Natural Vegetative Strips

Farmers' invention gains popularity

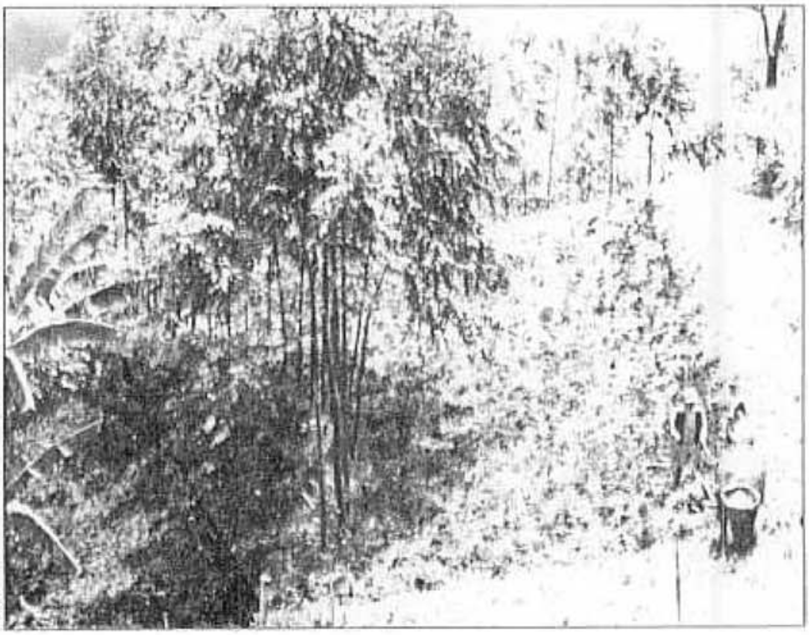
Contour hedgerows using nitrogen-fixing trees have been widely promoted in Southeast Asia to minimize erosion, restore soil fertility and improve crop productivity, but few farmers have taken them up- partly because establishing and managing them is very labour intensive. But establishing natural vegetative strips on contours, described in this article, takes only a fraction of the labour needed for conventional contour hedgerows.

Marco Stark, Augustin Mercado Jr and Dennis Garrity

Traditional contour hedgerows and farmers' modifications

Claveria is an upland area (400–800 m above sea level) of the southern Philippines with moderate rainfall (2200 mm a year) and degraded acidic soils. The area loses up to 200 metric tons per hectare a year of topsoil from cultivated fields, mainly because more than half of the cropping (mostly maize and vegetables) is done on lands with a slope of more than 15 percent (Fujisaka and others 1994).

The main tree species originally introduced for contour hedgerows was *Gliricidia sepium* (madre de cacao), planted in combination with *Pennisetum purpureum* (napier grass). But farmers in Claveria did not adopt the new technique as envisaged. Instead they quickly adapted it to minimize their labour inputs, by simply leaving marked contour lines unploughed during land preparation. Thus, they invented natural vegetative strips (NVS). Naturally occurring grasses and herbs rapidly covered the 50-cm-wide contour strips they left—which proved at least as effective as


ICRAF

Natural vegetative strips are the base for a highly productive and diverse agroforestry system: pineapple, guava and mango trees later replaced the natural strips. (M. Stark) the planted hedgerows in controlling soil erosion (Agus 1993). But cost only a fraction of the work. The strips are also less competitive with crops than planted tree or grass hedgerows (Ramiaramanana 1993).

In retrospect, the farmers' rejection of the tree hedgerow system seems an obvious and logical economic decision. We found that the time spent in pruning the hedgerows and using the prunings as green manure in the alleys did not pay off in terms of increased crop yields, particularly on phosphorus-deficient acidic soils such as those found in Claveria.

Today, over a thousand farmers in the area use the technique. Often the strips form a base for establishing fruit and timber trees, fodder grasses or other perennial cash crops.

The natural vegetative strips, however do not provide the large amounts of biomass needed to maintain soil fertility on the alleys between the strips. This means that an NVS cropping system will need to import nutrients to maintain soil fertility and sustain continuous crop production.

