

# research evidence for policy



Hillslope terraces are a highly effective means to reduce soil erosion and provide additional benefits such as carbon sequestration, higher yields and higher incomes. (Ethiopia). Photo: Gete Zeleke

## A four-way win for agricultural development



Case studies featured here were conducted in: Tajikistan and Ethiopia

### Policy message

- Access to land and land rights, supportive policies, infrastructure development, and market access are key to achieving resource-efficient agriculture.
- Public investments in smallholder agriculture can reduce land degradation, support agricultural development, and mitigate rural poverty.
- Helping farmers invest in their land means providing intensified training and extension services, plus access to affordable fertiliser and technology.
- Farmers are more likely to adopt soil and water conservation techniques by producing food, fodder, fibre, or fuel.
- Sustainable farming practices produce environmental benefits that are vital for society at large. Farmers should be compensated for providing these benefits.

- Rural farming areas in the developing world face major environmental, social, and economic challenges. Environmental problems include soil erosion, flooding, depleted soils, other forms of land degradation, and a changing climate. Despite increasing urbanisation, rural areas are still home to half the world's population. About 2.6 billion people are directly engaged in small-scale farming, and this number is expected to remain about the same over the next few decades.

- How can these agricultural areas tackle the challenge of producing more, while conserving and restoring the environment, and providing employment and a decent standard of living?

### Challenges in smallholder agriculture

- In many regions of the world, agriculture has made significant advances in productivity since the 1970s. In developed countries, yields and output per worker have both gone up dramatically (Figure 1). In Asia, the Green Revolution greatly increased yields per hectare of staple crops, but output per worker has scarcely risen. In other parts of the world, especially sub-Saharan Africa, yields and output per worker have remained very low, and in some places may even have declined.

- This means that there is significant potential to boost productivity in

these areas, and the consensus is that African agriculture in particular must improve its efficiency. However, any endeavour aiming at intensifying farming in Africa faces a triple challenge: inadequate and poor management practices have led to widespread soil degradation; years of continuous land use without sufficient inputs (e.g., fertiliser) have depleted the nutrients and organic matter of many soils; and there is a lack of funds for mechanisation and alternative or complementary livelihood options for many redundant farmers.

The major underlying reason for low yields per hectare – and a long-term threat to productivity – is degraded

## Definitions

**Natural resources** are the totality of components of nature that are considered useful and/or valuable. Some natural resources are renewable: they can regenerate within the time scale of about one human generation; others are non-renewable (Hurni et al. 1996).

**Land degradation** is a reduction in the capacity of the land to produce benefits from a particular land use under a specific form of land management. Land includes vegetation, wildlife, soil, and water in a landscape (Hurni et al. 1996).

**Sustainable land management** is a system of technologies and/or planning measures that aims to integrate ecological with socio-economic and political principles in the management of land for agricultural and other purposes, to achieve intra- and intergenerational equity (Hurni et al. 1996).

**Payment for ecosystem services** means offering incentives to farmers for managing their land in a way that provides additional environmental services. According to a recent definition, it is “a transparent system for the additional provision of environmental services through conditional payments to voluntary providers” (Tacconi 2012).

- soils. About one-third of the world's agricultural land, including most cropland and some pasture land, has been seriously degraded by soil erosion, including the loss of nutrients and organic matter. The loss of topsoil through erosion is particularly alarming given the soil's extremely slow regeneration rate: topsoil erosion occurs 30 to 40 times faster on average than the replacement rate of topsoil (Pimentel 2006).

### Conserving soil and water

- Conserving soils also means conserving water and using it more productively. In the case of unprotected soils, heavy rain runs across the soil and into rivers, carrying the topsoil with it. Making sure water can percolate into the soil raises groundwater levels and increases the water available for plants and crops. Harvesting water also makes irrigation possible, enabling multiple crops and increasing yields.
- There are many ways to conserve soil and water: they have been documented and promoted by the World Overview of Conservation Approaches and Technologies (WOCAT), a network co-funded by the Swiss Agency for Development and Cooperation since 1992. They include agronomic measures (e.g., planting along the contour), vegetative measures (e.g., green manure, mulching), structural

measures (e.g., bunds, terraces), and management measures (e.g., crop rotation, agroforestry). Different approaches are appropriate in different situations; but many technologies can be transferred successfully to other world regions if they are adapted to the local context.

