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Soil – a resource under threat

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Editorial

Dear Reader,

In late October 2013, scientists und practitioners, political decision-makers and representatives of civil society are to meet in Berlin, Germany, to discuss sustainable soil management and responsible land governance at Global Soil Week. Over the last few years, the increased rush on farmland has demonstrated just how precious and scarce soil is. However, seldom are public awareness and the need for action so far apart as is the case with "soil", which is reason enough for us to devote an entire edition of Rural 21 to this valuable resource.

Our authors first of all demonstrate the wide range of ecosystem services that the at once essential and finite resource of soil performs and show the dramatic effects that poor governance of transformation of soils has – in all areas of human life. Only an integrated approach addressing soil, land, water and ecosystem management can help meet the rising demand for land-related products and services and will also be able to secure food for the world's growing population in future (pages 6–12). However, often enough, attempts to get decision-makers to support soil conservation have failed. Since economic arguments are most likely to be successful, the Economics of Land Degradation initiative has been launched (page 9).

The second part then takes up sustainable land management practice. What is this concept actually about, and what experience has been gathered in the individual regions so far? The database of the World Overview of Conservation Approaches and Technology contains hundreds of case studies and practices (pp. 14–15). Conservation agriculture is regarded as one positive example of land use that does not put an excessive burden on the environment. It is above all widespread in Latin America. The article on page 13 shows where its strengths and weaknesses are. Of course, the best thing to do is to keep soils in an optimum condition right from the start. But thanks to a clever combination of various technologies, degraded soils can also be turned back into fertile cropland, as our example from the Sahel shows (pp. 16–17). Finally, we address a resource that is frequently neglected when considering sustainable management: rangeland. Here, it once again becomes apparent how changes in global framework conditions are resulting in sophisticated utilisation patterns that have been in use for centuries no longer working. New forms of rangeland management need to be developed to maintain the delicate balance between "use" and "conservation" (pp. 18–20).

The third part of our focus looks at the political level. There continues to be a lack of an international and legally binding policy framework for the regulation of soil protection. Why are the international community as well as individual countries so reluctant to reach such an agreement, and how would it have to be designed to approach the goal of a "land-degradation neutral world" as called for at the Rio+20 Conference last year? (pp. 24–27). But perhaps the future of soil protection and land governance lies with voluntary arrangements. Here, great hope has been placed in the Voluntary Guidelines on Responsible Governance of Tenure of Land, Fisheries and Forests that were adopted last year (pp. 21–23). The potential they bear will only be revealed over the next few years. But what is certain is that the growing attention that soil and land related questions have been receiving ought to be made use of to take up soil conservation in the Sustainable Development Goals, which are currently being negotiated by the international community (pp. 28–29).

One of the most important properties of soils is their ability to store organic carbon. Not only does this property have a positive effect on soil quality, but it also contributes to combating global warming. In order to promote increased carbon storage in soils, including the reduction of emissions from agricultural activities in the market mechanisms of the Kyoto Protocol is currently being discussed. Smallholders in particular could benefit from these measures, their advocates say. Quite on the contrary, opponents of this proposal maintain (pp. 30–31).

"Soils" also feature in the articles of our scientific world section. In the first contribution, our author explains why it has not been possible to simply transfer the Asian version of the Green Revolution to conditions in Africa (pp. 32–33). The second article examines the issue of what such a Green Revolution should be like for it to be sustainable and accommodate the specific context under which the smallholder farmers in sub-Saharan Africa operate (pp. 34–37). At any rate, simply raising fertiliser input won't do for a knowledge-intensive system such as Integrated Soil Fertility Management. The same applies to the system of Rice Intensification. Under which conditions this can result in better yields and which factors are crucial for the system to gain farmers' acceptance has been examined by our author in Timor Leste (pp. 38–40). Finally, our last contribution takes you to Zimbabwe, where a public-private partnership project is attempting to get the country's livestock sector, a long neglected area, going again (pp. 41–43).

You will certainly have views differing from those of our authors concerning some of the measures taken, such as Kenya's agricultural carbon project or the Malawi fertiliser subsidy programme. All the better – we look forward to your opinion!

Happy reading,

Silvia Richter

Partner institutions of Rural 21:

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In this issue

News

Focus: Soil – a resource under threat

Opinion

Scientific World

International Platform

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Photo: M. Noltze

Photo: Z. Nyamakanga

Social protection and food security – what works?

In the context of poverty reduction and the Millennium Development Goals, the importance of social protection has been growing. But three out of four people in developing countries still have no access to social security systems, especially in rural regions. In addition, the poor, and particularly those living in rural regions, have been most hardly hit by the food price shocks of the past years. It is against this background that the Overseas Development Institute (ODI) has conducted a study that is to clarify which social protection tools are most suitable for establishing links to food security. This study was discussed by experts in Bonn, Germany, in mid July.

In their study, the ODI researchers focused on two types of social protection: **direct social transfers** – these include cash and in-kind transfers, as well as food and cash for work programmes, and **insurance systems** – e.g. crop and livestock insurances and health insurance.

They define a food system as incorporating the following:

1. availability of food at macro level;
2. access to food by the household – (ability to produce or purchase food);
3. the utilisation of food, e.g. the intake of sufficient, safe and quality food;
4. crisis prevention and management.

To Rachel Slater, one of the authors of the ODI study, social protection means safeguarding the people from selling their last oxen to meet their short-term needs or eating the last corn of grain. "This may save one from starving today, but for tomorrow, it means total poverty, without any prospects," Slater said.

Cash transfers seem most promising

In their findings, the ODI experts arrive at the conclusion that the tool of cash transfers is most suitable for poverty reduction and food security. They base their results on surveys in Africa and Latin America which showed that the cash was used both for good-quality food and for agricultural inputs. Slater found no indications of the threat of dependence on cash transfers existing in Africa in particular. The ODI findings also show that it is not only the beneficiaries who benefit from transfers, but the local producers and merchants, too, for the lion's share of the money is spent in the community itself. However, Slater stresses that size matters. If cash transfers are to have a sustainable impact, they need a sufficient financial framework and have to be designed for a longer period.

Photo: FAO/P. Morin

Regarding the structured demand activities, which include school feeding and food for work programmes as well as local food aid procurement (LRP), the findings reflected the greatest impact on food security among local food aid procurement (e.g. the WFP Purchase for Progress – P4P), since these programmes did not only benefit the needy but also the smallholders in the region. Thus these programmes also had a certain development impact in the region. However, ODI scientist Steve Wiggins warned, LRP measures were not always popular with the World Food Program managers because they required a considerable effort. "Of course it is easier to buy grain from one major business than from 100 smallholders," Wiggins said.

School feeding und insurance systems showing only limited success

The findings also showed that the school feeding programmes, which were so popular with donors, only had a small positive impact on food security since providing schoolchildren with quality food started at a later point in time. As borne out by numerous surveys, a balanced diet is already a precondition for a child's normal development in babyhood or infanthood.

The authors of the ODI study found little evidence of food security regarding insurances as a social protection instrument. Above all, the crop and livestock insurances were not viable for the extensive and largely remote rural areas in developing countries, and so far, they had been of no interest in economic terms. ODI expert John Farrington regarded the weather index-based insurances, which were being used in Europe and other western countries, as more efficient. However, they tended to be more suitable for commercial farmers than for smallholdings since, as a rule, they could only be taken out for one crop, Farrington conceded.

Angelika Wilcke, *Rural 21*

Finding the balance between conserving and using tropical forests

How can certified sustainable wood products be brought out of their market niche so that instead of over-exploiting forests their sustainable management can be fostered? And how can investments for this be mobilised? These questions were at the centre of the international conference «Forests for Future Generations – Public and Private Responsibility for Sustainability», hosted by the German Federal Ministry for Economic Cooperation and Development (BMZ) in Berlin, Germany, in mid June.

"We have to make better use of the synergies between state regulations and private business initiatives to conserve tropical forests," Federal Development Minister Dirk Niebel noted, summing up the position of German development cooperation in his opening speech. Over 160 representatives of politics, business, science and civil society from a total of 37 countries emphasised that an effective dialogue between regulators and private sector sustainability initiatives could make an important contribution towards achieving this.

Who needs to move?

Hugo Maria Schally of the EU Commission's DG Environment described the FLEGT (Forest Law Enforcement, Governance and Trade) process as the means of choice to counteract illegal wood harvesting nation-wide at government level. Faced with the lack of a binding international definition for sustainable forest management, comprehensive national definitions of legal wood are formulated for the first time in the partnership agreements with countries that export tropical wood products. It was not enough to push the willing forward with voluntary standard initiatives, but rather, there was also a need to ensure that the unwilling comply with the regulations. Schally clearly stated that Voluntary Partnership Agreement (VPA) negotiations were an intergovernmental negotiation process taking place between the EU and tropical timber producing countries. Private standards initiatives could however contribute with their instruments and experience in fulfilling due diligence under the EU Timber Regulation.

Accordingly Kim Carstensen, Managing Director of the Forest Stewardship Council (FSC), explained that the FSC would modify its standards for forest management and chain of custody certification to the requirements of the EU Timber Regulation and the national FLEGT requirements. For example, the indicators of the Cameroonian legality definition would be integrated into the national FSC standard there.

Who are the key actors?

The EU is an important import market and, given the growing demand for wood, will also remain so. But large emerging countries that are experiencing economic booms are increasingly using wood for their own consumption. For example, Marcus Alves of the Brazilian Forest Service reported that the major share of wood harvested in his country was destined for the domestic market. Jirawat Tangkijngamwong of the Thai Timber Association views the EU voluntary partnership agreements as an opportunity and a big step forward in improving the statutory conditions for trading in wood. His pragmatic approach was that legality was the foundation. For the few Thai companies that could afford the certification costs, the FSC was the right approach – but not for the mass of small producers and companies in Thailand. Just like other wood processing countries, Thailand imports a lot of wood from other tropical countries. This emphasises the importance of seeking an active dialogue with emerging nations in the debate on boosting global demand for sustainably produced wood products.

Sustainable forest management requires investment that also generates economic returns. Many forest areas are converted because other land uses such as arable farming and cattle breeding frequently promise more profit. More attractive investment models and respective insurance systems for forests and sustainable forest management are therefore of great importance. But it is precisely here that the problems arise. The finance industry generally focuses on the short-term horizon, whereas trees need decades to grow.

Tuukka Castrén, a forest expert at the World Bank, explained that especially in tropical countries, rapid rates of growth could generate high yields, whereas weak government, corruption and unresolved tenure rights were creating high investment risks. Thus 70 per cent of forestry investment is currently being made in non-tropical countries such as the USA.

During the conference, it also became clear that just focusing on the forestry sector alone was too narrow if the aim was to use forests sustainably. Philipp Schukat of the GIZ Program for Social and Environmental Standards pointed out that sustainable management went beyond individual certified units. So land use planning at the national level and cooperation between different product-specific standards initiatives and companies was particularly important in order to reduce further deforestation resulting from agricultural expansion.

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Governing the transformation of soils must urgently be improved

We are continuously transforming a resource that is both essential and finite: our soils. We do so in a way that has serious social, economic and ecologic implications. There is an urgent need to shift these transformations to more sustainable pathways. Transgovernance can assume a pivotal role in this regard.

Soils are an essential resource. We produce more than 95 per cent of our food on them, and soils have important water buffering and cleaning functions. They store about 4,000 billion tons of carbon that is roughly ten times more than what the world's forests accomplish. Soils are not only essential but also increasingly scarce. The global available arable land per capita was cut by half from 1962 to 2008. In the Anthropocene, humankind has become a quasi-geological force. Due to human activities, it is difficult to find any natural soils without any human influence. Nitrogen input through rainfall is only one example. Given slow soil formation rates, soils are a finite resource in human terms. We are losing about 24 billion tons of this finite resource on agricultural lands per year because of wind or water erosion.

Land and soil degradation does not affect drylands only. In Europe, an area of about the size of Berlin is taken each year by the construction of housing or infrastructure. This is particularly challenging, as our cities were often founded on the most fertile soils. Soil contamination – diffuse or site specific – affects various regions. Exclusion and marginalisation processes further exacerbate scarcity of fertile soils. On average, soils across UN regions are more unequally distributed than income in the Republic of South Africa more than 20 years after the end of Apartheid. In some countries, such as Colombia, land distribution is becoming more unequal despite the fact that the country already belongs to those countries exhibiting the highest levels of inequality in land distribution. The situation is even worse when it comes to access to land by women. Across all UN regions, women hold fewer rights to land than men. Irresponsible land governance has increasingly gained international attention since large-scale international investments started to drive people off their land ("land grabbing").

Ecosystem services of soils are globally important. The provision of food is only one example. In a globalised world, the effects of these degradation processes are likely to spread beyond those areas suffering from degradation. Turning to the areas affected by land degradation, the poor are affected more strongly by degradation processes as they lack the means to respond to them. This is particularly troubling since the poor tend to live on more degraded soils. For sake of clarification only, this is not to say that poor people always degrade land. On a national scale, inequitable distribution of land is correlated with lower rates of GDP growth. Turning to the household level, access to fertile land is a determining factor for people moving out of or falling into chronic poverty. To cut a long story short, we are continuously transforming this essential and scarce resource in a way that has negative social, economic and ecologic implications.

Transgovernance – a useful concept

These examples emphasise that the transformation of our soils is poorly governed, if at all. So, how do we move to better governance regimes? The concept of transgovernance is useful here. It acknowledges that new forms and more

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traditional forms of governance coexist. They influence and might reinforce each other or give rise to tensions (for example, traditional and "modern" forms of land administration). Transgovernance builds on societies' reflexive capacities as a prime source of and a precondition for change. At the same time, recognising the importance of reflexivity limits the possibilities of outside interventions. Finally, transgovernance acknowledges that 21st-century societies have developed into "knowledge democracies" exhibiting the following characteristics:

More participatory forms of democracy co-exist with representative democracy in ways that are strongly influenced by culture. We are witnessing a growing importance of social media alongside the continuing relevance of more traditional media formats. In Knowledge Democracies, there is increasing awareness of the need to develop knowledge jointly by science and decision-makers in Government, civil society and business. This transdisciplinary approach to science does not diminish the need for disciplinary studies, however. These elements and the relations between them form the conceptual core of transgovernance.

Not only do soils urgently need transgovernance, there are also increasing governance efforts. To give just a few international examples: The FAO has recently founded the Global Soil Partnership that now counts on the support of an Intergovernmental Technical Panel on Soils (see page 25). The Committee on World Food Security has endorsed the Voluntary Guidelines on the Responsible Governance of Tenure of Land (see pages 21–23). The European Commission and the Government of Germany are partners in implementing the Economics of Land Degradation initiative (see page 9). Various national and sub-national initiatives could complement this list. These initiatives also provide a fertile ground for transgovernance. In this regard, the following threads assume particular importance:

Soils must be considered in the nexus

The 2011 Bonn Nexus Conference successfully introduced the nexus concept. Originating from within the water community, the nexus calls for balancing the water demand to increase water, energy and food security. For the responsible governance of the transformation of our soils, nexus thinking is crucial for strategic and conceptual reasons (see also article on pages 10–12). The strategic reason is straightforward. Despite promising new initiatives, soils do not ride the wave. They do not receive the attention they require. To raise people's awareness of the importance of soils, it is necessary to demonstrate the linkages between soils and other areas of societal concern such as food security, climate change or water security. Thinking conceptually of soils in the nexus has four dimensions.

- First, to achieve water, energy and food security, the various environmental resources must be thought of and managed in an integrated way. Food security is unattainable by focusing on soils or water alone. In fact, these linkages were already acknowledged during the 2011 conference.
- Second, and related to the above, given the manifold soil-related challenges to sustainable development, responses to these challenges need to build on the insights generated by soil science and broader interdisciplinary studies on soil management, such as land governance.
- Third, sustainable soil management options will only be found and put into practice if relevant groups in society co-operate.
- Fourth, it is necessary to think of the rural-urban nexus. We are living in an increasingly urban world. Consumption patterns in cities, expansion of cities and the availability of rural labour force are only examples of the ways cities influence soil use in rural areas. Adapted solutions demand attention to both rural and urban areas. Integration of different stakeholders and their knowledge and experiences in balancing the needs for soil ecosystem services make a strong case for transgovernance of soils.

Photo: Bilderbox.com

In Europe an area about the size of Berlin is taken up each year for housing or infrastructure.

