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Managing Soil Fertility on Terraces Forming Behind Vegetative Filter Strips: an Assessment of Farmers' Strategies[1]

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Abstract

The indigenous use of natural vegetative strips (NVS) to control soil erosion on the slope has been viewed as a low-cost alternative to planted tree hedgerows. As in conventional hedgerow systems, however, natural terrace formation resulting from redistribution of sediment from upper to lower terrace zones leads to the development of a soil fertility gradient with significantly lower crop yield on the degraded upper portion of each terrace. Since NVS produce little biomass which could be used to maintain soil fertility, the sustainability of annual crop production in NVS systems may be questionable. Interview surveys conducted in two upland locations in the Philippines showed that most farmers had observed soil fertility scouring to adversely affect crop performance on the upper part of the terrace. However, scouring was not usually perceived as a serious constraint of the technology. Farmers claimed that the benefits of overall increased crop yield and rise in land value due to contouring outweighed the negative effects of upper terrace yield decline; besides, they generally believed scouring to be a transitory phenomenon. On-farm experiments were conducted to assess farmers' strategies to overcome the negative effects of soil fertility scouring in NVS systems by skewing the application of nutrient inputs towards degraded upper terrace zones. Further research is required to identify methods to fully rehabilitate the degraded upper terrace through raising soil organic matter levels.

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1 Introduction

The indigenous practice of using natural vegetative strips (NVS) of 0.5 - 1 meter width as buffer or filter strips to reduce soil erosion on the slope can be viewed as an alternative technology to contour hedgerow intercropping with planted trees. It requires minimal labor for establishment and maintenance while reducing soil erosion at least as effectively as planted tree hedgerows (Garrity *et al.*, 1993). Local grasses and broad-leaf species growing in the strips compete less with adjacent alley crops (Ramiaramanana, 1993). However, sediment redistribution during natural terrace formation leads to the development of a soil fertility gradient with significantly lower crop yield on degraded upper terrace (alley) zones as compared to the lower terrace portion where eroded sediment and nutrients accumulate (Turkelboom *et al.*, 1993; Anecksamphant and Sajjapongse, 1994). Natural vegetative contour strips provide substantially less biomass compared to tree hedgerows which could be used to maintain soil fertility levels on the upper terrace and reduce the effects of scouring. Sustained continuous crop production in NVS systems therefore depends largely on the import of external nutrients.

Research has focused on significantly reducing within-alley soil movement through ridge tillage cultivation, a minimum tillage technology (Thapa *et al.*, 1996), and on biasing the application of hedgerow cuttings and crop residues towards degraded upper alley (terrace) zones in tree hedgerow systems (Mercado *et al.*, 1996). The suggestion to improve fertilizer use efficiency by matching fertilizer rates to site specific nutrient requirements at varied landscape positions (Fiez *et al.*, 1994) may also be applied to small-scale variations of soil fertility in vegetative contour strip systems.

Objectives of the study were to identify farmers' indigenous strategies to improve the NVS system with a special focus on overcoming the negative effects of soil fertility scouring on crop yield. Subsequent on-farm research focused on assessing indigenous strategies to obtain uniform crop yield across the alley-way by biasing the application of nutrient inputs towards degraded upper alley zones. The present study is part of a participatory technology development (PTD) project conducted under ICRAF's research program in the Philippines.

A farmer-based understanding of the benefits and constraints of natural vegetative contour strips, together with identifying and developing options for the improved management of NVS systems, will allow more confident extrapolation of the technology to other locations in the humid tropics.

2 Methodology

Fifty-three interviews were conducted among contour farmers in Claveria (Northern Mindanao) and Matalom (Southern Leyte) in 1995 and 1997, respectively. The municipality of Claveria is one of ICRAF's research sites in the Philippines located in an acidic upland area typical for the majority of degraded uplands in the SE-Asian region. In Matalom, the use of natural vegetative strips is an indigenous soil conservation technology which has been applied by local farmers for more than 50 years. Matalom is characterized by shallow calcareous soil conditions and less intensive cropping. Basic crop and soil data were collected from selected farms to document the effects of soil fertility scouring. Formal on-farm experiments conducted on existing NVS sites since 1995 assess identified farmer strategies to overcome the effects of soil fertility scouring.

2 Results and Discussion

Farmers' perceptions of soil fertility scouring

Most farmers had observed soil fertility scouring to adversely affect plant height and crop yield on the upper part of the alley, but did not consider scouring as a serious constraint of the technology. An example of the dramatic effect of soil fertility scouring on crop yield is shown in Figure 1. Farmers claimed that the benefits of overall increased crop yield and rise in land value due to contouring outweighed the negative effects of upper alley yield decline. In Claveria, scouring was generally observed or believed to be a transitory phenomenon, either affecting crop performance during the first three to five years after NVS establishment or for at least the same duration at a later stage, after more soil had been relocated within alleys. Under less intensive cropping in Matalom, however, it commonly takes several decades until terraces level off and until degraded upper alley soil conditions have been rehabilitated.