### Maintaining a public good requires public investment

Unfortunately, many soil conservation measures are uneconomic for farmers: building terraces may be the most effective way to stop erosion on steep slopes, for example, but it is very costly in terms of labour. So outside help is needed.

Erosion harms more than just the productivity of the soils that are washed away. It also has serious off-site effects. Flooding and sedimentation in rivers, reservoirs, and lakes cause major damage downslope and downstream. Dust storms carry away valuable nutrients and soil microfauna, darkening the sky in cities hundreds of miles away.

Soil and water conservation is a public good that provides many ecosystem services: it improves soil productivity, maintains groundwater levels and quality, conserves biodiversity, controls flooding while enhancing base flow downstream, maintains air quality, and mitigates the effects of climate change. It benefits many people in both upstream and downstream areas – not just individual farmers. But these ecosystem services are rarely paid for, even though they are in the interest of society and the world.

This provides strong justification for larger-scale investments in sustainable land management – investments that encourage and enable farmers and rural communities to implement conservation measures that will safeguard such ecosystem services well into the future. New ways are needed to encourage farmers to use the land in a responsible manner, and to compensate them for the ecosystem services they provide.



Simple measures like mixing soil with manure in a hole before planting can have remarkable effects for soil and water conservation (Niger). Photo: Will Critchley

## Mitigating the consequences of climate change

Agriculture is highly vulnerable to climate change: rising temperatures and shifting rainfall patterns make it difficult to grow certain crops. Extreme events like droughts and floods are likely to become more common. At the same time, agriculture – especially livestock keeping – is an important driver of climate change: it accounts for 14% of global greenhouse gas emissions (Pachauri and Reisinger 2007), while deforestation accounts for an additional 12% (van der Werf et al. 2009).

Agriculture is unusual in that it bears potential to mitigate climate change while producing even more output. Naturally, soils are second to the oceans in storing carbon – but they store more than the atmosphere or the living vegetation cover. Intensified land use, soil erosion, and many current agricultural practices deplete the level of carbon in the soils, and increase the amount of carbon dioxide in the atmosphere.

Appropriate land management techniques can reverse such negative trends. It should be possible to sequester between 1.2 and 3.1 billion tons of carbon in the soil annually, simultaneously increasing soil fertility and crop yields in the long run. That would have a double benefit: adding one ton of carbon per hectare to the root zone can increase grain production in developing countries by between 24 and 32 million tons (Lal 2011).

## A quadruple win?

Poor farmers contribute less to climate change than others, yet they are likely to suffer more than most as a result of it. Nevertheless, they must also be part of the solution. Fortunately, introduction of sustainable, conservation-oriented farming practices may produce a four-way win:

**Sequestering carbon.** Appropriate farming techniques applied in depleted dryland areas can sequester more carbon in the soil than they extract. For example, practices such as composting, mulching, or agroforestry build up the level of organic carbon in the soil. That will help mitigate climate change.

**Increasing yields.** Increasing the level of organic matter in the soil enhances crop production and yields. It makes soil nutrients more available, makes fertiliser more effective, and retains water in the soil where crop roots can reach it.

**Conserving soil and water.** Soil and water conservation practices increase soil organic matter and soil moisture. This in turn improves the soil structure, protecting the soil from erosion and increasing the infiltration of rainwater. This raises groundwater levels and reduces flooding downstream.

**Reducing poverty.** Higher yields mean higher incomes for small-scale farmers. This will help overcome rural poverty and create demand that stimulates the economy.

## Featured case studies

NCCR North-South research in Tajikistan and Ethiopia examines sustainable land management practices and their potential for improving soil quality and climate resilience through better soil organic matter management.

The main conclusions on natural resource management and agricultural development drawn in this policy brief – especially those relating to poverty – were derived from the International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD 2008). Additional information was taken from the World Development Report on Agriculture (World Bank 2008). [www.agassessment.org](http://www.agassessment.org)

The assessment of soil degradation and sustainable land management is based on a national study in Ethiopia, the Swiss-led Soil Conservation Research Programme (1981–98) and the Water and Land Resource Centre in Ethiopia (since 2011). In addition, the global soil and water conservation database established by WOCAT was also consulted. <https://www.wocat.net/>

