Comprehensive assessment of water management in agriculture

water for food, water for life issuebrief#10

Managing water by managing land:

Why addressing land degradation is necessary to improve water productivity and rural livelihoods

Photo: IWMI

Soil erosion, nutrient depletion, and other forms of land degradation reduce "crop per drop" and water availability, quality, and storage. Comprehensive Assessment (CA) findings show that reversing land degradation is an essential step in improving water productivity and rural livelihoods—particularly in low-yielding rainfed systems.

Global surveys suggest that 40% of agricultural land is already degraded to the point that yields are greatly reduced, and a further 9% is degraded to the point that it cannot be reclaimed for productive use by farm-level measures. The agricultural land lost to degradation has cut global crop yield by 13%. The problem is widespread, and it is growing by an estimated 5 – 10 million hectares a year.

Reversing this trend will demand more than just technical solutions. It will entail tackling the underlying drivers of unsustainable land use—drivers that are social, economic, political, and institutional. The CA review of global experience has yielded a number of lessons on how to best address land degradation (see Box 1).

Box 1: Recommendations for addressing land degradation

Focus on small-scale agriculture: Creating an environment conducive to small-scale farmer investment in improved land management is a promising pathway to reducing poverty and protecting land and water resources.

Invest in rehabilitating degraded land: Returns on such investments include increased crop yields, farmer incomes, and water productivity, and reduced water pollution and loss of downstream water storage.

Apply integrated landscape-level solutions: Single-sector, farm-level solutions alone will not halt land degradation. Finding lasting solutions requires looking at agricultural land as part of the larger landscape and taking an integrated, multisectoral approach.

Enhance the multifunctionality of agricultural landscapes: Agricultural lands provide multiple ecosystem services; these can be optimized to increase benefits and sustainability (see CA Issue Brief 1).

Develop land-use systems that can support more people: Rural population growth—which is likely to continue well into this century—will accelerate degradation unless land-use systems can be adjusted to accommodate higher population densities.

The land–water connection

Land degradation changes the way water moves through a catchment—with a tendency to promote rapid flow over the surface of the land (runoff) and to decrease subsurface flow. These changes have wide-ranging implications for water quality and availability and agroecosystem productivity and sustainability. Some of the basic mechanisms and impacts of land degradation are outlined below.

Soil erosion: Erosion by water is the most common form of land degradation worldwide. Soil erosion almost always rises substantially with agricultural activity. This is especially the case with annual cropping systems, where the soil surface is seasonally exposed to rain and wind. Erosion removes nutrients, thins the soil layer, and damages the soil structure—resulting in declining crop yields. In Ethiopia, for example, soil erosion is reducing yields by an average of 1 – 2% annually.

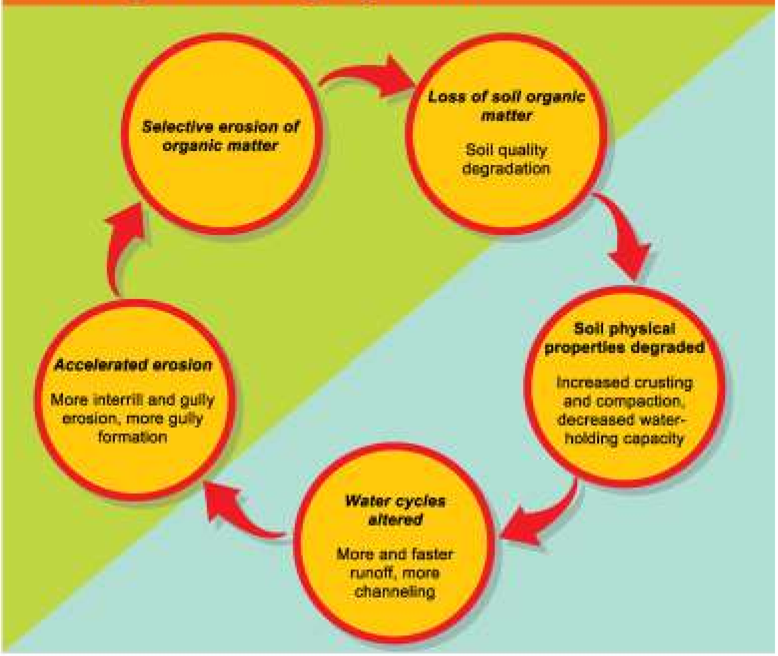
Loss of organic matter: The level of organic matter in the soil largely determines the rate and degree of water infiltration and the soil's water storage capacity. Erosion and practices such as slash and burn agriculture reduce organic matter content and thus also reduce the amount of water available in the soil for plant growth and increase runoff and attendant erosion (see Fig.1). At the larger landscape level, a reduction in soil organic matter can influence both local and regional water cycles. It also has implications for global carbon cycles—soil organic matter holds approximately 40% of the overall terrestrial carbon pool.

