Saving soil and water on sloping ground

This Action Sheet is about working with the contours of a slope to save soils from being washed away when it rains. Anything that makes the ground surface more level or divides a slope into shorter lengths will slow down rainfall runoff. Slower runoff means less soil erosion. It also means that there is more time for the rainwater to soak into the ground, so water stays in the soil and helps plants to grow. It's worth applying these ideas anywhere you want to keep soil stable and save water – whether in a small sloping garden or a large hilly farm.

To break up the slope, farmers and gardeners make ditches and ridges along the contours, plant them up with trees and shrubs, and then plant their crops in between. For example, in East Africa, farmers dig Fanya Chini (downhill ridges) on gentle slopes and Fanya Juu (uphill ridges) on steep slopes. Contour barriers not only stop soils washing away – they can help harvest the rainwater for your crops.

What kinds of land are these ideas suitable for?

All over the world, people work with contours when they are farming. Soil and water conservation are particularly important in semi-arid lands which receive 300 – 700mm of rain each year. These areas are prone to drought and have soils that are easily eroded. Before construction of contour barriers, it is worth considering whether they will work well and be affordable. Three key considerations are:

1. The steeper the land, the more costly construction will be. In semi-arid areas, water harvesting methods are not recommended for land with a slope of more than 5% because the speed at which water runs off when it does rain means that construction must be very strong to avoid soil erosion.
2. Soils need to be deep enough to allow water to soak in, and should be fertile enough for crops to benefit from the extra water. More water means higher crop yields, so the nutrients in the soil are used up more quickly. It may be necessary to maintain or improve soil fertility – for example by applying green manure (See Action Sheet 39) or composting (Action Sheet 31). Sandy soils will not benefit from extra water unless soil fertility is also improved at the same time. They also need a low infiltration rate, ie. water should soak in slowly.
3. Once you have decided to go ahead, the first step is to mark the contour lines - the lines connecting points at the same level - on the slope.

Agricultural Extension Officers should be able to give further advice.

Using a home-made A-frame to mark contour lines on a slope

You will need:

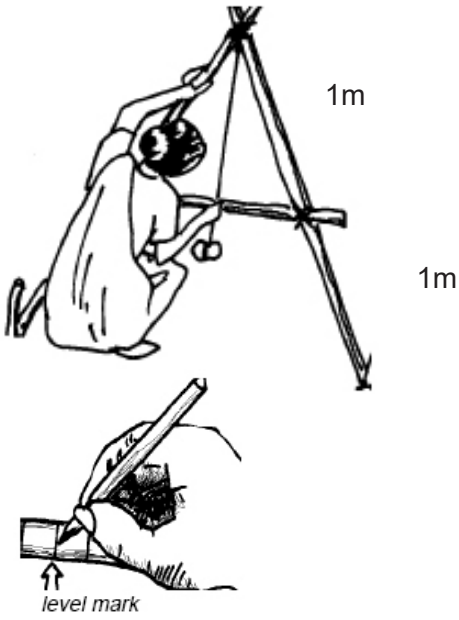
- 2 pieces of wood, approximately 5cm x 2.5cm and 2m long
- 1 piece of wood, 1m long
- 3 nails or screws, 5cm long (if unavailable use string instead)
- a short length of string
- a weight (for example a stone)

1. Place the two longer pieces of wood on the ground with their ends touching and the other ends 2m away apart. Fasten the 2 pieces together at one end with a nail or screw. If you have not got nails or screws, cut notches and use string to bind the two ends together. Fix them loosely at first.

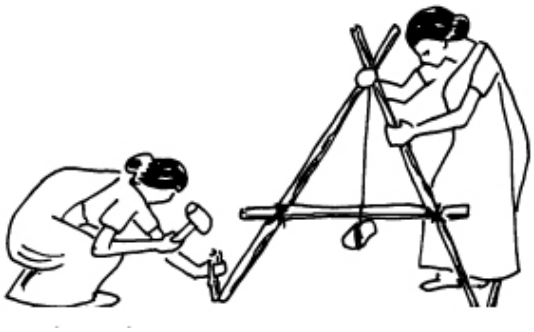
2. Fix the third piece of wood (1m) at exactly the middle of each of the long pieces. When the 3 pieces are in position, tighten all the screws or hammer the nails in firmly. If you are using string, tie them tightly.