Soil loss: mitigation and adaptation

Given the high rates of soil loss, transgovernance of soils must devote

Photo: J. Boethling

Access to land is extremely unequally distributed. Women are particularly disadvantaged.

attention to the mitigation of and the adaptation to soil loss. There is a wide array of sustainable land management (SLM) practices available (see, for example, the World Overview of Conservation Approaches and Technologies, pages 14–15). However, the adoption rates of SLM practices remain very low in many cases. To increase SLM adoption, more attention to contextual factors such as access to markets and credits or security of tenure is necessary. This requires localised solutions developed jointly with land users making use of their practical and traditional knowledge and respecting cultural diversity. We will probably also need to start thinking about soil engineering, technological approaches to support (or even substitute) the ecosystem services of soils. The high hopes placed on biochar are only one example in this regard. Soil engineering poses tremendous governance challenges. Which ecosystem service shall be supported? How to distribute the benefits? Taking into account that soil ecosystem services are of global importance, any effort towards soil engineering needs to build on the experiences with adaption to climate change: Those who are in most need of adaptation are often those with the least capacity to make use of adaptation options.

From policy design to pathways of change

In addressing the soil-related challenges to sustainable development, there are always several pathways of change available. Deciding among them is a highly political task. Transgovernance assumes a crucial role in facilitating a decision process on these pathways. Further, serious implementation gaps characterise sustainability governance in general and the responsible governance of our soils in particular. It is therefore pivotal to not only devote attention to policy design but to address triggers of change and possible ways to support them. Addressing the question of "how change happens" is a hallmark of transdisciplinary work. This requires attention to "politics and power". Integrated management will involve shifting responsibilities within ministries, while securing land rights of marginal groups in society is likely to involve confronting vested interests. Given the importance of access to fertile soils for the right to food, transgovernance of soils must engage with efforts to broaden and secure access to land for those whose subsistence depends on it. Doing this in a way that pre-empts people's decision to migrate would run counter to the essentials of transgovernance. However, secure access to land is essential to reduce vulnerability of these livelihoods and to enable them to take choices regarding their future. Learning from and documenting the experiences of civil society organisations assisting people in securing access to land is pivotal here. Often, it is they who have developed feasible strategies for change in adverse policy contexts.

Conclusions

Responsible governance of the transformation of our soils must build on and incorporate the various emerging initiatives on sustainable soil management. To foster the emergence of the urgently needed alliances for change among these initiatives, to contribute to the exchange of knowledge and to raise public and political awareness on the essential roles of soils in sustainable development, a multi-stakeholder platform is necessary. This platform must acknowledge that the exchange of knowledge does not come about in one-shot events. It requires an open and inclusive process for the co-evolution of knowledge between scientists and decision-makers in society. It is against this backdrop that the Institute for Advanced Sustainability Studies, jointly with its partners, has initiated and is co-hosting Global Soil Week (www.globalsoilweek.org). The increasing global awareness on the importance of soils and the growing number of initiatives on sustainable soil management provide a highly fertile ground for responsible governance of the transformation of our soils. We urgently need to make use of this momentum.

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Awareness, research, action: the Economics of Land Degradation (ELD) initiative

Rapidly increasing agricultural land prices and large-scale investments by local and foreign companies in land in developing countries reflect the risks of land degradation and perceived land scarcity. Yet despite the rising value of land and the growth in business interest, land degradation continues apace. This is due to a failure to investment in measures to prevent degradation in response to the rising demands for land-related products and services.

The Economics of Land degradation initiative (ELD) seeks to raise awareness of the often neglected issue of the loss of fertile soil and to establish a global approach to analysing the economics of land degradation. There is a growing recognition that the failure to invest in soil protection often results from limited knowledge of the actual costs of land degradation and the possible benefits of preventing and combating it. This is why the ELD initiative focuses on building of awareness of the risks of land degradation and providing government and private sector decision-makers with sound economic arguments for taking action to manage land sustainably.

Building on strong partnerships

The Economics of Land Degradation initiative was launched in October 2011 with the signature of a joint memorandum of understanding between Germany, the European Commission and the United Nations Convention to Combat Desertification (UNCCD). ELD offers a strong platform for raising public awareness of land degradation and advocating sustainable land-use strategies. The ELD Secretariat, which is hosted by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), is responsible for coordinating the work of the ELD initiative, serves as the contact point for partners and provides scientific, political, and financial coordination and outreach activities.

ELD has initiated fundamental research with wide support from a broad group of scientists and research institutions, from political partners, and from the business community (see ELD website). However, the initiative is still evolving and expanding and is open to new cooperation partners.

First achievements and the way forward

ELD conducts independent research work as well as collecting and reviewing existing case studies. The initiative is thus emerging as a knowledge brokering hub for the economics of land degradation. ELD has initiated a number of economic research projects on a global, regional and national level. A number of these confirm that it pays to invest in sustainable land management, since the economic losses due to land degradation and a lack of action are enormous. Alone the annual loss of income caused by desertification is estimated at about 49 billion US dollars. Indirect costs due to forced migration, sickness or famine go far beyond this figure.

Photo: J. Boethling

Water conservation in Niger: A farmer uses a laid-out water reservoir to irrigate his vegetable patch.

Satisfactory economic returns (from 12 to 40 %) have been cited for a number of projects in this field, including soil and water conservation (Niger), farmer-managed irrigation (Mali), forest management (Tanzania), and farmer-to-farmer extension (Ethiopia). Indeed, returns of over 40 per cent are on record for small-scale valley bottom irrigation in northern Nigeria and Niger. Niger loses approximately 8 per cent of its gross domestic product to overgrazing and excessive salinity in rice paddy fields, yet steps to combat these processes would only require a quarter of the costs incurred. According to the World Bank, agricultural investment has a strong record for reducing poverty. The overriding imperative for investing in drylands is, therefore, poverty reduction.

Further attention to the topic has been raised by a call for proposals for new case studies. The resulting work will contribute to our knowledge on the ELD and to the development of joint methodologies. Moreover, the initiative is collecting examples and data from the business, government and scientific sectors with a view to drawing up guidance for all three sectors by the beginning of 2015.

Further activities include promoting the ELD initiative by, for instance, establishing a complementary research network on ELD issues among German research institutions, and capacity building by developing e-learning courses and facilitating trainings and workshops to foster the inclusion of the ELD in decision-making processes.

You can follow the ELD initiative here:
www.eld-initiative.org

For a list of references, please visit:
➤ **www.rural21.com**

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A 'nexus' approach to soil and land management:

Turning vicious cycles into virtuous ones

Soils around the world are degrading rapidly, reducing ecosystem diversity and some important functions, threatening food and other human securities, and increasing vulnerability to climate change. This is a vicious cycle created by and leading to further unsustainable land-use practices. Integrated ('nexus') soil, land, water and ecosystem management can help to turn it into a virtuous cycle.

It may be the greatest challenge of our era: how to feed seven billion people and provide energy, water and other necessities in a world of growing demands but limited and, in many cases, declining resources. Agriculture is at the heart of this challenge; it provides food, animal feed, bioenergy, fibres and other crucial supplies, but it is also a major cause of land and water degradation and biodiversity loss.

In other words, even though we urgently need to *increase* agricultural productivity, the way we use the land is often *reducing* productivity – to the point that 24 per cent of the world's land, including more than a third of cropland, is degraded; twelve million hectares are lost to droughts or desertification each year. Economic losses are also substantial: the global cost of land degradation has been estimated at 3–5 per cent of agricultural GDP, and significantly higher in some countries, a UN review found.

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Land degradation occurs for many different reasons, including excessive tillage, large-scale monocultures, inadequate crop rotation and fallow periods, overgrazing, cultivation of steep slopes, removal of vegetation, overuse of chemicals, and other common but unsustainable practices. Soil organic matter is lost, reducing the soil's capacity to store water and nutrients, and fertility and biomass production decline, lowering agricultural yields.

As their livelihoods are threatened, farmers may exacerbate the problems by overusing resources even more, falling into a vicious cycle, as in the Peruvian case (see Box). The effects spill over onto surrounding landscapes, affecting the functioning of ecosystems – for example, through water pollution and changing local climate. Groundwater recharge and downstream reservoir storage may also be compromised, and biodiversity can decline, reducing pollination, natural pest regulation and climate resilience. Floods often increase as well. Degrading environmental conditions, in turn, feed back negatively on farming potentials.

An estimated 1.5 billion rural people depend on degraded land. The problem is particularly serious in Africa south of the Equator, Southeast Asia, southern China, north-central Australia, the Pampas in South America, and swaths of boreal forest in Siberia and North America, according to a 2008 report from the Global Assessment of Land Degradation and Improvement (GLADA) project. An astonishing 95 per cent of Swaziland's land is degraded; 66 per cent of Angola's, 64 per cent of Gabon's, 60 per cent of Thailand's, and 60 per cent of Zambia's. In China, 457 million people are affected by land degradation.

Soil and land degradation is also a serious problem in the context of planetary boundaries related to atmospheric carbon dioxide and climate change, nitrogen and phosphorus (not only in terms of water pollution, but also regarding depletion of global phosphorus resources), water (reducing "green water" stored in the soil and atmospheric moisture recycling) and biodiversity (see Rockström et al., 2009). Slowing and reversing soil and land degradation is therefore a key element in the management of the global commons.

Can the trend be reversed?

Overall, land degradation has increased, from 15 per cent of land surface per a 1991 assessment, to today's 24 per cent – and the areas identified by the two studies do not significantly overlap. This means a great deal of historically degraded land is now stable at

very low productivity. But land can also be restored; the GLADA study found that almost 16 per cent of global land area was improving, including 20 per cent of croplands – due to irrigation, forest plantations and land reclamation, and other measures.

This is where the "nexus" approach can be particularly valuable. To a great extent, unsustainable agricultural practices are the result of a narrow focus on a single goal in particular – to maximise crop yields and farm revenues. A nexus approach accounts for externalities and seeks to reduce tradeoffs and build synergies between different sectors and activities (water, energy, food), as well as natural resources (soil, land, water, carbon, nutrients) and climate regulation (e.g. through carbon sequestration).

Once we take into account the knock-on effects of common agricultural practices on soil quality, water resources, biodiversity, ecosystem services, etc., the cost-benefit equation changes. Integrated soil, land, water and ecosystem management becomes more sustainable, also economically.

How will farming change as a result of adopting a nexus approach? It becomes less input-intensive (in terms of energy, irrigation, agro-chemicals and other non-renewable inputs). It prioritises soil and water conservation – by minimising tillage, for example, and by diversifying and rotating crops more. It also embraces agro-ecological practices such as recycling of waste products, integrated pest management, water harvesting, and "green manuring" – in which cover crops are grown during fallow cycles to add nutrients and organic matter to the soil. All these approaches can support agricultural intensification – just more sustainably – and bring co-benefits such as reduced water pollution from agricultural runoff and increased terrestrial carbon storage.

How feasible is a nexus approach to soil and land management?

The case for a nexus approach to reducing soil and land degradation is strong. Soils are essential for all terrestrial life, playing a key role in biomass production; they are central to ecosystem, land and water management. In fact, soil organic matter is frequently used as a proxy indicator for the status of various ecosystem services. Soils also serve as "natural infrastructure", which is often less resource- and cost-intensive compared with hard infrastructure. And land degradation contributes to climate change, having reduced the amount of carbon removed from the atmosphere by nearly one billion tonnes.

Science has recognised nexus or integrated approaches for quite some time as providing opportunities to improve resource use efficiencies across different resources, while minimising over-exploitation and environmental degradation. Several initial assessments have demonstrated the potential benefits of nexus approaches (see e.g. Howells et al. 2013).

Some smallholder farmers also already take nexus approaches by necessity. They depend strongly on natural resources and their recycling, because they cannot afford additional inputs such as agro-chemicals or energy.

Still, implementation of nexus approaches at larger scales – across land-

Burning away a vital resource – the case of the Peruvian Amazon

In Amazonian Peru, soil is degrading rapidly because of a highly destructive set of practices. Farmers cut down forests, then burn the land to clear it for planting. They grow crops for one or two years, then seed grass for cattle grazing, or else abandon the land.

The soil nutrients, already limited, are quickly exhausted, and the soil pH level declines rapidly. Soil microbial biomass can decrease by 75 per cent within 12 months. Irreversible and complete soil structure collapse can occur within 30 months, and remediation on a large scale is nearly impossible.

Photos: Matthew Fielding

Digging into the soil in the southeast Peruvian Amazon reveals a typical soil profile, with a very thin topsoil layer above thick clay and minimal organic matter.

A 'virtuous cycle': The Kenya Agricultural Carbon Project

The Kenya Agricultural Carbon Project, implemented by the NGO Vi Agroforestry, is demonstrating the many potential benefits of "climate-smart" agriculture. It takes an integrated approach to agricultural land management, including recycling of residues, composting, cover crops, and land rehabilitation, and also operationalises the principles of a multi-functional production system by way of agro-forestry.

The goal is to achieve a "triple win" for smallholder farmers: increased agricultural productivity, reduced vulnerability to climate change, and soil carbon sequestration (yielding verified emission reductions, some of which the World Bank BioCarbon fund is purchasing). The climate mitigation potential of this project is significant even when taking into account potential increases in agricultural inputs (e.g. fertiliser, energy) and livestock-related greenhouse gas emissions.

A drawing from local stakeholders shows a multi-functional system that includes agroforestry, livestock, and diverse food crops, creating a highly productive and resilient landscape.

Photo: Bo Lager

scapes or regions – remains a big challenge. There are hardly any examples of up-scaling of local nexus approaches. Spatial planning has hardly begun to address dynamic multi-functional configurations of landscapes. Reasons for this implementation gap include the added complexity, the amount of knowledge required, high transaction costs, and institutional structures that are not conducive to cross-sectoral management and planning.

Even the Kenya Agricultural Carbon Project (see Box above) reveals the challenges of up-scaling. The main actors there are farmers groups supported initially by international donors and NGOs, but not yet state agencies which could mainstream such a nexus approach into their policy and decision-making.

New impetus for a well-known approach

To overcome these obstacles, we must first make clear that the nexus is not a new concept, but rather a new interpretation of previous systemic concepts and integrated approaches, such as ecosystem approaches introduced by the Convention on Biological Diversity (CBD), the landscape approaches endorsed by the World Bank, integrated water resource management (IWRM), and multi-functional production systems (e.g. agro-forestry, crop-livestock-biofuels, ecological sanitation), among others.

Why bother talking about the nexus, then? Because the concept currently enjoys a high profile among both researchers and policy-makers (see the nexus resource platform www.water-energy-food.org and the large number of nexus conferences, initiatives, etc.). Thus, using the nexus framework can provide new impetus to these concepts. The urgency of the soil and land degradation problem also creates new entry points for implementation.

An important strategy will be to identify more "win-win" opportunities. International agencies such as the UN Food and Agriculture Organization (FAO), and other donors and networks such as the Global Soil Partnership (see page 25) can provide useful knowledge and an important dialogue platform in this regard.

Institutional obstacles ("silos") can be overcome by bridging institutions that set overarching and long-term goals and negotiate tradeoffs. Institutions with a "nexus mandate", such as ministries of environment, need to be strengthened relative to more sectorally focused institutions (e.g. ministries of water or energy).

Investments can support up-scaling – for example, by targeting payments for ecosystem services at landscape- or regional-scale integration. For that, economic benefits of a nexus approach (or costs of conventional "silo" approaches) need to be recognised, such as in the proposed TEEB (The Economics of Ecosystems and Biodiversity) agriculture and food study. A July 2013 concept note for the study frames it in very nexus-compatible terms, citing a growing body of knowledge which shows that "agricultural production depends on services provided by healthy natural ecosystems". The note identifies a key knowledge gap that, if filled, could strengthen the case for integrated approaches: the values of many ecosystem services "are largely invisible in markets and thus are neither reflected in national accounting and statistics nor land use and management decisions".

Eventually, the main challenge for implementing (context-specific) nexus approaches to soil and land management will be to engage with actors at all levels: from farmers who are to change to ecologically sound practices, agro-businesses that will need new business models, to policy-makers who will have to co-ordinate across sectors.

References and further reading:
➤ **www.rural21.com**

What can conservation agriculture achieve?

Wind or water erosion are common phenomena on the majority of arable land. The resulting soil losses are generally higher than the rate of formation of new soil, so that the depth of fertile soil is decreasing. Moreover, eroded soil can cause severe off-site damages. One way of reducing erosion is the implementation of conservation agriculture (CA); this is a production system in which the soil is no longer ploughed.

According to the Food and Agriculture Organization of the United Nations (FAO), CA is based on three principles:

1. minimum soil disturbance (no tillage),
2. permanent organic soil cover and,
3. a diverse crop rotation or intercropping.

