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Agro-Ecology Determines Farm Typology Effect on Soil Fertility Variability in Small Holder Farmers; Ethiopia

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Abstract

The aim of this study was to investigate inter-related effects of agro-ecology and farmers' resource endowment (i.e., "wealthy", "medium wealthy", and "poor" farmers) on the spatial variability of soil fertility in Central and Western Ethiopia. Using a mid-infrared spectroscopic research approach, coupled to partial least squares regression analyses (midDRIFTS-PLSR), a prediction model was developed to assess soil fertility indicators across a regional scale, including various agro-ecological zones: "dega" (D) and "high dega" (HD) (2500–3500 m.a.s.l., temperature ≤9°C, rainfall 938 mm), "weina-dega" (WD) (1500–2500 m.a.s.l., 15 to 27°C, 1376 mm), and "kola" (K) (<1500 m.a.s.l., 15 to 27°C, 2037 mm). Furthermore, midDRIFTS peak area analysis of selected spectral frequencies (2930, 1620, 1159 cm^{-1}) was applied to characterise functional groups of soil organic carbon (SOC) and to calculate the SOC stability index 1620:2930, which were used as proxies of soil quality. Total carbon (TC) content in soils was predicted accurately (R^2 = 0.92, RPD = 3.46), whereas prediction of total nitrogen (TN) (R^2 = 0.86, RPD = 2.71) and pH (R^2 = 0.89, RPD = 3.02) was acceptable. Predictions of available phosphorous (Pav) and potassium (Kav) were not successful; hence, wet chemistry was used instead. Higher contents of Kav and TN (K) as well as higher TC (HD) were found in fields of wealthy compared to poor farmers. Highest and lowest areas of peak 2930 cm^{-1} were found on fields of wealthy farmers in D and K, respectively ($p < 0.05$). On the contrary, highest and lowest areas of peak 1620 cm^{-1} and SOC stability index were found on fields of poor farmers in D and K, respectively ($p < 0.05$). We conclude that for the observed soil fertility variability inter-related effects of agro-ecology and farmers' resource endowment were stronger than the individual factors. In this context, the mid-DRIFTS approach allowed a comprehensive insight into the spatially heterogeneous soil fertility across a regional scale.

Keywords: Agro-ecology, midDRIFTS, soil organic carbon

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