Tropentag, September 20-22, 2023, hybrid conference

"Competing pathways for equitable food systems transformation: Trade-offs and synergies"

Influence of coffee agroforestry systems on soil carbon stock and carbon mineralisation: A case study in northern Thailand

Sasiprapa Kullachonphuri[1], Phonlawat Soilueang[2], Nipon Mawan[1], Yupa Chromkaew[2], Sureerat Buachun[3], Wiriya Sanjunthong[1], Suwimon Wicharuck[4], Nuttapon Khongdee[1]

[1] *Chiang Mai University, Dept. of Highland Agric. and Natural Resources, Thailand*
[2] *Chiang Mai University, Dept. of Plant and Soil Science, Thailand*
[3] *Rajamangala University of Technology Lanna Phitsanulok Campus, Thailand*
[4] *Chiang Mai University, Energy Technology for Environment Research Center, Thailand*

Abstract

Deforestation affects soil carbon stock due to the soil environment under the canopy and the root systems of each plant species determine soil carbon mineralisation process. In the upper north of Thailand, forest area has recently been converted to agricultural area in particular coffee plantation. Therefore, the objective of this research was to assess soil carbon stock and carbon mineralisation in various coffee agroforestry systems. The study site was located at the Arabica coffee plantation of the Nhong Hoi Highland Agricultural Research Station in Chiang Mai province, Thailand. This study included four land use types: (1) forest (comparing site), (2) coffee monoculture, (3) coffee grown with forest, and (4) coffee grown with fruit trees. To investigate soil carbon stock, nondestructive soil samples were taken at three different soil depths: 0–20 cm, 20–40 cm, and 40–60 cm. For carbon mineralisation study, destructive soil samples at topsoil layer (0 – 20 cm) were taken into the laboratory for the incubation experiment. The soils were then sampled at day 1, 4, 7, 14, 21, 35 and 65 after incubation for dissolved organic carbon (DOC) and CO_2 emission analysis. This study revealed that the coffee with fruit trees at topsoil layer (0–20 cm) had the lowest soil carbon stock, followed by coffee monoculture and the forest, while the soil from the coffee grown with the forest had the highest soil carbon stock. The soil carbon stock at 20–40 and 40–60 cm depths did not differ ($p > 0.05$) between each land uses. Regarding DOC, forest soil was found to be considerably higher than coffee monocrop and coffee grown with fruit trees ($p < 0.05$), with DOC values of 25.23 mg kg^{-1}. Coffee monoculture had the lowest DOC (22.56 mg kg^{-1}). Cumulative CO_2 emission showed that coffee grown with forest contributed the highest CO_2 emission (10.3 mg kg^{-1}) while forest had the lowest value of CO_2 emission (4 mg kg^{-1}). Combined coffee and forest cultivation can boost biodiversity more than coffee monoculture. Coffee cultivation in association with forests or perennial fruit trees can be options for sustainable Arabica coffee cultivation in Northern Thailand.

Keywords: Agroforestry systems, Arabica coffee, land use change, soil microbial respiration

Contact Address: Nuttapon Khongdee, Chiang Mai University, Dept. of Highland Agric. and Natural Resources, Huay Kaew Road, 50200 Chiang Mai, Thailand, e-mail: nuttapon.k@cmu.ac.th