Conservation agriculture has been practised on a large scale for about 30 years. Although ploughing is still the standard, the area of land under CA increased from around 11 million hectares in 1990 to 106 million hectares in 2008/09 (source: FAO). It is estimated that CA is presently being practised on around 125 million hectares worldwide. Growth in CA has been most rapid in Latin America, especially in Brazil, Argentina and Paraguay, where CA now accounts for almost two thirds of the farmland. Other countries in which CA is prominent are the USA, Canada and Australia.

Many perceive conservation agriculture as a production system that is synonymous with monocultures, production of genetically modified organisms (GMO) and use of broad-spectrum herbicides. This is because on large areas that are cultivated without ploughing, particularly in North and South America, the other CA principles are not adhered to. This is not the proper CA as described above and should rather be called "conservation tillage".

Provided that the three basic principles (no tillage, permanent soil cover, diverse crop rotation or intercropping) are always observed, CA is an important form of sustainable land management. It can be practised on a wide range of sites, under various socio-economic conditions and in different sizes of farming operations.

Conservation agriculture has particular advantages in combating soil erosion and in improving water infiltration and storage in the soil. It is therefore a means of adapting to climate change, particularly to changing rainfall patterns.

After a conversion phase, the yield potential of conservation agriculture is just as high as, if not higher than, that of tillage farming. Since no soil tillage is needed, there is a saving of energy and capital. Production costs fall as a result, and the emission of greenhouse gases is reduced. On the other hand, at least during the conversion phase, higher production and labour costs may be incurred for weed control and for direct sowing equipment. This makes the conversion especially difficult for smallholder farmers, who often have no access to funds for inputs such as herbicides or farm equipment. Because smallholder farmers often also lack specialist knowledge, weed control poses a particular challenge for them. Furthermore, they frequently use their straw as feed for livestock, which makes it more difficult to maintain permanent soil cover. Therefore, CA is most widespread in large-scale farming operations, while it is hardly used by smallholders. The principle of maintaining a diverse crop rotation may also be difficult for farmers, if, for example, there is no market for legumes.

CA is often said to increase the carbon content in soils, so that farmers practising CA could be compensated for mitigating climate change. However, scientists are still debating the extent to which CA results in carbon enrichment in the soil, and further research is needed. More research is also needed regarding the adaptation of CA to local political, economic and social conditions and also to local environmental conditions. The question of which environmentally compatible strategies could be employed to control weeds, diseases and pests more effectively in CA also requires clarification.

In conclusion, CA is not a cure-all for the problems in agriculture. It is only one of several production systems which have their specific pros and cons. CA is particularly beneficial in areas that suffer from erosion. In order to successfully introduce CA on a larger scale and in a smallholder environment, strategies for the promotion of CA in specific regions, climates and farm types need to be developed. Since the environmental and economic advantages of conversion to CA only become apparent in the medium term, awareness raising is key to change the attitude of farmers, decision-makers, scientists, etc. towards CA. Policy development, training and access to appropriate machinery are other important preconditions. German development cooperation will continue to support these efforts.

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Photo: C. Schneemann/Landpixel

Direct sowing equipment has its price – one of the reasons why conservation agriculture is used more widely on larger farms.

Promoting best practices in sustainable land management

Protecting land is vital to achieving food security and reducing poverty. This is the insight on which the global WOCAT network was built two decades ago. WOCAT's early focus on soil and water conservation has expanded into a tried and tested facility for decision support in all aspects of sustainable land management for every kind of land manager. There is a special focus on providing sustainable benefits for the rural poor, both efficiently and cost-effectively.

Sharing and enhancing knowledge on sustainable land management (SLM) improves land and livelihoods. In pursuing this vision, WOCAT, the World Overview of Conservation Approaches and Technologies (www.wocat.net), has become a global network committed to the task of identifying, documenting, making available and disseminating best practices in SLM.

SLM entails the maintaining of healthy natural land resources (soil, water, vegetation and animals), productive functions (food security), ecological functions (water, nutrient, and carbon cycles) and biodiversity. Neglecting these elements results in land degradation, which is a threat to the environment as well as to livelihoods, especially in regions where the majority of people directly depend on agricultural production. More than two billion people are already affected by desertification, land degradation and drought. Studies show that, under the latest scenarios for climate change, the situation is likely to worsen due to unsustainable use of soil and water. There is, therefore, a pressing need to improve food security, promote climate change mitigation and adaptation, and reduce the risk of disasters. In all these fields, SLM plays a key role and must be given urgent attention.

The main objective of sustainable land management is to make human coexistence compatible with nature in the long term, helping to secure provisioning, regulating, cultural and supporting ecosystem services. Among these services, soil plays a key role: healthy and fertile soil is the foundation of land productivity. So investing in appropriate SLM practices is crucial. Failure to do so results in reduced soil

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Using WOCAT knowledge products for decision support

WOCAT produces various knowledge products, such as global, regional and national overview books and inventories of practices and guidelines. These products are available on the WOCAT website under "knowledge base" (www.wocat.net/en/knowledge-base.html).

Key publications on SLM technologies, approaches and principles are:

- *Where the land is greener – case studies and analysis of soil and water conservation initiatives worldwide* (2007) and *Desire for Greener Land – Options for Sustainable Land Management in Drylands* (2012). Both books contain an analysis of SLM technologies and approaches, policy recommendations, and detailed SLM case studies.
- *SLM in Practice – Guidelines and Best Practices for Sub-Saharan Africa* (2011) is a TerrAfrica Partnership Publication which was prepared by WOCAT and coordinated by FAO. The book sets out and illustrates the principles for best SLM practices such as increased productivity, improved livelihoods, and improved ecosystems. In addition, principles for scaling up SLM are listed, such as creating an enabling environment and ensuring local participation combined with regional planning, capacity building and training.
- The latest publication is *Water Harvesting – Guidelines to Best Practices* (2013). These guidelines introduce the concepts behind water harvesting and propose a harmonised classification system, followed by an assessment of suitability, adoption and scaling up of practices.

Apart from providing a wide range of options to land users and SLM projects, WOCAT has developed decision support tools for setting priority areas for upscaling SLM and the selection of SLM practices which are best suited for specific human and environmental conditions. These tools use the wealth of documented experiences and allow decision-makers and local communities to set their own criteria for the evaluation.

fertility, undermining the production of what is sometimes known as the four "f"s: food, fodder, fuel and fibre.

Building on knowledge from the field

The overall goal of the WOCAT network is to unite efforts in knowledge management and decision support for scaling up SLM. Its ultimate target group are all land users and the public, who are to be reached via SLM specialist intermediaries at various levels. At the field level, such intermediaries include technical staff and extension workers; at the national level, they may be decision-makers and researchers; and at the regional or global levels they include programme planners and donors. Specifically, WOCAT works to reach its goal by:

- Building up an effective global network of SLM specialists and creating new partnerships and synergies;
- Developing standardised tools and methods for knowledge management and decision support at local, national and global levels;
- Building up a global database on SLM, synthesising experiences, and disseminating targeted information through different media;
- Enhancing the capacity and knowledge base of a range of actors and stakeholders (research, training and education) needed to promote SLM adoption at different scales.

WOCAT knowledge products offer a range of options that can form part of an overall SLM adoption strategy for practitioners in the field, and help decision-makers and donors to better understand and implement their choices. The SLM technologies and approaches are flexible and can be adjusted to the local context while being embedded into institutional frameworks. An important ingredient in the network's success is a joint commitment on the part of all the institutions, projects and actors involved in SLM to building up a harmonised knowledge system and developing user-friendly applications. Effective SLM can only be achieved if local organisations and communities are at the centre of SLM efforts. WOCAT achieves this by enabling local stakeholders to participate meaningfully in resource management processes and by documenting and sharing their experiences.

Farmers explain their SLM methods

The farmer Momakhol Alikhonova lives in a rural mountain area in Tajikistan where, previously, people cooked using firewood. Today all the trees around the village have been cut down and the people depend heavily on cow dung as a source of energy used in inefficient stoves. The result was a lack of cow dung on the fields, and a decrease in soil fertility. Energy-efficient stoves were then introduced, requiring only one quarter of the amount of cow dung. The remaining cow dung is now applied to fields as manure, doubling the yield and improving soil conditions.

Photo: H. Liniger, WOCAT

Documenting SLM technologies and approaches

The most-used WOCAT tools and methods are WOCAT case study documentation questionnaires. Filled in by stakeholders (usually the specialist intermediaries mentioned above), these questionnaires allow WOCAT to document and evaluate locally-proven SLM practices that lead to greater productivity and protect the environment. Each case study deals with a specific SLM approach and one or more technologies, and can cover any area from as little as one farmer's field to entire catchments or districts. All this information feeds into the WOCAT SLM Technology and SLM Approach database. Over the last 15 years, the global database has grown to about 470 technologies and 240 approaches. They are taken from all continents with a lot of case studies from Africa and Asia in particular.

Until recently, the SLM practices gathered in the WOCAT database were presented in an attractive standardised soft- and hard-copy format. In the past year, WOCAT has made an important addition by producing videos of land users showing how SLM works, what problems it solves, how challenges can be overcome, and what benefits can be achieved locally, regionally and globally. In the videos, farmers from, for example, Tajikistan describe and demonstrate their sustainable land use methods. One farmer, Iskandar Mirzoev, reports on his knowledge of grafting apple trees, a technique that guarantees him an income in years with a poor harvest from some tree species. In another, Momakhol Alikhonova talks about her experience with energy-efficient ovens and how she uses them to minimise soil degradation (see Box). The videos have met with great interest among the local population, stimulating animated discussion of the practices shown.

Bio-reclamation – Converting degraded lateritic soils into productive land

Not only has soil degradation in Niger been halted thanks to an integrated approach combining water harvesting technologies, the application of organic residues and planting of fruit trees and vegetables. The strategy has also enabled increases in farmers' income as well as an active involvement of the country's largely marginalised women in food production through their gaining access to land.

Degraded lateritic soils occupy more than 50 per cent of the land surface of Niger. These laterites, which are rich in clay, are covered with a hard crust which minimises water infiltration and hinders seedling emergence. Consequently, degraded lands are mostly dedicated to grazing and firewood harvesting as their agricultural production potential is negligible. However, the high clay content in lateritic soils offers the advantage of higher Cation Exchange Capacity (CEC) and water holding capacity compared to those of sandy soils. Therefore, these soils have the potential to re-establish agricultural production if the compacted layer is broken. This is the rationale for the development of the Bio-reclamation of Degraded Lands (BDL) system which enhances the conversion of degraded crusted soils into productive lands. This is achieved by combining indigenous water harvesting technologies (micro-catchments, planting pits and trenches), application of animal and plant residues and plantation of high-value fruit trees and annual indigenous vegetables that are resilient to drought environments.

A multi-purpose strategy ...

The BDL is basically an agroforestry system, improved with the incorporation of high-value trees and high-value rain-fed traditional vegetables rather than the traditional trees and staple crops. It is an innovative production system of indigenous horticultural crops that provides solutions to a range of critical constraints affecting the rural population of the Sahel. Because of the simplicity of re-establishing tree and crop production, the potential for mass-adoption of BDL technologies is very high. The BDL reclaim the lost agricultural potential of degraded soils, physically by increasing water infiltration and harvesting, and biologically through planting of resilient woody species and income generating annuals. It is a multi-purpose strategy as it reduces further land degradation, increases water availability and productivity of the land while bringing economic benefits to farmers. Not only does the BDL mitigate desertification and climate change, but it also enhances women's empowerment. In

BDL at early stage of plant growth.

Photo: ICRISAT - Niger

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most West African countries, women are not allowed to crop and manage arable land. However, once productive land has been degraded by intensive cereal production, men commonly assign it to women. Local governments even provide contracts granting women the right to degraded land.

... with a multitude of species

The main woody species that can be planted in the BDL are the domesticated *Ziziphus mauritiana* (Pomme du Sahel), sweet tamarind (*Tamarindus indica*), the domesticated *Sclerocaria birrea* (marula) and the domesticated *Acacia senegal*. The first three tree species produce food, firewood, medicines and forage, while *Acacia senegal* provides gum, firewood and forage. In addition, two Australian acacias (*A. colei* and *A. tumida*) can be planted. These acacias provide firewood, mulch, and nitrogen to the soil as well as seeds rich in protein that serve as poultry feed.

The trees may be intercropped with traditional leafy vegetables (*Cassia tora, Gynandropsis gynandra, Corchorus stridens, Cerathotheca sesamoides, Leptadenia hastate, Hibiscus sabdariffa* and wild Amaranthus). These vegetables have very important roles in both human nutrition (food security) and income generation. Medicinal crops such as *Cassia acutifolia* (senna), *Cassia occidentalis* and Okra (*Albemoschus esculentum*) are also planted.

Over the last seven years, ICRISAT-Niger has conducted research to study the performance of BDL by combining several trees and leafy vegetable species adapted to each of the regions where the system is being implemented. The studies have allowed a selection of ideal plant mixtures according to sites' ecological conditions and farmers' interests. Current results show that by helping women grow indigenous vegetable and fruit trees, it is not only possible to increase their self-confidence to successfully produce food but also to enable them to improve family care while generating extra income.

The trees are intercropped with traditional leafy vegetables.

Photo: ICRISAT - Niger

The estimated value of fruit and vegetables produced is about 1,200 US dollars per hectare and year, indicating a remarkable additional income.

Thanks to the success demonstrated with women groups on BDL technology implementation, men are now expressing their interest and would like to have their own BDLs. Therefore, we have also initiated a study on the performance of mixes of cereals and legume crops planted in the zai pits (planting pits) in addition to the established crop-tree systems. Besides harvesting vegetables, this practice will increase production of staple food crops particularly in areas where the availability of arable land is limited and men have to rely on degraded land for cereal production. In field trials that included addition of 200 g of manure and 3 g of NPK fertiliser per hill, a total biomass of 4.5 t/ha was produced in plots with cereal-legume association, compared to 2.5 t/ha for cereal alone.

A clear economic and nutritional impact

BDL is highly significant in a region where scarce and fragile arable lands are under extreme pressure to produce sufficient food to meet the demands of an increasingly growing population that also faces the negative effects of climatic variation on food production. At the same time, the restored lands allow active integration of Niger's largely marginalised women to valued food production systems that improve their livelihood.

Additional BDL trials (ICRISAT non-published data) have demonstrated that a 200 m^2 plot can yield an annual income of FCFA 50,000 (approximately 100 US dollars), which is equivalent to what men traditionally earn from millet production per hectare. Besides equalling traditional income from millet production, children, and other members of participating households, benefitted from the increased availability of nutritious food through BDL implementation.

The system is being adopted by many NGOs as a major means to empower women and to improve household livelihood in various zones of intervention across Niger. For example in 2011, the NGO Clusa installed 25 BDLs of 1.5 ha each through activities conducted in the USAID funded Arziki project implemented in the Filingué department in the country's Southwest. Fifteen additional BDLs were installed in the department of Illela in the neighbouring Tahoua region through this funding programme.

Rangelands –sound management strategies for a vulnerable resource

Rangelands cover 30 per cent of the global land surface. They support a considerable share of the global ruminant value chains, are habitat for a high plant and animal diversity and have various ecological, economic and social functions. But rangelands are currently under pressure from global change processes. A focus on human-animal-environment interactions is necessary to avoid resource overexploitation and degradation.

Rangelands cover between 30 and 50 million km² world-wide, which is two to three times the area used for farming. Rangelands exist on all continents in different agro-ecological zones, and comprise ecosystems as different as natural grasslands, savannas, shrublands, desert fringes, tundras, alpine communities, marshes and meadows. Well-known examples are African savannas, the Australian outback, South America's cerrados and campos, North American prairies and Central Asian steppes. Here, crop production is usually severely constrained, either by low annual precipitation with high seasonal and inter-annual variability, or by periodically low temperature, with both leading to rather short and often variable vegetation periods and high production risk. In rangelands, soils are covered with indigenous vegetation consisting predominantly of grasses, grass-like plants, forbs, or shrubs. They are managed as natural ecosystems, provide a multitude of important ecosystem services and have a high potential to sequester carbon.

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Rangelands are predominantly used for livestock production – about 70 per cent of the African and 25 per cent of the Latin American ruminant livestock population is kept on rangelands – and contribute considerably to the agricultural gross domestic product (GDP) in many developing countries. The main feed resource is the natural vegetation, and rangeland-based livestock systems can operate with no or low levels of concentrate feed produced on agricultural land. Livestock keepers gain their livelihoods by transforming the natural vegetation into valuable products through livestock. Pastoralists and agro-pastoralists most often use communal rangeland resources whereas commercial ranching is usually done on privately owned rangeland.