Nutrient depletion: Globally, only half of the nutrients that crops take from the soil are replaced. This nutrient imbalance is further exacerbated by erosion. In sub-Saharan Africa, nutrient depletion, not water, is the primary constraint to improving crop and water productivity in the long-term. However, in these primarily small-scale rainfed systems, nutrient depletion needs to be addressed along with vulnerability to dry spells and droughts—without better water security, farmers are often unwilling to risk investments in improving soil fertility.

Sedimentation: Soil erosion increases the sediment loads in rivers, which in turn impairs downstream navigation channels, water treatment facilities, and hydropower and irrigation infrastructure and leads to sedimentation of lakes and reservoirs. An estimated 25% or more of the world's freshwater storage capacity will be lost to sedimentation in the next 25 – 50 years unless catchment-scale soil conservation measures are implemented.

Water pollution: Runoff from agricultural fields transports pesticides, herbicides, and fertilizers to the nearest water body, with negative consequences for human and ecosystem health. The Millennium Ecosystem Assessment has identified increased nutrient loads—primarily from nitrogen and phosphorous fertilizers—in surface water as the fastest growing threat to freshwater and coastal ecosystems, with the potential to cause irreversible damage.

Fig. 1. Cycle of negative soil-water relationships leading to increasing degradation



Drivers of land degradation

People make land-use decisions based on social, political, and economic contexts, not just the physical characteristics of land. Stopping land degradation will require addressing underlying drivers such as:

Insecure land tenure: Farmers are more likely to invest in sustainable land management when they have secure access to the land they farm. This does not have to mean private ownership. Well-functioning common property regimes generally encourage sustainable land-use practices and provide a good base of cooperation for halting or reversing land degradation when it does occur. But where no governance mechanisms are in place or where they have broken down, open-access conditions often arise. The result is almost always overexploitation and degradation—leading to "tragedy of the commons" scenarios.

Exclusion of women from land management decision-making: Women are the primary users of agricultural land in developing countries. They constitute up to 90% of the rice-producing labor force in Southeast Asia and produce up to 80% of basic household food stuffs in sub-Saharan Africa. Despite women's major contribution to agriculture, men—particularly in Africa—retain most ownership, control, and decision-making power over agricultural resources, including land. The result is that women, who have the most intimate relationship with the land and who are in the best position to manage it on a daily basis, are often excluded from decisions that affect its use.

