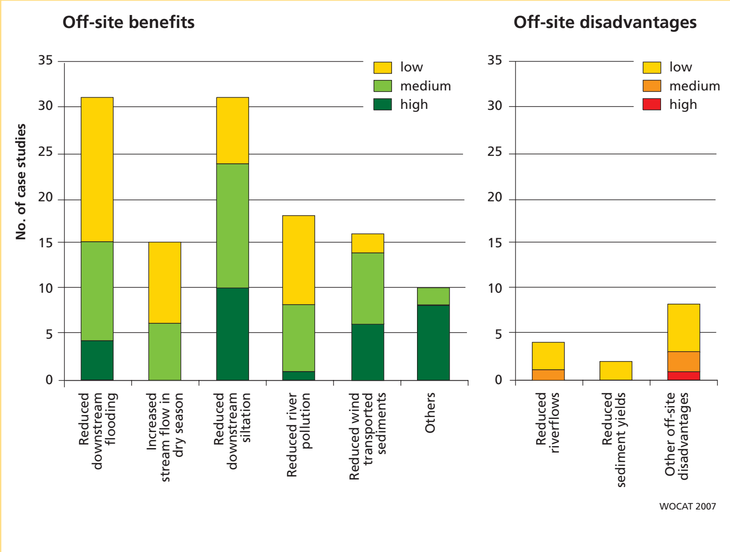


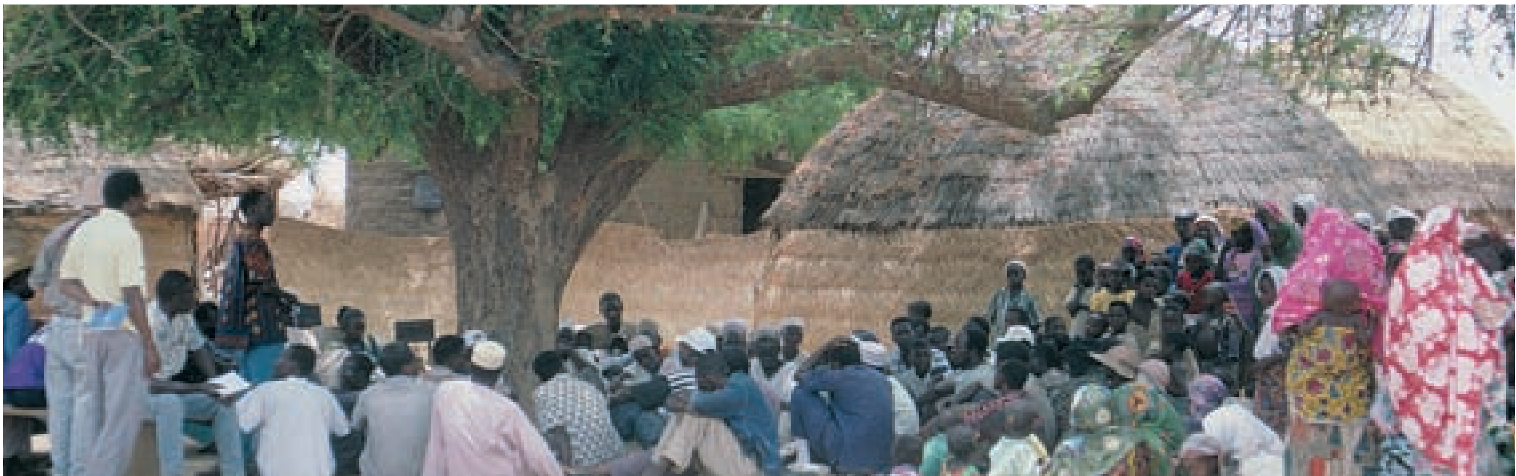
Figure 20: Perceived off-site (generally 'downstream') advantages/ benefits and disadvantages of the technologies described in the case studies.

cases. These cases referred to situations where terracing, and additional irrigation and water harvesting structures, reduced flows to downstream zones.

left: Agroforestry on steep slopes of the humid topics and subtropics have evolved into traditional systems - as here in the Kilimanjaro area of Tanzania. They are highly productive, have a positive impact on soil fertility, and provide crops, fodder, timber and fuelwood. (Hanspeter Liniger)

centre: An example of changing and adapting SWC practices over time in Kenya: in this situation earth bunds are being removed after 30 years of conservation service. The change in cultivation practice from deep to minimum tillage combined with mulching has resulted in greatly reduced runoff and soil erosion – even after heavy storms – and the protective soil bunds have become redundant. (Hanspeter Liniger)

right: Land use not only has on-site impacts, but it also affects people and settlements downstream. Originally, this settlement was built in a favourable location on a river fan from a mountain valley in Syria, where people depend directly on the water resources provided. If the mountains above are overused, floods will become a threat. (Hanspeter Liniger)



3 Analysis of approaches – *putting the practices into place*

Introduction – *definitions and overview*

According to WOCAT, a SWC approach constitutes 'the ways and means of support that help introduce, implement, adapt and apply SWC technologies on the ground'. This definition fits most comfortably within a project or programme framework where particular technologies are encouraged. It is also applicable to a technology that has spread spontaneously, although some issues such as 'extension' and 'use of incentives' are not relevant in these cases. This spread may have occurred either recently or through the ages as a tradition. Here the 'approach' is/was basically through transfer of knowledge within a community and through generations. An overall concept that best describes both situations (project promotion and spontaneous spread) is an 'enabling environment' within which conservation thrives. This analysis of approaches, we believe, sheds light on how SWC technologies can spread, and shows where investments can be made to 'make the land greener'.

This chapter reviews and analyses the 28 case studies of approaches presented in Part 2. The analysis broadly follows the various sections in the case studies: thus we look at names, objectives and emphases, followed by strengths and weaknesses and then the use of incentives and subsidies. Governance and decision-making issues are followed by a section on extension, training and adoption. Experience with land use rights is examined and this leads to monitoring, evaluation and responsiveness. A section on research completes the analysis.

The approaches documented in this book range from examples of self-mobilisation to those characterised by heavy subsidies and strong external technical support. However, it is not a simple matter of comparing these and saying one approach is necessarily 'better' than another: it all depends on the given situation. Allowance has to be made for the very great differences in circumstances: these include climatic zones, production systems, SWC technologies, wealth categories and development 'norms' concerning social goals and use of incentives and subsidies. Nevertheless we look for common threads, while trying to explain the differences.

A few words are necessary about the sample of approaches, and some basic differences between them. As discussed above, because the concept of an 'approach' is more readily applicable to a project or programme, this is where the datasets are most comprehensive and the data easiest to analyse. Where the questionnaire has been completed to describe a tradition (for example stone terracing in South Africa – the only tradition in this book where an approach is documented) a number of the questions are difficult to answer or irrelevant. In these cases (for example paddy rice terraces in Nepal and in the Philippines; stone terraces in Syria) the technology case studies stand alone. Only dedicated research could help unravel the circumstances leading to the evolution of these traditional technologies. Of the 28 approaches presented in the book, 20 are basically allied to projects/ programmes, and the other eight are descriptive of how spontaneous spread has occurred outside a structured campaign. One of these eight describes a tradition – the remaining seven refer to recent developments (Table 4).

There are 14 technology cases described in this book that are not matched one-to-one by approaches. In five situations the technologies comprise traditions where, as noted, we do not have information to reconstruct their origins. In a further two examples – from Ethiopia and Niger – a single approach in each case is 'shared' by two technologies. And in two further cases (from Kyrgyzstan and Australia, respectively) a single farmer has developed a conservation system outside a project framework. In the remaining five cases the specialist contributors have concentrated on the technologies, and not supplied the required information regarding the approach that led to the technological developments.

Without exception the sample here constitutes approaches that are viewed as being positive or at least 'promising'. Thus the analysis opens a window on denominators of success. Some of these denominators are common to many approaches, others are situation-specific. Within the sample there is a bias towards those approaches that have underpinned relatively successful technologies, and particularly technologies which are remedial (through mitigation or rehabilitation of erosion problems) rather than preventive (helping maintain sustainable systems). There is also, in-

left: A village discussion in Burkina Faso about the effects of degradation and solutions involving different stakeholders: while participatory, there are important questions to consider such as: who has a say? and who is marginalised? (Hanspeter Liniger)

right: Awareness raising in an indigenous reserve within Colombia where people are urged to cooperate: 'let's protect the natural resources; avoid slash-and-burn practices; do not remove earth'. (Mats Gurtner)

Table 4: Approaches analysed, titles, types, origin and lead actors/ agencies

Type/ name of approach	Country	Lead actor/ agency
Local initiative (tradition)		
Community tradition	South Africa	Local land users
Local initiative (recent)		
The 'triple bottom line' (TBL)	Australia	Local land users
Spontaneous spread	Kenya	Local land users
Transition from centralised regime to local initiative	Tajikistan	Local land users
Self-help group approach	Kenya	Local land users; with external support
Farmer initiative within enabling environment	Switzerland	Local land users; with external support
Self-teaching	South Africa	Individual initiative
Farmer innovation and self-help groups	Tajikistan	Individual initiative
Project/ programme		
Development and promotion of Ecograze	Australia	NGO
Incentive-based catchment treatment	Bolivia	NGO
Zabré women's agroecological programme	Burkina Faso	NGO
Integrated rural community development	Colombia	NGO
Soil management initiative (SMI)	United Kingdom	NGO
Market support and branding for input quality	India	NGO
Productive development and food security programme	Nicaragua	NGO
Participatory catchment rehabilitation	Peru	NGO
Joint forest management (JFM)	India	NGO/Government
Promoting farmer innovation (PFI)	Uganda	NGO/Government
Terrace approach	China	Government
Agroforestry extension	Costa Rica	Government
Local level participatory planning approach	Ethiopia	Government
Comprehensive watershed development	India	Government
Catchment approach	Kenya	Government
Applied research and knowledge transfer	Morocco	Government
Integrated watershed management	Nepal	Government
Participatory land rehabilitation	Niger	Government
Landcare	Philippines	Government
Participatory technology development (PTD)	Syria	Government

evitably, a focus on project/ programme-related initiatives, as these are the most conspicuous and best-known SWC interventions.

