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The Problem of Soil and Land Degradation

What is soil degradation?

Soil degradation has two major components: the loss of soil through erosion and the loss of soil fertility. Both components lead to progressively lower crop yields, increased costs of production, and may end up in land abandonment and desertification. Soil tillage is the principle cause of degradation of cropped fields. Soil tillage causes rapid breakdown of soil organic matter - the key to soil fertility.

Photo: Patrick Wall

Erosion of a hand-tilled field in Malawi after a heavy rainstorm.

What is a fertile soil?

A fertile soil allows the crop to produce close to the limit imposed by the environment (moisture and radiation), provided that the crop management is optimal. Soil fertility has three equally important components: soil chemical, physical and biological fertility. A reduction in any of the three components will generally result in lower yields. Soil organic matter is the key to all three components of soil fertility – reduced soil organic matter leads and biological fertility.

What is soil chemical fertility and how can it be maintained and improved?

Chemical soil fertility is the ability of a soil to provide all of the nutrients required by the crop. It is important to remember that chemical fertility depends on the availability of nutrients in the soil – nutrients in unavailable forms or in soil zones not accessible to roots do not help produce crops. The availability of nutrients is normally greater when they are associated with organic matter. Soil chemical fertility can be enhanced by applying manure, fertilizer, compost and lime.

What is physical soil fertility and how can it be maintained and improved?

Physical soil fertility is the ability of the soil to enable the flow and storage of water and air into the soil, to permit root growth and to anchor the plants. To be fertile a soil needs abundant and interconnected pore space. Pore space generally depends on aggregates (crumbs) of soil particles held together by soil organic matter. Soil tillage breaks down aggregates, decomposes soil organic matter, pulverizes the soil, breaks pore continuity and forms hard pans which restrict water and air movement and root growth. On the soil surface, the powdered soil is more prone to sealing, crusting and erosion. Improving soil physical fertility involves reducing soil tillage to a minimum and increasing soil organic matter.

Photo: Patrick Wall

Physical degradation of a soil as a result of intensive tillage. The surface has sealed and crusted, and the loosened topsoil above the hard pan caused by tillage has been eroded.

How can the biological soil fertility be maintained and improved?

Soil biological fertility refers to the quantity and diversity of soil fauna and flora present in the soil (earthworms, beetles, termites, fungi, bacteria, nematodes etc.). Biological activity is necessary to break down crop residues (including roots) into humus. Earthworms, termites and insects also transfer crop residues into the soil, increase soil porosity and pore continuity, and can help break down compacted layers. A constant food source is necessary to maintain soil fauna and flora: a bare soil results in low levels of biological activity. Tillage also disrupts the tunnels and habitats of organisms. The best way to increase soil biological activity in cropped soil is to get as close as possible to a natural system: stop soil tillage and leave plant residues as mulch on the surface.

Photo: Patrick Wall

A healthy top soil showing abundant earthworm activity. Earthworms are good indicators of soil biological activity and are almost completely absent from tilled soils.

Looking at soil degradation.

- ✓ An easy way to see soil physical degradation is to take some small soil clods of about 1 cm diameter from a ploughed field and from a virgin area nearby. Look at both soil samples and it will generally be easy to see the darker soil colour of the un-ploughed sample (higher organic matter content). Drop these clods carefully into a bowl of water and observe how the ploughed soil disintegrates while the unploughed soil stays intact (this works better with clay or loam soil than with sands that have very weak structure).
- ✓ Dig up some soil with a spade in a ploughed field and an unploughed area and look at the difference in number and diversity of fauna species. Generally you will see more organisms and more crumbs (aggregates) in the unploughed field.

Photo: Christian Thierfelder

A field-test of aggregate stability. Small clods from a ploughed field (right) and virgin land (left) have been dropped carefully into water. The lighter coloured clods from the ploughed field disintegrate while the clods from the virgin soil stay intact.

How can soil degradation be avoided?

The three biggest factors involved in soil degradation are a) soil tillage (breakdown of physical fertility); b) removal of crop residues (mainly by grazing or burning), and c) nutrient mining (not applying manure, compost or fertilizer in adequate amounts). The key therefore to avoid land and soil degradation is to reduce soil tillage to a minimum, leave as many crop residues as possible, and replenish the nutrients removed by the crops.

Ploughing is not necessary to produce a crop –
it harms the soil and leads to soil degradation

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