Demographic trends: Increasing population densities—due to natural population growth or to ill-conceived conservation and resettlement policies—tend to accelerate land degradation. This is particularly evident where populations spill over

Box 2: Land degradation and poverty

An estimated 1.7 billion rural people live on marginal land in areas with noticeable land and water degradation. Farmers in these areas often suffer from flooding and droughts along with insecure land tenure. This high-risk environment, coupled with poverty, puts farmers in the position of having to choose between survival and sustainability. But as land degradation worsens, the time, labor and agricultural inputs needed to produce the same or better harvests inevitably increase to the point that farmers can no longer keep up. The result is that poor farming communities get progressively poorer as land degradation reduces their crop yields, exacerbates malnutrition and food insecurity, and contributes to the loss or pollution of drinking water supplies.

onto previously uncultivated marginal dry lands (as has been happening rapidly in parts of East Africa) and where poor farmers are pushed further uphill onto ever steeper slopes (as is the case in parts of Asia and Central America). In both cases this land is especially vulnerable to degradation. But increased population densities do not have to mean increased land degradation. If conditions are conducive, high population densities can stimulate conservation and good land husbandry (see Box 4).

Enabling local solutions

The best chance of preventing and mitigating land degradation is to create an environment conducive to the development and evolution of local strategies and solutions. This will entail a change in thinking on the part of policymakers, planners, resource managers, and extension workers—from narrowly-focused, "blueprint" solutions to broader, more responsive programs and processes that tap local knowledge and speak more directly to farmer needs and concerns.

Tapping local knowledge: The indigenous skills and the innovative capacity of small-scale farming communities represent a vital local resource for managing and conserving land. To tap this resource requires:

- Participatory methods for implementing resource-conserving agriculture that emphasize training and capacity-building and ensure high levels of voluntary engagement by land and water users, including women.
- A move on the part of extensionists from standardized, technical approaches to more flexible approaches that respect indigenous knowledge and that provide farmers with a basket of options and the support to adapt them to local conditions.
- An understanding of local-level institutions and how they can be harnessed to tackle land degradation.

Responding to farmer needs: Many conservation-oriented interventions were unsuccessful because they failed to recognize that production rather than conservation is the priority of poor farmers. To be acceptable, new technologies and practices must show a direct and fairly immediate economic benefit to farmers. Practices that can simultaneously improve the soil, reduce its vulnerability to erosion, and improve production are most likely to be taken up. Examples include mulching, composting, cover cropping, mixed cropping, agroforestry, and integrating livestock and fisheries into farming systems.

However, addressing the needs of poor farmers requires going beyond productivity-enhancing, field-level practices to measures that will improve the overall profitability of small-scale farming. Farmers need access to markets and credit, as well as appropriate knowledge and technologies. Incorporating interventions aimed at improving land and water management into larger rural development and poverty reduction plans is one way of ensuring this happens.

Photo: W. Critchley

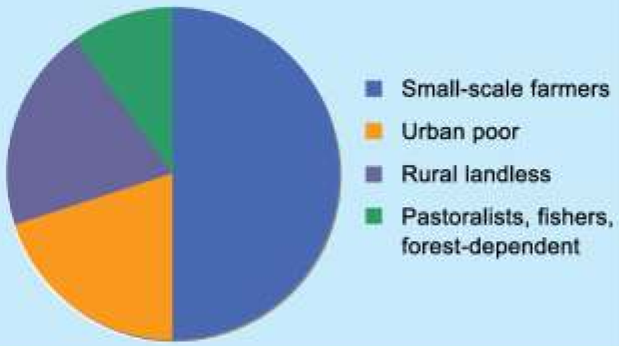
Vegetative barriers planted across slopes, such as the grass strips pictured here, can reduce erosion and provide fodder for livestock—resulting in a win-win investment for farmers.

Box 3: Reasons to invest in small-scale farmers

When it comes to reducing poverty and promoting sustainable use of land and water resources, concentrating investments and capacity-building at the level of small-scale farmers makes sense for a number of reasons:

- **Small-scale farmers have the greatest potential to influence land degradation**: They occupy the most marginal lands with the highest vulnerability to degradation.
- **Reducing rural poverty**: Farming is the major income source for much of the world's poor, and, despite growing urbanization, this is unlikely to change in the next 20 to 30 years.
- **Reducing hunger**: The largest proportion of the developing world's undernourished people are concentrated among small-scale farming groups (see Fig. 2).
- **National food security**: Small-scale farmers carry out 60% of global agriculture, providing 80% of food in developing countries.

