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On-farm research on innovative pioneer farms in North-Eastern Austria: microbial indicators affecting soil organic carbon (SOC) sequestration

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Increasing pressures on agriculture related to climate change, as well as recent policy frameworks, have generated widespread attention towards research on soil organic carbon (SOC) sequestration. Promoting SOC accrual is of immediate interest for maintaining and restoring soil health in order to ensure continuous soil fertility and functioning. However, despite extensive research regarding soil health promoting farming practices, studies reflecting realistic management outcomes from farms are still scarce. We therefore conducted an on-farm study comprising 21 sites in North-Eastern Austria to compare two farming systems (an innovative 'pioneer' and a standard system) and undisturbed field margins as a reference. Pioneer soils have been managed according to soil health-oriented principles with e.g., minimal tillage, high-diversity cover crops and organic amendments to improve soil biology for many years, whereas neighbouring fields under 'standard' cultivation represent the current state-of-the-art conventional practices. Based on recent findings suggesting a predominant role of microbial-derived compounds in the long-term accumulation of organic C, the study focused on available nutrients, microbial biomass C, nitrogen (N) and phosphorus (P), ergosterol, potential activities of C-, N- and P-liberating enzymes as proxies for microbial functioning, and amino sugar contents as proxies for microbial necromass. In addition to management effects, we also investigated whether differences in texture composition across the study sites and soil depth (0-5, 5-20, 20-35 cm) affect microbial biomarkers. Our results indicate that microbial parameters, especially microbial biomass and necromass C, are significantly enhanced in soils of pioneer farming systems. Yet, pioneer cultivation did not reach the levels prevailing in the undisturbed reference system. Moreover, differences between systems were strongly pronounced in the topsoil and declined in deeper soil layers. Soil texture had a profound leverage on management effects. In addition, we could identify significant management predictors for dissolved C contents, which is an important pathway for microbial-mediated SOC sequestration. Our on-farm approach provides meaningful information on how farming systems can be changed towards more sustainability and higher C sequestration.