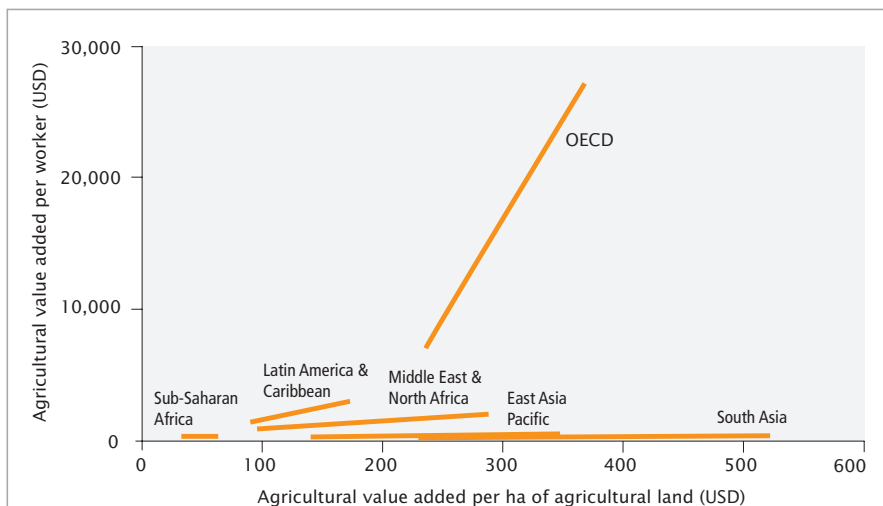
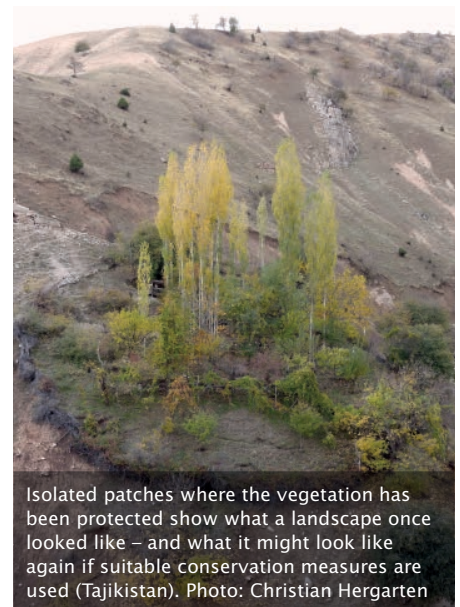


Figure 1: Growth in land and labour productivity by region, 1971–2003 ([www.un.org/esa/sustdev/publications/trends2008/fullreport.pdf](http://www.un.org/esa/sustdev/publications/trends2008/fullreport.pdf))



Isolated patches where the vegetation has been protected show what a landscape once looked like – and what it might look like again if suitable conservation measures are used (Tajikistan). Photo: Christian Hergarten



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## Policy implications of NCCR North-South research

**Encourage local investment in land and sustainable farming:** This includes enacting environmental policies and regulations to strengthen a sustainable agricultural sector, guaranteeing land rights to smallholders, and enhancing the status of land by constructing rural infrastructure like roads, markets, rural credit centres, schools, and health centres (human and livestock).

**Provide incentives to conserve soil and water:** Examples are subsidising conservation efforts, improving access to credit, providing seedlings for fruit trees, and launching programmes for controlling soil erosion.

**Support farmers' skills development and equipment:** This includes empowering farmers through training and extension work, and promoting participatory capacity building among farmers (e.g., farmer-to-farmer schools).

**Promote appropriate techniques:** Examples are promoting conservation agriculture, restricting grazing in sensitive areas, providing alternative forage sources, and promoting agroforestry. The most promising conservation techniques are often those that provide multiple benefits, such as planting fruit trees or other multi-purpose (e.g., ornamental, fodder) trees or bushes.

**Enable participatory integrated watershed management:** Rural communities' adoption of land management practices within a given watershed should be facilitated through participatory processes from day one. Conservation of rural landscapes cannot be done in isolation – it requires joint efforts between communities.

**Expand payment for ecosystem services:** Such payments are supported for planting trees through the Kyoto Protocol; this needs to be extended to compensate agricultural techniques that increase organic matter in the soil.

### Further reading

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The National Centre of Competence in Research (NCCR) North-South is a worldwide research network including six partner institutions in Switzerland and some 140 universities, research institutions, and development organisations in Africa, Asia, Latin America, and Europe. Approximately 350 researchers worldwide contribute to the activities of the NCCR North-South.

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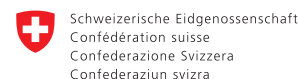
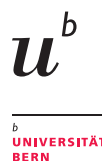
### This issue

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