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International
MOUNTAIN DAY

Soil

The thin layer of soil that covers most of the earth's land surface is vital to human survival. It sustains plants, animals, forests and people, making it one of the planet's most precious resources. Yet soils are dynamic, ever-changing bodies, and are highly vulnerable to erosion and degradation.

Nowhere is this more evident than in mountain regions, which for reasons of slope, geology and hydrology are especially vulnerable to erosion and loss of fertility through the leaching of nutrients. But a range of time-honoured techniques and approaches, often combined with newer innovative technologies, can stem soil erosion and enhance soil quality, even in the most challenging mountain enviroments. Properly applied, these technologies can make a significant contribution to sustainable mountain development around the world.

A rocky start

Two types of soil dominate in upland regions, both characterized by a very limited soil-forming process. *Leptosols* are shallow soils, with a high gravel content. Their limited soil volume makes them subject to drought, but also to waterlogging and run-off. They are highly susceptible to erosion. *Regosols* are generally deeper soils, but their topsoil is often poor and thin in organic matter. A third soil type, *andosols*, is commonly found in volcanic mountain areas. Andosols generally have a good capacity for moisture storage and are rich in nutrients, but have limited agricultural potential due to their occurrence on steep slopes.

Many highland regions inherently have less plant life and tree cover to protect soil from erosion. The gradient of mountain slopes makes surfaces unstable, making them particularly vulnerable to erosion by heavy rainfall and the rapidly moving water that are common at higher altitudes. Soil formation is slow in high mountain areas, due to low temperatures. As a result, mountain soils are relatively shallow and are often poorly anchored.

Eroded soils can increase sediment in streams and rivers, eventually causing flooding in nearby downstream areas. They also clog reservoirs, silt dams and obstruct irrigation channels. Although it may be decades or centuries before these effects can be measured in streams far from the degraded site, the damage is being done now.

Mountain soils are wearing thin

People living in mountain areas need to be aware of and work in harmony with the natural characteristics of upland soils. Yet all too often soil erosion and loss of soil fertility are instead aggravated by human intervention. A scarcity of good land often forces poor mountain dwellers to cut forests unsustainably, and then overgraze and over-cultivate the cleared land. The development of transport infrastructure and extractive industries are also responsible for degrading sensitive mountain soil systems. All these factors contribute to the cycle of poverty for poor mountainous communities.

Nature and nurture

In the hilly regions of the Hindu Kush and the Himalaya, for example, declining soil fertility and erosion are by now critical problems. Soil quality and quantity is already compromised because of gradient, instability and climate, especially the monsoon rainfall pattern. The growing population has led to an expansion of agriculture onto steeper slopes, leading to soil degradation, which is threatening food security, living standards, development opportunities and biodiversity. Fortunately, both strategies and approaches exist to enable mountain people to win the fight to maintain their soils.

Old and new approaches to soil conservation

Over centuries, mountain farmers around the world have learned to control soil erosion and maintain fertility through a range of practices. Traditional terracing techniques contribute considerably to soil conservation on sloping lands. Farmers may also apply newer technologies to maintain soil quality and prevent damage. In Burkina Faso, for example, land degradation and soil erosion have been halted by sculpting scalloped patterns of half moons into the land. In parts of western Hindu Kush Himalaya, where soils are shallow and gravelly, farmers have devised a technology to collect eroded soil from floodwater to make fertile arable land. Effective Microorganism Technology, a novel solution developed in Japan, consists of adding a liquid culture of bacteria to soil. Effects include revived soil fertility, improved yields and the suppression of soil-borne pathogens and pests.

The power of nitrogen

Nitrogen is crucial to a healthy soil, but deficiency results from erosion and degradation, especially in upland soils. Studies show that the practice of using nitrogen-fixing plants (NFP) is twice as efficient as adding nitrogen fertilizer, as well as less costly and less harmful to the environment. The best known nitrogen-fixing plants are nodule-bearing legumes, which form symbiotic associations with bacteria to trap nitrogen from the air and fix it in the soil.

It has been recognized for centuries that certain crops such as clover, alfafa, peas and beans can improve soil fertility. In non-mountain areas, legume crops have been used down the years in rotation and intercropping to replenish essential nitrogen in depleted soils.

Research shows that the use of nitrogen-fixing plants can also contribute significantly to sustainable mountain development. Besides legumes, there are at least 170 other plant species capable of fixing atmospheric nitrogen with bacteria; a number of them are suitable for cultivation at higher altitudes.

Living hedgerows

A new and effective development on the tradition of terracing mountain land comes in the form of Sloping Agricultural Land Technology (SALT).

Developed in the Philippines and now undergoing trials in China, Bangladesh, Nepal, India, Myanmar and Pakistan, it involves planting nitrogen-fixing plants along contour lines to form hedgerows. Food or cash crops are grown in between the alleys. The hedgerows act as barriers to soil erosion, while pruned leaves provide green manure and fodder for livestock. Results include a significant fall in soil loss and improvements in soil fertility and crop yields.

However, this should not be seen as a “miracle cure” as labour requirements are usually high, and returns are not sufficient to compete with other higher-paying off-farm employment opportunities.

Key facts

- The cost of traditional terracing techniques is rising with the increase in the market value of wage labour. For example, it costs up to US$ 4,800 to create one hectare of terraced land in northern Pakistan.

- Trials in the Three Gorges region of China showed that planting leguminous hedgerows on upland terrain can reduce soil loss by up to 94 to 99 percent.

- The effect of one tonne of nitrogen, biologically fixed by a legume crop, is equal to about two tonnes of nitrogen fertilizer; thus the hedgerows also offer a cost-effective way to increase soil quality.

Expert sources

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