THE EFFECT OF HEDGEROW LAYOUT ON EROSION AND FARM PRODUCTIVITY

1. BACKGROUND

UDP’s objectives include developing a replicable model for sustainable management of the natural resources in the uplands of five provinces of Region XI (Mindanao). With the disappearance of much of the natural forest cover the upland soils and water remain as the two most important remaining natural resources in the uplands.

Upland soils are highly sensitive to disturbance and low in resilience, and their use for agriculture is precipitating or accelerating land degradation. UDP surveys have verified previous estimates of soil erosion of 360-400 tons of soil/ha/year, which translates into reductions in the depths of soil profiles of 50-100 cm over the last 20 to 30 years. The basic fact is that as the slope becomes steeper, the risk of erosion increases relentlessly, making soil conservation interventions expensive, in terms of labour, and unreliable.

2. RATIONALE

Contour hedgerow intercropping with annual crops has been given special prominence in the Philippines as a cheap way to control erosion on sloping land. Alternatives to hedgerows of leguminous shrubs such as Flemingia and Rinsonii, include planting single lines of clumps of lemon grass, guinea grass or Napier grass across the slope. A simpler technique uses 0.5 metre-wide uncultivated Natural Vegetative Strips (NVS) across the slope to slow down run-off and filter out eroded soil.

A combination of soil loosening in the alleys by cultivation, particularly by ploughing, and water erosion, moves soil directly down slope to be intercepted by the hedgerow plants. The build up in soil behind the hedgerows reduces the slope between hedgerows.

Observations made during a series of UDP soil and water conservation consultancies since 2003 support the view that cross-slope barriers (i.e. hedgerows and NVS) are inappropriate when applied on slopes steeper that 25% (e.g. Young 1989; Hudson 1992). The combination of contour cultivation and soil erosion behind hedgerows and NVS leads to the formation of outwardly sloping terraces. These are unable to prevent a build up in volume and velocity of run-off during heavy rainstorms. The appropriate way to control erosion on sloping land in the humid tropics is with reverse-sloped terraces to divert and discharge run-off into waterways.


* VI = the vertical fall between adjacent hedgerows
While impressive amounts of soil have been held back by the hedgerows and NVS, it appears that poor hedgerow layout and choice of species is reducing the agricultural productivity of the land.

**Poor layout of hedgerows and NVS can be traced to the following:**

- It is not possible to establish accurate contour lines across steep slopes using the *carabou’s back* method, or the human eye. Attempts to do so produce mis-aligned hedgerows with low points that channel and concentrate run-off - increasing the risk of gulley formation. (*Photos 1 and 2*). (*Every point on a contour line has the same elevation*).

- “Enriching” the NVS with root crops results in damage to the protective soil conservation functions of the NVS when the roots and tubers are harvested. The primary function of NVS is to form a permanent barrier to slow down run-off. Any secondary uses should only be recommended provided they don’t adversely affect the primary function.

- Because SALT hedgerows and NVS are by nature permeable barriers, which only slow down and filter run-off, the conventional Vertical Interval (VI) formula is not an appropriate method for spacing cross-slope barriers. The VI is normally used to design terrace systems that store all the run-off or divert it into a safe disposal area. The practice of using a VI (usually 1.5 m – the eye height of a farmer) places the hedgerows too far apart. The distance between permeable or filter hedgerows should be based on soil depth, slope and cultivation requirements.

**Poor layout and management of hedgerows and NVS on steep slopes reduces productivity in the following ways:**

- One consequence of wide spacing is an increase in height of the riser as soil erodes from the back of the terrace and accumulates at behind the barrier. E.g. on a 40% slope, each metre between hedges increases the height of the riser by 40 cm. In time a 5-m wide terrace will have a 2.0 m high riser resulting in 1.5-2.0 m depth of topsoil accumulating at the front of the terrace (*Photo 3*). Most of this depth of soil is unavailable to the shallow rooting systems of the annual crops grown. If the exposed sub soil at the back of the terrace is composed of coarse volcanic sands and gravels it may not have sufficient nutrients or soil moisture to support annual or perennial crops. (*Photo 4*)

- The higher the riser the greater the energy of the run-off as it strikes the soil – increasing the chances of under-cutting the terrace, causing it to collapse, which takes land out of production.

- Exposed subsoil at the back of the terraces, due to the downhill movement of soil, is an indication the hedgerows are spaced too widely. This produces a gradient in fertility in which stunted crops are seen at the back of the terrace where the shallow soil is infertile, while plants grow more robustly immediately behind the hedgerows where there is an accumulation of eroded topsoil and more soil moisture (*Photo 5*).

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− In very heavy rain the surface layer of top soil gets saturated rapidly and most of the water runs off. BUT if the top soil has been eroded away exposing a permeable substrate of gravels and coarse sand, then hundreds of tons of water can be absorbed into the hillside during extended rainfall, increasing the possibility of the terraces slumping and causing a land slide. Examples of very permeable subsoils of gravels and coarse sands can be seen exposed behind hedgerows in Meliina, Tampakan. Just 30-40 cm of topsoil remain before deep deposits of unproductive lahar become exposed at Tapicong, South Cotabato (Photo 6). Skeleton soils, formed by the washing out fine and fertile silt and clay particles, have no potential for agriculture or forestry.

− Cutting into the base of terraces formed by NVS with the plough, to create an extra row for planting, threatens the stability of any trees planted earlier on the NVS. As the trees have little or no soil for root growth on the down hill side they are likely to fall over when large crowns have developed.

