Technical Paper

Slope Management

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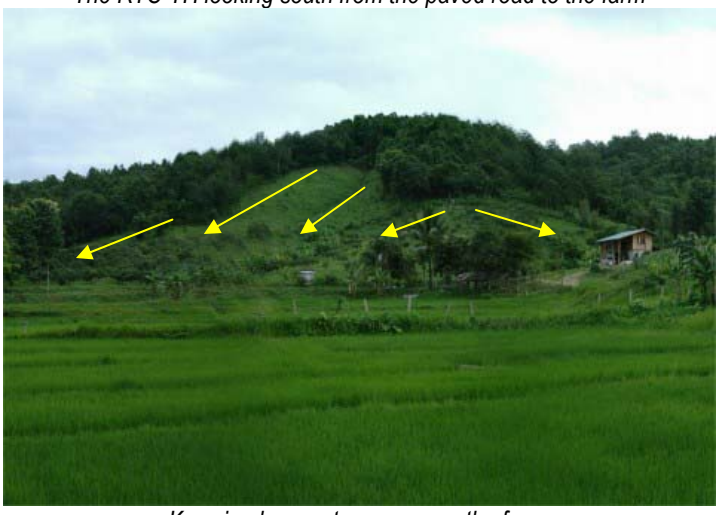
Community-based Environmental Education for the Self-sufficiency and Sustainability of Small Rural Family Farms

Reading the Land

You need to learn to read the land in order to protect the basic farm's natural resources (e.g. water and soil). The fundamental principles are gravity and the fact that water will flow from high to low elevation as it seeks its own level. Water is the primary erosion agent. Soil quality and topography (the shape of the land) are also important factors in soil erosion.

The RTC-TH looking south from the paved road to the farm

Start by getting as wide a view of the farm as possible either from a low elevation or a high elevation. See where the high (ridges) are and low places (valleys, swales). Then you can separate the level land from the sloping land. The slopes will be places where flowing water can erode soil. Look for rills or gullies. These are clear signs of soil erosion. Sheet erosion is harder to see. It removes soil uniformly and sometimes slowly. You need to do detailed studies to detect sheet erosion. The usual way to do this is to set stakes marking the soil level. Then periodically checking to see how much soil was removed.



Knowing how water moves on the farm.

Flat land is where soil can be deposited (piled up). Most people consider flat land to be ideal for farming. But flat land can also have problems. In some cases, water can form a pond or puddle. The soil in low places can get too wet and be hard to grow crops (unless they are adapted to wet conditions). The conditions can change with the seasons, too.

Global warming will affect future weather patterns. For northern Thailand, various models predict dry seasons getting warmer and longer. Wet seasons may get shorter, but more intense.

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Protect Natural Forest / Watersheds

The land upslope from the RTC-TH farm is natural forest land. Under natural forest cover and heavy rainfall, studies show 2% of the soil erodes. Soil erosion is a natural process. It cannot be totally or completely prevented. So 98% is perhaps the closest you can come to a situation of least soil erosion.

Generally, when the forest canopy density is about 70-75% or more, the watershed is in good condition. When the canopy density drops below 70%, soil erosion will increase and the watershed will not be in natural balance. Raindrops falling on this area will not impact the soil under the forest canopy. Tree leaves and limbs, under story vegetation, and leaf litter on the forest floor absorb the raindrop impact. The water slowly seeps into the soil. The excess begins to flow down slope.

Managing farm soil erosion begins with protecting natural forest (watershed) areas to provide naturally clean surface water for the farm.

Under the forest canopy, plant litter almost completely covers the forest floor. We need to try to follow this natural mulching method.

After a heavy rain, walk around the farm and see where the water if flowing, how much is flowing, and notice what color it is. Clear water is best. Light gray or milky indicates a very low rate of soil erosion. Very muddy water tells you soil erosion is intense.

The appearance of flowing water after a heavy rain can indicate the amount of soil erosion on your farm. Clear water, little erosion; milky, mild erosion; muddy, high erosion.

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Soil Erosion Basics


Demonstration results: Left, soil particles loosened by raindrops impacting bare soil cover the spalshboard. On the right, mulch protected the bare soil from raindrop impact so the splashboard is clean.

Soil erosion begins with raindrops hitting the soil surface at about 22.53 kmph / 14 mph. The impact loosens soil particles. As more rain drops hit the surface the amount of water increases and begins to flow down slope. As the water flows, it picks up and carries away the loosened soil particles. Water will flow faster on a steep slope. The faster the water flows, the more soil it can carry. It can also carry larger particles. This is also true when the amount of water increases.

So the first step in soil erosion management is to protect all bare soil from direct rain drop impact. Mulch can be living (growing grasses or other ground cover vegetation) or dead (dried leaves, cut grass, etc.). The main idea is to cover all bare soil to protect it from direct raindrop impact. Getting 65% coverage will reduce soil erosion as much as 90%.



Different amounts of mulch covering bare soil.