Fig. 2. Small-scale farmers constitute the largest share of the developing world's undernourished



Source: Food and Agriculture Organization. 2004. "The State of Food Insecurity in the World 2004." FAO: Rome.

Multifunctional landscapes: Increasing benefits and sustainability

Land degradation may be most immediately influenced by small-scale farmers, but its causes and impacts extend far beyond the farmer's field. For this reason, integrated landscape approaches are also needed to ensure sustainable land management. Such approaches take into account the ecology and function of the landscape's components and make strategic use of their potential.

The dominant trend in agricultural production systems has been to manage agricultural landscapes with the single objective of increasing crop yields. The net effect of this approach is a general decrease in the sustainability and resilience of such systems and the overall benefits they can provide. The CA suggests moving towards more integrated forms of resource management that seek to create multifunctional landscapes—maximizing ecosystem services while minimizing negative environmental impacts (see CA Issue Brief 1).

Multifunctionality can be enhanced at both farm and landscape scales. On-farm strategies can include plant diversification (particularly by creating a mosaic of perennial and annual crops), plant and animal integration, an emphasis on soil quality (particularly boosting soil organic matter, e.g. by incorporating manure and crop residues), and on biological solutions to fertility and pest control. Such measures can help improve sustainability, reduce vulnerability to variable rainfall and climate change, and contribute to other ecosystem benefits, such as carbon sequestration.

Photo: W. Critchley

A mosaic of perennial crops—tea, coffee, bananas and trees (Kenya). A diversified mix of perennials provides more stable plant cover—protecting the soil and increasing water infiltration—and gives farmers new income-earning potential. But, while it improves soil conservation, the switch from annuals to perennials can also increase local water consumption.

At the landscape level there are several ways to increase multifunctionality and thus overall benefits. For example:

- Actively managing nonfarmed land in and around farmed land, such as wastelands and riparian zones.
- Capitalizing on synergies between agricultural production and wild biodiversity.
- Valuing services such as carbon sequestration and clean water provision, and incorporating these into decision-making.

Box 4: Bright spots Success stories in sustainable agriculture

A CA-supported study examined 438 recent cases where communities were able to sustainably increase agricultural productivity and halt or even reverse land degradation. These cases demonstrate that it is possible to preserve and restore resources while simultaneously boosting productivity.

Impacts were greatest in small-scale agricultural systems, and farmers achieved the highest relative yield increases in areas where original yield levels were very low, less than 1.5 metric tons per hectare. These findings suggest that the "one ton" agricultural systems that dominate rain-fed farming in sub-Saharan Africa are promising targets for bright-spots type interventions.

Priming factors in successful cases included:

- Public and private investment
- Secure land tenure
- Appropriate integrated land and water technologies
- Aspirations for change among local populations
- Effective leadership

Comprehensive assessment of water management in agriculture

For more information. Email: comp.assessment@cgiar.org **Visit: www.iwmi.cgiar.org/assessment**

The Comprehensive Assessment of Water Management in Agriculture (CA) is a five-year initiative to analyze the benefits, costs, and impacts of the past 50 years of water development and management in agriculture, to identify present and future challenges, and to evaluate possible solutions. The CA's Issue Brief series, published by the International Water Management Institute (IWMI), presents key findings from the main Assessment report *Water for Food, Water for Life: A Comprehensive Assessment of Water Management in Agriculture* (Earthscan). More on the CA donors, co-sponsors (CBD, CGIAR , FAO, Ramsar), process and publications can be found at: www.iwmi.org/assessment.

This Brief is based on the chapter "Conserving land, protecting water" by Deborah Bossio, William Critchley, Kim Geheb, Godert van Lynden, and Bancy Mati in *Water for Food, Water for Life: A Comprehensive Assessment of Water Management in Agriculture*, 2007.

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