− The vertical riser, produced when the farmer ploughs or cuts into the NVS or ground close to the base of the hedgerow during cultivation, results in a wall of bare soil. The amount of soil moisture stored in the terrace for use by the crops may be reduced when the riser is exposed to drying out by wind and sun. It can also make the terraces more susceptible to erosion. (Photo 7).

The plant species used, and the way they are planted also affects their effectiveness:

− Crops such as pineapples, cassava and sugar cane, are not suitable for forming hedgerows. When these crops are harvested or replaced the partially formed terraces of eroded soil they held back become unprotected “waterfalls” in heavy rain. (Photo 8). The erosive energy of run-off increases by flowing over these semi-terraces. Hedgerows and NVS are meant to form permanent features of the landscape, so the plants used to form them should also be of a permanent nature.

− 15-30 cm gaps left between individual clumps of lemon grass, Guinea grass, Napier grass, planted across the slope in single lines as hedgerows, reduces the effectiveness of the hedgerow in slowing down run-off. Although eroded soil is deposited behind the clumps, the gaps concentrate and accelerate the flow of run-off carrying the fertile finer silt and clay soil particles with it during heavy storms.

− The SALT recommendations for using leguminous species such as Flemingia and Rinsonii are a double hedgerow (50 cm between each row) planted with seeds at 2 cm intervals. The terrace areas between hedgerows are 3-m wide. When insufficient seeds were supplied, farmers “economised” by planting widely-spaced single hedgerows with 15 cm or more between the seeds.

− Leguminous hedgerows are not suitable for soil conservation on steep slopes. Although they hold back stones and gravel, they are unable to provide the fine filter needed to hold back very silt and clay soil particles. Such hedgerows can lead to the formation of unstable terraces, where rows of thin plant stems 1-2 cm wide, hold back several tons of stony soil, creating a land slide hazard. (Photo 9).
3. STRATEGY

3.1 UDP actions under STOP

The development of Slope Treatment-Oriented Practices attempts to rectify the short-comings mentioned above. For example:

- Basing the distance between permeable or filter hedgerows on soil depth, slope and cultivation requirements. Restricting the use of hedgerows for annual crops to soils at least 100 cm deep on hill tops and upper slope land units, where volumes and velocities of run-off, and hence the erosion hazard, are lower. Terrace formation should result in 50 cm depth of soil at the back of the terrace.

- Using the A-frame to align the hedgerows accurately along contours.

- Minimising exposure of the bare soil in the riser by incorporating a 2-m wide NVS below the hedgerow to break up the height of the riser into two sections. This also deflects the energy of run-off passing through the hedgerows away from the base of the riser. Bananas planted in the NVS do not damage its primary function of soil conservation.

- Doubling the rows of Napier, guinea and lemon grasses by planting a second row of clumps row aligned with the gaps in the first row. (Vetiver grass is the most effective grass to use as a cross-slope barrier as its tillering forms a dense barrier, so only a single row is needed with splits planted 10-15 cm apart. Its roots go downwards – not sideways, and it dies back in the dry season).

- Substituting corn with fruit trees on the long slopes. Hedgerows are not needed if the land use is perennial crops.

However, there is a need to quantify the extent to which improper hedgerow layout is affecting production to argue for changes in policy, should the need arise. For example, the DA is advocating hedgerows be established on the long, very steep slopes in the mountains of Benguet Province.
Photo 1. Uneven terraces resulting from the carabao’s back method of contouring
(Brgy Maibo, Magsaysay, Davao del Sur)

Photo 2. Mis-aligned NVS from using the carabao’s back method of contouring. In 2003, furrows formed by ploughing caused run-off to flow to a low point forming a 1.0 m deep gully
(Brgy Amsipit, Sitio Tahakayo, Maasim, Sarangani)
Photo 3. Contour cultivation and water erosion reduced the original slope of 40% to 20%. The current riser height = 1.2m (based on height of oil drums). The 6-m spacing means the final riser will be 1.2m higher – a total of 2.4 m. (Palo 19, S. Cotabato)

Photo 4: A 3-m high riser between hedgerows on 55% slope
(Brg Lampitak, Sitio Melina, Tampakan, South Cotabato)
Photo 5  Fertility gradient on too-widely spaced NVS (planted with Achuete). Note the stunted growth of cassava below the upper NVS (on the right) while the best growth is immediately behind the lower NVS (on the left). The grass covering the riser protects it against drying out.  

(Brg Lampitak, Sitio Melina, Tampakan, South Cotabato)

Photo 6.  40 cm of soil remains before these lahar deposits are exposed creating a skeleton soil useless for agriculture or forestry  

(Brgy Lampitak, Sitio Tapicong, Tampakan, South Cotabato)
Photo 7. Soil on the riser face exposed to drying by wind and sunshine becomes unstable and prone to slumping. *(Brgy Amsipit, Sitio Tahakayo, Maasim, Sarangani)*

Photo 8: Wrong hedgerow material. The original hedgerows of cassava and sugar cane were removed as they attracted rats. The partially-formed outwardly-sloping terraces now increase the energy of run-off and the erosion risk. The lines are also off the contour.
Photo 9. Hedgerow of leguminous shrubs forming unstable terraces on 50-70% slopes. Note the potential land slide hazard from a few live stems 1-2 cm in diameter holding back several tons of eroded material. The fine soil particles have been washed away leaving a stony skeleton soils. (Dungga, Davao Oriental)