

## **Long-term effects of grass-clover ley on the structure of a silt loam soil in a cold temperate climate**

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Soil pore space structure is mediated by interacting biological and physical processes that can be strongly affected by land use or management change. The objective of this study was to investigate the long-term effects of grass-clover leys on the structure of a silt loam soil in a cold humid climate. The measurements were made in a long-term field trial established in 1956 at Offer in northern Sweden. This experiment includes four treatments with varying proportions of ley (1, 2, 3 or 5 years) in a 6-year forage-based rotation. We used X-ray tomography to quantify topsoil structural pore networks in the first year of arable cropping following the ley break, a few weeks after sowing in spring. Near-saturated infiltration was also measured as a proxy for soil structure in both topsoil and subsoil. Earthworm populations were quantified by both hand-digging and infiltration of mustard solution.

In the topsoil, the treatments with a greater proportion of ley in the rotation had larger organic carbon contents, near-saturated hydraulic conductivity and earthworm biomass as well as smaller bulk densities and larger total porosities. In contrast, no treatment effects were found for the volume, size distribution, connectivity and heterogeneity of the X-ray imaged pore space. Topsoil structure is seasonally dynamic and it seems possible that significant effects of long-term cropping treatments on the architecture of these larger pore networks (image resolution of 65 microns) would have been found later in the season, as a result of the re-establishment of earthworm biopores after tillage. No individuals of deep-burrowing anecic earthworm species were found at the site. Previous work has also showed shallow rooting at this site, with almost all visible roots of spring barley confined to the uppermost 30 cm. Thus, it is perhaps not surprising that no effects of crop treatment on organic carbon content were found in the subsoil. Likewise, there were no apparent treatment effects on macropore infiltration capacity, which was also generally very small (averaging 5 mm/h). We conclude that the long-term cropping treatments did not affect subsoil structure. The reasons for the poorly developed subsoil structure at the site are not yet clear, but may result from a lack of biological and physical structure-forming processes due to the combination of the silty texture and a harsh winter climate.