Titles, objectives and emphases – *what's in a name?*

The language of development – *justified jargon?*

The current thinking in rural development – including soil and water conservation – emphasises the importance of participation of land users in all aspects of the project cycle, and is reflected in new terminology. These changes reflect the 'new approach' that emerged at the end of the 20th century. That approach was a reaction to shortcomings in top-down policies and practices in the past. Several of the approaches reported here have the word 'participation' either specified in their titles or mentioned in their brief description, yet only one has it highlighted under objectives. While the names and objectives of many projects genuinely try to reflect the end-of-century new approach, it may well be that some are using terminology because it is 'developmentally correct' or even necessary to attract funding.

Apart from participation, other common terms in titles amongst the approaches documented here – and within the WOCAT database at large – are 'integrated', 'innovation'/

'initiative', 'community'/ 'group' and 'catchment'/ 'watershed'. These are mainstream concepts in the vocabulary of the new approach. Not many projects appear to have deliberately sought catchy descriptive titles, or simple acronyms, to set them clearly apart. Exceptions are 'Joint forest management' (JFM, from India) 'Promoting farmer innovation' (PFI, from East Africa) 'Landcare' (from the Philippines, originally from Australia) and 'Development and promotion of Ecograze' (from Australia). The name 'Catchment approach' from Kenya's highlands is actually misleading. That is because it basically comprises an approach based on communities or administrative units rather than a hydrological catchment. Naturally, descriptive names for approaches have had to be created in this book for most of the traditional and contemporary spontaneous technologies – where there was no specific project support. Thus we have suggested titles such as 'Farmer initiative within enabling environment' (from Switzerland) and 'The triple bottom line' (from Australia).

Objectives – *taking aim*

A search through the objectives of the various approaches brings up an interesting array of aims – several of which are broader than just targeting better soil and water conservation. Commonly, the contributors to the case studies mistakenly cite the objectives of the technology supported by the approach, rather than the objectives of the approach itself. Thus 'environmental impacts' may be put forward rather than, for example, 'institution strengthening'. In most cases we have reworded these and then returned to the contributors for approval.

Many of the case studies involve SWC as just one element – a subset – of a wider rural development programme. However, a common general pattern emerges regarding objectives, actions and implementation arrangements. This can be represented as follows:
- *goals:* environmental improvement and poverty alleviation
- *through:* improved plant and livestock production, requiring conservation of specific resources
- *based on:* raised awareness, a sense of ownership, gender equality and improved governance
- *combining:* joint efforts of various actors with strengthened institutions

Few sets of objectives are defined as explicitly as this but many, if not most, combine one or more of these elements. It is very common to see, for example, social and environmental goals expressed simultaneously. Some projects take particular and specific angles: in Costa Rica the agroforestry extension initiative deliberately seeks to harmonise different approaches within the country. 'Promoting farmer innovation' (from East Africa) sees the stimulation of local innovation as a key objective. Food security is explicit in a number of cases (eg in Burkina Faso, PR China and Nicaragua) and in Bolivia the paid-for gully control measures are aimed firstly at achieving downstream benefits for the city of Cochabamba. Four research-based initiatives ('Participatory technology development' from Syria, 'Development and promotion of Ecograze' from Australia, the 'Soil management initiative' from the UK and applied research and technology transfer from Morocco) all set out, deliberately, to refine and spread technologies through land users. The two non-project, spontaneous developments from Tajikistan have implicit objectives of restoring control of land and production from the state to individual farmers.

A new focus – *alternatives for financing SWC*

Looking at the most recent trends, we can see a new set of objectives emerging in SWC interventions. These new objectives address rapidly emerging global environmental concerns, particularly those of mitigating climate change (hence carbon sequestration through biomass and increased soil organic matter levels), above and below ground biodiversity, and water (hence ecosystem functioning as well as water use efficiency under rainfed and irrigated agriculture). There are some indicators of future trends in the cases analysed. It is likely that increasing attention will be paid to addressing SWC concerns through new marketing opportunities – of which fair trade coffee from Costa Rica and 'Vinatura' environmentally friendly wine from Switzerland are examples from our current analysis. It is reported that the community development project from Colombia has now branched out into production of various organic products. There are also wide-ranging possibilities of accreditation/ labelling schemes to command market premiums. These may even go beyond fair trade and eco-labels and eventually into the realms of 'SWC-friendly products'. Pilot schemes promoting payment/ compensation for ecosystem services are almost certainly forerunners for a new breed of programme. These, typically, comprise compensation to land users in upland areas for maintaining vegetation in catchment areas, from industries, dwellers in towns or farmers downstream, to ensure water supply and mitigate damage from floods and landslides. The rate of compensation should be based on estimated values of these services. The case study from Bolivia is an example of where this type of

left: World heritage sites include agricultural land: a signboard announcing the famous terraced landscape of Ifugao in the Philippines where local and international agro-ecotourism is growing in importance. (William Critchley)

centre: The terraces foothills of Annapurna in Nepal add to the touristic value of the area. Here land users benefit from directly from improved production on their terraces – and have off-farm income opportunities from tourism. (Hanspeter Liniger)

right: 'Max Havelaar' coffee and 'Vinatura' wine: labelling of products helps promote ecological production and fair wages – as well as opening new market niches. (www.vitiswiss.ch) approach could be developed. Ecotourism is already popular in parts of the world and agro-ecotourism is following cautiously in its environmental footsteps. In the case of the Ifugao terraces in the Philippines, agro-ecotourism helps, indirectly, to pay for their upkeep. Agro-ecotourism is currently on the agenda as a possibility to capitalise on the spectacular terraces of the Loess Plateau in China.

Strengths and weaknesses – *what works well and where challenges remain*

Strong points – *successes to learn from*

It is revealing to look through the strengths of the various approaches, as recorded by SWC specialists closely associated with the related project (where the approach is project-based). While the strengths are supposed to be a combination of the specialist's and the land users' views, it is probable that the specialist's voice is the more prominent. What tends to be reiterated in these 'strengths' are several of the objectives stated earlier. Thus we have institution building for specific aspects of natural resource management (UK, Peru, Kenya's self-help groups and landcare in the Philippines), ownership and involvement of the land users and indigenous knowledge (Syria, Nepal, Kenya's catchment approach and the example from Ethiopia) and changed attitudes (Peru and Bolivia). However, there are some less expected strengths highlighted in other cases. These include the impact of 'local promoters' in Colombia, the challenge to entrenched gender roles in Burkina Faso, and institutionalisation of the approach in Costa Rica.

Shortcomings – *weaknesses to address*

The documented weaknesses of the approaches are at least as important to this analysis as their strengths. These include:

- the period of intervention and funding needing to be of significant duration, but often too short to achieve lasting impact (many examples of this)
- the problem of participatory approaches being very demanding on human resources (Nicaragua; East Africa)
- the need for more training (Australia) and material incentives given to land users having the effect of being temporary 'bribes' and getting in the way of voluntary work afterwards (several examples)
- other less expected and location-specific weaknesses were: problems associated with over-supplied markets (for coffee in Costa Rica; for forest products in India), with land conflicts in Niger (once conservation investments had raised the value of land), and power struggles between various stakeholders in Burkina Faso, the Philippines and Tajikistan.

On the other hand, where the 'approach' describes a tradition or spontaneous spread of a technology, the weaknesses usually highlight the lack of support or recognition from outside.

Incentives – *helping hands or addictive stimulants?*

Incentives and participation – *hand-outs and taking part*

Genuine 'participation' is related to the level of input (labour, materials and intellectual) provided voluntarily by the land users/ beneficiaries. In other words, the lower the degree of outside subsidy, incentive or other support, the greater the level of genuine land user participation. Thus, one key aspect of any approach is the extent to which the approach includes subsidies and support for existing/ local efforts and resources to implement SWC technologies, and how far this might then influence further, and future, spread. If a high level of material subsidy is given, spontaneous uptake will be unlikely, as people will expect to receive continued support. The majority of direct or 'external' incentives provided by projects take the form of minor material inputs, such as seeds, tools and fertilizer, and payment for labour. However, in 15 out of the 20 project/ programme-based approaches there were low or negligible levels of inputs. In fact, 5 of these 15 cases provided no material incentives to land users at all, implying full cost borne – and thus full commitment – by land users. Examples are promoting farmer innovation (Uganda), market support (India) and participatory technology development (Syria).

Food-for-work – *earning a meal*

The use of food-for-work (labour paid through food rather than cash), especially when associated with acute food shortages, was commonplace in the late 20th century. But it has become largely discredited due to logistical complications, misadministration, and a growing awareness by donors of the 'dependency syndrome' that can so quickly result. The only such example we see here is from Ethiopia. In the agroforestry system from Colombia (integrated rural community development) food-for-work is mentioned as having been phased out. Nevertheless in this latter case, the cost of implementation was so high and the subsidy so large

that (regardless of the nature of the subsidy) one wonders indeed whether the technology can ever expand spontaneously outside the immediate surroundings of the project. One alternative to food-for-work is support given to institutions in terms of materials, training and infrastructure. This is becoming increasingly common, and is said to be a strong feature in 12 of the 20 project/ programme approaches. Another alternative form of support, a specific credit facility for farmers to tap into, is provided in only four cases. This could be a promising avenue for the future.