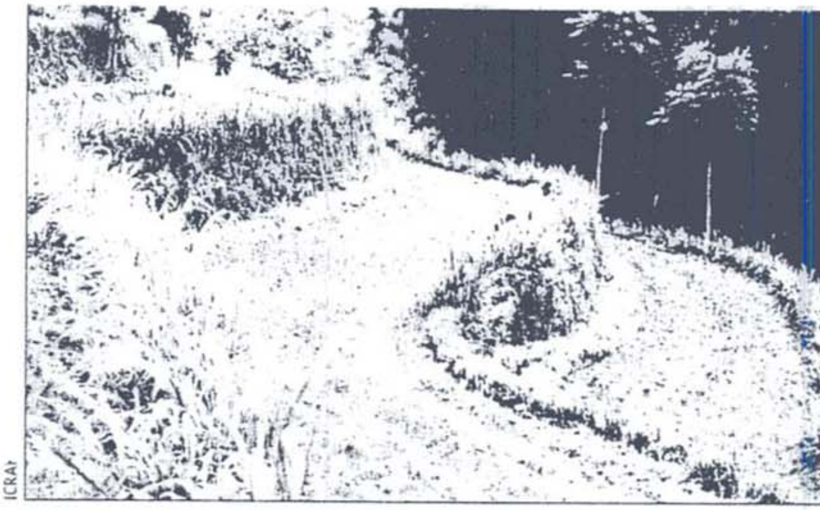
Scouring and sustainability concerns

As natural terraces are formed, soil is eroded from the upper to lower parts of the alley between the contour strips and a fertility gradient forms across the alleyway. (This is true whatever the hedgerow species.) The upper side of each alley has less organic matter and nutrient content, lower soil pH, and higher aluminium saturation. The result is reduced crop yield (fig. 1) (Stark 1999). But this gradual displacement of soil to the lower parts of the alley (known as 'scouring') can be desirable, as it further slows erosion and makes it easier to do field operations on the slope. The scouring effect seems particularly prominent where draught animals are used for ploughing, as is the case in Claveria (Garrity 1995).

Managing the soil appropriately and applying nutrients—manures, fertilizers—is necessary to cope with the fertility gradient that develops between the contour strips, because nutrients are regularly exported with the harvested crop, and vigorous fodder grass and natural vegetative strip species may compete with the crops. Since 1993, ICRAF has conducted trials in Claveria to investigate ways to reduce or prevent soil scouring . . . or to alleviate its effects. So far, we have studied two basic strategies to decrease or reverse the rate of scouring: applying more fertilizer nutrients, crop residues, or both from the strips in the upper alley areas; and practising minimum tillage (such as ridge tillage cultivation).

Farmers' experiences

The concern was that farmers might be discouraged from using contour vegetative strip systems if they observed reduced yields in the upper alleyways because of soil scouring. However, increasing numbers of farmers in Claveria continued establishing natural vegetative strips on their sloping fields. To get more insight into their rationale, we surveyed 30 adopters and 30 non-adopters of natural vegetative strips or fodder grass strips. Most farmers had observed the adverse effects of scouring on plant height and crop yields on the upper part of each alley (typically three to four maize rows). They attributed this to water runoff and tillage operations and believed that scouring had only a short-term effect on crop performance (3–5 years). This did not deter them from contour farming, although some farmers applied up to twice as much mineral fertilizer as normal on the upper 3–4 rows of maize on the alleys. We decided that natural vegetative strips would be even more attractive after there were improvements in soil and labour management, especially if we included farmers' indigenous strategies as basic principles in future research efforts.


ICRAF

From 40 percent slope to level ground in eight years: natural vegetative strips combined with napier grass for fodder build a strong barrier that prevents the sediment from tillage and water-induced erosion moving downhill. (M. Stark)

Trials in farmers' fields

We selected five farmers' fields with natural vegetative strips as experimental sites. The slope in these fields is 20 to 30 percent and the terraces are at different stages of development. All the fields show signs of soil scouring affecting the fertility. The study aimed to improve crop yields on the upper alley zones and to improve efficiency in using fertilizer across the alleyways. Our longer-term aim is to rehabilitate degraded soils on upper alley zones and to extrapolate our results by modelling the processes driving nutrient balances and soil organic carbon levels in the different zones across the alleys.

When we skewed application of nitrogen, phosphorus and potassium fertilizers, with up to three times more applied on the degraded upper terrace (alley) zones than on the more fertile lower zones, yields in the upper terrace increased dramatically. The practice did not, however, significantly increase crop yields of the terraces as a whole. The grain yield increase on the upper terrace was counterbalanced by a smaller yield increase on the lower terrace zones, which received less fertilizer. Data on these results were collected over four cropping seasons. Applying nutrients on the more fertile lower alley zones achieved higher fertilizer use efficiency. Thus, we found no particular advantage in skewing fertilizer applications rather than uniformly distributing N, P and K across the alley.

Another experiment showed that crop yields on the degraded upper terrace zones significantly improved when all the residues from the previous maize crop were concentrated on the upper part of the terrace (fig. 2). Also, applying lime to raise the soil pH improved the maize yield (Stark 1999).

We also investigated labour-saving techniques to establish the natural vegetative strips. Again, the ideas for the treatments we tested came from our farmer partners. To reduce labour for natural vegetative strip establishment, we used the so-called cow's back method, described in an earlier issue of *Agroforestry Today* (volume 8, issue 3, page 22). This made establishing contour strips even easier and further stimulated adoption.

Farmers' interest in growing fruit and timber trees on the contour strips has been supported by ICRAF through technical backup and by providing seed of some hard-to-acquire species. (M. Stark)

ICRAF

Future directions

The redirection of research at ICRAF's research site in northern Mindanao—from testing traditional hedgerow species and assessing introduced soil management techniques to building research largely on farmers' indigenous knowledge—is a milestone in itself. Researchers have learned that natural vegetative strips are the most appropriate method for soil conservation under the conditions prevailing in the area, and that soil fertility scouring is of lesser concern to farmers than initially thought. However, certain aspects require more in-depth investigation, such as the long-term effects of selective application of nutrient inputs and lime to favour growth in the upper alleys. Crop residues and low-cost rock phosphate are of special interest under low-input cropping conditions.