The key advantage of living mulch is that it also anchors the soil. As the mulch (living or dead) decays, it slowly releases nutrients and organic materials to the soil. These improve the soil structure. Soil moisture retention increases along with overall soil health (e.g. numbers of earthworms and soil bacteria). This reduces the amount of

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surface runoff (water flowing on the land surface). All of these increase the ability of soil to resist erosion.

No-till (no plowing) or Low-till (minimal plowing) and leaving crop residues in the field (mulching) are other sustainable agricultural practices that help reduce soil erosion on the farm.

Soil Erosion on Slopes

Rills and gullies form as more water begins to flow down slope. As more soil is removed, they deepen and widen. The amount of water, slope angle, and soil quality all play a part in soil erosion. Rills and gullies are easy to see on a slope. Sheet erosion can occur very slowly or so uniformly that you may not notice it until it is too late.

The water flow velocity decreases at the bottom of the slope. It is usually flatter here. Soil is deposited here. This is how valleys and other low spots get filled in over time.

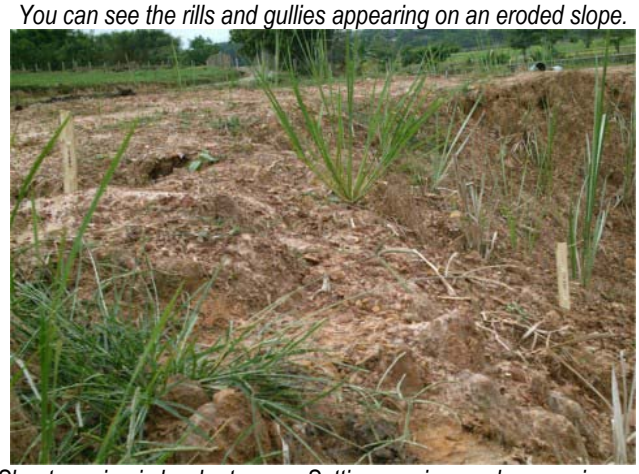
Setting marker or erosion "pins" in the soil helps to detect sheet erosion. Two erosion pins are placed in the ground (see bottom photo). The left pin is on level ground. The right pin is on a slope. The ground level is marked on each pin with the date recorded. After a rain, you can check to see if the soil level has changed relative to the mark on the pin.

If sheet erosion is found, take steps to reduce the erosion as much as can be reasonable done for your circumstances and resources.

Mulch and plant as you see fit. Start with protecting the bare soil as much as possible. Plant ground cover vegetation. This can help cover bare soil, hold the soil in place, and improve soil structure by adding organic matter. Remember, covering 65% of the bare soil can reduce soil erosion by as much as 90%.

Rills and gullies deepen and widen as flowing water flows removes soil to make a channel. Soil is deposited when the slope flattens.

You can see the rills and gullies appearing on an eroded slope.



Sheet erosion is harder to see. Setting erosion markers or pins can help to detect sheet erosion. detect

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Check Dams

Use check dams to slow the movement of water in the channels when rills get large enough to be gullies. Check dams can be natural collections of debris (e.g. rocks, soil, leaves, branches, etc.) entangled in the channel. We can make an obstruction to catch debris to imitate nature.

A natural check dam forms when debris collects in a water flow channel.

A simple check dam is made using locally grown bamboo.

RTC-TH check dams are made using local bamboo from the farm. The bamboo is split into strips. The strips are woven into a fence-like net. This is anchored in a gully using bamboo poles. Branches and leaves are put behind the check dam (on the uphill side). The idea isn't to stop the water, but to slow it down. When the water slows down, the sediments (soil particles carried in the flowing water) are trapped behind the check dam to fill in the gully. Soil accumulating behind the check dam can eventually fill in the rill or gully. Permanently planting this flow path will go a long way to preventing further erosion.

The banana trees in the gully make a planted flow path reducing water velocity and soil erosion.

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Terracing

Water normally flows down the slopes and into the central gully (a planted flow path). The water then flowed into the fish ponds. Overflow from the ponds went to the rice paddies and eventually off the farm.

Terracing the upper slopes of the farm reduces soil erosion by slowing the flow velocity. The terraces divert water away from the gully to flow across the slopes. This gives the water more time to soak into the soil. This increases soil moisture storage and increases water retention on the farm.

To help cover and anchor the soil, grass seeds are sown on the terrace outslopes. Legumes are planted on the terrace flats to help improve the soil for future plantings. Both grass and legumes provide livestock forage for the farm, but also protect bare soil from raindrop impact.

Prior studies revealed the amount of water flowing down from the natural forest area above the farm is slow and do not pose a threat to the terraces. Future studies and efforts will be made to assess rainwater harvesting potential to mitigate anticipated drought conditions from global warming.

Harvesting water on the upper levels of the farm would permit gravity flow watering systems for the lower terraces. But additional feasibility studies are needed.

Terracing redirects surface runoff away from the gully across the slope. This reduces soil erosion and gives water more time to soak into the soil.

Mulch on the terrace to protects the bare soil from raindrop impact.

Different ground covers planted on the terrace anchor the soil and protect it from raindrop impact. Both produce forage for farm livestock.

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