Support for labour – rewards for work

There are arguments in favour of subsidies under specific circumstances, such as the rehabilitation of the ancient stone bench terraces in Peru. The original, historic, investment in terracing will be lost unless the poverty-stricken local people are assisted in a one-off rehabilitation process to re-establish dilapidated terraces. Another consideration is the different norms and standards from country to country. Thus in India, under joint forest management, participation of the community is considered a cornerstone of the approach. Indeed, unless the community acts together in 'social fencing', meaning collective agreement to protect an area from livestock and other uses, the concept collapses. The long-term commitment of the government and donors to broaden the cover of this initiative, combined with the poverty of the people, means that spread will continue to occur despite the very high level of subsidy. Here the national norm for paid labour is 85–95% of the local cost of a daily wage. In most parts of Africa, under most SWC initiatives, this relatively high level of subsidy would certainly not be considered to constitute 'true' participation.

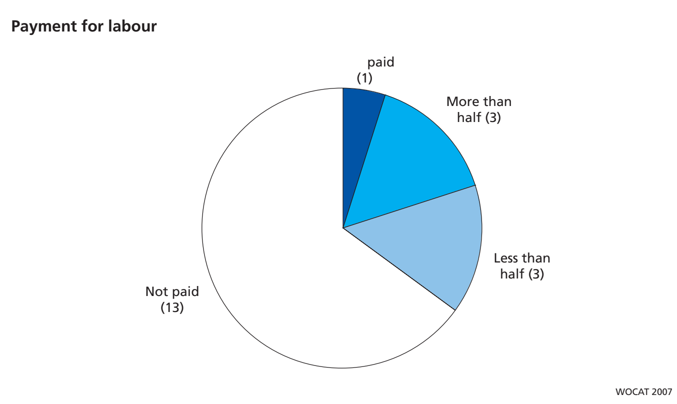


Figure 21: Level of labour paid by projects/ programme under reported approaches

Voluntary labour is provided by land users in 13 of the 20 cases (Figure 21). It is fully paid by the project in only one situation documented here: the exceptional case of Bolivia where the primary beneficiaries are not those involved in the gully control treatments, but city dwellers, downstream. In over half of the project/ programme-based approaches it is believed that there will be at least a 'moderately negative' impact of current material incentives on the land users in years to come. The 'negative impact' here implies a perceived constraint on voluntary uptake or maintenance in the future, after apparent enthusiasm proves later to be 'pseudo-interest' in SWC. Nevertheless, initial, highly subsidised investment in SWC – as in Ethiopia during the 1970s – may in some cases leave a framework that persists several decades after, and forms the basis for future, participatory soil and water conservation.

The discussion about incentives is central in project/programme-based initiatives. Locally originated approaches appear to be fully participatory, as there is/ was no outside agency providing inputs. The main incentive at play in those cases is/ was evidently that of improved production resulting from conservation efforts. This is essentially an 'internal' incentive. Most traditions – take stone terracing in South Africa, for example – have not arisen through projects or programmes, and labour has been voluntary (though perhaps coercive under some ancient civilisations?), from original construction through maintenance by successive generations. Thus incentives should not exclusively be seen as payments, but the stimulus that a land user experiences through higher production, or through saving time and money.

Uptake of technologies and incentives – *stimulating adoption*

In three of the technology groups more than 50% of the current uptake is attributable to incentive schemes: these are (a) grazing land management, (b) gully rehabilitation and (c) water harvesting measures. One common denominator that connects these three groups of technologies is the high initial labour requirement – and this partially explains why they are so often subsidised. One would have expected terraces also to fit into this category with their high labour requirement. The reason why only half of the terrace-related technologies are supported by incentives is because several of the cases are ancient traditions that are no longer under construction: incentives are simply not required when they didn't exist (presumably) during construction. Few incentives are used in the terrace approach from China. But it is an exception in a number of ways. Not only is this the

left: Food-for-work was a common approach to soil and water conservation in the 1970s and 1980s as seen here in Ethiopia. It helped in implementing SWC, but in several cases created dependency on outside aid rather than providing a stimulus for adoption of such technology. (Hans Hurni)

centre left: Abandoned terraces and erosion in Lanzarote, Canary Islands due to migration of labour from inland farms to tourism on the coast. Some terraces however are still maintained and used for crop production – see centre of picture. (William Critchley)
centre right: Environmental stewardship in North Yorkshire, United Kingdom: moving away from production-based subsidies to rewards for environmental protection. (William Critchley)

right: Payment for ecosystem services is growing in importance – downstream users of water will increasingly have to pay for conservation of forested uplands (Jamaica). (William Critchley) largest, most closely organised implementation programme analysed here, but the achievements are remarkable, considering the low level of material support to land users. The key here is the conversion of eroded slopes to highly productive farmland. This production stimulus also underpins those groups of technologies that have the highest rates of adoption without incentives. These are the three groups of (a) vegetative strips/ cover, (b) conservation agriculture, and (c) manure/ composting systems. It is no coincidence that these are the technologies that give the quickest returns to land users, at the lowest investment cost.

Subsidies and markets – *manipulating the economy*

The cases from the 'developed' countries in Europe – Switzerland and the UK – stand apart. Here there are heavy government subsidies in general for agriculture, though the current tendency is to decouple these from production and link farm level support instead to environmental protection and 'stewardship'. However, the triple bottom line case from Australia does not benefit from subsidies for sugar cane, which is not protected from world market prices: environmental protection has been achieved despite the relatively low prices and lack of external support. These same global market prices can have a direct influence on land management in other situations. In Kenya, the high price of coffee in the 1970s stimulated and helped pay for construction of terracing systems amongst small-scale producers. Most have been kept up, despite the slump in prices soon afterwards. In Costa Rica, however, the international drop in coffee prices over the last two decades has had a negative impact on spontaneous uptake of the Café arbolado system.

While conservation agriculture does not attract a direct subsidy in the UK case presented here, it does form part of an environmental package that helps the farmer qualify for benefits. This transition towards environmental protection is the shape of things to come in 'developed' countries, where food production has become a secondary concern in the countryside. Aesthetic, recreational and cultural considerations, ecosystem services, and food quality concerns have taken over. And there is the need to keep some farmers on the land as 'stewards' of the countryside. In these situations there is, effectively, an urban-rural flow of tax money, dedicated to keeping the countryside from degenerating. Payments for ecosystem services are a promising policy and management approach with two options:

- payment or tax concessions by the government for ecosystem services rendered (eg through subsidies, as in Europe)
- payment or compensations directly by users of an ecosystem service to those who ensure that service (eg as suggested in the Bolivia case study – namely payments from city inhabitants to the farmers in the catchments above). The idea is that this type of payment/compensation could be sustainable, and would economically underpin investment in SWC.

Ecosystem services

Ecosystem services are the benefits people obtain from ecosystems. These include provisioning services: the products obtained from ecosystems, including food, fibre, medicine; regulating services: including air quality regulation, climate regulation (carbon sequestration), water regulation; cultural services: the nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences etc; supporting services: those that are necessary for the production of all other ecosystem services, including soil formation, photosynthesis, nutrient cycling, water cycling, etc [note: the term 'Environmental services' is commonly used as an alternative].

Source: summarised from Millennium Ecosystem Assessment, 2005. Ecosystems and Human well-being Synthesis. Island Press, Washington, DC.

Funding, governance and decision-making – *who calls the tune?*

Taking all the 20 project-based case studies together, it is striking that – calculating the average proportions of fund-

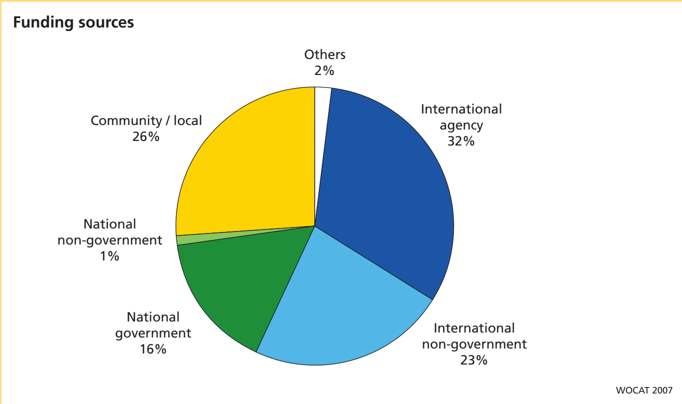


Figure 22: Average proportions of funding sources in reported approaches

ing sources – a quarter of the contributions are from local communities and nearly one-sixth from national governments (Figure 22). The international community provides, on average, just over half, namely 55%. Outside donors are important investors in these successful examples of SWC interventions – but not at such a high level as might have been expected. The level of community/ individual contributions and their 'buy-in' to the initiatives is generally impressive, considering that many of the projects cover very poor areas.

'Participation' does not just mean providing labour, materials or ideas. There is a governance dimension to it also. The ultimate form of participation, namely 'self-mobilisation', is applicable de facto to all the spontaneous approaches. Under the project/ programme approaches, the great majority are 'interactive' or 'self-mobilised' during most of the phases of the initiatives (initiation, planning, implementation, monitoring/ evaluation and research; Figure 23), implying that there is strong local initiative as well as two-way communication between outsiders (who naturally benefit also through salaries) and local beneficiaries. This is a firm indicator of self-governance, and is clearly a trademark of the new approach to participatory development that characterises most of the cases analysed.

