FORMAS

Swedish Research Council

SLU

World Agroforestry

EXTENSION DOCUMENT
TECHNICAL GUIDELINES

HOW TO MEASURE SOIL EROSION IN SLOPING LANDS?

Hanoi | March 2024

ABOUT THE PROJECT

The Project ***"Agroforestry: potential for sustainable development in the uplands"*** aims to contribute to sustainable development in sloping upland areas, with focus on evaluating agroforestry practices and systems addressing production and productivity, soil conservation, management practices such as nutrient application and weeding, and competitive effects between trees, crops and forage grass in young and mature agroforestry systems, study fruit value chains and market links, and assess opportunities and bottle-necks for wider agroforestry adoption and increasing of scale.

The Project (formally two projects) is funded by Formas, a Swedish Research Council for Sustainable Development and Vetenskapsrådet / Swedish Research Council, respectively. It is carried out between January 2020 and December 2023 (Formas), and December 2024 (VR), by SLU - Swedish University of Agricultural Sciences and the International Centre for Research in Agroforestry (ICRAF - also known as World Agroforestry) in Viet Nam, the Soil and Fertilizers Research Institute (SFRI) and the Departments of Agriculture and Rural Development from provinces of Dien Bien, Son La and Yen Bai.

SOIL EROSION

Soil erosion is a gradual process that occurs when the effects of water or wind detach and remove soil particles from the ground (Al-Kaisi, 2000). According to the Food and Agriculture Organization (FAO), soil erosion poses the single greatest threat to global food security, with an estimated 33% of the world's soil already degraded by erosion (FAO, 2015). While sloping land is a crucial resource for upland agriculture, it is also susceptible to erosion. Soil erosion and nutrient losses from sloping land are exacerbated by reduced water infiltration capacity, topographical characteristics, irregular and heavy rainfall events, and inadequate agricultural management techniques (Mao et al., 2020). The erosion of topsoil results in the loss of soil organic matter, nitrogen, phosphorus, and potassium, leading to decreased soil fertility and adverse impacts on crop production (Sulaeman and Westhoff, 2020).

Evaluating soil erosion processes is critical for understanding the extent and causes of erosion, assessing environmental implications, planning conservation activities, developing erosion prediction systems, and implementing conservation policies (Hassim et al., 1995; Toy et al., 2002).

Photo: ICRAF Viet Nam

SOIL EROSION MEASUREMENT USING BOUNDED EROSION PLOTS WITH SOIL TRAPS

Bounded erosion plots with soil traps remain one of the most used approaches for assessing field erosion rates over short- and medium-time periods. The installation costs for erosion plots with soil traps are often relatively low.

To monitor soil erosion, each plot is a physically isolated land area with known dimensions, slope gradient, slope length, and soil type (Yaxian and Baoyuan, 2021). The plots should be uniformly set up following the slope direction (Fig. 1).

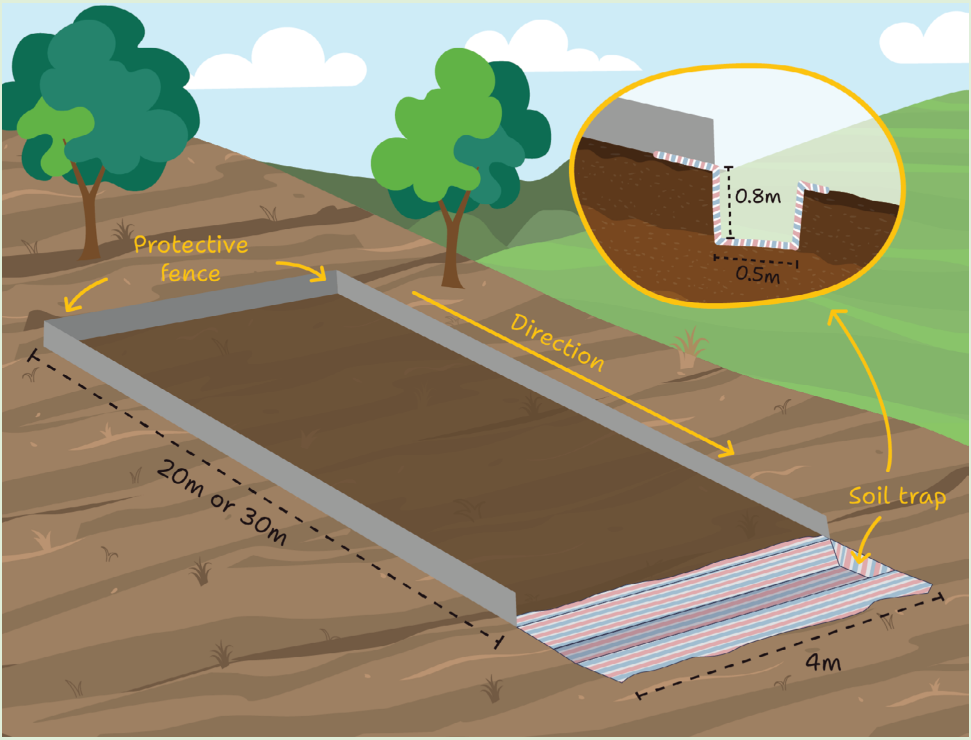

Figure 1. *Erosion measurement system with fence and soil trap*

A recommended plot size by Morgan (2005) is 10 m x 2.0 m for shrub lands, and 20 m x 5.0 m for forests and woody crops. In studies in northwest Vietnam, we have used plot sizes of 20 or 30 m x 4.0 m in fruit tree agroforestry with maize or coffee, and in sole crop plots (Do et al., 2023).

