**Tropentag, September 18-20, 2019, Kassel**

"Filling gaps and removing traps
for sustainable resource management"

# Taking Stock of Carbon along a Land-Use Gradient in the Highlands of Java, Indonesia

Joep Van der Poel[1], Sara Andrea Vaca Sanchez[2], Axel Mentler[2], Katharina Keiblinger[2], Hatma Suryatmojo[3], Kristin Banyu Risang Hobo[3], Lidia Situmorang[3], Ngadisih Ngadisih[4], Rima Darmawanti[4], Reinhard Rebernig[5], Hermine Zimmermann[5], Oliver Gardi[1], Lindsey Norgrove[1]

[1] *Bern University of Applied Sciences (BFH), School of Agricultural, Forest and Food Sciences (HAFL), Switzerland*

[2] *University of Natural Resources and Life Sciences Vienna (BOKU), Inst. of Soil Research, Dept. of Forest and Soil Sciences, Austria*

[3] *Universitas Gadjah Mada (UGM Yogyakarta), Fac. of Forestry, Dept. of Forest Resource Conservation, Indonesia*

[4] *Gadjah Mada University (UGM Yogyakarta), Fac. of Agricultural Technology, Dept. of Agricultural and Biosystem Engineering, Indonesia*

[5] *University of Natural Resources and Life Sciences Vienna (BOKU), Centre for Development Research (CDR), Austria*

## Abstract

Retaining or adding trees to cropping systems is widely assumed to increase carbon (C) stocks by building biomass, adding litter to soil, providing a stable microclimate, enhancing soil biological and physical properties and increasing temporal stability. Agroforestry may also provide landscape-level services such as watershed and biodiversity conservation and, on steep slopes in high rainfall areas, reduce the risk of soil erosion and landslides. Yet trees can compete with crops for space, nutrients and water and such trade-offs might be acute where population density is high, such as in Java Indonesia, where densities can exceed 900 $km^{-2}$.

We hypothesised that soil C stocks are higher in cropping systems where trees are included, and in abandoned tree regrowth. We selected two villages, Leksana and Penanggungan, in the Central Javan highlands (>1000 m a.s.l.). Here, maize, potatoes, vegetables and other crops are farmed on Nitisols, under a range of intensification scenarios, including or excluding trees. We compared cropped fields (i) with trees; (ii) without trees; (iii) without trees and with intensive pesticide and fertiliser use; and (iv) abandoned tree regrowth. On five fields of each type, we assessed tree vegetation (>2 cm diameter at breast height), soil C and bulk density (0–10 and 10–30 cm depths).

Trees on cropped fields were commonly two nitrogen-fixers, the native *Paraserianthes falcataria*, averaging 270 stems $ha^{-1}$ and the exotic *Calliandra calothyrsus*, combined with both native and exotic fruit and timber trees. Mean aboveground C in trees was 6.3 Mg C $ha^{-1}$. In the abandoned regrowth, *P. falcataria* densities were lower (222 $ha^{-1}$) while densities of *C. calothyrsus* exceeded 11,000 stems $ha^{-1}$ and aboveground C stocks were 60.4 Mg C $ha^{-1}$. Contrary to our hypothesis, soil C concentrations were high (5.1–7.9 % at

**Contact Address:** Joep Van der Poel, Bern University of Applied Sciences (BFH), School of Agricultural, Forest and Food Sciences (HAFL), Bern, Switzerland, e-mail: joep.vanderpoel@students.bfh.ch

0–10 cm depth) and neither concentrations nor stocks were significantly different between any of the plot categories, ranging from 71–89 Mg C ha$^{-1}$ to 30 cm depth. This indicates either that factors other than including trees have a stronger influence on soil C or more time is required to detect differences in such C-rich soils.

**Keywords:** Agroforestry, carbon stocks, Java, land-use gradient, space-for-time-substitution