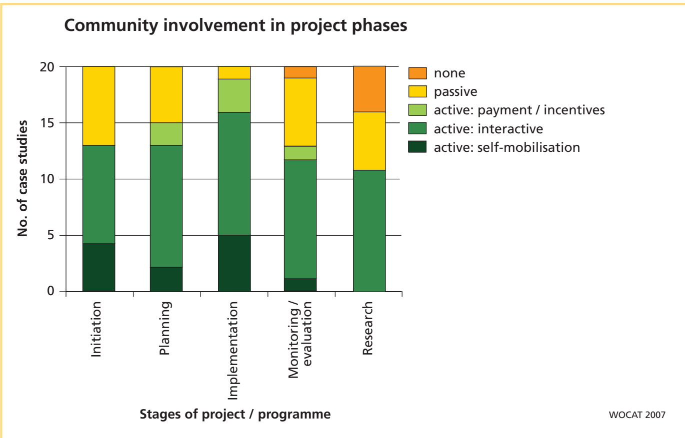


Figure 23: Community involvement in different stages for project-based case studies

Strong community involvement is highlighted further by the fact that nearly half of the projects/ programmes claim that the choice of technology was principally the choice of the land users (either alone or supported in their choice by SWC specialists; Figure 24). The final piece of evidence regarding ownership of the process is that the actual design of the approach shows significant international 'expert' input in less than half of the project/ programme approaches. The others were designed by national and local experts.

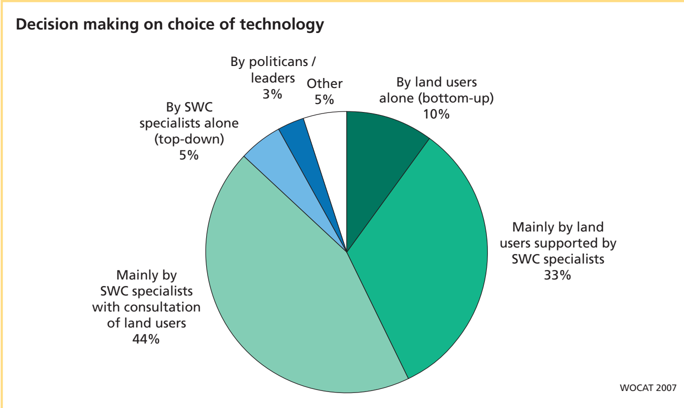


Figure 24: Decision making on choice of technology for project-based case studies

While the question pertaining to the difference in participation between men and women was asked at a very basic level, gender as an issue in SWC (as with many other rural activities) was highlighted in the results. There is a marked division of tasks in SWC responsibilities and activities: there is a 'moderate or great' difference in the roles of men and women related to SWC, in nearly two-thirds of the cases. However, this should not be interpreted automatically as proof of bias or discrimination. Some SWC tasks are traditionally divided between men and women: in a number of cases, for example, it is said that the heavy construction work of terrace bunds is left to the men. On the other hand, although there are not enough data to support the proposition definitively, the in-field agronomic measures that contribute so much to conservation (and are often 'unseen' as SWC) are very much the preserve of women in developing countries. Women's conservation activities may not always be conspicuous, but they are often vital.

Extension, training and adoption – *spreading and accepting the word*

Methods used – *the means towards the end*

The answers given to the various questions on extension and training tend to mix and match these two aspects to the extent that it is difficult to disaggregate them. To most respondents, training (in skills) and extension (spreading the

left and centre: Participatory approaches involve land users and specialists reviewing problems and solutions together. They require sensitivity and mutual respect, but can generate lasting solutions through considering priorities of all stakeholders. Examples here from India (Hanspeter Liniger), Syria (Francis Turkelboom) and Burkina Faso (Hanspeter Liniger)

centre right: Gender sensitivity is essential in understanding and documenting good land management practices – women often feel freer to express themselves to other women, as here in Iran. (William Critchley)

right: Father to son transfer was the traditional way of passing on knowledge: now this needs to be supplemented by documentation (Nicaragua). (Mats Gurtner) message) go hand-in-hand. In all of these areas there has been a switch to more participation, devolution of powers, and less authoritarianism. There is, for example, a common view about the need for empowerment of beneficiaries, a shared concern that marginalised people in society should receive more attention, and a joint recognition of the need for accountability and openness. In the case from Nicaragua, this common ground is clear: the conservation approach documented under WOCAT is described as being part of a much wider programme of 'popular education'.

Broadly speaking, there are three forms of extension and training:

- First, that which could be termed the 'multiple strategy'. This is what is adopted by the majority of the project/ programme-based approaches. It includes several or all of the following: awareness-raising ('sensitisation' is a term often used, artificially constructed from French and Spanish equivalents), training workshops and seminars around specific themes, exposure visits, hands-on training, and the use of demonstration plots.
- The second main form is based on informal farmer-to-farmer extension and exchange of ideas. Here projects assist through facilitating exchange between farmers: for example by enabling farmers to visit each other for mutual learning.
- The third is centred on the use of trained 'local promoters'. These are basically local farmers who are trained to become facilitators/ extension workers under a project.

None of these are mutually exclusive, and all are forward-thinking methods. Spontaneous spread of technologies has almost exclusively occurred through farmer-to-farmer exchange of information, including visitors from afar, not just neighbours. Farmer-to-farmer transmission was the only form of 'extension' for thousands of years, and not only has it not died out, but it is being rejuvenated through progressive projects. The recent cases of spontaneous spread of specific technologies (eg grevillea in Kenya; green cover in Switzerland; green cane trash blanket in Australia) may have been helped by the media (radio, television, the press, internet, etc), though this does not come across clearly in the case studies. The spread of conservation agriculture in the UK is an exception, however, being the only explicit example of internet-supported extension. Even in this case the internet is secondary, behind face-to-face learning and written material.

WOCAT's philosophy is that specialists, and literate land users as well, learn from what is written (or available on CD-ROM or the internet). The self-taught implementation of vetiver grass barriers in South Africa is the only case amongst those 28 analysed here where the written or digital media are explicitly cited as the *main* source of inspiration and guidance. However, as noted above, this might have happened to some extent in some other examples. Correspondingly, there is very little mention in the case studies of producing or using extension materials. Not surprisingly, there is no mention of internet-based learning in developing countries. Perhaps this will change as digital barriers are increasingly broken down and the internet (and even more so, the mobile phone) infiltrates into rural areas.

Adoption – *uptake and spread*

So, what of adoption rates being stimulated by extension and training programmes? How far has the message been spread? Information is limited to the case study areas – and it should be recalled that the WOCAT case study approach presents information from limited areas, rather than an assessment of the spread of technologies or approaches countrywide or internationally. Amongst the approaches presented here, adoption runs into the thousands of people, with respect to compost pits in Burkina Faso and rehabilitation of terraces in Peru; with respect to the 'Green cane trash blanket' system for sugar cane in Australia; and with people managing forest land under 'Joint forest management' in India. The *fanya juu* terrace under Kenya's catchment approach has also spread widely. But it may have become a victim of its own success, being implemented sometimes where cheaper agronomic (or vegetative) remedies may have been more appropriate. The most widely spread technology documented here is that of conservation agriculture in the UK, which covers approximately 40% of arable land in England. In other examples the spread is either less in absolute terms (eg conservation agriculture in Morocco, which is in an experimental stage, or the single farmer examples from Tajikistan and South Africa), or the case study covers only a sample area and, as a result, the coverage appears to be less than it actually is. Examples of this latter situation are green cover within the vineyards of Switzerland, which is actually widespread throughout the vine growing regions, and terracing on the Loess Plateau of China, where again only a small area was considered for the case study.

Land use rights – *a sense of security*

Whether land use rights affect the spread of SWC technologies – and if so, in what way – is one of the most interesting issues here. A common assumption is that private ownership

of land equals security, thus giving the owner an incentive to invest. This is confirmed by at least two case studies reviewed – examples from Nicaragua and Kenya. However, the issue here seems to be security of tenure rather than titled ownership, the former providing as great an incentive as the latter. Thus, where there is security even if actual ownership is absent, this can give the same degree of confidence to carry out SWC measures. This is highlighted in the cases from Burkina Faso, Nepal and China, and the lack of security of tenure is given as a hindrance in Ethiopia. Confirming this point, building structures or planting trees on land may help make an imprint of rights to the land, effectively 'staking a claim'. This can be witnessed through the case of traditional terracing in South Africa, and in a slightly different way in the case of the innovative farmer and his fruit garden in Tajikistan. The farm boundary planting of grevillea trees in Kenya works in much the same way. A variation on this is in Niger, where a land market has opened up, as fields have been brought back into production and reacquired value, bringing with it problems of claims to ancient lands. In India, the success of the joint forest management approach is based on the transfer of usufruct rights of degraded forest land from the state to villagers. A new challenge emerges from countries in the former Soviet block, and from China, where land use rights, previously held by the state, are now being transferred to villages and sometimes individuals. Figure 25 illustrates the importance of individual land use rights in relation to technologies. Three-quarters of the technology case studies (31 out of 42) originate from individually controlled land. Of the others, three are on leased land, three on common land with regulations, and a further three on common land which is subject to open access (without regulations). One of the remaining two is situated on land granted under a mining concession, and in the last case the land use rights are unclear.