Rangeland as a social-ecological system

"Range succession", "state and transition", "non-equilibrium" or "cusp catastrophe" models have been employed to understand rangeland vegetation dynamics under the influence of different bio-geophysical drivers. However they do not adequately consider that the impact of grazing animals is determined by the livestock keepers' management and therefore its effect is highly variable in space and time. Shaped by the people who use and manage them, rangeland-based livestock systems are therefore called "social-ecological systems". Range conditions result from long-term human-animal-environment interactions, and

New concepts in grazing management

In **targeted grazing,** animals are "grazed" at specific points in time, for specific durations and at specific intensity in a particular area in order to achieve specific vegetation management goals, the focus being on using animals to deliberately improve the vegetation. **High-density** and **ultra-high density grazing, mob-grazing** or **bunch-grazing** are similar strategies, with very high numbers of animals herded or confined by makeshift electric fences on small patches for very short durations, aimed at their eating all the available forage and trampling the residue so that no standing biomass remains. Plant litter trampled and mixed into the soil with the animals' urine and faeces will predominantly be decomposed by biotic processes and increase soil organic matter much more than standing litter left to predominantly abiotic decomposition. **Circuit grazing** considers different nutrient and secondary compound contents of plant species and takes the animals along a grazing circuit that will lead to intake of a variety of different plant species in such a sequence that the satiation threshold will be higher. This means that animals will have higher feed intake and consequently better performance than if they were to feed on the same plant species in a different sequence.

Photo: M.-L. Hertkorn

A young Boran lady takes goats and sheep to the well, near Goray in South Ethiopia. Water is an important rangeland resource that influences herders' decisions about rangeland use.

the human users are inherent drivers of the system rather than a disturbance for its inherent ecological properties. This view focuses on dynamics of rangeland systems and on their capacity to tolerate disturbance, i.e. their resilience and adaptive capacity.

Major external threats and internal challenges

Rangelands today are under pressure from numerous competing claims. Globally, population growth triggers food production to expand onto rangelands, and climate change increases variability and the occurrence of extreme weather events, exacerbating uncertainty and risk. Globalisation of markets facilitates access to use rights and concessions for rangelands that can be profitably exploited and speculated with by outsiders.

Operating under communal use of common property with no formalised land titles, the vast majority of today's rangeland-using communities are particularly vulnerable. Having developed sophisticated rangeland utilisation patterns and shaped the larger ecosystem and the resource distribution in it over millennia, they now face change processes at a pace their own hitherto functioning adaptation strategies are unable to respond to in good time. And they find themselves increasingly marginalised by the economic system and – consequentially – their own governments and societies regard them as standing in the path of progress. Ironically, the evidence of such progress producing negative externalities by far outnumbers the evidence of positive examples of alternative forms of rangeland use. Scientists and decision-makers are still at a loss to unambiguously demonstrate positive effects of projects investing in rangelands (particularly foreign direct investment projects) on social and economic welfare.

Rangeland degradation can mostly be observed around areas with concentrated human population. Sedentarisation was mainly triggered by fixed point delivery of infrastructure and services, or by insecurity in the areas. Additionally, during the past decades, the size of rangeland available to the respective communities has in many cases shrunk considerably due to external claims, often targeting specifically important rangeland patches and thus rendering much larger rangeland stretches unsuitable for profitable livestock production.

Key issues for sustainable rangeland management

Sustainable rangeland management solutions must be **ecologically sound** with no long-term ill-effects for the natural resource base, **economically profitable** with no necessity for subsidies and **socio-culturally acceptable** with respect to chartered and un-chartered access and benefit rights for rangeland-dependent communities and consensual resource allocation. New concepts must be studied, understood, tested, modified and adapted with rangeland users and representatives of governing bodies in trans-disciplinary research approaches to render them suitable in the respective locations. Nevertheless certain key principles for sustainable rangeland management can be generally advocated:

1. Livestock mobility is the principal strategy to make use of the high spatio-temporal variability of the vegetation resources which translates into rangeland patches with different vegetation communities. Together with the high inter- and intra-annual rainfall variability, these patches show different forage quantity and quality throughout the year. Therefore, for livestock to be productive, grazing units with an above-average quality and quantity of forage have to be selected at any given point in time (throughout the year) in order to permit the animals the best possible energy and nutrient intake for as long a period as possible during the year. This strategy requires mobility, and moving animals strategically to appropriate forage areas is paramount in guaranteeing that the animals remain productive and the system remains ecologically and

Photo: S. Krätli

Cattle, although being grazers, do also select highly nutritious plants in their diet. The selection capacity varies in different cattle breeds and herding systems. Red Bororo cattle that are kept by Wodaabe herders in Niger are renowned for their pronounced feeding selectivity.

economically viable. On large-scale commercial ranches, rotational and deferred grazing systems can mimic this strategy to some extent. Therefore, rangeland users' knowledge is key to sustainable management.

2. Time, timing and location are crucial factors in grazing as plants and plant communities are heterogeneously distributed and differently react to and tolerate animal impact (defoliation, trampling) or disturbance and must be allowed different time-spans for recovery. Plants that are re-grazed too soon and too frequently will continuously lose root-biomass and finally die. Concentrated high impact of grazing animals for short durations on abundant senescent vegetation can remove low quality forage and stimulate high quality regrowth if followed by sufficient rest periods. Palatability has been demonstrated to be a compound property of a diet determined by nutrient content, variety, taste, secondary compounds, sequence of ingestion and post-ingestive experience rather than by taste and/or presence of toxins alone, and animals learn to utilise a larger variety of plants if herded consciously and knowledgably. These findings offer scope for a more even utilisation of available forage and to deliberately induce changes in rangeland vegetation and its quality through herding and animal impact. New management concepts (see Box on page 18) show promising results in both private and common property systems across different ecosystems on different continents.

3. Different animals prefer different plants and select and compose diets differently. It is therefore important to monitor vegetation and ensure that grazing pressure is exerted to warrant an even utilisation of all vegetation strata. This is best achieved with systems using different livestock species with different feed preferences and integrating wildlife. On communal land, this could be achieved through community-based co-management approaches. On private land, mixed livestock wildlife ranching systems would be an option.

4. Institutional and legal mechanisms are important to secure tenure and resource-management arrangements when rangelands are used in a communal way. In some countries, there are efforts to revitalise pastoral customary institutions with their communal regulation of pasture and water management. These aim at overcoming the effects of people and livestock concentrations and the concurrent overexploitation and resource degradation.

5. With the increasing interest to invest in rangelands, communities need to re-organise their resource governance system. Bio-cultural Community Protocols (BCPs) are currently being implemented with different pastoral communities, such as the Boran and the Samburu in northern Kenya, as a framework for mainstreaming community rights and securing the hitherto unchartered customary access to grazing land. This builds on experience gained in South Africa, Ghana, Burkina Faso and Ethiopia, where BCPs were introduced to address issues of access and benefit sharing relating to natural resources. With BCPs, local communities can articulate their governance and stewardship of their localities, affirm their knowledge and strategies for resource use and assert their rights under customary, national and international law.

6. As infrastructure in the vast rangelands is usually underdeveloped, integration of rangeland-based livestock systems into the market economy is constrained, especially for pastoral producers. Improving information flows e.g. via mobile phones improves pastoralists' access to information such as early warning in case of droughts or epidemics. Market integration of pastoral livestock production is an important buffer for increasing climatic variability. Improved access to a combination of financial, insurance and early warning services can offer alternatives to storing capital "on the hoof" and is a precondition for increasing commercial livestock offtake from pastoral systems.

The article has been prepared in the framework of "GrassNet" – a cross-continental research network for sustainable adaptation of grassland systems vulnerable to climate change that is funded by the German Academic Exchange Service (DAAD).

New instruments for better land governance

The livelihoods of many rural dwellers are dependent on having secure and equitable access to land. Tenure security is also a prerequisite for sustainable land management. The massive interest of commercial investors has increased the pressure on land globally. This article describes the international community's efforts to improve the responsible governance and management of land.

Following the global food crisis of 2008, land is firmly back on the international political agenda. It is a key issue in the debates on food security, agriculture and rural development. What is more, it is also a hot topic among investors who regard farmland as an important new source of revenue.

Demand for arable land is increasing

According to the latest figures on the dynamics of the land rush published by the Land Matrix (www.landmatrix.org) in 2013, more than 775 investment deals have been concluded since the year 2000, covering 32.6 million hectares in low and middle income countries. Another 10.8 million hectares are currently under negotiation.

At the same time, 75 per cent of the world's malnourished population live as subsistence farmers, pastoralists or landless agricultural workers in rural areas – often with limited or no access to land, or with their land rights threatened by evictions, expropriations or sales and leases of the land to investors. For these people, secure and equitable access to land is a key to the realisation of their right to food and other human rights.

Other farmers – often including smallholders – would like to expand their activities and invest in their own farms. A study commissioned by the UN Committee on World Food Security has recently revealed that limited access to land and other natural resources is one of the three most binding constraints on smallholder farming investment, especially for women. Highly skewed distribution of access to land and water critically hinders the productive potential of smallholder farmers.

Governance of land tenure – a highly political issue

How people and communities gain access to land is defined and regulated by societies through systems of tenure. The tenure systems determine who can use which resources, for how long, and under what conditions. The systems may be based on written policies and laws or on unwritten customs and practices. There are numerous countries with plural land rights systems, where customary and/or communal forms of land tenure coexist with formal legal systems.

The opportunity to acquire and use tenure rights depends not only on the tenure system itself but also on how the system is governed. The governance of tenure is a crucial element in determining if and how people, communities and others are able to acquire the rights (and associated duties) to use and control the land. Many tenure problems arise

Limited access to land and other natural resources discourages smallholders, especially women, from making farming investments.

Photo: FAO/G. Bizzarri

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because of weak governance characterised by corruption or the discrimination of certain marginalised groups, or simply by the insufficient technical and human resources of the land administration authorities.

In light of the increasing acquisitions of arable land for large-scale agricultural investments, one particularly burning aspect of tenure governance is the recognition and protection of existing legitimate tenure rights, as well as participatory land use planning. Tenure systems and their governance are highly political issues because they are linked to the power relations within societies.

The Voluntary Guidelines on Responsible Governance of Tenure of Land, Fisheries and Forests

With the growing international attention on land issues, an interest has emerged for international guidance on how the tenure of land should be governed responsibly.

In 2009, the UN Food and Agriculture Organization (FAO) started a participatory and inclusive process which led to the endorsement of the *Voluntary Guidelines on Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security (VGGT)* in Rome, Italy, in May 2012 by the member states of the Committee on World Food Security of the United Nations (CFS). The VGGT are the first globally endorsed instrument of soft law that deals with the politically sensitive issue of access to land and other natural resources with strong reference to the state's obligations under international law, especially international human rights instruments.

The VGGT promote secure tenure rights and equitable access to land, fisheries and forests as a means of eradicating hunger and poverty, supporting sustainable development and enhancing the environment, with a special emphasis on marginalised and vulnerable groups. They are intended to provide states with guiding standards and principles for shaping their strategies, policies, legislation and administration in terms of the tenure of land, fisheries and forests. But they also address other actors such as the private sector and civil society by laying down guidelines on issues such as the conducting of investments or the controlling of government actions. The VGGT include

- minimum standards for the recognition and protection of all forms of legitimate tenure rights ranging from traditional customary and communal rights to formal individual rights;
- provisions for expropriations, compensation processes and redistributive reforms of land ownership;
- standards for the effective participation and consultation of people concerned in decision-making processes, for instance in land use planning or with regard to investments.

In addition, the VGGT formulate minimum standards for investments which require transactions in tenure rights. Key elements include the conduct of prior impact assessments on tenure rights and the right to food of the population concerned, transparency, appropriate consultations and – in the case of indigenous communities – the obtaining of their free, prior and informed consent.

References to sustainable land use and protection of the environment. While the VGGT primarily focus on secure land rights in the context of food security, they also talk about the sustainable use of land and environmental protection, since these issues are intertwined and dependent on each other. In the chapter on investments, the environment is explicitly mentioned among the values which need to be protected against the potential risks arising from large-scale investments. Furthermore, impact assessments prior to investment projects and redistributive reforms should also cover the possible negative environmental impacts of the investments or reforms. Other references to environmental safeguards on the prevention of land degradation are contained in the chapter on consolidation and readjustment approaches as well as in the chapter on spatial planning. In the latter, it is explicitly pointed out that spatial planning should take duly into account the need to promote diversified sustainable management of land, fisheries and forests, including agroecological approaches and sustainable intensification, and to meet the challenges of climate change and food security (guideline 20.5).

The VGGT are not legally binding, and their implementation is entirely voluntary. Nevertheless, the guidelines possess a high degree of legitimacy due to the fact that the text was actively negotiated point by point over a period of several weeks by almost 100 countries, more than 25 civil society organi-

sations, the private sector and various international organisations, before finally being unanimously adopted by the CFS.

The German Federal Government considers the adoption of the VGGT to be a milestone towards good governance in the land sector. Having championed the drafting of the guidelines, the Federal Government is now actively involved in their implementation in different ways. One example of its commitment is the organisation of the international conference "Policies against hunger: Land ahead!", which was hosted by the Federal Ministry of Food, Agriculture and Consumer Protection in June 2013. At the conference, policymakers shared experiences with representatives of farmers' associations, the private sector, civil society and international organisations, exchanging ideas for the improved governance of land in the spirit of the VGGT. One of the key conclusions of the participants was the call for inclusive, participatory, multi-stakeholder dialogues at country level because the implementation of the VGGT is not a purely technical process – it is, in essence, a social and political question (see also www.rural21.com ➤ News).

Praised by all participants: The participative and inclusive character of the negotiations on the VGTT.

Photo: FAO/G. Napolitano

The G8 2013 land transparency initiative

The success story of Rome greatly contributed to the fact that land was put on this year's G8 agenda. In their Lough Erne 2013 Communiqué, the G8 pledged to support greater transparency in land transactions and to increase capacity for building good land governance systems in developing countries. To support the implementation of the VGGT and regional processes such as the African Union's Land Policy Initiative, the G8 countries established partnerships with a number of developing countries and relevant international organisations in order to accelerate and target the support of existing national land governance programmes in conjunction with farmers, the business sector and civil society. Initial partnerships have been launched with Burkina Faso (US), South Sudan (EU), Namibia (Germany), Nigeria (UK), Niger (EU), Senegal (France) and Tanzania (UK).

FAO's activities for VGGT implementation. The G8 also acknowledged the role of the FAO in providing global policy guidance for good land governance and transparency. Building on the adoption of the VGGT, the FAO has set up a support programme which contains the following elements: awareness raising, tools for capacity development, support to countries, strengthening of partnerships (e.g. with the World Bank, IFAD and the African Land Policy Initiative), as well as monitoring and evaluation.

Principles for responsible agricultural investment in the context of food security and nutrition (rai)

In response to the major increase of world-wide agricultural investment activities and the associated opportunities and risks, the CFS decided in 2012 to develop a set of voluntary principles designed to guide responsible investments in agriculture. Such investments are essential for enhancing food security and nutrition, reducing poverty and promoting agricultural development. The principles are intended to clearly spell out the obligations and responsibilities of states and the private sector with regard to the human rights of local populations and the sustainable use of natural resources.

The new CFS process takes into account the *Principles for Responsible Agricultural Investments that Respect Rights, Livelihoods and Resources,* presented by the World Bank, the FAO, the International Fund for Agricultural Development (IFAD) and the United Nations Conference on Trade and Development (UNCTAD) in 2010. Since these principles were highly contested by several governments and civil society due to a perceived lack of inclusiveness in the drafting process as well as lack of references to human rights, the decision was taken to draw up a new catalogue.

The zero draft of the principles is expected to be presented in summer 2013. It will serve as the basis for the subsequent consultation process with all the affected stakeholders. The text of the principles is set to be negotiated in spring 2014. Endorsement by the CFS is scheduled for October 2014.

The recent momentum in the development of international soft law instruments on land issues can be seen as a success. Whether or not these guidelines and principles are brought to life on the ground depends on the political will of governments and the ability of civil society to hold governments accountable and to demand the protection of their human and tenure rights.

Elisa Manukjan headed the German delegation at the negotiations of the VGGT in Rome. The article expresses her personal views and does not represent the official position of the German Federal Ministry of Food, Agriculture and Consumer Protection.

Soil conservation in the European Union

Since 2006, a European Union-wide strategy on soil conservation has been in existence that is to address the complex roles that soil plays as a natural resource. However, a legally binding agreement has so far met with opposition by a blocking minority of EU Member States. Does the EU nevertheless offer prospects for soil conservation?