The NVS technology, along with improved soil fertility management practices, still needs to be tried out in the contrasting conditions of the shallow soils derived from marine limestone that are typical of the central Philippines, and adapted to them. This major, contrasting soil environment is common in several other countries in Southeast Asia, including eastern Indonesia, parts of Vietnam, and southern China.

Lately we have widened our research focus to include the suitability and management of a range of timber and fruit tree species planted on natural vegetative strips and their interaction with associated field crops. We believe that by promoting natural vegetative strips as a base for planting fruit and timber trees we will not only widen the use of the strips but also demonstrate that farmers can make more productive use of them. Local interest in tree planting has increased sharply in recent years due to rising wood and fruit prices, and to a more dynamic extension system. This extension system, called Landcare, involves self-governing farmer groups assisted by technicians, researchers and local government working together to develop and disseminate technologies that suit the diverse range of circumstances in upland farming.

References

Agus F. 1993. Soil processes and crop production under contour hedgerow systems on sloping Oxisols. PhD dissertation, North Carolina State University, Raleigh, NC, USA.

Fujisaka S, Jayson E, Dapusala A. 1994. Trees, grasses, and weeds: species choices in farmer-developed contour hedgerows. *Agroforestry Systems* 25:13–22.

Garrity DP. 1995. Improved agroforestry technologies for conservation farming: pathways toward sustainability. In: *Proceedings of the International Workshop on Conservation Farming for Sloping Uplands in Southeast Asia: Challenges, Opportunities and Prospects*. Proceedings No. 14. Bangkok, Thailand: IBSRAM. p145–168.

Ramiaramanana DM. 1993. Crop-hedgerow interactions with natural vegetative filter strips on sloping acidic land. MSc thesis. University of the Philippines, Los Baños.

Stark M. 1999. Soil management strategies to sustain continuous crop production between vegetative contour strips on humid tropical hillsides: technology development and dissemination based on farmers' adaptive field experimentation in the Philippines. PhD dissertation. University of Kassel, Witzenhausen, Germany.

ACKNOWLEDGEMENT

The PhD study presented in this article was supported partly by the Studienstiftung des Deutschen Volkes.

AUTHOR NOTE

Marco Stark is a PhD graduate from the University of Kassel, Germany, conducting research on contour hedgerow improvement with ICRAF Philippines at ICRAF's outreach site in northern Mindanao, a benchmark site of the global Alternatives to Slash-and-Burn Programme. Augustin Mercado Jr is an ICRAF research officer in Claveria, the Philippines, and Dennis Garrity is regional coordinator for ICRAF Southeast Asia.

For more information contact Marco Stark, ICRAF-Philippines, Claveria, Misamis Oriental 9004, Philippines, email: marco@cdo.weblinq.com or mstark@wiz.uni-kassel.de.

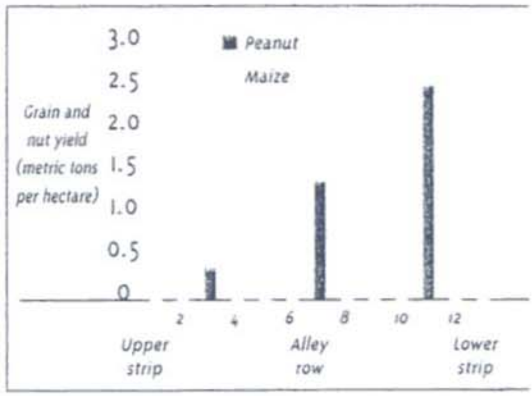


Figure 1. Yield of unfertilized native maize and peanut intercrop across a single alley between vegetative contour strips (grain at 14 percent, nuts at 12 percent moisture content; one crop 1995, farmers' practice, n = 3).

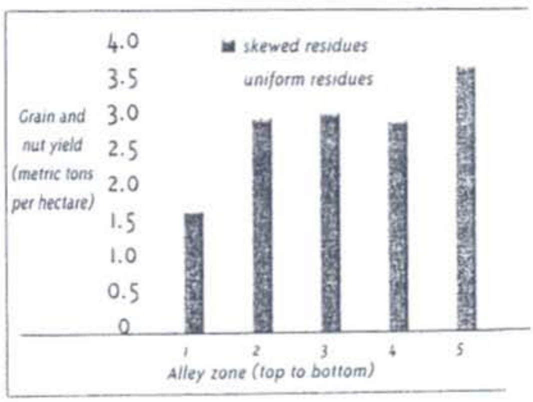


Figure 2. Hybrid maize grain yield response to crop residue distribution (skewed residues: 10 metric tons per hectare on zones 1, and 2 metric tons per hectare on other zones; uniform residues: 4 metric tons per hectare on all zones; letters 'a' and 'b' indicate significant differences between means at zone 1; P " 0.05; ANOVA by zone; LSD test; n = 12).