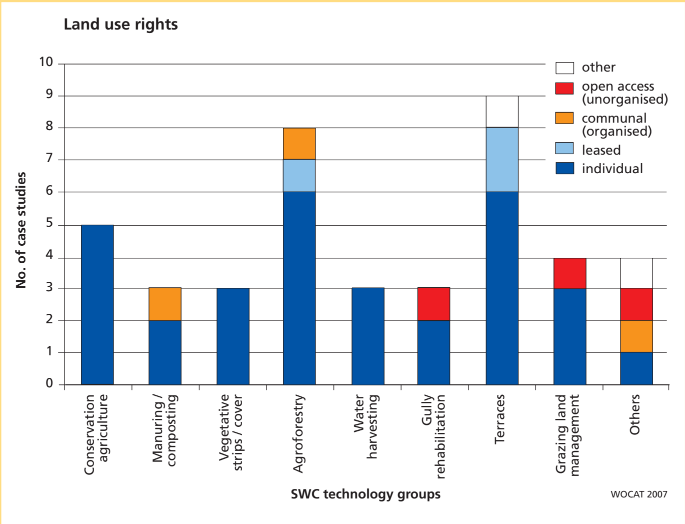


Figure 25: Land use rights with respect to SWC technology groups (see Analysis of Technologies for descriptions of these groups)

The most difficult situations are open access regimes. Such tenure systems are represented in this book under gully rehabilitation, grazing land management, and riverbank stabilisation. There is a need to try to identify and evaluate more successful examples on land with open access – especially on grazing land, where there is very little evidence of recent successes. Under open access regimes (or common property situations with weak regulatory mechanisms), there is the double dilemma of nobody accepting responsibility and no-one being prepared to invest in the land. The potential for 'tragedy of the commons' situations is an active and present danger. That scenario, which depicts a free-for-all descent into land degradation, needs to be countenanced.

Monitoring, evaluation and research – *counting the costs, assessing the consequences*

Monitoring and evaluation – *weighing the evidence*

The majority of projects are involved in monitoring and evaluation (M&E). However, this mainly refers to the basic requirements imposed by governments or funding agencies: financial indicators, and recording physical targets of dubious value (eg 'running kilometres' of conservation structures built; number of tree seedlings raised in nurseries). There is little or no mention of truly 'participatory' M&E, with only five of the 20 project-based cases being 'self-mobilised' to carry out monitoring. Apparently, even the most forward-thinking projects have not ventured so far into the realms of participation that they open up that complex set of issues, which involve such questions as: What is meaningful to whom to measure? Who measures what? Who records the results? Who interprets the results and uses them?

The most interesting aspects of M&E reported are the reactions of projects to findings derived from M&E. Figure 26 demonstrates that 17 out of 19 projects/ programmes have responded by modifying the approach or some of the activ-

left: Insecure land user rights limits the acceptance and maintenance of labour-intensive SWC measures. Runoff after heavy rainfall in Afdeyu, Eritrea indicates clearly where maintenance needs to be improved. (Mats Gurtner)

centre: Farmer-to-farmer learning is becoming increasingly recognised as a vital part of knowledge sharing. It is a component of many successful SWC initiatives (Uganda). (William Critchley)

right: Photo-monitoring of an upper catchment where farmers are encouraged to implement SWC measures to protect their own resources and to avoid off-site effects of degradation in the city of Cochabamba, Bolivia. (Georg Heim)

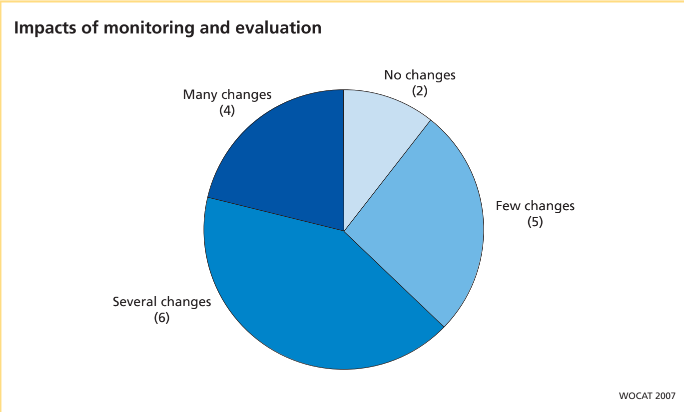


Figure 26: Number of changes – either modifications to technologies or to approach (or both) – as a result of M&E under project-based case studies

ities to a certain extent (note: in the case from Morocco it is said to be 'too early to know' as M&E is ongoing – thus Morocco is not included in the figure).

In specific cases there are notable changes in activities and even in the approach design itself. A steady evolution has taken place in many (if not most) of the longer-term interventions, as would be expected. Thus we see changes over the years reported in the cases from Colombia, Nicaragua and Niger. In the case of the 'Catchment approach' in Kenya, the contributing SWC specialist warns that it is changing continuously, and each time an update is asked for, the data will differ. Here the project is a true 'moving target' for a questionnaire. Two projects reported major changes: in Nepal this was the result of an external evaluation, and in Costa Rica, the project was struggling to make headway with its top-down methodology. It turned this on its head, making it 'bottom up', and the participatory approach that emerged was eventually institutionalised in the ministry. Adaptation, in order to remain relevant to land users and changing conditions, is vital. 'Development and promotion of Ecograze' (Australia) notes that it needs to adapt to each given situation and individual rancher. In the UK, the 'Soil management initiative' 'is constantly refining its advice on the basis of results monitored in the field'. A final comment is the scarcity of written information regarding the approaches presented here. With notable exceptions (the 'Soil management initiative' from the UK, 'Development and promotion of Ecograze' from Australia, and the 'Catchment approach' from Kenya, for example) for most contributors, this WOCAT-related exercise is the first time their methodology and experience have been documented, proving that very point.

Research – *the need to enhance knowledge*

A number of the technologies reported here were designed through a strong research initiative; this is true of 'Ecograze' in Australia, and conservation agriculture both in the UK and in Morocco. However, while 16 of the 20 project-based approaches claim a significant research component, this is rarely comprehensive, and usually concentrates on specific aspects of the project or the associated technology. In the UK, the 'Soil management initiative' looks at various specific problems such as slugs and grass weeds; under 'Joint forest management' in India, various elements of the programme have been studied, including socio-economic aspects; in Costa Rica, research has been limited to on-farm trials. However, the knowledge gaps in the data – as well as various contradictions – bear testimony to the fact that we need a broader contribution from research. How otherwise is it possible to assess technical, ecological, social and economic impact? Naturally, research must be transdisciplinary: scientists simply have to work together with land users to achieve optimal impact.

A further researchable area concerns preconceived notions of success or impacts. What is 'right and beneficial' for the environment can evolve into an unchallenged belief system. Examples are in India where the amount of groundwater recharge seems to be overestimated, given the small recharge area; in Kenya, where the *fanja juu* terrace is sometimes applied in areas where it is actually unnecessary; and tree-planting everywhere being perceived as unquestionably 'good'. There is a need for objective research, to look at things in context, and to avoid the danger of extrapolation and generalisation: 'good' or 'bad' depends on the context. A clear opportunity exists for research to engage in long-term monitoring, both on-site and off-site. We need to know impacts on the land – soil, water and vegetation – and the three should not be dissociated.

left: Monitoring the impacts of different land use and conservation efforts is an identified weakness where research needs to take a more active role (Switzerland). (Hanspeter Liniger)

centre: Training specialists to document and evaluate SWC in PR China: joint efforts are needed to close the gap in knowledge management. (Xin Shen)

right: Documenting and evaluating SWC as a team is a learning process between stakeholders: here a local farmer, an SWC specialist and a researcher working together in Nepal. (Hanspeter Liniger)

4 Conclusions and policy points – *support for descision makers*

The following comprises the consolidated conclusions from analysis of the case studies – 42 technologies and 28 approaches – which cover a wide range of soil and water conservation from all over the world. These conclusions are further informed and influenced by WOCAT's broader database, and have been developed through discussions amongst the WOCAT network partners. Some of the conclusions are new; others reconfirm what is already known but deserves repeating. They are presented under the following headings: 'Knowledge management', 'SWC technologies', 'SWC approaches' and 'Overall conclusions'.

In reviewing the conclusions, it has been possible to identify a number of related points that have clear policy implications for planners and decision-makers in governments and development agencies. These are presented in boxes following each of the sets of conclusions. Given that they are based on a global-level analysis, they may require fine-tuning and more explicit formulation to reflect specific national and regional situations. These policy points reflect, furthermore, 'what' needs to be done rather than 'how' it can be achieved. Once again the particular circumstances must be taken into account to define specific strategies and the activities that are appropriate in each case. This global overview provides a 'model' that could be used for the comprehensive documentation and analysis of experience leading to refined policy guidelines at the national and regional levels.

Knowledge management– *capitalising on scattered experiences*

Documentation – *the basis for decision support*

Worldwide, there are numerous positive experiences derived from investments in soil and water conservation (SWC) that contribute to sustainable land management (SLM). These counter the prevailing and pessimistic view that land and environmental degradation is inevitable and continuous: 42 of the 350 cases in the WOCAT database are presented in this book.

Apart from the cases documented through WOCAT (and elsewhere), the vast body of knowledge and wealth of experience in SWC remains scattered and localised. There is still a rich untapped SWC diversity which is not readily available to land users, those who advise them, or planners and decision-makers. Thus the basis for sound decision making is lacking, mistakes are being repeated, and 'the wheel is being reinvented'.

The WOCAT tools provide a unique standardised method for the comprehensive documentation, evaluation and dissemination of SWC knowledge from various sources (including land users, SWC specialists and researchers from different disciplines). This has been lacking so far: with few exceptions – 'Ecograze' from Australia; *'Fanya juu* terraces' from Kenya; 'Forest catchment treatment' from India – the experiences presented in the book have not been reported comprehensively elsewhere.

Land users and SWC specialists are usually happy and willing to discuss their work, and they welcome interest and recognition from outsiders. Occasionally, however, there is a reluctance to report weaknesses in government or donor-sponsored programmes. This challenges the documentation process, and affects the comprehensiveness and quality of the data.

Knowledge gaps, inconsistencies, and contradictions within the case studies have been uncovered while compiling them, and data quality has been considerably improved through an intensive review process.