It is generally recognised that relevant soil degradation processes are on-going within Europe. There is increasing public awareness that soil contamination, soil erosion and landslides, and soil sealing by infrastructure and housing are a threat to our daily lives. But other, more subtle threats exist as well and are already affecting our lives by limiting vital soil functions. Soil compaction, soil salinisation, acidification, loss of organic carbon and the associated loss of biodiversity in soils are some of the threats that may be less visible to us but are equally important.

Addressing soil degradation in Europe has a long history. The oldest soil conservation service in the world is the Icelandic Soil Conservation Service, founded in 1907. Other European countries followed with dedicated legislative initiatives and public services and organisations addressing soil protection and conservation. Different priorities were identified by the various national soil conservation services and legislations. In most cases, soil protection was seen as a task within the improvement of agricultural production, but in some countries, already at a very early stage, other considerations emerged, linked especially with soil contamination and the large amount of historical industrial and mining installations that posed a severe problem for public health. Some countries addressed very specific national issues. In Italy, for instance, the issue of slope stability and the threat of landslides were considered urgent priorities in national soil protection legislation.

The EU Soil Thematic Strategy

These highly diversified approaches to soil protection in various European countries needed to be addressed once the European Union was established. Only at a very late stage of European integration was the issue of soil protection considered. After that, other environmental areas, like air, water, nature (biodiversity), were covered by coherent EU-wide approaches.

Following extensive preparatory work and public consultation, the European Commission took the initiative in 2006 to present a coherent EU Thematic Strategy for Soil Protection. The Strategy includes several very innovative aspects, like the focus on soil functions, and then on soils per se, thus putting at the centre of legislation the need to protect for the public good the soil functions that deliver services to all of us. With this approach, it has been possible to avoid addressing the issue of private property rights, which constitutes the major difference between soils and the other environmental areas, like air and water. The Strategy recognises that all soils deliver services to all of us, and that therefore, there is an obligation to protect these vital functions for us and for future generations. The fact that soils can only be regenerated in their full multi-functionality after a very long process of soil formation starting from the original bedrock, often taking several thousands of years, requires the introduction of sustainable criteria in soil management, given that it can be

In Italy, the issue of slope stability and the threat of landslides are priorities in national soil protection legislation.

Photo: Bilderbox.com

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The Global Soil Partnership

In 2011, the UN Food and Agriculture Organization (FAO), with the support of the European Commission, initiated a new global partnership for soil protection and sustainable management of soils. The main driver of this initiative was the need to go beyond the current stalemate in legally binding international agreements for achieving soil protection and build upon an open voluntary partnership a new "coalition of the willing" of governments, NGOs and stakeholders genuinely committed to soil protection and sustainable soil use. Opposition by a few countries and interest groups to sustainable soil management and soil protection should not be an obstacle to the vast majority of countries and institutions that are genuinely determined to make progress and assure for future generations the availability of the necessary vital soil resources for food security and for all the other essential ecosystem services that soils provide for all of us.

The Global Soil Partnership (GSP) was officially launched at the FAO in Rome, Italy, on the 7th–9th of September 2011 and includes all member countries of FAO and all NGOs and stakeholders interested in the issue. The GSP is open to all partners that commit themselves to sustainable soil management according to the World Soil Charter of FAO. The partnership is supported by a secretariat hosted by the FAO and is steered by a high level Intergovernmental Technical Panel on Soils (ITPS) of 27 experts nominated by the FAO member countries. Activities of the GSP are organised according to five main pillars of action (sustainable soil management, education and awareness, research and development, data and information, harmonisation of methods and standards) that are implemented through Regional Soil Partnerships responsible for the actions at local scale. Regional partnerships have already been established for Latin America and the Caribbean, Middle East and North Africa, West and Central Africa, East and South Africa and Asia. Other regional partnerships will follow soon. Full details on the GSP are available at www.fao.org/globalsoilpartnership/en/.

Photo: FAO

Launch of the Regional Soil Partnership in Accra/Ghana.

considered as a non-renewable natural resource.

Soil functions are currently under threat in Europe by a series of relevant soil degradation processes. Essentially, the EU Soil Thematic Strategy recognises eight major threats: soil erosion, decline of soil organic matter, soil contamination, loss of soil biodiversity, salinisation, compaction, soil sealing and landslides. These threats are obviously interlinked and do not occur in all countries of the EU. The proposed Soil Framework Directive, the binding legislative element of the Soil Thematic Strategy, requires EU member states to delineate areas at risk and to take adequate measures to revert the on-going soil degradation processes.

Lessons learnt

Where are we with the EU Soil Thematic Strategy? Since its adoption by the Commission, the Strategy has immediately entered its implementation phase. Many of the measures foreseen, like integration of soil protection criteria in other EU legislation (e.g. the Common Agricultural Policy), increased research and awareness raising activities, etc., have been consistently applied by the European Commission. Unfortunately, the binding legislative component proposed by the EC, the Soil Framework Directive, has encountered opposition by a blocking minority of EU Member States (Germany, France, United Kingdom, The Netherlands and Austria) that is still preventing full adoption of the Directive in the EU Council.

More promising recent developments have emerged at international level beyond the EU. The new Global Soil Partnership (GSP), proposed by the United Nations Food and Agriculture Organization (FAO) and recently adopted by the FAO member countries, also allows for a new approach to soil protection on a voluntary basis in Europe (see Box). The GSP is essentially a "coalition of the willing" bringing together the national governments, NGOs and other stakeholders that have a genuine interest and commitment to soil protection. There is great hope that such a voluntary approach, based on a partnership and on voluntary commitments, may prove more effective than the traditional binding legislative approach, which, despite all the efforts by the European Commission, is still not showing sufficient progress in Europe.

Future challenges

The major drawback of such voluntary approaches is obviously the lack of accountability/liability and sanctioning mechanisms. Given that there is no legal obligation to act, lack of soil protection at EU level cannot be sanctioned.

Still, one of the main effects of this recent surge of attention to soils on a global scale is that several national governments have been giving this subject increased attention. Recent new national soil protection legislative proposals, like in Italy, are raising hopes that on the long term a coherent EU approach to soil protection may be achievable.

UNCCD – the accord for global land stewardship

With more than 900 million people world-wide affected by chronic hunger, international action on soil conservation is urgently required. The United Nations Convention to Combat Desertification (UNCCD) enjoys substantial support, and the author of this article demonstrates that it could play a key role as a global policy and monitoring framework in addressing land and soil degradation.

Healthy soil is an essential but largely overlooked natural resource. More than 99 per cent of food world-wide comes from soil ecosystems. Land, of which soil is a key component, not only provides food and raw materials, but plays a key role in regulating water and the global carbon budget, and is a valuable source of biodiversity.

Yet, each year, twelve million hectares of land are subject to desertification and drought. And about 20 per cent of the world's cultivated areas are affected by land degradation. As of this year, 168 of the Convention's 195 Parties have declared that they are suffering from desertification. But the tide is turning.

The Rio+20 outcome on desertification, land degradation and drought contained in *The Future We Want* has boosted political momentum to address the challenge globally by strengthening the UNCCD's mechanisms and profiling land and soil in the post-2015 global development agenda. This move towards a holistic framework with lasting solutions to land degradation and drought issues places food production on a more sustainable and environment-friendly path.

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With population growth and changing consumption patterns, the demand for food is expected to increase by at least 50 per cent by 2030, which may require an additional 120 million hectares of agricultural land by 2030, a new farm the size of South Africa. But this is not the only reason why the loss of cultivable land urgently has to be stopped. The international community is losing up to USD 490 billion a year due to land degradation, equivalent to five per cent of global agricultural GDP.

Empirical studies on sustainable land management presented by scholars also revealed that the cost of preventing land degradation is significantly lower than the cost of inaction and that sizeable economic and ecosystem benefits accrue from sustainable land management.

The *de facto* global policy of degrading land and then abandoning it and migrating is unsustainable because productive soil and land are finite, making land restoration indispensable. So what can be done, bearing in mind that governments usually do not or are ill-prepared to respond to slow-moving crises such as land degradation and drought?

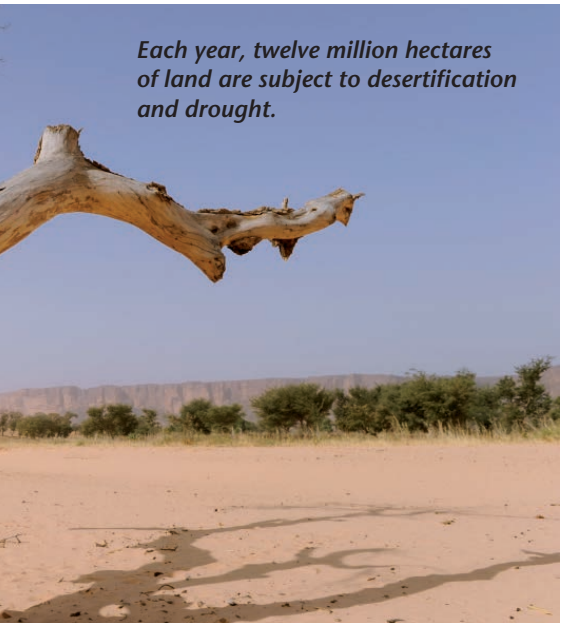
International legislation on soil conservation

Following the Rio Earth Summit in 1992, there has been significant growth in laws to manage the natural environment. But despite continuous calls by soil scientists for an international and legally binding policy framework, soil has remained a policy blindspot, and existing legislation is fragmented.

From 2000 to 2011, the Sustainable Use of Soil and Desertification Specialist Group of the International Union for the Conservation of Nature (IUCN) Commission on Environmental Law has investigated the legislative aspects of soil. To address the problem of soil conservation globally, it proposed negotiating a legal instrument, either a Protocol or a technical annex on Security and Sustainable Use of Soil under the UNCCD, or a separate Convention focusing on sustainable use of soils. Experts concur that the last option is not politically viable, given the long process of negotiating and ratifying yet another convention on the environment.

A number of arguments have been advanced for strengthening the UNCCD, as it is already well positioned to address the problem of soil and land degradation. The Convention encompasses soil in its definition of land: "the terrestrial bio-productive system that comprises soil, vegetation, other biota and the ecological and hydrological processes that operate within the system" (Art 1.). And compared to other international agreements related to soil, UNCCD has near universal support, with its 195 countries and the European Union. The Convention values traditional knowledge and a participatory approach ensuring that successful experiences from the ground filter into its policy and knowledge processes.

By providing a platform for policy-makers to learn about successful initiatives such as farmer managed natural regeneration initiatives in the Sahel and by collecting and documenting over 240 sustainable land techniques and creating the Land for Life Award, the Convention has legitimised and enabled the diffusion of these practices. It is also unique in its linking environment and sustainable development, which can be a big advantage in further promoting synergy with the conventions on biodiversity and climate change. Any global soil-protection strategy must contain both environmental and development elements.



Each year, twelve million hectares of land are subject to desertification and drought.

Photo: J. Boethling

The UNCCD's current mandate is limited to drylands ecosystems, which is often presented as a major barrier to serving as the global policy instrument on land stewardship. Nonetheless, some countries without drylands are listed in Annex V of the Convention and have ratified it, *de facto*, recognising that land degradation and unsustainable soil use is a global issue, not restricted to drylands.

Further, more than half the parties have already designed a National Action Programme as a basis for all action to combat land degradation, including soil degradation. The national reports submitted provide empirical data on the status of land cover in affected regions in order to signal changes in soil and land improvement at country level.

Environmental agreements lack mechanisms to sanction non-implementers, but the UNCCD's development and application of indicators is reputed to be the most advanced assessment mechanism among environmental conventions, and the shift to a land-degradation neutral world strengthens its value.

The way forward

Last year, at the United Nations Conference on Sustainable Development (Rio+20) in Rio de Janeiro, governments recognised desertification, land degradation and drought as challenges of global dimensions that continue to hamper sustainable development, particularly in developing countries. They stressed "the need for urgent action to reverse land degradation" and agreed "to strive to achieve a land-degradation neutral world".

The eleventh Conference of Parties (COP11) to the UNCCD, taking place from 16th–27th September 2013 in Windhoek, Namibia, convenes under the theme "A stronger UNCCD for a Land-Degradation Neutral World". The Parties will have a chance to address the target-setting approach at the level of impact and consider creating a working group under the UNCCD that could discuss further steps to enhance parties' action at all levels.

Some of the options have already been long in discussion. At the 2011 UN General Assembly High-Level Meeting on Desertification, Land Degradation and Drought held in New York, many leaders made a call to "enhance and foster the implementation of the UNCCD as a global policy and monitoring framework to address the issues of soil and land degradation". Indeed, several mechanisms could be explored for achieving this purpose through attaching a protocol or an annex on global land and soil degradation. Addressing this agenda at a global level requires a scientifically credible, transparent and independent assessment of existing, policy-relevant knowledge on land and soil degradation as well as a monitoring of its trends provided by a globally recognised science-policy interface.

Finally, we should learn from the shortcomings of the Millennium Development Goals, which failed to consider natural resources. Degrading lands are underperforming natural assets, but are very often all the rural poor have in many developing countries. Here, degradation correlates with poverty, food insecurity and child mortality. Ensuring land stewardship is profiled strongly in the post-2015 global development context and could make the difference.

Today, over 900 million people world-wide are affected by chronic hunger. Science says the global temperature is on track to rising above 4°C, so that droughts will become even more frequent, prolonged and intense, and will put millions of people under threat of starvation. We will not sustainably achieve food security and alleviate poverty without co-ordinating international action on sustainable soil and land conservation.

Let's put soils on the global sustainable development agenda

In order to adequately address the important role of soils and land for sustainable development, a holistic approach is needed. This article discusses why biophysical but also socio-economic aspects have to be considered – using the example of Guatemala, one of the first countries to support the proposal to create the Sustainable Development Goals.

In the outcome document of Rio+20, the international community identified the need to take actions on land and soils and committed to strive to achieve a land-degradation-neutral world within the context of sustainable development. The conference also set in motion a process to develop universal Sustainable Development Goals (SDGs). The SDGs are closely linked to the post-2015 development agenda process, which includes discussions on the future of the Millennium Development Goals (MDGs) which are to reach their target date in 2015. Merging the two processes into a comprehensive sustainable development agenda is a possibility and may be decided at the 68th session of the United Nations General Assembly in September 2013.

The SDGs have the mandate to address the social, environmental and economic dimensions of sustainable development in an integrated manner. At the same time, they need to consider national realities, capacities and respect national policies and priorities. Particularly, the SDGs should build upon the lessons learned from the MDGs.

Global goals can play an important role in raising awareness on fundamental issues and providing a common vision. The MDGs were successful in this regard. Moreover, with proper adaptation and effective implementation in various national contexts, such international goals have the potential of achieving a lasting impact through catalysing actions towards solutions. The success of the MDGs in terms of implementation certainly varied across countries and goals.

Photo: A. Lobos

Soil and land resources are far more than a mere production factor for the people in Guatemala.

This raises two questions. How can the soil and land agenda be appropriately incorporated into the SDGs? And what approaches and safeguards can ensure an effective implementation of the soil and land related SDGs in different national contexts? The case of Guatemala can provide insights to address these questions.

Land and soil degradation in Guatemala: multiple dimensions of a problem

Guatemala's total population has doubled in the last ten years; it is now 14 million, with nearly 8 million people living in rural areas. More than half of the population are considered poor, and 15 per cent extremely poor. Guatemala has the fourth highest rate of chronic malnutrition in the world and the highest in Latin America and the Caribbean. It is important to note that Guatemala underwent a 36-year long civil war, which was mainly caused by a history of inequality and discrimination and was ultimately triggered by a 1952 land reform.

The degradation of soil and land resources affects 90 per cent of Guatemala's municipalities. Exploring several closely entangled dimensions of this complex problem is crucial to developing appropriate solutions. Essentially, biophysical issues include soil erosion and contamination influenced by inadequate use of fertilisers and land-use changes due to monocultures and deforestation. This results in alteration of hydrological cycles and is worsened by the effects of climate change in terms of extreme weather events and plague attacks to crops.

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These biophysical attributes are associated with the social, economic and political features of the country. Guatemala's land distribution is the second most unequal in Latin America; the largest 2.5 per cent of farms occupy nearly two-thirds of all agricultural land. Often, land tenure of especially poor populations is insecure. It is estimated that 70 per cent of the territory is subject to unclear titles and overlapping boundaries. People have very strong cultural connections with soil and land resources, which are commonly referred to by the word *tierra* (land) and associated with a sense of belonging (homeland), and seen as a sign of power and status in society (landowner), and as a source of food and high-value resources. These meanings and associations add complexity to the planning and design of sustainable soil and land management practices and policies.