3. Hang a string down from the tip of the A frame, and attach a weight to it, so that it swings below the cross-bar.

4. Calibrate the A-frame by placing it upright on ground you know is level. When the stone stops swinging, mark the position where the string crosses the cross bar. Turn the A frame around, putting the legs in exactly the opposite position, and measure the centre-point again. If it is in the same place, then it is the level ground marker. If it is in a slightly different position, then mark the point exactly between this point and the last, and use that as the level ground marker. Test it out again on another piece of ground.



You may want to cut a notch in the A-frame cross-bar to indicate the level ground marker, but be sure that the notch will not catch the string.



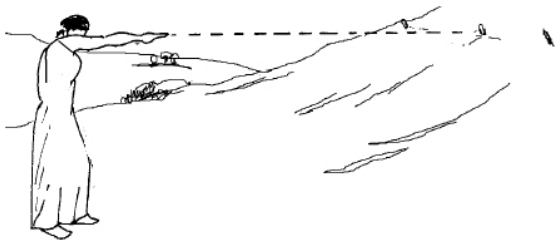
Using an A-frame

Start near the top of the slope. Stand on the hillside with the A-frame, adjusting it until you find level ground as indicated when the weighted string hangs at the level ground marker. Drive a stake in next to one foot of the A-frame. Keeping one of the feet in place, turn the A-frame across the hillside to find the next point along the level or contour line. Keep moving along the hillside with the A-frame, driving stakes in to mark the contour line, which should be smooth, with no sharp bends. When the line is finished, move down the hill to mark out the next contour line.

How far apart should the contour lines be?

The distance between contour lines depends on the steepness of the slope. It could be as little as 8 metres or as much as 30 metres. The steeper the slope, the closer the contour barriers have to be to prevent erosion. It also depends upon the amount of rain that falls, and on what you are going to do with the land.

One very simple method of deciding where to mark out the next contour line is to stand straight with one arm outstretched level in front of you. Walk backwards down the slope, looking at your outstretched hand until the previous contour line can be seen at the end of your hand. Start the next contour line where you are standing.



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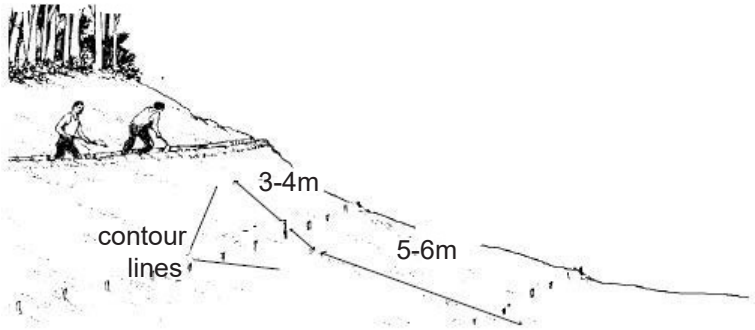


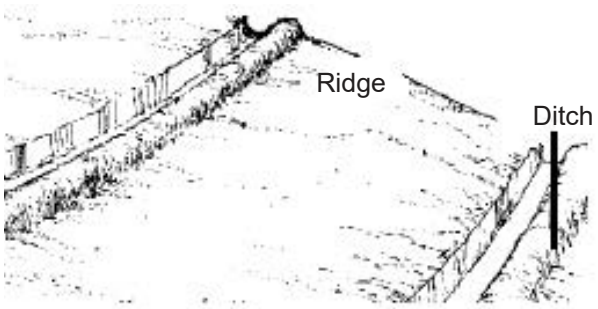
What next?

When you have marked out contour lines, you can do a number of things:

- Make a barrier along the contours, either with soil or with rocks, to make a wall to reduce erosion. Piles of rocks can also catch and channel water.
- Leave a strip of uncultivated ground, about 50cm wide, along each contour line. This is called a natural vegetative strip (NVS), and the plants which grow there will also help to bind the soil and reduce water flow down the slope. Over time, you could remove certain plants and encourage others to grow in the NVS so you are managing the natural process. If gullies or streams flow down through the contour lines, you can block them up with sticks and rocks. In time, soil will settle in the gully where you have blocked it and eventually the ground will become more level.
- Dig swales, a ditch running along the contour line. Swales collect rainwater, allowing it to soak slowly into the ground instead of just running away. To help hold the water in, the downhill side of the swale is built up into a ridge (or 'berm'), using the soil that has been dug out.