Policy points: documentation

Concerted efforts to standardise documentation and evaluation of SWC technologies and approaches are needed and fully justified, especially in the light of the billions of dollars spent annually on implementation.

To assure the quality and usefulness of information, scattered knowledge about SWC needs to be identified, documented and assessed through a thorough and interactive review process that involves the joint efforts of land users, technical specialists and researchers.

left: … 'where the land is greener' … there are numerous positive experiences that contribute to sustainable land management – but this wealth of information is not tapped, and often not even recognised. There is an urgent need to make use of this valuable knowledge (Tajikistan). (Hanspeter Liniger)

right: Local knowledge is vital in designing effective and appropriate solutions. It is vital to give local land users a forum to share their knowledge with other farmers and specialists – and more investments are justified under SWC projects to facilitate this process (Syria). (Hanspeter Liniger)

Once documented, experiences with SWC need to be made widely available and accessible in a form that allows land users, advisors and planners to review a 'basket' of alternative options, setting out the advantages and disadvantages of each, thereby enabling them to make informed choices rather than following set prescriptions of 'what to do'.

The implementation of new SWC efforts should build on existing knowledge from within a location itself or, alternatively, from similar conditions and environments elsewhere.

There is need for a standardised methodology - like the WOCAT tools – to facilitate comprehensive data collection, knowledge management and dissemination.

Monitoring and Evaluation – *a prerequisite to improve SWC and to justify investments*

Monitoring and evaluation (M&E), especially of the technical efficiency and cost-effectiveness of SWC technologies and approaches, are weak spots in many, if not most projects. Likewise, traditional land use systems and local land management innovations are rarely documented and assessed for their conservation effectiveness.

All too often 'institutional amnesia' means that governments and donors remain unaware of historical experience in SWC, and fail to learn the lessons from past efforts.

Experience shows that M&E leads to important changes and modifications in approaches and technologies: nearly all (17 of 20) of the project-based approaches presented here reported changes as a result of M&E.

SWC initiatives are constantly evolving: they are 'moving targets'. This is a positive sign; the implication is that they are responding to changing circumstances and opportunities that arise. However, it also means that monitoring of changes and evaluation of impacts must keep track: 'snapshot' data quickly become outdated.

In the evaluation process land users play a central role in the assessment of the specific, as well as the overall, benefits and disadvantages.

In the compilation of SWC knowledge using WOCAT tools, a number of issues are addressed where commonly little or no information is available. Through the case studies in this book a special effort was made to fill gaps regarding the on- and off-site environmental, social and economic impacts of SWC, including short and long-term costs and benefits.

An additional lack of information concerns the geographic coverage of SWC. This results from inadequate monitoring of the extent and effectiveness of conservation. Although several countries and regions have land degradation maps, mapping of SWC efforts and areas under SLM has been badly neglected. Such mapping can contribute to raising awareness of what has been achieved, as well as justifying further investments and guiding future decision-making.

In the process of compiling the case studies, we noted preconceived notions of what constitutes success and over-optimistic assumptions of impacts. Special efforts were made to reduce biases and misconceptions, unsubstantiated extrapolation, and generalisation.

Policy points: monitoring and evaluation

Monitoring and evaluation in SWC projects/ programmes must be improved. It needs to do more than just monitor the timely delivery of project outputs; it should also evaluate whether the expected environmental and development benefits have been realised in a cost-effective manner.

Rigorous impact assessment, involving the evaluation of strengths and how to sustain them, as well as evaluation of weaknesses and how to overcome them, is a must.

Land users have to be involved as key actors in monitoring and evaluation activities: their judgement of the pros and cons of SWC interventions is crucial.

There is a need to develop mechanisms to monitor and evaluate local conservation practices, land management innovations and traditional land use systems.

More investment in training and capacity building is needed for objective and unbiased monitoring and evaluation, for impact assessment, and to improve skills in knowledge management including the dissemination and use of information.

Mapping of conservation coverage is essential, in order to visualise the extent and effectiveness of human achievements.

Complexity and knowledge gaps – *the role of research*

The problems of land degradation are complex and so are the answers. There is a danger of simplification. Blueprint solutions for the implementation of SWC do not take account of this complexity.

Effective SWC depends on both suitable technologies and closely matched approaches for their promotion.

Despite the fact that 16 of the 20 project-based approaches presented here claim a significant research component, information regarding on-site impacts is rarely quantified, and off-site impacts are often completely neglected. The main issues concern short and long-term costs, benefits and impacts, valuation of ecosystem services, area coverage, and the extent and effectiveness of SWC.

There are still important research questions to be addressed with respect to the processes that drive spontaneous spread of technologies and how project approaches can best stimulate these processes: we do not yet fully understand why SWC technologies are spontaneously adopted in some situations, while under other circumstances the same technologies spread very slowly.

The case studies have shown that participatory development of technology – where SWC specialists, researchers and land users act together – yields positive and practical results. Examples from the case studies include those from Syria ('Participatory technology development'), Australia ('The triple bottom line'), Kenya ('Self-help groups') and the Philippines ('Landcare'). The main challenge for research is not to 'invent' new SWC technologies, but rather to identify – together with land users – the most suitable technologies for a given set of conditions.

Policy points: complexity and knowledge gaps

There are no simple 'silver bullet' solutions to the complex problems of land degradation. It is therefore important to understand the ecological, social and economic causes of degradation, to analyse what works and why, and how to modify and adapt particular technologies and approaches to locally specific circumstances and opportunities.

Technologies and associated approaches need to be flexible and responsive to changing complex ecological and socio-economic environments. An urgent and specific area for further investigations and research is quantification and valuation of the ecological, social and economic impacts of SWC, both on-site and off-site, including the development of methods for the valuation of ecosystem services.

SWC research should seek to incorporate land users, scientists from different disciplines and decision-makers. A continuous feedback mechanism is needed to ensure active participation of these stakeholders.

Researchers need to take a more active role in further development of tools and methods for knowledge exchange and improved decision support.

SWC technologies – *measures and their impacts*

General

Soil erosion by water is cited as being addressed in almost 90% of the examples. Chemical degradation (typically soil fertility decline) is addressed in 62%, wind erosion and water degradation each in around 30% of the cases, while vegetation degradation is mentioned in only 17%, and physical degradation (mainly compaction) in merely 9%. Frequently, multiple degradation types are stated as being addressed by SWC measures.

The responses indicate the common perception of soil erosion by water as being the main degradation problem, rather than the consequence of other less obvious degradation processes such as declining vegetation cover, soil compaction, etc.

We can differentiate between prevention, mitigation and rehabilitation of land degradation. Of the case studies in the book, 17% fall under prevention, 52% under mitigation and 31% under rehabilitation. Prevention and mitigation usually provide the best pay-back. Rehabilitation may be the most visible form of SWC – but can be very costly.

It is commonly assumed that enough is known about SWC technologies and that it is 'just' a question of applying them. However, modifications to technologies and new combinations of measures are frequently necessary to make them match area-specific social, political, economic and environmental situations.

left: In this example from Ethiopia, introduced terraces have not been accepted by local land users: they are being ploughed under. In situations like this, it is important to know in what circumstances they were established and to understand the reasons why they are not maintained. (Karl Herweg)

right: Documenting and evaluating local knowledge in Nepal: land users and SWC specialists discuss the strengths and weaknesses of traditional irrigated rice terraces and document these through the use of WOCAT tools. (Hanspeter Liniger)

Most conservation technologies can spread widely with incremental on- and off-site benefits. Some, however, are subject to the 'island effect', where the measures thrive *because* they are isolated. An example is water harvesting where the area of concentration (the 'island') benefits from runoff water harvested from a catchment area without conservation measures.

Improved soil cover (mentioned in 55% of the cases), and fertility (57%) are the most prominent factors underpinning increased productivity and minimized land degradation.

Where improvements to the soil are cited, these are manifested in terms of better structure (mentioned in 40% of the cases) improved infiltration (60%), and reduced surface runoff (60%) as well as reduced evaporation loss and increased soil biological activity. Successful technologies support nature to self-restore its functions and services.

In the cases located in humid areas (45%) the main focus is on maintenance of soil fertility, drainage of excess water, and reduction of soil loss. Benefits may only be noted in the long-term – apart from situations where terraces, for example, bring land into production for the first time.

In the cases located in dry areas (55%), the main focus is on water rather than soil conservation. Although water is the main limiting factor, it is wasted without appropriate conservation measures. Seasonal surface runoff in the order of 15–20% and evaporation loss from the soil surface of an additional 40–70% are common, leaving less than half of the rainfall available for crop and fodder production. Significant improvements to infiltration and water storage in the soil as well as reduction of water loss by evaporation have been achieved mainly through mulching, minimum tillage, intercropping and water harvesting – either in-situ or by storage in dams (for example conservation agriculture from Kenya; *doh* from India). There is considerable evidence of increased yields in rainfed agriculture through improved water management, combined with simultaneous attention to soil fertility through better residue management, composting and crop rotation, which counter nutrient depletion.

The importance of land management for water-related benefits is often neglected, even in areas of water scarcity and water conflicts. This is despite the wide range of ecologically and economically promising technologies available that reduce water wastage and pollution.

Around half of the technologies described in the book are applied on soils with low/ very low fertility or low organic matter. Half of these cases report a medium to high increase in soil fertility after treatment with SWC technologies.

Conservation measures leading to increased soil organic matter and thus carbon sequestration represent a win-win scenario: land resources are improved at the local level and at the same time a contribution is made to the mitigation of climate change.

Policy points: SWC technologies – general

Given limited financial and human resources, more attention should be focused on the prevention and mitigation of degradation before investing in areas that require costly rehabilitation, even though the achievements may not be so visible.