Only eight per cent of Guatemalan soils are biophysically suitable for permanent and intensive cultivation. But carrying out land-use planning based strictly on this fact could affect the food security of rural populations in particular whose main source of income and food is agricultural production. Trade-offs in primordial soil functions cannot be overlooked and are at the core of a sustainable development approach that considers environmental, social and economic dimensions in an integrated manner.

Triggering action at the national level

Once the SDGs are launched, actions to implement them at national level are expected to be set in motion. Guatemala does not have a soil and land specific policy or law in place. Soil and land resources are in turn affected by various polices and laws in different sectors. For example, the government's fertiliser distribution programme has failed to introduce fertilisers as a component of an integrated rural development strategy and has often resulted in contamination of soil and water resources. An initiative for an Integral Rural Development Act, which would aim to increase and channel public investments towards small-scale agricultural production, has been in development for the past three years with no foreseeable agreement due to intense lobbyism by the business sector and civil society organisations. A governance structure that integrates the linkages among different policies and provides a role for all actors concerned is an absolute precondition to achieve a comprehensive strategy and concerted actions for soil sustainability.

Precious resource – resource under pressure.

Photo: A. Lobos

A lesson learned from the implementation of the MDGs is that there is a need to move beyond official development assistance and explore partnerships at all levels for capacity building, technology transfer and developing incentives to encourage public participation. Proper dissemination of the SDGs to different sets of stakeholders at various levels could serve as an important step towards integrating them into the local agendas and establishing new funding mechanisms.

Conclusions

Soils and land are crucial resources for sustainable development and need to be addressed in the SDGs. Given their key role for the water-energy-food security nexus, they should be addressed as a target under a goal e.g. on food security. At this juncture, it is important to focus on the development of global targets and indicators for the sustainable use and management of soils and land. The Guatemalan example illustrates the need to match targets with the most pressing societal issues, in other words to follow a 'people-centred approach'. Targets and indicators for soils at global level need to deal with degradation but also the restoration of land and soil resources. Preventing unsustainable land use changes and ensuring ecosystem services of soils will move the global agenda forward. On the other hand, socio-economic aspects of soil and land degradation such as poverty, the right to food and secure tenure cannot fall between the cracks. A global agenda for soils and land calls for a holistic approach.

The implementation of the SDGs will require new thinking and broadening the set of stakeholders engaged in their implementation. Prompting the participation of government and other actors at the national level can prove to be quite challenging. Creating resonance through an early dissemination of the goals and the joint development of implementation strategies can help overcome participation challenges by increasing ownership, fostering partnerships and activating new sources of funding.

Payments for soil carbon seques

"A good incentive for soil conservation"

Soil carbon is important for soil structure and related nutrient and water holding properties. Increasing soil carbon stocks results in improved crop growth and contributes to enhanced climate resilience. In addition, the increase in soil organic carbon through sustainable agricultural land management (SALM) practices, such as the use of cover crops, residue management and agroforestry, will also reduce the need for synthetic nitrogen fertiliser at a given level of crop production.

Soils are the largest terrestrial store of carbon. Following the Industrial Revolution, soil carbon emissions from changing land-use and agricultural activities have come to account for about 19 per cent of total atmospheric carbon emissions, with cumulative losses of as much as 110–145 t CO_2/hectare occurring on cultivated soils. A significant proportion of these losses are, however, recoverable. The International Panel on Climate Change (IPCC) estimates that, at a carbon price of between 50–100 US dollars/t CO_2, agriculture has the second largest economic mitigation potential (after energy saving measures in buildings). Within the agricultural sector, 70 per cent of this potential could be realised in developing countries. Soil carbon sequestration contributes 89 per cent of the total agricultural mitigation potential.

Paying small farmers for soil carbon sequestration

Since 2007, the author has been assisting the government of Kenya to access global carbon markets for soil carbon as part of the Kenya Agricultural Carbon Project (KACP). The project is being implemented in Western Kenya by some 60,000 smallholder farmers on 45,000 hectares of land. They have extension and project management support from the NGO Vi Agroforestry and receive technical assistance from the World Bank BioCarbon Fund, which purchases their emission reductions. Based on consensus among world leading soil carbon researchers, a soil carbon accounting methodology was developed and double validated by independent certifiers against the Verified Carbon Standard, which is the most widely used standard in the voluntary carbon market. In line with the roll-out plan, SALM practices have now been adopted on 35,000 hectares in this successfully validated and verified project. Successful verification, including verification of safeguards, grievances and benefit-sharing mechanisms, was set as the basis for payment to farmers for providing environmental services. From a farmer perspective, as reported in Rural 21 back in January 2009, the increase in climate risk-adjusted crop yields is the main incentive for farmers to participate in the project. In 2012, farmers participating in the project had on average 40 per cent higher yields than farmers in a control site.

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Overcoming barriers to adopting sustainable land management practices

If climate adaptation is to be possible, we need to use every available means – including soil carbon sequestration – to turn down the heat from present emission trends towards 4°C warming within the century. The above project demonstrates, along with other scientific evidence, the synergies between soil carbon sequestration, smallholder income and adaptation to climate change. This project developed and then applied carbon accounting methodologies to provide conservative and cost-effective estimates for soil carbon stock changes as a basis for environmental service payments. Of course there are weaknesses, limits and challenges that need to be addressed, but payments for soil carbon sequestration is one promising approach to overcoming current barriers to the adoption of sustainable agricultural land management practices.

A scaled approach at the landscape or regional level and an appropriate financing mechanism, possibly through Nationally Appropriate Mitigation Actions (NAMAs), is required to enable more farmers to benefit from adopting these practices. Monitoring arrangements should be improved not only to provide data on mitigation performance but also to give farmers the information they need to manage crops better and cope with climate change. Safeguards and benefit-sharing mechanisms also need to be developed to ensure equity and to address other potential issues, such as land use rights. At least thirty developing countries have already expressed an interest in implementing agricultural NAMAs, which testifies to the high level of interest in exploring similar options.

*The author wishes to acknowledge the input from the co-authors **Matthias Seebauer**, of UNIQUE forestry and land use, and **Johannes Wölcke**, of Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ).*

For references and further reading: ➤ **www.rural21.com**

tration – the right path to take?

"Smallholders and the climate could lose out"

More than three times as much carbon is stored in soils across the world as it is in the atmosphere, making them one of the most important global carbon sinks. Therefore, processes impacting on the soil in which carbon is released, such as deforestation or agricultural activities, significantly contribute to climate change. The debate on the reduction of greenhouse gas emissions from agricultural activities and their consideration in the international climate negotiations has brought soils as carbon reservoirs more to the public eye.

One way to promote increased carbon storage in soils is to include the reduction of emissions from agricultural activities in the market mechanisms of the Kyoto Protocol (KP). As yet, it has only been possible to consider such measures to a very limited degree, if at all. The decision taken at the climate negotiations in June 2013 to initially focus solely on adaptation to the impacts of climate change also rules out any integration into market mechanisms for the time being. However, owing to their high sequestration potential, the question whether and how soils should be taken into account in the land-use sector in the long run continues to stay on the agenda.

Too many uncertainties

Healthy soils ensure good harvests, support the adaptation of agricultural systems to climate change and provide further important ecosystem services. Thus, they contribute to food security and development, particularly in rural areas in developing countries. It is undisputed that numerous measures to promote carbon sequestration also have positive effects on the chief functions of soils. However, a one-sided emphasis on their storage capacity, which is what including them in carbon markets would imply, has to be rejected owing to the agricultural reality in many countries of the South. The danger here is that financial and technical resources are focused on emission reduction and are thus not available for other relevant aspects.

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Accounting under the Kyoto mechanisms would mean that industrialised countries could offset measures applied for carbon storage against their reduction commitments. In order to ensure that reduction or storage really have taken place, the highest levels of accuracy need to be achieved in monitoring, reporting and verification (MRV). But in the case of soils in particular, considerable uncertainties still prevail that make the development of accurate MRV systems highly complex and cost-intensive. The possibility of a premature release of stored carbon into the atmosphere adds a further uncertainty factor to such projects.

Competition for land will increase

Elaborate MRV systems contribute to the already high transaction costs of agricultural mitigation projects. Therefore, they can only be of interest on a large scale and under good climatic and pedologic conditions. This could encourage large-scale industrialised farming while at the same time neglecting smallholders particularly in marginal areas. The latter lack access to input, knowledge and infrastructure, and therefore the basic preconditions for participating in such processes. Competition for land and thus for the best soils is going to further increase, which especially represents a threat to people without documented land titles. The market-based exploitation of carbon sequestration would additionally aggravate this conflict.

Therefore, financing via market-based tools has to be rejected owing to technical and socio-economic obstacles. Nevertheless, it is true that soils need to be given greater consideration, also with regard to climate change. Many sustainable soil and land management practices are well-documented and are often just waiting to be implemented. Thanks to their wide range of benefits, they might also be supported via other international processes or institutions, such as the Committee on World Food Security (CFS) of the UN Food and Agriculture Organization (FAO).

But in addition, in the context of the United Nations Framework Convention on Climate Change (UNFCCC), support e.g. via Nationally Appropriate Mitigation Actions (NAMAs) in developing countries could boost innovation and financing. Moreover, it could provide incentives for the integration of emission reductions in comprehensive agriculture and land-use strategies whose most important goals continue to be food security and rural development.

Why the Green Revolution failed in sub-Saharan Africa

Crop yield improvement is dearly needed in sub-Saharan Africa, but remarkably, African farmers do not adopt the available 'Green Revolution' fertiliser technologies. This has many reasons, a crucial one being soil properties.

The problems of poverty and malnutrition in sub-Saharan Africa (SSA) are well-known. Over the last five decennia, per capita food production has even decreased. The SSA food system is further threatened by rapid population growth, wide-spread soil erosion and agricultural practices of 'nutrient mining', leading to increasingly impoverished soils. It is further reasonable to assume that area expansion will take place on increasingly marginal soils. The single quick-fix solution to all these problems and threats, so it would seem, is the application of 'Green Revolution' technologies that are based on improved crop varieties in combination with ample supplies of irrigation water, inorganic fertilisers and pesticides. Since the 1960's, these have dramatically increased crop yields in South and East Asia. Such technologies never took root in SSA, and fertiliser use per hectare remains negligible at less than 10 kg. The question we try to answer here is why African farmers are reluctant to use fertilisers.

A common narrative on the underlying causes for the failure of the Green Revolution in SSA is the lack of irrigation facilities and that rainfall is very unreliable, while soil fertility is also very low: 'the unlucky fate of Africa '. But there may be many other reasons why African farmers do not adopt fertilisers: lack of agro-dealer networks, lack of credit, lack of collateral, high fertiliser prices while farmers are cash constrained, and, indeed, possibly, the promoted technologies are not appropriate under the environmental conditions of Africa. Below, these issues are discussed with a production ecology perspective because, as will be shown, problems in this sense have primacy in being solved.

Facts and myths

Irrigation potential, to begin with, is very modest in Africa, simply because, unlike Asia, it lacks extensive tracts of flat alluvial deposits under easy command of large rivers. Hence, the future agriculture of Africa will have to achieve most of its production increases under rainfed conditions. Unlike the common narrative, the rainfed climatic yield potential for grains is in the order of 7–10 tons/ha in large parts of the savanna and highland zones, where most rural Africans live. These potentials are lower only in wet areas such as the Congo basin and the drier zones around the Sahara and Kalahari, and in the Horn of Africa. It has been established that even in the Sahel, soil moisture is less restrictive for plant growth than soil nutrient content. Obviously, this holds a *fortiori* under wetter conditions such as in the savanna and highland zones. The climatic yield potentials imply that 3- to 4-fold yield increases can be achieved in large parts of Africa, provided that appropriate fertiliser technologies are applied.

With respect to soils and soil fertility, the prevailing image is one of vast expanses of uniform acid red and old

Sharp soil boundaries due to differences in the mineralogy of parent rock in Angonia district, Mozambique. ***Photo right:*** *In the middle a tilted structural ridge with on the left a red soil with modest levels of organic matter (Ferric Luvisol) and on the right a brown soil very high in organic matter (Luvic Phaeozem);* ***Photo below:*** *In the foreground reddish brown fertile soil with remnants of tall grasses (burned at end of dry season) and in the background pale sandy soil of low fertility with Miombo woodland vegetation.*

Photo: R. Voortman

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soils that are leached of nutrients and consequently very unfertile, that suffer from aluminium toxicity and that fix the phosphorus that is applied as fertiliser. In the booklet 'Myths and science of soils in the tropics', a group of authoritative scholars show that in many ways, this is a gross simplification. Soils in the tropics are spatially as variable as in temperate zones. Soils with the combination of all mentioned undesirable properties do occur in Africa, but mainly in the rainforest zone. Elsewhere, soils mostly lack these properties. Moreover, naturally, the best soils have often been selected for putting into use. Thus from the production ecological perspective, African soils do not share common soil chemical properties that would make fertilisers ineffective.

Yet, African soils seem to behave unruly. Most African countries have 'blanket', pan-territorial, fertiliser recommendations similar to those of Asia: high doses, and mostly containing N and P only. It has been shown that a large portion of farmers applying these technologies do not recover the cost. Agronomic research also mostly tests high dose technologies with this restricted selection of essential plant nutrients. The results are very variable: sometimes, appreciable yield improvement is achieved, often the yield increase is very modest, and unexpectedly frequent yields even decline. Also, in a considerable number of cases, the application of N and P together has no greater effect on yield than either N or P separately. Other observations show that yields do not further increase, or even decline, above doses as low as 20 kg. On theoretical grounds, these phenomena must be taken as a sign that, rather than N and P, other essential nutrients are the most limiting, or that at low doses of N or P other nutrients soon become most limiting. Research on other essential plant nutrients is very rare, but does show that Ca, Mg, K and S can be effective and small doses of micronutrients can also increase crop yield considerably. In any case, the yield increase per kilo nutrient with high-dose N-P applications is frequently low to the extent that it is quite rational for farmers not to adopt such technologies.

Soil properties vary considerably

Apparently African soils are different from those of the Green Revolution of Asia. In this context, it is important to observe that the largest yield increases in Asia have been achieved mainly on volcanic soils and in alluvial valleys. Most volcanic soils are inherently rich, including in micronutrients. River plains are also often fertile and, because the deposits consist of a mixture of material of a different geologic origin, here too, the chances of micronutrient deficiencies are less. This is the reason why simple fertiliser technologies, consisting of macronutrients N and P only, could be so successful. The African cultivated soils are of a different origin and have developed from crystalline bedrock. The soil chemistry therefore reflects the mineral composition of its parent material. Consequently, the chances of an unbalanced chemical composition are great and, beyond N and P, may refer to any of the essential plant nutrients. Moreover, due to geological phenomena of rock formation, such as uplift, tilting, folding and faulting, the parent rock is very variable in space, even within short distances. Thus, African soils are locally homogeneous and spatially variable and, hence, at short distances, entirely different fine-tuned and site-specific fertiliser compositions and doses may be required to achieve the agro-climatic yield potentials.

Furthermore, fertilisers are expensive in Africa, which implies that to ensure profitability of its use, the applied fertiliser must have very large yield impacts, much larger than in Europe. Appropriate fertilisers then preferably contain only the most limiting nutrient(s). Moreover, low doses should be preferred, so as to avoid decreasing marginal returns, but also to fit the small purse of African farmers. As such, high fertiliser costs further underscore the issues of fine-tuning and site-specificity.

In sum, in African rainfed agriculture, the weather may impact on crop yields, just as anywhere else, but these effects will be dwarfed by the potential of appropriate fertiliser technologies that raise yields close to agro-climatic yield potentials. A Green Revolution is possible, but fine-tuning and site-specificity, while considering the entire spectrum of essential nutrients, is knowledge intensive. The hitherto literally trial and error approach has to be curbed to an approach whereby yield response to added nutrients is related to the nutrient content in the soil. In doing so, we may develop the unifying principles on the 'chemistry' between soils, plants and fertilisers that within a coherent analytical framework will allow the quick development of appropriate fertiliser technologies for SSA.