It is important that the ditch is closed at both ends, otherwise it can become a channel for the water and cause erosion further down the hill.

When you dig swales near buildings, make sure they are far enough away from the foundations or they could cause the walls to crack



How do you keep the berm from falling over?

It is a good idea to plant vegetables, big grasses such as cane grass, or trees on the berm so that the plants can use the water that is collecting in the swale, helping to stablise the berms (stop them from falling down). Planting may seem like more work, but without planting, the ditches and ridges will regularly need to be repaired and re-dug.

If you are planting vegetables on the swale, plant those that like a lot of water closer to the ditch, and the ones that don't like too much water high up on the berm or on the other side of it.

If you decide to plant trees along the swales, choose multipurpose trees that provide useful products like fruit, fodder, and firewood, and help improve the soil. For example, the leguminous tree Gliricidia sepium is a good food for livestock and a source of green manure. Before planting your tree seeds, test for good seed by floating them in water. Only plant the seeds that sink. For more information on tree-planting, see Action Sheet 49.

On steep slopes, plant small leguminous trees close together in a zig-zag pattern. The trees will grow up close enough to stop erosion. On slightly sloping land, where erosion is less of a problem, you can plant trees further apart. They will be able to grow larger and produce more wood and leaves.

When planting trees on the berm, plant fodder grasses or plants like pineapple on downhill slope of the berm as well. This helps stop erosion of the berm itself. Keep any grass very short, about 2-3 cm above the ground, and feed the cuttings to livestock.

Plant crops between the contours. As long as you keep the hedges pruned (see below), the roots of the trees (or hedges) should not grow deep enough to affect crop growth, but it is a good idea to leave a space of 25-30cm between the crops and the hedgerow.

How much maintenance does the planted swale need?

Once hedges become established, there is only pruning and some weeding to do. Early on, you will need to weed it regularly whilst the seedling grow up. In the first few weeks, keep checking on the seedlings, and plant more seeds to fill in any gaps. After 6-8 months, the plants should have roots that are deep enough to survive the dry season.

Until the trees are big enough to stop erosion, you will need to keep clearing the ditch of any soil that has washed into it. In the second year, you may need to prune back the hedgerow to a height of 1⁄2 to 1 metre, so that the trees will not shade crops growing on the land between the barriers. You can mix the leaves in to the soil as green manure, and lay cut branches down behind the hedges as an additional barrier, or use for firewood. You will then need to keep pruning the hedge every 2-3 months to stop the plants from going to seed and spreading where they are not wanted. In long, dry seasons, leave the hedge to grow out so it can shade the soil from strong sunlight. This will help reduce the growth of weeds and conserve soil moisture. The leaves will provide lots of valuable green manure for the next season.

What should we expect to see?

Soil washed down the hillside is trapped by the hedges, and gradually builds up behind the barriers. Eventually, the slope of the hillside will become more level. You can help this process along by moving soil from the upper section of the gap to the lower section. When the soil is level, there is even less runoff of water.

Once the hedge is well established, you can move the contour ditch from above the hedgerow to below it. There, it can continue to catch runoff water, making the most of the rain for your crops.

What else can be done to collect water using the contours of the land?
You can build infiltration pits along the lowest point of a valley to collect water. These can be as large as 6m long, 2m wide and 1m deep and have walls built sloping outwards to avoid collapse. Deeper and larger pits can be built in clay soil, because it is more stable. You can make a chain of these pits along the bottom of a valley, so that when the first is full, water flows into the next pit, and so on. Channels, pipes or siphon systems can be used to join the chain of pits. It is a good idea to build cross-ties or ridges into channels to slow down the flow of water and encourage it to soak into the soil. The pits and channels will need some maintenance, and may need to be dug out again after heavy rain. See also Action Sheets 45: Rainwater Harvesting for Crops and 14: Runoff Water Harvesting.

Infiltration pits:

- Harvest water,
- Provide water to crops during drought years,
- Provide grass to livestock and for thatching roofs,
- Trap nutrients washed away from the field,
- Can be converted to compost pits,
- Reduce siltation to river systems down slope,
- Can be used to grow crops,
- Can be used for fish-farming.

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