Promotion of SWC technologies that lead to improved management of natural resources - soil, water and vegetation - has the potential not only to reduce land degradation but also to address simultaneously global concerns of water scarcity, land use conflicts, climate change (through carbon sequestration), biodiversity conservation, and poverty alleviation. Continued, sustained investments in optimising and adapting technologies to their specific environments as well as recognising innovative improvements are needed.

In dry areas, investments in water harvesting and improved water use efficiency, combined with improved soil fertility management, should be emphasised to increase production, reduce the risk of crop failure, and lower the demand for irrigation water.

In humid areas, long-term investments are required to maintain soil fertility and minimise on-site and off-site damage caused by soil erosion, as the impacts on production and conservation may only accrue in the medium and long term.

Soil and water conservation measures – *the combination challenge*

Agronomic measures

Agronomic measures, such as manuring/ composting and crop rotation, have the advantage that they can be integrated into daily farming activities. They are not perceived as an additional 'conservation' burden, as they require comparatively low inputs and have a direct impact on crop productivity.

'Conservation agriculture', which is expanding rapidly worldwide, combines the benefits of lower input costs, reduced workload, minimised erosion, more efficient water use, and improved soil properties, while maintaining or improving yields.

Whenever measures are combined, the agronomic component is usually prominent. In the case studies, 70% of combined measures have an agronomic component.

Vegetative measures

Many vegetative measures have developed under traditional land use systems: for example agroforestry.

In all the cases presented, vegetative measures are noted as being multipurpose in function. Agroforestry systems, for example, apart from their conservation effect, can be directly useful for production of fodder, fruits, nuts, fuelwood and timber, as well as for nitrogen fixation.

Successful SWC associated with intensive and diverse smallholder agroforestry systems can lead to partial restoration of 'forest function': in some areas 'more people means more trees'.

Some vegetative measures compete with crops for nutrients and water: this is a particular problem where land is scarce and the vegetation is not directly productive itself (eg vetiver grass lines and windbreaks). In these situations, the protective vegetation needs to be carefully managed, eg through pruning of roots and branches.

In many situations – even in severely erosion-prone areas (steep slopes, high rainfall) – vegetative measures such as agroforestry may be adequate alone. Nine of the 11 vegetative measures documented in this book are employed in the humid tropics where they provide protective ground cover and effective maintenance of soil fertility. However, in certain circumstances, supplementary structural measures are required.

Structural measures

Structures are 'attention grabbers' because they are spectacular and conspicuous. However, they are hardly ever adequate on their own. Terraces on steep slopes or barriers within gullies, form physical frameworks which need additional agronomic and vegetative measures to be fully effective.

Structural measures are commonly associated with high investments. There are exceptions; for example V-shaped microcatchments or small contour bunds. Terraces are also low in cost when they gradually evolve through water and tillage erosion, leading to sedimentation behind vegetative strips.

There is always a danger of exacerbating erosion, through concentration of runoff, if structures breach as a result of poor design, construction or maintenance.

There are many traditional and ancient terrace systems, where maintenance and rehabilitation are needed and can further be justified on the basis of cultural heritage, for aesthetic reasons, or even for income-generating 'agro-eco-tourism'.

Water harvesting systems rely on structural measures to impound rainfall runoff but are also combined with other measures designed to reduce evaporation – for example mulching. They have great potential for further application in drought-prone areas.

Management measures

Management measures are particularly applicable to land used communally – for example improvement of grazing land, where uncontrolled 'open-access' use has led to degradation. In this situation no interventions work without an initial, fundamental change in management.

These measures often result in improved vegetative cover by initially reducing the intensity of land use. Subsequently, land use intensity can be increased due to natural regeneration – or where climatic conditions allow, through the planting of more productive species. Increased intensity of use cannot be maintained, however, without ensuring continued improved management.

Combined SWC measures

55% of the technologies presented in the book are combinations of various agronomic, vegetative, structural and/or management measures. These are either (a) superimposed on the same plot of land, or (b) dispersed over a catchment (eg cut-off drains and afforestation in the upper catchment and check dams in gullies) or a landscape, or (c) phased over time (eg through a rotation system). Combinations support each other and often address multiple degradation types.

left: The way land is used - and its conservation/ degradation status – has a profound impact on water supplies: here in Kyrgyzstan, as elsewhere, soil erosion causes siltation of reservoirs and affects hydropower generation amongst other off-site impacts. (Hanspeter Liniger)

right: A Colombian farmer demonstrating the establishment of a SWC technology: he was trained by a local NGO programme and works now as a promoter assisting community members in SWC implementation. (Mats Gurtner)

Policy points: soil and water conservation measures

Agronomic and vegetative measures should be given priority as they are cheaper than structures, often result in rapid increases in yield, and provide additional benefits such as soil cover, soil structure and soil fertility improvements.

Structural measures should be promoted primarily for extra support where other measures are not sufficient on their own.

Management measures are especially important on grazing land, where they should be considered as the initial intervention to achieve the major aim of SWC on grazing land: namely to increase ground cover, and to improve species composition and productivity.

Combined SWC measures – overlapping, or spaced over a catchment/ landscape, or over time - tend to be the most versatile and the most effective in difficult situations: they are worthy of more emphasis.

Land use types – *a lack of focus on marginal areas and grazing land*

SWC applied on a specific land use type interacts with other, adjacent land with different uses: for example, interventions on cropland can be affected by, and can affect, grazing land nearby.

Most SWC efforts have been made on cropland, and new challenges are emerging as crop cultivation continues to be intensified and expanded into marginal areas.

All but six of the SWC technologies presented in this book are applied under purely rainfed conditions. These illustrate the wide variety of options and the great potential for improving land management in degradation-prone rainfed areas.

On the other hand, irrigated farming systems are of global importance for food production. Poor irrigation practices and associated problems – such as depletion of water resources, salinisation and waterlogging – are widespread (eg the case from Kyrgyzstan). Measures for the sustainable use of irrigated land have not yet been adequately identified and documented.

Only three case studies in this overview book address grazing land. This reflects not just a general neglect of documentation, but insufficient SWC investments in these areas, and the difficulty of identifying viable solutions. This is despite the fact that the livelihoods of many rural people are primarily based on ranching or pastoral livestock production systems – often located in highly vulnerable dryland and marginal areas. The potential for sustainable production increases and improved ecosystem services in such areas are not being adequately tapped.

Successful combinations of management and vegetative measures on grazing land vary from 'cut-and-carry' of improved fodder species in subhumid or humid areas, to protection (enclosure) for regeneration of natural species in the drier regions.

Improved forest management and agroforestry systems are often not perceived as SWC and are thus less frequently documented as such.

Policy points: land use types

There is a need for continued SWC investments in cropland and mixed land, because of intensification and farming expanding into more marginal and vulnerable areas. Special attention needs to be given to rainfed farming, without neglecting irrigated cropland.

Grazing land – and especially communally used areas in dry degradation-prone environments - is a priority for attention with regard to its neglected potential for increased production, and provision of on-site and off-site ecosystem services.

Agroforestry and improved forest management need to be further recognised and promoted due to their multipurpose functions, which go well beyond conservation - including biodiversity, provision of fuel/construction wood and other forest products.

SWC approaches – *supporting and stimulating the implementation*

General

The case studies documented span a wide variety of different approaches: about two thirds of the technologies are implemented under a project, while the others are based on local innovation, traditional/ indigenous systems, and individual initiatives.

Two thirds of the case studies relate to small-scale farming systems. 31% are associated with subsistence farming, helping to reduce poverty and improve livelihoods. However, for

mixed (40% of cases) and commercial farming (29%), there are also opportunities for improved SWC and related benefits.

As is the case with technologies, there are no 'one-size fits all' solutions to approaches. But there are common denominators of success, including a focus on production aspects, security of access, long-term commitment and investment, participation of stakeholders, and capacity building.
Successful approaches are always built upon human resources: people's knowledge, creativity and initiative.

Many factors such as the level of incentives, type of training, and institutional arrangements are locally specific and need to be tailored to a given situation.

Scattered independent project interventions and approaches cannot achieve the same impact as a coherent and collaborative programme. The Kenyan 'Catchment approach' and Chinese 'Terrace approach' provide positive examples of such collaborative programmes.

Development rhetoric ('participation', 'bottom-up', 'gender balance', 'accountability', etc) permeates through the objectives and titles of SWC approaches. While this serves a useful purpose in defining direction, the practice still often lags behind the rhetoric.

Policy points: soil and water conservation approaches – general

More attention and support should be given to local innovation as well as to traditional systems, rather than focussing solely on project-based SWC implementation of standard technologies.

Further efforts are needed to identify appropriate SWC technologies that assist small-scale and subsistence farmers to improve their livelihoods and escape from the poverty trap.

Project/ programme interventions need to break out of the typical three-year project cycle and commit to a minimum of five years, and preferably ten or more. SWC requires long-term commitment from national and international implementation and research institutions. A clear strategy is needed to sustain results beyond the project life-time.

Partnership alliances need to be developed between different agencies – with their various SWC initiatives and interventions – for synergy of efforts and cost-effectiveness.

Profitability and enabling environment – *motivating the land users*

Some drivers of conservation at times have little to do with degradation. Other reasons, especially economic factors, can propel farmers to change, and addressing degradation may be only a spin-off: three quarters of the 'SWC' cases analysed are directly related to increasing productivity and/or farm income, with conservation coming in 'through the back door'.

In areas characterised by subsistence farming and rural poverty, SWC is an opportunity for improving livelihoods or merely ensuring survival. There are several clear cases of this, including those from Niger ('Planting pits and stone lines'), India ('Forest catchment treatment') and the Philippines ('Natural vegetative strips').