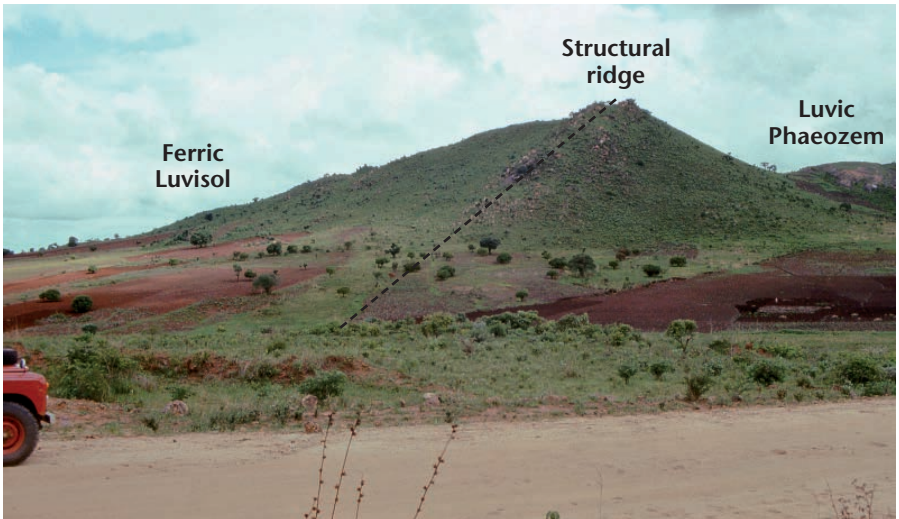

Photo: R. Voortman

Integrated Soil Fertility Management – a concept that could boost soil productivity

Soils are naturally poor in sub-Saharan Africa, and poor management has further reduced their productive capacity. The author argues that more fertiliser use is required to reverse further nutrient mining and productivity decline and that this agro-input is best used in combination with other measures to ensure that most of its nutrients are taken up by the crop.

The need for sustainable intensification of agriculture in sub-Saharan Africa (SSA) has gained support, in part because of the growing recognition that farm productivity is a major entry point to break the vicious cycle underlying rural poverty. Fertiliser use is extremely low in much of the sub-Saharan Africa region (8 kg/ha on average), and this is one of the main factors explaining lagging agricultural productivity growth. Most of the soils in Africa are inherently infertile, and poor agricultural management practices during the past decades have led to a severe decline in their productive capacity. Given the low levels of fertiliser use and poor soils in SSA, fertiliser use must increase if the region is to reverse the current trends of low crop productivity and land degradation. There are renewed efforts to raise fertiliser use in SSA from the current 8 kg to 50 kg nutrients per ha by improving the marketing, policy and socio-economic environment to increase fertiliser availability at prices affordable to smallholder farmers. Since fertiliser is very expensive for most smallholder farmers in SSA, the Alliance for a Green Revolution in Africa (AGRA) has adapted Integrated Soil Fertility Management (ISFM) as a framework for boosting crop productivity through combining fertiliser use with other soil fertility management technologies, based on site conditions.

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Taking smallholder farming conditions into account

Before proposing a definition for ISFM, it is important to sketch the context under which the smallholder farmer in SSA operates. At the regional scale, overall agro-ecological and soil conditions have led to diverse population and livestock densities across SSA and to a wide range of farming systems. Each of these systems has different crops, cropping patterns, soil management considerations, and access to inputs and commodity markets. At the national scale, smallholder agriculture is strongly influenced by governance, policy, infrastructure, and security levels. Within farming communities, a wide diversity of farmer wealth classes, inequality, and production activities may be distinguished. Analysis of farmer wealth classes in north-east Zimbabwe illustrates the variability that is typical of farmer communities in maize-based farming systems. Use of cattle manure and more fertiliser by the wealthier farmers results in higher farm-level productivity than on poorer farms. At the individual farm level, it is important to consider the variability between the soil fertility status of individual fields (Figure 1), which arises due to farmers preferring to apply limited fertilisers and organic nutrient resources to small areas of the farms. Any definition of ISFM must consider these attributes.

What is Integrated Soil Fertility Management?

We define ISFM as *'A set of soil fertility management practices that necessarily include the use of fertiliser, organic inputs, and improved germplasm combined with the knowledge on how to adapt these practices to local conditions, aiming at maximising agronomic use efficiency of the applied nutrients and improving crop productivity. All inputs need to be managed following sound agronomic principles.'* A conceptual presentation of the definition is shown in Figure 2. The definition includes a number of concepts that are described below.

1. Focus on agronomic use efficiency. Fertiliser and organic inputs are both scarce resources in the areas where agricultural intensification is needed. This is why the definition focuses on maximising their use efficiency. Agronomic efficiency (AE) is defined as the extra

Photos: KE Giller

*Figure 1: Photographs of a 3-week old maize crop in two different plots within the same farm (about 200 m apart) in Western Kenya. Both maize crops were planted at the same time. The left photograph shows a responsive plot near the homestead while the right photograph shows a less-responsive plot with high densities of 'couch grass' (*Elymus repens *(L.) Gould ssp.* repens*), an obnoxious weed (see insert in the centre). Adapted from Vanlauwe et. al, 2010.*

produce generated (in kg) per unit of nutrients applied (in kg).

2. Fertiliser and improved germplasm. In terms of response to management, two general classes of soils are distinguished: (i) soils that show acceptable responses to fertiliser (Step A – blue line, Figure 2) and (ii) soils that show minimal or no response to fertiliser due to other constraints besides the nutrients contained in the fertiliser (Step B – green line, Figure 2). We have classified above soils as 'responsive soils' and 'poor, less-responsive soils' respectively. In some cases, where land is newly opened, or where fields are close to homesteads and receive large amounts of organic inputs each year, a third category of soil exists where crops respond little to fertiliser as the soils are fertile. These soils need only maintenance fertilisation and are termed 'fertile, less responsive soils'. The ISFM definition proposes that application of fertiliser to improved germplasm on responsive soils will boost crop yield and improve the agronomic efficiency relative to current farmer practice, characterised by traditional varieties receiving too little and insufficiently managed nutrient inputs (Step A – blue line, Figure 2). Major requirements for achieving production gains on 'responsive fields' within Step A include (i) the use of disease-resistant and improved germplasm, (ii) the use of the correct fertiliser sources, and rates, (iii) appropriate fertiliser use in terms of placement and timing, and (iv) crop and water management practices.

3. Combined application of organic and mineral inputs. Organic inputs contain nutrients that are released at a rate determined in part by their chemical characteristics or organic resource quality. However, organic inputs applied at low rates commonly used by smallholder farmers in Africa seldom release sufficient nutrients for optimum crop yield. Combining organic and mineral inputs has been advocated as a sound management principle for smallholder farming in the tropics because neither of the two inputs is usually available in sufficient quantities and because both inputs are needed in the long run to sustain soil fertility and crop production.

4. Adaptation to local conditions. As previously stated, soil fertility status within and between farms is highly variable and a challenge before the African Green Revolution is adjusting recom-

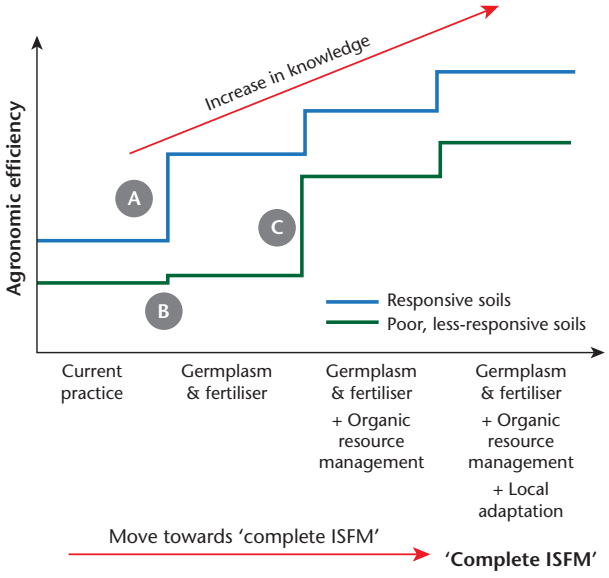

Figure 2: Conceptual relationship between the agronomic efficiency (AE) of fertilisers and organic resource and the implementation of various components of ISFM, culminating in complete ISFM towards the right side of the graph. Soils that are responsive to NPK-based fertiliser and those that are poor and less-responsive are distinguished. The 'current practice' step assumes the use of the current average fertiliser application rate in SSA of 8 kg fertiliser nutrients per ha. The meaning of the various steps is explained in detail in the text. Adapted from Vanlauwe et. al, 2010.

Figure 3: Application of phosphor fertiliser to a dual purpose soybean variety that produces substantial amounts of leafy biomass and leaves a net amount of fixed N in the soil and rotation of this soybean with a N-efficient and disease-resistant maize variety that receives a minimal amount of N fertiliser is a good example of an ISFM strategy. Adapting fertiliser rates to prevailing soil fertility conditions would qualify such intervention as 'complete ISFM'.

mendations to include such variability in soil fertility status. Firstly, soil fertility status can vary considerably within short distances. Often, the soil organic matter (SOM) content is a good proxy for soil fertility status, provided that this parameter is not over-extrapolated across dissimilar soils. Soil organic matter contributes positively to specific soil properties or processes fostering crop growth, such as cation exchange capacity, soil moisture and aeration, or nutrient stocks. On land where these constraints limit crop growth, a higher SOM content may enhance the demand by the crop for N and consequently increase fertiliser N use efficiency.

5. A move towards 'complete ISFM'. Several intermediary phases are identified that assist the practitioner's move towards complete ISFM from the current 8 kg ha^{-1} fertiliser nutrient application with local varieties. Each step is expected to provide the management skills that result in yield and improvements in agronomic efficiency (Figure 2). Complete ISFM comprises the use of improved germplasm, fertiliser, appropriate organic resource management and local adaptation. Figure 2 is not necessarily intended to prioritise interventions but rather suggests a need for sequencing towards complete ISFM. It does however depict key components that lead to better soil fertility management. For less-responsive soils, investment in soil fertility rehabilitation will be required before fertiliser AE will be enhanced.

Integration of ISFM principles in farming systems

Principles embedded within the definition of ISFM need to be applied within existing farming systems. Two examples clearly illustrate the integration of ISFM principles in existing cropping systems: (i) dual purpose grain legume – maize rotations with P fertiliser targeted at the legume phase and N fertiliser at rates below those recommended that are targeted at the cereal phase in the moist savanna agro-ecozone (Sanginga et al., 2003) (Figure 3) and (ii) micro-dose fertiliser applications in legume-sorghum or legume-millet rotations with retention of crop residues and combined with water harvesting techniques in the semi-arid agro-ecozone (Bationo et al., 1998). As for the grain legume-maize rotations, application of appropriate amounts of mainly P to the legume phase ensures good grain and biomass production, with the latter in turn benefiting a subsequent maize crop and thus reducing the need for external N fertiliser (Sanginga et al., 2003). As for the micro-dose technology, spot application of appropriate amounts of fertiliser to widely spaced crops such as sorghum or millet substantially enhances its use efficiency, with further enhancements obtained when combined with physical soil management practices aiming at water harvesting.

Dissemination of ISFM

The gradual increase in complexity of knowledge as one moves towards complete Integrated Soil Fertility Management (Figure 2) has implications on the strategies to adapt for widespread dissemination of ISFM. Furthermore, a set of enabling conditions can favour the uptake of ISFM. The operations of every farm are strongly influenced by the larger rural community, policies, supporting institutions and markets. Not only are farms closely linked to the off-farm economy through commodity and labour markets, but the rural and urban economies are also strongly interdependent. Farming households are also linked to rural communities and social and information networks, and these factors provide feedback that influences farmer decision-making. Because ISFM is a set of principles and practices to intensify land use in a sustainable way, uptake of ISFM is facilitated in areas with greater pressure on land resources.

The first step towards ISFM acknowledges the need for fertiliser and improved varieties. An essential condition for its early adoption is access to farm inputs, produce markets and

financial resources. To a large extent, adoption is market-driven as commodity sales provide incentives and cash to invest in soil fertility management technologies, offering opportunities for community-based savings and credit schemes. Policies towards sustainable land use intensification and the necessary institutions and mechanisms to implement and evaluate these are also a factor that facilitates the uptake of ISFM. Policies favouring the importation of fertiliser, its blending and packaging, or smart subsidies are needed to stimulate the supply of fertiliser as well. Specific policies addressing the rehabilitation of degraded, non-responsive soils may also be required since investments to achieve this may be too large to be supported by farm families alone.

While dissemination and adoption of complete ISFM is the ultimate goal, substantial improvements in production can be made by promoting the greater use of farm inputs and germplasm within market-oriented farm enterprises. Such dissemination strategies should include ways to facilitate access to the required inputs, simple information fliers, spread through extension networks and knowledge on how to avoid less-responsive soils. A good example where the 'seeds and fertiliser' strategy has made substantial impact is the Malawi fertiliser subsidy programme. Malawi became a net food exporter through the widespread deployment of seeds and fertiliser, although the aggregated agronomic efficiency was only 14 kg grain per kg nutrient applied (Chinsinga, 2008). Such AE is low, and ISFM could increase this to at least double its value with all consequent economic benefits to farmers. As efforts to promote the 'seed and fertiliser' strategy are under way, activities such as farmer field schools or development of site-specific decision guides that enable the tackling of more complex issues can be initiated to guide farming communities towards complete ISFM, including aspects of appropriate organic matter management or local adaptation of technologies. The latter will obviously require more intense interactions between farmers and extension services and will take a longer time to achieve its goals.

References and further reading:
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In brief

■ 'Carbon farming': Jatropha plantations could mitigate climate change

New biomass plantations in desert regions could slow climate change, according to scientists at Hohenheim University in Germany. In a joint study with the management consultancy Atmosphere Protect GmbH, scientists conclude that each hectare of Jatropha curcas could bind up to 25 tons of atmospheric carbon dioxide annually for over 20 years. The researchers call this approach ‚carbon farming'. Jatropha grows on barren, dry soils which cannot be used to grow food. As the plant cannot survive entirely without irrigation despite its high tolerance to drought, coastal regions where seawater can be desalinated would be particularly suitable for cultivation. Bioenergy from the plantation's fruits and pruning can be used to cover part of the energy for irrigation. According to the scientists, an area over around one billion hectares is suitable for ‚carbon farming' worldwide. The costs are around EUR 42–63 for each ton of carbon dioxide bound. Based on this, the scientists regard the method as economically promising and competitive with other approaches, such as subterranean storage of carbon dioxide. *(Hohenheim University, ile)*

■ Early prediction of crop failures possible

Climate models can help predict some crop failures several months before harvest, according to a new study. The research showed that in about one-third of global cropland, temperature and soil moisture have a strong relationship to the yield of wheat and rice at harvest. And, for those two key crops, the model could predict crop failures three months in advance for about 20 per cent of global cropland. The impact of climate extremes – the kind of events that have a large impact on global production – is more predictable than smaller variations in climate, but even variations of 5 per cent in yield were correctly simulated in the study for many parts of the globe, the authors said. In the study, the scientists created and tested a new crop model, incorporating temperature and precipitation forecasts and satellite observations from 1983 to 2006. They then examined how well the data predicted the crop yield or crop failure that actually occurred at the end of each season. The ultimate yields can be estimated according to the climatic condition several months before. According to the scientists, the pattern is set by the pre-existing conditions experienced in spring. The team studied four crops – maize, soybeans, wheat and rice – but the model proved most useful for wheat and rice. Crop failures in regions of some major wheat and rice exporters, such as Australia and Uruguay, could be predicted several months in advance, according to the study. *(University of Leeds/ile)*

Experience with the System of Rice Intensification in Timor Leste

The System of Rice Intensification (SRI) is a natural resource management technology that has supporters and opponents. Evidence of the technology's impacts is mixed. Recent research results from Timor Leste suggest that SRI can improve yields and incomes of smallholder farmers when proper extension systems are in place.

Rice is the number one food crop in large parts of the developing world. This is especially true in Asia, but in Africa, too, the importance of rice is growing. Given population growth, rising demand and limited land resources, further increases in rice yields will be required. However, yield growth has slowed down recently, and additional inputs are facing diminishing returns. Moreover, rice production with high input regimes leaves a significant environmental footprint; in some regions excessive use of fertiliser, pesticides and water has led to environmental problems, including the depletion of natural resources. Heavily fertilised, continuously flooded rice fields also contribute to greenhouse gas emissions and climate change, while climate change itself is likely to impact negatively on rice production. In some regions, rice farmers are already having to cope with water scarcity and droughts. Future yield growth must hence be accomplished with less reliable water supplies, less environmental degradation and less resource depletion.

How to achieve higher yields with lower quantities of inputs is becoming the crucial question. Here we argue that natural resource management (NRM) technologies offer interesting perspectives. This is demonstrated by one concrete example, namely SRI that smallholder farmers in Timor Leste have recently started to adopt.