The erosion measurement plots are enclosed by fiber-cement sheets, sheet metal, wood, or any material preventing leaking and overland flow into and out of the plots (Morgan, 2005), with fiber-cement being recommended for its cost-effectiveness and durability (Fig. 2a).

Figure 2. *(a) Protective fence made of fiber-cement sheets at measuring areas for soil erosion, (b) The dimensions of the soil trap is 0.5m wide and 0.8m depth below each erosion plot.*
(Photo taken at an agroforestry trial of docynia indica-coffee-forage grass in Tuan Giao district, Dien Bien province)

A soil trap is established at the bottom of each erosion plot (Fig. 1). The trap's capacity should be sufficient to capture rainwater while allowing sediments to settle, even during the highest rainstorms. The dimensions of a soil trap depend on the plot size and precipitation regime; for instance, for a plot size of 20 m x 4.0 m, a recommended sediment trap dimension is 4.0 m long, 0.5 m wide, and 0.8 m deep. The trap's bottom and sides are covered by plastic fabric or fiber materials that support the soil walls while enabling water infiltration (Fig. 2b). The trap retains water with suspended particles until they settle to form sediment. The time interval for removing and weighing the sediment depends on the trap's capacity and the time resolution of the required data (Fig. 3).

Once collected and weighed, the sediment is homogenized, and a subsample of at least 300 g of fresh sediment/soil is collected and dried at 60°C until a constant weight is reached. The percent water content of the fresh material is then calculated and used to correct the measured total fresh soil weight for moisture content. The calculated dry weight of soil is then divided by the contributing area (expressed in hectares) to obtain the soil loss in metric tons per hectare (Tuan et al., 2014; Do et al., 2023).

Figure 3. *Collecting eroded soil in soil traps at the longan-mango-maize-forage grass agroforestry trial in Mai Son district, Son La province*

REFERENCES

Al-Kaisi, M., 2000. Integrated Crop Management News Agriculture and Natural Resources Soil erosion: An agricultural production challenge.

Do, V.H., La, N., Bergkvist, G., Dahlin, A.S., Mulia, R., Nguyen, V.T., Öborn, I., 2023. Agroforestry with contour planting of grass contributes to terrace formation and conservation of soil and nutrients on sloping land. Agric. Ecosyst. Environ. 345, 108323. https://doi.org/10.1016/J.AGEE.2022.108323

FAO, 2015. The role of soils in ecosystem processes., Status of the World's Soil Resources -Main Report.

Hashim, G.M., Ciesiolka, C.A.A., Yusoff, W.A., Nafis, A.W., Mispan, M.R., Rose, C.W., Coughlan, K.J., 1995. Soil erosion processes in sloping land in the east coast of Peninsular Malaysia. Soil Technol. 8, 215–233. https://doi.org/10.1016/0933-3630(95)00021-6

Mao, Y.T., Hu, W., Chau, H.W., Lei, B.K., Di, H.J., Chen, A.Q., Hou, M.T., Whitley, S., 2020. Combined cultivation pattern reduces soil erosion and nutrient loss from sloping farmland on red soil in Southwestern China. Agronomy 10. https://doi.org/10.3390/agronomy10081071

Morgan, R.P.C. 2005. Soil erosion and conservation, 3rd edn. Blackwells, Oxford, p 304.

Toy, T.J., Foster, G.R. and Renard, K.G., 2002. Soil erosion: processes, prediction, measurement, and control. John Wiley & Sons.

Tuan, V.D., Hilger, T., MacDonald, L., Clemens, G., Shiraishi, E., Vien, T.D., Stahr, K., Cadisch, G., 2014. Mitigation potential of soil conservation in maize cropping on steep slopes. F. Crop. Res. 156, 91–102. https://doi.org/10.1016/j.fcr.2013.11.002

Yaxian, H. and Baoyuan, L., 2021. Measuring erosion and sediment yields on slopes and in small catchments. Available at: https://static.iahr.org/upload/file/20210616/20210616172908_67641.pdf

NOTES

WE HOPE THAT THIS DOCUMENT IS USEFUL

FORMAS

Swedish Research Council

SLU

World Agroforestry

CONTACT

Viet Nam Coordinator: PhD. La Nguyen, ICRAF Viet Nam,
E-mail: l.nguyen@cifor-icraf.org | *Phone:* +84 (0)962021472

PhD. Do Van Hung, ICRAF Viet Nam, Swedish University of Agricultural Sciences,
E-mail: d.hung@cifor-icraf.org | *Phone:* +84 (0)977843201

MSc. Pham Huu Thuong, ICRAF Viet Nam, Swedish University of Agricultural Sciences,
E-mail: p.thuong@cifor-icraf.org | *Phone:* +84 (0)912755998