Generally, it is assumed that SWC implies high investment, but there are examples of profitable cost- and time-saving technologies, such as conservation agriculture, that provide a strong motivation for further implementation.

The assessment of costs and benefits were difficult for contributors to compile and may not be free of bias. In 62% of the cases, benefits in the short-term in relation to investment costs were noted by land users, thus demonstrating rapid pay-back. However in the remaining cases, more than three years were required before benefits began to outweigh the investment costs.

Off-site damage caused by degradation as well as off-site benefits of conservation – eg protection from flooding, sedimentation or pollution – are mentioned in three quarters of the case studies, and one third mentioned increased river flow during dry seasons. However, the value of these off-site benefits has not yet been assessed, and needs to be, in order to justify investments on that basis.

The establishment of an 'enabling environment' is extremely important in the promotion of SWC, emphasising the 'pull' (motivation), eg better marketing channels or secure access to land, as well as the 'push' (enforcement), eg SWC legislation and national campaigns.

While private ownership tends to stimulate conservation of land, adequate security of access – under private ownership or other tenure regimes – is the key to investing willingly in SWC. There are challenges to overcome, for example in

left: Grazing land has been neglected and viable solutions, especially for drylands, need to be further identified and documented: here is an example from Central Asia. Land use rights is a major issue. (Hanspeter Liniger)

right: Traditional terraces in the foothills of the Himalayas showing the investments made over generations. Such terraces are commonly associated with irrigation, but here – where there is rainfall alone to depend on – land users have found a way to survive by catching water where it falls. (William Critchley) countries where land was, or is still, held by central authority.

The establishment of effective marketing channels for agricultural products can help stimulate SWC; on the other hand, markets can become saturated or depressed, and discourage conservation initiatives through reduced producer prices.

The current international concern with environment – climate change, loss of (agro-) biodiversity, scarcity of water, and a renewed interest in combating desertification and alleviating rural poverty – presents a new opportunity for product marketing using labels such as 'organic'; 'fair trade'; 'land friendly'; 'sustainably harvested', and perhaps even 'anti-desertification'.

Policy points: profitability and enabling environment

SWC needs to be stimulated by further emphasising improved production (of plants and animals) and reduced costs, which are the primary interest of land users, and have direct consequences on livelihoods in small-scale subsistence farming.

Accurate assessment of costs and benefits (in monetary and non-monetary terms) – using participatory and transdisciplinary methods – is urgently needed to evaluate SWC technologies in terms of their short- and long-term gains: without this, land users and development agencies cannot make informed decisions about which technologies and approaches are the most viable options.

To help prevent off-site damage, further on-site investment in SWC is required: this is usually cheaper and more effective than dealing with the downstream consequences.

An enabling environment should be nurtured for SWC to thrive best, building on people's and nature's capacity. Indirect measures such as credit, market opportunities or legislation to stimulate conservation activities must not be overlooked.

Security of land use rights is important in conservation: policies to improve the rights of individual land users and/or rural communities to use their local land resources on a secure and long-term basis must be recognised as an important means of supporting SWC.

Opportunities need to be seized that connect SWC with emerging environmental priorities – especially carbon sequestration (by increasing soil organic matter), biodiversity (above and below ground), water and ecosystem service provision. Ways of recognition and payment for these services need to be further explored to justify SWC investments. The benefits of improved land management for water quantity and quality must be further stressed and used as a motivation for SWC, especially in areas of water scarcity and water-related conflicts.

Access to local and international markets has to be improved to enable producers to make SWC investments in their land. Fair prices, certification, and labelling schemes for products can stimulate conservation.

Subsidising SWC – *the delicate issue of direct incentives*

While norms regarding incentives differ considerably from country to country, the case studies show that direct material incentives (money, inputs, etc) should be used carefully – in 15 out of the 20 project-based case studies of approaches there were low or negligible levels of direct incentives, illustrating the fact that these did not play a major role. At best they offer a step-up to impoverished farmers, at worst they can distort priorities and do great harm by creating dependency and pseudo-interest in SWC.

High levels of subsidies to agriculture in industrialised countries present a complex and controversial case. The new tendency to support environmental stewardship of the countryside may offer a less controversial form of incentives (see case study from the UK).
Off-site benefits and other ecosystem services are mentioned in over 90% of the case studies, but not valued in monetary terms. This information is required for cost-benefit analysis and as a basis for negotiations between different stakeholders – and is also required under various international conventions.

Where there are substantial off-site benefits but no significant on-site gains, direct payment/ compensation for ecosystem services is an opportunity to promote SWC, providing the lasting advantages that continuous payments can ensure: examples are the case studies from Switzerland and (potentially), Bolivia.

Only four of the documented projects provide or facilitate access to credit. The potential for provision of concessionary credit (below normal market rates), to enable investment in the land, has not been sufficiently exploited.

Policy points: subsidising SWC

SWC may require heavy investment costs that exceed the capacity of local land users and thus need to be covered by national and international initiatives. But direct material incentives should – in principle – only be considered where there is a need to overcome initial investment constraints and subsequent maintenance does not require continued support. This may be needed where the environmental improvements and social benefits are likely to be realised only in the long term.

Before considering the use of direct incentives, alternative approaches should be explored, such as the adaptation of technologies, or the identification of cheaper technologies. The possibilities of removing some of the root causes of land degradation (related, for example, to land policy framework, land tenure security and market access) also need to be assessed.

Rural areas may need and deserve compensation from urban/ industrial zones for the environmental and aesthetic services they provide. And downstream beneficiaries of the environmental protection provided by upstream communities should be prepared to pay compensation for these services.

The value of the ecosystem services needs to be determined and agreed upon between users and providers. The establishment of compensation schemes may require support and guidance from policy level and external actors.

Provision of microcredit at concessionary rates for better land management/ SWC requires serious consideration, as an alternative to handouts and payments, where farmers have financial constraints.

Extension, training and adoption – *building capacity and spreading the message*

Training and extension are key elements of project-based approaches. There has been a general switch to more participation, devolution of powers, and less authoritarianism. But increased empowerment requires enhanced capacity. During the compilation of the case studies, clear shortcomings regarding documentation and evaluation of SWC were identified. However, training in knowledge management is not reported under any of the approaches documented in this book.

More than half the successful projects/ programmes analysed in this book have had little or no international expert input. Clearly local and national initiatives are worth trusting and investing in.

Individual SWC innovations by local land users are also a potential way forward. There are several examples (Tajikistan; East Africa, etc) where local initiative has uncovered promising technologies and methods that are being spread informally: in the current situation of downsized and under-funded extension services, 'do-it-yourself' in terms of research and extension is making a comeback amongst land users.

Population pressure and demographics have complex relationships with the state of the land. Rapid land use change can lead to degradation; but increased population density may drive improved conservation of limited land resources, and close contact with neighbours can stimulate farmer-to-farmer exchange of ideas.

Policy points: extension, training and adoption

On the basis of standardised tools and methods, training in proper documentation, evaluation and dissemination of SWC knowledge, as well as its use for and improved decision-making, needs to be strengthened.

Investment in training and extension to support the capacity of land users and other local and national stakeholders must be a priority to adapt better to changing environmental, social and economic conditions, and to stimulate innovation.

Local innovation and farmer-to-farmer extension should be promoted as effective and appropriate strategies.

Overall conclusions – *investing in SWC for ecosystems, society and the economy*

The cases presented in this book demonstrate the value of investing in rural areas despite recent global trends of neglecting agriculture and focusing on industry and the service sector.

Ecologically, SWC technologies – in all their diversity – effectively combat land degradation. But a majority of agricultural land is still not sufficiently protected, and SWC needs to spread further. The potential ecosystem benefits go far beyond reducing soil erosion and water loss; these include regulation of watershed hydrological function – assuring base flows, reducing floods and purifying water supplies – as well as carbon sequestration, and preservation of above- and below-ground biodiversity.

left: Supporting and stimulating implementation: farmers sharing their SWC knowledge and experience with other farmers – and external specialists also (Kenya). (Hanspeter Liniger)

right: Profitability is the fruit of investment in the land: if measures are maintained and soil fertility built up, a good harvest is the result (Nepal). (Hanspeter Liniger)

Socially, SWC helps secure sustainable livelihoods by maintaining or increasing soil productivity, thus improving food security and reducing poverty, both at household and national levels. It can also support social learning and interaction, build community spirit, preserve cultural heritage, and counterbalance migration to cities.

Economically, SWC pays back investments made by land users, communities or governments. Agricultural production is safeguarded and enhanced for small-scale subsistence and large-scale commercial farmers alike, as well as for livestock keepers. Furthermore, the considerable off-site benefits from SWC can often be an economic justification in themselves.

Policy points: investing in SWC

Investment in rural areas and SWC is a local concern, a national interest, and a global obligation. Thus it must be given priority:

- at the local level: to increase income, improve food security, and sustain natural resources – thus helping to alleviate poverty in areas where the livelihoods of the majority depend on agricultural production;
- at the global and national level: to safeguard natural resources and ecosystem services and in many cases to preserve cultural heritage.

Investments in SWC must be carefully assessed and planned on the basis of properly documented experiences and evaluated impacts and benefits: concerted efforts are needed and sufficient resources must be mobilised to tap the wealth of knowledge and learn from SWC successes. These investments will give 'value for money' in economic, ecological and social terms.

left: Investment in rural areas needs to continue for environmental, social and economic reasons. The justification for stepping up efforts is based on maintaining ecosystem services as well as securing livelihoods (Kenya). (Hanspeter Liniger)

right: Building on local knowledge to document, monitor, evaluate and disseminate SWC: it all adds up to better support for decision making by land users and specialists (Thailand). (Hanspeter Liniger)