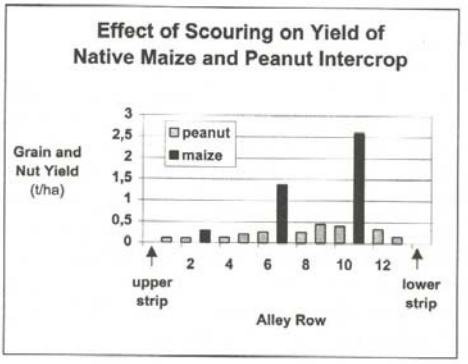

Figure 1: Yield of unfertilized native maize and peanut intercrop across a single alley between vegetative contour strips (grain at 14 %, nuts at 12 % moisture content; means of three replications; 1. crop 1995, farmer's practice)

Skewing the application of nutrient inputs towards the degraded upper alley was found to be a common strategy among farmers in Claveria to reduce the negative effects of soil fertility scouring on crop yield (Tab. 1). Since the application of external inputs was not an option for most farmers in Matalom, only few had applied strategies to maintain soil fertility, aside from fallowing the land.

Table 1: Locals strategies to reverse or avoid the effects of soil fertility scouring used among farmers in Claveria (n=30)

Farmers' Methods to Overcome Scouring Effects	Count	Percent
Up to two times more fertilizer on upper alley crop rows	12	34.3
Applying fertilizer uniformly across alley	5	14.3
Additional mulch application on upper alley crop rows	4	11.4
Skewing the distribution of crop residues towards upper alley	2	5.7
Skewing the application of lime towards upper alley	2	5.7
None	10	28.6
Total*	35	100

* Multiple responses possible

Technology validation: an assessment of farmers' strategies

On-farm trials to evaluate farmers' management strategies have been conducted in Claveria since 1995. Experiments showed that skewing the application of mineral fertilizer (treatments T3 and T4) towards upper alley zones resulted in significantly higher hybrid maize grain yield on the degraded upper alley compared to uniform fertilizer distribution (T2). The application of 1.5 times more NPK-fertilizer on upper compared to lower alley zones (T3) was optimal and resulted in the lowest crop yield response slope, i.e. the most uniform crop performance across the alley. A three times higher fertilizer application (T4) over-compensated for the within-alley fertility gradient (negative slope) (Fig. 2). NPK fertilizer was applied at the recommended rate of 80-30-30 kg NPK ha^{-1} $season^{-1}$ (full fertilizer rate); treatment T1 represents the control with no fertilizer applied.

Looking at grain yield harvested from the alley as a whole, there were no significant differences between uniform and skewed fertilizer treatments, because placing increasingly higher portions of the fertilizer amount on the upper alley, constantly reduced yield on the lower alley zones. The yield decline on lower alley zones followed a linear trend, at a rate almost identical with the rate of yield increase on more heavily fertilized upper alley zones (i.e. the fertilizer efficiency on upper and lower alley zones were not significantly different from each other). The study was, however, limited to only a small number of treatment levels and maize varieties.

Initial investigation of the skewed distribution of either crop residues or lime showed positive effects on upper alley crop yield. A long-term investigation of methods to fully rehabilitate soil fertility on degraded alley zones through raising soil organic matter levels is required. Computer models could be useful in extrapolating experimental results.

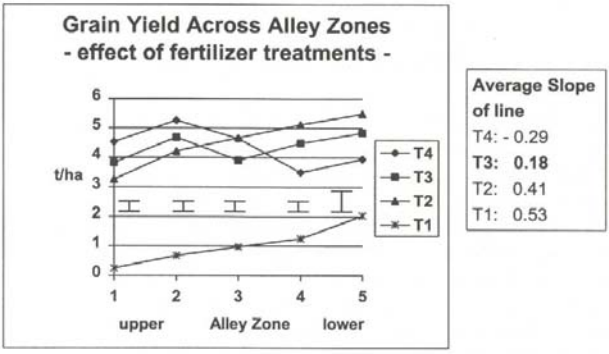

Figure 2: Effect of fertilizer treatments on hybrid maize grain yield across alley zones; 1st crop 1996, full fertilizer rate (Note: LSD values [bars inside graph] computed separately by alley zone for $P < 0.05$)

4 Conclusion and Recommendations

The adoptability of the NVS technology can be enhanced by building on indigenous strategies to improve the NVS system. Further experimental evaluation of farmers' practices is required to identify strategies to fully rehabilitate degraded upper alley soil conditions in the long-run. These strategies are: skewing the application of crop residues, mulch and/or lime with higher amounts on the degraded upper alley zones, and clean-scraping the lower portion of the NVS bunds to add nutrients (with the scraped plant and soil material) to the upper part of the alley.

Other indigenous technology modifications which need to be evaluated before their wider dissemination include:

- Adding value to the area "lost" to NVS and reinforcing buffer function: most farmers perceived NVS as an intermediate step towards the development of more complex agroforestry systems. Interaction effects and overall system productivity need to be evaluated for a variety of perennials planted on the contour strips and a number of different planting arrangements. Under low-intensity cropping, vetiver grass (*Vetiveria zizanioides*) could provide reinforcement for the NVS because low pruning frequency

and prolonged fallow periods (with free grazing animals causing damage to the strips) result into weak buffer strips.

- Reducing labor requirements for establishment of NVS: most farmers had substituted labor-intensive methods for simple eye-estimate to determine the (semi-) contour line. Loss of efficiency in controlling soil erosion needs to be quantified.

Strengthening the partnership between farmers, researchers and the local government has become an important goal of the research program and proved to be a successful model for the efficient, low-cost and sustained development and dissemination of soil-conserving and income-generating technologies among small-scale farmers in the study area.

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