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NRM technologies

Recently, NRM technologies have been proposed to improve the efficiency of cropping systems in a sustainable way. These technologies build on integrated agronomic principles, responding to a wide range of challenges in different environments. Prominent examples include conservation agriculture, agroforestry and organic farming, all of which have attracted considerable attention over the last few decades. NRM approaches reduce the use of external inputs by enhancing the potential of locally available resources through improved management practices. This is in contrast to many conventional technologies, such as high-yielding crop varieties, where the innovation is related to a particular input.

Unlike standardised input packages, NRM technologies involve the adaptation of practices to local conditions. As a result, best practices in one place cannot necessarily be generalised. This is especially true in smallholder agriculture due to highly diversified resource endowments and farm management options. Location-specific adaptation may result in adoption patterns and impacts that vary from one place to another. This also makes impact assessment more complicated, contributing to controversies over the potential role of NRM technologies on a broader scale. The ongoing scientific and public debate reveals that there are important knowledge gaps concerning the ramifications of NRM technologies in theory and practice.

SRI principles and components

In rice production, SRI is one of the most prominent natural resource management technologies. The aim of SRI is to contribute to higher yields with lower amounts of external inputs such

as seed, water and fertiliser through better management of irrigation, soil fertility and pests. SRI is a farmer-centred innovation that originated in Madagascar in the mid-1980s. SRI methods have since been introduced in almost 50 countries, including major rice producers like India, China, the Philippines, and Vietnam.

Based on the experience from Madagascar, several SRI core components were developed, including early transplanting, single seedlings, wide spacing and intermittent irrigation (see Table). Sometimes additional components are recommended, including organic fertilisation and regular weeding, among others. Weeding is more important in SRI than in conventional rice production, because weeds spread more rapidly under non-flooded conditions.

SRI core components

Early transplanting	Rice seedlings should be transplanted at an age of younger than 15 days to minimise the transplant shock.
Single seedlings	Rice seedlings should be planted singly to permit better root growth and tillering.
Wide spacing	Rice plants should be planted in square patterns of a minimum distance of 20 x 20 cm, in order to keep all leaves photosynthetically active.
Intermittent irrigation	Rice fields should be kept moist but not continuously flooded, in order to minimise anaerobic conditions that hamper the growth of roots and soil organisms.

Source: Noltze et al. (2013)

Adoption of SRI in Timor Leste

In Timor Leste, the System of Rice Intensification has been introduced since 2007 through a programme jointly implemented by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and the Timorese Ministry of Agriculture and Fisheries. The rice sector in Timor Leste is constrained by low levels of mechanisation, insufficient irrigation and weak transport infrastructure. At the farm level, this implies shortages of rice seeds, irrigation water and chemical inputs.

To analyse SRI adoption and impacts, we conducted a survey of close to 400 randomly selected households and also collected soil samples from farmers' rice plots. The data show that SRI adoption rates vary regionally, and that even among the SRI users partial adoption is commonplace. Partial adoption implies that farmers use SRI techniques only on part of their total rice area. In addition, different SRI components are adopted to varying degrees. Regression analysis demonstrates that socioeconomic household characteristics tend to influence SRI adoption decisions. Participation in special training programmes is an important factor, because SRI is a knowledge-intensive technology. Moreover, sufficient availability of family labour is an important determinant of adoption. SRI is relatively labour-intensive, and, especially in the early phase of adoption when farmers are experimenting with the new system, family labour cannot easily be replaced by hired labour.

Photo: M. Noltze

SRI farmer using mechanical weeding to prevent excessive weed growth, enhance soil aeration and incorporate biomass for soil nutrient management.

However, socioeconomic characteristics alone can explain adoption only to a limited extent. Plot level characteristics also determine the use of SRI. A key factor is the availability of a technical irrigation system that allows farmers to control water levels in accordance with SRI recommendations. Water management by user groups may hinder SRI adoption, because then farmers cannot control water levels on their plots individually. Close proximity of a plot to the homestead also increases the likelihood of adoption, as this facilitates monitoring and experimenting with the new technology. Improved rural infrastructure could also help reduce the time to reach plots at larger distances. Finally, the decision to adopt SRI is influenced by soil characteristics and topography, including conductivity, loam content, and slope, which are all related to water and nutrient holding capacity. Ignoring such factors in SRI dissemination programmes may lead to unsatisfactory adoption outcomes.

Adaptation through knowledge

The analysis in Timor Leste suggests that successful adoption of SRI requires a substantial amount of experimenting with how to adapt the technology and its components to location-specific conditions. While some degree of farmer experimentation is desirable, this can be quite challenging in terms of knowledge, management time and

Photo: M. Noltze

Rice harvest in Timor Leste

the risk of failure. Frustrating experience entails disadoption and negative publicity for the technology as a whole. Hence, extension efforts have to be sufficiently flexible and location-specific, which requires new skills for extension agents, including experience with participatory learning.

Historically, public extension programmes have not always been very effective in developing countries. Thus, developing new cost-effective extension approaches is important. Without improved extension models, widespread and successful adoption of NRM technologies is unlikely to happen among smallholder farmers. The integration of local farmer knowledge through community-based learning and farmer-to-farmer transfer could be promising to make extension programmes more sustainable.

Yield and income effects of SRI

We also used the survey data from Timor Leste to analyse the impacts of SRI adoption on rice yields and household incomes. If one simply compares yields on SRI and conventional rice plots, the difference in our sample is insignificant. However, such a comparison can be misleading due to possible selection bias. Since farmers decided themselves whether or not to adopt the new technology, there may be systematic differences between the characteristics of adopters and non-adopters. Indeed, we find that SRI farmers in Timor Leste are those that operate under more unfavourable conditions. In other words, without SRI, they would have lower yields than other farmers. Controlling for these differences, we find that SRI adoption has a positive net yield effect of 46 per cent. This substantial gain is the average effect for the adopters. For farmers who have not adopted, switching to SRI could increase yields by an estimated eleven per cent. These findings underline that yield impacts are situation-specific, which is in line with earlier studies on SRI in different countries.

The impact of SRI on total household income is an average increase of two per cent for technology adopters. This effect is statistically significant, but lower than what one might expect when looking at the yield gains. The reason is that SRI requires more labour and management time from farmers, which has to be subtracted from other economic activities. While the revenue from rice production increases through SRI adoption, the income from other sources is somewhat reduced. It should be stressed, however, that the data refer to the early stages of SRI adoption in Timor Leste. With more experience, management time can possibly be reduced, which could lead to higher household income gains in the future.

Interestingly, when splitting up the sample by farm size, income gains for smaller farms of less than two hectares are larger than those for relatively larger farms. Household income effects of SRI have not been analysed previously in the scientific literature.

Outlook

SRI and other NRM technologies clearly have the potential to increase productivity while reducing the use of external inputs. However, they are relatively knowledge-intensive and require local adaptation, so that successful adoption by smallholders depends on proper extension programmes. Moreover, SRI requires more labour and management time, at least during the early stages of adoption. The results from Timor Leste and other countries suggest that impacts of SRI are quite situation-specific.

While SRI seems to be promising in many situations, this technology should not be seen as a substitute for other innovations, such as improved seed. There is still limited knowledge about the interactions of SRI with different rice varieties. But the highest SRI yields reported in the literature were actually achieved with high-yielding rice varieties and hybrids, suggesting that breeding and agronomic innovations are complementary. The development of sustainable production systems requires smart combinations of various technologies.

Further reading

Noltze, M., Schwarze, S., Qaim, M. (2012). Understanding the adoption of system technologies in smallholder agriculture: The system of rice intensification (SRI) in Timor Leste. Agricultural Systems 108, 64–73.

Noltze, M., Schwarze, S., Qaim, M. (2013). Impacts of natural resource management technologies on agricultural yield and household income: The system of rice intensification in Timor Leste. Ecological Economics 85, 59–68.

Revival for Zimbabwe's meat market

Zimbabwe used to be well-known for its high-quality meat exports. The sector was hard hit by the economic crisis that set in during the 1990s and coincided with the impact of a failed land reform and recurrent drought. Now, a new livestock-fattening scheme is to contribute to the survival of the branch and help resource-poor smallholders earn a living by marketing their meat.

Gratiano Kariba Marema is 75 years old and does not really look like a typical Zimbabwean smallholder farmer. Wearing suit and tie and a hat, he is showing us his cattle in a bigger herd on free grazing. "I am too old to do farming. I concentrate on livestock," he says. He remembers the old days when Zimbabwean meat was exported world-wide, and he hopes to participate in the revival of the sector in the country. He was one of the first farmers to adhere to a livestock fattening pilot scheme in sales pens at Chivaka village in Bikita district in 2012. This public-private partnership venture is being run by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) in co-operation with a private slaughterhouse, Montana Meats (see Box on page 42). In 2012, 32 farmers participated in the venture, with a total of 49 animals; in 2013, a further 40 livestock owners joined the scheme.

The importance of cattle

Zimbabwe used to be the breadbasket of southern Africa. High-quality meat was exported even to Europe. The economic decline exacerbated by recurrent droughts did not leave the livestock sector out. It is struggling to improve as the overall situation gets better, but it needs re-orienting from what were formerly a few big and efficient cattle farms towards producers comprising many resource-poor smallholders.

Bikita District in Masvingo Province in the southeast of Zimbabwe is mainly (85 %) composed of natural regions IV (450 to 650 mm annual precipitation) and V (less than 450 mm) and is very mountainous. The soils are particularly poor, sandy and rocky. Rainfalls in the region are erratic. Therefore, it is not advisable to cultivate maize or other crops. Livestock should be the main source of rural income in this area, but even this faces a lot of problems. The type of grass (couch grass, spear grass) is not ideal to feed cattle. Buffalo bean is a common indigenous climber that irritates the skin of cattle, which hinders good development. The type of cattle introduced, "Brahman" and "Africander", do not really fit into this area as they are not adapted to local conditions. The local "Mashona" race would be the best option, although most animals are crossbreeds that get by on the whole.

Cattle are used for ploughing, logging, and transport of goods or people. One very important aspect is the "lobola", the price a young man has to pay to get married to a wife. Even if the women dies and the husband did not

Gratiano has shared his experience in several meetings, always praising the advantages farmers could get out of the new feeding scheme. This has enabled him to encourage numerous other livestock keepers.

Photo: R. Behrens

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pay cattle to her parents, he must do so before she is buried. Traditionally, cattle are slaughtered in August for hero's holidays, an important celebration remembering the fallen heroes in the liberation war, and for Christmas and New Year celebrations, when families gather together. Cattle also represent savings for most of the people, and are commonly known as the farmer's bank, which of course is not commercialised.

Throughout the year, but especially in the winter, a large proportion of the cattle delivered to abattoirs are not ready for slaughter. They lose condition starting from August up to November, when the rains start again. With the new green grass, they get better until April/May. Then both fodder and water become scarce. As, in general, cattle are only sold when the farmer requires cash, the animals delivered to abattoirs are of a poorer grade than they could be if they were considered as a revenue-generating resource rather than as a cash reserve. Consequently, the consumer is also adversely affected.

The project

The GIZ Food Security and Livelihood Project has been working in Bikita since October 2011. The interventions mostly cover poor rainfall areas with less than 650 mm of annual precipitation. Livestock rearing is recommended for these areas, but farmers still grow maize and other crops. The limitations for livestock are water from June to November coupled with restricted pasture from August to November. Cattle lose weight and value, and some even die. The GIZ project supports the repair of dams and building of weirs and bush pumps that help solve the water problem. The support given to the feed pens is one way of reducing the pressure on the pasture through overstocking.

Due to the scarcity of natural pasture in August 2012, the GIZ project decided to contact the company Montana Meats, which had started a pen-fattening scheme in the neighbouring Zaka district in June 2012. A similar pilot was established in Bikita District.

Who is doing what?

Cattle are put in the pens for 60 to 90 days depending on their age and condition at inception. The younger ones and the highly emaciated stay longer. They are inducted using "Bimectin" injections, which will cure the worms, and a tag is put in the ear and a brand on the skin to identify the animals. This is paid by Montana Meats. The food, supplied by the private feed company National Foods, consists of molasses, yellow maize, cotton seed cake, grass, sugar cane, urea and others. This year, hay has been added to the diet to improve the fibre intake. It seems to be very convenient for the cattle.

Cattle dipping at Mikita

Photo: R. Behrens

The private-sector partner

Montana Meats Pvt Ltd is a company that purchases cattle throughout Zimbabwe, both for direct slaughter and for feeding before slaughter. Montana has feedlots, abattoirs and administration facilities countrywide, and logistics solutions are in place to facilitate the project. The company describes its aims as follows:

- to establish a long-term partnership between the company and cattle producers
- to offer a financial package that will enable the cattle producer to fatten his cattle to their full value without the initial burden of sourcing finance, and
- to ensure a supply of good quality, healthy, nutritious, and safely monitored beef to the country.

Feeding and care remain in the hands of the farmers, as does ownership of the cattle until slaughter. They are assisted by a permanent caretaker employed by Montana Meats. The company also pre-finances the feed. A beast consumes dry matter which is equivalent to three per cent of its body mass daily. The weight increases by one to two kg per day, and meat quality improves very much. Normally, cattle are on free range from June 1st and just feed on the scarce natural vegetation, so that they would not be marketable in the winter (dry season). Finally, Montana Meats pay Harare prices on the day of slaughter, in cash. Prices vary, going up from June to December and decreasing from January to May.

Each animal needs about 50 litres of water per day. Currently, GIZ is supporting Bikita district with the repair of two feedlots and assisting in water supply. In Chivaka, a former sales pen has been repaired. Water is pumped from the river by a mobile diesel pump; a weir will be constructed to store water over the dry season. In Demba village, 50 km away from Chivaka, another sales pen is being repaired, and a solar pump will be

fixed on an existing borehole to provide water for the cattle. In the southern isolated Ward 1 (the Ward is the smallest administrative unit) water is supplied by a diesel engine installed to serve a rural health station. All three stations together in Bikita can accommodate cattle from about 150 farmers.

Co-operation with the private sector will be extended to four other districts through an EU-financed agriculture extension component. Less investment is to take place in reconstruction and water supply in these districts, but more emphasis will be put on training of extension field staff, whereby cattle marketing is only one aspect of overall marketing training.

The further steps

The next step is to include goats in the feeding schemes. GIZ has started a goat improvement programme. Twenty male Boer goats (a breed of goat that was developed in South Africa in the early 1990s for meat production) and 22 Boer goat cross-bred females were introduced in May 2013 as the base of the activity. Currently, most goats are not really being commercially bred in Zimbabwe, inbreeding takes place, and the animals are becoming smaller and smaller each generation. Since the beginning of the activity, 20 goat clubs have been formed by the project and are trained by Taonga Mzezewa, the livestock adviser from Sustainable Agriculture Technology, a private Zimbabwean NGO and implementation partner of the project, in co-operation with members of the line ministries, LPD (Livestock Production Department) and the Veterinary Department. The aim is not only to supply breeding stock, but to induce a sustainable, economically viable development in the sector. It is envisaged that the clubs exchange their bucks amongst themselves and, later, to others to boost the sector's revival. There already is a strong market for goat meat in Bulawayo, the second largest city after the capital Harare and located in the southwest of the country, but there is no supply at all in Masvingo Province, in the southeast. Therefore, Montana Meats have expressed interest in joining the scheme. The modalities of co-operation have yet to be worked out. The goat programme is set for three years.

Back to the farmer

Gratiano himself had put in nine cattle of his own stock. When the cattle from the pilot project were slaughtered in November 2012, he was present to check that everything went right. Ultimately, some cows fetched more than 1,000 US dollars after fattening, while only one had a loss of 125 US dollars after deduction of cost for food. This had been a poor animal from the beginning and could not convert the feed. Nevertheless, without feeding the animal was not marketable. At the time of induction, Gratiano's nine animals had a (slaughterhouse) value of 3,420 US dollars. After two months of feeding, their value had increased to 7,253 US dollars (USD). The feed cost for 9 tonnes at 265 USD per tonne was at 2,250 USD, leaving Gratiano with a profit of 1,298 USD after deduction of costs for inspection and transport. A rural worker earns 5 US dollars a day in Zimbabwe.

When asked why he was actively promoting the scheme, Gratiano replied: "If I had not done this, some of my animals could have died. Their value would certainly have decreased during the dry season. The action was very profitable for me, and I will continue with the scheme, but with fewer animals, to maintain my herd."

Mention should be made that Gratiano and his wife, who is also a teacher, are animal lovers. They raise chicken, turkeys, guinea fowls, rabbits and goats at their homestead. Their retirement is secured!

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