**Summary review of the international literature on soil erosion in Vietnam[1]**

The literature unanimously identifies soil erosion as a major problem in the northern mountainous region of VN. Maize and cassava based systems appear to be the most susceptible. Causes for accelerated soil erosion are increased population pressure, land scarcity and market development and 'market forces' (Valentin *et al.* 2008); (Ziegler *et al.* 2009). On a catchment scale, runoff increases with land under maize. Maize cover is closely related to sediment yield, making the maize system the most vulnerable land use. Rates are highest in intensive, double cropping systems where fallow periods are short. Erosion events are limited to a relatively short time period during the rainy season during plot preparation and weeding until canopy closure. Tillage erosion, in contrast to surface erosion is a large contributor to total erosion. This implies that minimising tillage for plot preparation and/or weeding are practical options to reduce soil loss. It is also important to note that erosion on the upper slopes is less compared to lower slopes. This is related to land use history where the steeper, upper slopes were brought into cultivation more recently than the lower slopes.

Slash and burn swidden systems are considered sustainable as long as 1 cropping cycle is followed by 8 years of fallow. Using this wide ratio shows that any system that promotes fallowing is not a practical option given that continuous maize production is becoming the norm.

In farmers fields, surface erosion rates can reach up to 350 t/ha (Ziegler *et al.* 2009). However, many other studies also report much lower erosion. For example, soil loss may be as low as 4-6 t/ha and mainly associated with weeding during the early crop phase (Ziegler *et al.* 2007), or 15 t/ha under cassava and less than 5 t/ha under fallow (Podwojewski *et al.* 2008). Low erosion rates on some soils are due to very low bulk density and high water intake rates if tillage erosion is ignored.

Compared to the potentially very high total rates, reduction in tillage and a move towards no-tillage systems may be an important soil management option to try. The added benefit would be increased soil structural stability as organic matter builds up which reduced soil erodibility. Several publications investigate this beneficial effect, but generally do not extrapolate from biophysical processes to farmer adoption. Reduction in tillage lessens labour, *i.e*. it is potentially farmer friendly, but requires herbicide which farmers may not be able to afford. Other tillage related options are reducing tillage to the flatter slopes only, cultivation along the contour or deliberately placing charred logs horizontally across the hill slope to form revetments to curb soil loss. (Ziegler *et al.* 2009).

The majority of literature describes various types of ago forestry systems. Common multi purpose shrubs and trees are Hong Dao bean, Acacia arnangium, Casuarina cunninghamiana (Kardell 1993). Using Tephrosia candida as hedge rows and source for mulch is often mentioned (Fagerstrom *et al.* 2002) but generally fails in farmers fields because there is no immediate benefit to the farmer besides erosion control. The best outline is given by (Wezel *et al.* 2002). They emphasize that farmers are likely to be more interested in conservation measures if they provide direct benefits

[1] Composed by Dr Gunnar Kirchhof

such as animal fodder or weed suppression, while soil conservation is a secondary, long-term benefit. They list the following as potential intercrops or hedges: Leucaena leucocephala (Lam.), De Wit, Cajanus cajan (L.) Millsp. or Indigofera sp. But they point out that adoption will be low if farmers are left unaware of feed value and if mulching is only done under the trees and not spread. The 'selling point' of mulching is not mulching *per se* but weed suppression. In terms of problem ranking, weed control is most important, followed by pest/diseases, then rats followed by soil fertility. Soil erosion control is the least important problem. This ranking is probably closely related to the use of fertiliser and improved varieties.

Lablab purpureus, sweet and Vigna umbellate, Ohwi and Ohashi are suitable for weed control and N enrichment in maize systems. Some farmers plant Pachyrhizus erosus or yam bean between maize for bean and tuber production. This creeping plant species is still persistent after maize harvest remaining as mulch until the beginning of the following cropping season. In perennial timber systems Tectona grandis may be an option. This may be combined with mulch lines, stone barriers and grass or weed strips (Turkelboom et al., 1996). Microterraces have been promoted by soil conservation projects since 1998 and were adopted by some farmers, however its long-term effectiveness has still to be proven.

Burning of fields and fallows for land preparation is still a common practice with short-term advantages in labour economy, weed and pest control, but with disadvantages of increased nutrient leaching by inducing nutrient flushes. Farmers still have few alternatives to burning and need assistance to replace or at least improve this practice. Potential improvements are the timing of fires, top–down burning, firebreaks and different aspects of ash fertilisation and tillage (van Keer et al., 1998).

Adoption of soil conservation methods is not driven by degree of intensification and/or farm income (Valentin *et al.* 2008) and Sidle *et al.* (2006) advocate that the 'apparent' need of subsistence farmers to generate additional sources for short-term income from the land have placed increasing demands and pressures on soil and water resources.

Trung *et al.* (2008) present a simple variance based system to assess soil quality. Although it is very amenable for quick assessment, it should only be used with caution as it represent a simplified averaging of soil quality indicators and hence does not account for the most significant limiting factors.

For our project, treatments should include methods to reduce tillage, perhaps reduced weeding through the use of herbicides as well as carefully selected species as hedge rows or intercrops. It is important that farmer's see a direct immediate benefit, *e.g.* labour saving weed control and add-on value from inter- or cover crops. If new types of multi purpose trees or shrubs are introduced, it will be important to ensure that farmers field schools demonstrate their benefits. Use of single purpose species such as for example Tephrosia, will be futile for adoption. Local knowledge will be needed to decide on suitable species.

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